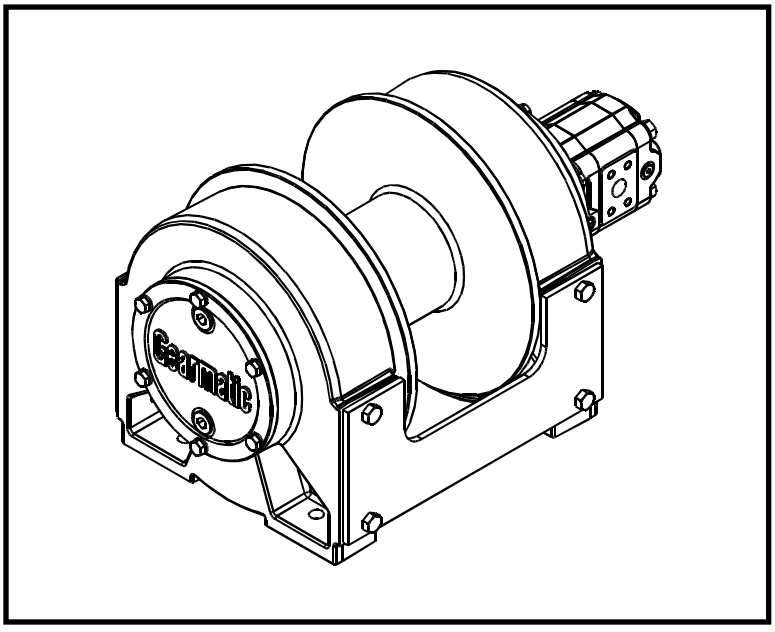
Gearmatic®

GH15C

w/6-Bolt Motor Flange

EQUAL SPEED and HIGH SPEED REVERSE HYDRAULIC HOIST



SERVICE AND MAINTENANCE MANUAL

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INTRODUCTION

The following service instructions have been prepared to provide assembly, disassembly, and maintenance information for the Gearmatic Model GH15C standard hoist. It is suggested that before doing any work on these units, all assembly and disassembly instructions should be read an understood.

Some illustrations in this manual may show details or attachments that are different from your hoist. Also, some components have been removed for illustrative purposes.

Continuing product improvement may cause changes in your hoist, which are not included in this manual. Whenever a question arises regarding your Gearmatic hoist or this manual, please contact Gearmatic Technical Support Department for the latest available information.

Telephone- 1-918-251-8511
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FAX- 1-918-259-1575
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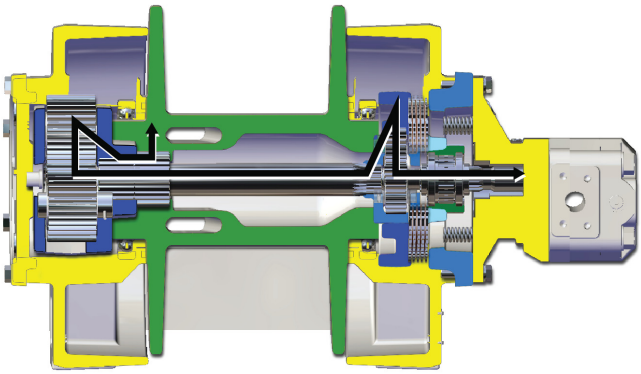
EXPLANATION OF MODEL NUMBER

GH15 C - SPL - 34 051 - 01

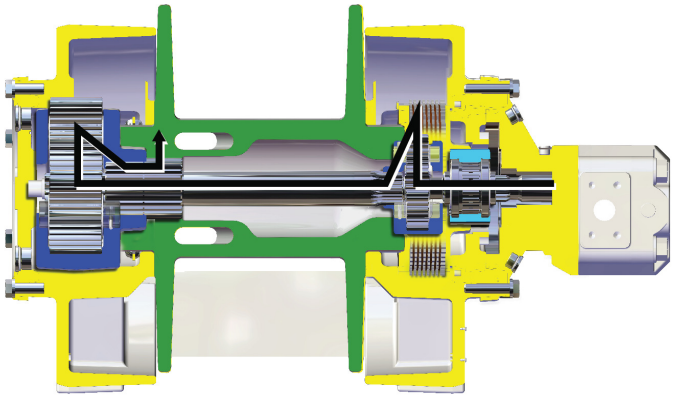
GH	- DESIGNATES GEARMATIC HOIST
C	- EVOLUTIONARY DESIGNATION
SPL	- SPECIAL ORDER DESIGNATION
34	- TOTAL GEAR REDUCTION (34:1)
051	- MOTOR DISPLACEMENT (5.1 CU. IN/rev)
01	- DRUM OPTION ----***(Other Options include 02,04)***

POWER FLOWS

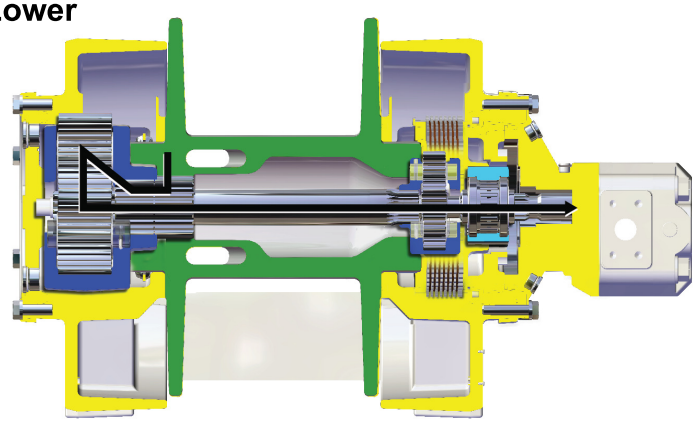
Equal Speed Raise and Lower



High Speed Reverse Raise



High Speed Reverse Lower



GENERAL SAFETY RECOMMENDATIONS

Safety for operators and ground personnel is of prime concern. Always take the necessary precautions to ensure safety to others as well as yourself. To ensure safety, the prime mover and hoist must be operated with care and concern for the equipment and a thorough knowledge of the machine's performance capabilities. The following recommendations are offered as a general safety guide. Local rules and regulations will also apply.

1. Be certain equipment (boom, sheave blocks, pendants, etc.) is either lowered to the ground or blocked securely before servicing, adjusting, or repairing hoist.
2. Be sure personnel are clear of work area BEFORE operating hoist.
3. Read all warning and caution tags provided for safe operation and service of the hoist and become familiar with the operation and function of all controls before operating the hoist.
4. Inspect rigging and hoist at the beginning of each work shift. Defects should be corrected immediately. Do not operate a hoist with defects.
5. Keep equipment in good operating condition. Perform scheduled servicing and adjustments listed in the "Preventive Maintenance" section of this manual.
6. An equipment warm-up procedure is recommended for all start-ups and essential at ambient temperatures below +40°F (+4°C).
7. Do not exceed the maximum pressure (PSI, kPa) or flow (GPM, lpm) stated in the hoist specifications found in the specific sales brochure.
8. Operate hoist line speeds to match job conditions.
9. Protective gloves should be used when handling wire rope.
10. Never attempt to handle wire rope when the hook end is not free. Keep all parts of body and clothing clear of cable rollers, cable entry area of fairleads, sheaves and hoist drum.
11. When winding wire rope on the hoist drum, never attempt to maintain tension by allowing wire rope to slip through hands. Always use "Hand-Over-Hand" technique.
12. Never use wire rope with broken strands. Replace wire rope that is damaged. Refer to wire rope supplier manual.
13. Do not weld on any part of the hoist without approval from Gearmatic Engineering.
14. Use recommended hydraulic oil and gear lubricant.
15. Keep hydraulic system clean and free from contamination at all times.
16. Use correct anchor wedge for wire rope and pocket in drum.
17. Do not use knots to secure or attach wire rope.
18. The Gearmatic designed wire rope anchors are not intended to support the rated load. ALWAYS maintain a minimum of five (5) wraps of wire rope on the drum. It is recommended that the last five (5) wraps of wire rope be painted bright red to serve as a visual reminder.
19. Never attempt to clean, oil or perform any maintenance on a machine with the engine or prime mover running, unless instructed to do so in this manual.
20. Never operate hoist controls unless you are properly positioned at the operators station and you are sure personnel are clear of the work area.
21. Assure that personnel who are responsible for hand signals are clearly visible and that the signals to be used are thoroughly understood by everyone.
22. Ground personnel should stay in view of the operator and clear of the hoist drum. Do not allow ground personnel near wire rope under tension. A safe distance of 1½ times the working length of the wire rope should be maintained.
23. Install guarding to prevent personnel from getting any part of body or clothing caught at a point where the cable is wrapped onto the drum or drawn through guide rollers or potential "pinch points".
24. Install switches or valves that will shut off power to the hoist, in locations where they can be reached by anyone entangled in the wire rope before being drawn into the hoist or any "pinch point".
25. "Deadman" controls, which automatically shut off power to the hoist whenever the operator leaves his station or releases the hoist control lever, should be installed whenever practical.
26. Never allow anyone to position any part of body under a suspended load.
27. Avoid sudden "shock" loads or attempting to "jerk" a load free. This type of operation may cause heavy loads, in excess of rated capacity, which may result in failure of wire rope, hoist or crane structure.
28. Whenever possible, install the hoist in a location that is not immediately adjacent to a "normal" operator's station.
29. All hoist controls shall be located within easy reach of the operator. The controls shall be installed in such a location that the operator is removed from the electrical path to ground if the load, rigging, or wire rope come in contact with or within proximity to an electrically energized conductor.

GENERAL INSTALLATION

1 The hoist must be mounted with the centerline of the drum in a horizontal position. The mounting plane can be rotated to any position around this centerline.

2. When mounting the hoist, use grade 8 capscrews or bolts and nuts using both mounting holes in each end plate. Use narrow, hardened washers under the bolt heads and nuts

3. It is important that the hoist be mounted on a surface that will not flex when the hoist is in use, since this could bind the working parts of the hoist. Also, be sure the hoist is mounted on a flat surface. If necessary, use shim stock to insure proper mounting. The mounting surface must be flat within 0.020 inches (.5 mm).

4. Hydraulic lines and components that operate the hoist should be of sufficient size to assure minimum back pressure at the hoist motor ports. To insure adequate static brake load holding ability, back pressure on the hoist should not exceed 100 psi (690 kPa).

Oil having 150 to 330 SUS viscosity (150 ISO CT) at 100°F (38°C) and viscosity index of 100 or greater will give good results under normal temperature conditions. The use of an oil having a high viscosity index will minimize cold-start trouble and reduce the length of warm-up periods. A high viscosity index will minimize changes in viscosity with corresponding changes in temperature.
Maximum cold weather start-up viscosity should not exceed 5000 SUS with a pour point at least 20°F (11°C) lower than the minimum temperature.

In general terms; for continuous operation at ambient temperatures between 50 and 110°F (10-43°C) use ISO VG 46 – 68 (SAE20); for continuous operation between 10 and 90°F (-12 and 32°C) use ISO VG 32 (SAE10W).

NOTE: *Install hydraulic oil circulating oil return line. See the hydraulic circuit drawing and circulating line size requirements on* ***page 7.***

⚠ WARNING ⚠

DO NOT weld hoist to mounting surface. Welding may not provide adequate structural support for hoist loads. This may cause loss of load control, which could result in property damage, personal injury or death. Welding may also damage bearings and seals, resulting in premature failure.

⚠ WARNING ⚠

DO NOT use a control valve with any detents or latching mechanism that would hold the control valve in an actuated or running position when the operator releases the control handle. Use of the wrong type of control valve could lead to unintentional operation of the hoist, which could result in property damage, personal injury or death.

5. Make certain that the hoist drum is centered behind the first sheave and the fleet angle does not exceed 1½ degrees. ***See Page 10 for details.***

NOTE: *The hoist should also be mounted perpendicular to an imaginary line from the center of the drum to the first sheave to ensure even spooling.*

6. The hoist directional control valve must be a three-position, four-way valve without detents and with a spring centered motor spool such that the valve returns to the centered position whenever the handle is released, and both work ports are opened to tank (open center, open port, ***see PAGE 7***.

7. The hydraulic oil filter should have a 10 micron nominal rating and be a full-flow type.

8. High quality hydraulic oil is essential for satisfactory performance and long hydraulic system component life.

DESCRIPTION OF OPERATION

DESCRIPTION OF HOIST

The hoist has three basic assemblies

1. Primary planetary housing and motor assembly

2. Final planetary housing assembly

3. Drum and Base assembly

The hydraulic motor is bolted to the brake cylinder bolted to the primary end bracket. The drum assembly is supported by both end bracket assemblies which receives additional support from the tie plates.

PLANETARY GEAR TRAIN

The hydraulic motor shaft is directly coupled to the inner race of the overrunning brake clutch. When driven by the primary sun gear, the primary planet gears walk around the ring gear in the primary housing and drive the primary planet carrier.

The primary planet carrier drives the output sun gear shaft which passes through the drum and drives the output planet gears. As the output planet gears are driven by the sun gear shaft, the planet gears walk around the ring gear machined in the output end bracket and drive the output planet carrier. As the output planet carrier rotates, it drives the drum through a splined connection.

BRAKE SYSTEM

The brake system contains three basic components.

