Pull-MASTER

THE LOGICAL CHOICE

INSTRUCTION AND PARTS MANUAL

MODEL M5

Design Revision 'B'

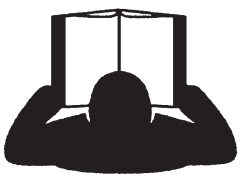
PLANETARY HYDRAULIC WINCH

TWG

POWER to Move the World™

TWG Canada
LANTEC and Pullmaster Brands
19350 – 22nd Ave • Surrey, BC V3S 3S6
Voice: + 1 604-547-2100 • Fax: + 1 604-547-2147 • www.team-twg.com

A DOVER COMPANY



READ THIS MANUAL BEFORE INSTALLING, OPERATING OR SERVICING THIS PRODUCT. THIS MANUAL CONTAINS IMPORTANT INFORMATION. MAKE THIS MANUAL AVAILABLE TO ALL PERSONS RESPONSIBLE FOR THE OPERATION, INSTALLATION, SERVICING AND MAINTENANCE OF THIS PRODUCT.

Effective 2011/10/01
SUPERSEDES ALL PRIOR WARRANTIES

LIMITED WARRANTY

50130-0

Seller warrants that each article (whether Gear Drive Products, Brake Products and/or Winch Products, all of which are covered hereunder) sold under this order shall at the time of shipment (i) conform to applicable specifications, and (ii) be free from defects in material and workmanship during normal and ordinary use and service (the "Warranty").

Buyer's exclusive remedy and Seller's sole obligation under this Warranty shall be, at Seller's option, to repair or replace any article or part thereof which has proven to be defective, or to refund the purchase price of such article or part thereof. Buyer acknowledges that Buyer is knowledgeable concerning the articles covered by this Warranty and sold in connection therewith which are being purchased, that Buyer has reviewed this Warranty and that the remedies provided hereunder are adequate and acceptable to Buyer.

This Warranty shall expire one (1) year from the date the article is first shipped by Seller. Notice of claimed breach of this Warranty must be given by Buyer to Seller within the applicable period. Such notice shall include an explanation of the claimed warranty defect and proof of date of purchase of the article or part thereof for which warranty coverage is sought. No allowances shall be made by Seller for any transportation, labor charges, parts, "in and out" costs, adjustments or repairs, or any other work, unless such items are authorized in writing and in advance by Seller. Nor shall Seller have any obligation to repair or replace items which by their nature are expendable.

If an article is claimed to be defective in material or workmanship, or not to conform to the applicable specifications, Seller will either examine the article at Buyer's site or issue shipping instructions for return to Seller. This Warranty shall not extend to any articles or parts thereof which have been installed, used, or serviced otherwise than in conformity with Seller's applicable specifications, manuals, bulletins, or instructions, or which shall have been subjected to improper installation, operation, or usage, misapplication, neglect, incorrect installation, overloading, or employment for other than normal and ordinary use and service. This Warranty shall not apply to any article which has been repaired, altered or disassembled, or assembled by personnel other than those of Seller. This Warranty shall not apply to any article upon which repairs or alterations have been made (unless authorized in writing and in advance by Seller). This Warranty shall not apply to any articles or parts thereof furnished by Seller to Buyer's specifications and/or furnished by Buyer or acquired from others at Buyer's request.

SELLER MAKES NO EXPRESS WARRANTIES AND NO IMPLIED WARRANTIES OF ANY KIND, OTHER THAN THE WARRANTY EXPRESSLY SET FORTH ABOVE. SUCH WARRANTY IS EXCLUSIVE AND IS MADE AND ACCEPTED IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Buyer expressly agrees that Seller is not responsible to perform any work or investigation related in any way to torsional vibration issues and is not responsible for the detection or remedy of Natural Frequency Vibration of the mechanical system in which the unit is installed. Buyer acknowledges, understands and agrees that this Warranty does not cover failures of the unit which result in any manner from the operation of the machine or unit at vibration frequencies at or near the natural frequency vibration of the machine in such a way that damage may result. Buyer expressly agrees that Seller is not responsible for failure damage or accelerated wear caused by machine or ambient vibration. Further, Buyer acknowledges and agrees that Buyer is always solely responsible for determination and final approval of the “application factor” which may be used in Seller’s calculations and this application factor is 1.0 unless otherwise stated in Seller’s quotation specifications.

The remedies for this Warranty shall be only those expressly set forth above, to the exclusion of any and all other remedies of whatsoever kind. The limited remedies set forth above shall be deemed exclusive, even though they may fail their essential purpose. No agreement varying or extending the foregoing Warranty, remedies, exclusions, or limitations shall be effective unless in writing signed by an executive officer of Seller and Buyer. This Warranty is non-transferable. If a party who had purchased articles from Buyer, or from persons in privity with Buyer, brings any action or proceeding against Seller for remedies other than those set forth in this Warranty, Buyer agrees to defend Seller against the claims asserted in such action or proceeding at Buyer’s expense, including the payment of attorneys’ fees and costs, and indemnify Seller and hold Seller harmless of, from and against all such claims, actions, proceedings or judgments therein. Buyer also agrees to defend and indemnify Seller of, from and against any loss, cost, damage, claim, debt or expenses, including attorneys’ fees, resulting from any claims by Buyer or third parties to property or injury to persons resulting from faulty installation, repair or modification of the article and misuse or negligent operation or use of the article, whether or not such damage to property or injury to persons may be caused by defective material, workmanship, or construction.

ADVISORY: *Winches and hoists are not approved for lifting or handling personnel or persons unless specifically approved in writing from Seller for the specific intended application.*

Under no circumstances shall Seller be liable (i) for any damage or loss to any property other than the warranted article or part thereof, or (ii) for any special, indirect, incidental, or consequential damage or loss, even though such expenses, damages, or losses may be foreseeable.

The foregoing limitations on Seller's liability in the event of breach of warranty shall also be the absolute limit of Seller's liability in the event of Seller's negligence in manufacture, installation, or otherwise, with regard to the articles covered by this Warranty, and at the expiration of the Warranty period as above stated, all such liabilities shall terminate. Buyer’s purchase of any article(s) covered by this Warranty shall constitute acceptance of the terms and conditions hereof and shall be binding upon Buyer and Buyer’s representatives, heirs and assigns. The laws of the Province of British Columbia shall govern Buyer’s rights and responsibilities in regard to this Warranty and the transaction(s) subject thereto, and the Province of British Columbia shall be the exclusive forum and jurisdiction for any action or proceedings brought by Buyer in connection herewith or any dispute hereunder. If any of the terms and conditions contained within this Warranty are void, the remaining provisions thereof are and shall remain valid and enforceable.

SAFETY RECOMMENDATIONS

DANGER

FAILURE TO COMPLY WITH THE FOLLOWING SAFETY RECOMMENDATIONS AND LOCAL RULES AND REGULATIONS WILL RESULT IN PROPERTY DAMAGE, SEVERE INJURY OR DEATH.

Definition: **Caution** indicates a potentially hazardous situation which, if not avoided may result in minor or moderate injury.

Definition: **Warning** indicates a potentially hazardous situation which, if not avoided could result in death or serious injury.

Definition: **Danger** indicates a potentially hazardous situation which, if not avoided will result in death or serious injury.

The planetary hydraulic winches are made for hoisting and lowering loads and to be operated by trained and professional personnel. They are not designed for operations involving lifting or moving personnel. The winches are powered by hydraulic power. The ropes / cables for hoisting operations are not supplied by PULLMASTER. The winches are always assembled in an application, they do not function as an independent machine and it is not allowed to use them as such.

The winches are to be used within the specifications as listed in the manual under "SPECIFICATIONS". Other use as foreseen in the functional description of the hydraulic winch is not allowed without written permission from PULLMASTER.

1. Do not install, operate or service winch before reading and understanding manufacturer's instructions.
2. The winch described herein is not designed for operations involving lifting or moving personnel.
3. Do not lift or carry loads over people.
4. Do not exceed recommended operating pressure (psi) and operating volume (gpm).
5. Do not jerk the winch. Always smoothly accelerate and decelerate load.
6. Do not operate a damaged, noisy or malfunctioning winch.
7. Do not leave a load suspended for any extended period of time.
8. Never leave a suspended load unattended.
9. Winch should be maintained and operated by qualified personnel.
10. Inspect winch, rigging, mounting bolts and hoses before each shift.
11. Warm-up equipment before operating winch, particularly at low ambient temperatures.
12. Verify winch function by raising and lowering a full test load to a safe height before each shift.
13. Do not weld any part of the winch.
14. Verify gear lubrication and brake circulation supply and return before operating winch.
15. Be sure of equipment stability before operating winch.
16. Wear proper clothing to avoid entanglement in rotating machinery.
17. Always stand clear of the load.
18. Use only recommended hydraulic oil and gear lubricant.
19. Keep hydraulic system clean and free from contamination at all times.
20. Maintain winch and equipment in good operating condition. Perform scheduled maintenance regularly.
21. Keep hands clear when winding wire rope onto the winch drum.
22. Do not use the wire rope as a ground for welding.
23. Rig the winch carefully. Ensure that the wire rope is properly anchored to the correct cable anchor slot at the cable drum.
24. Do not lift a load with a twisted, kinked or damaged wire rope.
25. Consult wire rope manufacturer for size, type and maintenance of wire rope.
26. Maintain five wraps of wire rope on the cable drum at all times.
27. In case of a power failure or breakdown leading to an unexpected stop of the hydraulic power circuit, stand clear of the area and the load being hoisted, take the necessary precautions to prevent access to area where the load is halted.
28. The noise level of the winch is 86 dBA measured on a distance of 1.00 meter, 1.60 meters high. The measuring equipment used was: Realistic #42-3019.
29. Clean up any oil spillage immediately.
30. Wear proper clothing and personal protection equipment such as, footwear, safety goggles and a hard hat. Read manual first.

