Gleaner®

A86
Rotary Combine

SERVICE MANUAL
79032990 A Rev.

CONTENTS

Part Number 79032990 A Rev. (English)

Printed in U.S.A.
July 2008

Gleaner®

A86
Rotary Combine

SERVICE MANUAL
79032990 A Rev.

01 - General Information

Contents

Contents

GENERAL INFORMATION

SAFETY ALERT SYMBOL

FIG. 1: The safety alert symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!

Look for the safety alert symbol both in this manual and on safety signs on the machine. The safety alert symbol will direct you to information that includes your safety and the safety of others.

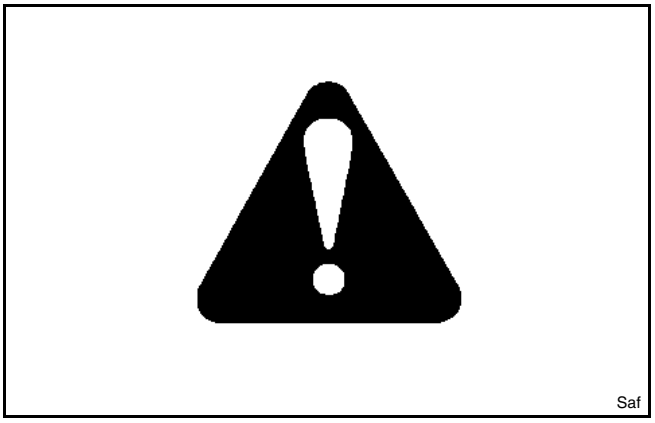


FIG. 1

SAFETY MESSAGES

FIG. 2: The words DANGER, WARNING, or CAUTION are used with the safety alert symbol. Learn to recognize these safety alerts and follow the recommended precautions and safety practices.

DANGER: Indicates an imminently hazardous situation that, if not avoided, will result in DEATH OR VERY SERIOUS INJURY.

WARNING: Indicates a potentially hazardous situation that, if not avoided, can result in DEATH OR SERIOUS INJURY.

CAUTION: Indicates a potentially hazardous situation that, if not avoided, can result in MINOR INJURY.

FIG. 2

INFORMATIONAL MESSAGES

The words IMPORTANT and NOTE are not connected to personal safety, but are used to give additional information and tips for operating or servicing this equipment.

IMPORTANT: Identifies special instructions or procedures which, if not strictly observed, can result in damage to or destruction of the machine, process, or the surroundings.

NOTE: Identifies points of particular interest for more efficient and convenient repair or operation.

A WORD TO THE OPERATOR

FIG. 3: Read and understand the Operator's manual and the Operator's manual for all attachments before operating the combine.

Learn how to operate the combine and how to use the controls properly.

Do not let anyone operate the combine without instruction and training.

For your personal safety and the personal safety of others, follow all safety precautions and instructions found in the manuals and on decals fastened to the combine and the combine attachments.

Personal injury or death can result if these precautions are not followed.

WARNING: An operator must not use alcohol or drugs which can affect operator alertness or coordination. An operator taking prescription or over the counter drugs needs medical advice on whether or not the operator can properly operate machines.

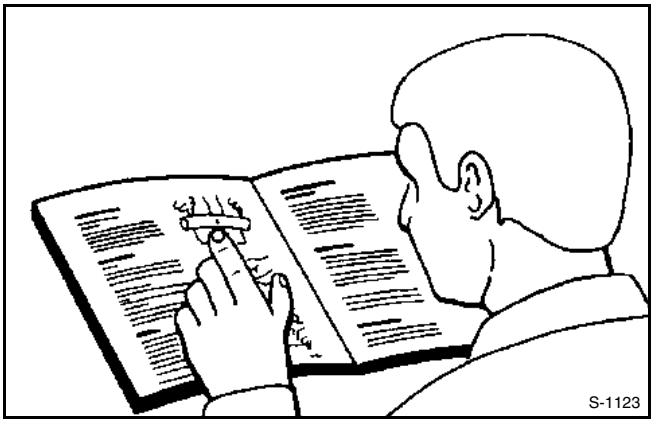


FIG. 3

FIRE PREVENTION AND FIRST AID

FIG. 4: If equipped, a fire extinguisher (1) will be install on the front of the left-hand combine platform.

Be prepared for emergencies. Always carry one or more suitable fire extinguishers - ABC rating, dry chemical, 2.2 KG (5 lb). Check fire extinguishers regularly to make sure the fire extinguishers are properly charged and in operating condition.

Mounting a fire extinguisher near the operator cab and a fire extinguisher near the engine compartment is recommended.

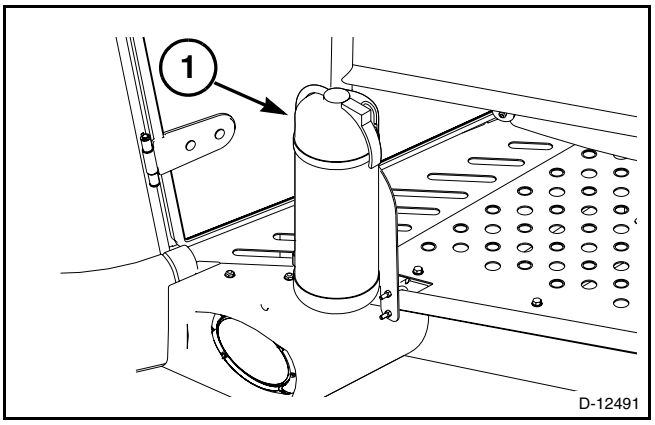


FIG. 4

FIG. 5: To reduce the risk of fire or damage if fire occurs:

- Check for over heated components
- Frequently clean the engine compartment of any chaff and crop debris
- Frequently clean areas of the machine & header where crop can accumulate
- Mount a fire extinguisher within easy reach at the front and rear of the machine

If any flame cutting, welding, or arc welding is to be done on the machine or header, make sure to clear any crop material or debris from around the area. Make sure the area below the work area is clear of any flammable material as falling molten metal or sparks can ignite the material.

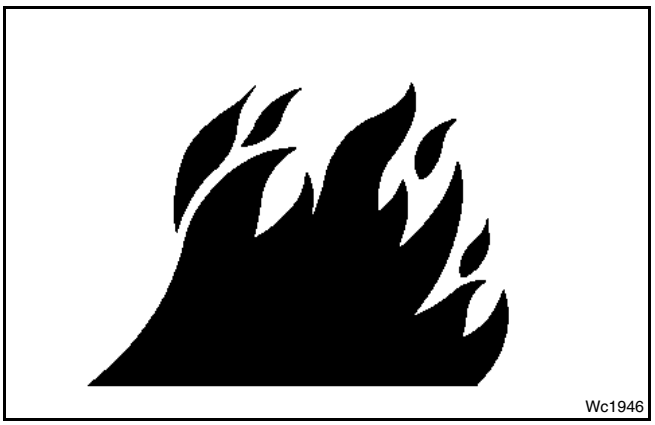


FIG. 5

PREPARE FOR OPERATION

Make sure the combine is in the proper operating condition as shown in the combine operator manual. Make sure the machine has the correct equipment needed by local regulations.

Read and understand all operating instructions and precautions in this manual before operating or servicing the machine. Make sure you know and understand the positions and operations of all controls.

Make sure that all controls are in neutral and the parking brake is engaged before starting the machine. Make sure that all people are well away from your area of work before starting and operating the machine.

All equipment has a limit. Make sure you understand the speed, brakes, steering, stability, and load characteristics of the machine before you start. Check all controls in an area clear of people and obstacles before starting your work.

Be aware of the machine size and have enough space available to permit operation. Never operate the machine at high speeds in crowded locations.

OPERATION

WARNING: In order to provide a better view, photographs and illustrations in this manual can show an assembly with the shield removed. Do not operate the combine unless all shields are in location. Replace the shields immediately after completion of inspection, repairs, cleaning or adjustments and before operation begins.

FIG. 6: Wear close fitting clothing and personal protection equipment for operating or doing lubrication and maintenance on the combine. Tie up long hair to prevent hair from becoming entangled in moving parts.

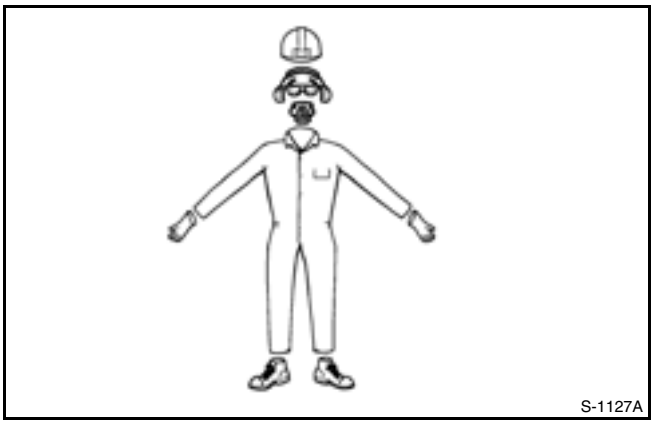


FIG. 6

FIG. 7: Face the ladder and use the handrails when getting on or off the combine.

FIG. 7

FIG. 8: Never operate the engine in a closed building unless the exhaust is vented outside.

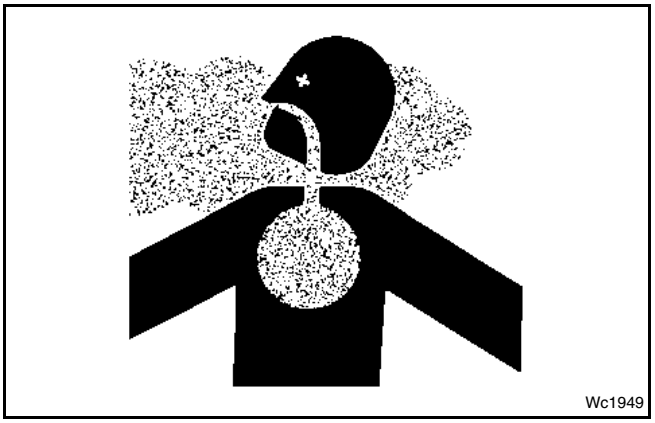


FIG. 8

FIG. 9: Always wear the seat belt when the combine is moving. If another person is riding in the instructor seat, make sure the person wears a seat belt. Seat belts must be worn fitted tightly around the hips and not twisted.

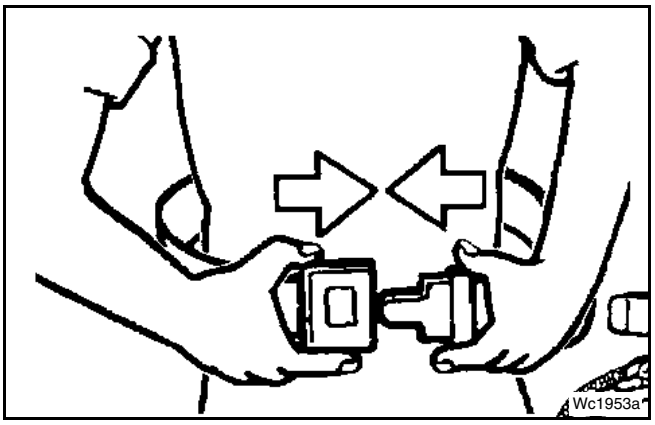


FIG. 9

FIG. 10: Never permit anyone on any part of the combine or attachments except in the operator seat and the instructor seat when the engine is running.

Do not get on or off the combine while the combine is moving.

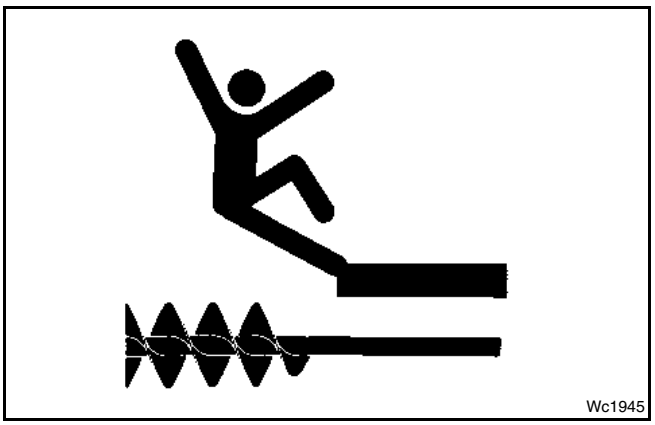


FIG. 10

FIG. 11: Prevent contact with electrical power lines. Always put the grain tank unloader tube in the transport position and lower the radio aerial before moving the combine near electrical wires. Contact with electrical power lines can cause electrical shock, resulting in very serious injury or death.

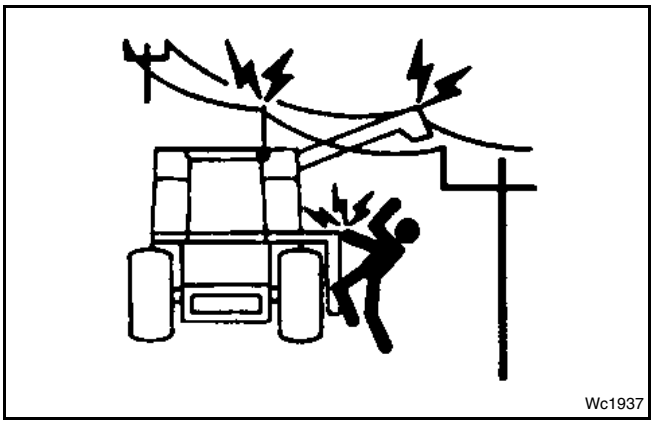


FIG. 11

FIG. 12: Use extra care and reduce speed when operating on hillsides or near ditches or embankments especially with a full grain tank to prevent rollover. Travel speed must be such that complete control and machine stability is kept at all times. Shift to a lower gear before going down a steep hill.

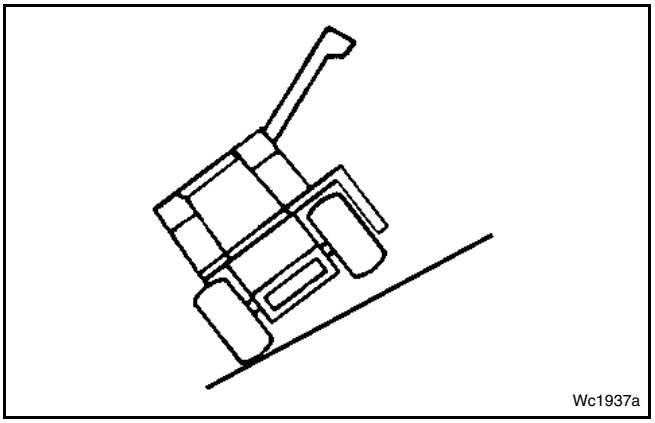


FIG. 12

FIG. 13: Always turn off the engine, shift the transmission to neutral, set the parking brake and remove the start key before leaving the operator cab or before permitting inspection, cleaning, lubrication, adjustment or repair of any part of the combine or attachments unless specifically shown in this manual. Never leave the combine while the engine is operating.

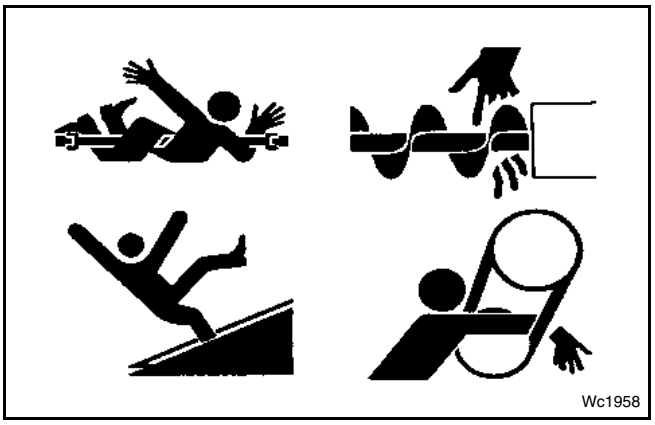


FIG. 13

FIG. 14: Never work under the header or feeder house, unless the stop is properly engaged on the header lift cylinder, the engine is stopped, the parking brake is set, and the start key is removed from the start switch.

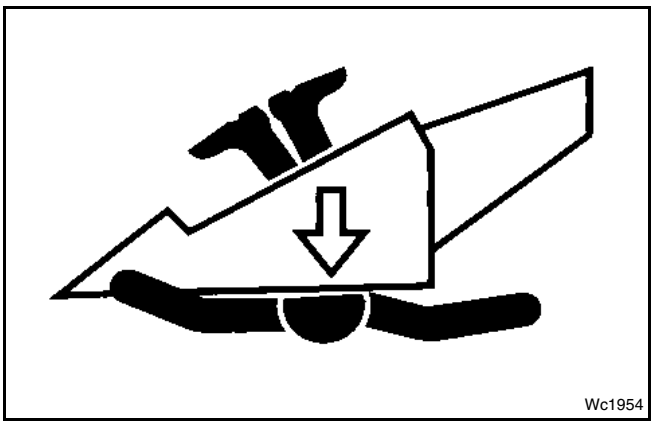


FIG. 14

FIG. 15: Always stop the combine engine before fueling. Do not smoke while fueling.

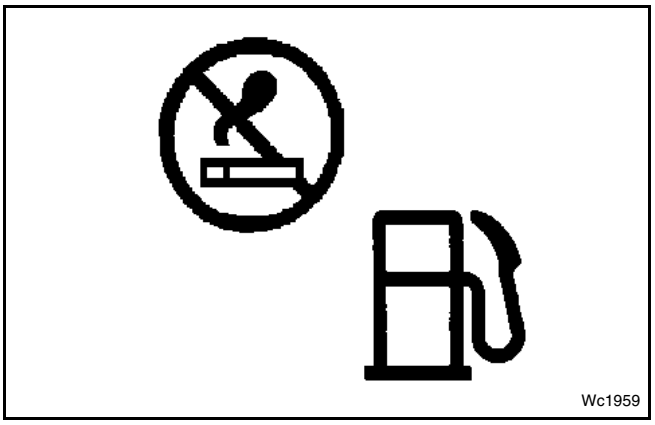


FIG. 15

TRANSPORTING COMBINE ON PUBLIC ROADS

FIG. 16: Consult your local law enforcement agency for local regulations about the movement of farm equipment on public roads.

- Use head lights, flashing warning lights, tail lights, and turn signals day and night unless not permitted by local law. Make sure the lights, reflectors, and SMV emblem (if required) are installed, in good condition, and wiped clean.
- Check to make sure all combine road lights (especially the amber flashers and red tail lights) are working.
- Lock the brake pedals together with the locking strap so that both front wheel brakes will be applied at the same time.
- Empty the grain bin.
- Position the unloading auger tube in the folded (transport) position.
- Remove the header if possible. If the header is to remain on the combine during transport, position header so the operator can see as good as possible. Make sure the header has enough ground and road clearance.

IMPORTANT: Do not carry the header at a height more than approximately 610 mm (24 in) off of the ground or road surface.

- Open the hydraulic accumulator shut off valve before transporting the combine. This will reduce header movement and combine loping when moving on rough roads.

CAUTION: Maintain proper tire pressure at all times to make sure of stability during road travel.

- Measure the overall width and height of the combine. These measurements are important when transporting along narrow roads and where under passes can be found.

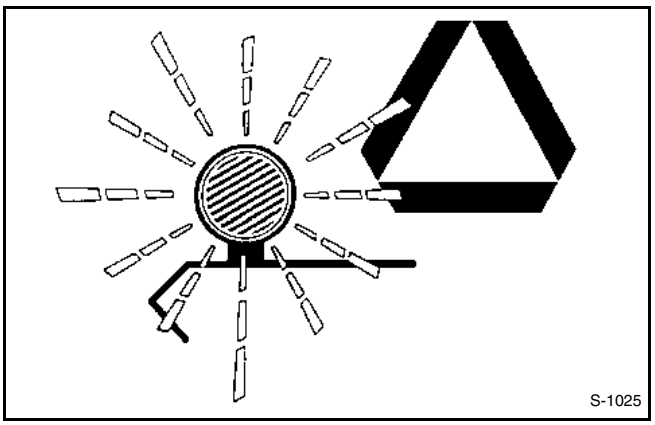


FIG. 16

- Be aware of the other vehicles on the road. Keep well over to your side of the road, and pull over when possible, to let faster vehicles pass.
- Adjust travel speed to keep control at all times. Never permit the combine to coast down hills.
- Reduce the speed of the combine by slowly pulling the hydrostatic control lever to neutral, before applying the brakes. Do not apply the brakes quickly, especially if the combine is equipped with a large header, since weight movement (during rapid braking) can cause the rear wheels to come off the ground and result in loss of steering control.
- When taking the combine to a complete stop, slowly move the hydrostatic control lever to the neutral position, then push the hydrostatic high pressure release valve pedal and apply the brakes (if necessary).
- Make all turns slowly. The combine is steered by the rear wheels and can loose control if turned quickly at transport speeds. This condition will be seen more when a large header is installed on the combine.
- Remember steering to the right moves the rear of the combine to the left and vice versa.
- If the engine is not running, the steering will become manual and be very difficult to handle. Difficult steering also can result in loss of control.
- Drive component damage can result from towing.

