



G O P R E P A R E D TM

SERVICE MANUAL

FOR THE

Warn

Mid-Frame Winches

M-6000, M-8000, XD9000

12V DC

Electric Winch

- COMPLETE REPAIR / REPLACEMENT INSTRUCTIONS
- TROUBLE SHOOTING GUIDE

As you read these instructions, you will see **NOTICES, CAUTIONS** and **WARNINGS**. Each message has a specific purpose. A **NOTICE** is additional information to help you complete a procedure. **CAUTIONS** are safety messages that indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. A **CAUTION** may also be used to alert against unsafe practice. **WARNINGS** are safety messages that indicate a potentially hazardous situation, which, if not avoided could result in serious injury. **CAUTIONS** and **WARNINGS** identify the hazard, indicate how to avoid the hazard, and advise of the probable consequence of not avoiding the hazard. **PLEASE WORK SAFELY!**

Warn Industries, Inc

**12900 SE Capps Road
Clackamas, OR 97015 USA**

REV A

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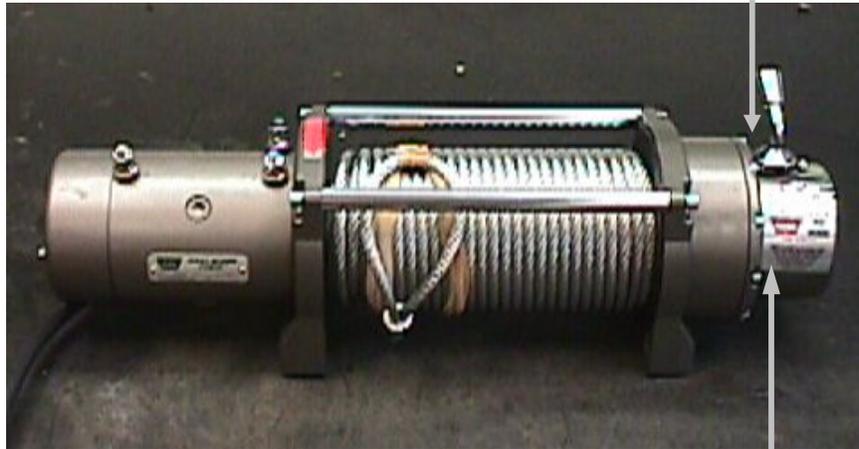
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SECTION 1 - Getting Started

1.1 Winch Model Identification

To ensure proper winch repair it is necessary to correctly identify the model and part number of your winch. This makes ordering replacement parts easier, and helps you obtain the necessary information from your Authorized Service Center. **NOTE: For a part description, item number and quantity, refer to the Replacement Parts List in this manual for your specific winch model.**

WINCH SERIAL NUMBER: identifies when winch was manufactured and identifies individual winch.



WINCH NAME PLATE LABEL: Identifies model designation and identifies winch configuration and winch pull rating.

Figure 1.1 Locations of Product Identification Nomenclature

1.2 Definitions And Winch Operation

1.2.1 Definitions

Operation and service of a Warn planetary winch can be explained easier by defining a few major structural components. Refer to *Figure 1.2* for the following definitions:

MOTOR: The electric winch is driven by a high speed, low torque electric motor. A 12-volt DC vehicle battery generally powers the electric motor.

DRUM: The winch drum is the structural component of the winch used to store wire rope and to transmit torque from the winch motor and gears to the wire rope.

DRUM SUPPORTS: Drum supports are the structural components of the winch that mount the winch to the vehicle. The drum rotates while being held by the drum supports and both the motor and gear train are attached to a drum support.

GEAR TRAIN: Warn electric planetary winches consist of a gear train made up of three planetary gear stages. The purpose of the gear train is to multiply motor torque and to reduce motor speed transmitted to the drum. Warn gear trains are enclosed in a housing and are lubricated with grease.

FREESPOOL CLUTCH: A freespool clutch is incorporated in the gear train to allow the user to pull the wire rope off the drum to the anchor point where the hook will be attached, without using the winch motor. This is referred to as "Freespooling".

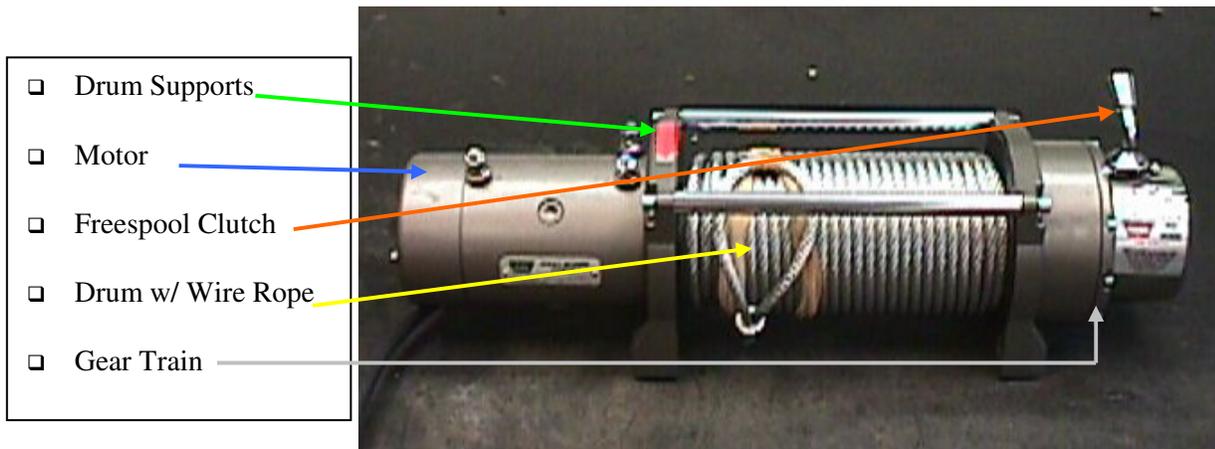
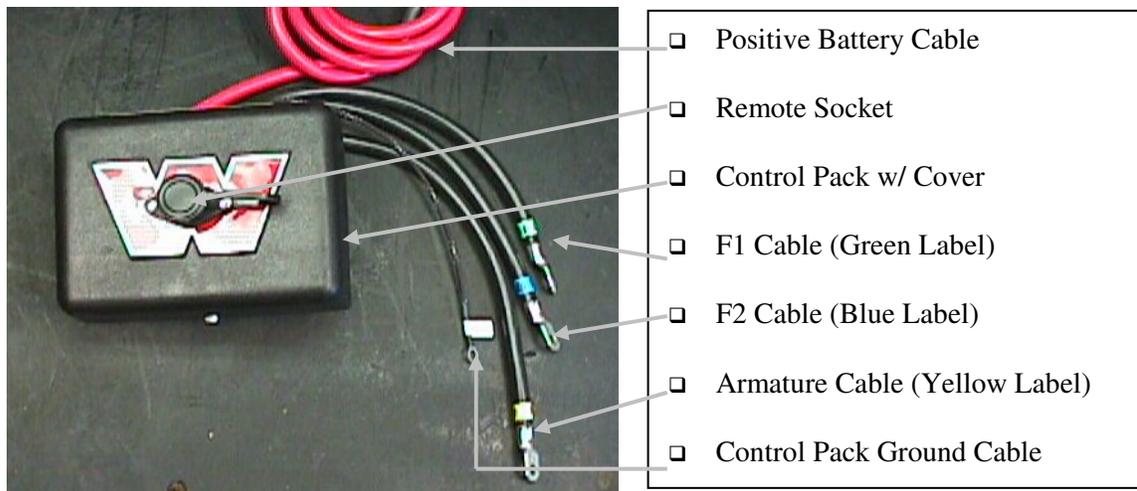


Figure 1.2 Major Winch Components

MOTOR CONTROLS: The electric winch motor controls consist of a control pack (also referred to as a solenoid pack), which is most often mounted to the motor, and a remote control handle connected to the control pack with a cord. The winch motor power source cables are connected to the control pack which in turn feeds power to the winch motor through electrical cable connections. The main function of the control pack is to allow the operator to switch the winch on and off in both directions.



BRAKE: All planetary winches are equipped with a **directional sensitive** automatic brake. The brake requires that the wire rope be wound onto the drum in the correct direction to operate properly. A Drum rotation label is located on the motor end drum support to help identify proper rotation. When the wire rope is reeled in, the brake is not activated. When reeling out under load, however, the brake slows the winch drum to an acceptable speed and holds the load when the winch is shut off. The brake is usually located inside the winch drum and dissipates heat through the drum and wire rope.