DESCRIPTION OF THE MODEL M5

GENERAL DESCRIPTION:

The PULLMASTER Model M5 is a planetary, hydraulic winch having equal speed in both directions. The main components of this unit are:

- hydraulic gear motor
- multi-disc brake with static and dynamic function
- primary planet reduction
- final planet reduction
- brake housing
- final drive housing
- cable drum

FUNCTION IN FORWARD ROTATION (HOISTING):

In forward rotation, the output torque and rpm of the hydraulic motor are transmitted to the sungear of the primary planet reduction. The output torque and rpm of the primary reduction stage are transmitted to the final reduction stage by the final sungear shaft, which is splined to the primary planet hub. Final output torque and rpm are then transmitted to the cable drum, which is splined to the final drive planet hub. In forward rotation, or when a load is raised, an over-running clutch, which connects the motor drive shaft to the automatic brake assembly, permits free rotation of the sun gear without effecting the brake. When the winch rotation is stopped, the load on the cable drum causes the over-running clutch to lock and the maximum load is held safely by the disc brake.

FUNCTION IN REVERSE ROTATION (LOWERING):

In reverse rotation, hydraulic pressure from the reversing side of the hydraulic motor is channelled to the brake piston, causing the brake piston to release the multi disc brake against a number of brake springs. The over-running clutch, connecting the motor drive shaft to the brake assembly, locks, causing the brake discs to rotate between divider plates. Thus, a completely smooth lowering speed can be achieved in a stepless operation by modulation of the winch control valve handle. When the control handle is returned to neutral position, rotation stops and the disc brake applies automatically.

During the lowering operation of the winch, the friction created by the brake discs results in temperature. This temperature is dissipated by an internal circulation flow, supplied out of the hydraulic motor. This circulation flow of approximately 1 (US) gpm - 4 l/min, must be returned directly to the reservoir with a permissible back pressure of 30 psi (2 bar).

IMPORTANT: Under no circumstances must the back pressure in the brake housing be permitted to exceed 30 psi (2 bar). Excessive pressure in the brake housing will damage the oil seal separating the brake housing from the drum interior. Damage to this seal will cause the drum to fill up with hydraulic fluid. In order to forewarn potential damage to the drum seals and the end cover of the winch, when the cable drum fills up with hydraulic fluid, a breather relief (see PARTS REFERENCE, item 130) is installed on the end cover. The breather relief bleeds to atmosphere and serves as a warning signal that the oil seal between the brake housing and drum has been damaged.

EXPLANATION OF MODEL CODING

M 5 X - XX - XX - XX X - B XXXX

BASIC UNIT SERIES
M = Equal speed in both directions

SIZE OF UNIT

REDUCTION RATIO
Only used for non standard reduction ratios

TYPE OF BRAKE
-3 Automatic brake, clockwise drum rotation, internal circulation flow

-6 Automatic brake, counterclockwise drum rotation, internal circulation flow

HYDRAULIC MOTOR
-230 Hydraulic gear motor, 1.20 cubic inch displacement (Other motors are optional)

DRUM SIZE
-1 7 inch drum diameter X 11 1/2 inch flange diameter X 8 inch length - STANDARD (For other drum sizes refer to Appendix A)

OPTIONS

DESIGN REVISION *

SPECIFICATION NUMBER
Describes features not identified by preceding codes

NOTE: Clockwise and counterclockwise drum rotation is the direction of rotation for pulling or hoisting, established by looking at the hydraulic motor.

*** Model M5 Design Revision 'B'**
Instruction and Parts Manual # PMC 316 PUB.960901
Effective from Serial # 46161

OPTIONS

COUNTERCLOCKWISE ROTATION:

The drum rotation of the standard PULLMASTER Model M5 planetary winch is clockwise for hoisting when looking at the hydraulic motor of the winch. Drum rotation for counter clockwise hoisting direction is available as an option.

CABLE DRUM SIZES:

Aside from the standard drum sizes listed in APPENDIX A, the PULLMASTER Model M5 planetary winch can be supplied with optional drums to accommodate large wire rope storage capacity.

OPTIONAL GEAR SECTION FOR THE HYDRAULIC MOTOR:

The performance of the standard PULLMASTER Model M5 planetary winch can be changed by using a different displacement motor. (Contact the factory for performance information.)

The PULLMASTER WINCH CORPORATION will consider other options for quantity requirements.

SPECIFICATIONS

Performance specifications are based on standard hydraulic motor, gear ratio and cable drum with 1/2 inch diameter wire rope. For other cable drums and gear ratios, refer to APPENDIX A. Performance specifications for winches supplied with optional motors are provided in attached supplement.

CABLE DRUM DIMENSIONS (STANDARD DRUM):

Barrel diameter	7.00 in	178 mm
Flange diameter	11.50 in	292 mm
Barrel length	8.00 in	203 mm

CABLE STORAGE CAPACITY:

(Size of wire rope)		
1/8 in	2115 ft	645 m
3/16 in	959 ft	292 m
1/4 in	532 ft	162 m
5/16 in	359 ft	109 m
3/8 in	227 ft	69 m
7/16 in	166 ft	51 m
1/2 in	152 ft	46 m

MAXIMUM OPERATING PRESSURE: 2000 psi 138 bar

MAXIMUM OPERATING VOLUME: 14.5 (US) gpm 55 l/min

MINIMUM OPERATING VOLUME: 4 (US) gpm 15 l/min

DRUM TORQUE AT MAXIMUM PRESSURE: 22,500 lb-in 2,542 Nm

DRUM RPM AT MAXIMUM VOLUME: 35 rpm

HOISTING LINE PULL AT MAXIMUM PRESSURE:

Bare drum	6,000 lb	26.7 kN
Full drum	4,091 lb	18.2 kN

HOISTING LINE SPEED AT MAXIMUM VOLUME:

Bare drum	69 ft/min	21 m/min
Full drum	101 ft/min	31 m/min

PERMISSIBLE SYSTEM BACK PRESSURE AT MOTOR RETURN PORT: 65 psi 4.5 bar

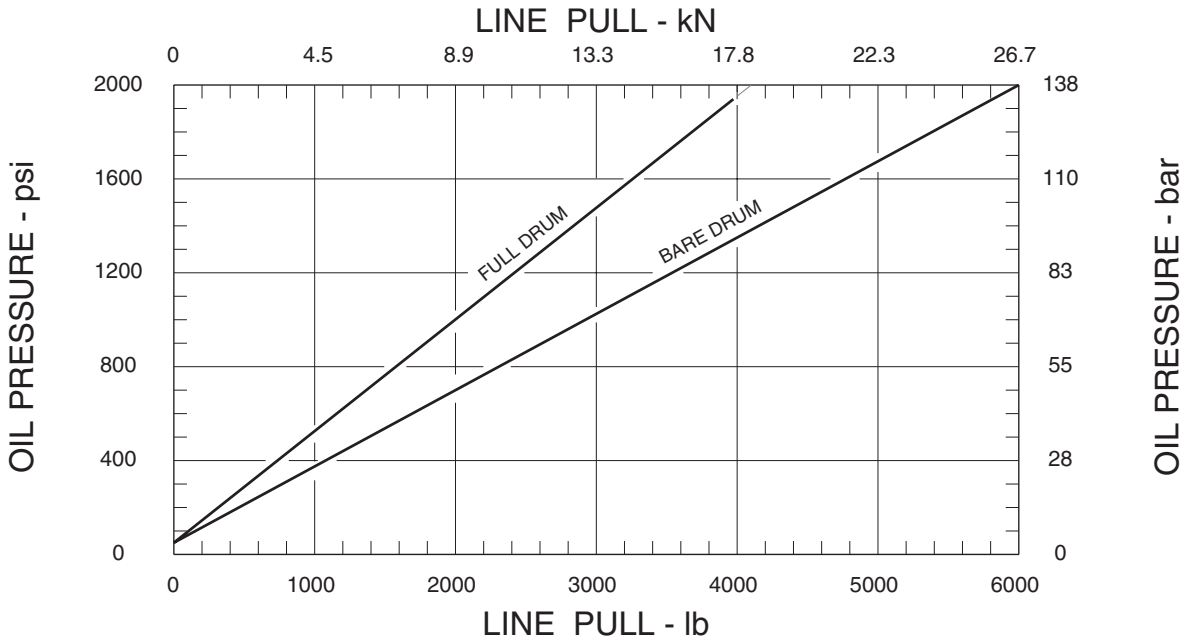
PERMISSIBLE PRESSURE AT CIRCULATION RETURN PORT: 30 psi 2 bar

LUBRICATING OIL: Refer to RECOMMENDATIONS for viscosity and instructions. Refer to APPENDIX A for oil volume required.