CAUTION: Do not tow the combine on a public road.

MAINTENANCE

FIG. 17: Escaping fluid under high pressure can be almost invisible but penetrate the skin causing serious injury.

Consult a doctor immediately if you receive an injury by escaping fluids. Fluid injected into the skin must be surgically removed within a small number of hours or gangrene can result.

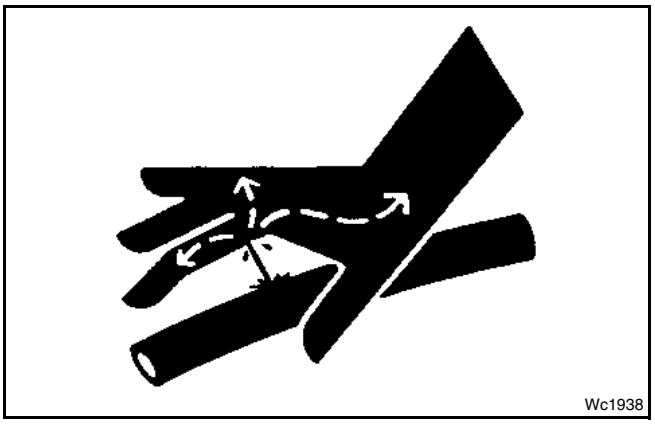


FIG. 17

FIG. 18: Use a piece of cardboard or wood to look for possible leaks, never use your hands.

Relieve pressure from the hydraulic and fuel injection systems by lowering raised equipment, turning off accumulator valve and turning off the engine before loosening any part of the systems. Tighten all connections before applying pressure.

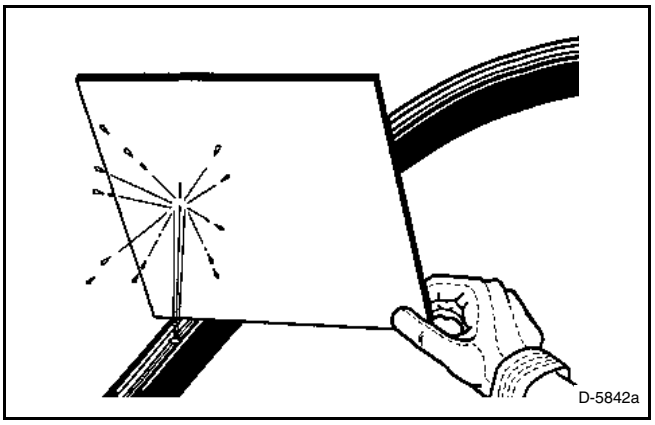


FIG. 18

FIG. 19: Be aware that the surfaces in and around the engine compartment will be hot if the engine has been running, even for a short time.

Always permit parts that contain hot fluid to cool before handling or disconnecting.

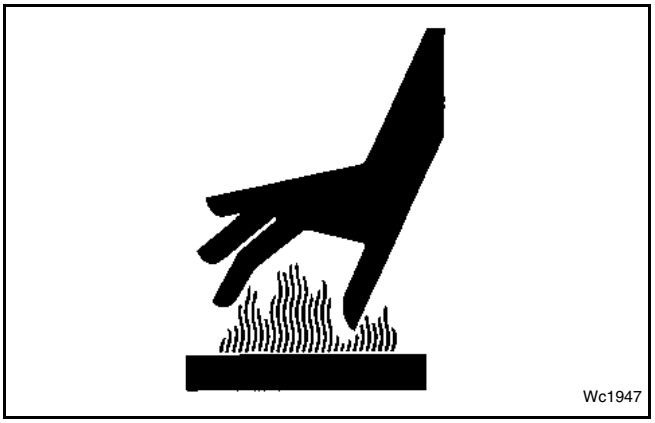


FIG. 19

FIG. 20: Do not remove the radiator cap if the engine is hot. Only remove the cap when the cap is cool enough to touch with bare hands. Loosen cap slowly to the first notch to relieve pressure, then remove the cap.

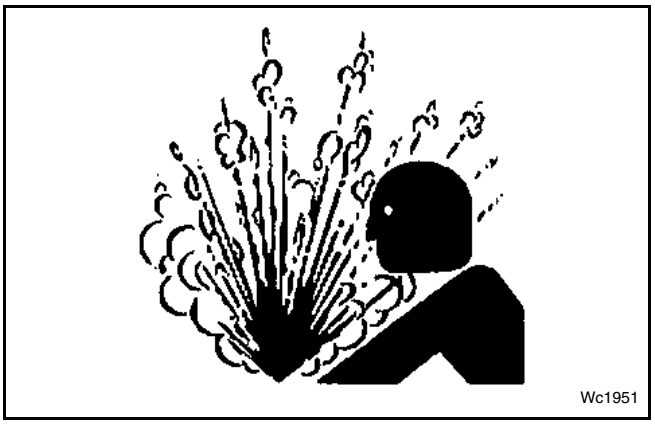


FIG. 20

FIG. 21: Remove spilled oil, antifreeze, or fuel immediately from the operator ladder and platform and other access areas.

Keep all access areas clean and free of obstructions.

FIG. 21

ENGINE SAFETY

FIG. 22: Make sure that all shields, guards, and access doors are in location and properly closed before starting the engine.

Start the engine from the operator seat only. Be sure that the transmission is in neutral and the header, separator, and unloader clutches are disengaged.

Be sure that all bystanders are clear of the combine before starting the engine.

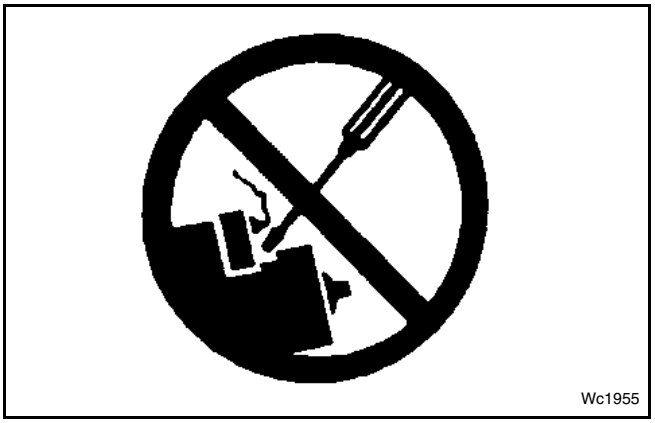


FIG. 22

FIG. 23: Engine is equipped with an electric starting aid. Do not use aerosol starting fluid! Use of this fluid can cause an explosion that can result in severe injury or death.

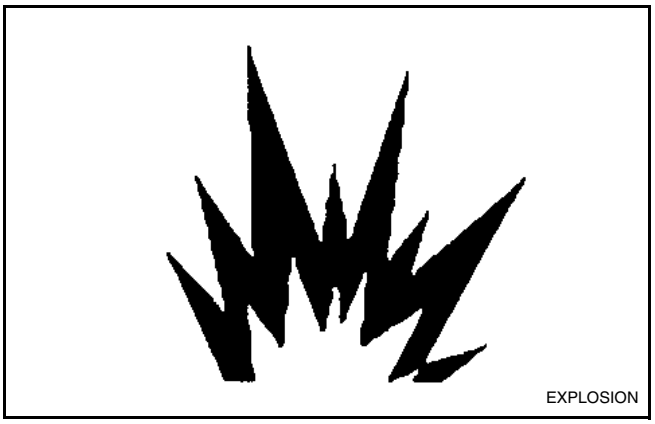


FIG. 23

TIRE SAFETY

FIG. 24: Tire explosion and serious injury can result from over inflation. Do not exceed the tire inflation pressures. See the Operator's manual for the correct tire pressure.

Replace worn or damaged tires. When tire service is needed, have a qualified tire mechanic service the tire. See the Operator's manual for the correct tire size.

Do not weld on the rim when a tire is installed. Welding will cause an explosive air/gas mixture that will ignite with high temperatures. This can happen to tires that are inflated or deflated. Removing the air or breaking the bead is not enough.

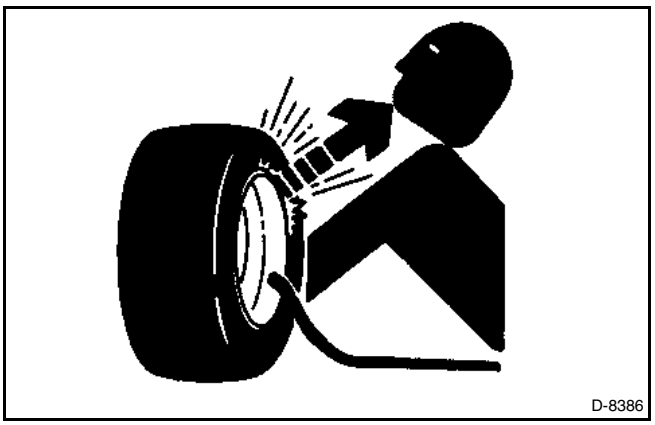


FIG. 24

BATTERY SAFETY

FIG. 25: Electrical storage batteries give off highly flammable hydrogen gas. Keep lighted smoking material and open flame or electrical sparks away from the battery. Do not lay tools or other conductive materials on the battery.

Be careful when connecting the booster cables to the combine batteries. Electrical component damage or battery explosion can result if the booster cables are not installed correctly.

Do not charge a frozen battery as the battery can explode. Warm the battery to 16°C (60°F).

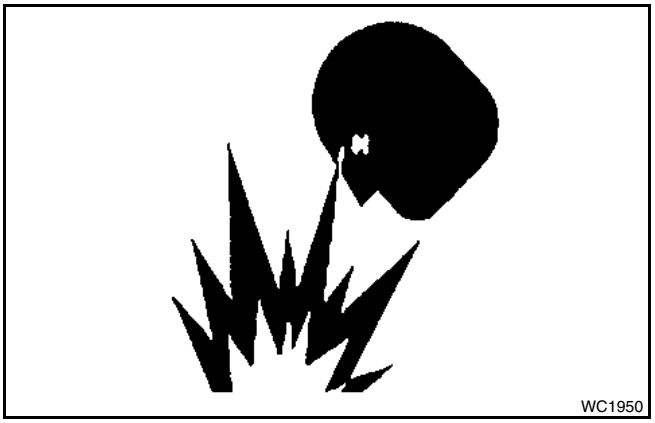


FIG. 25

FIG. 26: Fluid in the electrical storage batteries contains sulfuric acid. Avoid all contact of fluid with eyes, skin, or clothing. If contact does occur, flush off immediately with large amounts of water.

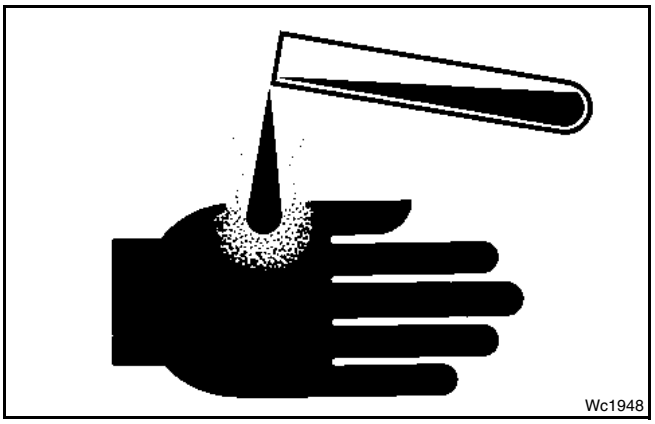


FIG. 26

ACCUMULATOR SAFETY

FIG. 27: The accumulator (1) is charged with dry nitrogen gas. Use only dry nitrogen when charging the accumulator. Do not use air or oxygen or an explosion will occur.

Nitrogen gas when released can cause localized freezing. Be sure to wear protective gloves and glasses when handling nitrogen.

Do not drop the accumulator. A charged accumulator contains nitrogen under pressure. If the shut off valve breaks away from the accumulator, the escaping nitrogen will propel the accumulator at a high rate of speed.

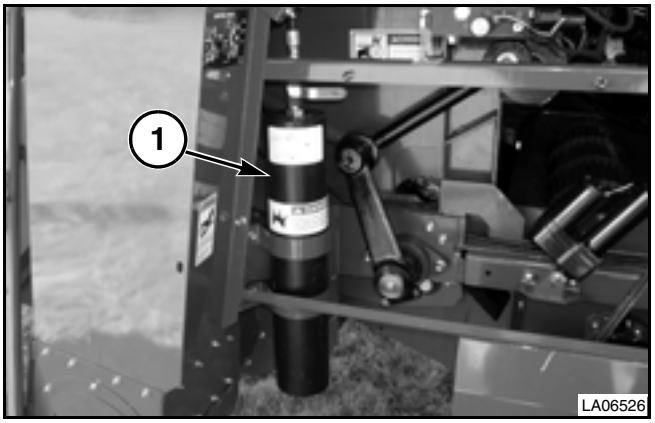


FIG. 27

HEADER LIFT CYLINDER STOP

FIG. 28: A header lift cylinder stop is supplied on the left-hand header lift hydraulic cylinder.

Header lift cylinder stop (1) in the disengaged position.

FIG. 28

FIG. 29: Header lift cylinder stop (1) in the engaged position.

Properly engage the header lift cylinder stop as shown before going under the header or feeder house for any reason.

To engage the header lift cylinder stop:

1. Raise the feeder house until the cylinder rod is fully extended to permit engagement of the header lift cylinder stop.
2. Release the hook and lower the header lift cylinder stop onto the cylinder rod.
3. Lower the feeder house until the header lift cylinder stop contacts the end of the cylinder.

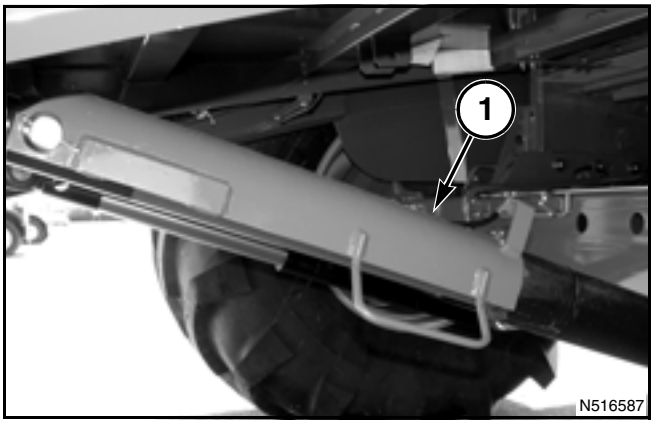


FIG. 29

WHEEL CHOCKS

FIG. 30: Wheel chocks (1), if equipped, are included with the combine and are stored on the left-hand side of the combine.

Use wheel chocks in front of and behind the left-hand drive tire any time the combine is parked. Return the wheel chocks to the mounting brackets after use.

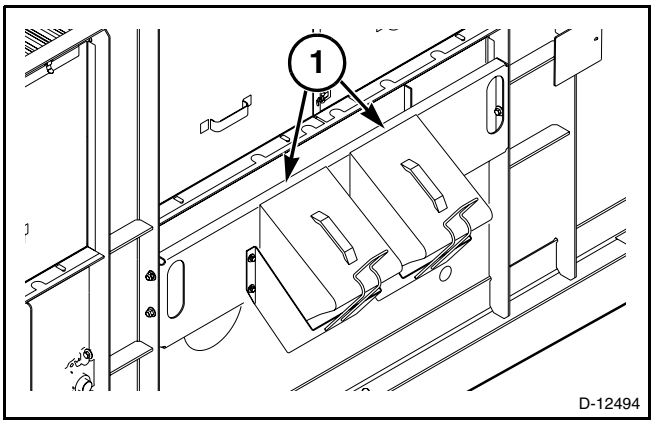


FIG. 30

SHIELDS AND LATCHES

FIG. 31: To operate the shield latches, twist the latch handle (1) clockwise using the header wrench and pull out on the shield.

The left-hand shield latch is located in the middle of the lower section of the left-hand shield.

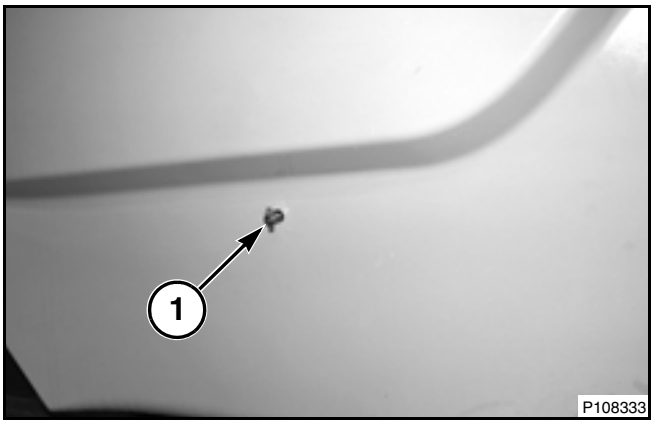


FIG. 31

FIG. 32: The right-hand side of the combine has three shields.

The front right-hand shield latch (1) is located in the middle of the lower section of the right-hand shield (2).

The middle right-hand shield latch (3) is located in the front section of the right-hand, middle shield (4).

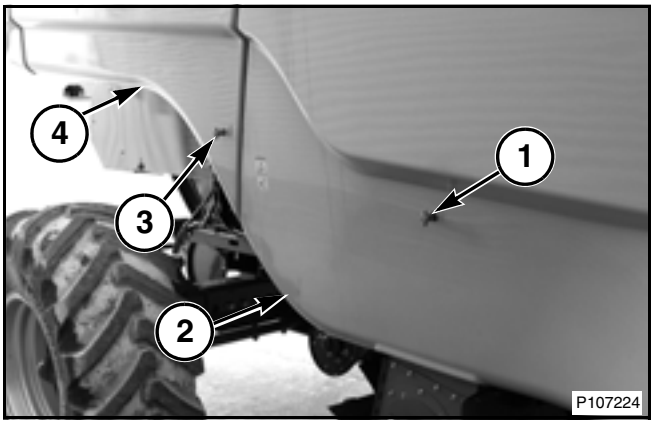


FIG. 32

FIG. 33: The engine platform ladder shield latch (1) is located in the rear section of the shield (2).

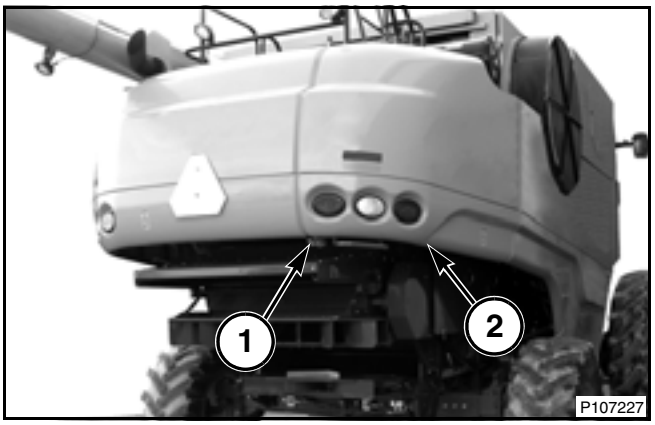


FIG. 33

FIG. 34: To access the drives on the right-hand and left-hand side of the feeder house, use the proper tool to turn the latch counter clockwise.

To close the access doors, close the access door until the door latches.