1. Spring applied, multidisc-friction brake

2. Overrunning brake clutch assembly

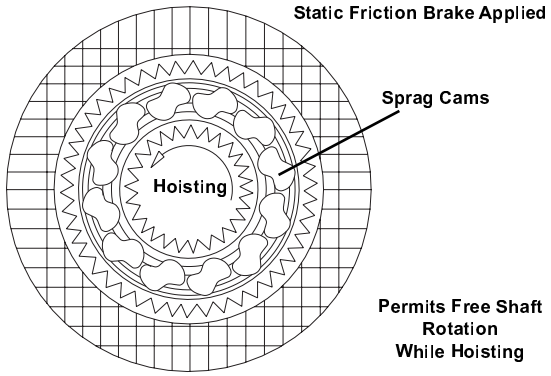
3. Hydraulic piston and cylinder

The brake consists of friction discs which are internally splined to the outer hub of the overrunning brake clutch. Spring force applied to the brake piston clamps the brake discs lock the overrunning brake clutch outer hub to the primary end housing.

The sprag type overrunning brake clutch is installed between the motor shaft and primary sun gear. The overrunning brake clutch allows the motor shaft to turn freely in the direction to haul-in cable and locks up to force the friction brake discs to turn with the motor shaft to pay out cable. The brake plate remains fully applied when hauling in cable and must be released by lowering pressure to pay out cable.

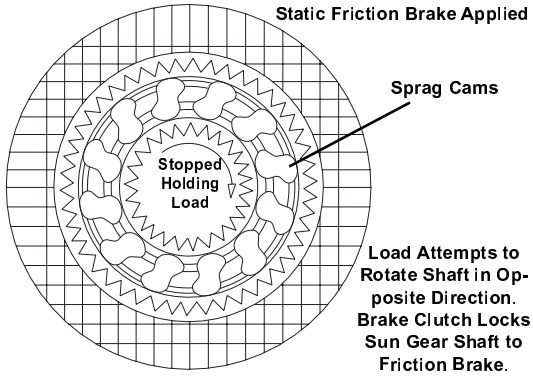
When hoisting or pulling a load, the brake clutch allows free rotation of the motor shaft and primary sun gear. The sprag cams lay over and permit the primary sun gear to turn free of the outer clutch hub. Figure 2. The friction brake remains fully engaged. The hoist is not affected by any braking action when hoisting.

Figure 2



When the hoisting operation is stopped, the load attempts to turn the primary sun gear in the opposite direction. This reversed input causes the sprag cams to instantly engage and firmly lock the motor shaft and primary sun gear to the outer brake clutch hub. (Figure 3).

Figure 3



When the hoist is powered in reverse, to lower the load, the motor and gear train will not rotate until sufficient lowering pressure is supplied to the brake release piston through the motor port to overcome the brake spring force. With no load on the hoist, approximately 400 PSI is required to compress the brake springs and allow the friction brake discs splined to the outer brake clutch hub to turn free. As lowering pressure increases, the brake is gradually released allowing the motor to drive the gear train in reverse to reel out wire rope.

When the control valve is returned to neutral or "hold", the lowering pressure will decrease and the brake will apply to hold the load.

If the load on the drum barrel tries to drive the motor faster than the supply of oil will permit (i.e. if the motor tries to act as a pump), the hydraulic pressure acting on the brake piston will decrease, causing an increase in the effective spring load, resulting in an increase in braking effort. In this way, a balanced pressure is supplied to the motor and brake release piston according to the load on the hoist drum.

The speed of the hoist in reverse and forward is dependent only on the volume of oil supplied to the motor through the control valve.

HYDRAULIC CIRCUIT

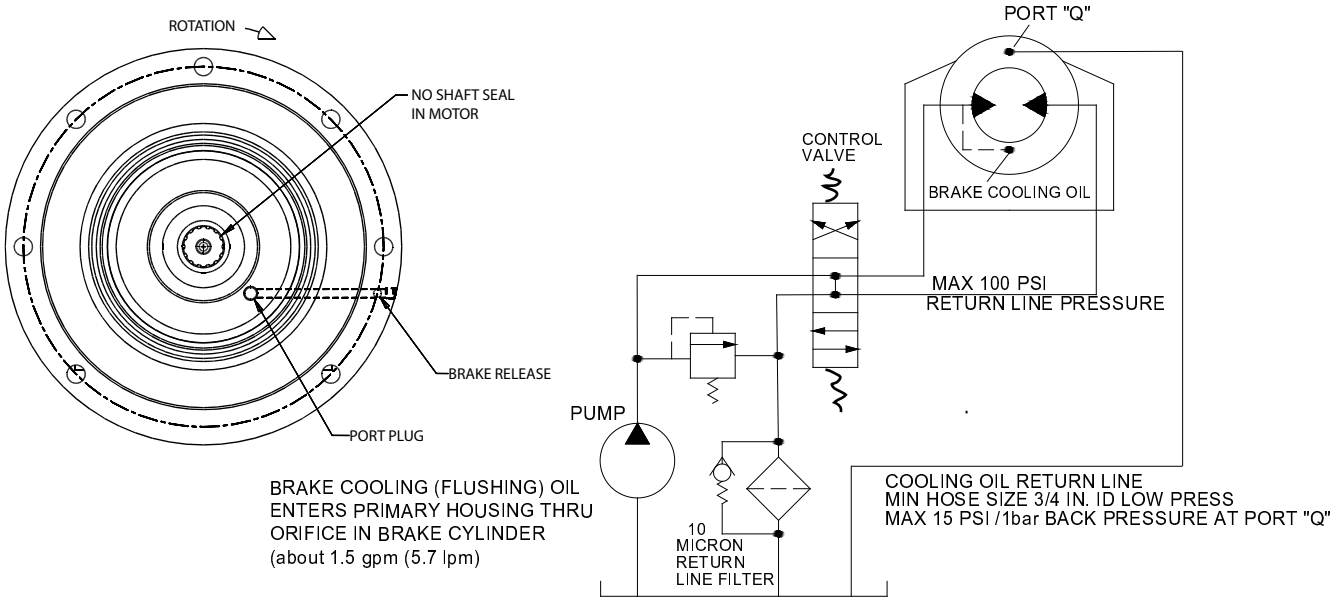


Figure 4

THERE IS A CIRCULATION RETURN PORT IN EACH END OF THE WINCH.
ONE OF THEM MUST BE CONNECTED TO TANK WITH A TANK LINE.

It is necessary to circulate oil through the GH15C Primary Planet housing. This provides cooling for the brake and also ensures that the housing is completely filled with oil.
Figure 4 illustrates a basic hydraulic circuit. Oil is circulated through the primary housing so that it enters through the brake cooling orifice and leaves at port "Q". Port "Q" should be located as close to top dead center as possible.

⚠ CAUTION ⚠

The pressure in the hoist case due to circulation must never exceed 15 psi (1.03 bar).
Excessive pressures will damage seals.

In order to maintain maximum efficiency in the hoist, select the size of hydraulic lines according to the maximum volume of oil to be used in the hoist (see Table). If the hydraulic lines used are too small, they may cause excessive back pressure at the reverse motor port sufficient to release the brake (100 psi maximum) (6.9 bar).

HOSE REQUIREMENTS		
Oil Flow GPM (l/min)	**Pressure Lines Inside Dia.**	**Return Lines Inside Dia.**
36-60 GPM (136-227 l/min)	1-1/4 in. (32 mm)	1-3/4 in. (44 mm)
61-80 GPM (228-303 l/min)	1-1/2 in. (38 mm)	2 in. (51 mm)

If trouble is experienced due to the use of long hoses it will be necessary to use hoses which are one size larger.
Line from Port Q – ½" (13 mm) Minimum

Once the hydraulic circuit has been completed, bleed all air from the primary housing before running the hoist.

In order to obtain smooth control during low speed lowering, it is recommended that the hydraulic pump is operated at maximum gpm (l/min) and that the control valve is used to control the hoist speed.

The sizes shown in the table are to be used as a guide only.

Cable Wedge Installation

Check to ensure the wedge does not protrude from either end of the pocket, causing it to interfere with proper spooling of wire rope onto the drum (see figures 9 & 10). If there is interference or the wedge does not seat firmly, contact the GearmaticTechnical Support Department at 918-251-8511 to determine the proper wedge size.

It is important that the wire rope have the proper tensioning when it is installed on the drum. When the wire rope is first installed, you should operate the hoist, with light to moderate loads, with reeving that let's you place these loads on the hoist drum with all the rope off the drum except for the last five wraps.

Correct Installation

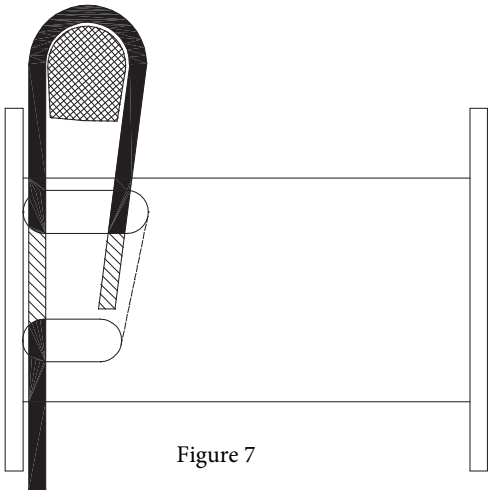


Figure 7

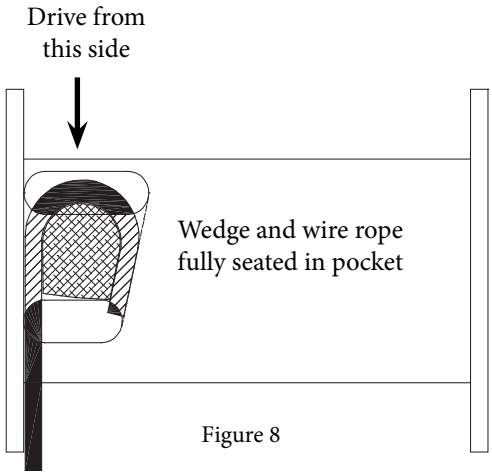
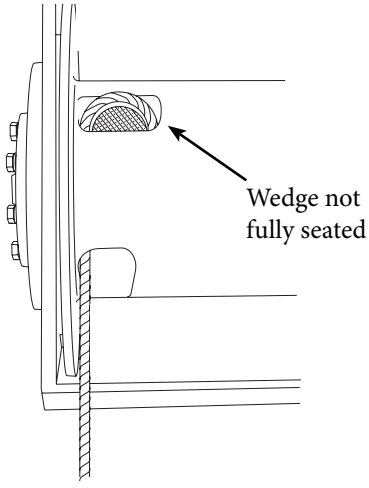
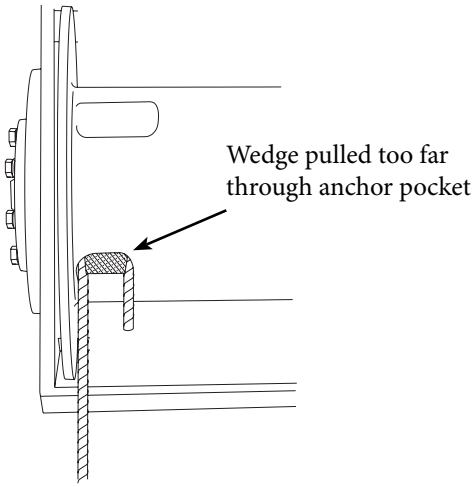


Figure 8



- Wire rope not tight against wedge
- Wedge may be too large

Figure 9



- "Dead" end of wire rope and/or wedge may interfere with proper spooling
- Wedge may be too small

Figure 10

WIRE ROPE WEDGE PART NUMBERS

WEDGE PART NO.

24493 for 1/2 thru 3/4 in. (13 - 19 mm)
* 24494 for 3/4 thru 1 in. (19 - 25 mm)

* Standard Anchor

HOIST OPERATION

The following warnings and instructions are basic to safe hoist operation. Please read them carefully and follow them each time your hoist is operated. These instructions are provided in addition to any information furnished by the Original Equipment Manufacturer. Equipment operators should be completely familiar with the overall operation of the piece of equipment on which the hoist is mounted (i.e. crane, dredge, drill rig, etc.). If you have any questions concerning the safe operation of this hoist or the equipment it is mounted on, contact the equipment manufacturer that installed the hoist, or the Gearmatic Technical Support Department at 1-918-251-8511, Monday through Friday, 0800 to 1630 hours CST, by fax at 1-918- 259-1575, or via the internet at www.paccarwinch.com.

⚠ WARNING ⚠

Ground personnel must stay in view of the operator and clear of the load and hoist drum at all times. Do not allow personnel near the hoist line under tension. Do not allow personnel near the hoist drum while the hoist is in operation. Do not allow personnel to be in line with the load. Do not allow personnel to stand under a suspended load. A safe distance of at least 1½ times the working length of the cable should be maintained by ground personnel. A broken cable and/or lost load may cause property damage, personal injury or death.

⚠ WARNING ⚠

Failure to properly warm up the hoist, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

Warm-up Procedures

A warm-up procedure is recommended at each start-up and is essential at ambient temperatures below +40°F (4°C).

The engine should be run at its lowest recommended RPM with the hydraulic hoist control valve in neutral allowing sufficient time to warm up the system. The hoist should then be operated at low speeds, raise and lower with no load on the hook, several times to prime all lines with warm hydraulic oil, and to circulate gear lubricant through the planetary gear sets.

⚠ CAUTION ⚠

If the hoist is mounted on a crane that has an extendable boom, care must be taken to pay-out cable as the boom is extended. Failure to pay-out sufficient cable could result in a "two-blocking" condition that could result in damage to and/or failure of the hoist, cable, sheaves and/or boom.

