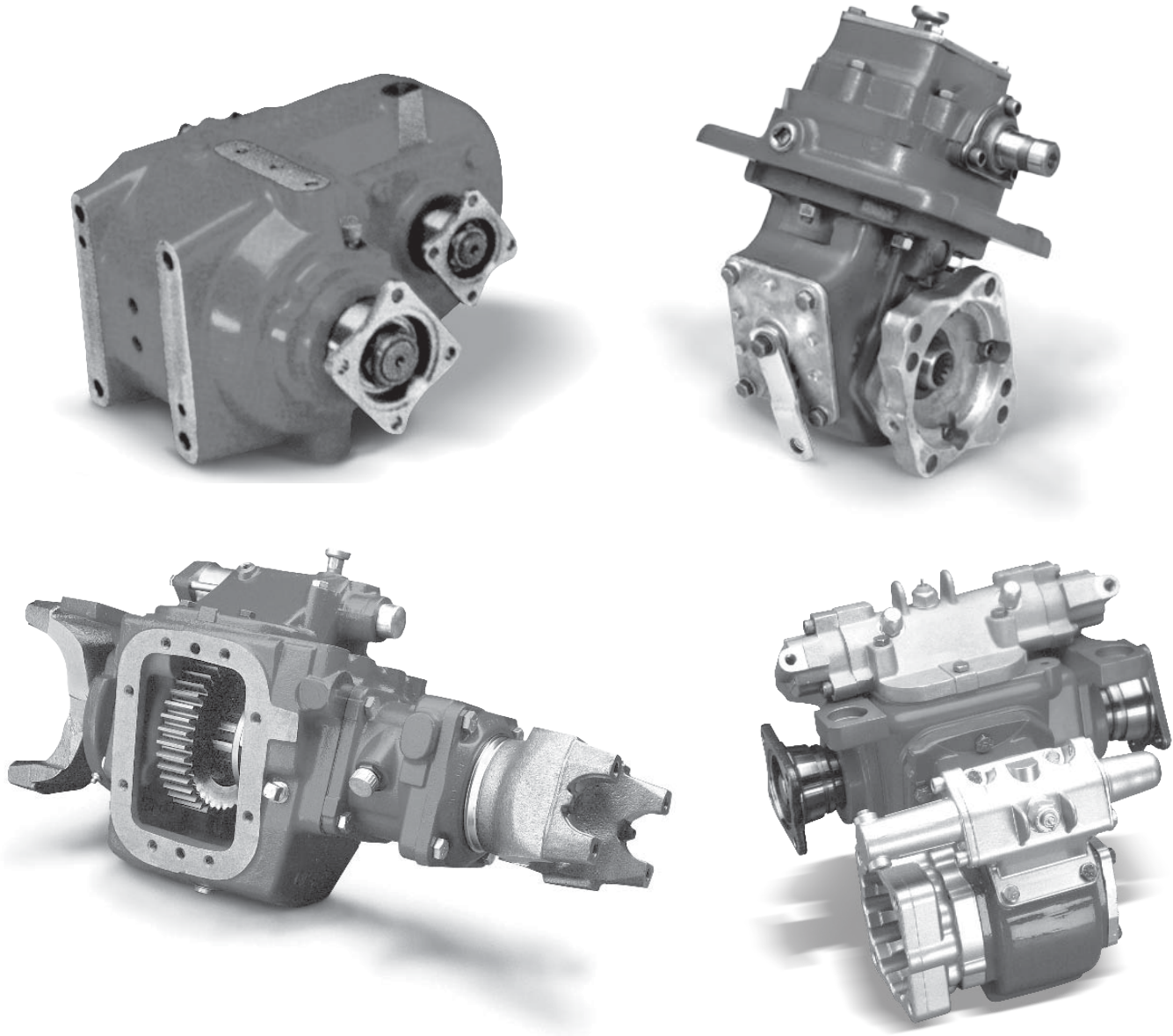


Effective: April 2016
Supercedes: HY25-1202-M1/US March 2016



Split Shaft and Gear Box Owner's Manual

901, 912, 941, 2442 Series



ENGINEERING YOUR SUCCESS.



WARNING — User Responsibility

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

This document and other information from Parker-Hannifin Corporation, its subsidiaries and authorized distributors provide product or system options for further investigation by users having technical expertise.