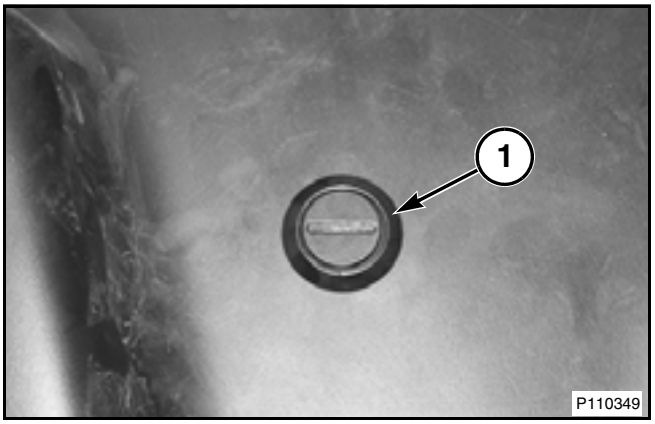


FIG. 34

HOW A COMBINE WORKS

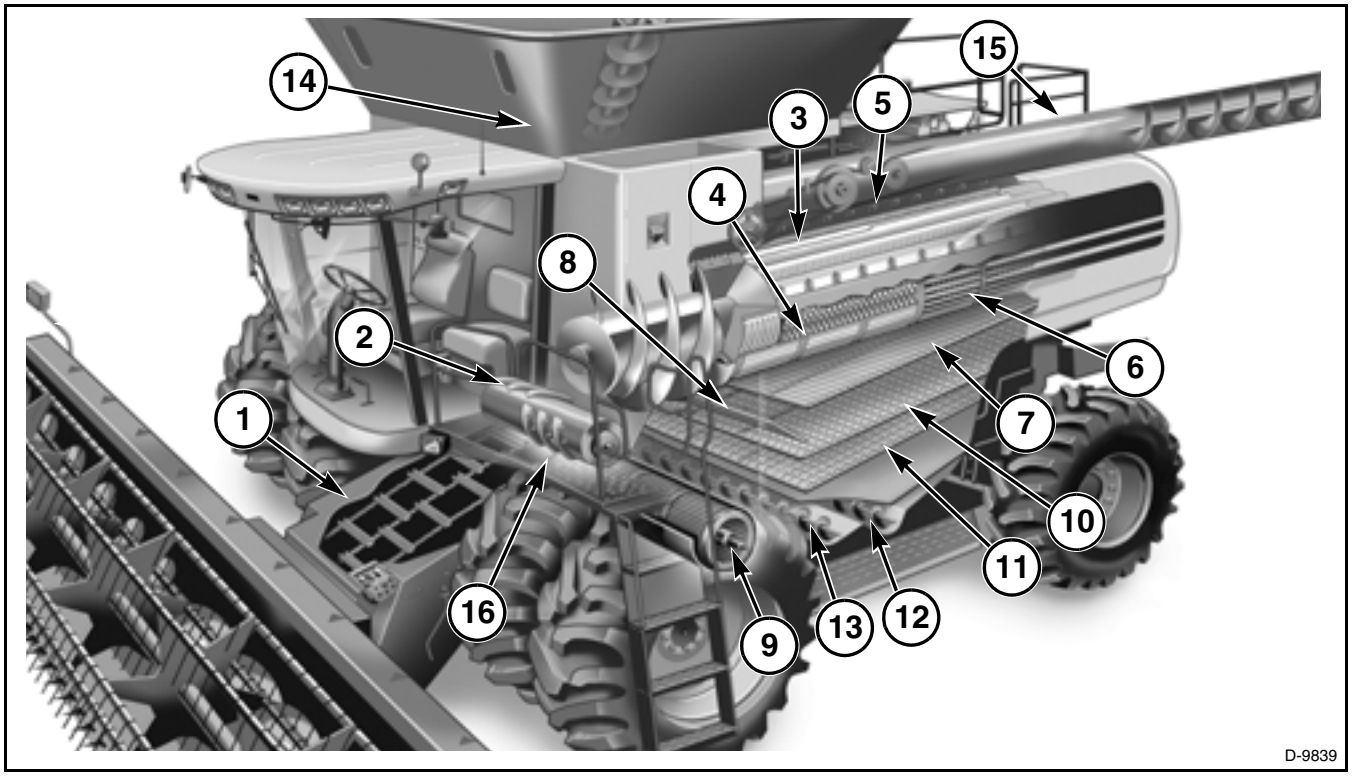


FIG. 35

FIG. 35: Four functions are done in the overall harvesting operation of a combine. These are:

- Cutting and Feeding
- Threshing
- Separating
- Cleaning

Cutting and Feeding

The crop is gathered by a header which is supported by the feeder housing.

The grain header uses a reel to direct the crop into the header auger after the crop is cut by the knife and the header auger moves the crop into the feeder (1).

When a pickup header is used, the crop, already cut and laying in a swath, is lifted by a pickup and fed to the header auger where the retractable fingers move the crop into the feeder.

The feeder elevator transports the crop to the front of the accelerator beater (2) which moves the crop to the rotor inlet area and the rotor (3). The feed beater also guides rocks and other foreign objects into the stone trap (16) located forward and below the beater.

Threshing and Separating

The rotor does four functions as the crop moves in rotary motion from front to rear:

- Intake
- Threshing
- Separating
- Discharge

The auger flighting in the intake area starts the crop on a spiral route around the rotor and moves the crop to the threshing area.

Threshing and first separation are done in the threshing zone as a result of relationship between the rotating cylinder bars and the stationary open grate concave (4). Contact with the helical guide vanes (5) causes the material to move rearward and in a circular route, letting the material pass over the concave several times.

Remaining separation occurs in the separating section. Centrifugal force carries the grain and chaff through the grate (6) while the straw moves rearward in the rotor cage. Again, the spiral motion of the crop lets the crop pass over the separating grates several times.

Cylinder bars on the rotating rotor hold the crop against the grates until the crop reaches the end. Paddles then bat the material into a discharge chute where the crop is moved to a straw spreader, chopper, or discharged directly to the ground.

Grain, chaff, and unthreshed heads which go through the separator grates are carried to the cleaning shoe by the separator return pan (7).

Cleaning

The material is moved from the front of the separator return pan onto a short cascade pan (8) which in turn moves the mixture across a fingered comb and onto the front of the chaffer sieve.

The cleaning fan (9) supplies air to keep the chaff in suspension during the cleaning process in the shoe.

The air blast passing through the reciprocating adjustable chaffer (10) separates and blows the chaff out of the combine. The grain and tailings drop through to the cleaning sieve.

The adjustable cleaning sieve (11) does the final cleaning. The clean grain falls through the sieve into the clean grain auger trough. The tailings, chaff and other material continue to the end of the sieve and into the return auger trough (12) for processing again.

The grain elevator paddle chain moves the clean grain from the clean grain auger (13) to the grain tank filling auger and into the grain tank (14). The return elevator carries the tailings back to the rotor intake for threshing and processing.

The grain in the grain tank is unloaded into a truck or trailer through the unloading auger (15).

COMBINE SERIAL NUMBERS

The combine is identified by serial numbers which are important if you require service or repair parts.

NOTE: References to left-hand and right-hand used all through this manual are referring to position when seated in operator seat and facing forward

Machine Serial Number

FIG. 36: The machine serial number plate (1) is located on the combine left-hand side frame at the rear corner.

FIG. 36

Engine Serial Number

FIG. 37: The engine serial number is on the engine data plate (1) located on the cylinder head.

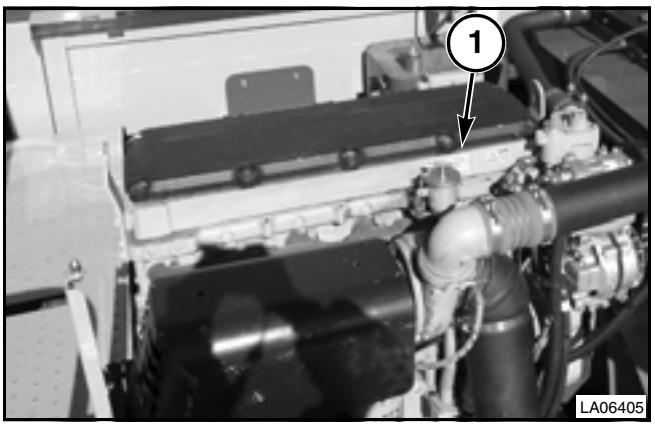


FIG. 37

Transmission Serial Number

FIG. 38: The transmission serial number is stamped on the serial number plate that is fastened to the left-hand side of the transmission housing at location (1).

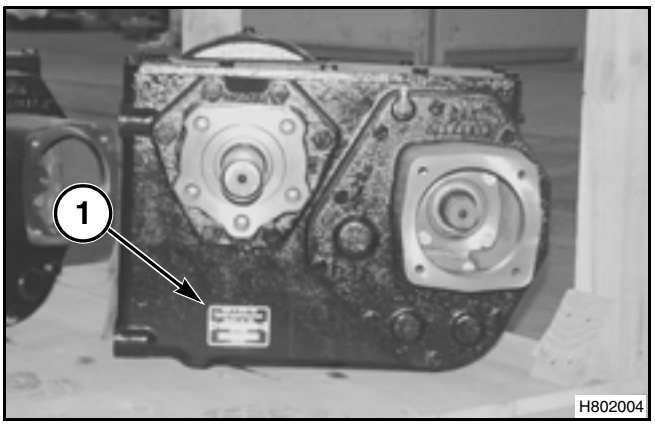


FIG. 38

Final Drive Serial Number

FIG. 39: The final drive serial number is stamped on the plate that is on the inner half of the final drive housing at location (1).

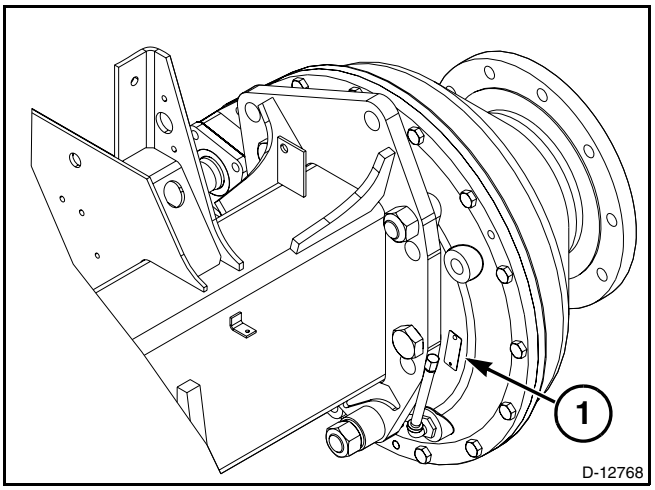


FIG. 39

LUBRICATION AND MAINTENANCE

For efficient and low cost operation of any machine proper lubrication and maintenance is needed. Follow the instructions in the Operators manual (and on the lubrication decals and charts located on the right-hand and left-hand side frames of the machine) to make sure the combine is lubricated at regular service intervals.

CAUTION: Always raise the header and engage the header lift cylinder stop, lower the reel, turn off the engine, and remove the ignition key before doing any lubrication or maintenance functions on the combine.

NOTE: Refer to the combine Operators manual for lubrication and maintenance instructions for the correct year model combine.

DIESEL FUELS

Important Storage and Handling Precautions

Read the following information completely. Following these procedures will help with low cost and problem free operation of the diesel engine used in the combine.

Always use clean fuel and clean fuel handling equipment.

Select a fuel supplier of good reputation, and buy only clean diesel fuel that meets the required specifications.

Store fuel in tanks equipped with a water drain. Drain the water trap regularly to remove condensation and dirt particles.

Do not store diesel fuel in galvanized tanks.

If necessary to store fuel in drums, make sure the drums are free of water, gasoline, or sediment.

Keep drums under cover away from direct sun light and rain. Keep plugs in location and tight.

Do not move the tank or drum, if possible.

Do not use the last several gallons of fuel from the storage tank since the fuel can contain water and sediment.

Fill the combine fuel tank at the end of each day of operation to prevent condensation.

Replace the fuel filters at the correct intervals. Dirty fuel filters will reduce power. Make sure to carefully clean the outside of the filters before removing the filters. Use only original equipment filters.

The fuel injection system can be damaged by water, sediment, or bad fuel. Problem free operation and service life of the fuel injection system and components will vary a large amount on the maintenance given to the fuel system.

Fueling the Combine

Fuel is highly flammable and caution must be taken when fueling the combine.

Always stop the engine when fueling the combine.

Do not smoke or have an open flame near the fuel.

Clean any surfaces where fuel was spilled to prevent chaff deposit and possible fire hazards.

Do not use containers and funnels to move fuel, as the containers are difficult to keep clean.

Fuel Specifications

Diesel fuel does two major functions in a Diesel Engine.

- Diesel fuel supplies all the energy for the engine.
- Diesel fuel cools and lubricates the precision parts of the fuel injection pump and injectors.

Use grade Number 2 diesel fuel as shown in ASTM D 975, when temperatures are above the freezing point. The use of other fuels will result in reduced engine performance and higher fuel consumption. Number 1 diesel can be used when temperatures are below 0 degrees C (32 degrees F).

Do not use fuels that contain more than 0.5% (by weight) sulfur. High sulfur content can result in excessive corrosion in the injection equipment and combustion system.

The cetane number of a diesel fuel is a rating similar to the octane numbers used to rate the combustion in gasoline. Never use a fuel with a cetane number below 40. When operating at higher elevations, use a higher cetane fuel.

Diesel engines will run on different types of diesel fuel. Some fuels will provide better performance, higher efficiency, be more problem free, and lower maintenance costs than other fuels. Fuel must be selected on overall operating costs, and not on the price per gallon of the fuel.

Fuel Conditioners

Good quality fuels contain enough additives to clean and protect your combine engine. Fuel conditioners, when used according to directions, can help fuels when stored for extended periods of time. Conditioners also help to remove moisture, varnish, and deposits from the fuel system. When added to the fuel in extremely cold weather, fuel conditioners will help prevent fuel from gelling and separation of wax particles. Gelling and separation of diesel fuel can result in filter plugging, poor performance, and difficult starting.

TIRES AND WHEELS

Tire Pressure

Tire pressures for both the front and rear tires must be checked every 50 hours of operation or weekly. See the Operators manual for the correct tire pressures.

NOTE: The combine is sent from the factory with the tires over inflated. Pressures must be checked and adjusted before operating the combine in the field.

NOTE: Combines can be sent with special 16.9 x 34 shipping tires and wheels for clearance requirements. Do not install the header, or move the base combine on these shipping tires more than necessary to unload the combine from the truck.

After the combine is unloaded, replace the shipping tires and wheels with the operating tires and wheels ordered with the combine.

Removing Wheel from Combine and Removing Tire.

- Park the combine on level ground with the brakes locked and the combine blocked securely during wheel removal.
- When removing a drive wheel, secure the wheel with a tire dolly or hoist before removing the wheel retaining nuts or capscrews.
- Do not unseat the beads of an inflated tire. Deflate the tire completely before servicing.
- Do not inflate a tire that has been run flat or very under inflated without removing and checking for tire and rim damage.
- Do not remove or install the tire on the rim without the proper tools. Do not hit the tire or rim with a hammer.

Tire Mounting

Precaution	Reason for Precaution
Never mount a damaged tire.	The tire structure can be weak to the point at which the tire will not hold up to the stresses of inflation and operation. The tire will fail with explosive force.
Always inspect the well, bead seat areas, flanges, and rim to make sure the surfaces are clean and smooth. Remove any rust, corrosion, or old rubber with a chisel or wire brush.	Failure to provide clean, smooth rim surfaces can cause the bead to catch on the well of rim and break with explosive force when inflated.
Apply lubricant (thin vegetable oil, soap solution, or approved tire mounting rubber lubricant) to the inside and outside surfaces of both beads. Apply lubricant to flanges and bead seat areas of the rim.	Failure to provide proper lubricant can cause the bead to catch on the edge of the bead seat and break with explosive force when inflated. Lubrication is required for proper position of the tube for the tube to extend properly.
Check to make sure the tire is centered on the rim before inflating.	Failure to center the tire on the rim can cause the bead to catch on the edge of the bead seat and break with explosive force when inflated.
Always use an extension hose with a clip on chuck and extension gauge when inflating.	Extension equipment permits the operator to stand clear of the assembly during inflation. If the assembly fails for any reason, the operator will be away from the explosive force.
Never use pressure above 241 kPa (35 psi) (283 kPa (41 psi) for 800/65 R32 tires) to seat the tire beads. If the beads have not seated by the time the pressure reaches this pressure, remove the valve core, deflate the assembly, completely replace the valve core, position the tire on the rim, lubricate the tire beads, and the rim bead seats. Inflate the tire.	Use of inflation pressure above 241 kPa (35 psi) (283 kPa (41 psi) for 800/65 R32 tires) to seat the beads can cause the assembly to fail with explosive force. Be sure the rim diameter is exactly the same tire diameter being used.

Wheel Installation

The discs are offset in the wheel rim.

FIG. 40: To set the front wheels out in field position, mount the wheel with larger offset to the outside.

To set the front wheels in for field position, locate with smaller offset to the outside.

CAUTION: When removing the wheels, lift the Combine using a jack able to support the weight of the combine, and block securely using solid blocks or steel supports. DO NOT use concrete blocks to support the combine.

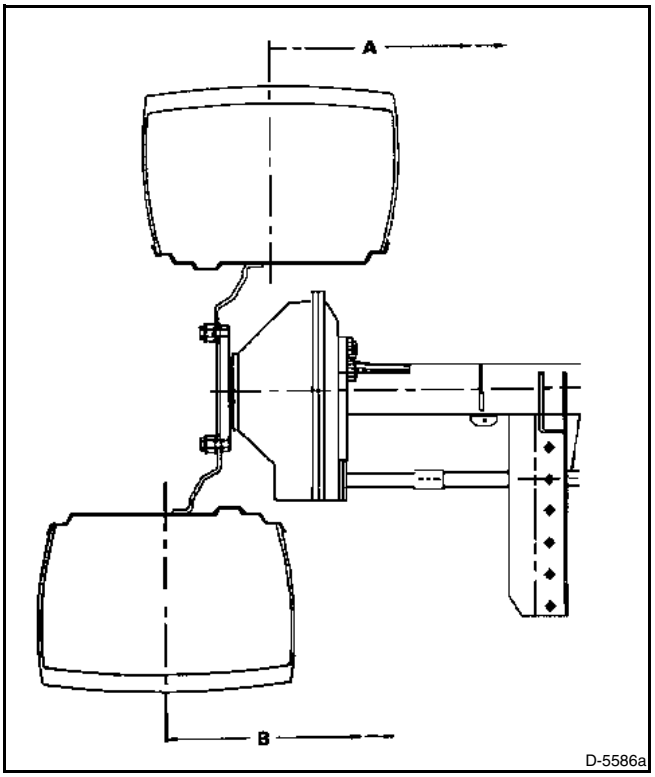


FIG. 40

FIG. 41: The drive wheels can be reversed for a wider wheel tread if necessary. When reversing the wheels make sure that there is enough clearance between the valve stem and the final drive housing to prevent the valve stems from being damaged.

If there is not enough clearance, or operating in conditions where the ground is too soft, remove the two plugs that were sent in the Instruction Group envelope under the instructor seat. Inflate a tire slightly over the normal pressure and remove the valve stem. Quickly insert and tighten the plug (1) instead of the stem. Repeat the procedure on the other wheel.

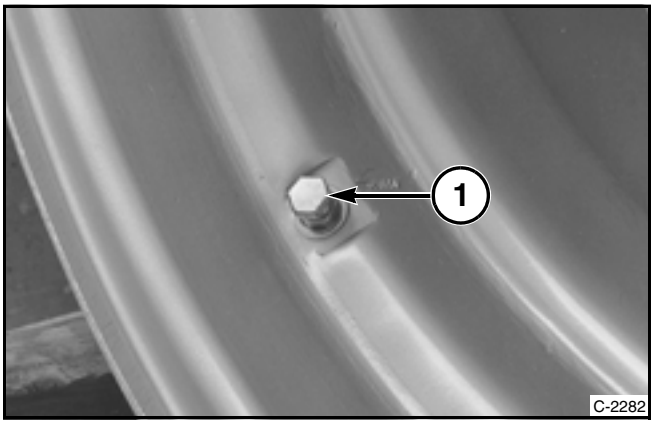


FIG. 41

Wheel Bolt Torque

After operating for one hour, check the torque on all the lug nuts and bolts. Again at ten hours of operation, check to make sure the nuts and bolts have held the correct torque specification. After the first ten hours, check the lug nuts and bolts every 100 hours of operation.

Maintenance of Tires

To reduce the amount of wear, and extend the life of the tires, the tires must be kept at the correct pressures and checked at regular intervals.

When the combine is going to be out of use for an extended period, or is being stored, block both sides of the axles to take weight off the tires.

If oils or solvents are spilled on a tire, clean immediately. Never park or stop the combine with the tires standing in an area of oil.

If possible, park the combine where the tires will be kept from direct sun. This is important if the combine is parked for extended periods, or is being stored.

If mounting tubeless tires, make sure the flange and bead area of the tire and rim are free from dirt, rust, or old rubber. The rim must be smooth and clean. Any areas of rust must be cleaned and painted with a rust preventing type paint.

WARNING: Failure to follow correct procedures when mounting a tire on a wheel or rim can cause the tire to EXPLODE which can result in serious injury or death. DO NOT mount a tire unless you have the proper equipment and experience to complete the job. A qualified tire repair service has the proper equipment.