After the hoist/boom is properly positioned, we recommend the operator slowly pay-out, then haul-in a short length of cable. The hoist should perform these operations in a smooth and controlled manner. If the hoist does not operate smoothly or makes any unusual sounds, the source of the problem should be identified and corrected before any attempt is made to lift a load.

Slowly pay-out wire rope from the hoist drum until it reaches the load. Securely fasten the hoist cable to the load and be sure all ground personnel are a safe distance from the load. Slowly lift the load a short distance and stop. A small amount of "bounce" may be observed, depending on the weight of the load, size and type of wire rope, reeving and the amount of boom extension. Allow the load to stabilize and then watch for any sign of downward movement or cable drum rotation. The hoist static brake should hold the load in place without allowing any downward movement at all. If the load creeps down, it should be lowered to the ground immediately and the source of the problem identified and corrected.

If the hoist is holding the load securely, proceed with normal operations in accordance with the equipment manufacturer's operating procedures and load charts.

FLEET ANGLE CHART

First sheave should not be closer than
1.59 ft/in. of drum WIDTH

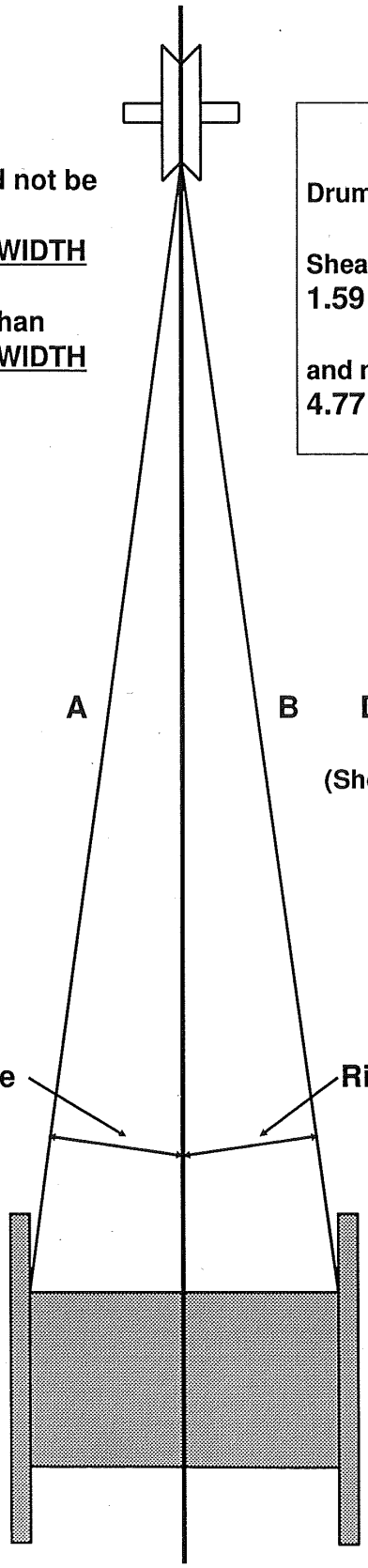
but no further than
4.77 ft/in. of drum WIDTH

Example:

Drum width = 12 in.

Sheave should be no closer than
1.59 X 12 = 19.1 ft

and not further than
4.77 X 12 = 57.2 ft



Distance "A" and "B"
MUST BE EQUAL
(Sheave is on drum centerline)

Left Fleet Angle

Right Fleet Angle

Min. Angle = 1/2°

Max. Angle = 1 1/2°

PREVENTATIVE MAINTENANCE

A regular program of preventive maintenance for your planetary hoist is required to minimize the need for emergency servicing and promote safe, reliable hoist operation.

The user of Gearmatic hoist products is responsible for hoist inspection, testing, operator training and maintenance noted below with frequency dependent upon the severity of the hoist duty cycle and the thoroughness of the preventive maintenance program. Field experience, supported by engineering tests, indicate the three service procedures listed below are the most critical to safe, reliable hoist operation and MUST be observed.

- Regular Hydraulic Oil Changes
- Use of Proper Hydraulic Oil – recommended type for prevailing ambient temperatures and additives.
- Periodic Disassembly and Inspection of All Wear Components – in compliance with ANSI specification B30.5c, 1987 and API RP 2D.

Crane inspection records as well as records of preventive maintenance, repairs and modifications must be available for a minimum of five (5) years. These records should include but not limited to, hoist model and serial number, name and employer of repair technician, date and description of work performed.

Pre-use Inspection (each shift the hoist is used): This inspection must be performed prior to placing the crane into service and then as necessary during the day for extended operation.

1. Check for external oil leaks and repair as necessary. **This is extremely important due to the accelerated wear that can be caused by insufficient lubricating oil in the hoist.** Lubricant level must be visible in the lower half of the sight glass. Use only recommended lubricants. See Recommended Lubricants chart in this manual.
2. Check hydraulic plumbing for damage, such as chafed or deteriorating hoses and repair as necessary.
3. Visually inspect for loose or missing bolts, pins, keepers or cotter pins and replace or tighten as necessary.
4. The gear oil should be changed after the first 100 hours of operation or 30 days. The regular gear oil change intervals may be adopted after the first oil change.
5. Inspect the full length of wire rope, rigging and all sheaves according to the wire rope rigging and equipment manufacturer's recommendations.
6. A warm-up procedure is recommended at each start-up and is mandatory at ambient temperatures below +40°F (4°C). The engine should be run at its lowest RPM with the hydraulic hoist control in neutral allowing sufficient time to warm up the system. The hoist should then be operated at low speeds, hoisting and lowering with no load, several times to prime all hydraulic lines with warm oil and to circulate lubricant through the planetary gear sets.

Quarterly Inspection (every 3 months) or monthly in Severe Duty Applications or prior to placing the machine in service if it has not been used for three months or more.

1. Perform the Pre-use Inspection.
2. Inspect all hoist fasteners for tightness and corrosion. Replace all corroded fasteners and tighten per the torque specifications on page 15.
3. The hydraulic system filters should be changed after the first 50 hours of operation then every 500 hours or quarterly or in accordance with the crane manufacturer's recommendations.

⚠ WARNING ⚠

Failure to properly warm up the hoist, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

Annual Inspection, Testing & Preventive Maintenance or semi-annually in Severe Duty Applications.

1. Perform the Pre-Use and Quarterly Inspections.
2. Change the hydraulic oil after an oil sample is taken.

⚠ WARNING ⚠

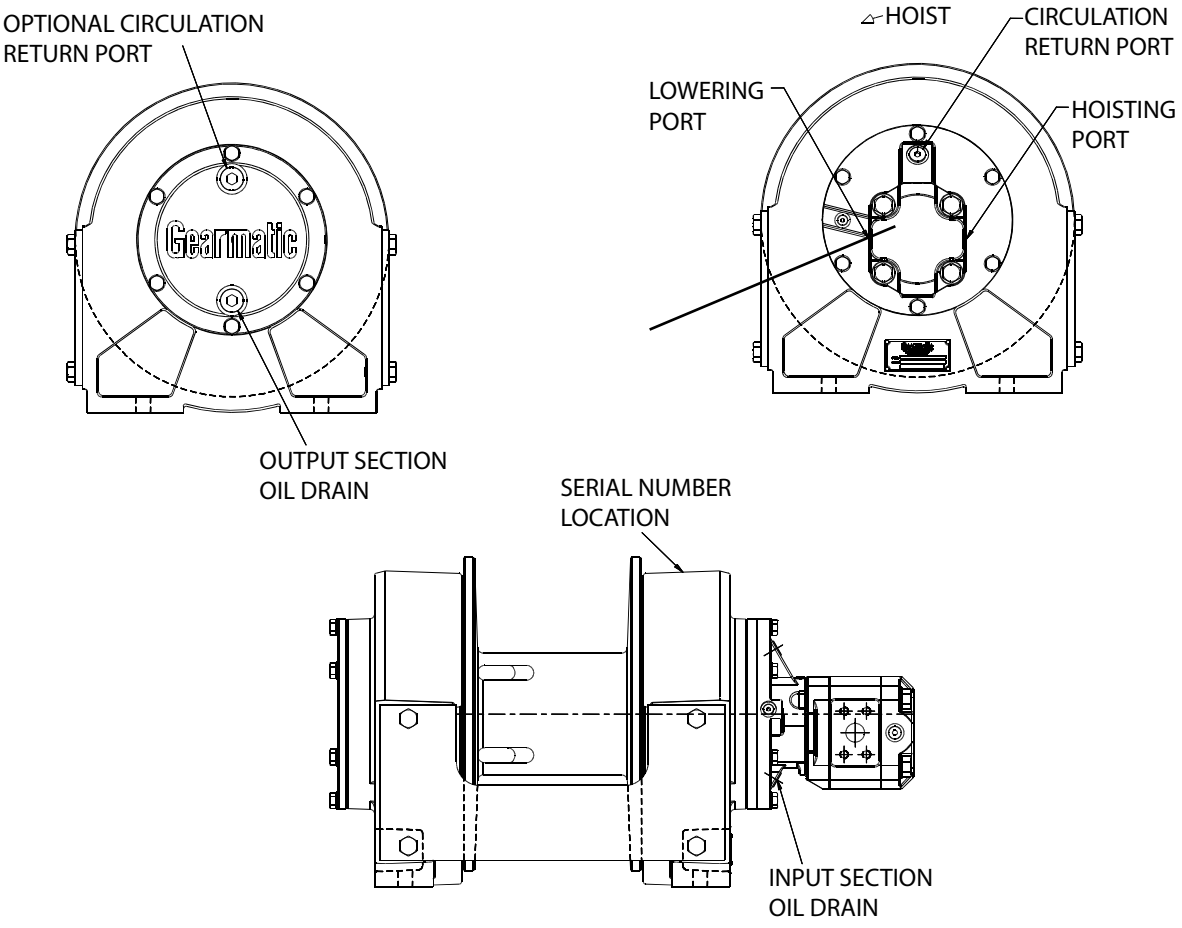
The hydraulic oil must be changed to remove wear particles that impede reliable and safe operation of the brake clutch and erode bearings and seals. Failure to change hydraulic oil at recommended intervals may contribute to intermittent brake slippage, loss of load control, injury or death.

⚠ WARNING ⚠

Failure to use the proper type and viscosity oil may result in loss of load control, property damage, injury or death.

The hydraulic oil should be changed whenever the ambient temperature changes significantly and an oil from a different viscosity range would be more appropriate. Oil viscosity is critical to reliable brake operation. Our tests indicate that excessively heavy or thick oil may contribute to intermittent brake slippage. Make certain the oil viscosity used in your hoist is correct for your prevailing ambient temperature.

NOTE: *If the oil sampling/analysis has not been performed as required, tear-down inspections will be required. Refer to Hoist Disassembly section of this manual.*



Tear-down Inspection

If a hoist has an unknown history of repair and/or maintenance, the hoist should undergo a tear-down inspection prior to being placed into service.

A tear-down inspection of the hoist should include the complete disassembly, cleaning, inspection and replacement of all worn, cracked, corroded or distorted parts such as pins, bearings, shafts and brake components. All seals and o-rings should be replaced during a tear-down inspection. Always use new Spirol pins in the planet gear shafts.

Load Test

Before placing the hoist back in service, the rebuilt hoist must be pull tested to the rated load of the hoist with a dynamometer or equivalent measuring device. The hoist should be dynamically tested by rotating the drum several times, in both raising and lowering directions, while under load of ***at least 30 %*** of the hoist rated lifting capacity. Check for smooth, quiet operation during this procedure.

RECOMMENDED BOLT TORQUE

The general purpose torque shown in the chart applies to SAE Grade 5 & Grade 8 bolts, studs and standard steel full, thick and high nuts.

Higher or lower torques for special applications will be specified such as the use of spanner nuts, nuts on shaft ends, jam nuts and where distortion of parts or gaskets is critical.

Lubricated torque values based on use of SAE 30 engine oil applied to threads and face of bolt or nut.

RECOMMENDED FASTENER TORQUE

		Torque (LB-FT)			
Bolt Dia.	Thds Per	Grade 5		Grade 8	
Inches	Inch	Dry	Lubed	Dry	Lubed
1/4	20 28	8	6	12	9
5/16	18 24	17	13	24	18
3/8	16 24	31	23	45	35
7/16	14 20	50	35	70	50
1/2	13 20	75	55	110	80
9/16	12 18	110	80	150	110
5/8	11 18	150	115	210	160

		Torque (LB-FT)			
Bolt Dia.	Thds Per	Grade 5		Grade 8	
Inches	Inch	Dry	Lubed	Dry	Lubed
3/4	10 16	265	200	380	280
7/8	9 14	420	325	600	450
1	8 14	640	485	910	680
1 1/8	7 12	790	590	1290	970
1 1/4	7 12	1120	835	1820	1360
1 3/8	6 12	1460	1095	2385	1790
1 1/2	6 12	1940	1460	3160	2370

TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
A		
Hoist will not pull maximum load.	1. System relief valve may be set too low.	Install a pressure gauge in the hoisting port and apply a stall pull on the hoist. If pressure is low, increase relief valve setting until recommended pressure is obtained. NOTE: If pressure does not increase in proportion to adjustment, relief valve may be contaminated or worn out. In either case, the relief valve may require disassembly or replacement.
	2. If this trouble occurs suddenly after working at a maximum pull, a particle of dirt may be lodged under the system relief valve, holding it partially open. If this is the cause, a considerable loss in line speed may be noticed as the load on the cable is increased.	Remove relief valve, disassemble and clean parts thoroughly in a suitable solvent. Reassemble and install relief valve. Reset pressure according to specifications.
	3. If the pump is belt driven, the belts may be slipping.	Check belts when pump is at full PSI (kg/cm^2) (stall pull on hoist). Tighten belts if they are found to be slipping.
	4. The oil level in the reservoir may be too low. The suction line may be restricted or have an air leak causing cavitation at the inlet port. This will cause the pump to make a whining noise.	Check oil level in the reservoir. Check the suction line for damage, externally and internally. Replace suction line if necessary.
	5. The hoist may be mounted on an uneven or flexible surface which causes distortion of the hoist base and binding of the gear train. Binding in the gear train will absorb horsepower needed to generate the rated line pull and cause heat.	Reinforce mounting surface. If necessary, use steel shim stock to level hoist. First loosen, then evenly retighten all hoist mounting bolts to recommended torque.
	6. Be certain hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures increase motor internal leakage and reduce motor performance.	Same as remedy for A-5. Same as remedy for B-4.
	7. Hoist line pull rating is based on 1st layer of wire rope. Expected line pull may be in excess of hoist rating.	Refer to hoist performance charts for additional information.
	8. After all the causes listed above have been investigated and it is found that the hoist will stall at maximum pressure without developing the maximum pull on the bare drum, the trouble may be in the hoist.	Install a pressure gauge in the motor hoist port and apply a stall pull on the hoist. If the pressure is up to maximum and the bare drum line pull is less than the specified line pull, the trouble may be in the hoist or hydraulic motor. Disassemble hoist according to disassembly instructions and check that gear train turns freely. If gear train is found to be satisfactory, inspect the hydraulic motor, according to the service instructions for the hydraulic motor.

TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
B Considerable reduction in line speed.	1. Same as A-2. 2. Same as A-4. 3. Same as A-6. 4. If this trouble has increased gradually, the hydraulic pump or hoist motor may be worn. 5. Prime mover(engine or electric motor) may be operating at low speed.	Same as remedy for A-2. Same as remedy for A-4. Same as remedy for A-5 and B-4. Remove and inspect pump. If satisfactory, consult the disassembly instructions for the hoist and remove and inspect the motor according to the service instructions for the hydraulic motor. Check/Adjust throttle speed, tune engine
C Lowering speed is significantly slower than hoisting speed.	1. Control valve may be restricted in its travel. 2. Same as A-1. 3. Oil may be too thick causing a high resistance to rotation at the brake plates and causing the relief valve to by-pass. 4. Same as F-1.	Check the travel of the control valve spool. The spool travel should be the same in both directions. Same as remedy for A-1. Follow warm-up procedure in "Preventive Maintenance" section. Same as remedy for F-1.
D Brake will not hold when control valve is returned to neutral after lifting a load.	1. Excessive system back pressure acting on the brake release port. 2. Friction brake will not hold due to worn or damaged brake discs. 3. Brake clutch is slipping.	Install a pressure gauge at the lowering port of the hydraulic motor. Operate the pump at full throttle and monitor pressure in "neutral" and haul-in positions. If the pressure is greater than 100 PSI (7KPA), check for restrictions in the return line from the hoist to the control valve and the control valve to the reservoir. Disassemble hoist to inspect/replace worn parts. Improper hydraulic oil may cause the brake clutch to slip. Replace brake parts and refill reservoir with recommended hydraulic oil. Brake clutch may be damaged or worn. Disassemble and inspect brake clutch.
E Brake will not control or stop the load when lowering.	1. Same as D-1, 2, or 3. 2. Hoist is being overloaded. 3. After the causes listed above have been investigated and found to be satisfactory, the trouble may be in the hoist.	Same as remedies for D-1, 2, or 3. Install a pressure gauge at the hoist port and apply a stall pull on the hoist. If the pressure is higher than the maximum specified PSI, reduce the pressure. Disassemble the primary drive assembly according to the disassembly instructions. Inspect the brake springs, brake discs and brake clutch assembly. Check that the brake clutch assembly will "lock up" in the required direction of rotation.

TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
F		
The hoist will not lower the load or not lower the load smoothly. ***NOTE:*** If circulation return hose was not installed, drum seals will quickly fail. Also If the brake piston seal is defective, you will usually notice excessive oil flow from the hoist circulation vent port.	1. The friction brake may not be releasing as a result of a defective brake piston seal. 2. Friction brake will not release as a result of damaged brake disc. 3. Hydraulic system flow too low for smooth operation of hoist motor and brake release. 4. Same as B-4. 5. Same as A-3. 6. Same as A-5. 7. Control valve handle being operated too quickly. 8. No oil circulating through the hoist. 9. Control Valve does not have good metering characteristics.	Check brake piston seals. Disassemble brake to inspect brake discs. Operate pump at maximum RPM. Same as remedy for B-4. Same as remedy for A-3. Same as remedy for A-5. Operate control valve smoothly when starting and stopping a load. Conduct operator training as required. Install oil circulation return line. See section on hydraulic circuit. See "Hoist Installation" sections for control valve specifications.
G		
The hoist runs hot.	1. Same as A-5. 2. Be certain that the hydraulic system temperature is not more than 180 degrees F. Excessive hydraulic oil temperatures may be caused by: A. Plugged heat exchanger. B. Too low or high oil level in hydraulic reservoir. C. Same as A-1. D. Hydraulic pump not operating efficiently. 3. Excessively worn or damaged internal hoist parts. 4. Circulation oil drain line may be restricted.	Same as remedy for A-5. Thoroughly clean exterior and flush interior. Fill/drain to proper level. Same as remedy or A-1. Remove and inspect pump. Check suction line for damage. If pump is belt driven, belts may be slipping. Replace/tighten belts. Disassemble hoist to inspect/replace worn parts. Inspect the vent drain line for damage or restrictions.
H		
Hoist "chatters" while raising rated load.	1. Same as A-1. 2. Same as B-4. 3. Same as F-3. 4. Same as F-7.	Same as remedy for A-1. Same as remedy for B-4. Same as remedy for F-3. Same as remedy for F-7.

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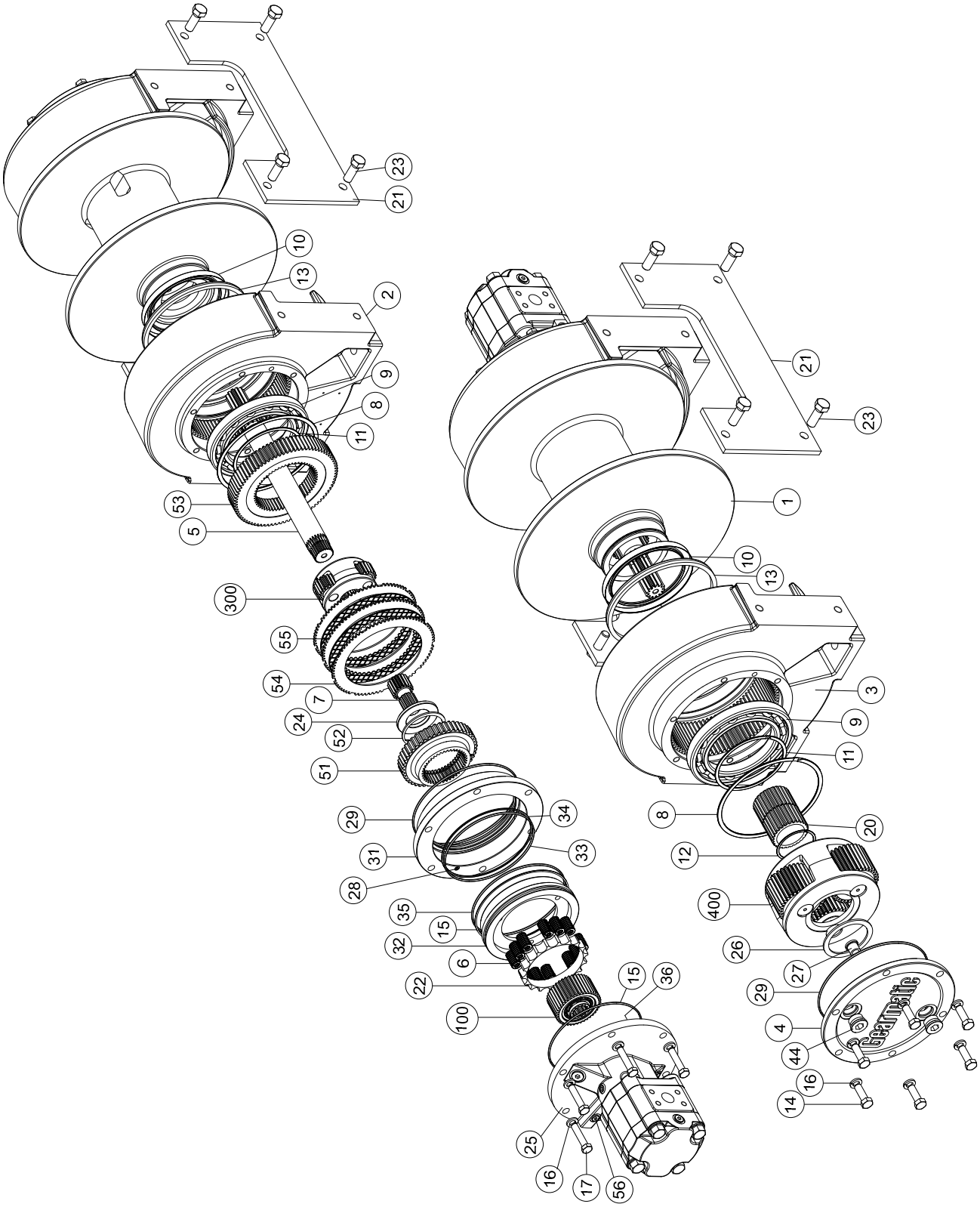
MAIN COMPONENTS (EQUAL SPEED)

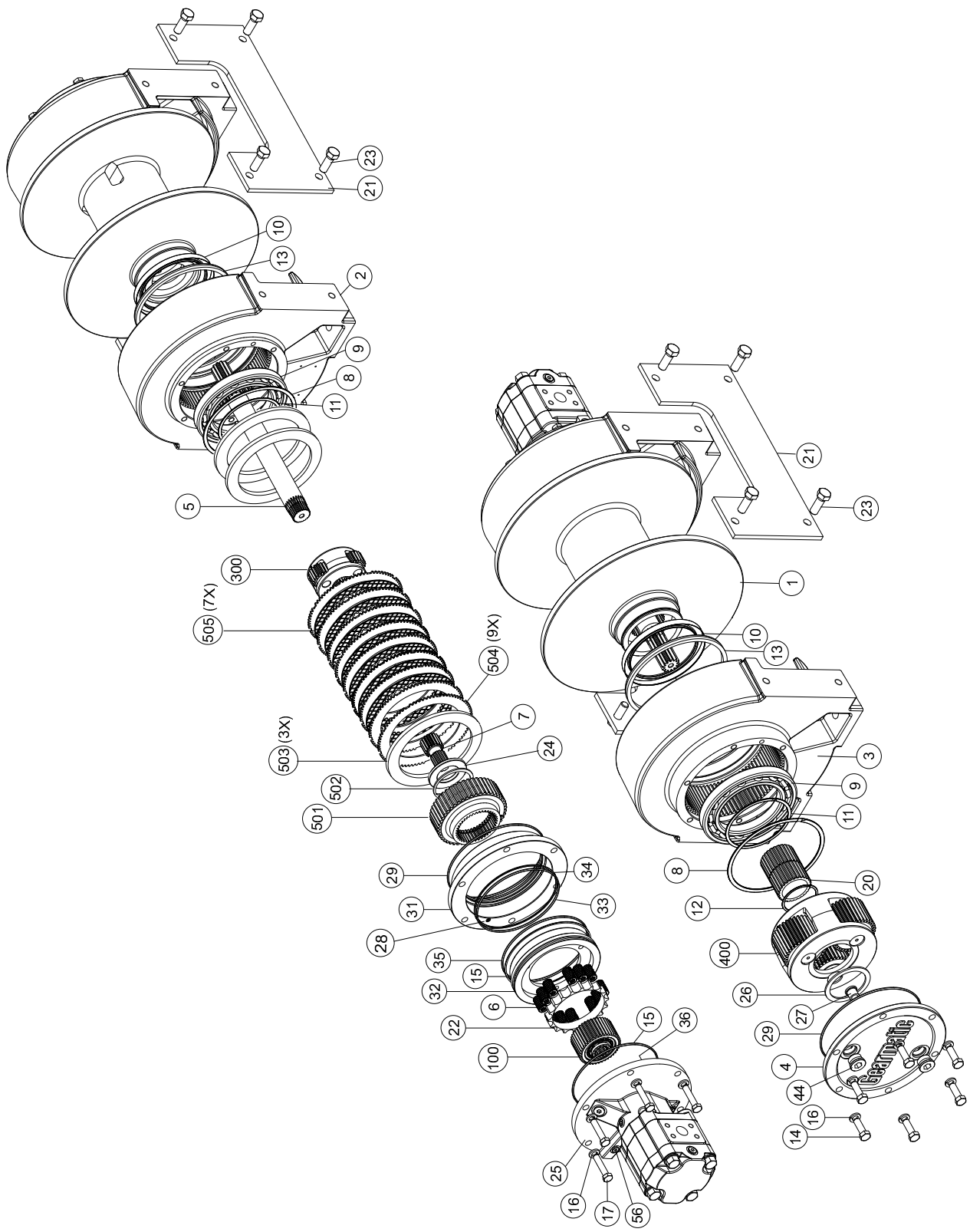


MAIN COMPONENTS (EQUAL SPEED)