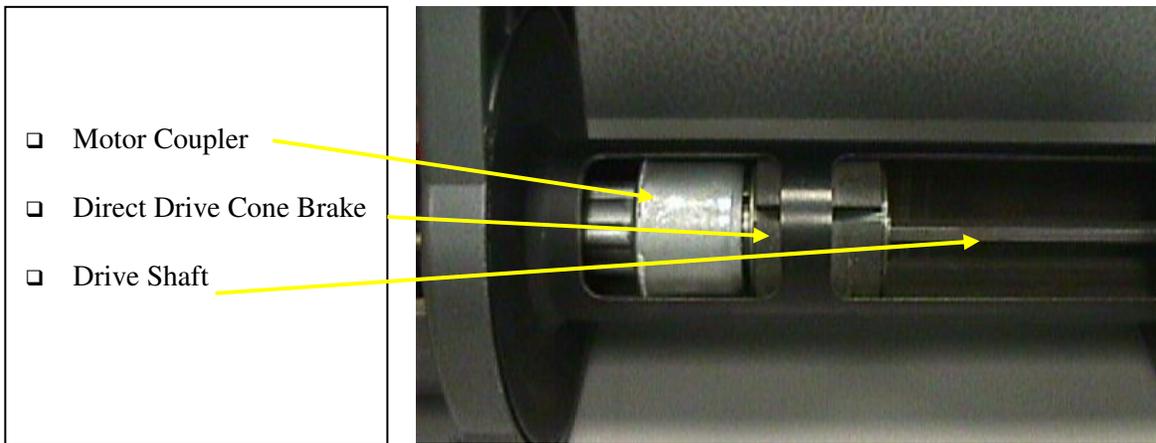


Figure 1.4 Internal Winch Brake

POWER-IN and POWER-OUT - Terms used to describe winch operation. When the wire rope is reeled in under motor power, it is being "powered in". When the wire rope is reeled out under motor power it is being "powered out". (This is different than when the winch is "freespooled out", which refers to the wire rope being pulled out by hand with the freespool clutch disengaged.)

1.2.2 Winch Operation

A Warn winch is a compact device used to pull heavy loads over short distances up to 100'. (Refer to Figure 1.2 when reading the following section). The vehicle battery and charging system generates the power for pulling the load.

Power feeds from the battery power source into the winch control pack. At the push of a remote control switch the power flows to the winch motor.

The winch motor turns the electrical energy into mechanical energy. The motor shaft turns the motor coupler, which, in turn, drives the brake.

On power-in operation, the brake simply rotates and drives the planetary gears, starting with the gear carrier stage farthest from the winch drum (the first stage carrier.) The first stage carrier, in turn, drives the second stage carrier, which then drives the third stage carrier. The third stage directly drives the drum. Since the wire rope is connected to the drum, the rope winds around the drum, causing the load to be drawn in.

On power-out operation, the motor is reversed and the winch drum is rotated in the opposite direction. All winch components operate in the same manner as during power-in except the brake. During power-out, the load tries to "over speed" the motor (make the motor turn faster than it would under its own power.) When the brake detects this over speed it engages just enough to make the load and motor run at the same speed and slow the load. When the remote control switch is released, the brake engages and completely stops the load.



Long power- out cycles under load can over heat the brake and cause it to no longer hold the rated load

SECTION 2 – Disassembly & Assembly

2.1 Owner/Operator Repairs



PLEASE READ THIS BEFORE ATTEMPTING REPAIRS

THIS MANUAL IS INTENDED FOR USE BY THE WINCH OWNER AND/OR OPERATOR, SOME REPAIRS SHOULD BE DONE ONLY BY A WARN AUTHORIZED SERVICE TECHNICIAN. IF YOU DO MAKE REPAIRS, IT IS IMPORTANT THAT YOU DO NOT ATTEMPT THEM WITHOUT THE PROPER TOOLS AND EQUIPMENT. IT IS ALSO IMPORTANT TO CORRECTLY FOLLOW THE INSTRUCTIONS. FAILURE TO DO SO MAY CAUSE THE WINCH TO FAIL RESULTING IN SERIOUS BODILY INJURY OR PROPERTY DAMAGE.

IMPORTANT NOTE: OWNER REPAIRS WILL VIOLATE THE WARRANTY ON THE COMPONENTS BEING REPLACED OR REPAIRED.

2.2 Suggested Tools

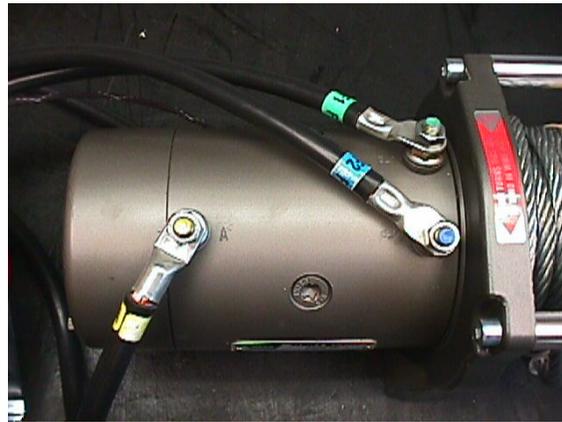
The following tools are suggested for these procedures: 1 – 5/32" HEX KEY WRENCH, 1- 1/4" HEX KEY WRENCH, 1 – 13mm, 1 – 1/2", 3/8" BOX OR OPEN END WRENCHES, 1- FLAT HEAD SCREWDRIVER, 1- PLIERS, 1-TORQUE WRENCH.

2.3 Disassembly

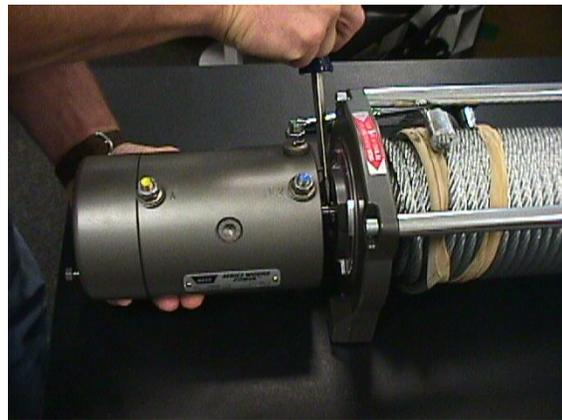


Always disconnect all wires from the **POSITIVE BATTERY TERMINAL BEFORE** beginning ANY WORK on the winch. **FAILURE TO DO SO MAY CAUSE THE WINCH TO FAIL RESULTING IN SERIOUS BODILY INJURY OR PROPERTY DAMAGE.**

- ❑ Mark electrical cables for easier assembly later. Remove winch from vehicle.
- ❑ Repairs are easier and safer when winch is removed from vehicle and located on a workbench.



- ❑ Remove motor from the motor end drum support by removing the two motor bolts.
- ❑ Visually verify that the armature shaft is moving out with the motor housing. Use a screwdriver if needed to move armature with motor. Caution, if the armature falls out of the motor the motor brushes will need to be reset to allow reinstallation.



- ❑ Stand winch on gear housing end
- ❑ Remove the two tie rod bolts. A second wrench or pliers attached to the tie rods may be required to remove the bolts.



- ❑ Remove the split plastic drum bushing.
- ❑ Check the drum bushing and drum support for excessive wear



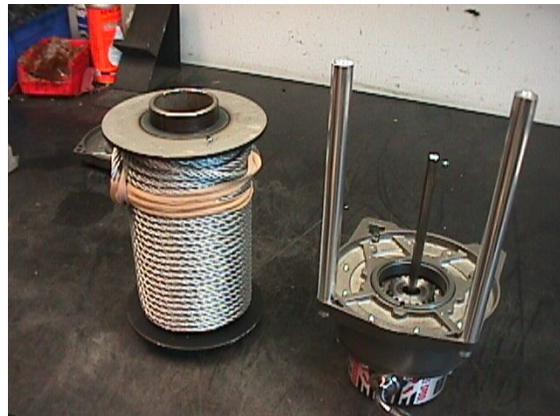
- ❑ Remove the motor side drum support and the aluminum motor coupler from the drum assembly



NOTICE

If brake removal is required, go to SECTION 3 - BRAKE REMOVAL AND REPLACEMENT for brake removal procedures

- ❑ Remove the drum assembly from the gear train end of the winch.
- ❑ Remove the drive shaft from the gear train end of the winch



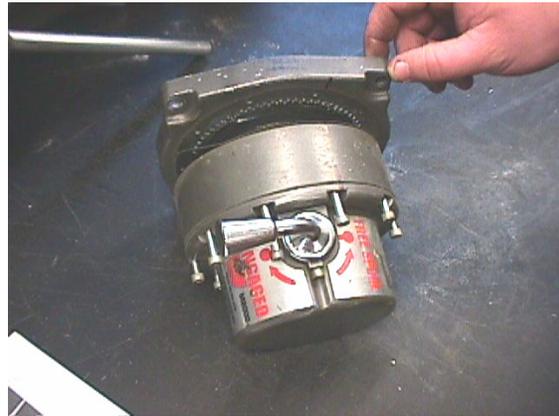
- ❑ Mark the housing ring gear and drum support with a marking pen in one location so they can be easily realigned during assembly.