Never exceed 241 kPa (35 psi) or the maximum inflation pressures specified by tire manufacturers for mounting tires. Inflation beyond this maximum pressure can break the bead, or even the rim, with dangerous explosive force. If both beads are not seated when maximum recommended pressure is reached, deflate, position the tire again, lubricate the bead, and inflate the tire.

DRIVE BELTS

Banded Drive Belt

FIG. 42: A banded drive belt is made of two or more V-belts (of a standard cross section size) banded together at the top with a tie band (1). The V-belts and the tie band are vulcanized together to form a multiple strand banded belt.

The cross section and spacing of the strands are such that the banded belt operates on standard sheaves.

The tie band clears the top of the sheaves so that each belt strand has full wedging capacity in the sheave grooves, just as a single belt. The banded belt operates at the same tension as matched belts on an regular multiple strand V-belt drive.

Most V-belt drives operate without any problem, requiring only regular maintenance. There are times when forces acting on the drive can cause belts to whip, turn over, or come off the sheaves. The banded belt was designed to correct these belt stability problems which are most frequently caused by intermittent or shock loading of the drive.

Banded belts have standard dimensions and cross section sizes and are made to order, with the number of strands being determined by the power needs of the drive. Spacing between the strands of the belt are the same as the standard spacing for multiple groove sheaves.

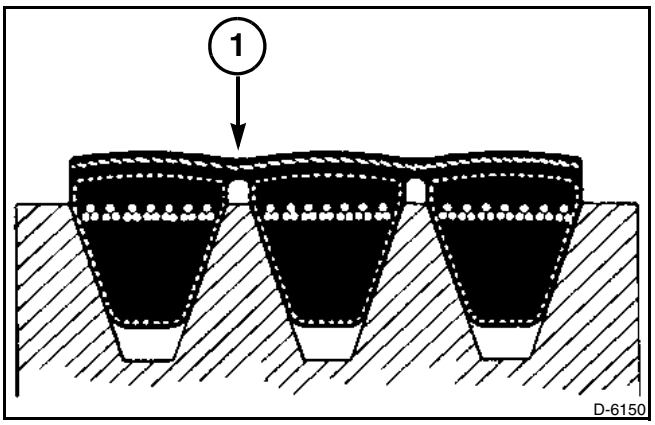


FIG. 42

Maintenance of Belts

FIG. 43: Cross sections of some of the belts used on the combine are shown.

A drive inspection must be done every one to two weeks.

Check belts frequently for excessive wear, tearing, breaking, increasing, and unraveling.

Belt tensions are controlled with spring loaded idlers on most drives on the combine. Over tightening puts too much strain on the belt and too much loading on the shafts and bearings.

Look and listen for any not normal vibration or sound while watching the drive in operation. A drive kept in good condition will operate smoothly with little noise.

Inspect the guards for looseness or damage. Keep all guards free from debris, dust, or grime deposit on either the inside or the outside of the guard. Deposits of material on the guards operate as insulation causing the drives to run hotter.

Belts that are running hot, running in a hot environment, or from slipping will harden and form cracks from the bottom of the belt up.

An internal temperature increase of 10 degrees C (18 degrees F) can cut belt life in half.

Inspect for oil or grease leaking on the drive. This can indicate over lubricated bearings or a fluid leak. If this material gets on the rubber belts, the belts can increase in size and become distorted, causing an early belt failure.

Belts must be replaced if there are signs of cracking, fraying, or not normal wear.

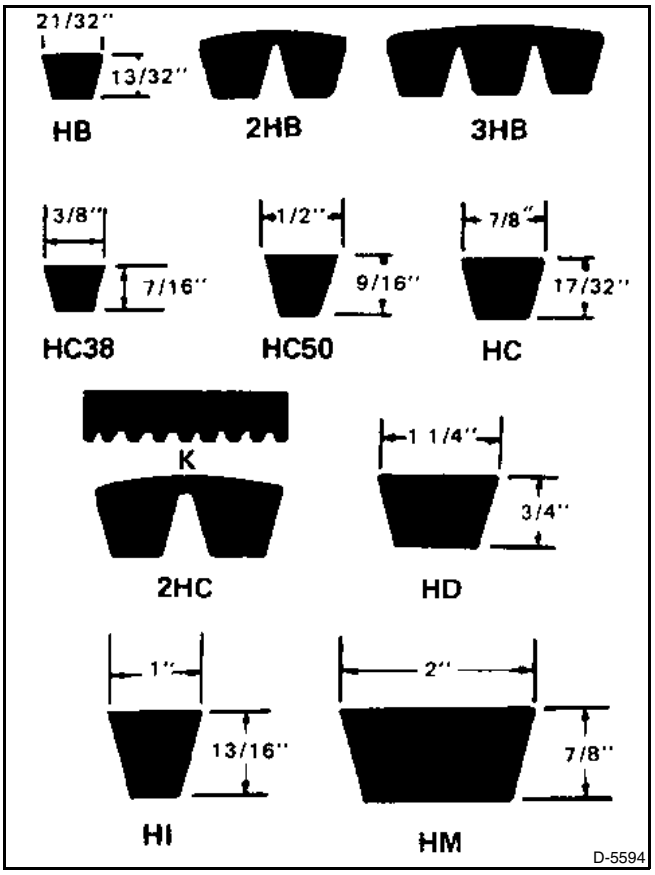


FIG. 43

Belt Changing Guides

Removal

FIG. 44: Before Removing or Installing any drive belts.

Lower the header to the ground.

Remove the starter key.

Engage the parking brake.

Disconnect the battery at battery switch.

Raise or remove the shields or guards and locate the guards away from the drive so that the guards do not cause problems with working on the drive.

Loosen the tensioner until the belt is slack and can be removed without prying. Never pry off a belt, as the sheave can be damaged. Prying off belts also adds risk of injury.

Inspect the old belt for any not normal wear. Excessive or not normal wear can indicate problems with the drive or past maintenance procedures. Refer to the Belt Problem and Wear Guide.

Inspect the sheaves for not normal or excessive wear, damage, distortion, and pitting. If surfaces show pitting or excessive wear, the sheave must be replaced.

Check the sheaves for deposits of dirt and dust in the bottom of the grooves. Clean sheaves with a damp cloth. Do not sand or scrape the grooves to remove debris.

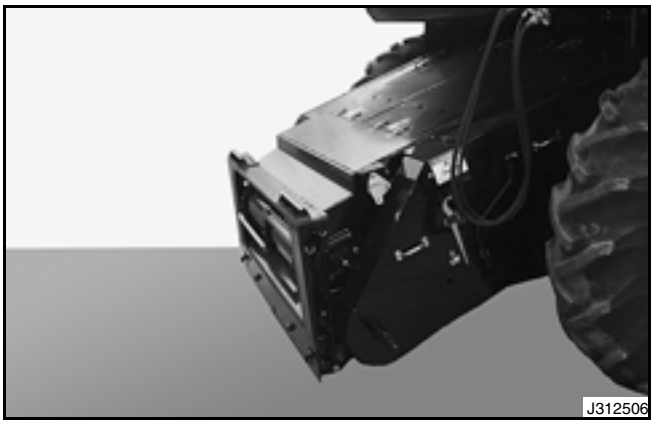


FIG. 44

Installation

Check the sheave alignment. For long belt life the sheaves must be aligned properly.

FIG. 45: Order a new belt by the part number, not by measuring the old belt.

Time must be taken to make sure the selection of the proper size belts for the different sheaves is correct.

(A) Indicates the wrong belt installed.

(B) Indicates the correct belt installed.

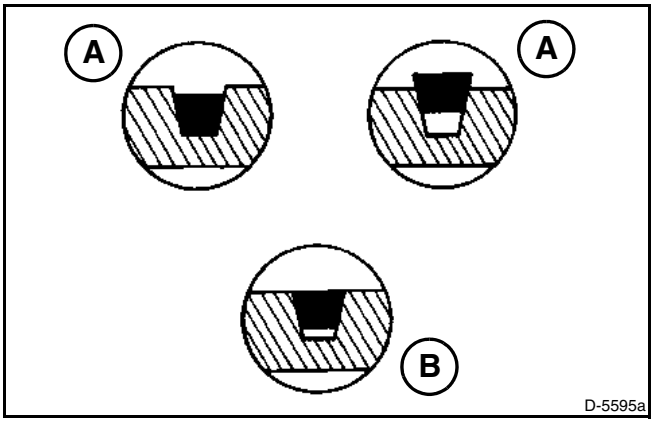


FIG. 45

FIG. 46: Replace all the belts on multiple belt drives. Never replace a single belt or part of a multiple belt drive. If a new belt is used with old belts, the load will not be divided evenly between the belts. Mixing new and old belts can lead to early belt failure and not even sheave wear.

(A) Indicates a new belt position.

(B) Indicates a used belt position.

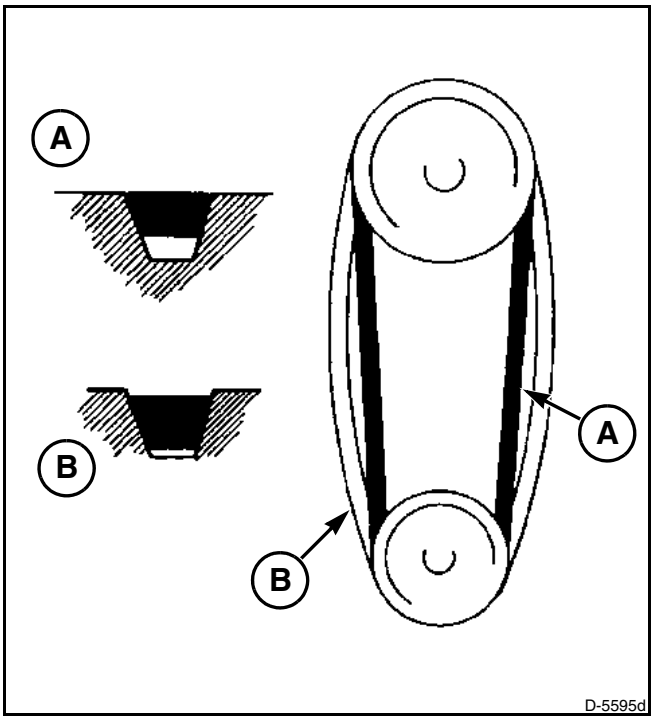


FIG. 46

FIG. 47: When replacing a belt, never force a belt over the rim of a pulley. Do not pry or use force to install the belt (A). This can break the cords in the belt. Loosen all the tensioners before installing the new belt. If the belt still can not be easily installed, run the belt over the rim while rotating the pulley (B).

Tension the belts making sure the belts are at the correct tension. More belts are damaged by not enough tension than by too much tension. But, do not over tension the belt as this damages the belt tensile members and puts an additional load on the shafts and bearings.

Rotate the belt drive three revolutions. Check the belt tension and adjust as necessary.

Check the drive alignment and adjust as necessary.

Install the guards or shields.

Start the drive, looking and listening for any not normal noise or vibration. If possible, stop the drive and check the bearings and sheaves for excessive heat. If the bearings and sheaves are too hot the belt tension can be too high or the bearings are not properly lubricated or failing. Temperature can be checked with an infrared pyrometer.

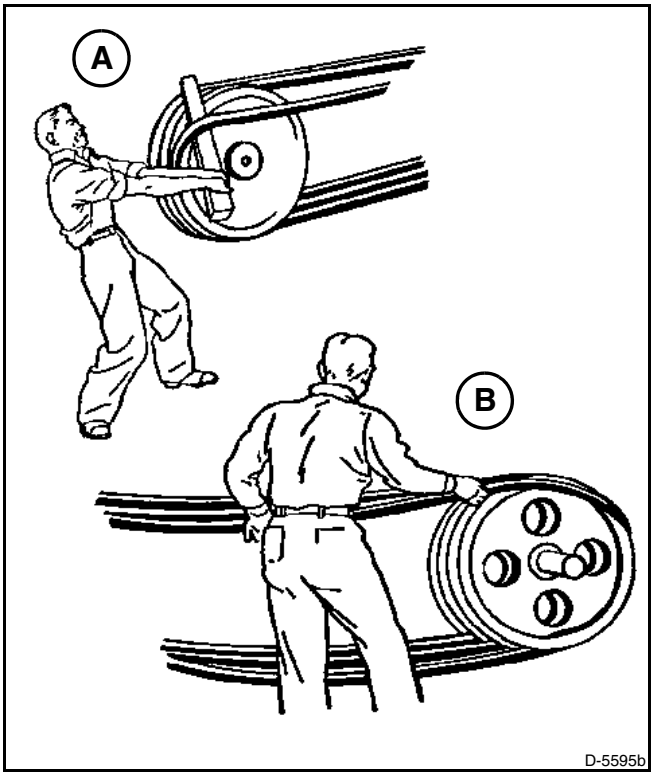


FIG. 47

Belt Sheave Alignment

FIG. 48: Check the sheave and shaft alignment. Running the belts with the sheaves out of alignment will cause severe side wear.

Not aligned belt drives will be noisier than properly aligned drives since interference is at the belts enter point into the sheave.

To check the alignment use a long straight edge (1) made of wood, metal, or any rigid material. Line the straight edge along the outside face of both sheaves. If the drive is properly aligned, the straight edge will contact each sheave evenly. The straight edge must touch the two outer edges of each sheave for a total of four points of contact.

Shafts not in alignment (C) will show up as a gap (2) between the outside face of the sheave and the straight edge.

Check for tilting or shafts not aligned by using a bubble level. For proper alignment, the bubble must be in the same position as measured on each shaft.

Not aligned correctly Parallel (A).

Not aligned correctly Angular (B).

Rotate the drive and look for excessive sheave movement. If excessive sheave movement is seen inspect the sheave and shaft. If no problem can be seen, remove and install the sheave. Not correctly mounted sheaves or out of round sheaves are some times the root of vibration or more severe problems. A dial indicator can be used to measure side to side sheave movement or diameter vibration by holding the dial indicator up to the sheave sidewall or top of the belt inside the pulley groove.

IMPORTANT: Always turn off the machine before using the dial indicator. Rotate the drive by hand to make your measurements.

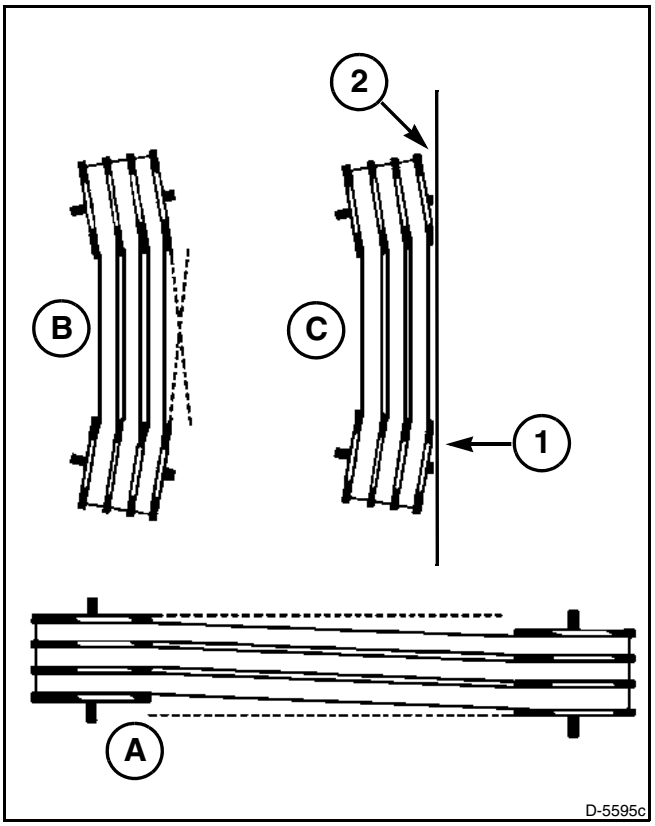


FIG. 48

Belt Run In Procedure

A run in procedure is needed for all belt drives so that the best belt life can be reached.

A run in procedure is made of starting the drive and operating the drive under full load for up to 24 hours. After the belts have run-in, stop the drive and check the belt tension.

Running the belts under full load for an extended period of time will seat the belts into the sheave grooves.

Belt tension will drop after the first run-in and seating procedure. This is normal. Adjust the belt tension as necessary.

Since tension in the belts will drop after the first run-in and seating procedure, failure to check and tension the belt will result in low belt tension and belt slippage. This slippage will result in early belt failure.

Belt Troubleshooting

When troubleshooting a belt drive problem, stand back and watch the drive while the drive is in operation and when drive is not. Is there a warm rubber smell? Is the belt moving around the drive in a normal way? Are there chirping, squealing, or grinding noises? Is there a deposit of dust or debris under the drive which will cause problems with the belts?

When the belt drive makes excessive noise, the belt is frequently blamed. To find the problem spray the belt with soapy water while the drive is running. If the noise goes away, or decreases, the belt is part of the problem. If the noise is still present, the problem can be caused by other drive components.

NOTE: Do not use belt conditioner or dressing on the belts.

Not correctly tightened belt drives can make noise.

Belt Problem and Wear Guide

The following charts show some of the more common types of drive belt failures and possible causes for each failure.

When problem solving a drive belt failure, determine which problem or SYMPTOM / OBSERVATION shows the failure that is occurring. Then find the POSSIBLE CAUSES and take action as shown under the CORRECTIONS / REMEDY column.

TABLE 1 Short Belt Life and Early Belt Failure

Symptom / Observation	Possible Causes	Corrections / Remedy
Rapid belt failure, when no reason can be seen.	Belt tensile member broken or damaged from not correct installation.	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Worn driver or driven sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Driver or driven sheave center distances vary during operation.	Check for failed bearings and loose bearing housing mounting hardware and repair as required. Properly install a new original equipment belt and adjust the belt tension and idler spring.

TABLE 2 Belt Extended Beyond Idler or Sheave Take Up

Symptom / Observation	Possible Causes	Corrections / Remedy
Idler spring can not be adjusted to properly tension the drive belt.	Belt extended and worn.	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt tensile member broken.	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt over loaded.	Reduce the load on the belt. Properly install a new original equipment belt and adjust the belt tension and idler spring.
Belt strands not equal.	Sheaves not aligned (not equal work done by each belt strand).	Align the sheaves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt tensile members broken or damaged from not correct installation.	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Trash or debris fell into the sheave grooves.	Clean trash or debris from the sheave grooves. Correct the cause of trash or debris entering the sheave grooves and make sure all the protective shields are installed. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt strand lengths not matched.	Properly install a new original equipment belt and adjust the belt tension and idler spring.

TABLE 3 Belt Turns Over in Sheaves

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt turns over in the sheaves and runs or can turn over and come off sheaves when no reason can be seen.	Excessive lateral belt movement.	Properly adjust the belt tension.
	Trash or debris fell into the sheave grooves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering the grooves. Make sure all protective shields are installed.
	Sheaves not aligned.	Align the driver, driven, and idler sheaves. Check alignment with the drive loaded and unloaded. Properly adjust the belt tension.
	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt tensile members broken or damaged from not correct installation (belt forced onto sheaves).	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Intermittent or shock loading of the drive belt.	Correct the cause of intermittent and shock loading of the drive belt.
	Belt strand lengths are not equal (multiple strand or power band belts).	Properly install a new original equipment belts and adjust the belt tension and idler spring.

TABLE 4 Drive Belt Makes Noise

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt makes noise.	Belt slippage.	Properly adjust the belt tension.
	Belt or sheaves contaminated with oil, grease, or chemicals.	Repair cause of oil, grease, or chemicals. Clean the belt and sheave grooves with a degreasing solvent that is not flammable or toxic, then wash the belts with a soap and water solution. Properly adjust the belt tension.
Belt makes a slapping sound.	Belt tension too loose.	Properly adjust the belt tension.
	Belt strand lengths are not equal.	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Driver and driven sheaves not aligned.	Align sheaves and check alignment with the sheaves loaded and unloaded. Properly adjust the belt tension.
	Idler sheave not aligned.	Align sheaves and check alignment with the sheaves loaded and unloaded. Properly adjust the belt tension.
Belt makes a rubbing sound.	Belt rubbing on some obstruction.	Remove the obstruction and align the drive to give needed clearance.
Belt makes a not normal or loud noise.	Belt profile does not equal sheave groove profile.	Replace the worn sheaves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Trash or debris fell into the sheave grooves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering the sheave grooves and make sure all the protective shields are installed.
Drive makes a grinding sound.	Damaged or failed shaft bearings.	Replace the damaged or failed bearings as required.

TABLE 5 Not Correct Driven Shaft Speed

Symptom / Observation	Possible Causes	Corrections / Remedy
Rotation burns on the sides of the belt.	Belt tension too loose causing belt slippage.	Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt or sheaves contaminated with oil, grease, and chemicals.	Repair cause of oil, grease, and chemicals. Clean the belt and sheave grooves with a degreasing solvent that is not flammable or toxic. Wash with a mild soap and water solution. Properly adjust the belt tension.