ITEM	DESCRIPTION	QTY
100	OVERRUNNING CLUTCH ASSEMBLY (PG 31)	1
300	PRIMARY PLANET CARRIER ASSEMBLY (PG 28)	1
400	OUTPUT PLANET CARRIER ASSEMBLY (PG 30)	1
1	CABLE DRUM	1
2	PRIMARY END BRACKET	1
3	PRIMARY OUTPUT BRACKET	1
4	COVER	1
5	OUTPUT SUN GEAR	1
6	DIE SPRING	12
7	PRIMARY SUN GEAR	1
8	RETAINING RING	2
9	BALL BEARING	2
10	OIL SEAL	2
11	RETAINING RING	2
12	RETAINING RING	1
13	V-RING SEAL	2
14	CAPSCREW 1/2-13 X 1-1/2 NC GD8 Z HX HD	6
15	O-RING	2
16	LOCKWASHER (1/2 Z)	12
17	CAPSCREW 1/2-13 X 2-1/4 NC GD8-Z HX HD	6
19	O-RING	1
20	CONNECTOR	1
21	TIE PLATE	2
22	SPRING SPACER	1
23	CAPSCREW 5/8-11 X 1-1/4 NC GD8 Z HX HD	4
24	THRUST SPACER	1

ITEM	DESCRIPTION	QTY
25	HYDRAULIC MOTOR, 5.1 CU.IN.	1
26	THRUST WASHER	1
27	BUSHING	1
28	ORIFICE PLUG	2
29	O-RING	2
30	O-RING	1
31	BRAKE CYLINDER	1
32	BRAKE PISTON	1
33	BACK-UP RING	1
34	O-RING	1
35	BACK-UP RING	1
36	PIPE PLUG	1
44	PLUG, -12 ORB	2
51	BRAKE HUB	1
52	RETAINING RING	1
53	RING GEAR	1
54	STEEL BRAKE DISC	5
55	FRICTION DISC	4
56	PLUG, -4 ORB (USED W/ 108241 MOTOR)	2
	PLUG, -4 ORB (USED W/ 107267 MOTOR ADAPTER)	1
NS	CABLE WEDGE 3/4	1
NS	CABLE WEDGE 9/16-5/8	1

MAIN COMPONENTS (HIGH-SPEED REVERSE)



MAIN COMPONENTS (HIGH-SPEED REVERSE)

ITEM	DESCRIPTION	QTY
100	OVERRUNNING BRAKE ASSEMBLY (PG 31)	1
300	PRIMARY PLANET CARRIER ASSEMBLY (PG 28)	1
400	OUTPUT PLANET CARRIER ASSEMBLY (PG 30)	1
1	CABLE DRUM	1
2	PRIMARY END BRACKET	1
3	PRIMARY OUTPUT BRACKET	1
4	COVER	1
5	OUTPUT SUN GEAR	1
6	DIE SPRING	12
7	PRIMARY SUN GEAR	1
8	RETAINING RING	2
9	BALL BEARING	2
10	OIL SEAL	2
11	RETAINING RING	2
12	RETAINING RING	1
13	V-RING SEAL	2
14	CAPSCREW 1/2-13 X 1-1/2 NC GD8 Z HX HD	6
15	O-RING	2
16	LOCKWASHER (1/2 Z)	12
17	CAPSCREW 1/2-13 X 2-1/4 NC GD8-Z HX HD	6
19	O-RING	1
20	CONNECTOR	1
21	TIE PLATE	2
22	SPRING SPACER	1
23	CAPSCREW 5/8-11 X 1-1/4 NC GD8 Z HX HD	4
24	THRUST SPACER	1

ITEM	DESCRIPTION	QTY
25	HYDRAULIC MOTOR, 5.1 CU.IN.	1
	MOTOR ADAPTER (SAE C)	1
26	THRUST WASHER	1
27	BUSHING	1
28	ORIFICE PLUG	2
29	O-RING	2
30	O-RING	1
31	BRAKE CYLINDER	1
32	BRAKE PISTON	1
33	BACK-UP RING	1
34	O-RING	1
35	BACK-UP RING	1
36	PIPE PLUG	1
44	PLUG, -12 ORB	2
56	PLUG, -4 ORB (USED W/ 108241 MOTOR)	2
	PLUG, -4 ORB (USED W/ 107267 MOTOR ADAPTER)	1
501	RING GEAR	1
502	INTERNAL RETAINING RING	1
503	BRAKE SPACER	3
504	STEEL BRAKE DISC	9
505	FRICTION DISC	7

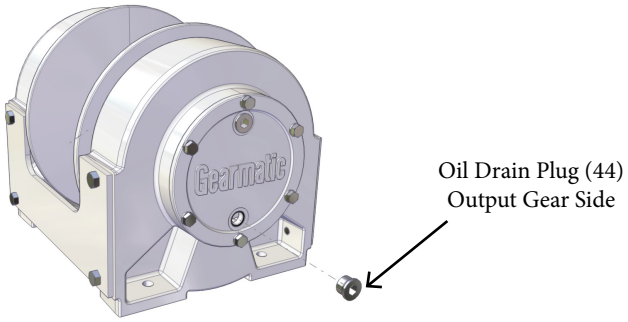
EQUAL SPEED HOIST DISASSEMBLY

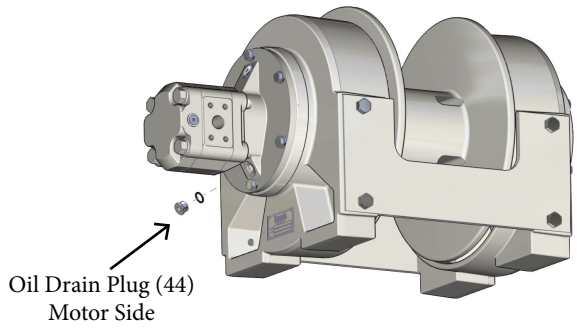
Motor End Service

⚠ CAUTION ⚠

The GH15C weighs approximately 585 lbs (265 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

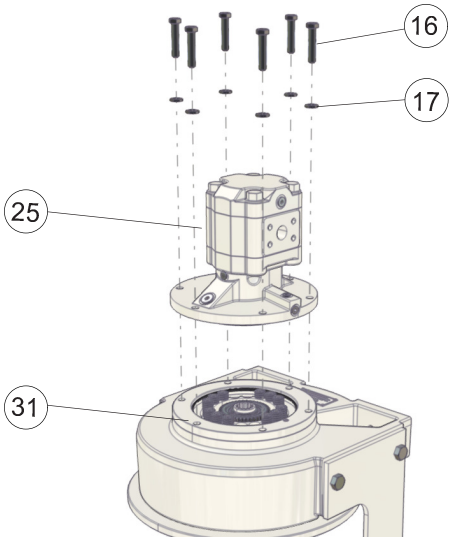
1. Remove wire rope from hoist. Drain gear cavity oil by removing the oil from the output gear side of the hoist by the drain plug (44). Drain the hydraulic oil from the motor side of the hoist using the drain plug at the bottom of the motor. Dispose of oil in an environmentally responsible manner.



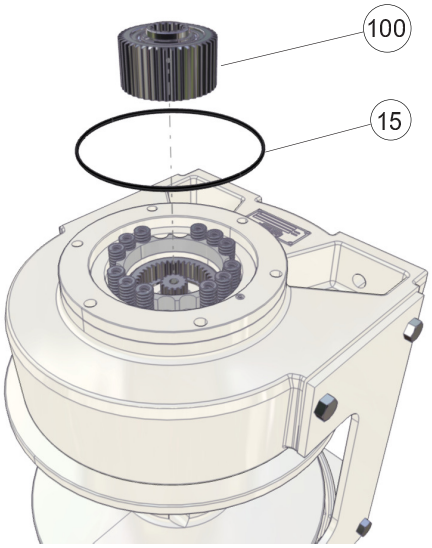


2. Remove the hydraulic hoses and mounting bolts. Clean outside surface of hoist in preparation for disassembly. To ease aligning part's on reassembly, mark the hoist bolted connections with a pain pen or scribe line.

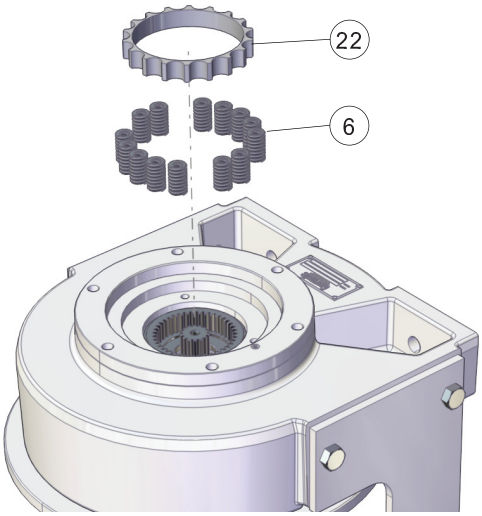
3. Stand hoist with motor end up and secure hoist to prevent falling. Remove the spring tension from the hydraulic motor (25) to the brake cylinder (31) by loosening the six capscrews (16) one turn each alternating across the motor. Remove the six capscrews and lockwashers (17) securing the motor to the brake cylinder and lift the motor off the hoist by turning in a slight rotary motion when lifting out of the housing.



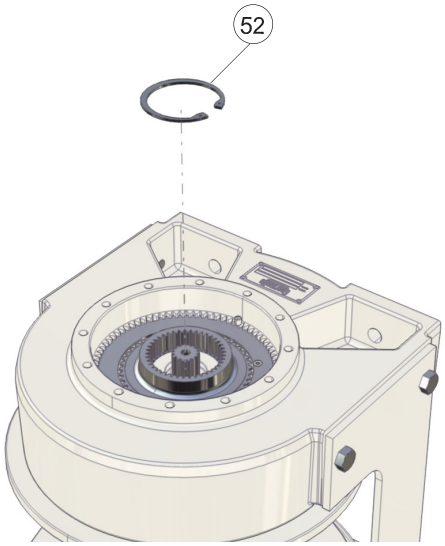
4. Remove the overrunning clutch assembly (100). Remove and discard the motor o-ring (15).



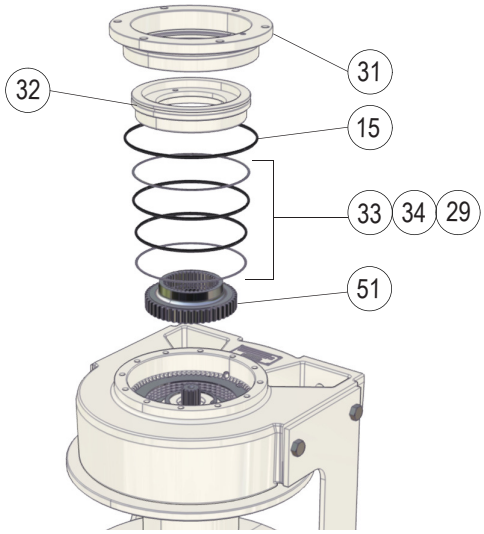
5. Remove the spring spacer (22) and the 12 die springs (6).

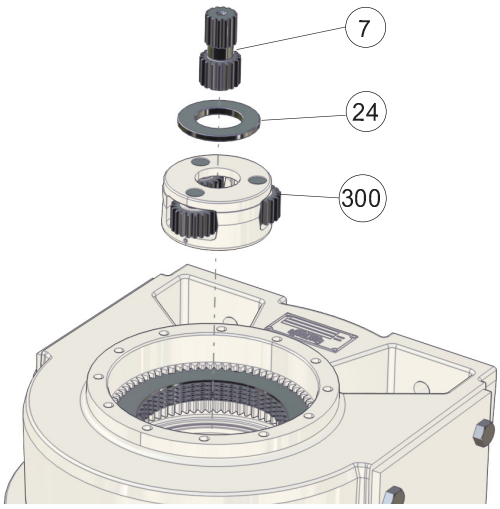


6. Remove snap ring (52).

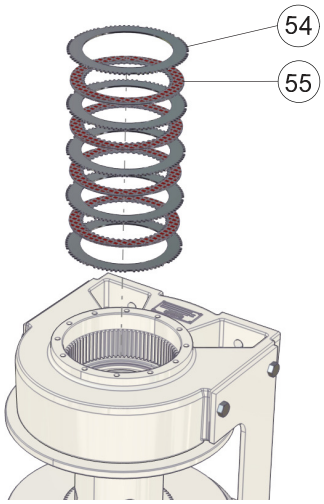


7. Remove the brake piston (32). Remove and discard brake piston o-ring (15), back-up ring (33) and o-ring (34). Remove brake cylinder (31), o-ring (29), and brake hub (51).
8. Remove the primary sun gear (7), thrust washer (24), and primary planet carrier assembly (300).