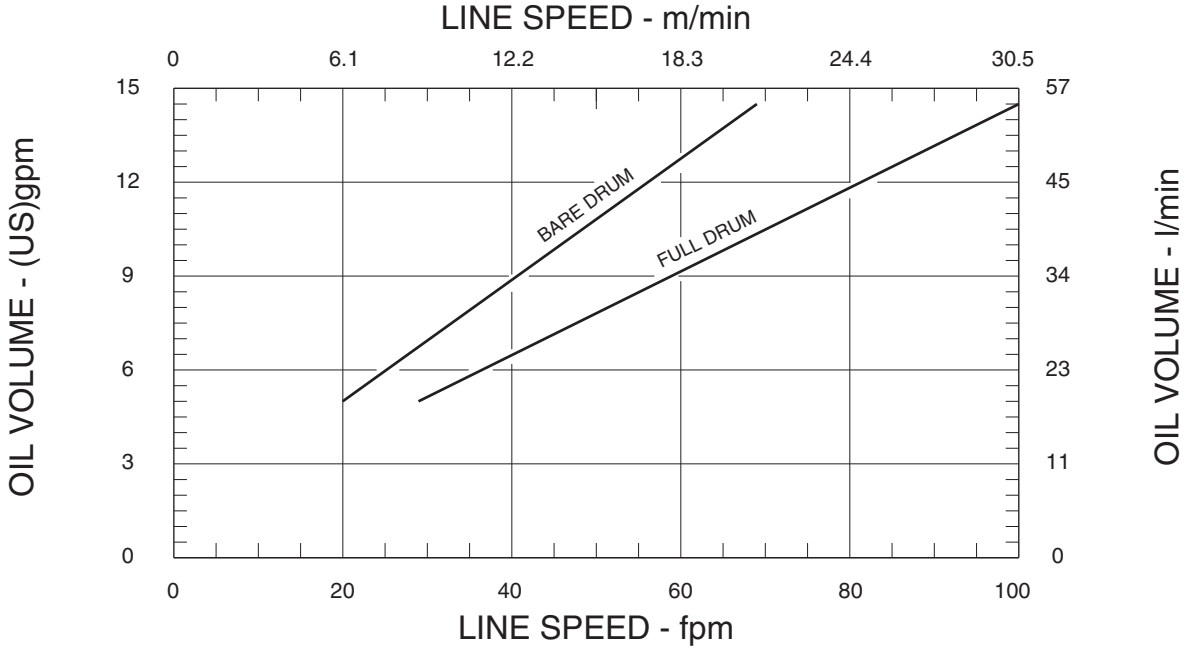
PERFORMANCE GRAPHS

PG-M5-A

LINE PULL VS. OIL PRESSURE:



LINE SPEED VS. OIL VOLUME:



Performance graphs are based on standard hydraulic motor and cable drum with 1/2 inch diameter wire rope.

TYPICAL HYDRAULIC CIRCUITS

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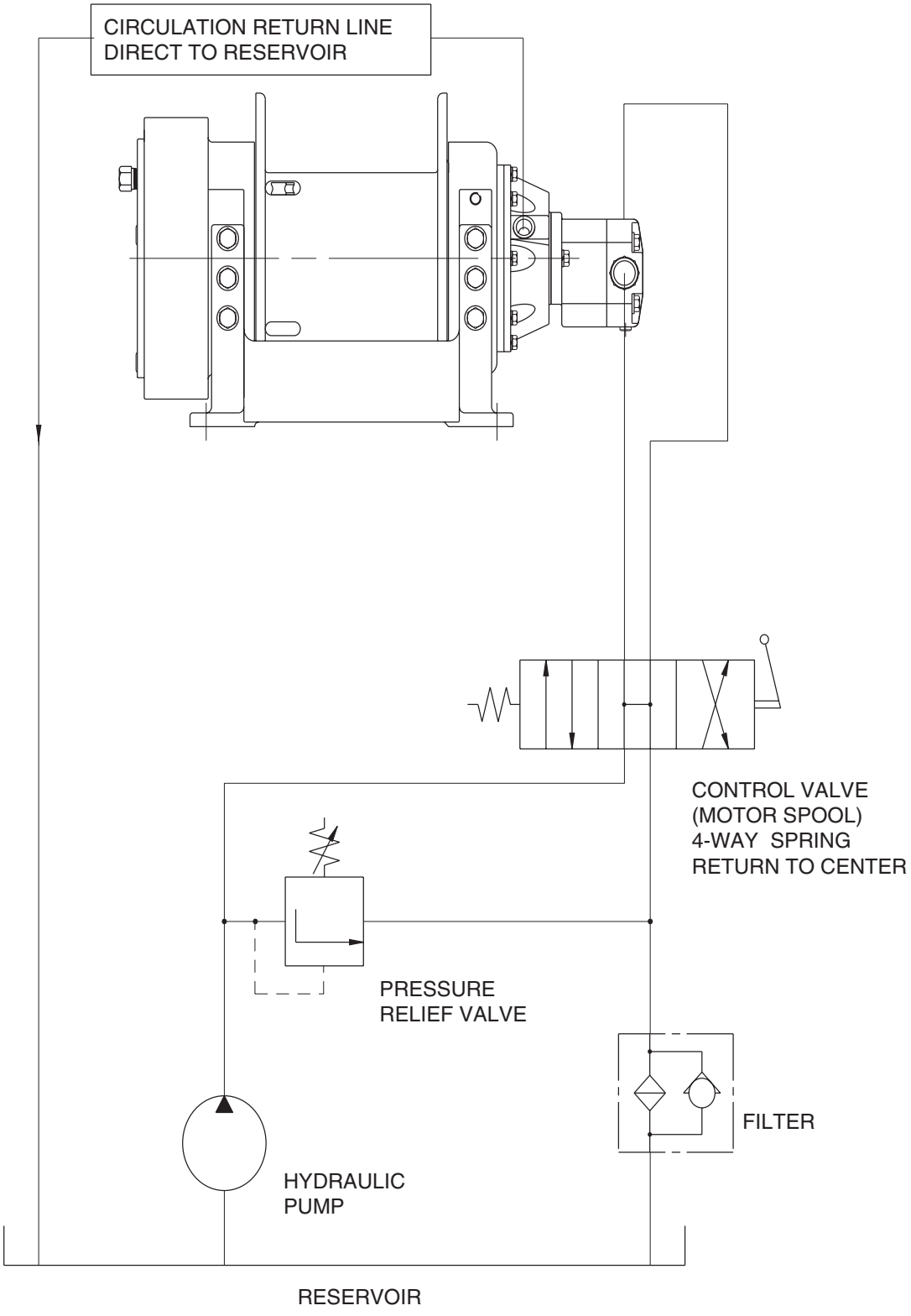


RECOMMENDATIONS

HYDRAULIC FLUID:

The hydraulic fluid selected for use with PULLMASTER planetary winches should be a high grade, petroleum based fluid, with rust, oxidation and wear resistance. Fluid cleanliness and operating viscosity are critical to winch reliability, efficiency and service life.

For optimum performance, the recommended viscosity range at operating temperature is 81 - 167 SUS (16 - 36 CS). For extreme operating conditions of short duration, the maximum viscosity range of 58 - 4635 SUS (10 - 1000 CS) should not be exceeded.

For optimum performance, the winch recommended hydraulic fluid temperature operating range is 80 - 150F (27 - 66 C). For extreme operating conditions of short duration, the maximum temperature range of -5 - 180F (-21 - 82 C) should not be exceeded.

LUBRICATION:

The winch gear train requires oil bath lubrication. The winch is shipped from the factory without lubricating oil.

IMPORTANT: ADD LUBRICATING OIL UP TO THE LEVEL OF THE OIL FILL PORT BEFORE RUNNING WINCH.

Refer to INSTALLATION DIMENSIONS for location of lubricating oil fill port. Refer to APPENDIX A for quantity of oil required. For normal operating temperature use SAE 90 lubricating oil. For temperature beyond normal operating range, consult lubricating oil supplier or factory.

HYDRAULIC PUMP:

For maximum performance of the PULLMASTER planetary winch, the hydraulic pump must supply the maximum flow of hydraulic fluid at the hydraulic pressure stated in SPECIFICATIONS.