TABLE 6 Hot Shaft or Idler Sheave Bearings

Symptom / Observation	Possible Causes	Corrections / Remedy
Driver and driven shaft support bearings or idler sheave bearings run hot.	Drive belt adjusted too tight or over tightened.	Properly adjust the belt tension.
	Drive belt under tightened and slipping causing heat.	Properly adjust the belt tension.
	Worn sheave grooves (check with groove gauge) causing belts to bottom in the sheave grooves and not send power unless over tightened.	Replace the worn sheaves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Failed bearings or poor bearing maintenance.	Replaced the failed bearings. Follow the bearing maintenance and lubrication schedule recommendations.

TABLE 7 Belt Broken

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt pulled apart.	Belt over loaded.	Reduce the load on belt. Determine the cause of over loading. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Shock loading of the belt from not equal feeding.	Correct the cause of not even feeding and shock loading. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Belt came off the sheaves and became tangled in the machine.	Check the sheave alignment. Check for trash and debris in the sheave grooves. Properly install a new original equipment belt and adjust the belt tension and idler spring.
	Trash and debris has fallen into the sheave grooves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering the sheave grooves and make sure all the protective shields are installed. Follow the bearing maintenance and lubrication schedule recommendations.
	Belt rolled or forced onto the sheaves breaking the belt tensile member.	Properly install a new original equipment belt and adjust the belt tension and idler spring.

TABLE 8 Belt Side Walls / Bottom Burned

Symptom / Observation	Possible Causes	Corrections / Remedy
Sides and bottom of the belt burned.	Belt slippage when machine engages.	Properly install a new belt and adjust the belt tension. Engage the machine properly.
	Belt over loaded.	Reduce the load on the belt. Correct the cause of over loading. Properly install a new belt and adjust the belt tension.
	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install a new belt and adjust the belt tension.
Rotation burns on the side walls of the belt in a separated area.	Belt slippage because of not enough belt tension.	Properly install a new belt and adjust the belt tension.
	Belt over loaded.	Reduce the load on the belt. Correct cause of the over loading. Properly install a new belt and adjust the belt tension.

TABLE 9 Belt Side Walls Flaking, Soft, Sticky, or Swollen

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt cover has flaked off and side walls are soft and sticky. Low adhesion between belt cover plies. Belt cross section is swollen.	Belt or sheaves contaminated with oil, grease, or chemicals.	Repair the cause of oil, grease, or chemicals. Clean the sheave grooves with a degreasing solvent that is not flammable or toxic, then wash the grooves with a mild soap and water solution. Properly install a new belt and adjust the belt tension.
Decreased performance of belt rubber compounds.	Use of belt dressing.	Do not use belt dressing. Clean sheave grooves with a degreasing solvent that is not flammable or toxic, then wash the sheave grooves with a mild soap and water solution. Properly install a new belt and adjust the belt tension.

TABLE 10 Belt Side Walls Dry and Bottom Breaking

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt side walls dry and bottom of belt cracking.	Constant belt slippage causing heat and gradually making the belt under cords hard.	Properly install a new belt and adjust the belt tension.
	Not correct storage of repair or extra belts.	Store belts unwound from pegs in a cool and dry location, away from excessive heat or direct sun light.

TABLE 11 Belt Bottom Cut

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt operates over the edge of the sheaves and cuts the bottom surface.	Sheaves not aligned.	Align the sheaves. Adjust the tension. Check the alignment with the drive loaded and unloaded.
	Trash and debris in the sheave grooves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering sheave grooves and make sure all the protective shields are installed.
	Belt forced over the edge of the sheaves during installation without relieving idler tension.	Back off idler tension when installing the belt.

TABLE 12 Belt Comes Off Drive Sheaves

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt comes off sheaves when no reason can easily be seen.	Sheaves not aligned.	Align the sheaves. Adjust the tension. Check alignment with the drive loaded and unloaded.
	Trash and debris in the sheave grooves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering the sheave grooves and make sure all the protective shields are installed.

TABLE 13 Sheaves Worn or Damaged

Symptom / Observation	Possible Causes	Corrections / Remedy
Sheave grooves worn (check with groove gauge).	Excessive belt tension.	Replace the worn sheaves. Properly install new belt and adjust the tension.
	Contamination of sheave grooves with damaging trash or debris.	Replace the worn sheaves. Correct the cause or source of damaging trash or debris entering the sheave grooves. Make sure all protective shields are installed. Properly install new belt and adjust the tension.
Sheaves damaged or broken.	Belt forced onto the sheaves.	Replace damaged or broken sheaves. Back off tension when installing belt.
	Trash or debris fell into the sheave grooves.	Replace the worn sheaves. Correct the cause of damaging trash or debris entering the sheave grooves. Make sure all protective shields are installed. Properly install the new belt and adjust the tension.
	Not correct method used to install the sheave.	Used correct method to install the sheave.

TABLE 14 Belt Moves and Vibrates

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt moves too much and laterally.	Belt tension too loose.	Properly adjust the belt tension.
	Sheaves not aligned.	Align the sheaves. Adjust the belt tension.
	Belt strands not extended equally.	Properly install a new original equipment belt and adjust the belt tensioner.
Belt vibrates.	Excessive radial or lateral run out of the sheaves.	Replace the sheaves with defects.
	Loose drive components.	Tighten the loose drive components.
	Belt profile does not equal the sheave groove profile.	Properly install a new original equipment belt and adjust the belt tensioner.

TABLE 15 Belt Top Surface Worn

Symptom / Observation	Possible Causes	Corrections / Remedy
Severe wear patterns on the top surface of the belt.	Belt rubbing on belt guides, shields, or other obstruction.	Adjust the belt guides, shields, or remove obstruction. Align the sheaves. Properly adjust the belt tension.
	Back side idler sheave malfunction or damaged.	Replace the back side idler sheave.

TABLE 16 Belt Top Corners Worn

Symptom / Observation	Possible Causes	Corrections / Remedy
Top corners of the belt worn or frayed.	Worn sheaves (check with groove gauge).	Replace the worn sheaves. Properly install new belt and adjust the belt tension.
	Belt profile does not equal sheave groove profile.	Properly install new belt and adjust the belt tension.

TABLE 17 Belt Side Walls Worn

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt side walls worn.	Constant belt slippage.	Properly adjust the belt tension.
	Sheaves not aligned.	Align the sheaves. Properly adjust the belt tension.
	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install new belt and adjust the belt tension.
	Belt profile does not equal sheave groove profile.	Properly install new belt and adjust the belt tension.

TABLE 18 Belt Bottom Surface Worn

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt bottom surface worn or frayed.	Trash and debris fell into the sheave grooves.	Clean trash and debris from the sheave grooves. Correct the cause of the trash and debris entering the sheave grooves. Make sure all protective shields are installed. Properly install new belt and adjust the belt tension.
	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install new belt and adjust the belt tension.
	Belt profile does not equal the sheave groove profile.	Properly install new belt and adjust the belt tension.

TABLE 19 Belt Bottom Corners Worn

Symptom / Observation	Possible Causes	Corrections / Remedy
Bottom corners of the belt worn or frayed.	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install new belt and adjust the belt tension.
	Belt profile does not equal the sheave groove profile.	Properly install new belt and adjust the belt tension.

TABLE 20 Belt Side Wall Cords Frayed

Symptom / Observation	Possible Causes	Corrections / Remedy
Cords in the side walls of the belt are loose or frayed.	Sheaves are not aligned.	Align the sheaves. Properly install new belt and adjust the belt tension.
	Belt tensile members broken or damaged from not correct installation (belt forced onto sheaves).	Properly install new belt and adjust the belt tension.

TABLE 21 Belt Side Walls or Under Cord are Stiff or Hard

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt side walls have a smooth surface and the belt under cord is stiff and hard.	Worn sheave grooves (check with groove gauge).	Replace the worn sheaves. Properly install new belt and adjust the belt tension.
	Constant belt slippage causing heat and gradually making the belt under cords hard.	Properly install new belt and adjust the belt tension.
	Sheave center distances vary during operation.	Check for failed bearings and bearing housing mounting hardware and repair as required.

TABLE 22 Banded Belt Tie Band Worn or Frayed

Symptom / Observation	Possible Causes	Corrections / Remedy
Top of tie band worn and frayed.	Belt rubbing on the belt guides and shields or other obstruction.	Adjust the belt guides, shields, or remove the obstruction. Align the sheaves. Properly adjust the belt tension.
	Back side idler sheave malfunction or damaged.	Replace the back side idler sheave.

TABLE 23 Banded Belt Tie Band Blistered or Perforated

Symptom / Observation	Possible Causes	Corrections / Remedy
Large holes or blisters show up in the belt tie band.	Trash or debris fell into the sheave grooves and deposits between the strands of the belt. The sheaves then force the trash and debris through the belt tie band.	Clean trash or debris from the sheaves grooves and belt strands. Correct the cause of trash and debris entering the drive sheave grooves and belt strands. Make sure all protective shields are installed.

TABLE 24 Banded Belt Has One or More Strands Riding Outside Sheave Grooves

Symptom / Observation	Possible Causes	Corrections / Remedy
Belt has one (or more) strands riding outside of the sheave grooves and there is a groove worn into the side wall of the next belt strand that is still running the sheave grooves.	Belt tension too loose.	Properly adjust the belt tension.
	Sheaves not aligned.	Align the sheaves. Properly adjust the belt tension.
	Trash and debris fell into the sheave grooves making the belt change grooves on the sheaves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering the sheave grooves. Make sure all protective shields are installed.

TABLE 25 Banded Belt Has One Strand Separating From Tie Band

Symptom / Observation	Possible Causes	Corrections / Remedy
Outside belt strand and the next strand have started to separate from the tie band (belt has moved from one sheave groove causing the outside strand to run off the sheaves).	Belt tension too loose.	Properly adjust the belt tension.
	Sheaves not aligned.	Align the sheaves. Properly adjust the belt tension.
	Trash and debris fell into the sheave grooves making belt change grooves on the sheaves.	Clean trash and debris from the sheave grooves. Correct the cause of trash and debris entering the sheave grooves. Make sure all protective shields are installed.

TABLE 26 Banded Belt Has All Strands Separating From Tie Band

Symptom / Observation	Possible Causes	Corrections / Remedy
All belt strands have separated from the tie band.	Belt tension too loose permitting the belt to contact the belt guides or guards.	Properly install new belt and adjust the belt tension.
	Belt rubbing on the belt guides, shields, or other obstruction.	Adjust the belt guides, shields, or remove the obstruction. Align the sheaves. Properly install new belt and adjust the belt tension.
	Worn sheave grooves.	Replace the worn sheaves. Properly install new belt and adjust the belt tension.
	Sheave groove spacing not correct.	Replace the sheaves with defects. Properly install new belt and adjust the belt tension.
	Back side idler sheave malfunction or damaged.	Replace the back side idler sheave. Properly install new belt and adjust the belt tension.

ROLLER CHAINS

Inspection of Drive Chains and Sprockets

Experience will determine how frequently drive chains will need to be inspected and serviced. Make a regular schedule and follow the schedule.

With new chains and sprockets some adjustment of chain tension can be looked for during the first run-in period.

Inspect the chains and sprockets for the following:

1. Wear of the chain link side plates.
2. Wear on the sides of the sprocket teeth.
3. Alignment of the sprockets, idlers, and shafts.
4. Chain elongation.
5. Wear on the working faces of the sprocket teeth.

Check for interference between the drive and other parts of the equipment. If there is any interference, correct immediately. Interference can cause not normal and damaging wear on the chain and interference part. If the edges of the chain link plates hit against a rigid part, link plate will become weak because of strain and a chain failure can result.

Check for and remove any deposit of debris or foreign material between the chain and sprockets. A small amount of material in the sprocket roll seat can cause tensile loads large enough to break the chain if forced through the drive.

Inspect the chain for cracks, broken, or parts with a distortion. If any of these conditions are found, replace the complete chain. Even if parts of the chain look in good condition, the complete chain has been damaged.

Drive Chain Adjustment and Tightening

Proper adjustment and tightening is necessary for long drive chain service life.

Over tightening causes the drive chains to elongate and puts additional loading on the sprockets, shafts, and bearings.

Loose drive chains will climb on the sprocket teeth and cause excessive wear.

FIG. 49: To check drive chain tension, turn the driver sprocket in a direction that is opposite to the normal direction of rotation (to remove all the slack from the idler sprocket strand of the chain). Measure the slack at the middle point of the longest drive strand as shown.

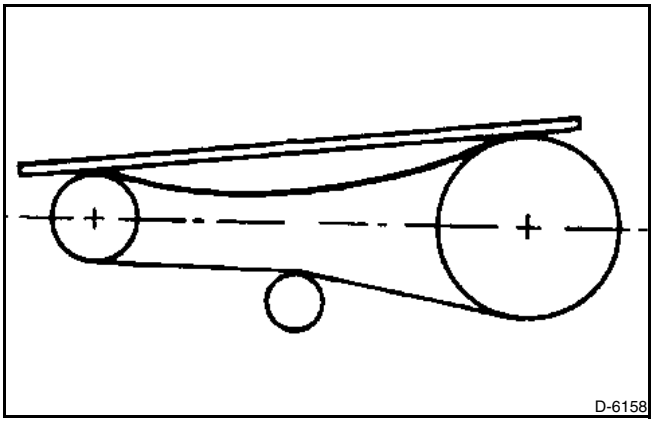


FIG. 49

As a general rule:

- Horizontal and inclined drive chains must be adjusted to have approximately 20 mm of slack per meter of distance between the center of the driver and driven shaft (0.25 inches of slack per foot of distance between the center of the driver and driven shaft) or approximately 2 percent of the distance between the center of the driver and the driven shaft.
- Vertical drive chains that see shock loads or changes of rotation must be adjusted to have approximately 10 mm of slack per meter of distance between the center of the driver and the center of the driven shaft (0.125 inches of slack per foot of distance between the center of both the driver and the driven shaft) or approximately 1 percent of the distance between the center of the driver and the center of the driven shaft.

Drive Chain Sprocket and Idler Alignment

If there is wear on the inside surface of the chain roller link plates, the sprockets are not aligned. Make sure that:

FIG. 50: The shafts that the driver and driven sprockets are mounted on are in the same location, level with each other.

Check for tilting or shafts not in alignment by using a bubble level. For proper alignment, the bubble must be in the same position as measured on each shaft.

Rotate the drive and look for excessive movement. If movement is shown inspect the sprocket and shaft. If there is no problem shown, remove and install the sprocket. Not correctly mounted sprockets or out of round sprockets are from time to time the root of vibration or more severe problems. A dial indicator can be used to measure side to side sprocket movement or diameter vibration by holding the dial indicator up to the sprocket sidewall.

IMPORTANT: Always turn off the machine before using the dial indicator. Rotate the drive by hand to make the measurements.

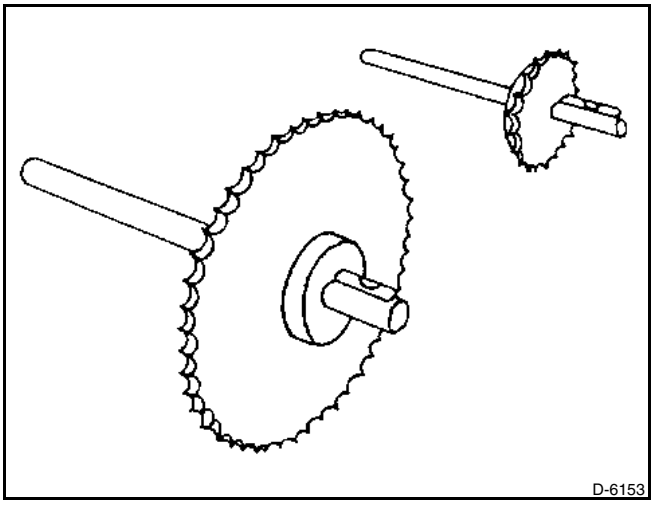


FIG. 50

FIG. 51: The shafts (that the driver and driven sprockets are mounted on) are parallel to each other.

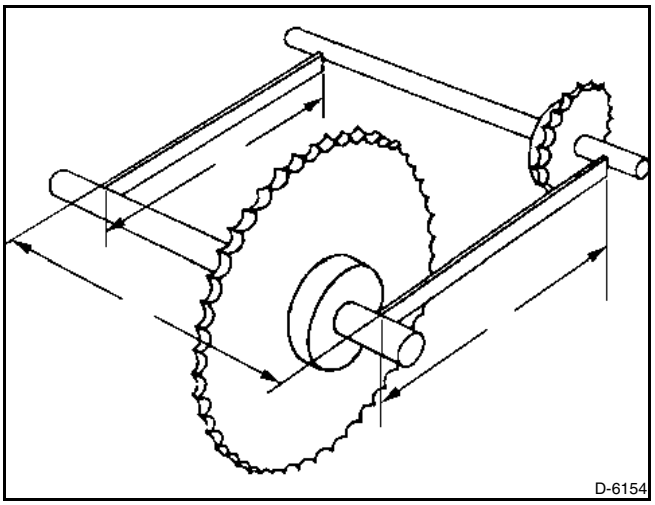


FIG. 51

FIG. 52: The driver and driven sprockets are in line (not offset).

To check the alignment use a long straight edge (1) made of wood, metal, or any rigid material. Line the straight edge along the outside face of both sprockets. If the drive is properly aligned, the straight edge will contact each sprocket evenly. The straight edge must touch the two outer edges of each sprocket for a total of four points of contact.

Shafts not aligned will show up as a gap between the outside face of the sprocket and the straight edge.

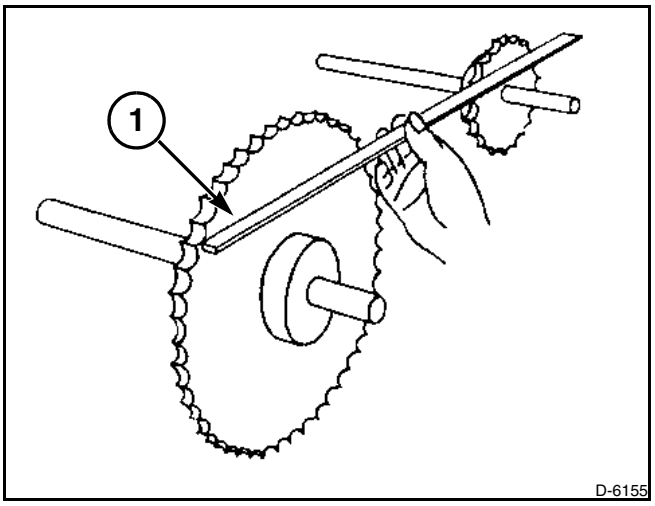


FIG. 52

FIG. 53: The idler and adjusting sprockets are in alignment with the driver and driven sprockets.

Bad alignment, especially with multiple strand chains results in not equal loading across the width of the chain and can cause an early chain failure.

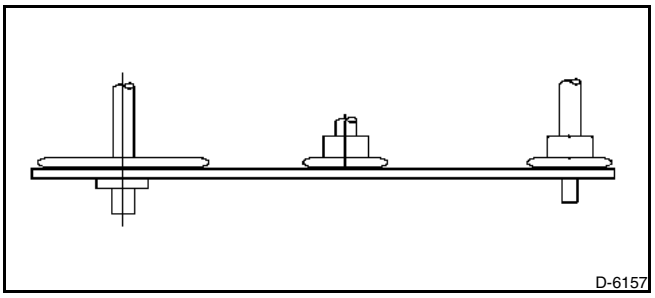


FIG. 53

Drive Chain Elongation and Sprocket Wear

Drive chain wear occurs on the inside of the chain in the load bearing areas between the chain outer link hardened pins and the chain inner link bushing surfaces. This wear causes chain elongation which is referred to as chain stretch.

This wear is not seen on the outside of the chain and cannot be measured with the chain under tension. To measure chain elongation, remove the chain and select a 305 mm (1 ft) section of chain. Push the selected section of chain tightly together and measure the distance between the link pins. Then pull the same selected section of chain and measure the distance between the same link pins. If the movement (elongation) is more than 10 mm per meter (0.125 inches per foot), the chain is worn out and must be replaced.

When wear of this amount or more is seen, the hardened surfaces on the link pins are worn through. The chain is worn out, and making frequent adjustments will be necessary.

Gradual increase in chain slack is the result of normal chain wear. A sudden increase in chain slack indicates one or more of the following problems:

1. Not enough lubrication or failure of the lubricant.
2. Excessive over loading or shock loading of the chain drive.
3. Loose bearing mounting hardware or a failed drive.
4. Loose idler sprockets, chain guide blocks, or failed idler sprocket bearings.