The user, through its own analysis and testing, is solely responsible for making the final selection of the system and components and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application, follow applicable industry standards, and follow the information concerning the product in the current product catalog and in any other materials provided from Parker or its subsidiaries or authorized distributors.

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Offer of Sale

The items described in this document are hereby offered for sale by Parker Hannifin Corporation, its subsidiaries or its authorized distributors. This offer and its acceptance are governed by the provisions stated in the "Offer of Sale".

Patent Information

The Chelsea® Power Take-Off or its components shipped with this owner's manual may be manufactured under one or more of the following U.S. patents:

7,159,701 7,007,565 6,962,093 1,326,036 60,321,840.7

Other patents pending.

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Foreword

This booklet will provide you with information on correct installation of Chelsea® Power Take-Offs (PTOs). Proper installation and set up procedures will help you get additional and more profitable miles from your truck equipment and components.

It is important that you be sure that you are getting the right transmission/PTO combination when you order a new truck. An inadequate transmission will overwork any PTO in a short period of time. In addition, a mismatched transmission and PTO combination can result in unsatisfactory performance of your auxiliary power system from the start.

If you have questions regarding correct PTO and transmission combination, please contact your local Chelsea® Auxiliary Power Specialist. They can help you select the properly matched components to ensure correct and efficient applications.

Safety Information

These instructions are intended for the safety of the installer, operator & supporting personnel. Read them carefully until you understand them.

General Safety Information

To prevent injury to yourself and/or damage to the equipment:

- Read carefully all owner's manuals, service manuals, and/or other instructions.
- Always follow proper procedures, and use proper tools and safety equipment.
- Be sure to receive proper training.
- Never work alone while under a vehicle or while repairing or maintaining equipment.
- Always use proper components in applications for which they are approved.
- Be sure to assemble components properly.
- Never use worn-out or damaged components.
- Always block any raised or moving device that may injure a person working on or under a vehicle.
- Never operate the controls of the Power Take-Off or other driven equipment from any position that could result in getting caught in the moving machinery.

Proper Matching of PTO



WARNING: A Power Take-Off must be properly matched to the vehicle transmission and to the auxiliary equipment being powered. An improperly matched Power Take-Off could cause severe damage to the vehicle transmission, the auxiliary driveshaft, and/or to the auxiliary equipment being powered. **Damaged components or equipment could malfunction causing serious personal injury to the vehicle operator or to others nearby.**

To avoid personal injury and/or equipment damage:

- Always refer to Chelsea catalogs, literature, and owner's manuals and follow Chelsea recommendations when selecting, installing, repairing, or operating a Power Take-Off.
- Never attempt to use a Power Take-Off not specifically recommended by Chelsea for the vehicle transmission.
- Always match the Power Take-Off's specified output capabilities to the requirements of the equipment to be powered.
- Never use a Power Take-Off whose range of speed could exceed the maximum.



This symbol warns of possible personal injury.

Safety Information (Continued)

Cold Weather Operation of PowerShift PTO

 **WARNING:** During extreme cold weather operation [32°F (0°C) and lower], a disengaged PowerShift Power Take-Off can momentarily transmit high torque that will cause unexpected output shaft rotation. This is caused by the high viscosity of the transmission oil when it is extremely cold. As slippage occurs between the Power Take-Off clutch plates, the oil will rapidly heat up and the viscous drag will quickly decrease.

The Power Take-Off output shaft rotation could cause unexpected movement of the driven equipment resulting in serious personal injury, death, or equipment damage.

To avoid personal injury or equipment damage:

- Driven equipment must have separate controls.
- The driven equipment must be left in the disengaged position when not in operation.
- Do not operate the driven equipment until the vehicle is allowed to warm up.

Rotating Auxiliary Driveshafts

 **WARNING:** 

- Rotating auxiliary driveshafts are dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.
- Do not go under the vehicle when the engine is running.
- Do not work on or near an exposed shaft when the engine is running.
- Shut off the engine before working on the Power Take-Off or driven equipment.
- Exposed rotating driveshafts must be guarded.

Guarding Auxiliary Driveshafts

 **WARNING:** We strongly recommend that a Power Take-Off and a directly mounted pump be used to eliminate the auxiliary driveshaft whenever possible. If an auxiliary driveshaft is used and remains exposed after installation, it is the responsibility of the vehicle designer and PTO installer to install a guard.