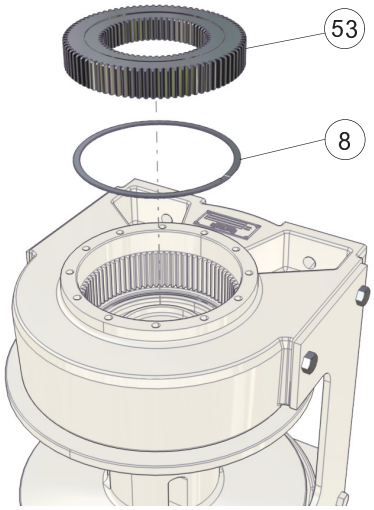




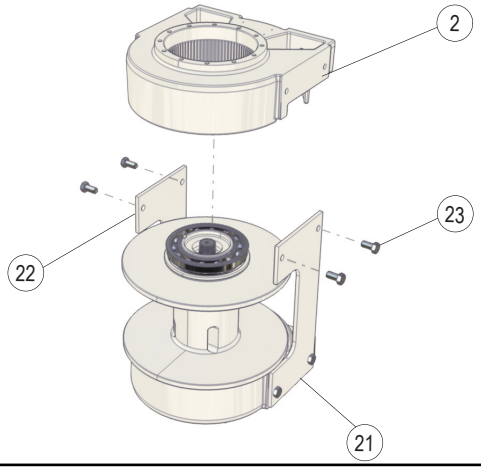
9. Remove the five steel brake discs (54) four brake friction discs (55).



10. Remove the ring gear (53) and retaining ring (8).



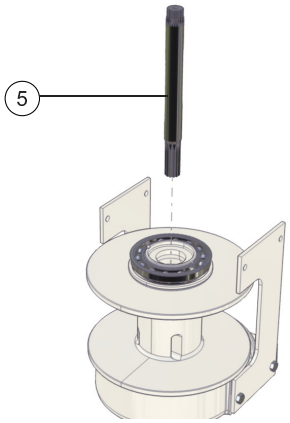
11. Mark the tie plates to the side of the hoist to ease re-assembly. Support the end bracket (2) with an overhead hoist. Remove the top 2 bolts (23) on each tie plates (21-22) and loosen the bolts on the bottom. Use eye bolts and lift the motor end bracket straight off of drum.

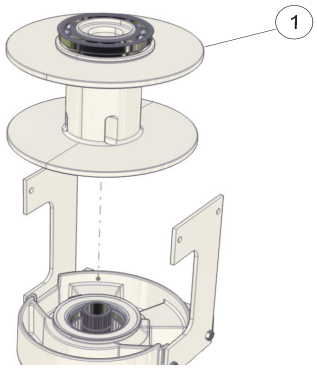


⚠CAUTION⚠

The drum weighs approximately 182 lbs (82 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death. The motor end bracket weighs approximately 102 lbs (46 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

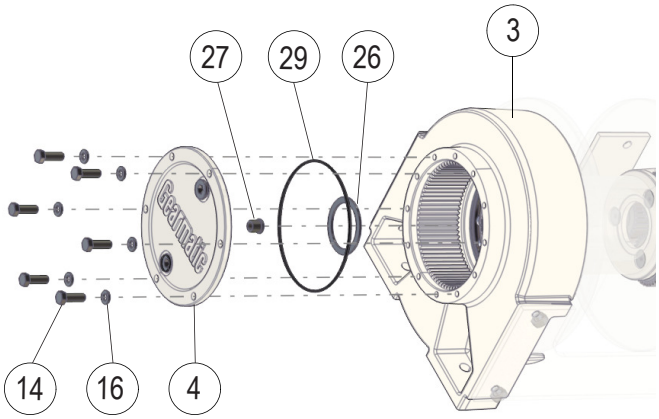
12. Remove sun gear shaft (5). Use lifting clamps to lift drum assembly (1) straight up and off the output end bracket.



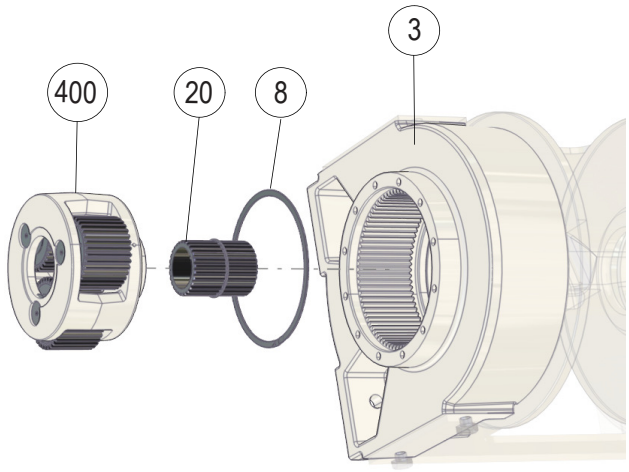


OUTPUT END SERVICE

1. Remove capscrews (14) and lockwashers (16) securing end cover (4) to output end bracket (3). Remove cover (4). Remove and discard o-ring (29). Remove thrust washer (26) and thrust button (27).



2. Remove output planetary assembly (400), retaining ring (8), and connector (20).



⚠CAUTION⚠

The output end bracket weighs approximately 110 lbs (49 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

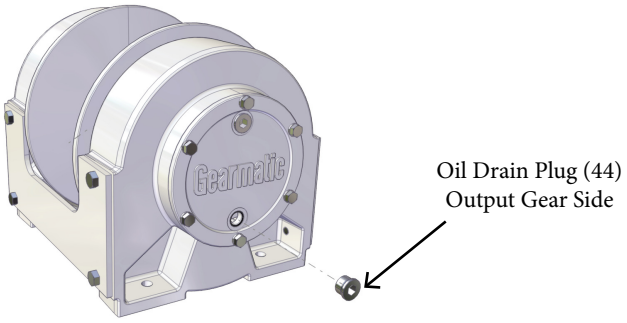
HIGH SPEED REVERSE HOIST DISASSEMBLY

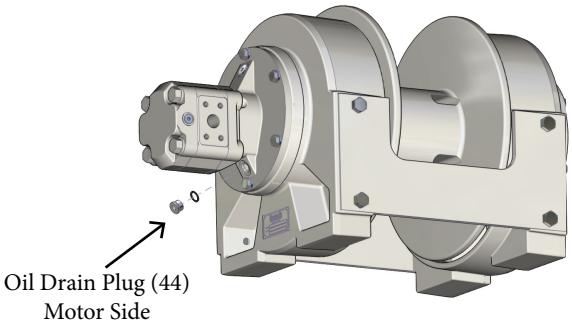
MOTOR END SERVICE

⚠ CAUTION ⚠

The GH15C weighs approximately 585 lbs (265 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

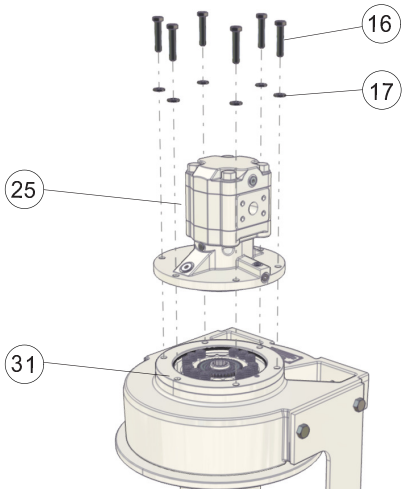
1. Remove wire rope from hoist. Drain cavity oil by removing the oil from the output gear side of the hoist by the drain plug (44). Drain the oil from the motor side of the hoist using the drain plug at the bottom of the motor. Dispose of oil in an environmentally responsible manner.



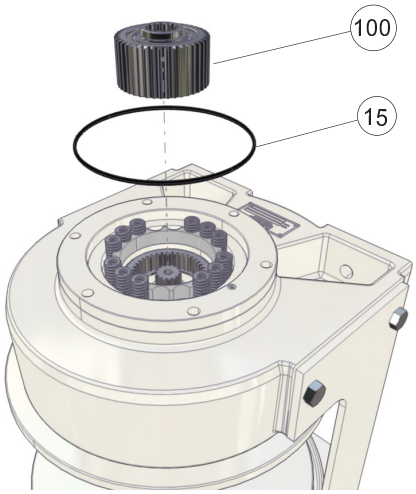


2. Remove the hydraulic hoses and mounting bolts. Clean outside surface of hoist in preparation for disassembly. To ease aligning part on reassembly, mark the hoist bolted connections with a pain pen or scribe line.

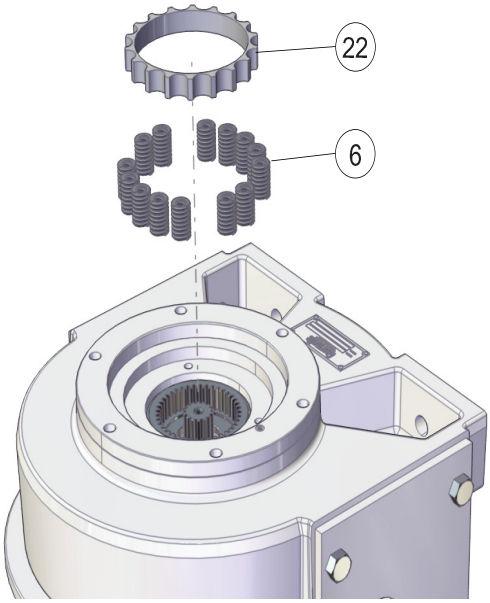
3. Stand hoist on output end with the motor up and hoist secured to prevent falling. Remove the spring tension from the hydraulic motor (25) to the brake cylinder (31) by loosening the six capscrews (16) one turn each alternating across the motor. Remove the six capscrews and lockwashers (17) securing the motor to the brake cylinder and lift the motor off the hoist using by turning in a slight rotary motion when lifting out of the housing.



4. Remove the overrunning clutch assembly (100). Remove and discard the motor o-ring (15).

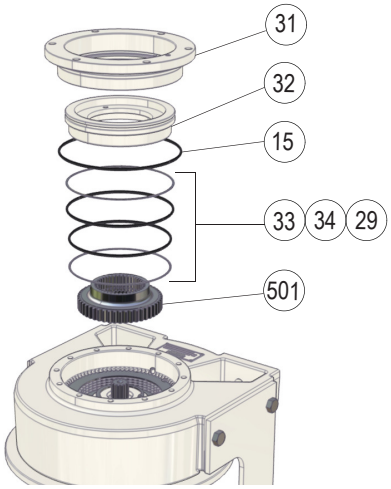


5. Remove the spring spacer (22) and the 12 die springs (6).

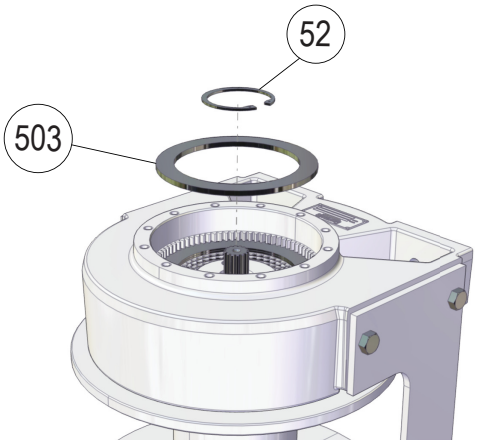


6. Remove the brake piston (32). Remove and discard brake piston o-ring (15), back-up ring (33) and o-ring (34). Remove brake cylinder (31), o-ring (29), and ring gear (501).

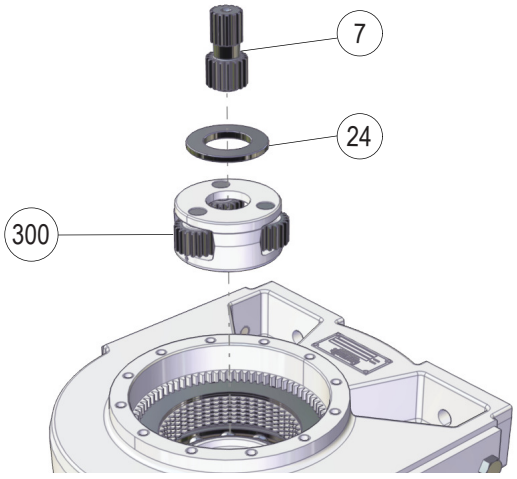
7. Remove brake spacer (503) and snap ring (52).



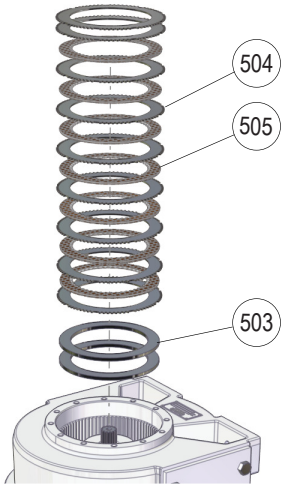
8. Remove the primary sun gear (7), thrust washer (24), and



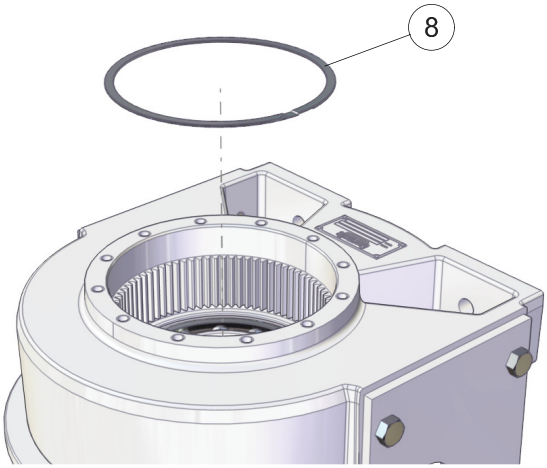
primary planet carrier assembly (300).