HYDRAULIC CONTROL VALVE:

The standard control valve used for operating the PULLMASTER planetary winch must have a four-way, spring return to neutral feature, which provides for open flow from the pressure ports of the winch to the reservoir in neutral position of the control (motor spool). It is important to point out that good speed control, especially when lowering a load, depends on the "metering" characteristics of the control valve. The better the oil flow is "metered" the better will be the speed control.

HYDRAULIC PRESSURE RELIEF:

The hydraulic circuit for the PULLMASTER planetary winch requires a pressure relief set at the operating pressure (see SPECIFICATIONS). Usually, a pressure relief is part of the hydraulic control valve. Where this is not the case, a separate pressure relief valve must be installed and set at the recommended maximum pressure.

HYDRAULIC RESERVOIR:

It is recommended that the hydraulic reservoir has sufficient capacity to provide good heat dissipation in order to prevent over-heating of the hydraulic fluid. The hydraulic reservoir should be made from clean and scale-free material to prevent contamination of the hydraulic fluid. In order to prevent air from being mixed with the hydraulic fluid, the reservoir should have an over-flow baffle separating the return lines from the suction line and all return lines should enter the reservoir below the fluid level. The reservoir should be mounted close to and above the hydraulic pump in a location which provides for free air circulation around the reservoir.

HYDRAULIC HOSES:

The following hydraulic hoses are recommended for maximum efficiency of the PULLMASTER Model M5 planetary winch:

Pressure lines:	Equivalent to SAE 100R12-12
Circulation return line:	Equivalent to SAE 100R4-10

It is recommended that a larger size of hydraulic hose is installed where the pressure lines or the circulation lines are excessively long.

HYDRAULIC FILTER:

Consult hydraulic component manufacturer for recommendation. Generally, 5 to 10 micron filters are acceptable. In order to prevent accidental stoppage of the return line flow, the filter should have a by-pass feature.

USE OF AN E STOP:

(FOR EUROPEAN MACHINERY DIRECTIVE APPLICATIONS)

The use of an E stop (emergency) is mandatory in the controls circuit. The E stop is to be placed in the operator's control panel. The E stop must be designed and placed in line with EN 60204 and EN 418.

INSTALLATION INSTRUCTIONS

DANGER

FAILURE TO FOLLOW INSTALLATION INSTRUCTIONS WILL RESULT IN PROPERTY DAMAGE, SEVERE INJURY OR DEATH.

The initial installation or mounting of a PULLMASTER planetary winch is critically important for proper operation and performance. If the winch is mounted to an uneven surface, the centre line of the unit can be distorted to a point where the winch will not operate in either direction. It is therefore very important that the following instructions are observed when a PULLMASTER planetary winch is installed:

1) Make certain that the mounting platform is sufficiently strong in order to avoid deflection when a load is lifted.

2) Set the winch on the mounting platform and check for surface contact on all mounting pads of the winch.

3) If there is a space between the mounting surface and one of the mounting pads, the mounting surface is not even and the space below the mounting pad must be shimmed. If this condition exists, proceed as follows:

   a) Install mounting bolts snug tight on the three mounting pads which are in contact with the mounting surface. (For mounting bolt size and grade see INSTALLATION DIMENSIONS.)

   b) Measure the space underneath the fourth mounting pad with a feeler gauge and use shim stock of equivalent thickness in the space between the mounting pad and the mounting surface.

   c) Only after this procedure should the fourth mounting bolt be installed. Tighten all four bolts per BOLT TORQUE CHART.

4) Fill the winch with lubricating oil. See APPENDIX A for oil volume required.

5) Use recommended circuit components and hydraulic hoses.

6) The circulation return line of the winch should be plumbed in such a manner that the brake housing remains full of oil at all times. Connect the circulation return line directly to reservoir. Do not connect to a common return line.

7) Before operating the winch with a load, verify adequate circulation flow through the circulation return line as stated in TYPICAL HYDRAULIC CIRCUIT. Verify that pressure measured at the circulation supply port does not exceed the permissible pressure stated in SPECIFICATIONS. Winches equipped with the internal circulation option will supply circulation flow only when the winch is run in the lowering direction.

8) Verify that breather relief, item 130, is in place on end cover above oil level. Rotate end cover if breather relief is below oil level.

IMPORTANT:

Do not replace breather relief with a pipe plug. The breather relief does not prevent oil seal failure but serves as an indicator or warning that the oil seals between brake housing and the cable drum interior have failed and must be replaced immediately. If these oil seals are changed, additional failure of the drum seal and potential damage to the end cover is prevented.

OPERATING INSTRUCTIONS

DANGER

FAILURE TO FOLLOW OPERATING INSTRUCTIONS WILL RESULT IN PROPERTY DAMAGE, SEVERE INJURY OR DEATH.

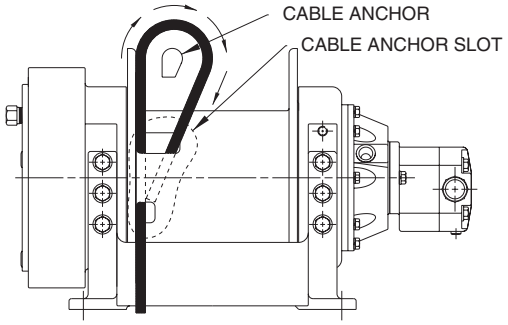
After the PULLMASTER planetary winch has been installed in accordance with the INSTALLATION INSTRUCTIONS, the wire rope can be fastened to the cable drum.

IMPORTANT: The ropes, chains, slings, etc. are not part of the winch and are not covered by this manual. Refer to manufacturer's handling, inspection and maintenance recommendations to avoid potential accidents. For selection of ropes, etc. please check following product standards: DIN 15020, prEN818-1/9, prEN 1492-1/2, prEN 1677-1/3 and other relevant product standards.

1) The cable drum of the PULLMASTER planetary winch has two cable anchor slots, one for clockwise and one for counterclockwise hoisting. Standard rotation for hoisting is clockwise when looking at the hydraulic motor of the unit. It is critical to select the cable anchor slot which will permit winding of the wire rope on the drum in the correct direction of rotation. If the wire rope is wound on the cable drum in the wrong direction of rotation, the winch will have no braking capacity. Each winch is shipped from the factory with a label on the drum indicating the correct cable anchor slot.

WIRE ROPE INSTALLATION
Clockwise hoisting winch shown.
(Use cable anchor slot on opposite side of drum for counterclockwise hoisting winch.)

Feed the wire rope through the cable anchor slot. Loop rope back into slot as shown. Insert cable anchor into slot, small end first and long side nearest the drum flange. Pull rope tight to wedge rope in slot.



SI1013 - M5

2) On wire rope installation, care must be taken that the wire rope is wrapped completely around the cable anchor and properly pulled into the cable anchor slot in the cable drum. The cable drum requires 5 wraps of wire rope for safety.

3) The winch operation is controlled by a single control valve lever which has a **forward**, a **reverse** and a **neutral** position. Speed control in either direction is obtained by modulation of the control valve lever. Maximum line speed in either direction is obtained when the control valve lever is moved as far as it can go. The disc brake of the winch will come on automatically when the winch control lever is returned to **neutral**.

4) Always warm up equipment prior to operating winch, particularly in low ambient temperature. Circulate hydraulic oil through the winch control valve for several minutes to warm the hydraulic system. To prime the winch with warm oil, operate the winch at slow speed, forward and reverse, several times.

5) Prevent corrosion damage to winch interior. If not used regularly, run winch up and down at least once every two weeks.

6) To ensure proper winch installation and function, raise and lower a full test load to a safe height before using winch for regular operation at the start of each shift.

   If, after a new installation, the winch does not function properly, refer to the TROUBLESHOOTING section of this manual.

TROUBLE SHOOTING

GENERAL:

In most cases, when the hydraulic winch does not perform satisfactorily, the cause for malfunction is found somewhere in the hydraulic circuit. Before the winch is removed from its mounting and disassembled, all of the hydraulic circuit components should be checked for proper function.

IMPORTANT:

The hydraulic oil volume relates to the line speed or rpm of the winch.

Therefore, if the winch does not produce the specified maximum rated line speed or drum rpm, a loss of hydraulic flow somewhere in the hydraulic circuit can be analysed. If this condition exists, install a flow meter into the hydraulic circuit to check the volume of oil supplied to the pressure port of the hydraulic winch motor when the winch control is completely opened. The flow meter should indicate the maximum operating volume. If this test indicates a loss of hydraulic flow, check the hydraulic pump, the relief valve and the control valve. If the pump is driven by V-belts, check for belt slippage.

The hydraulic pressure relates to the pulling capacity of the winch.