Using Set Screws

 **WARNING:** Auxiliary driveshafts may be installed with either recessed or protruding set screws. If you choose a square head set screw, you should be aware that it will protrude above the hub of the yoke and may be a point where clothes, skin, hair, hands, etc. could be snagged. A socket head set screw, which may not protrude above the hub of the yoke, does not permit the same amount of torquing as does a square head set screw. Also, a square head set screw, if used with a lock wire, will prevent loosening of the screw caused by vibration. Regardless of the choice made with respect to a set screw, an exposed rotating auxiliary driveshaft must be guarded.

Important: Safety Information and Owner's Manual

Chelsea Power Take-Offs are packaged with safety information decals, instructions, and an owner's manual. These items are located in the envelope with the PTO mounting gaskets. Also, safety information and installation instructions are packaged with some individual parts and kits. **Be sure to read the owner's manual before installing or operating the PTO** Always install the safety information decals according to the instructions provided. Place the owner's manual in the vehicle glove compartment.

 This symbol warns of possible personal injury.

Safety Information (Continued)

WARNING: Operating the PTO with the Vehicle in Motion

Some Power Take-Offs may be operated when the vehicle is in motion. To do so, the PTO must have been properly selected to operate at highway speeds and correctly matched to the vehicle transmission and the requirements of the driven equipment.

If in doubt about the PTO specifications and capabilities, avoid operating the PTO when the vehicle is in motion. Improper application and/or operation can cause serious personal injury or premature failure of the vehicle, the driven equipment, and/or the PTO.

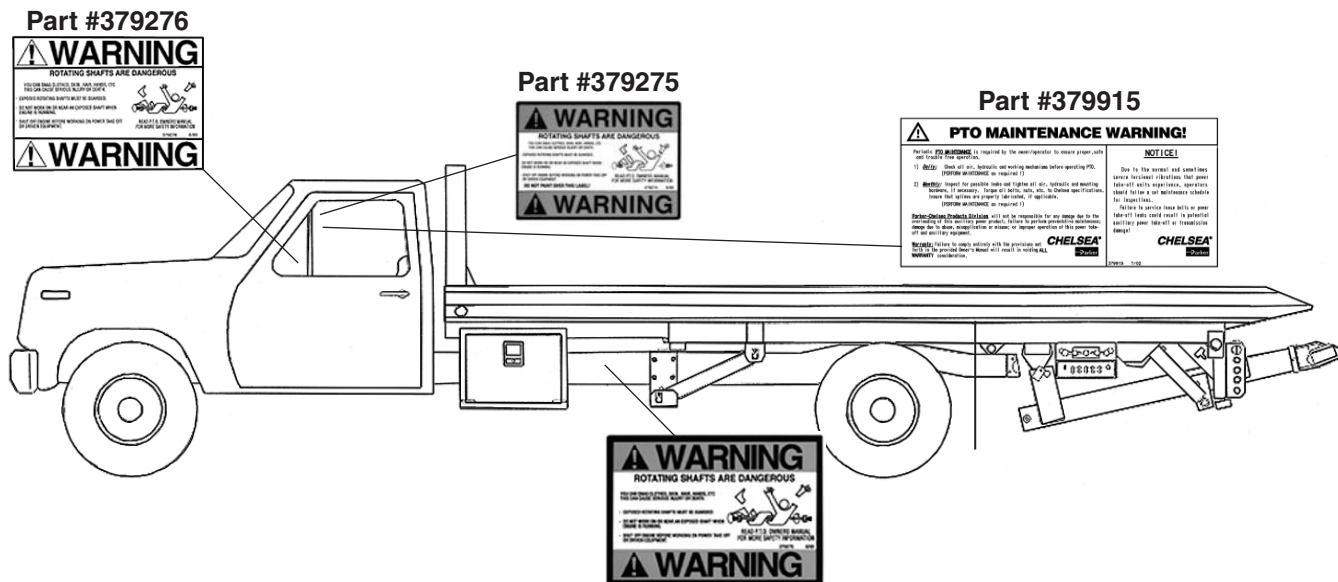
Always remember to disengage the PTO when the driven equipment is not in operation.