Normal Tooth Wear

FIG. 54: Normal Tooth Wear.

Worn sprockets must not be used with new roller chain.

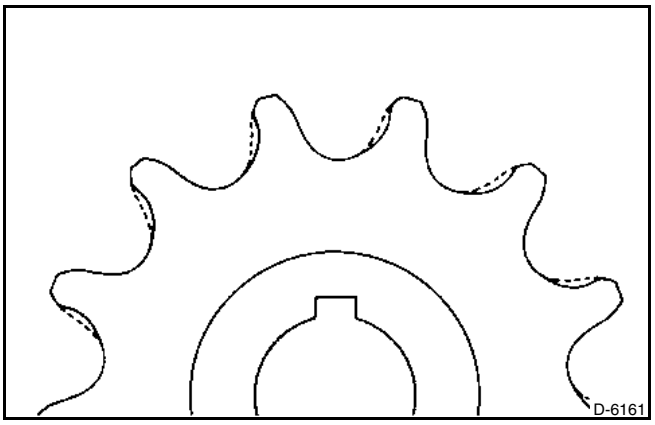


FIG. 54

Not Normal Tooth Wear

FIG. 55: Chain tension that is not correct can cause not normal wear on the outer tips of the sprocket teeth. Not enough chain and sprocket lubrication can cause not normal wear of the sprocket teeth.

Check for roughness or binding when the chain engages or disengages from the sprocket. Inspect the sprocket teeth for reduced tooth section and curved tooth tips.

If these conditions are present, the sprocket teeth are excessively worn and the sprocket must be replaced. Do not run new chain on worn sprockets as this will cause the new chain to wear rapidly.

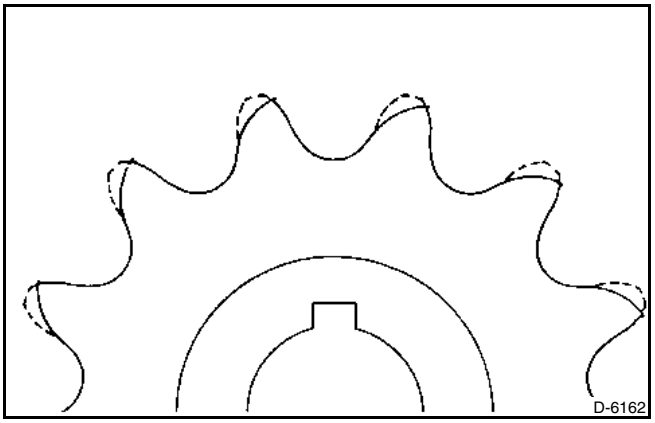


FIG. 55

Worn Chain on New Sprockets

FIG. 56: A worn or elongated drive chain must never be used with new sprockets since the chain no longer fits the sprocket teeth properly. The pitch of the chain is larger than the pitch of the sprocket teeth. A worn or elongated drive chain rides high on the outer tips of the sprocket teeth, causing rapid wear on the outer tips of the sprocket teeth.

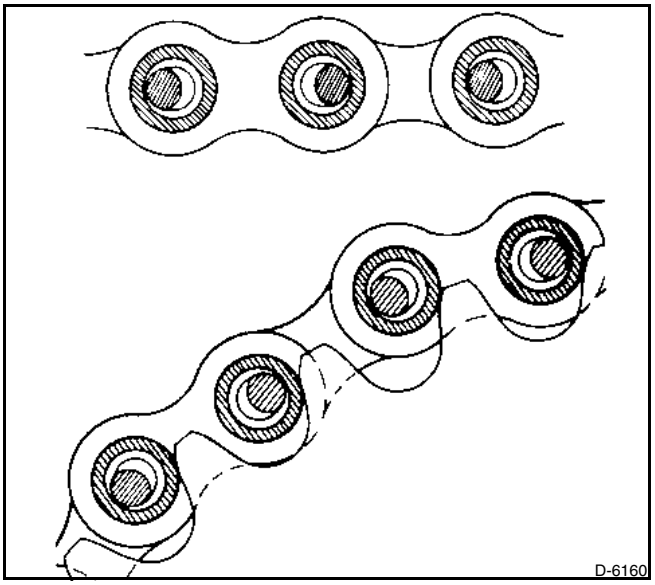


FIG. 56

Drive Chain Service Tips

FIG. 57: To extend drive chain service life follow these rules:

- Chains must be removed from the combine for cleaning and lubrication at the end of every season. In addition, drive chains must be lubricated daily (except when operating in dusty or sandy field conditions).
- Periodically, check the alignment of all sprockets and idlers. A sprocket not in alignment will wear on the sides of the sprocket teeth or on the inside of the chain inner (roller) links.
- To remove a chain, turn the drive until the connecting link is fully engaged on one of the sprockets (to relieve the tension on the connecting link pins), then remove the connecting link pins and lift the chain off the sprockets.
- Never insert a new link in a chain that has been elongated by wear. The pitch of the new link will be shorter than the pitch of the worn links. The shock each time the new link engages a sprocket will soon destroy the chain.
- Do not install a new chain on worn sprockets. Operation under such conditions will do more damage to a new chain than many hours of normal use.
- Do not install a worn or elongated chain on new sprockets. A worn or elongated chain will ride high on the outer tips of the sprocket teeth causing rapid wear of the new sprockets.
- As a drive chain wears and extends, always remove links to make sure the chain length and tension are correct.

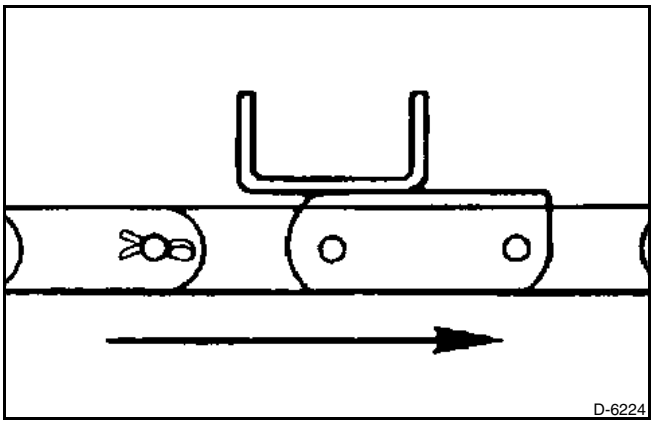


FIG. 57

Chain Replacement

Pin Removal

If the chain is of cotter pin type construction, remove the cotter pins.

If the chain is of riveted type construction, grind the pin heads off so the pin ends are flush with the link plate. Drive the pins out of the link plate.

Installation

Check all adjustments, alignment, and make sure all setscrews, bolts, and nuts are tight on the chain drive.

Fit the chain around both sprockets and put the free ends together on one sprocket for connection. The sprocket teeth will locate the chain end links. Install the connecting link, connecting link cover plate, and the spring clip or cotter pins. On larger pitch chains or heavy multiple strand chains, lock the sprockets for this operation. When press fit cover plates are used, be careful not to drive the plate on so far as to grip the roller links. Stiff joints can result if this is done.

On drives with long spans, support the chain with a plank or bar as the connection is made.

FIG. 58: When using spring clip connectors, always install the spring clip (1) with the open end of the clip trailing in the direction of chain travel to prevent removal or loss of the spring clip.

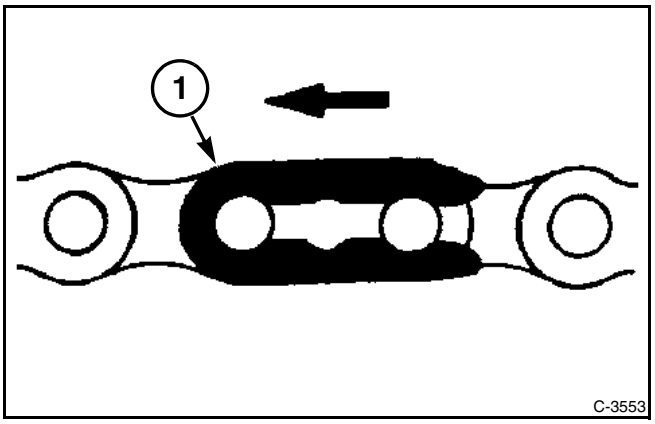


FIG. 58

Cleaning and Lubricating Chains

Roller chain is made of a series of connecting moving metallic bearings, which must be properly lubricated to get the maximum service life out of the chain. Many slow speed drives operate with little or no lubrication beyond the first factory lubrication. But proper lubrication will extend the life of every chain drive. The chain drive requires lubrication for six purposes.

1. To reduce wear of the pin bushing joint.
2. To cushion shock loads
3. To remove heat generated.
4. To flush away foreign materials.
5. To lubricate chain sprocket contact surfaces.
6. To retard rust or corrosion.

Lubricate chains with AGCO chain and cable lubricant or light engine oil at least once every ten hours of operating time. Apply the lubricant when the chain is warm, then let the extra oil drain off before operating the combine.

WARNING: Never lubricate the chains with the combine mechanism in operation.

Once every season, or when the chains show signs of becoming stiff, remove the chains from the combine and service as follows:

- Clean in solvent to remove dirt.
- Permit the chain to soak as long as possible in engine oil, over night if possible.
- Remove the chain from the oil and put the chain in position to permit extra oil to drain off.
- Wipe the chain with a clean cloth.

IMPORTANT: The chain must be permitted to drain completely.

NOTE: The clean grain tailings elevator and the feed house conveyor chains do not have to be lubricated.

A reservoir of lubrication is located between the pins and bushings. Lubricating the chain periodically can prevent surface rust. If the chain requires cleaning, use kerosene applied with a cloth. Do not apply kerosene directly or soak chain in kerosene.

IMPORTANT: The chain must not come in contact with solvents such as gasoline, benzene, acetone, or other corrosive materials as this will damage the O-rings.

Drive Chain Lubrication

Drive chain service life will vary according to the method the chain is lubricated. A properly lubricated chain will last 100 to 200 times longer than the same chain which is poorly lubricated and not kept in good condition.

Lubrication of the chain pins and inner link bushing surfaces which contact each other while the chain is under full load are most important. Lubrication to a smaller degree is also required between the chain rollers and inner link bushing surfaces.

Oil must be applied to the upper edges of the chain link side plates on the slack chain strand before the chain engages a sprocket. Since access of oil to the chain pins and bushings is only possible through the clearances between the link side plates when the chain is slack.

If oil is applied only to the chain rollers the oil can not reach the chain link side plate pins and bushings, and can not slow chain wear.

The elongation of roller chains results from wear between the pins and bushings only. Roller wear does not cause or add to the extending of roller chains.

Drive Chain Lubricants

Lubrication specifications are met by the use of a good grade of clean engine oil without detergents.

Detergent oils are not required but oils with anti-foam, anti-rust, or film strength additives can be beneficial.

The proper lubricant viscosity for many operating temperatures are shown in the chart below.

Ambient Operating Temperatures		**Recommended Lubricant**
degrees F	**degrees C**	**Viscosity**
-20 to 20	- 29 to - 7	SAE 10
20 to 40	- 7 to 4	SAE 20
40 to 100	4 to 38	SAE 30
100 to 120	38 to 49	SAE 40
120 to 140	49 to 60	SAE 50

NOTE: Heavy oils and greases are too stiff to enter the chain joints and must not be used.

With proper lubrication, a separating wedge of lubrication is formed between the pins and bushings in the chain joints much like that formed in journal bearings.

The viscosity of the lubricant changes the lubricants film strength, and capacity to keep moving parts separate. The highest viscosity oil which will flow between the chain link plates and fill the pin bushing areas will provide the best wear life. This is needed to reduce metal to metal contact. If the lubricant is supplied with enough volume, the lubricant also cools and cushions shock loads.

Good Drive Chain Lubrication

Connector link pins, on removal from a properly lubricated drive chain, will have a high luster polish and will not be changed in color.

Drive chains which are operated without proper lubrication will have a reddish brown oxide in the joints. On removal, the connector link pins will be changed in color, rough, with grooves, or damaged.

When operating in dust containing excessive amounts of damaging particles (sandy field conditions), the chain must not be lubricated on the outside. The oil will pick up damaging particles that forms a grinding compound with the lubricant (similar to valve lapping compound) which causes early wear of both the sprockets and the drive chain.

Under severe conditions, the chain must be removed every 50 hours of operation cleaned and lubricated, following the procedure shown below:

1. Remove the chain from the sprockets.
2. Wash the chain in cleaning solvent (varsol or kerosene). If the chain is gummed, soak the chain for several hours in the cleaning solvent, and then wash the chain in clean fluid.
3. Using clean and dry compressed air, blow the chain dry or wipe the chain dry with a clean towel or cloth.
4. Inspect the chain for wear and corrosion.
5. Soak the chain in engine oil to internally lubricate the pins, bushings, and rollers.
6. Position the chain in a vertical position and permit the extra lubricant to drain off.
7. Wipe the chain dry with a clean shop towel or cloth.
8. While the chain is off the sprockets, clean the sprockets with cleaning solvent (varsol or kerosene), and inspect the chain for wear and corrosion.
9. Check the driver, driven, and idler sprocket alignment and make corrections if found necessary.
10. Install the drive chain and properly adjust the chain tension.

Roller Chain Drive Troubleshooting Guide

TABLE 27 Troubleshooting Guide

Symptom / Observation	Possible Causes	Corrections / Remedy
Tight Joints.	Dirt or foreign material in the chain joints.	Clean and lubricate the chain.
	Not enough lubrication.	Replace the chain. Make a proper lubrication and maintenance schedule.
	Sprockets not in alignment.	Align the sprockets. Replace the sprockets and chain if needed.
	Internal corrosion or rust.	Remove the cause of corrosion or protect the chain. Lubricate the chain. Replace the chain.
	Over loading bends pins or spreads roller.	Remove the cause of over loading. Replace the chain.
Rusted Chain	Exposed to moisture.	Replace the chain. Protect from moisture.
	Not enough lubrication.	Properly lubricate the chain.
Turned Pins	Not enough lubrication.	Replace the chain. Proper lubricate the chain.
Increased Hole Size	Over loading.	Remove the cause of over loading. Replace the chain.
Broken Pins	Over loading.	Remove the cause of over loading. Replace the sprockets if indicated. Replace the chain.
Broken Link Plates	Over loading.	Remove the cause of over loading. Replace the sprockets if indicated. Replace the chain.
Missing Parts	Broken and lost.	Find and correct the cause of damage. Replace the chain.

TABLE 27 Troubleshooting Guide (cont'd)

Symptom / Observation	Possible Causes	Corrections / Remedy
Broken, Cracked, or Rollers with Distortion	Speed too high.	Reduce the speed Replace the chain.
	Chain riding too high on the sprocket teeth.	Tension the chain more frequently. Worn or elongated chain on new sprockets. Replace the chain.
Pin Galling	Not enough lubrication.	Reduce the speed or load. Provide proper lubrication.
Chain Climbs Sprocket Teeth	Excessive chain slack.	Tension the chain.
	Excessive chain wear.	Replace and tension the chain.
	Excessive sprocket wear.	Replace the sprockets and chain.
	Excessive over loading.	Remove the cause of over loading. Replace the chain.
Missing or Broken Cotter Pins	Cotter pins not installed correctly.	Install the new cotter pins correctly
Chain Surfaces Corroded or Pitted	Exposure to corrosive environment.	Protect from corrosive environment. Replace the chain. Lubricate the chain.
Cracked Link Plates	Loading more than chain capacity.	Reduce loading. Replace the chain.
Damaged Link Plates Edges	Chain hitting an obstruction.	Remove the interference. Replace the chain.
Worn Link Plate Edges	Chain rubbing on casing, guide, or obstruction.	Remove the interference. Replace the chain if 5% or more of the height is worn away. Tension the chain.

TABLE 27 Troubleshooting Guide (cont'd)

Symptom / Observation	Possible Causes	Corrections / Remedy
Excessive Noise	Chain hitting an obstruction.	Remove the interference. Replace the chain.
	Loose casing or shaft mounts.	Tighten the fasteners
	Excessive chain slack.	Tension the chain.
	Excessive chain wear.	Replace and tension the chain.
	Excessive sprocket wear.	Replace the sprockets and chain.
	Sprockets not aligned.	Align the sprockets. Replace the chain and sprockets, if needed.
	Not enough lubrication.	Replace the chain if needed. Lubricate the chain.
Wear on Inside of Roller Link Plates and one side of Sprockets.	Sprockets not aligned.	Align the drive. Replace the sprockets and chain if needed. Tension the chain.
Chain Clings to Sprocket.	Excessive sprocket wear.	Replace the sprockets and chain.
	Sprockets not aligned.	Align the drive. Replace the sprockets and chain if needed. Tension the chain.

STORAGE PREPARATION

When the combine is to be out of service over an extended period of time, prepare the combine for storage following the operations below:

Combine

The following procedure will help to reduce rodent damage or insect infestation of the grain remaining in the combine after the harvest.

Open the stone trap, unloader, and all elevator doors and run the unloading and threshing mechanism with the cleaning fan in the highest speed position for approximately 15 minutes.

Run the left-hand front wheel onto a block of wood, and using either high pressure water or air, clean the grain tank. Clean the feeder, grain pans, sieves, augers, and elevators (in that order).

After cleaning the combine, permit the combine to drain and dry out, then store under cover. Leave all the elevator doors open. The wheels must be lifted up and blocks put under the axles to protect the tires. The right-hand side of the combine must be lifted higher to permit water to run out of the grain tank if stored outside.

Fumigate and use rodent repellent within one week of storing. Use the repellent only as recommended and authorized by the manufacturer and local authorities.

Clean the machine completely (including the engine compartment). Clean the area above the cleaning fan housing and inside the fan screens. Make sure the drain holes in the bottom of the fan housing are open.

Remove the chains. Wash in solvent and soak in oil to lubricate the chains and prevent rust.

Lubricate the combine completely and service according to the Lubrication & Maintenance chart.

Retract all of the hydraulic cylinders and cover shown parts of the piston rods with grease.

During extended storage, start the engine at least once a month and run the air conditioner compressor for a moment to lubricate the shaft seal and to prevent loss of refrigerant.

When the combine is stored for more than six months, the belt tension must be removed so that the belts do not take a set.

IMPORTANT: In cold temperatures, to prevent damage to the compressor unit, Do not turn the air conditioner on until the compressor has heated up from the heat of the engine.

If the engine is not able to be operated, turn the compressor shaft over multiple times by hand to lubricate the shaft seal.

Service the cab filters.

Engine

Clean all the external parts of the engine.

Run the engine until operating temperature is reached. Stop the engine and drain the oil pan.

Clean the crankcase breather hose. Replace the oil filter and fill the oil pan with new lubricating oil.

Service the air cleaner.

Check the coolant level and antifreeze protection.

Remove the batteries and store in fully charged condition.

NOTE: Do not store batteries on a concrete floor.

CAUTION: Always vent the combine exhaust system to the outside. NEVER operate engine in a closed building without correct ventilation.

PREPARATION FOR USE AFTER STORAGE

Combine

Check all the belts and adjust tensioners as required.

Install the chains and adjust idlers. Check alignment.

Check the transmission, final drives, and hydraulic oil levels. Inspect for leaks and repair. Add lubricant if necessary.

Check the operation of the air conditioning system. If the air conditioning is not operating correctly, repair.

Close the grain tank doors, elevator doors, and stone trap.

Check the tire inflation.

CAUTION: Make sure all shields, covers, access doors and guards are installed and in proper position.

Engine

Clean all the external parts.

Install new fuel filters. Bleed the fuel system.

Install and connect the batteries.

Start the engine, checking for oil pressure and oil, fuel, and water leaks.

After the engine is started, Do not immediately accelerate. The engine must be run at low rpm for approximately two minutes to make sure of good oil distribution and lubrication of all the internal moving parts and seal contact surfaces.

TORQUE CHARTS

Standard Torque Specifications

Foot Pounds (lbf ft) Newton Meters (Nm)

Use this chart as a guide when tightening bolts and nuts that do not have special torque specifications.