If the winch will not produce the specified maximum line pull, install a pressure gauge in the pressure line leading to the hoisting port on the hydraulic winch motor. Stall the winch to prevent rotation of the drum and then open the control valve. Check the hydraulic pressure reading of the installed pressure gauge. If the pressure reads below the specified maximum operating pressure, look for trouble in the hydraulic pump, the relief valve and the control valve. If the hydraulic pump is driven by V-belts, check for belt slippage. When checking oil pressure and volume in the hydraulic circuit, make sure that the hydraulic reservoir is filled to the top level and the hydraulic pump is running at maximum operating rpm.

Only after the hydraulic system has been checked and found to be in order, use the following indications for probable causes of failure in the winch:

FAILURE	PROBABLE CAUSE
Winch will not produce line pull at maximum pressure as listed in SPECIFICATIONS.	a) Winch is mounted to an uneven surface. (See INSTALLATION INSTRUCTIONS.) b) Cable sheaves or block purchase operated with the winch are not turning freely. c) Damage or wear in the hydraulic motor. d) The relief valve pressure may be set too low. (See SPECIFICATIONS for maximum operating pressure.) e) Excessive back pressure in the hydraulic circuit might cause the automatic brake to release momentarily.
Winch will not produce line speed at maximum volume as listed in SPECIFICATIONS.	a) Winch is mounted to an uneven surface. (See INSTALLATION INSTRUCTIONS.) b) Cable sheaves or block purchase operated with the winch are not turning freely. c) Damage or wear in the hydraulic motor. d) Excessive back pressure in the hydraulic circuit.
Winch will not reverse.	a) Leakage out of the brake piston prevents the disc brake from being released against the brake springs. This is caused by damaged O-ring seals on the brake piston or connecting tube. b) Insufficient hydraulic pressure. (See SPECIFICATIONS for minimum operating pressure.) c) Winch is mounted to an uneven surface. (See INSTALLATION INSTRUCTIONS.) d) Hydraulic pressure is not reaching the brake piston due to plugged connecting tube.

TROUBLE SHOOTING

FAILURE	PROBABLE CAUSE
Brake will not hold.	a) Brake plates or divider plates have been damaged by contamination in the hydraulic fluid or lack of circulation flow in the brake housing. b) Brake piston is seized in the brake housing because of contamination in the hydraulic fluid. c) Excessive back pressure in the return line of the hydraulic circuit causes the brake to release. d) Control valve has incorrect spool which traps hydraulic pressure in the brake piston when the control valve handle is returned to neutral position. For proper function of the automatic brake, both pressure ports of the winch must be open to the reservoir in neutral position of the control valve. e) Wire rope is fastened to the incorrect cable anchor slot. f) Sprag clutch is damaged or surfaces where sprag clutch engages on primary sungear or brake hub are worn or indented.
Brake vibrates when lowering a load.	a) Pump is too slow. Pump rpm must be maintained at normal operating speed when a load is lowered. b) Brake is running too hot. This is caused by insufficient circulation flow. To check the circulation, observe the flow of oil from the circulation return line of the winch (approx. 1 (US) gpm - 4 l/min) when the winch is reversed. c) Control valve for the winch operation has poor metering characteristics. d) Damaged brake plates or divider plates. e) Over-running clutch, which connects the primary sungear with the brake assembly, is damaged. f) Air has mixed with hydraulic oil resulting in foamy oil.
Oil leaks.	a) Oil leaks from the motor flange are caused by a damaged O-ring seal on the motor flange. b) Oil leaks occurring between the cable drum flanges and housing are caused by excessive pressure in the brake housing. Excessive pressure in the brake housing will damage the oil seal between the brake housing and cable drum interior. c) If the breather relief on the end cover leaks, the seal between the drum interior and the brake housing is damaged and must be replaced. This condition is caused by excessive pressure in the brake housing of the winch, or operation with the incorrect hydraulic fluid during cold weather, or a restriction in the circulation return line leading back to tank.

Refer to the SERVICE INSTRUCTIONS if it becomes necessary to disassemble the Model M5 winch.

SERVICE INSTRUCTIONS

GENERAL:

Before disassembling the PULLMASTER Model M5 planetary winch, read and understand the following instructions.

Replace expendable parts such as O-rings and oil seals when reassembling the winch. Have a winch seal kit (Part No. 23099) on hand before the unit is disassembled.

NOTE: Backup washers may be included with seal kit. Install with oil seals as per instructions. If not present in seal kit, the oil seals supplied do not require backup washers.

Disconnect all hydraulic hoses, remove the winch from its mounting and relocate to a clean working area, similar to one used for service work on any other hydraulic component. Special tools are not required to service the winch. Adjustments and calibrations are not required.

All parts, as they are removed from the winch assembly, should be inspected for wear and damage. Worn or damaged parts must be replaced. Thoroughly clean parts before reassembly. Do not use solvent to clean the brake friction plates.

During reassembly, lubricate all O-rings and oil seals with grease before installation.

The following SERVICE INSTRUCTIONS refer to part descriptions and item numbers which appear in ASSEMBLY DRAWING on page 20.

DISASSEMBLY

REMOVAL OF HYDRAULIC MOTOR ASSEMBLY:

The motor is not user serviceable and must be replaced if not functioning properly. Contact your nearest PULLMASTER WINCH CORPORATION Distributor for a replacement. Remove the motor assembly as follows:

1) Remove two capscrews, item 935, and lockwashers, item 937. Pull hydraulic motor, item 950, out of winch assembly.
2) Remove and discard O-ring, item 811.
3) Connecting tube, item 830, will either be in motor or motor adaptor. Note and mark which brake release port part is from (required for reassembly) then remove. Remove motor plug, item 888, from other brake release port. These parts must be reinstalled properly for winch brake to function correctly. Remove and discard three O-rings, item 831.

DISASSEMBLY OF BRAKE HOUSING ASSEMBLY:

The majority of service and repair work is done on the brake housing assembly which is accessed by removing the hydraulic motor assembly. Disassemble brake housing assembly as follows:

1) Remove motor adaptor, item 800, by removing eight capscrews, item 931, and lockwashers, item 933. Allow brake springs, item 752, to expand safely by unscrewing capscrews one turn at a time.
2) Remove and discard O-ring, item 539.
3) Remove six brake springs, item 752. Examine springs for damage and measure overall length. Overall spring length should be 1.25 inch. Springs measuring less then 1.19 inch should be replaced.
4) Pull brake piston, item 750, out of brake housing, item 700. Verify free movement of by-pass valves. If valves are seized, replace piston assembly.
5) Remove and discard O-rings, items 751 and 753.
6) Thoroughly inspect brake piston outer diameters and brake housing inner bores for scoring caused by hydraulic fluid contamination. Minor surface damage may be repaired by polishing with a fine emery cloth.

7) Pull primary sungear, item 440, with brake hub assembly, item 720, and clutch aligners, items 722 and 724, from brake housing.

8) Disassemble brake hub assembly by removing circlip, item 727, from primary sungear, item 440. Remove primary sungear from brake hub, item 720. Remove sprag clutch aligners, items 722 and 724, and sprag clutch, item 723, from brake hub.

DANGER

MINOR SURFACE DEFECTS WHERE THE SPRAG CLUTCH ENGAGES THE BRAKE SHAFT AND BRAKE HUB, WILL RESULT IN BRAKE FAILURE AND ALLOW THE LOAD TO DROP, CAUSING PROPERTY DAMAGE, SEVERE INJURY OR DEATH. THOROUGHLY INSPECT THESE AREAS AND, IF NECESSARY, REPLACE BRAKE SHAFT, SPRAG CLUTCH AND BRAKE HUB AS A SET.

9) Thoroughly inspect primary sungear, item 440, and brake hub, item 720, particularly surfaces where sprag clutch, item 723, engages.

10) If any indentation or surface damage is detected, replace brake hub, sprag clutch and primary sungear as a set.

DANGER

DAMAGED FRICTION OR DIVIDER PLATES WILL REDUCE BRAKING CAPACITY AND ALLOW THE LOAD TO DROP CAUSING PROPERTY DAMAGE, SEVERE INJURY OR DEATH. DO NOT USE SOLVENT TO CLEAN THE FRICTION PLATES. PERFORM THOROUGH INSPECTION AND, IF NECESSARY, REPLACE FRICTION AND DIVIDER PLATES AS A SET.

11) Remove four friction plates, item 715, and five divider plates, item 713, and inspect for damage or wear. Plates should be flat and smooth. Plates should not show heat discoloration. Paper material on friction plates should be intact and grooved. If any damage is detected, replace friction and divider plates as a set.

12) Remove thrust bearing, item 739, and thrust washers, item 737. Inspect bearing and washers and replace if damaged or worn.

13) Remove two flat head capscrews, item 693, and brake housing, item 700. Remove brake spacer, item 712, and discard O-ring, item 695.

DISASSEMBLY OF PRIMARY DRIVE:

If the primary drive requires service or repair, disassemble as follows:

1) Remove pipe plug, item 503, from cable drum, item 500, and pipe plug, item 121, from end cover, item 120, to drain lubricating oil from winch interior. Remove breather relief, item 130.