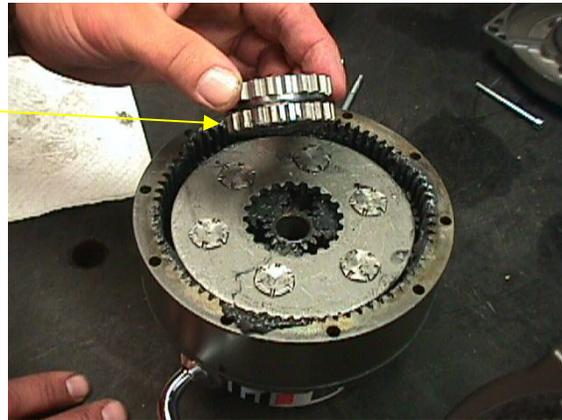
- ❑ Remove the ten allen head cap screws
- ❑ Remove the drum support from the ring gear.



- ❑ Remove complete gear-train from drum support



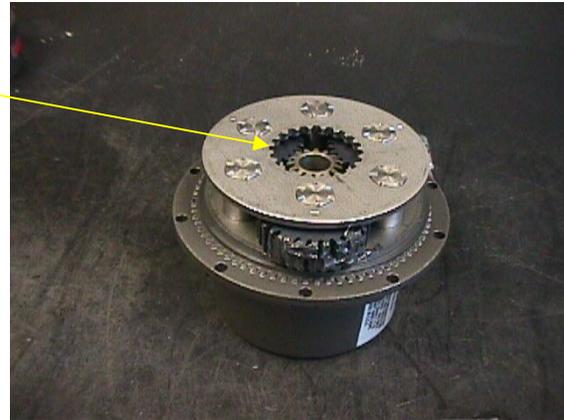
- ❑ Remove the drive spline from the third stage carrier



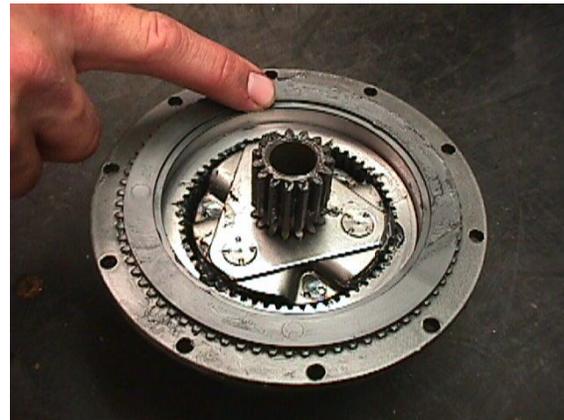
- ❑ Remove the ring gear from the end housing



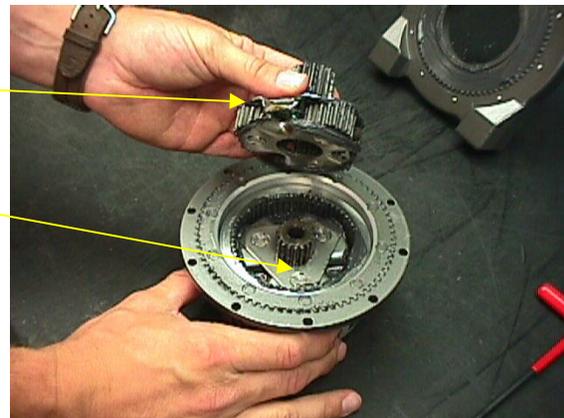
- ❑ Note that the splined end of the third stage gear is facing up.
- ❑ Remove the third stage carrier



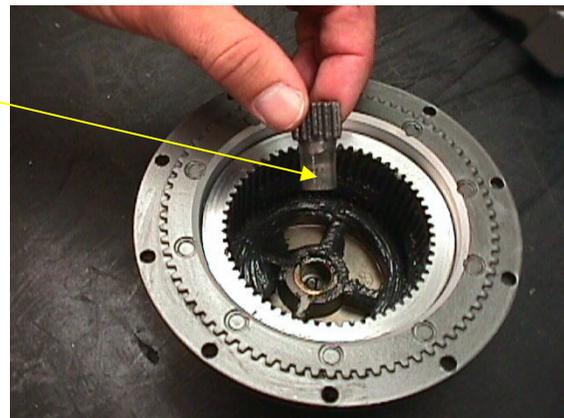
- ❑ After removing the third stage gear you will see the second stage gear.
- ❑ Note the position of the groove in the thrust washer.



- ❑ Remove the second stage planetary gear from the gear housing.
- ❑ Remove the first stage gear.



- ❑ Remove the loose first stage sun gear. Check for worn or chipped gear teeth.
- ❑ Check all gears for excessive wear and replace if necessary.



- ❑ Remove the free spooling clutch handle from the gear train by removing the allen head set screw then lifting the handle out of the housing.



- ❑ Remove the O-ring seal and seal retainer, inspect the O-ring seal for wear.



- ❑ Remove the sliding ring gear from the gear train end housing.
- ❑ Check all gears for excessive wear, worn or chipped gear teeth.



2.4 Reassembly

- ❑ Apply a light coat of machine oil to the inside of the gear housing where the sliding ring gear rides.

CAUTION

Do not apply grease to the machined surface of the gear housing. This will cause difficulty in free-spooling



- ❑ Install the sliding ring gear with the grooved end up.



- ❑ Grease the o-ring seal, install the o-ring seal and seal retainer onto the gear housing. Then place the clutch lever into the hole in the housing.
- ❑ Clutch lever eccentric must align with machined groove in ring gear.



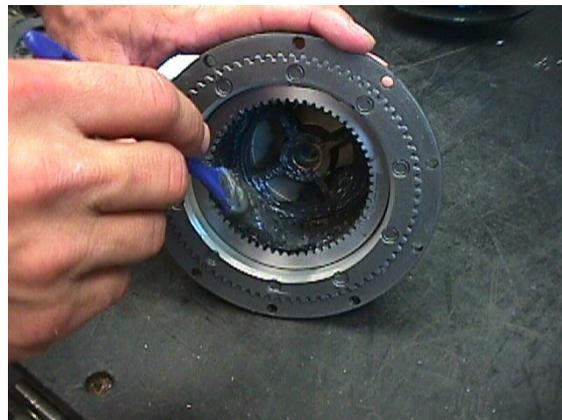
- ❑ Secure the clutch lever with the allen head set screw.



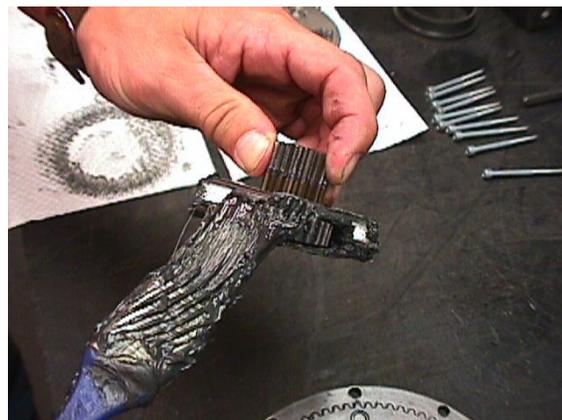
- ❑ Apply a light coating of machine oil to the sun gear shaft.
- ❑ Install the sun gear into the bushing in the end of the housing.



- ❑ Coat the inside of the ring gear teeth with grease until all spaces between the teeth are filled.
- ❑ Use a grade of moly-disulfide grease with good performance between -50°F (-45.5°C) and $+125^{\circ}\text{F}$ (51.7°C). Aeroshell #17 is recommended.



- ❑ Completely fill the teeth of the first stage and second stage carrier assemblies with grease and place into the gear housing.
- ❑ Use light grade machine oil on the three planetary gear bushings inside the carrier assembly.