Chelsea PTO Safety Label Instructions

1. The two black and orange on white 5" x 7" pressure sensitive vinyl labels, part number 379274, must be placed on the vehicle frame rails (one (1) on each side), in a position that would be **HIGHLY** visible to anyone that would go under the truck near the PTO rotating shaft. If the vehicle is to be painted after these labels are installed, cover them with two (2) blank masking covers. Remove the masking covers after painting.
2. Place the one (1) black and orange on white 3.5" x 5" pressure sensitive vinyl label, part number 379275, on the visor nearest the operator of the vehicle, this must be placed near the PTO visor label.
3. Place the one (1) red and white with black lettering 3.5" x 7.5" pressure sensitive vinyl label, part number 379915, on the opposite side of the visor from the above label part number 379275.
4. Place the one (1) white and black heavy duty card, part number 379276, in the vehicle glove box in a position highly visible to the operator. For example, try to place this card on top of whatever may be in the glove box.

If you require labels, please order part number 328946X at no charge from your local Chelsea Warehouse or send request direct to:

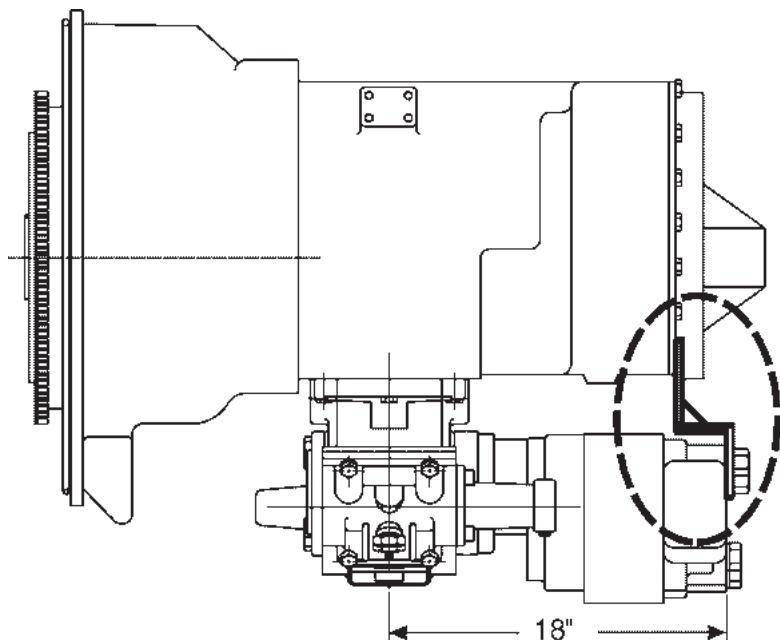
Parker Hannifin Corporation
Chelsea Products Division
8225 Hacks Cross Road
Olive Branch, MS 38654
Customer Service: (662) 895-1011



 This symbol warns of possible personal injury.

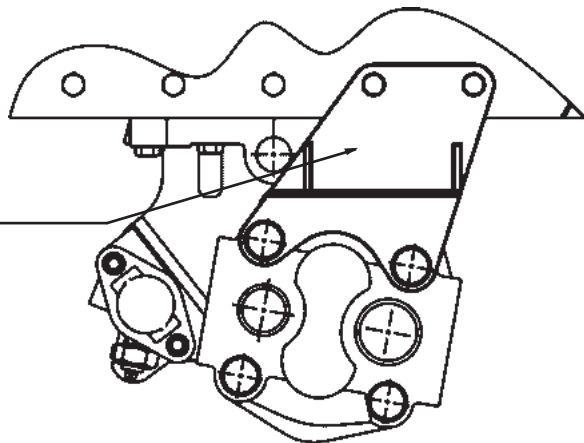
Part #379274

Direct Mount Pump Support Requirements (Universal)



NOTE:

For Proper Bracketing, Attach at 2 or More Transmission Bolt Locations and 2 or More Pump Locations. Contact Transmission Manufacturer for Proper Bracket Mounting Locations.



! Use CAUTION to ensure the support bracket does not pre-load pump / PTO mounting. When mounting the pump, it should be fully supported by a jack until the support bracket is secured in place, then the jack can be released. This will make sure the PTO is not being stressed by the bracket.