NOTE: Breather relief, item 130, is not user serviceable. Must be replaced if not functioning properly.

2) Stand winch upright on end cover, item 120. Remove 12 capscrews, item 911, and lockwashers, item 931. Remove base, item 550.
3) Remove circlip, item 535, and, with two heel bars, pry end housing, item 698, away from cable drum flange. Remove and discard O-ring, item 539.
4) Press ball bearing, item 103, out of end housing, item 698.
5) Remove seal carrier, item 538, from end housing and discard Parker seal, item 543, and O-ring, item 545.
6) Remove six socket head capscrews, item 537, and bearing flange, item 530, from cable drum. Remove circlip, item 517, from inside bearing flange. Press oil seal, item 531, against journal bearing, item 706, to remove. Discard oil seal, item 531, and O-ring, item 539.
7) Remove primary planet hub assembly, and final sungear, item 340, from cable drum, item 500.
8) If necessary to remove primary planet gears, remove circlip, item 411, from chamfered side of planet pin, item 410, and press pin out of planet hub, item 400. Inspect needle bearing, item 423, and two thrust washers, item 421, and replace if damaged.
9) Remove circlip, item 343, from end of final sungear, item 340, and extract from planet hub.
10) Inspect sungear stopper, item 344, for excessive wear. Replace if less than .03 inch protrudes out of final sungear, item 340.

DISASSEMBLY OF FINAL DRIVE:

Stand winch on cable drum flange with final end up and disassemble as follows:

1) Remove retaining ring, item 124, and pull end cover, item 120, out of final housing, item 100.
2) Discard O-ring, item 123, and inspect planet hub stopper, item 126, and sungear stopper, item 122, for excessive wear. Replace if planet hub stopper is less than .14 inch or if sungear stopper is less than .37 inch thick.
3) Remove final planet hub assembly from final housing, item 100.
4) Inspect three final planet gears, item 320, for damage or wear. If it is necessary to remove final planet gears, remove circlip, item 313, and press planet pin, item 310, out of planet hub, item 300. Inspect needle bearing, item 323, and two thrust washers, item 321, and replace if damaged.
5) To separate cable drum from final housing, first remove circlip, item 513. Insert two heel bars between flange of cable drum and final drive housing and gently pry cable drum out of ball bearing, item 103.
6) Remove circlip, item 104, and press ball bearing, item 103, out of final housing, item 100. Check ball bearing and replace if damaged.
7) Remove and discard oil seal, item 105.

REASSEMBLY

Thoroughly clean all parts. Use only new, well-greased O-rings and oil seals. Unless otherwise specified, torque fasteners per BOLT TORQUE CHART as back of manual.

REASSEMBLY OF FINAL DRIVE:

Reassemble final drive end of winch as follows:

1) Press new, well-greased oil seal, item 105, into final housing, item 100.
2) Press ball bearing, item 103, into final housing and secure with circlip, item 104.
3) Press cable drum, item 500, into ball bearing, item 103, and secure with circlip, item 513.
4) Reassemble final planet hub assembly. Press needle bearing, item 323, into final planet gear, item 320. Position thrust washers, item 321, on either side of planet gear and press planet pin, item 310, into final planet hub, item 300. Retain with circlip, item 313.
5) Insert final planet hub assembly into final housing, item 100. Ensure that planet hub spline is fully engaged with cable drum, item 500.
6) Install new, well-greased O-ring, item 123, into end cover, item 120. Verify that planet hub stopper, item 126, and sungear stopper, item 122, are installed into end cover.
7) Gently insert end cover into final housing, item 100, and fasten with retaining ring, item 124.
8) Turn winch up on end with cable drum opening upwards.

REASSEMBLY OF PRIMARY DRIVE:

Reassemble primary drive as follows:

1) Reassemble primary planet hub assembly. Press sungear stopper, item 344, into end of final sungear, item 340. Insert final sungear into planet hub, item 400, and fasten with circlip, item 343. Press needle bearing, item 423, into primary planet gear, item 420. Position thrust washers, item 421, on either side of planet gear and press planet pin, item 410, into primary planet hub, item 400. Retain with circlip, item 411.
2) Insert final sungear and primary planet hub assembly into cable drum. Rotate drum by hand until sungear engages final planet gears and primary planet gears engage cable drum.
3) Press new, well-greased oil seal, item 531, into bearing flange, item 530, followed by journal bearing, item 706. Install circlip, item 517, and new, well-greased O-ring, item 539, into bearing flange.
4) Fasten bearing flange, item 530, to cable drum, item 500, using six socket head capscrews, item 537.
5) Install new, well-greased O-ring, item 545, and Parker seal, item 543, into seal carrier, item 538. Install seal carrier into opening of end housing, item 698, and press ball bearing, item 103, tight against seal carrier. Press end housing, with seals and ball bearing, onto bearing flange. Fasten with circlip, item 535.

REASSEMBLY OF BRAKE HOUSING ASSEMBLY:

Reassemble brake housing assembly by reversing the disassembly procedure:

1) Place brake spacer, item 712, in end housing with flat side facing up.

2) Install new, well-greased O-ring, item 695, onto mounting flange of brake housing, item 700. Fasten brake housing to end housing using two flat head capscrews, item 693.

3) Install thrust bearing, item 739, with thrust washer, item 737, on either side, into bearing flange, item 530.

4) Install sprag clutch, item 723, into bore of brake hub, item 720. Position sprag clutch aligners, item 722 and 724, on either side of brake hub. Carefully slide primary sungear, item 440, into brake hub assembly and secure with circlip, item 727.

IMPORTANT: For proper brake function, verify that brake hub rotation is correct. When viewed from motor end, primary sungear of a clockwise hoisting winch must turn freely clockwise and lock in the counterclockwise direction.

5) Install primary sungear assembly, carefully twisting shoulder of sungear through oil seal, item 531. Ensure oil seal is not damaged as sungear is installed.

DANGER

INCORRECT ASSEMBLY OF THE FRICTION PLATE AND DIVIDER PLATE STACK WILL REDUCE BRAKING CAPACITY AND ALLOW THE LOAD TO DROP, CAUSING PROPERTY DAMAGE, SEVERE INJURY OR DEATH. REASSEMBLE PER INSTRUCTIONS.

6) Starting and finishing with divider plate, alternately install five divider plates, item 713, and four friction plates, item 715.

7) Install new, well-greased O-ring, item 751, into brake housing and new, well-greased O-ring, item 753, into piston gland. Carefully install brake piston in brake housing. Rotate piston to align connecting tube hole with corresponding hole in motor.

8) Install six brake springs, item 752.

9) Install new, well-greased O-ring item 539, onto motor adaptor flange, item 800.

10) Position motor adaptor with hydraulic motor mounting holes horizontal and connecting tube holes of piston and motor adaptor aligned. Tighten eight capscrews, item 931, and lockwashers, item 933, one turn at a time to evenly compress springs.

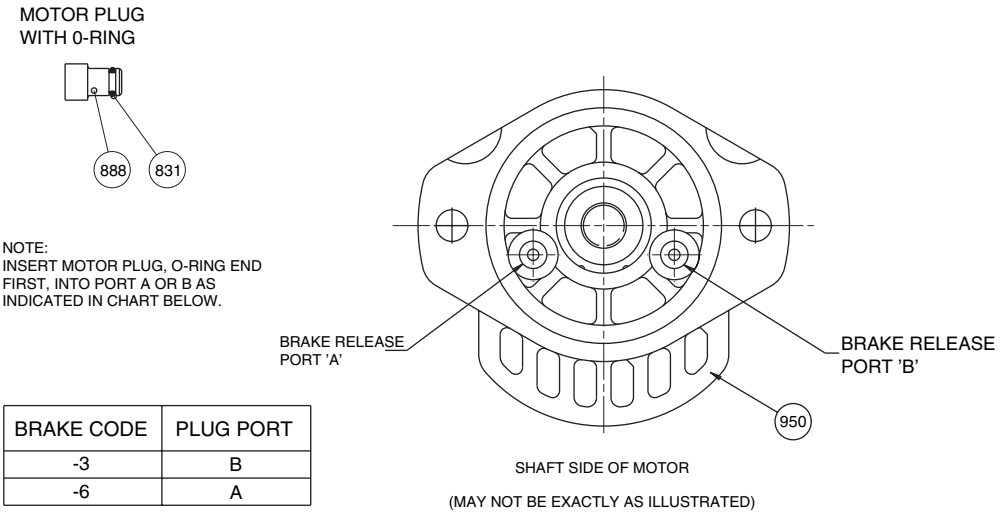
SERVICE INSTRUCTIONS CONTINUED

REPLACEMENT OF HYDRAULIC MOTOR ASSEMBLY:

Replace the hydraulic motor assembly by reversing the removal procedure.

IMPORTANT: Before installing motor, determine brake code of winch. Install motor plug as indicated below.