SIZE	SUGGESTED ASSEMBLY TORQUE VALUES (STANDARD HARDWARE)											
	SAE GRADE 2 ASSEMBLY TORQUE				SAE GRADE 5 ASSEMBLY TORQUE				SAE GRADE 8 ASSEMBLY TORQUE			
	DRY		LUBE		DRY		LUBE		DRY		LUBE	
	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m
5/16”-18	11	15	8	11	17	23	13	18	25	34	18	24
5/16”-24	12	16	9	12	19	26	14	19	25	34	20	27
3/8”-16	20	27	15	20	30	41	23	31	45	61	35	47
3/8”-24	23	31	17	23	35	47	25	34	50	68	35	47
7/16”-14	30	41	24	33	50	68	35	47	70	95	55	75
7/16”-20	35	47	25	34	55	75	40	54	80	108	60	81
1/2”-13	50	68	35	47	75	102	55	75	110	140	80	108
1/2”-20	55	75	40	54	90	122	65	88	120	163	90	122
9/16”-12	65	88	50	68	110	149	80	108	150	203	110	149
9/16”-18	75	102	55	75	120	163	90	122	170	230	130	176
5/8”-11	90	122	70	95	150	203	110	149	220	298	170	230
5/8”-18	100	136	80	108	180	244	130	176	240	325	180	244
3/4”-10	160	217	120	163	260	353	200	271	380	515	280	380
3/4”-16	180	244	140	190	300	407	220	298	420	569	320	434
7/8”-9	140	190	110	149	400	542	300	407	600	813	460	624
7/8”-14	155	210	120	163	440	597	320	434	660	895	500	678
1”-8	220	298	160	217	580	786	440	597	900	1220	680	922
1”-12	240	325	170	230	640	868	480	651	1000	1356	740	1003
1-1/8”-7	300	407	220	298	800	1085	600	813	1280	1735	960	1302
1-1/8”-12	340	461	260	353	880	1193	660	895	1440	1952	1080	1464
1-1/4”-7	420	569	320	434	1120	1519	840	1139	1820	2468	1360	1844
1-1/4”-12	460	624	360	488	1240	1681	920	1247	2000	2712	1500	2034
1-3/8”-6	560	759	420	569	1460	1979	1100	1491	2380	3227	1780	2413
1-3/8”-12	640	868	460	624	1680	2278	1260	1708	2720	3688	2040	2766
1-1/2”-6	740	1003	560	759	1940	2630	1460	1979	3160	4284	2360	3200
1-1/2”-12	840	1139	620	841	2200	2988	1640	2224	3560	4827	2660	3606


GRADE 2
NO MARKS


GRADE 5
3 MARKS


GRADES 8
6 MARKS

Std_Torq.doc

STD_TORQ

FIG. 59

FIG. 59: Standard Torque Chart.

NOTE: Mild steel torque values (SAE Grade 2) are also to be used when weld nuts, or other low strength nuts are used.

Metric Capscrew Markings and Torque Values

SUGGESTED ASSEMBLY TORQUE VALUES (METRIC HARDWARE)												
	GRADE 8.8 ASSEMBLY TORQUE				GRADE 10.9 ASSEMBLY TORQUE				GRADE 12.9 ASSEMBLY TORQUE			
	DRY		LUBE		DRY		LUBE		DRY		LUBE	
SIZE	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m	Ft.-Lb.	N.m
M4	2	3	2	3	3	4	3	4	4	5	3	4
M5	4	5	4	5	6	8	5	7	7	9	6	8
M6	7	9	6	8	10	13	9	12	12	16	10	14
M8x1.25	16	22	15	21	23	31	21	29	28	38	26	35
M8x1	18	24	16	22	25	34	23	31	30	40	27	37
M10x1.5	32	44	30	40	45	61	42	57	55	74	50	68
M10x1.25	34	46	32	43	48	65	44	60	58	78	53	72
M10x1	37	50	34	46	52	70	47	64	62	84	57	77
M12x1.75	56	76	52	70	78	106	73	99	94	127	87	118
M12x1.5	58	79	55	74	82	111	76	103	98	133	91	124
M12x1.25	60	82	56	76	86	116	79	107	103	139	94	128
M14x2	88	120	82	111	124	168	116	157	149	202	139	188
M14x1.5	96	130	89	120	135	183	125	169	162	219	150	203
M16x2	138	187	128	173	193	262	179	243	232	314	215	291
M16x1.5	146	198	135	183	205	278	190	257	246	333	227	308
M18	190	258	176	239	267	362	248	336	319	433	297	402
M18x2	201	272	186	252	282	382	261	354	338	458	313	424
M18x1.5	212	287	195	264	297	403	274	372	356	483	328	445
M20x2.5	267	362	248	336	375	509	348	472	450	610	417	566
M20x2	281	381	260	352	395	535	364	494	473	641	437	592
M20x1.5	295	400	271	368	415	562	381	517	496	673	457	620
M22	363	492	336	456	510	691	472	640	611	828	565	766
M22x2	380	515	350	475	534	724	493	668	639	866	590	800
M22x1.5	396	537	364	494	557	755	512	694	667	904	613	831
M24x3	461	625	427	579	648	878	600	814	775	1051	719	975
M24x2	499	677	460	624	701	951	646	876	840	1139	774	1049
M24x1.5	519	704	476	646	729	989	670	908	873	1184	802	1088
M27	674	915	624	846	948	1285	877	1189	1135	1539	1050	1424
M27x2	726	984	668	905	1019	1382	937	1271	1221	1655	1123	1522
M30	918	1244	850	1152	1289	1748	1194	1619	1544	2094	1430	1939
M30x2	1009	1368	927	1257	1418	1922	1303	1766	1698	2302	1561	2116

METTORQ

FIG. 60

FIG. 60: Metric capscrews are known by the grade number stamped on the head of the capscrew or on the surface of metric nuts. The higher the number, the higher the strength of the capscrew.

NOTE: Do not use these values when the torque values are specified in another section of the manual.

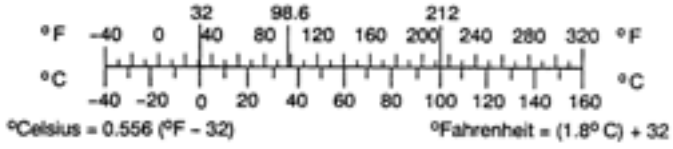
These values are for clean, dry threads. Reduce the value by 10 percent when lubricant is used. Reduce the value by 20 percent if new plated capscrews are used.

Capscrews threaded into aluminum must have two diameters of thread engaged and can require 30 percent more reduction in the torque.

METRIC CONVERSIONS

	MULTIPLY:	BY:		To Get: MULTIPLY	BY:		To Get:
LINEAR	inches	x 25.4	=	millimeters (mm)	x 0.03937	=	inches
	feet	x 0.3048	=	meters (m)	x 3.281	=	feet
	yards	x 0.9144	=	meters (m)	x 1.0936	=	yards
	miles	x 1.6093	=	kilometers (km)	x 0.6214	=	miles
	inches	x 2.54	=	centimeters (cm)	x 0.3937	=	inches
	microinches	x 0.0254	=	micrometers (um)	x 39.37	=	microinches
AREA	inches^2	x 645.16	=	millimeters^2 (mm^2)	x 0.00155	=	inches^2
	inches^2	x 6.4516	=	centimeters^2 (cm^2)	x 0.155	=	inches^2
	feet^2	x 0.0929	=	meters^2 (m^2)	x 10.764	=	feet^2
	yards^2	x 0.8361	=	meters^2 (m^2)	x 1.196	=	yards^2
	acres	x 0.4047	=	hectometers^2 (hm^2)	x 2.471	=	acres
			=	hectares (ha)			
VOLUME	inches^3	x 16387	=	millimeters^3 (mm^3)	x 0.000061	=	inches^3
	inches^3	x 16.387	=	centimeters^3 (cm^3)	x 0.06102	=	inches^3
	inches^3	x 0.01639	=	liters	x 61.024	=	inches^3
	quarts	x 0.94635	=	liters	x 1.0567	=	quarts
	gallons	x 3.7854	=	liters	x 0.2642	=	gallons
	feet^3	x 28.317	=	liters	x 0.03531	=	feet^3
	feet^3	x 0.02832	=	meters^3 (m^3)	x 35.315	=	feet^3
	fluid oz.	x 29.57	=	milliliters (ml)	x 0.03381	=	fluid oz.
	yards^3	x 0.7646	=	meters^3 (m^3)	x 1.3080	=	yards^3
	teaspoons	x 4.929	=	milliliters (ml)	x 0.2029	=	teaspoons
	cups	x 0.2366	=	liters	x 4.227	=	cups
	bushel	x 35.239	=	liters	x 0.02838	=	bushels
	bushel	x 0.03524	=	meters^3 (m^3)	x 28.378	=	bushels
MASS	ounces (av)	x 28.35	=	grams (g)	x 0.03527	=	ounces (av)
	pounds (av)	x 0.4536	=	kilograms (kg)	x 2.2046	=	pounds (av)
	tons (2000 lbs)	x 907.18	=	kilograms (kg)	x 0.001102	=	tons (2000 lbs)
	tons (2000 lbs)	x .90718	=	metric tons(t)	x 1.1023	=	tons(2000 lbs)
	tons (long) (2240 lbs)	x 1016.05	=	kilograms (kg)	x .000984	=	tons (long) (2240 lbs)
FORCE	ounces - f (av)	x 0.278	=	newtons (N)	x 3.597	=	ounces - f (av)
	pounds - f (av)	x 4.488	=	newtons (N)	x 0.2248	=	pounds - f (av)
	kilograms - f	x 9.807	=	newtons (N)	x 0.10197	=	kilograms - f
PRESSURE OR STRESS	pounds/sq.in.	x 6.895	=	kilopascals (kPa)	x 0.145	=	pounds/sq. in.
	pounds/sq.in.	x 0.0689	=	bar	x 14.503	=	pounds/sq. in.
POWER	horsepower	x 0.746	=	kilowatts (kW)	x 1.34	=	horsepower
	ft-lbf/min.	x 0.0226	=	watts (W)	x 44.25	=	ft - lbf/min.
TORQUE	pound - inches	x 0.11298	=	newton-meters (N.m)	x 8.851	=	pound-inches
	pound - feet	x 1.3558	=	newton-meters (N.m)	x 0.7376	=	pound-feet
VELOCITY	miles/hour	x 1.6093	=	kilometers/hour (km/h)	x 0.6214	=	miles/hour
	feet/sec.	x 0.3048	=	meters/sec. (m/s)	x 3.281	=	feet/sec.
	kilometers/hr.	x 0.27778	=	meters/sec. (m/s)	x 3.600	=	kilometers/hr.
	miles/hours	x 0.4470	=	meters/sec. (m/s)	x 2.237	=	miles/hour

TEMPERATURE



METCONV

FRACTIONS, DECIMALS, AND MILLIMETERS CONVERSION CHART

Inches		mm	Inches		mm
Fraction	Decimal		Fraction	Decimal	
-	0.0004	0.01	-	0.3937	10.0
-	0.004	0.1	13/32	0.406	10.319
-	0.01	0.25	-	0.413	10.5
1/64	0.0156	0.397	27/64	0.422	10.716
-	0.0197	0.5	-	0.4331	11
-	0.0295	0.75	7/16	0.438	11.113
1/32	0.03125	0.794	29/64	0.453	11.509
-	0.0394	1.0	15/32	0.469	11.906
3/64	0.0469	1.191	-	0.4724	12.0
-	0.059	1.5	31/64	0.484	12.303
1/16	0.062	1.588	-	0.492	12.5
5/64	0.0781	1.984	1/2	0.5	12.7
-	0.0787	2.0	-	0.5118	13.0
3/32	0.094	2.381	33/64	0.5156	13.097
-	0.0984	2.5	17/32	0.531	13.494
7/64	0.109	2.778	35/64	0.547	13.891
-	0.1181	3.0	-	0.5512	14.0
1/8	0.125	3.175	9/16	0.563	14.288
-	0.1378	3.5	-	0.571	14.5
9/64	0.141	3.572	37/64	0.578	14.684
5/32	0.156	3.969	-	0.5906	15.0
-	0.1575	4.0	19/32	0.594	15.081
11/64	0.172	4.366	39/64	0.609	15.478
-	0.177	4.5	5/8	0.625	15.875
3/16	0.1875	4.763	-	0.6229	16
-	0.1969	5.0	41/64	0.6406	16.272
13/64	0.203	5.159	-	0.6496	16.5
-	0.2165	5.5	21/32	0.656	16.669
7/32	0.219	5.556	-	0.6693	17.0
15/64	0.234	5.953	43/64	0.672	17.066
-	0.2362	6.0	11/16	0.6875	17.463
1/4	0.25	6.35	45/64	0.703	17.859
-	0.2559	6.5	-	0.7087	18.0
17/64	0.2656	6.747	23/32	0.719	18.256
-	0.2756	7.0	-	0.7283	18.5
9/32	0.281	7.144	47/64	0.734	18.653
-	0.2953	7.5	-	0.7480	19.0
19/64	0.297	7.541	3/4	0.75	19.05
5/16	0.312	7.938	49/64	0.7656	19.447
-	0.315	8.0	25/32	0.781	19.844
21/64	0.328	8.334	-	0.7874	20.0
-	0.335	8.5	51/64	0.797	20.241
11/32	0.344	8.731	13/16	0.8125	20.638
-	0.3543	9.0	-	0.8268	21.0
23/64	0.359	9.128	53/64	0.828	21.034
-	0.374	9.5	27/32	0.844	21.431
3/8	0.375	9.525	55/64	0.859	21.828
25/64	0.391	9.922	-	0.8661	22.0

Inches		mm	Inches		mm
Fraction	Decimal		Fraction	Decimal	
7/8	0.875	22.225	1-3/4	1.750	44.45
57/64	0.8906	22.622	-	1.7717	45.0
-	0.9055	23.0	1-25/32	1.781	45.244
29/32	0.9062	23.019	-	1.8110	46.0
59/64	0.922	23.416	1-13/16	1.8125	46.038
15/16	0.9375	23.813	1-27/32	1.844	46.831
-	0.9449	24.0	-	1.8504	47.0
61/64	0.953	24.209	1-7/8	1.875	47.625
31/32	0.969	24.606	-	1.8898	48.0
-	0.9843	25.0	1-29/32	1.9062	48.419
63/64	0.9844	25.003	-	1.9291	49.0
1	1.0	25.4	1-15/16	1.9375	49.213
-	1.0236	26.0	-	1.9685	50.0
1-1/32	1.0312	26.194	1-31/32	1.969	50.006
1-1/16	1.062	26.988	2	2.0	50.8
-	1.063	27.0	-	2.0079	51.0
1-3/32	1.094	27.781	2-1/32	2.03125	51.594
-	1.1024	28.0	-	2.0472	52.0
1-1/8	1.125	28.575	2-1/16	2.062	52.388
-	1.1417	29.0	-	2.0866	53.0
1-5/32	1.156	29.369	2-3/32	2.094	53.181
-	1.1811	30.0	2-1/8	2.125	53.975
1-3/16	1.1875	30.163	-	2.126	54.0
1-7/32	1.219	30.956	2-5/32	2.156	54.769
-	1.2205	31.0	-	2.165	55.0
1-1/4	1.25	31.75	2-3/16	2.1875	55.563
-	1.2598	32.0	-	2.2047	56.0
1-9/32	1.281	32.544	2-7/32	2.219	56.356
-	1.2292	33.0	-	2.244	57.0
1-5/16	1.312	33.338	2-1/4	2.25	57.150
-	1.3386	34.0	2-9/32	2.281	57.944
1-11/32	1.406	35.719	-	2.2835	58.0
-	1.4173	36.0	2-5/16	2.312	58.738
1-7/16	1.438	36.513	-	2.3228	59.0
-	1.4567	37.0	2-11/32	2.344	59.531
1-15/32	1.469	37.306	-	2.3622	60.0
-	1.4961	38.0	2-3/8	2.375	60.325
1-1/2	1.5	38.1	-	2.4016	61.0
1-17/32	1.531	38.894	2-13/32	2.406	61.119
-	1.5354	39.0	2-7/16	2.438	61.913
1-9/16	1.562	39.688	-	2.4409	62.0
-	1.5748	40.0	2-15/32	2.469	62.706
1-19/32	1.594	40.481	-	2.4803	63.0
-	1.6142	41.0	2-1/2	2.5	63.5
1-5/8	1.625	41.275	-	2.5197	64.0
-	1.6535	42.0	2-17/32	2.531	64.294
1-21/32	1.6562	42.069	-	2.559	65.0
1-11/16	1.6875	42.863	2-9/16	2.562	65.088
-	1.6929	43.0	2-19/32	2.594	65.881
1-23/32	1.719	43.656	-	2.5984	66.0
-	1.7323	44.0	2-5/8	2.625	66.675

Inches		mm	Inches		mm
Fraction	Decimal		Fraction	Decimal	
-	2.638	67.0	3-17/32	3.531	89.694
2-21/32	2.656	67.469	-	3.5433	90.0
-	2.6772	68.0	3-9/16	3.562	90.4877
2-11/16	2.6875	68.263	-	3.5827	91.0
-	2.7165	69.0	3-19/32	3.594	91.281
2-23/32	2.719	69.056	-	3.622	92.0
2-3/4	2.75	69.85	3-5/8	3.625	92.075
-	2.7559	70.0	3-21/32	3.656	92.869
2-25/32	2.781	70.6439	-	3.6614	93.0
-	2.7953	71.0	3-11/16	3.6875	93.663
2-13/16	2.8125	71.4376	-	3.7008	94.0
-	2.8346	72.0	3-23/32	3.719	94.456
2-27/32	2.844	72.2314	-	3.7401	95.0
-	2.8740	73.0	3-3/4	3.75	95.25
2-7/8	2.875	73.025	-	3.7795	96.0
2-29/32	2.9062	73.819	3-25/32	3.781	96.044
-	2.9134	74.0	3-13/16	3.8125	96.838
2-15/16	2.9375	74.613	-	3.8189	97.0
-	2.9527	75.0	3-27/32	3.844	97.631
2-31/32	2.969	75.406	-	3.8583	98.0
-	2.9921	76.0	3-7/8	3.875	98.425
3	3.0	76.2	-	3.8976	99.0
3-1/32	3.0312	76.994	3-29/32	3.9062	99.219
-	3.0315	77.0	-	3.9370	100
3-1/16	3.062	77.788	3-15/16	3.9375	100.013
-	3.0709	78.0	3-31/32	3.969	100.806
3-3/32	3.094	78.581	-	3.9764	101.0
-	3.1102	79.0	4	4.0	101.6
3-1/8	3.125	79.375	4-1/16	4.062	103.188
-	3.1496	80.0	4-1/8	4.125	104.775
3-5/32	3.156	80.169	-	4.1338	105.0
3-3/16	3.1875	80.963	4-3/16	4.1875	106.363
-	3.189	81.0	4-1/4	4.25	107.95
3-7/32	3.219	81.756	4-5/16	4.312	109.538
-	3.2283	82.0	-	4.3307	110
3-1/4	3.25	82.55	4-3/8	4.375	111.125
-	3.2677	83.0	4-7/16	4.438	112.713
3-9/32	3.281	83.344	4-1/2	4.5	114.3
-	3.3071	84.0	-	4.5275	115.0
3-5/16	3.312	84.1377	4-9/16	4.562	115.888
3-11/32	3.344	84.9314	4-5/8	4.625	117.475
-	3.3464	85.0	4-11/16	4.6875	119.063
3-3/8	3.375	85.725	-	4.7244	120
-	3.3858	86.0	4-3/4	4.75	120.65
3-13/32	3.406	86.519	4-13/16	4.8125	122.238
-	3.4252	87.0	4-7/8	4.875	123.825
3-7/16	3.438	87.313	-	4.9212	125.0
-	3.4646	88.0	4-15/16	4.9375	125.413
3-15/32	3.469	88.106	5	5.0	127.0
3-1/2	3.5	88.9	-	5.1181	130
-	3.5039	89.0	5-1/4	5.25	133.350

Inches		mm	Inches		mm
Fraction	Decimal		Fraction	Decimal	
5-1/2	5.5	139.7	-	9.8425	250.0
-	5.5118	140.0	10	10.0	254.001
5-3/4	5.75	146.05	-	10.2362	260.0
-	5.9055	150.0	-	10.6299	270.0
6	6.0	152.4	11	11.0	279.401
6-1/4	6.25	158.75	-	11.0236	280.0
-	6.2992	160.0	-	11.4173	290.0
6-1/2	6.5	165.1	-	11.8110	300.0
-	6.6929	170.0	12	12.0	304.801
6-3/4	6.75	171.45	13	13.0	330.201
7	7.0	177.8	-	13.7795	350
-	7.0866	180.0	14	14.0	355.601
-	7.4803	190.0	15	15.0	381.001
7-1/2	7.5	190.5	-	15.7480	400.0
-	7.8740	200.0	16	16.0	406.401
8	8.0	203.2	17	17.0	431.801
-	8.2677	210.0	-	17.7165	450.0
8-1/2	8.5	215.9	18	18.0	457.201
-	8.6614	220.0	19	19.0	482.601
9	9.0	228.6	-	19.6850	500.0
-	9.0551	230.0	20	20.0	508.001
-	9.4488	240.0	25	25.0	635.0
9-1/2	9.5	241.3	30	30.0	762.0