Chelsea requires the use of pump supports (Support Brackets) in all applications to ensure the Maximum Bending Moment (MBM) of the PTO / Pump assembly is not exceeded. Exceeding the MBM can result in damage to PTO, transmission, driven equipment, and / or personnel. It is the responsibility of the installer to ensure that adequate support is implemented. All applications are unique and it is important to consider all parameters in designing a proper support bracket.

PTO warranty will be void if a pump bracket is not used when one of the following conditions are present:

1. The combined weight of pump, fittings and hose exceed 40 pounds [18.14 kg].
2. The combined length of the PTO and pump is 18 inches [45.72 cm] or more from the PTO centerline to the end of the pump.

ALSO: Remember to pack the female PTO shaft with grease before installing the pump on the PTO (reference Chelsea grease pack 379688).

! This symbol warns of possible personal injury.

Shifting Procedures

Gear Box Operation

Vehicle Stationary

Before shifting the gear box into or out of gear, make sure the gears in the unit and input shaft have stopped rotating.

Split Shaft Operation

Manual Transmission—Vehicle Stationary

Road mode to PTO mode:

1. Disengage the clutch and stop the vehicle.
2. Engage the parking brakes.
3. Shift the split shaft to PTO mode.
4. Select the desired transmission gear as required.
5. Engage the clutch.
6. Apply throttle as required.

PTO mode to road mode:

1. Disengage the clutch.
2. Shift the split shaft to road mode.
3. Disengage the parking brakes.
4. Resume normal driving procedures.

Automatic Transmission

Road mode to PTO mode:

1. Stop the vehicle.
2. Engage the parking brakes.
3. Shift the transmission into Neutral "N."
4. Shift the split shaft to PTO mode.
5. Shift the transmission into the desired drive range position.
6. Apply throttle as required.

PTO mode to road mode:

1. Shift the transmission into Neutral "N."
2. Shift the split shaft to road mode.
3. Release the parking brake.
4. Resume normal driving procedures.

CAUTION: Inadvertent shift may cause vehicle movement or unexpected engagement of PTO.

Split Shaft and Gear Box Specifications

Model No.	Horsepower at		Intermittent Torque Rating PTO Shaft	Approximate Weight	Lube Capacity	Liters
	500 RPM	1000 RPM				
2442F	23.5	47.0	250 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442L	23.5	47.0	250 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442Q	21.4	42.8	225 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442R	21.4	42.8	225 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442S	19.0	38.0	200 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442U	18.6	37.2	195 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442W	16.7	33.4	175 Lbs-ft	69 Lbs.	1.5 pt.	.7
2442X	13.2	26.5	140 Lbs-ft	69 Lbs.	1.5 pt.	.7
					2.5 qt. vertical	2.4
901•			500 Lbs-ft	185 Lbs.	3.0 qt. horizontal	2.8
912•			*	130 Lbs.	2.5 qt. less PTO	2.4
941•			**	60 Lbs.	2.25 pt.	
For allowable split shaft input torque, please consult the chart on page 8.						
* The 912 has 3 eight bolt PTO openings on it. For correct PTO applications please consult your HY25-3000/US catalog.						
** The 941 has 2 six bolt PTO openings on it. For correct PTO applications please consult your HY25-3000/US catalog.						

Horsepower-Torque-RPM Conversion Chart

To find the Torque. Given: 100 HP at 1750 RPM

Then: with a straight edge on HP scale at 100 (Left Side) and on RPM scale at 1750.

Find Answer on T scale = 300 foot pounds torque (Middle).