SI-1029



BRAKE CODE	PLUG PORT
-3	B
-6	A

1) Install three new, well-greased O-rings, item 831; two onto connecting tube, item 830, and one onto motor plug, item 888. Install connecting tube and motor plug into motor, item 950. Verify that holes are same as parts were removed from.
2) Install new, well-greased O-ring, item 811, onto motor pilot, item 950.
3) Fasten motor to motor adaptor using two capscrews, item 935, and lockwashers, item 937.

IMPORTANT: Before operating the winch, add lubricating oil up to the level of the end housing oil fill port. (Refer to INSTALLATION INSTRUCTIONS for location of fill port. Refer to APPENDIX A for oil volume required.)

To ensure proper reassembly, run the winch in both directions without load.

DANGER

LIFTING A LOAD WITH A NEWLY SERVICED WINCH WILL ENABLE AN INSTALLATION OR SERVICE PROBLEM TO GO UNDETECTED AND ALLOW THE LOAD TO DROP, CAUSING PROPERTY DAMAGE, SEVERE INJURY OR DEATH. TO ENSURE PROPER REINSTALLATION, REFER TO PROCEDURES AND TESTS DESCRIBED IN "INSTALLATION" AND "OPERATING INSTRUCTIONS".

RECOMMENDED MAINTENANCE

Winch gear train lubricating oil should be changed after the initial six months or 50 hours of operation, whichever comes first. Lubricating oil should then be changed every 12 months or 500 operating hours, whichever comes first.

Hydraulic system fluid should be changed at least once every 12 months.

For optimum performance over an extended period of time, the following preventive maintenance service should be done every 12 months or 500 operating hours, whichever comes first:

1) Disconnect all hydraulic hoses and remove the winch from its mounting.

2) Disassemble the winch as per instructions.

3) Discard and replace all O-rings and oil seals.

4) Clean all parts and inspect for wear and damage as per instructions. Replace worn or damaged parts as required.

5) Reassemble the winch as per instructions.

6) Follow INSTALLATION and OPERATING INSTRUCTIONS when returning winch to its mounting.

When ordering parts for the PULLMASTER Model M5 planetary winch, always quote the complete model and serial numbers of the unit.

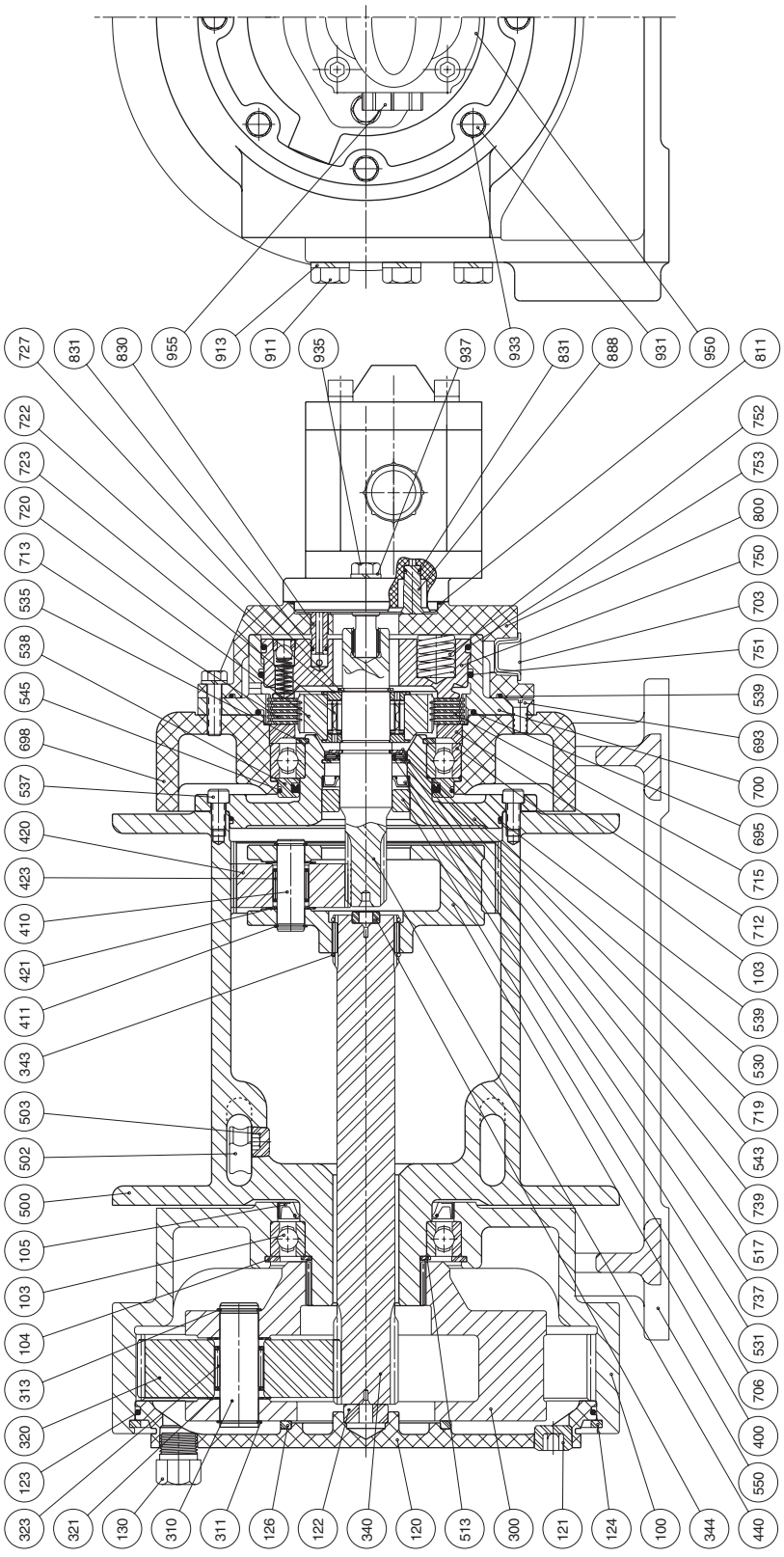
MODEL # _____

SERIAL # _____

PULLMASTER WINCH CORPORATION reserves the right to change specifications and the design of PULLMASTER planetary winches at any time without prior notice and without incurring any obligations.

ASSEMBLY DRAWING

G1287



Design Revision 'B' - Effective from Serial # 46161

PARTS REFERENCE

ITEM NO.	QTY.	PART NO.	DESCRIPTION
100	1	20072	FINAL HOUSING
103	2	25007	BALL BEARING 070 X 110 X 20 #6014
104	1	25006	CIRCLIP ROTOR CLIP HO-433
105	1	25008	OIL SEAL 3.000 X 4.003 X .375
120	1	20071	END COVER
121	1	25032	PIPE PLUG 1/2 NPT SOC HD
122	1	20063	SUNGEAR STOPPER
123	1	25069	O-RING -274 10" ID 1/8" CS
124	1	20898	RETAINING RING
126	1	20092	PLANET HUB STOPPER
130	1	20458	BREATHER RELIEF
300	1	20073	PLANET HUB
310	3	20079	PLANET PIN
311	3	25091	CIRCLIP ROTOR CLIP SH-87
313	3	25004	CIRCLIP ROTOR CLIP C-87
320	3	20076	PLANET GEAR
321	6	25068	THRUST WASHER TORRINGTON #TRA 1423
323	3	25005	NEEDLE BEARING TORRINGTON #B1416
340	1	*	FINAL SUNGEAR
343	2	25239	CIRCLIP ANDERTON #A1000 - 0150
344	1	20082	SUNGEAR STOPPER
400	1	20069	PLANET HUB
410	3	20080	PLANET PIN
411	6	25119	CIRCLIP ROTOR CLIP SH-62
420	3	20075	PLANET GEAR
421	6	25064	THRUST WASHER TORRINGTON #TRA 1018
423	3	25063	NEEDLE BEARING TORRINGTON #B1012
440	1	22882	PRIMARY SUNGEAR
500	1	*	CABLE DRUM
502	1	20085	CABLE ANCHOR
503	1	25085	PIPE PLUG 3/8 NPT SOC HD
513	1	25055	CIRCLIP ROTOR CLIP SH-262
517	1	26280	CIRCLIP ROTOR CLIP HO-187
530	1	*	BEARING FLANGE
531	1	25062	OIL SEAL
535	1	25012	CIRCLIP ROTOR CLIP SH-275
537	6	25001	CAPSCREW - SOC HD 5/16 - 18NC X .62 GRADE 5
538	1	20377	SEAL CARRIER
539	2	25061	O-RING -163 6" ID 3/32" CS
543	1	25281	SEAL - PARKER 3" ID #1870 - 3000
545	1	25280	O-RING -90 DURO -154 3-3/4" ID 3/32" CS
550	1	*	BASE
693	2	25271	CAPSCREW - FLAT HD 5/16 - 18NC X .75
695	1	25026	O-RING -248 4-3/4" ID 1/8" CS
698	1	20379	END HOUSING
700	1	20334	BRAKE HOUSING
703	1	25388	PLASTIC CAPLUG 1/2 NPT
706	1	20086	JOURNAL BEARING
712	1	20024	BRAKE SPACER
713	5	25024	DIVIDER PLATE
715	4	20034	FRICTION PLATE
719	1	25539	CIRCLIP ROTOR CLIP SE-118
720	1	22881	BRAKE HUB

*These parts vary according to drum code. Refer to APPENDIX B.