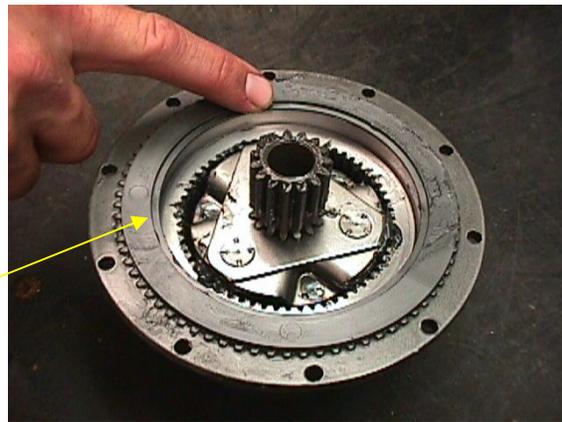
- ❑ It may help to align all the planetary gear teeth if you install the hex drive shaft into the first stage sun gear and rotate slightly as you slide the gears into place.
- ❑ Install the second stages rotating the shaft to align the teeth.
- ❑ Remove the shaft to allow for installation of the drum support.



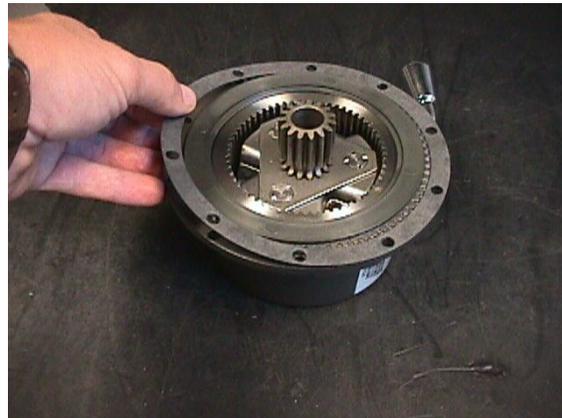
- ❑ Apply a light coating of grease to the thrust washer and install on the gear housing.

CAUTION

The thrust washer must be installed with the groove facing up for proper operation.



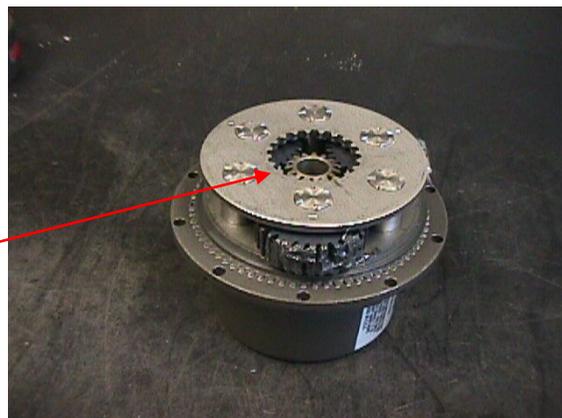
- ❑ Install the gasket material on to the gear housing.
- ❑ Line up the holes in the gasket with those in the housing.



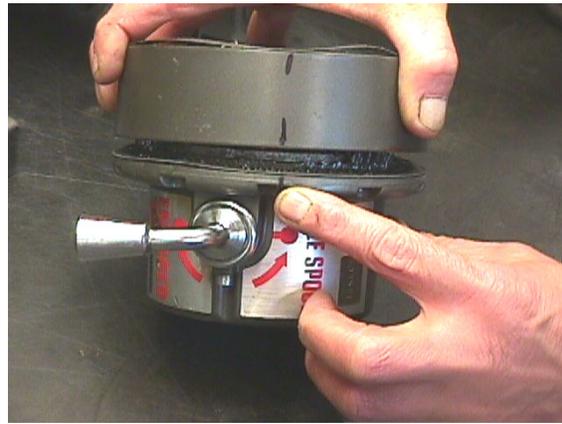
- ❑ Grease and install the third stage planetary gear set on to the second stage assembly and trust washer.

CAUTION

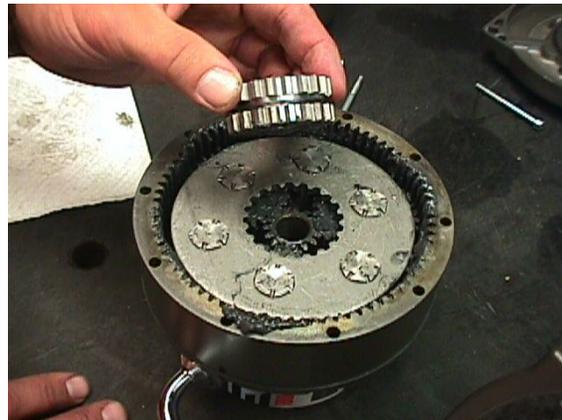
Make sure that the splined end of the third stage planetary is facing up.



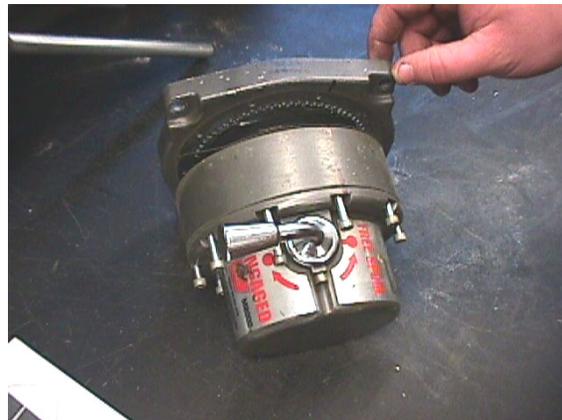
- ❑ Install the third stage ring gear on to the third stage planetary gear set and the housing.
- ❑ Make sure to line up the index marks that were made during the disassembly process when reassembling.



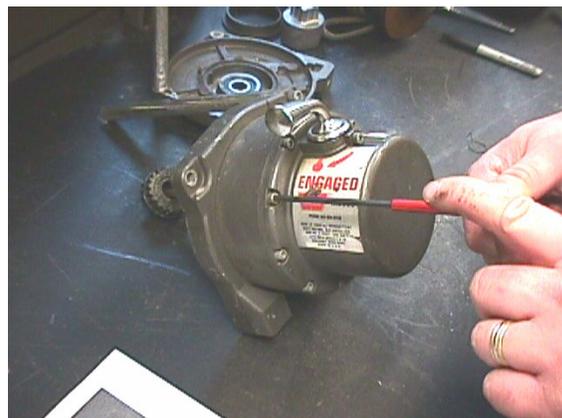
- ❑ Insert the drive spline into the third stage carrier.



- ❑ Apply the second gasket to the ring gear, making sure you line up the holes in the gasket and those in the ring gear.
- ❑ Install the gear train onto the end support by lining up the index marks you made during disassembly.



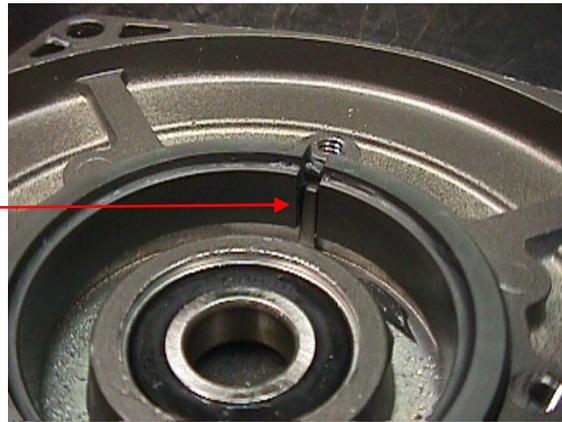
- ❑ Attach the gear train to the end housing using 10 allen head screws.
- ❑ Reinstall the tie rods if they have been removed during disassembly.



- Apply a light coating of grease to the inside of the drum bushing and install into the drum support

CAUTION

For the bushing to fit properly the slot in the bushing must fit over the index tab in the drum support.



NOTICE

If the brake has been removed from the drum, go to section 3-BRAKE REMOVAL AND REPLACEMENT for brake installation procedures.