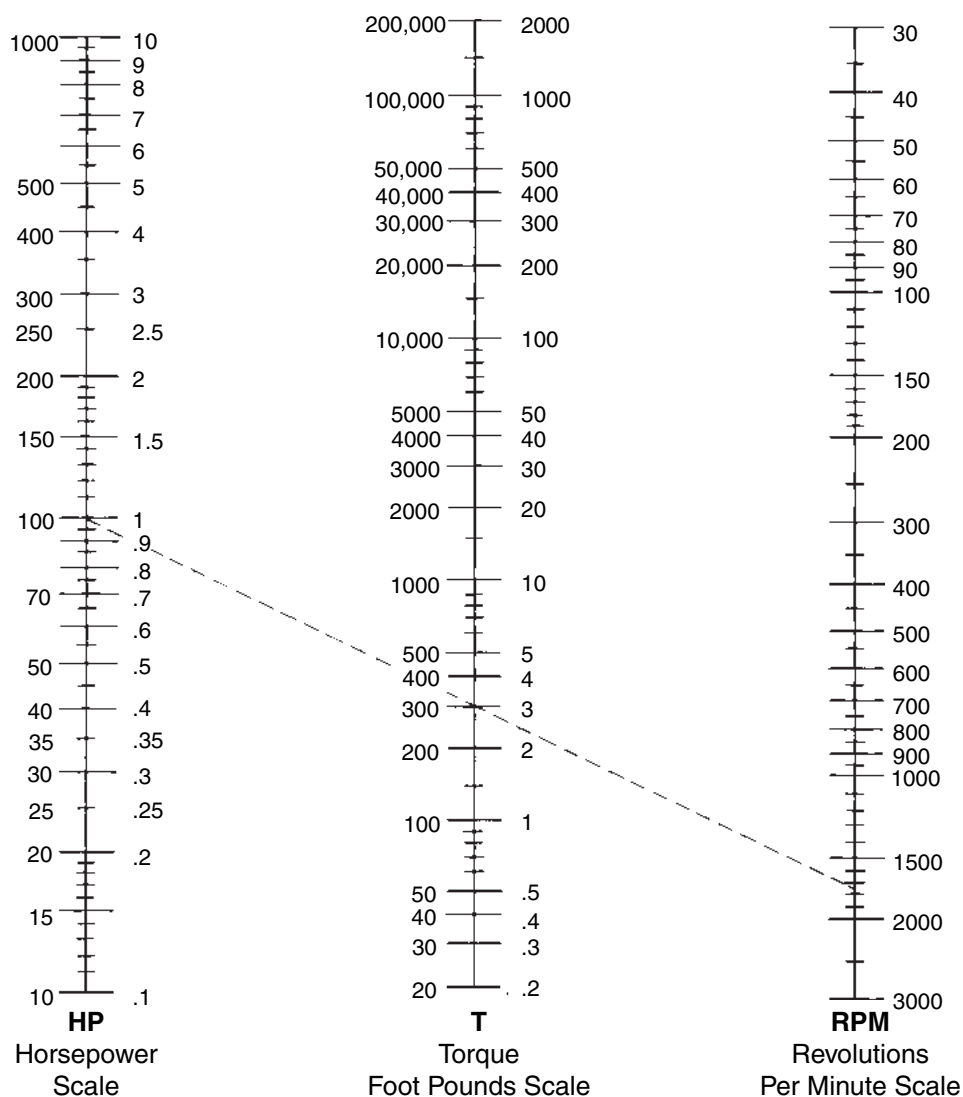
Formula: $\frac{HP \times 5252}{RPM} = T$ Foot Pounds Torque

To find the HP. Given: 3 pounds feet torque at 1750 RPM

Then: with a straight edge on the T scale at 3 (Middle) and on the RPM scale at 1750.

Find Answer on the HP scale = 1 Horsepower (Left Side)

Formula: $\frac{T \times RPM}{5252} = HP$ Horsepower



Application Data for Installation of a Split Shaft

Split Shaft Through Torque Ratings

The torque capacity of the Chelsea Split Shaft units is limited by either the engine capacity or the vehicle wheel skid conditions. To correctly choose a split shaft model for a given application, the maximum torque from the engine, and the maximum torque due to wheel conditions, should be calculated. The limiting value obtained by these calculations should then be compared with the charted split shaft torque capacity.

Formula

Maximum Through Torque From the Engine

1. Maximum Torque From the Engine = Maximum Net Engine Torque X Manual Transmission Low Gear Ratio X 85% Efficiency
2. For an automatic transmission, the maximum torque from the engine should be taken from the engine-transmission performance curve stall torque value. This information is generally available from the manufacturer of the automatic transmission.

Maximum Torque Due to Wheel Skid Conditions

$$3. \text{ Maximum Lbs-ft of Torque} = \frac{\text{GVW} \times f \times \text{RAD}}{12 \times \text{AR}}$$

Where: GVW = maximum gross vehicle weight on the rear wheels only

f = coefficient of friction

RAD = tire loaded rolling radius (inches)

AR = axle ratio

Based on past experience, the coefficients of friction used have been:

f = 0.8 for on-highway service (dry pavement)

f = 0.5 for off-highway service

These are generally used values but if information is available for a specific application, the appropriate coefficient of friction can be used.