DECIMAL EQUIVALENTS OF 8THS, 16THS, 32NDS, AND 64THS

8ths	16ths	32nds	64ths	
1/8 = 0.125	1/16 = 0.625	1/32 = 0.03125	1/64 = 0.015625	33/64 = 0.515625
1/4 = 0.25	3/16 = 0.1875	3/32 = 0.09375	3/64 = 0.046875	35/64 = 0.546875
3/8 = 0.375	5/16 = 0.3125	5/32 = 0.15625	5/64 = 0.078125	37/64 = 0.578125
1/2 = 0.5	7/16 = 0.4375	7/32 = 0.21875	7/64 = 0.19375	39/64 = 0.609375
5/8 = 0.625	9/16 = 0.5625	9/32 = 0.28125	9/64 = 0.140625	41/64 = 0.640625
3/4 = 0.75	11/16 = 0.6875	11/32 = 0.34375	11/64 = 0.171875	43/64 = 0.671875
7/8 = 0.875	13/16 = 0.8125	13/32 = 0.40625	13/64 = 0.203125	45/64 = 0.703125
	15/16 = 0.9375	15/32 = 0.46875	15/64 = 0.234375	47/64 = 0.734375
		17/32 = 0.53125	17/64 = 0.265625	49/64 = 0.765625
		19/32 = 0.59375	19/64 = 0.296875	51/64 = 0.796875
		21/32 = 0.65625	21/64 = 0.328125	53/64 = 0.828125
		23/32 = 0.71875	23/64 = 0.359375	55/64 = 0.859375
		25/32 = 0.78125	25/64 = 0.390625	57/64 = 0.890625
		27/32 = 0.84375	27/64 = 0.421875	59/64 = 0.921875
		29/32 = 0.90625	29/64 = 0.453125	61/64 = 0.953125
		31/32 = 0.96875	31/64 = 0.484375	63/64 = 0.984375

DECIMAL EQUIVALENTS OF LETTER SIZE DRILLS

Letter	Size of Drill in Inches	Size of Drill in mm
A	0.234	5.953
B	0.238	6.0452
C	0.242	6.1468
D	0.246	6.2484
E	0.25	6.35
F	0.257	6.5278
G	0.261	6.6294
H	0.266	6.7564
I	0.272	6.9088
J	0.277	7.0358
K	0.281	7.1374
L	0.29	7.366
M	0.295	7.493
N	0.302	7.6708
O	0.316	8.0264
P	0.323	8.2042
Q	0.332	8.4328
R	0.339	8.6106
S	0.348	8.8392
T	0.358	9.0932
U	0.368	9.3472
V	0.377	9.5758
W	0.386	9.8044
X	0.397	10.0838
Y	0.404	10.2616
Z	0.413	10.4902

DECIMAL EQUIVALENTS OF NUMBER SIZE DRILLS

Number	Size of Drill in Inches	Size of Drill in mm	Number	Size of Drill in Inches	Size of Drill in mm
1	0.2280	5.7912	41	0.0960	2.4384
2	0.2210	5.6134	42	0.0935	2.3749
3	0.2130	5.4102	43	0.0890	2.2606
4	0.2090	5.3086	44	0.0860	2.1844
5	0.2055	5.2197	45	0.0820	2.0828
6	0.2040	5.1516	46	0.0810	2.0574
7	0.2010	5.1054	47	0.0785	1.9939
8	0.1990	5.0546	48	0.0760	1.9304
9	0.1960	4.9784	49	0.0730	1.8542
10	0.1935	4.9149	50	0.0700	1.7780
11	0.1910	4.8514	51	0.0670	1.7018
12	0.1890	4.8006	52	0.0635	1.6129
13	0.1850	4.6990	53	0.0595	1.5113
14	0.1820	4.6228	54	0.0550	1.3970
15	0.1800	4.5720	55	0.0520	1.3208
16	0.1770	4.4958	56	0.0465	1.1811
17	0.1730	4.3942	57	0.0430	1.0922
18	0.1695	4.3053	58	0.0420	1.0668
19	0.1660	4.2164	59	0.0410	1.0414
20	0.1610	4.0894	60	0.0400	1.0160
21	0.1590	4.0386	61	0.0390	0.9906
22	0.1570	3.9878	62	0.0380	0.9652
23	0.1540	3.9116	63	0.0370	0.9398
24	0.1520	3.8608	64	0.0360	0.9144
25	0.1495	3.7973	65	0.0350	0.8890
26	0.1470	3.7338	66	0.0330	0.8382
27	0.1440	3.6576	67	0.0320	0.8128
28	0.1405	3.5687	68	0.0310	0.7874
29	0.1360	3.4544	69	0.0292	0.74168
30	0.1285	3.2639	70	0.0280	0.7112
31	0.1200	3.0480	71	0.0260	0.6604
32	0.1160	2.9464	72	0.0250	0.6350
33	0.1130	2.8702	73	0.0240	0.6096
34	0.1110	2.8194	74	0.0225	0.5715
35	0.1100	2.7940	75	0.0210	0.5334
36	0.1065	2.7051	76	0.0200	0.5080
37	0.104	2.6416	77	0.0180	0.4572
38	0.1015	2.5781	78	0.0160	0.4064
39	0.0995	2.5273	79	0.0145	0.3683
40	0.0980	2.4892	80	0.0135	0.3429

TAP DRILL SIZES - S.A.E. & METRIC

The tap drill sizes shown in the chart below gives the theoretical drill size for a 60 percent or a 75 percent thread depth. Generally, drill sizes must be selected from the 60 percent thread chart as these sizes will provide a thread which will have approximately 90 percent of the maximum holding strength. Drill sizes from the 75 percent thread chart are recommended for soft metals or for shallow holes tapped in mild steel when thread engagement will be less than 1.5 times the thread diameter.

Tap Size		Drill Size	Tap Size		Drill Size
60 percent	75 percent		60 percent	70 percent	
		48			1/8
		1.95 mm			3.20 mm
		5/64		M4x0.75	3.25 mm
	3-48	47			30
		2.00 mm		M4x0.7	3.30 mm
	M2.5x0.45	2.05 mm	M4x0.75		3.40 mm
3-48	3-56	46	M4x0.7	8-32	29
		45			3.50 mm
		2.10 mm		8-36	28
M2.5x0.45	M2.6x0.45	2.15 mm	8-32		9/64
3-56	4-36	44			3.60 mm
		2.20 mm			27
M2.6x0.45		2.25 mm			3.70 mm
4-36	4-40	43			26
		2.30 mm		M4.5x0.75	3.75 mm
4-40	4-48	2.35 mm		10-24	25
		42			3.80 mm
		3/32			24
	M3x0.6	2.40 mm		M4.5x0.75	3.90 mm
4-48		2.45 mm			23
		40			5/32
M3x0.6	M3x0.5	2.50 mm	10-24		22
		39		M5x1	4.00 mm
	5-40	38		10-32	21
M3x0.5		2.60 mm			20
5-40	5-44	37		M5x0.9	4.10 mm
		2.70 mm	M5x1	M5x0.8	4.20 mm
5-44	6-32	36	10-32		19
		2.75 mm	M5x0.9		4.25 mm
		7/64	M5x0.8		4.30 mm
		35			18
		2.80 mm			11/64
		34			17
6-32	6-40	33			4.40 mm
	M3.5x0.6	2.90 mm		12-24	16
		32			4.50 mm
M3.5x0.6		3.00 mm			15
6-40		31		M5.5x0.9	4.60 mm
		3.10 mm	12-24	12-28	14

Tap Size		Drill Size	Tap Size		Drill Size
60 percent	75 percent		60 percent	70 percent	
		13			6.70 mm
		4.70 mm			17/64
M5.5x0.9		4.75 mm		M8x1.25	6.75 mm
12-28		3/16	5/16-18		H
		12			6.80 mm
		4.80 mm			6.90 mm
		11		5/16-24	I
		4.90 mm	M8x1.25	M8x1	7.00 mm
		10			J
		9			7.10 mm
	M6x1	5.00 mm	5/16-24		K
		8			9/32
		5.10 mm		M8x1	7.20 mm
	1/4-20	7			7.25 mm
		13/64			7.30 mm
		6			L
M6x1		5.20 mm			7.40 mm
		5			M
	M6x0.75	5.25 mm			7.50 mm
		5.30 mm			
1/4-20		4			19/64
M6x0.75		5.40 mm			7.60 mm
	1/4-28	3			N
		5.50 mm			7.70 mm
		7/32		M9x1.25	7.75 mm
		5.60 mm			7.80 mm
1/4-28		2			7.90 mm
		5.70 mm		3/8-16	5/16
		5.75 mm	M9x1.25	M9x1	8.00 mm
		1			O
		5.80 mm			8.10 mm
		5.90 mm	M9x1		8.20 mm
		A			P
		15/64			8.25 mm
	M7x1	6.00 mm			8.30 mm
		B	3/8-16	1/8-7 NPT	21/64
		6.10 mm			8.40 mm
		C		3/8-24	Q
M7x1		6.20 mm		M10x1.5	8.50 mm
		D			8.60 mm
	M7x0.75	6.25 mm			R
		6.30 mm	3/8-24		8.70 mm
		E	1/8-27 NPT		11/32
		1/4		M10x1.25	8.75 mm
M7x0.75		6.40 mm	M10x1.5		8.80 mm
		6.50 mm			S
	5/16-18	F			8.90 mm
		6.60 mm	M10x1.25	M10x1	9.00 mm
		G			T

Tap Size		Drill Size	Tap Size		Drill Size
60 percent	75 percent		60 percent	70 percent	
		9.10 mm	5/8-16		37/64
		23/64			14.75 mm
M10x1		9.20 mm	M16x1.5		15.00 mm
		9.30 mm			15.25 mm
	7/16-14	U			39/64
		9.40 mm		M17x1.5	15.50 mm
	M11x1.5	9.50 mm	M17x1.5	M18x2.5	15.75 mm
		3/8			5/8
		V	M18x2.5	M18x2	16.00 mm
		9.60 mm	M18x2		16.25 mm
		9.70 mm		3/4-10	41/64
		9.75 mm		M18x1.5	16.50 mm
M11x1.5		9.80 mm	3/4-10	M19x2.5	21/32
7/16-14		W	M18x1.5		16.75 mm
		9.90 mm	M19x2.5		17.00 mm
	7/16-20	25/64			43/64
		10.00 mm			17.25 mm
7/16-20		X	3/4-16	3/4-16	11/16
	M12x1.75	10.20 mm		M20x2.5	17.50mm
		Y			17.75 mm
		13/32			45/64
		Z	M20x2.5	M20x2	18.00 mm
M12x1.75	M12x1.5	10.50 mm	M20x2		18.25 mm
	1/2-13	27/64			23/32
M12x1.5	M12x1.25	10.75 mm		M20x1.5	18.50 mm
M12x1.25		11.00 mm			47/64
1/2-13		7/16	M20x1.5		18.75mm
1/4-8 NPT					19.00 mm
		11.25 mm			3/4
		11.50 mm			19.25 mm
	1/2-20	29/64		7/8-9	49/64
		11.75 mm		M22x2.5	19.50 mm
	9/16-12	15/32	7/8-9		25/32
	M14x2	12.00 mm			19.75 mm
		12.25 mm	M22x2.5	M22x2	20.00 mm
9/16-12		31/64		7/8-14	51/64
M14x2	M14x1.5	12.50 mm	M22x2		20.25 mm
	9/16-18	1/2		M22x1.5	20.50 mm
M14x1.5	M14x1.25	12.75 mm	7/8-14		13/16
M14x1.25		13.00 mm			20.75 mm
9/16-18		33/64	M22x1.5	M24x3	21.00 mm
		13.25 mm			53/64
	5/8-11	17/32			21.25 mm
	M15x1.5	13.50 mm			27/32
M15x1.5		13.75 mm	M24x3		21.50 mm
5/8-11		35/64			21.75 mm
	M16x2	14.00 mm			55/64
		14.25 mm		M24x2	22.00 mm
	5/8-18	9/16		1-8	7/8
M16x2	M16x1.5	14.50 mm	M24x2		22.25 mm

Tap Size		Drill Size	Tap Size		Drill Size
60 percent	75 percent		60 percent	70 percent	
	M24x1.5	22.50 mm	M25x2		23.25 mm
1-8		57/64	1-12	1-14	59/64
M24x1.5		22.75 mm		M25x1.5	23.50 mm
	M25x2	23.00 mm	M25x1.5		23.75 mm
	1-12	29/32		1-14	15/16

AMERICAN STANDARD PIPE THREAD AND TAP DRILL SIZES

Pipe Size Inches	Threads Per Inch	Root Diameter Small End of Pipe and Gauge	Tap Drill	
			Taper NPT	Straight NPS
1/8	27	0.3339	Q	11/32
1/4	18	0.4329	7/16	7/16
3/8	18	0.5676	9/16	37/64
1/2	14	0.7013	45/64	23/32
3/4	14	0.9105	29/32	59/64
1	11-1/2	1.1441	1-9/64	1-5/32
1-1/4	11-1/2	1.4876	1-31/64	1-1/2
1-1/2	11-1/2	1.7265	1-47/64	1-3/4
2	11-1/2	2.1995	2-13/64	2-7/32

ELECTRICAL FORMULAS

To calculate or find an electrical value that is not known, use the formulas shown below:

Amperes (Current Flow)

VOLTS / OHMS = AMPERES

Volts (Electromotive Force)

AMPERES X OHMS = VOLTS

Ohms (Resistance)

VOLTS / AMPERES = OHMS

Watts

VOLTS X AMPERES = WATTS

NOTE: 1000 watts = 1 kilowatt

Horsepower

746 X WATTS = HORSEPOWER

0.746 X KIILOWATTS = HORSEPOWER

1.341 X HORSEPOWER = KILOWATTS

1341 X HORSEPOWER = WATTS

BELT SPEED CALCULATION FORMULAS

To calculate or find belt speed in ft/min, use the formulas below: = Belt Speed (ft/min)

Driver Sheave Diameter (inches) X 3.1416/12 X Driver Sheave Speed (rpm) = Belt Speed (ft/min)

Driver Sheave Diameter (inches) X 0.2618 X Driver Sheave Speed (rpm) = Belt Speed (ft/min)

GEOMETRICAL FORMULAS

To calculate or find the following geometrical values, use the formulas shown below:

Circumference of a Circle

Diameter of circle X 3.1416 = Circumference of circle

Area of a Circle

(Diameter of circle)^2 X0.7854 = Area of circle

Volume of a Cylinder

(Diameter of circle)^2 X0.7854 X Length of cylinder= Volume of cylinder

Volume of a Sphere

(Diameter of circle)^3 X0.5236 = Volume of sphere

Area of a Triangle

Length of triangle base X Length of triangle height / 2 = Area of triangle

METRIC TO IMPERIAL AND IMPERIAL TO METRIC CONVERSION FACTORS

To change metric measurements into imperial measurements or imperial measurements into metric measurements use the conversion factors shown below:

Measures of Temperature

Degrees Centigrade (Celsius) to Degrees Fahrenheit

(C X 1.8) + 32 = F

Degrees Fahrenheit to Degrees Centigrade (Celsius)

(F - 32) X 0.556 = C

Measures of Power

Kilowatts to Horsepower

Kilowatts X 1.34104 = Horsepower

Horsepower to Kilowatts

Horsepower X 0.7457 = Kilowatts

Measures of Pressure

kiloPascals to Pound-force per Square Inch

kiloPascals X 0.14504 = Pound-force per Square Inch

Pound-force per Square Inch to kiloPascals

Pound-force per Square Inch X 6.8947 = kiloPascals

Measures of Length

Millimeters to Inches

mm X 0.03938 = Inches

Inches to Millimeters

Inches X 25.4 = mm

Centimeters to Inches

Centimeters X 0.3937 = Inches

Inches to Centimeters

Inches X 2.54 = Centimeters

Meters to Feet

Meters X 3.2808 = Feet

Feet to Meters

Feet X 0.3048 = Meters

Meters to Yards

Meters X 1.09361 = Yards

Yards to Meters

Yards X 0.9144 = Meters

Kilometers to Miles

Kilometers X 0.62137 = Miles

Miles to Kilometers

Miles X 1.6093 = Kilometers

Measures of Area

Square Millimeters to Square Inches

Square Millimeters X 0.00155 = Square Inches

Square Inches to Square Millimeters

Square Inches X 645.16 = Square Millimeters

Square Centimeters to Square Inches

Square Centimeters X 0.1550 = Square Inches

Square Inches to Square Centimeters

Square Inches X 6.4516 = Square Centimeters

Square Meters to Square Feet

Square Meters X 10.7640 = Square Feet

Square Feet to Square Meters

Square Feet X 0.0929 = Square Meters

Square Meters to Square Yards

Square Meters X 1.196 = Square Yards

Square Yards to Square Meters

Square Yards X 0.836 = Square Meters

Square Kilometers to Square Miles

Square Kilometers X 0.38614 = Square Miles

Square Miles to Square Kilometers

Square Miles X 2.5889 = Square Kilometers

Hectares to Acres

Hectares X 2.47104 = Acres

Acres to Hectares

Acres X 0.40469 = Hectares

Measures of Volume (Dry)

Cubic Millimeters to Cubic Inches

Cubic Millimeters X 0.000061 = Cubic Inches

Cubic Inches to Cubic Millimeters

Cubic Inches X 16 387.06 = Cubic Millimeters

Cubic Centimeters to Cubic Inches

Cubic Centimeters X 0.0610 = Cubic Inches

Cubic Inches to Cubic Centimeters

Cubic Inches X 16.387 = Cubic Centimeters

Cubic Meters to Cubic Feet

Cubic Meters X 35.3145 = Cubic Feet

Cubic Feet to Cubic Meters

Cubic Feet X 0.028317 = Cubic Meters

Cubic Meters to Cubic Yards

Cubic Meters X 1.308 = Cubic Yards

Cubic Yards to Cubic Meters

Cubic Yards X 0.7646 = Cubic Meters

Cubic Meters to Bushels

Cubic Meters X 27.4959 = Bushels

Bushels to Cubic Meters

Bushels X 0.03639 = Cubic Meters

Measures of Volume (Liquid)

Milliliters to Fluid Ounces

Milliliters X 0.35195 = Fluid Ounces

Fluid Ounces to Milliliters

Fluid Ounces X 28.413 = Milliliters

Centiliters to Fluid Ounces

Centiliters X 0.35195 = Fluid Ounces

Fluid Ounces to Liters

Fluid Ounces X 0.02841 = Liters

Liters to Imperial Quarts

Liters X 0.880 = Imperial Quarts

Imperial Quarts to Liters

Imperial Quarts X 1.13652 = Liters

Liters to Imperial Gallons

Liters X 0.21997 = Imperial Gallons

Imperial Gallons to Liters

Imperial Gallons X 4.546 = Liters

Liters to U.S. Quarts

Liters X 1.0567 = U.S. Quarts

U.S. Quarts to Liters

U.S. Quarts X 0.946 = Liters

Liters to U.S. Gallons

Liters X 0.2642 = U.S. Gallons

U.S. Gallons to Liters

U.S. Gallons X 3.785 = Liters

Measures of Mass (Weight)

Grams to Ounces

Grams X 0.03527 = Ounces

Ounces to Grams

Ounces X 28.355 = Grams

Kilograms to Pounds

Kilograms X 2.2046 = Pounds

Pounds to Kilograms

Pounds X 0.45359 = Kilograms

Metric Tonnes to Pounds

Metric Tonnes X 2204.628 = Pounds

Pounds to Metric Tonnes

Pounds X 0.000454 = Metric Tonnes

Long Tons to Short Tons

Long Tons X 1.1023 = Short Tons

Short Tons to Long Tons

Short Tons X 0.90718 = Long Tons

Measures of Effort (Torque)

Inch Ounces to Inch Pounds

Inch Ounces X 0.0625 = Inch Pounds

Inch Pounds to Inch Ounces

Inch Pounds X 16 = Inch Ounces

Inch Pounds to Foot Pounds

Inch Pounds X 0.0834 = Foot Pounds

Foot Pounds to Inch Pounds

Foot Pounds X 12 = Inch Pounds

Inch Ounces to Newton Meters

Inch Ounces X 0.00706 = Newton Meters

Newton Meters to Inch Ounces

Newton Meters X 141.6112 = Inch Ounces

Inch Pounds to Newton Meters

Inch Pounds X 0.1130 = Newton Meters

Newton Meters to Inch Pounds

Newton Meters X 8.8507 = Inch Pounds

Foot Pounds to Newton Meters

Foot Pounds X 1.3556 = Newton Meters

Newton Meters to Foot Pounds

Newton Meters X 0.73756 = Foot Pounds