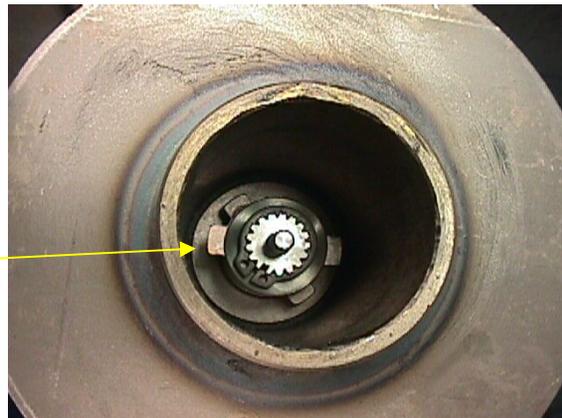
- With the brake installed in the drum, insert the hex drive shaft into the brake and then install the drum with the shaft, onto the gear train assembly.
- You may need to spin the hex shaft to line it up with the sun gear in the gear housing.



CAUTION

Brake will not function properly if the coupler tangs are not positioned properly

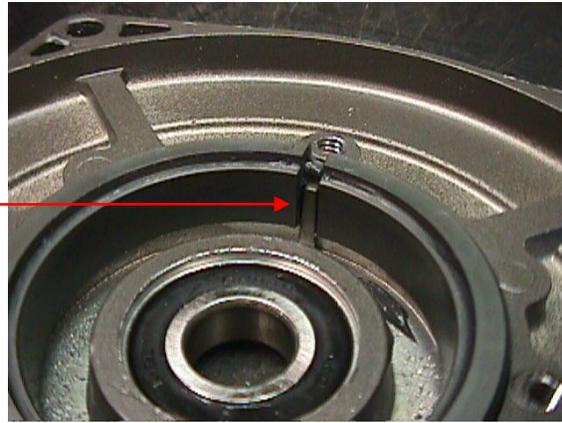
- Install the aluminum motor coupler over the brake assembly with the internal tangs on the motor coupler at a 90 degree angle to the tangs on the cam follower of the brake assembly.
- Cam Follower tang.



- ❑ Apply a light coating of grease to the inside of the drum bushing and install it into the drum support

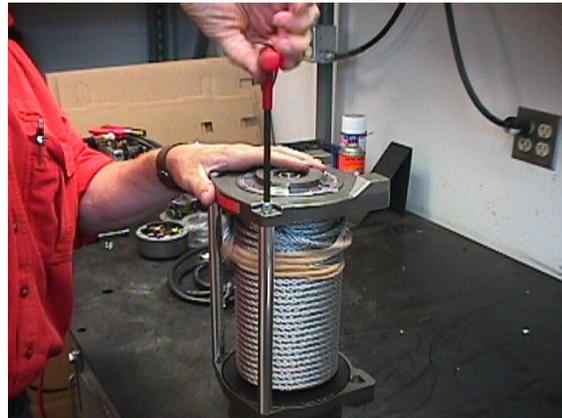
CAUTION

For the bushing to fit properly the slot in the bushing must fit over the index tab in the drum support.



- ❑ Install the motor end drum support on to the drum and attach the tie rods with the two allen head cap screws.

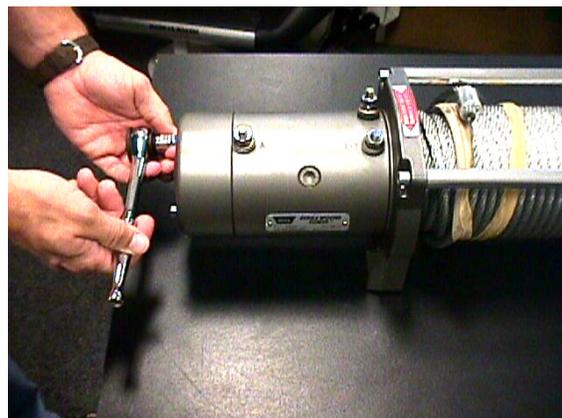
- ❑ Torque the cap screws to 18-22 ft. lb. (24.4-29.8 Nm)



- ❑ Install the motor on to the drum support making sure that the index pin in the motor housing seats into the index hole in the end support.
- ❑ You may need to rotate the motor back and forth to get the splines on the motor to line up with those in the motor coupler.



- ❑ Secure the motor with the two motor bolts. Torque the bolts to 5-7 ft. lb. (6.8-9.5 Nm)



- ❑ Reattach the electrical cables from the control pack to the motor.



NOTES:

SECTION 3 - Brake Removal And Replacement For MID-Frame Winches

NOTICE

Warn Industries does not offer individual replacement brake parts. The complete brake assembly must be replaced.

3.1 Suggested Tools

These tools are suggested for the following procedures: 1-7/32" Hex Key Wrench, Rubber Mallet.

3.2 Disassembly

- ❑ Remove the wire rope from the drum or secure it on the drum for ease of working.
- ❑ Remove the drum from the winch as described in *winch disassembly section 2.3*



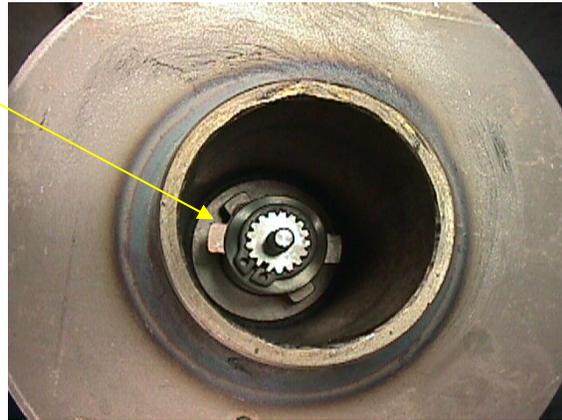
- ❑ Set drum on solid working surface (table, bench, etc). then remove the aluminum motor coupler from the drum tube.





The brake unit is spring loaded. Should the brake unit unwind it will be necessary to replace it with a new brake assembly. Never attempt to rewind a brake unit that has come unwound.

- ❑ There are **two** ways to remove the brake assembly from the drum.
- ❑ Number 1: Pinch the brake tangs together and lift out.
- ❑ The friction material will be loose when the brake is removed from the drum.
- ❑ Lock the brake tangs together with locking pliers or a clamp to prevent the brake from coming unwound.
- ❑ If the brake assembly will not slide out, set the drum on end and use a steel rod, drift pin or similar tool and push the brake out of the drum



- ❑ Number 2: Remove the brake assembly by pinching the brake tangs together, then partially slide the brake out of the motor end of the drum.
- ❑ If the brake assembly will not slide out easily, set the drum on end and use a steel rod, drift pin or similar tool and push the brake out of the drum.



- ❑ To prevent the spring loaded brake assembly from unwinding, use either a cardboard or steel tube with an internal diameter of 2 1/8" to hold the brake together.
- ❑ Remove the complete brake assembly from the drum



3.3 Reassembly/ New Brake Installation

- ❑ Set the drum assembly on a solid work surface and slide the brake unit through the cardboard sleeve into the drum about 6"



- ❑ With the brake installed in the drum, insert the hex drive shaft into the brake and then install the drum with the shaft on to the gear train assembly.
- ❑ You may need to spin the hex shaft to line it up with the sun gear in the gear housing.



Brake will not function if the motor coupler tangs are not positioned properly.

- ❑ Install the aluminum motor coupler over the brake assembly in the drum with the internal tangs on the coupler at a 90 degree angle to the tangs on the cam follower of the brake assembly.
- ❑ Cam Follower tang.



- ❑ Install the aluminum Motor coupler over the brake assembly in the drum with the internal tangs on the coupler at a 90 degree angle to the cams on the brake assembly.



- ❑ Reinstall drum support and motor as outlined in the winch basic assembly instruction in section 2.4.