9. Remove nine steel brake discs (504) seven brake friction plates (505), and two additional brake spacers (503).

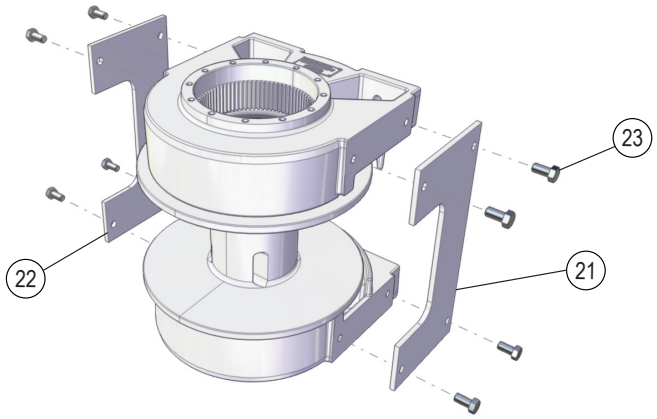


10. Remove retaining ring (8).

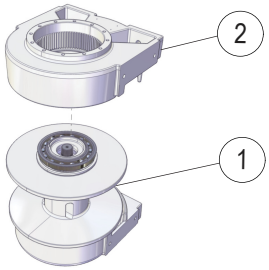


⚠ CAUTION ⚠

The motor end bracket weighs approximately 102 lbs (46 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

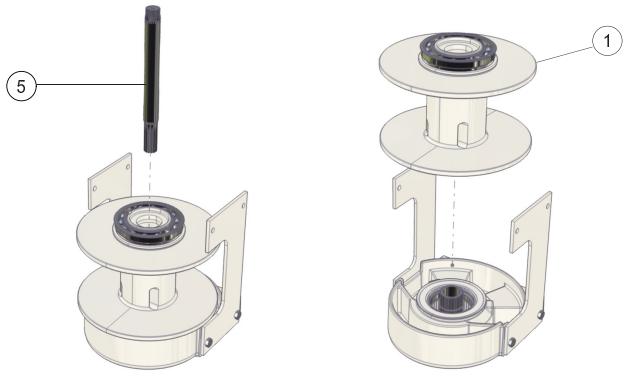


11. Mark the tie plates to the side of the hoist to ease re-assembly. Support the end bracket (2) with an overhead hoist. Remove the top 2 bolts (23) on each tie plates (21, 22) and loose the bolts on the bottom. Use eye bolts and lift the motor end bracket (2) straight off of cable drum



⚠CAUTION⚠

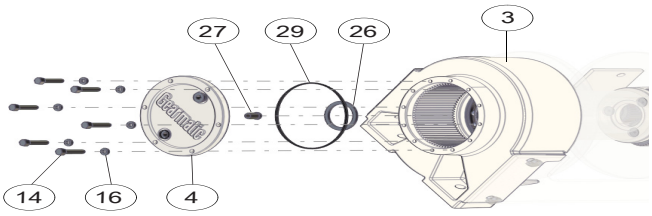
The drum weighs approximately 182 lbs (82 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.



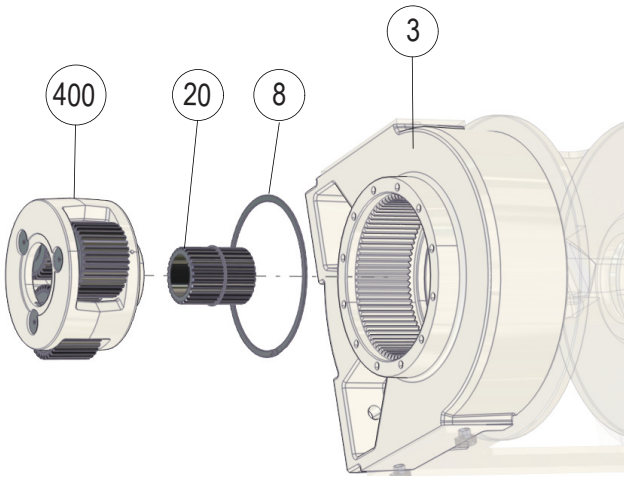
12. Remove sun gear shaft (5). Use lifting clamps to lift cable drum assembly (1) straight up and off the output end bracket.

Output End Service

1. Remove capscrews (14) and lockwashers (16) securing end cover (4) to output end bracket (3). Remove cover (4). Remove and discard o-ring (29). Remove thrust washer (26) and thrust button (27).



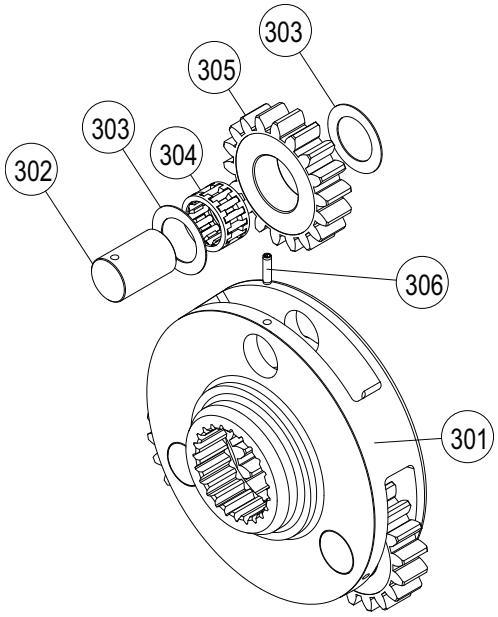
2. Remove output planetary assembly (400), retaining ring (8), and connector (20)



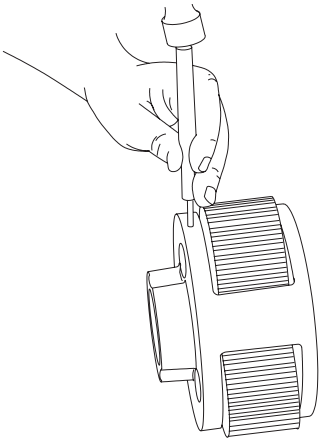
⚠CAUTION⚠

The output end bracket weighs approximately 110 lbs (49 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

PRIMARY PLANET CARRIER SERVICE



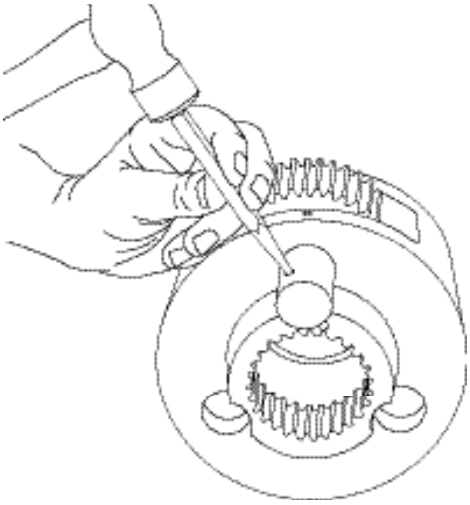
DISASSEMBLY
OUTPUT PLANET CARRIER



1. Remove the planet gears by first driving the roll pins (item 306) into the center of the planet gear shafts (item 302).

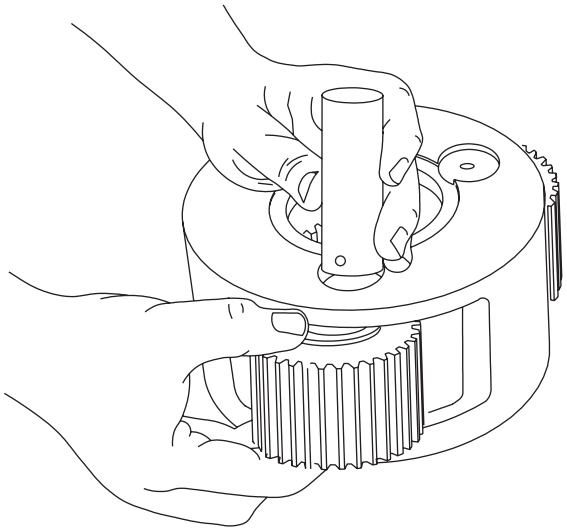
2. Use a punch to drive the roll pins from the planet gear shafts. DO NOT reuse the roll pins.

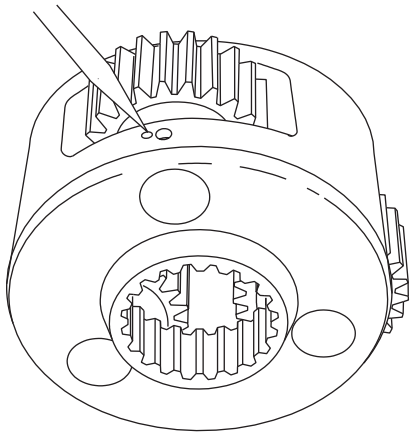
DISASSEMBLY
OUTPUT PLANET CARRIER



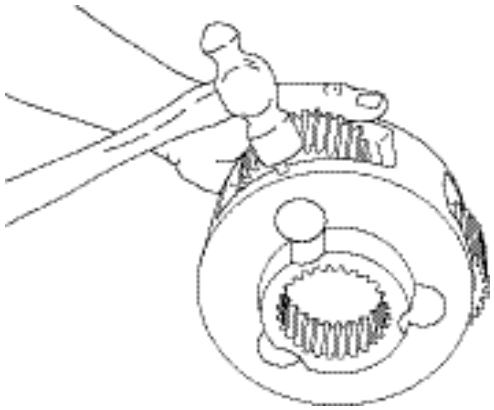
3. Remove the planet shafts, bearings, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, the bearing should be replaced. The cage should be inspected for unusual wear or deformation, particularly the cage bars. If there is damage that will impair the cage's ability to separate, retain and guide the rollers properly, the bearing should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary.

ASSEMBLY





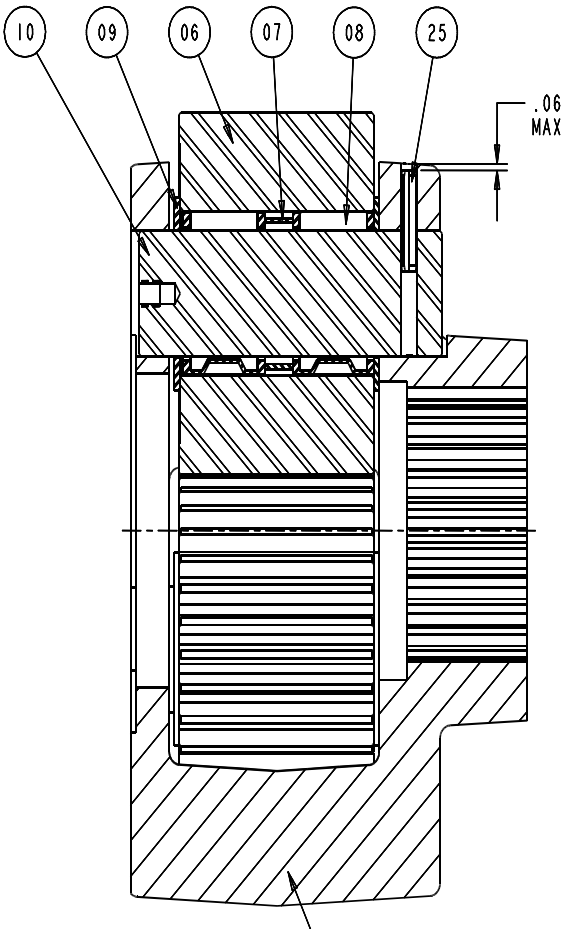
1. Install a bearing into a planet gear and place a thrust washer on each side of the gear. Position this assembly into an opening in the carrier. Slide a planet gear shaft through the carrier, thrust washer, bearing and remaining thrust washer.



2. Carefully align the pin hole in the carrier with the hole in the shaft and drive a new roll pin into place. ALWAYS use NEW roll pins.

3. The roll pin is slightly recessed into the carrier when properly installed. With a center punch, stake the carrier next to the pin hole as shown. This will distort the hole and prevent the pin from backing out in operation. Repeat these steps for each of the three planet gears.

OUTPUT PLANET CARRIER SERVICE



P/N	ITM	DESCRIPTION
26277	6	PLANET GEAR
25443	7	BEARING SPACER
25292	8	ROLLER BEARING
24306	9	THRUST WASHER
25613	10	PLANET GEAR SHAFT *
25562	11	OUTPUT PLANET CARRIER
23584	25	PIN-SPIROL

DISASSEMBLY

1. Follow steps 1 and 2 of the Primary Planet Carrier disassembly procedure to remove the roll pins from the planet gear shafts. Caution should be used when removing roller bearings; the roller bearings will fall out following removal of gear shaft.

2. Remove the planet shafts, bearings, spacers, thrust washers and gears. Thoroughly clean all parts and inspect for damage and wear. The bearing rollers should not exhibit any irregularities. If the rollers show any sign of spalling, corrosion, discoloration, material displacement or abnormal wear, they should be replaced. The thrust washer contact areas should be free from any surface irregularities that may cause abrasions or friction. The gears and shafts should be inspected for abnormal wear or pitting. Replace if necessary.