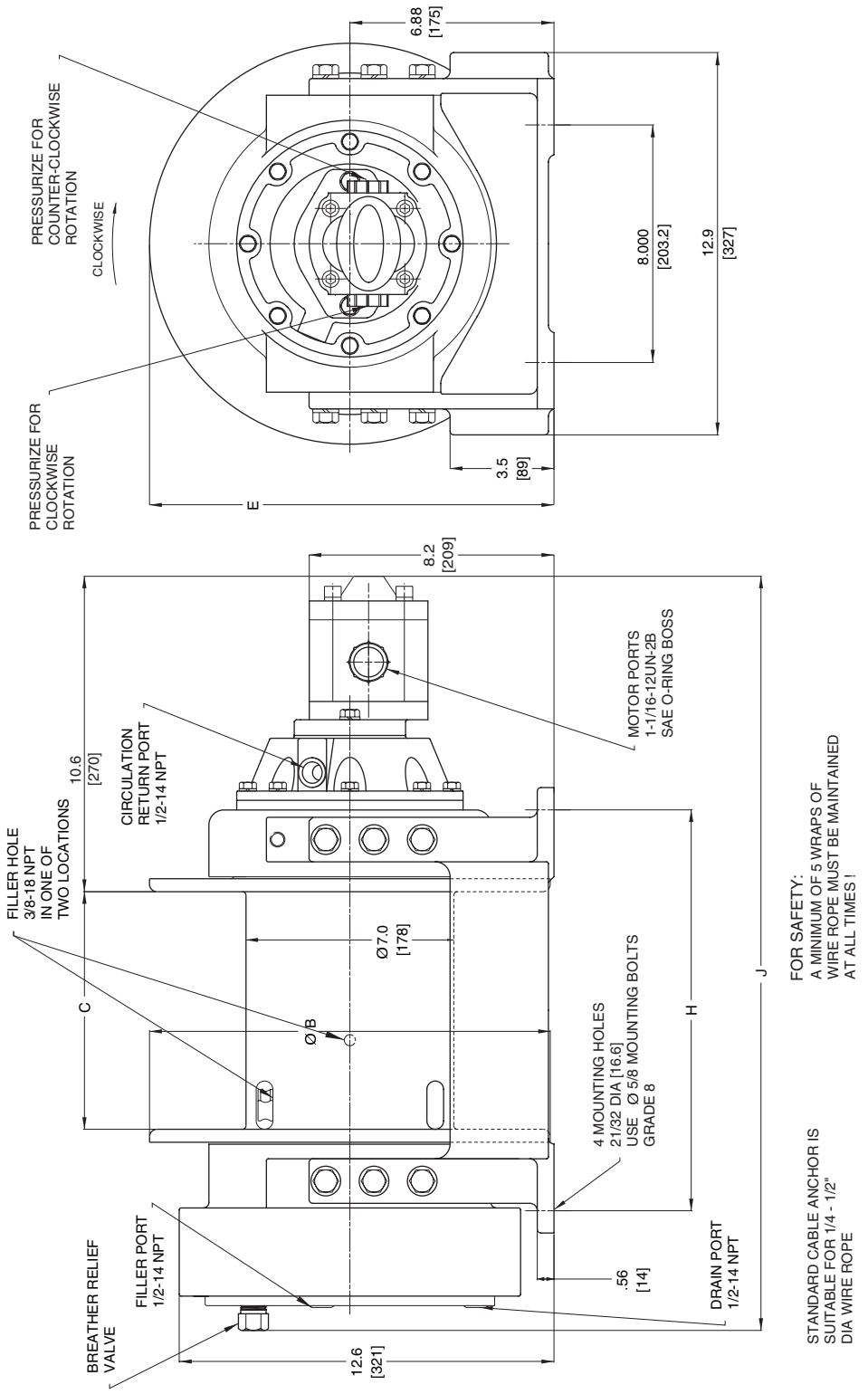
PARTS REFERENCE - CONTINUED

ITEM NO.	QTY.	PART NO.	DESCRIPTION
722	2	20183	SPRAG CLUTCH ALIGNER
723	1	25187	SPRAG CLUTCH
727	1	25492	CIRCLIP ROTOR CLIP SH-106
737	2	25483	THRUST WASHER INA # AS 3047
739	1	25537	THRUST BEARING INA # AXK 3047
750	1	21597	PISTON SUBASSEMBLY
751	1	25258	O-RING -90 DURO -247 4-5/8" ID 1/8" CS
752	6	20340	BRAKE SPRING
753	1	25261	O-RING -90 DURO -246 4-1/2" ID 1/8" CS
800	1	21401	MOTOR ADAPTOR
811	1	25016	O-RING -042 3-1/4" ID 1/16" CS
830	1	20337	CONNECTING TUBE
831	3	25018	O-RING -90 DURO -010 1/4" ID 1/16" CS
873	1	25031	PIPE PLUG 1/4 NPT SOC HD
888	1	22962	MOTOR PLUG
911	12	25013	CAPSCREW - HEX HD 1/2 - 13NC X 1.25 GRADE 5
913	12	25014	LOCKWASHER 1/2"
931	8	25027	CAPSCREW - HEX HD 5/16 - 18NC X 1.25 GRADE 5
933	8	25025	LOCKWASHER 5/16"
935	2	25264	CAPSCREW - HEX HEAD 3/8 - 16NC X 1.00 GRADE 5
937	2	25037	LOCKWASHER 3/8"
950	1	26894	MOTOR -230 PARKER
955	2	25536	PLASTIC CAPLUG SAE #12 ORB
		23099	WINCH SEAL KIT, CONSISTS OF ITEMS: 105, 123, 531, 539, 543, 545, 695, 751, 753, 811 AND 831.
			* These parts vary according to drum code. Refer to APPENDIX B.

Refer to PAGE 20 for ASSEMBLY DRAWING.

INSTALLATION DIMENSIONS

I1127



DRUM CODE	B	C	E	H	J	UNITS
-1	11.5	8.0	12.6	13.500	25.4	in
	292	203	321	342.90	645	mm
-2	13.5	8.0	13.6	13.500	25.4	in
	343	203	346	342.90	645	mm
-4	13.5	12.0	13.6	17.500	29.4	in
	343	305	346	444.50	747	mm

APPENDIX A

DRUM CODE	CABLE DRUM SIZES INCHES (MILLIMETERS)			WIRE ROPE STORAGE FEET (METERS)			LINE PULL AT MAXIMUM PRESSURE* POUNDS (KILONEWTONS)		LINE SPEED AT MAXIMUM VOLUME* FEET/MINUTE (METERS/MINUTE)		LUBRICATING OIL VOLUME REQUIRED U.S. GALLONS (LITERS)
	BARREL	FLANGE	LENGTH	1/2 inch	7/16 inch	3/8 inch	BARE DRUM	FULL DRUM	BARE DRUM	FULL DRUM	
STANDARD REDUCTION RATIO											
-1	7.0 (178)	11.5 (292)	8.0 (203)	152 (46)	166 (51)	227 (69)	6000 (26.7)	4091 (18.2)	69 (21)	101 (31)	0.8 (3.0)
-2	7.0 (178)	13.5 (343)	8.0 (203)	231 (71)	297 (90)	375 (114)	6000 (26.7)	3462 (15.4)	69 (21)	119 (36)	0.8 (3.0)
-4	7.0 (178)	13.5 (343)	12.0 (305)	347 (106)	445 (136)	562 (171)	6000 (26.7)	3462 (15.4)	69 (21)	119 (36)	1.0 (3.8)

* Performance specifications are based on standard hydraulic motor with 1/2 inch diameter wire rope.

APPENDIX B

ITEM NUMBERS

340	500	530	550

PART DESCRIPTION

FINAL SUNGEAR	CABLE DRUM	BEARING FLANGE	BASE

STANDARD REDUCTION RATIO

DRUM CODE	PART NUMBERS			
-1	20078	20067	20068	20074
-2	20078	20297	20068	20074
-4	21008	21019	21018	20325

BOLT TORQUE CHART

BOLT DIAMETER Inches	TORQUE lb-ft	TORQUE Nm
1/4	9	12
5/16	18	24
3/8	32	43
7/16	50	68
1/2	75	102
9/16	110	149
5/8	150	203
3/4	265	359
7/8	420	569
1	640	868
1 1/8	800	1085
1 1/4	1000	1356
1 3/8	1200	1627
1 1/2	1500	2034

NOTE: Unless otherwise specified, torque bolts per above chart.