SECTION 4.0 - Electric Motor & Control Pack Overview And Wiring Reference

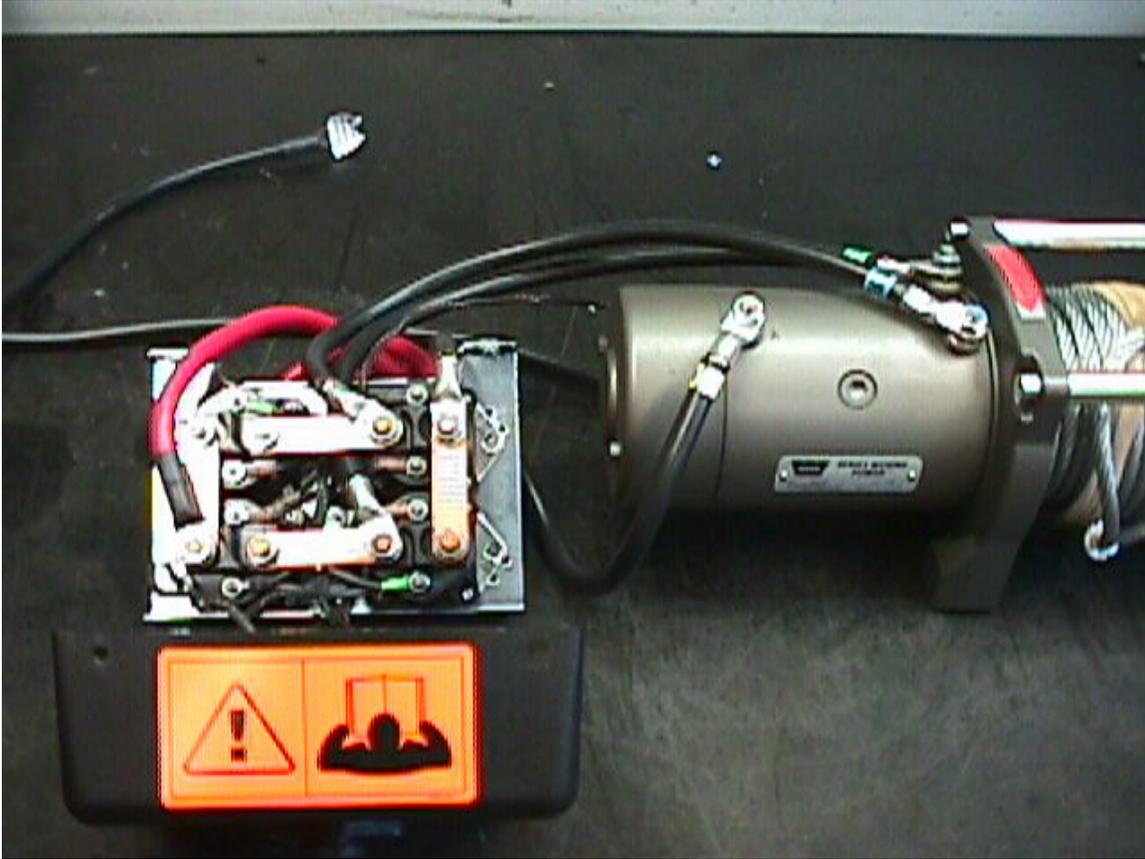


Figure 4.1

4.1 Overview Of Control Pack Operation

Electrical operation of the winch control assembly consists of four heavy-duty solenoids. In the power out mode, the black wire and the white wire are triggered by the remote control switch to energize solenoids number 2 and 3. (see figure 4.2)

In the power-in mode, the green wire and the white wire are triggered by the remote control switch to energize solenoids numbers 1 and 4.

CAUTION

Because of the large amounts of current needed to pull loads at the higher capacities we recommend using a ground cable the same size as the positive (+) battery lead.

The ground cable should be attached directly to the bolt located on the under side of the motor housing from the three terminals. And also to the negative (-) battery terminal.

Figure 4.2 is the basic wiring diagram of the 12v winch control pack .The redundant solenoid system provides safety against run on from stuck / shorted solenoids.

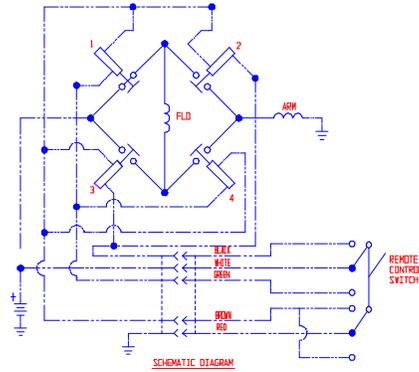
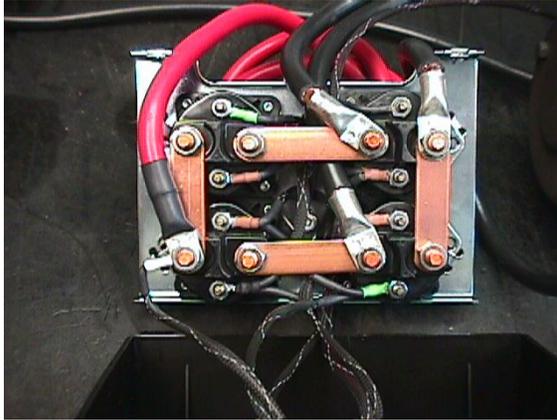


Figure 4.2 Control Pack and Wiring Schematic

Figure 4.3 is the basic wiring diagram of the 5-wire remote control. The five-wire remote is designed to control both the voltage side of the circuit as well as the ground. When the remote control is unplugged, the ground circuit is disconnected.

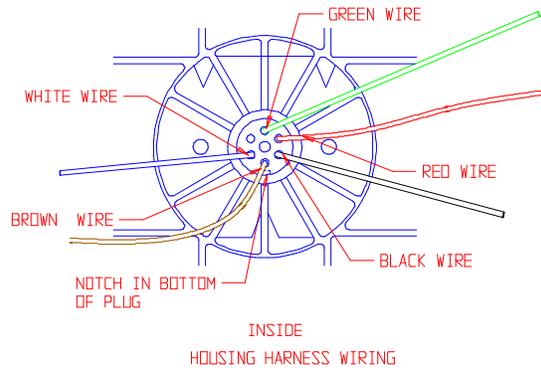


Figure4.3 Remote Control Plug And Wiring Schematic

The drawing in figure 4.4 is for routing the wires in the control pack to prevent heat damage from the bus bars in a 12 VDC control pack.