ASSEMBLY

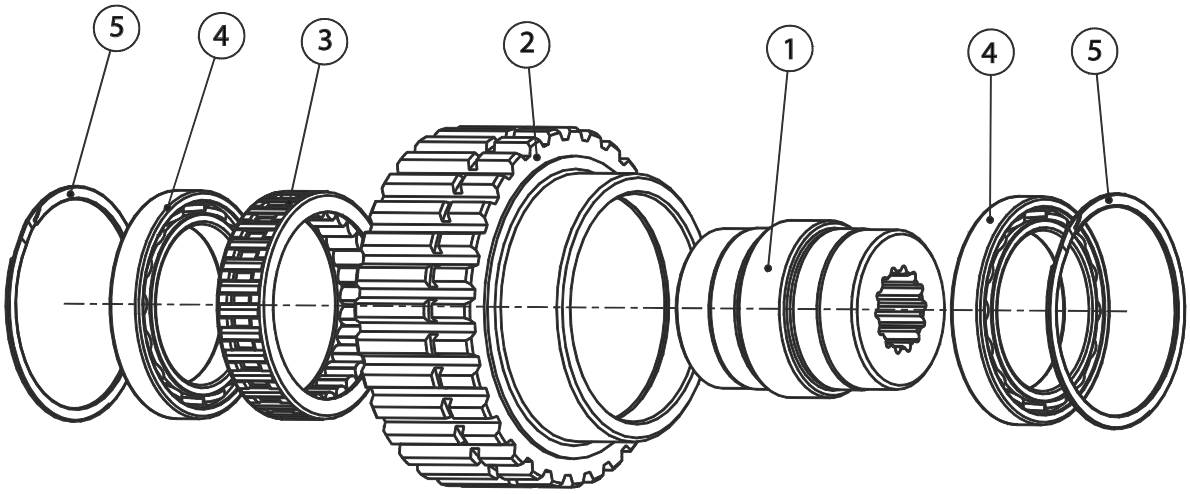
1. Place the output carrier on a clean work surface with the drive pins down.

2. Apply a liberal coat of oil soluble grease to a thrust washer and center it on one side of a planet gear. Place the planet gear on a clean work surface with the thrust washer down. Apply a liberal coat of oil soluble grease to the bore of the gear. Stack a row of loose roller bearings into the planet gear, using the grease to hold them in position. There are 15 rollers in each row. Install a bearing spacer. Stack a second row of loose roller bearings on top of the bearing spacer. Place a second thrust washer on the planet gear. Carefully slide the planet gear, bearings and thrust washers into the carrier. Install a planet gear shaft into the carrier and through the planet gear bearings.

3. Follow steps 2 and 3 of the Primary Planet Carrier assembly procedure to install and stake a NEW roll pin in the carrier.

Repeat this procedure for each of the planet gears.

OVER-RUNNING CLUTCH SERVICE



NOTE: *Outer race (item 2), Inner race (item 1) and Over-running clutch (item 3) are NOT SOLD individually as replacement parts. If any of these parts require replacement, the entire over-running clutch assembly must be replaced. Carefully note the relative orientation between the inner and outer races, and the direction of free rotation of the inner race. The clutch MUST be re-assembled correctly for proper hoist operation.*

⚠ WARNING ⚠

The polished surfaces of the inner and outer race and the over-running cams must be perfectly smooth to insure positive engagement of the clutch. The slightest defect may reduce clutch effectiveness, which may lead to loss of load control and result in property damage, injury or death. Always replace the entire clutch assembly if any component is defective. For these reasons, the over-running clutch assembly should be disassembled for inspection only if the hoist has exhibited any unusual operation that would point toward a clutch malfunction, or the over-running clutch assembly shows external signs of mechanical damage.

DISASSEMBLY

1. Remove one of the retaining rings (item 5) from the outer race (item 2). Push the inner race (item 1), bearings (item 4) and over-running clutch (item 3) through the outer race.

2. Use a small punch and hammer to tap one of the bearings (item 4) off of the inner race. The over-running clutch can now be removed from the inner race. Closely inspect the over-running clutch and the polished surfaces of the inner and outer race for wear, cracks, pitting, corrosion or mechanical damage. Closely inspect the bearings for any signs of damage, wear, corrosion, pitting or heat discoloration.

⚠ WARNING ⚠

Failure to assemble the over-running clutch assembly with all parts oriented correctly may result in reduced brake effectiveness, which may lead to loss of load control and result in property damage, injury or death.

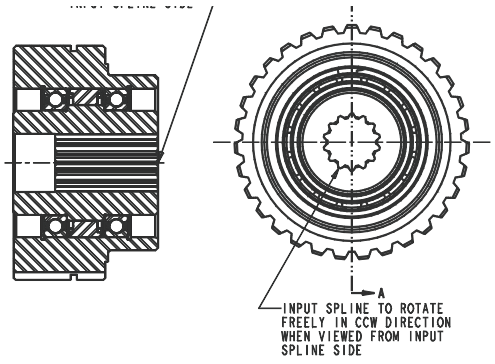
1. If both bearings (item 4) have been removed from the inner race, install one of them now.

2. Install the over-running clutch onto the inner race. Rotate the inner race slightly to get the clutch started onto the inner race.

3. Install the other bearing onto the inner race.

4. The outer race should have one retaining ring (item 5) installed in one end. Carefully slide the inner race, with bearings and clutch, into the outer race. Install the other retaining ring into the outer race.

For the GH15C, the input shaft will turn free in direction of drum rotation. For standard rotation hoisting, see drawing below:



HOIST ASSEMBLY

1. Assemble Brake, Cable Drum, Overrunning Clutch, and Planet Carrier subassemblies following the procedures in the subassembly section of this manual.

2. Press ball bearing (9) into output end bracket (3) and install retaining ring (8). Set the output end bracket (9) with drum end up for seal installation. Apply Loctite Aviation Gasket Sealant (or a non-hardening sealant) to the outside diameter of the drum seals (10 and 13) and install the seal in the output end bracket (3). Ensure the drum seal is flush with the output end bracket.

3. Set output end bracket (3) assembly with the drum end down and ensure it is level and stable. Carefully lower output carrier assembly (400) into the output end bracket.

4. Apply general purpose grease to thrust washer (26) and install on the output end bracket (4). Grease the thrust button (27) and install in the recess in the final drive housing cover. Apply enough grease to keep the thrust washer and thrust button in the housing cover when it is placed on the housing.

5. Install o-ring (29) on the output end bracket cover and apply a light coat of grease to the o-ring surface. Check proper alignment of housing cover (4) on output end bracket. Install the housing cover on the housing and secure with lockwashers (16) and capscrews (14). Torque to value on torque chart. NOTE: The capscrews may be torqued after the hoist is assembled and on its mounting feet.

6. Set output end bracket on the deck with the drum side up in preparation for installing the drum.

7. Apply grease to the inner race of the output end bracket bearing (9) and seal (10). Use lifting straps to lower the drum assembly onto the end aligning the splines of the drum with the output planet carrier splines.

⚠ CAUTION ⚠

The drum weighs approximately 182 lbs (82 kg). Make certain lifting equipment has adequate capacity. Using undersized or poorly maintained lifting equipment may result in a dropped load, property damage injury or death.

8. Grease the splines of the sun gear (20) and install into the output planet carrier assembly.

9. Install bearing (9) in the primary end bracket. Apply Loctite Aviation Gasket Sealant (or a non-hardening sealant) to the outside diameter of the oil seal (10) and (13) and install in primary housing.

10. Lightly grease the inner race of the drum bearing (9) and drum seal (10).Use ½ -13 eyebolts in the tapped holes of the primary housing and slowly lower it onto the drum.

11. Install the tie-plates (21) using capscrews (23). Tighten to torque chart value.

ASSEMBLY (STEPS 12 THRU 18 FOR EQUAL SPEED ONLY)

12. Install ring gear (53) into the primary end bracket (2).

13. Install primary planet carrier subassembly (300) into the ring gear.

14. First install a steel brake disc followed by a friction disc and alternate the steel disc with a friction disc until they are installed. A total of five steel and four friction disc's will need to be installed for equal speed.
    NOTE: You must finish with a **STEEL** disc on **TOP**. Install brake spacer (24) and retaining ring (52). Install brake hub (51)

15. Install o-ring (29) brake cylinder (31).

16. Install o-ring (34), back up ring (33), o-ring (29), and brake piston (31).

17. Install spring spacer (22) and twelve brake springs (6). Install sprag clutch (100).

18. Install o-ring (29). Install motor 25 using capscrews (17) and lockwashers (16). Tighten screws evenly one turn each alternating across the motor.

ASSEMBLY (STEPS 12 THRU 19 FOR HIGH SPEED REVERSE ONLY)

12. Install first brake spacer first (503).
    NOTE:
    A total of three brake spacer's are required for High Speed Reverse assembly. For an illustration highlight of this assembly see page 26.

13. Install nine steel brake discs (504) and seven friction discs (505).

14. Install primary planet carrier subassembly (300) and ring gear (501). For an illustration highlight of this process, see page 26, number 8.

15. Install one additional spacer (24) and primary sun gear (7).

16. Install o-ring (29) brake cylinder (31).

17. Install o-ring (34), back up ring (33), o-ring (29), and brake piston (32).

18. Install spring spacer (22) and twelve brake springs (6). Install sprag clutch (100).

19. Install o-ring (29). Install motor 25 using capscrews (17) and

METRIC CONVERSION TABLE

English to Metric			Metric to English		
LINEAR					
inches (in.)	X 25.4	= millimeters (mm)	millimeters (mm)	X 0.03937	= inches (in.)
feet (ft.)	X 0.3048	= meters (m)	meters (m)	X 3.281	= feet (ft.)
miles (mi.)	X 1.6093	= kilometers (km)	kilometers (km)	X 0.6214	= miles (mi.)
AREA					
inches^2 (sq.in.)	X 645.15	= millimeters^2 (mm^2)	millimeters^2 (mm^2)	X 0.000155	= inches^2 (sq.in.)
feet^2 (sq.ft.)	X 0.0929	= meters^2 (m^2)	meters^2 (m^2)	X 10.764	= feet^2 (sq.ft.)
VOLUME					
inches^3 (cu.in.)	X 0.01639	= liters (l)	liters (l)	X 61.024	= inches^3 (cu.in.)
quarts (qts.)	X 0.94635	= liters (l)	liters (l)	X 1.0567	= quarts (qts.)
gallons (gal.)	X 3.7854	= liters (l)	liters (l)	X 0.2642	= gallon (gal.)
inches^3 (cu.in.)	X 16.39	= centimeters^3 (cc)	centimeters3 (cc)	X 0.06102	= inches^3 (cu.in.)
feet^3 (cu.ft.)	X 28.317	= liters (l)	liters (l)	X 0.03531	= feet^3 (cu.ft.)
feet^3 (cu.ft.)	X 0.02832	= meters^3 (m^3)	meters3 (m3)	X 35.315	= feet^3 (cu.ft.)
fluid ounce (fl.oz.)	X 29.57	= millileters (ml)	milliliters (ml)	X 0.03381	= fluid ounce (fl.oz.)
MASS					
ounces (oz.)	X 28.35	= grams (g)	grams (g)	X 0.03527	= ounces (oz.)
pounds (lbs.)	X 0.4536	= kilograms (kg)	kilograms (kg)	X 2.2046	= pounds (lbs.)
tons (2000 lbs.)	X 907.18	= kilograms (kg)	kilograms (kg)	X 0.001102	= tons (2000 lbs.)
tons (2000 lbs.)	X 0.90718	= metric tons (t)	metric tons (t)	X 1.1023	= tons (2000 lbs.)
tons (long) (2240 lbs.)	X 1013.05	= kilograms (kg)	kilograms (kg)	X 0.000984	= tons (long) (2240 lbs.)
PRESSURE					
inches Hg (60°F)	X 3600	= kilopascals (kPa)	kilopascals (kPa)	X 0.2961	= inches Hg (60°F)
pounds/sq.in. (PSI)	X 6.895	= kilopascals (kPa)	kilopascals (kPa)	X 0.145	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.0703	= kilograms/sq.cm. (kg/cm^2)	kilograms/sq.cm. (kg/cm2)	X 14.22	= pounds/sq.in. (PSI)
pounds/sq.in. (PSI)	X 0.069	= bars	bars	X 14.5	= pounds/sq.in. (PSI)
inches H_2O (60°F)	X 0.2488	= kilopascals (kPa)	kilopascals (kPa)	X 4.0193	= inches H_2O (60°F)
bars	X 100	= kilopascals (kPa)	kilopascals (kPa)	X 0.01	= bars
POWER					
horsepower (hp)	X 0.746	= kilowatts (kW)	kilowatts (kW)	X 1.34	= horsepower (hp)
ft.-lbs./min.	X 0.0226	= watts (W)	watts (W)	X 44.25	= ft.-lbs./min.
TORQUE					
pound-inches (in.-lbs.)	X 0.11298	= newton-meters (N-m)	newton-meters (N-m)	X 8.851	= pound-inches (in.lbs.)
pound-feet (ft.-lbs.)	X 1.3558	= newton-meters (N-m)	newton-meters (N-m)	X 0.7376	= pound-feet (ft.-lbs.)
pound-feet (ft.-lbs.)	X .1383	= kilograms/meter (kg-m)	kilogram/meter (kg-m)	X 7.233	= pound-feet (ft.-lbs.)
VELOCITY					
miles/hour (m/h)	X 0.11298	= kilometers/hour (km/hr)	kilometers/hour (km/hr)	X 0.6214	= miles/hour (m/h)
feet/second (ft./sec.)	X 0.3048	= meter/second (m/s)	meters/second (m/s)	X 3.281	= feet/second (ft./sec.)
feet/minute (ft./min.)	X 0.3048	= meter/minute (m/min)	meters/minute (m/min)	X 3.281	= feet/minute (ft./min.)

TEMPERATURE

°Celsius = 0.556 (°F - 32) °Fahrenheit = (1.8°C) + 32

COMMON METRIC PREFIXES

mega	(M)	= 1,000,000 or 106	deci	(d)	= 0.1 or 10^{-1}
kilo	(k)	= 1,000 or 10^3	centi	(c)	= 0.01 or 10^{-2}
hecto	(h)	= 100 or 10^2	milli	(m)	= 0.001 or 10^{-3}
deka	(da)	= 10 or 10^1	micro	(m)	= 0.000.001 or 10^{-6}