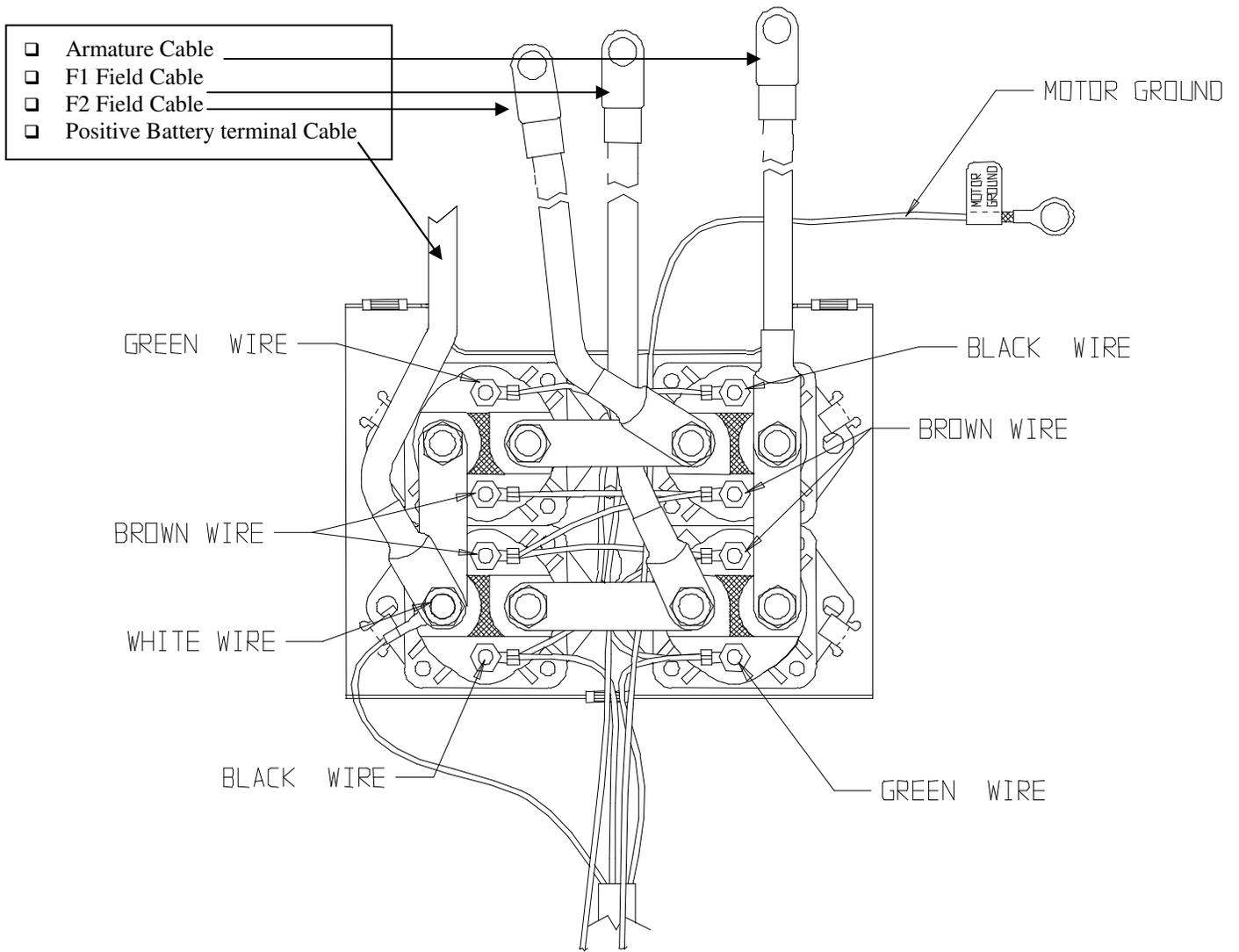


Figure 4.4 12v Winch Control Pack Wiring Diagram

4.2 Electric Motor Removal and Motor Brush Replacement

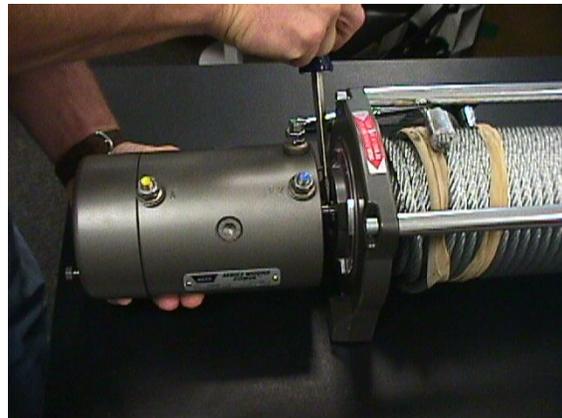
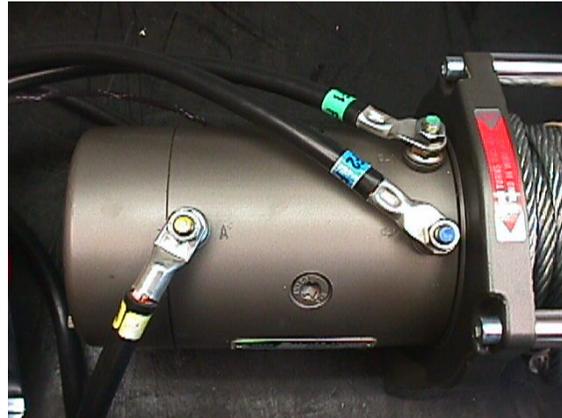
⚠ WARNING

Always disconnect all wires from the **POSITIVE BATTERY TERMINAL BEFORE beginning ANY WORK on the winch. FAILURE TO DO SO MAY CAUSE THE WINCH TO FAIL RESULTING IN SERIOUS BODILY INJURY OR PROPERTY DAMAGE.**

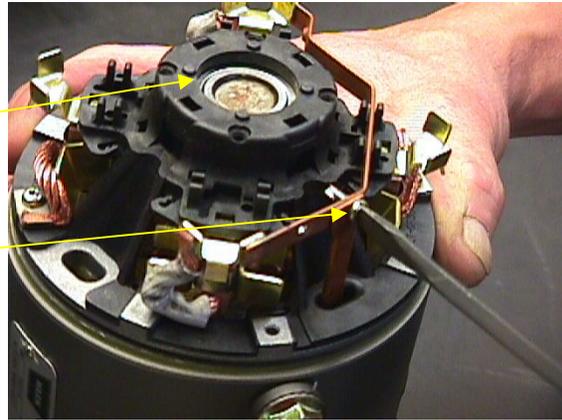
- ❑ Mark electrical cables for easier assembly later. Remove winch from vehicle.
- ❑ Repairs are easier and safer when winch is removed from vehicle and located on a workbench.
- ❑ Disconnect cables from the control pack, and disconnect the battery ground cable.

- ❑ Remove motor from the motor end drum support by removing the two motor bolts.

- ❑ Remove motor end cap from motor housing
- ❑ Plastic brush holder and brushes will be visible



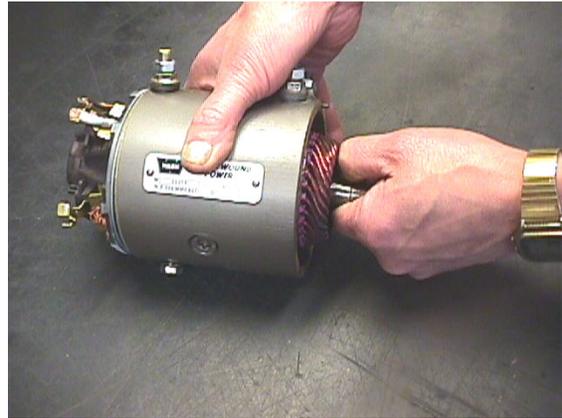
- ❑ Note the location of the armature bearing in the brush holder. 4 plastic lock tabs secure the bearing.
- ❑ Remove screw from copper strap. This will allow the release of the brush holder from the motor housing.



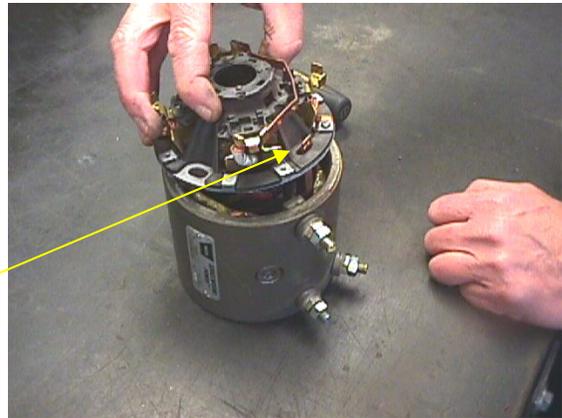
- ❑ Pull armature firmly to remove from motor housing and brush holder.

CAUTION

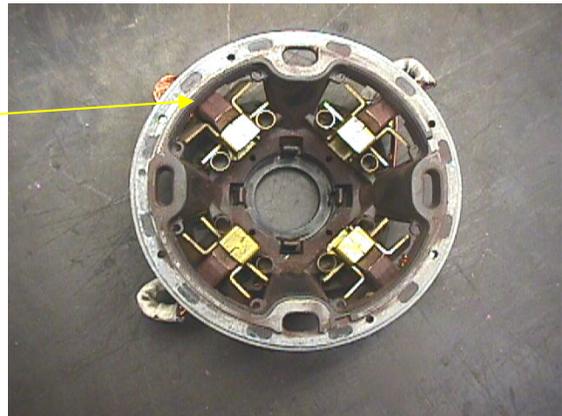
Remove armature carefully to prevent breaking of lock tabs that secure armature bearing to brush holder.



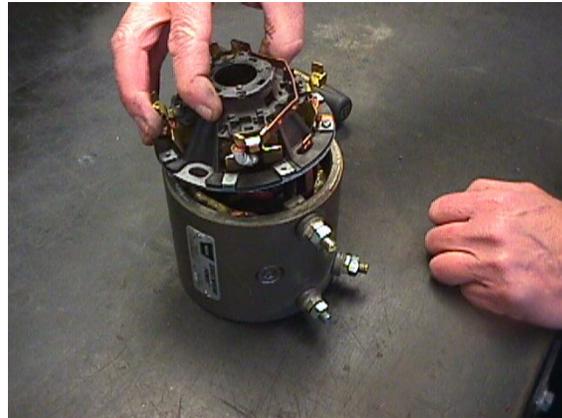
- ❑ Remove the brush holder from the motor housing.
- ❑ Inspect brushes, replace brushes if they measure less than 1/2 inch in length.
- ❑ Note the location position of the slot the brass strap slides through.



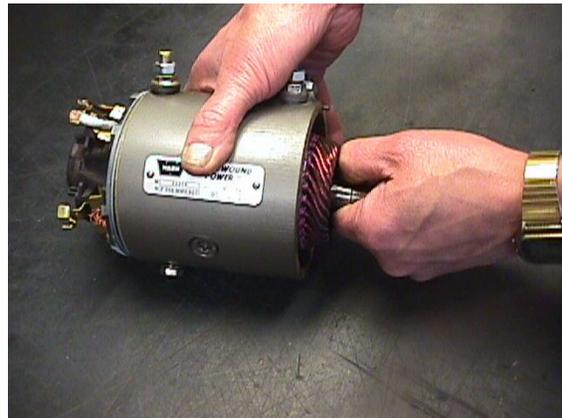
- ❑ Secure the four brushes. Pull the brush outward and angle them down so they stay secured in the bracket.
- ❑ The brushes must be secured before the armature can be installed.



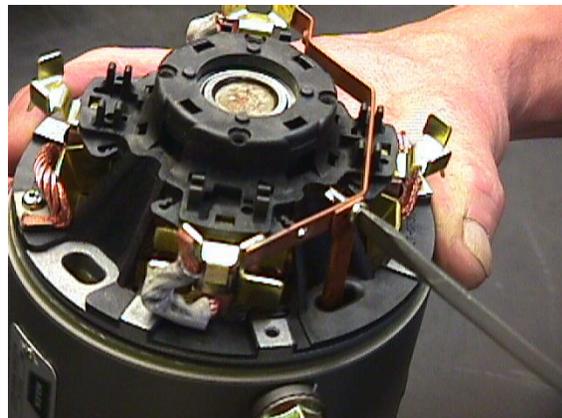
- ❑ Align brush holder slot with motor housing strap so it lines up with screw hole.



- ❑ Carefully install armature into motor housing.
- ❑ Place brush holder on flat surface, gently align motor housing, armature and brush holder.
- ❑ Snap armature bearing into brush holder clips.



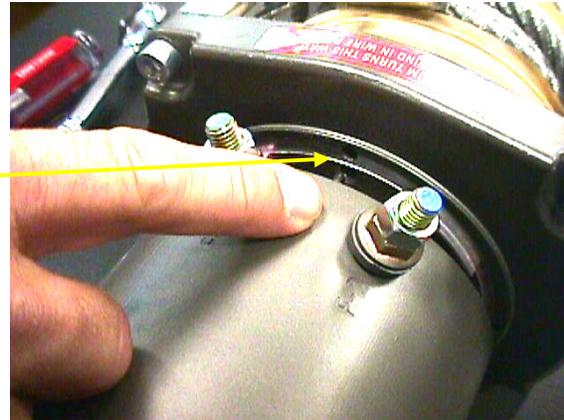
- ❑ Secure motor housing strap to brush holder.
- ❑ Inspect all electrical connections to ensure they are tight. Inspect cable insulation for damage, and make sure cables are not being pinched.



- ❑ Reinstall motor cap assembly.

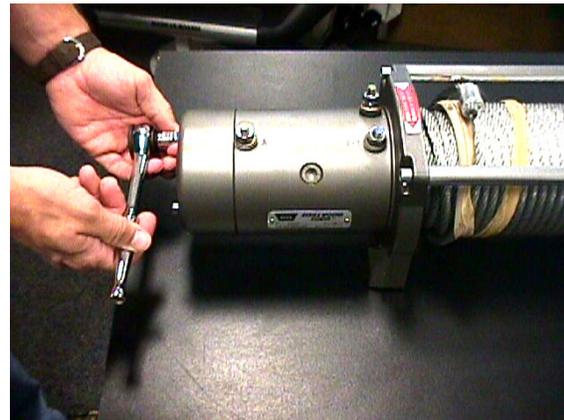


- ❑ Install the motor on to the drum support making sure that the index pin in the motor housing seats into the index hole in the end support.



- ❑ You may need to rotate the motor back and forth to get the splines on the motor to line up with those in the motor coupler.

- ❑ Secure the motor to the drum support with the two motor bolts.



SECTION 5 – Winch Trouble Shooting Guide

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
5.1.1 Winch does not hold load	a. Wire Rope is spooled onto the drum in the wrong direction.	Remove all wire rope from drum and respool in the proper direction. (see directional label on drum support).
	b. Load exceeds winch rating.	Refer to the Winch Operators Manual for the correct line pull rating for your winch. DO NOT EXCEED THE LINE PULL RATING SHOWN ON THE IDENTIFICATION LABEL
	c. Brake inside winch drum is badly worn or broken.	Replace brake. Entire brake assembly must be replaced. Refer to this manual for winch brake replacement.
5.1.2 Brake over heats and will not hold load.	a. Wire rope is spooled onto drum in the wrong direction. Winch is working against the brake in the power-in mode	Remove all wire rope and respool in the proper direction. (See directional label on drum support)
	b. Load exceeds rating for winch.	Refer to Winch Operators Manual for the line pull rating for your winch. DO NOT EXCEED LINE PULL RATING SHOWN ON IDENTIFICATION LABEL.
	c. After a very long power-out cycle (over 30 feet under heavy load), brake has overheated.	Let brake cool for approximately 30 minutes. These winches are rated for intermittent duty operation only. As the load is increased, the duration of power-out cycles must be reduced to limit brake temperature. Allow adequate time for brake to cool between extended power-out cycles.
5.1.3 Difficulty in spooling wire rope OFF drum by hand.	a. Bent drum flange.	Rotate drum on winch and inspect for bent drum flanges. A bent drum must be removed and replaced. See (Section 2.3) drum removal instructions.
	b. Worn drum bushings.	Remove drum from winch (Section 2.3). Inspect drum bushings and drum support for wear.

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
	c. Free spool clutch inside gear train is damaged.	Remove and inspect clutch ring gear, clutch shaft, and gear housing for burrs or damage. Remove burrs with file. Replace parts if necessary. (See section 2.3 for gear train disassembly).
	d. Wire rope is bound up on the drum.	By connecting the hook to a load and alternately powering-in and powering-out, the wire rope will usually work itself free. IMPORTANT:DO NOT PUT YOUR HANDS NEAR THE WIRE ROPE OR FAIRLEAD WHEN ATTEMPTING TO FREE A BOUND ROPE.
	e. Winch is not mounted correctly, which causes winch to bind.	Check mounting hole dimensions. Follow mounting specifications and procedures as described in the operator's manual. Be sure mounting surface is flat to within 0.020 inch. Be sure all mounting bolts are tight.
	f. Internal corrosion on ring gear, will not allow ring gear to rotate smoothly.	Disassemble gear train, inspect and clean sliding ring gear, replace if necessary.
	g. End housing has grease between ring gear and inside machined surface, not allowing the ring gear to rotate easily.	Remove gear train. Clean all grease from machined surface of gear housing and ring gear. Apply light oil on machined surfaces.
5.1.4 Winch lacks power, pulls slowly, stalls or will not run at all.	a. Ground cable is not directly attached to motor housing or is an incorrect size.	Attach ground cable to threaded hole in motor housing – not to a terminal.
	b. Loose connections on battery or motor terminals.	Be sure all connections are tight and clean.
	c. Vehicle battery not fully charged.	Charge battery.
	d. Battery terminals are corroded.	Clean terminals.
	e. Battery is too small or defective.	Replace with conventional automotive battery with minimum of 650 cold cranking amps rating.
	f. Solenoid ground cable disconnected.	Check solenoid ground cable for damage, connect to threaded hole in motor housing.

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
	g. Short circuit in winch power supply or wiring.	Check battery cables and motor cable leads for loose connections, worn or cracked insulation, and fraying or bare spots. Replace cable if necessary.
	h. Remote control switch or cord is damaged.	Test winch operation with replacement remote control. Replace remote control if defective.
	i. Battery ground wire connected to vehicles frame.	Connect ground wire directly to negative battery terminal.
5.1.5 Winch does not have the same pulling power as when it was new.	See All possible Causes for problem 5.1.4.	See corresponding Corrective Actions for problem 5.1.4.
5.1.6 When remote control switch is activated, only a “clicking sound” results and winch does not operate in either power-in or power-out mode.	a. Faulty electrical grounding.	See possible Cause a. and corresponding Corrective Action for problem 5.1.4.
	b. Faulty battery, battery cable or battery cable connections.	See problem 5.1.4 Possible Causes b. through e. and corresponding Corrective Actions.
	c. Water in motor, caused by submersion or improper installation of motor.	Replace motor. See Section 2.
	e. Worn or damaged brushes caused by damaged armature commutator or normal wear.	Replace motor.
5.1.7 Electrical sparks appear around the motor or motor end housing.	a. See possible causes for 5.1.4 and 5.1.6.	See corresponding Corrective Action.
	b. Electrical ground is not sufficient. Ground wire was not installed, or the battery ground wires and wire terminals are corroded.	Install a ground wire to the motor housing, and attach to the negative terminal of the battery.
5.1.8 When the remote control is activated, winch operates in only one direction.	a. Remote control switch is damaged.	Check remote control switch and cable. Replace if necessary. Check all connections inside control pack. Check all pins in plug and receptacle for damage.
	b. Also see Possible Causes and Corrective Actions for problem 5.1.4.	
	c. One of the solenoids in the control pack is sticking or is damaged from prolonged use.	Replace solenoid.