Split Shaft Through Torque Capacity

Split Shaft Model	Shaft Outside Diameter	Maximum Nominal Torque Rating (Lbs-ft)			
		Diesel Engine		Gas Engine	
		Automatic Transmission	Manual Transmission	Automatic Transmission	Manual Transmission
901	1-3/4"	3,300	3,100	4,200	3,900
912	2-3/4"	13,000	12,000	16,000	15,000
941	1-1/2"	3,100	2,900	4,200	3,900

Service Factor Chart

Duty	Vehicle Description	Service Factor
Extra Light	Light Vehicle on Highway	1.0
Light	Light Vehicle off Highway	1.1
Heavy	Heavy Vehicle on Highway	1.2
Extra Heavy	Heavy Vehicle off Highway	1.3

The allowable split shaft torque can be calculated using the above charted values and the following equation:

$$\text{Allowable Split Shaft Torque} = \frac{\text{Maximum Nominal Torque Rating}}{\text{Application Service Factor}}$$

Lubrication Information

To ensure proper lubrication and operating temperatures in these units, it is most important that the proper lubricants be used and that correct oil levels be maintained.

Recommended Lubricants

The following lubricants are recommended, in order of preference, for use in all Chelsea Split Shafts and Gear Boxes.

Models 901, 912, 941, and 2442

Temperature	Grade	Type
Above 0°F	SAE 30, 40, or 50	Heavy Duty Engine Oil Meeting Spec
Below 0°F	SAE 30	MIL-L-2104B or MIL-L-45199 Series 3
Above 0°F	SAE 90	Straight Mineral Gear Oil
Below 0°F	SAE 80	

Do Not Use Extreme Pressure Additives, such as found in multi-purpose or rear axle type lubricants. These additives are not required in our split shafts and gear boxes, and they may in some cases create transmission problems. Multi-purpose oils, as a group, have relatively poor oxidation stability, a high rate of sludge formation and a greater tendency to react on or corrode the steel and bronze parts.

Oil Changes

We recommend an initial oil change and flush after the split shaft is placed in actual service. This change should be made any time following 1,000 miles, but never to exceed 4,000 miles, of over-the-road service. In off-highway use, the change should be made after 24 and before 100 hours of service have elapsed. There are many factors that influence the following oil change periods, and we have not specified a definite mileage interval.

In general, it is suggested that a drain and flush period be scheduled every 20,000 miles for normal over-the-highway operations. Off-the-highway usually requires an oil change every 30 days. The oil level in the split shaft should be checked every 2,000 miles on-highway, or every 24 hours in off-highway operation. When it is necessary to add oil, we recommend that types or brands of oil not be mixed. The correct oil level in all Chelsea Split Shafts is established by the filler plug opening.

Refill—First, remove all dirt around the filler plug. Then refill with new oil of a grade recommended for the existing season and prevailing service.

Overfilling

Do not overfill the gear box or split shaft. Overfilling usually results in oil breakdown due to excessive heat and aeration from the churning action of the gears. Early breakdown of the oil will result in heavy varnish and sludge deposits that plug up oil ports and buildup on splines and bearings. Overflow of oil usually escapes onto clutch or parking brakes, causing additional trouble.

Installation Instructions – Split Shaft

Split shaft Power Take-Offs are installed into the vehicle driveline. This requires cutting and reworking driveshafts. No attempt will be made here to list driveline fabrication or rework procedures. For answers to specific questions, contact the Drivetrain Service Division. Listed are the necessities for a good Power Take-Off installation that will run quietly and without vibration. The unit itself should be suspended from a rubber isolated crossmember and will replace the center bearing for the driveline. Grade 8-Bolts should be used for all fastenings.

1. Front—a short coupled joint connecting the transmission to the split shaft should be installed so as to permit equal joint angles of less than 3°.

Rear—A two joint assembly connecting the split shaft to the rear axle should be installed so as to permit equal joint angles of less than 5° to ensure the best performance. The joint angles should be kept within a minimum of 1° to 3°.

Front & Rear—the two joint assembly at the front and rear should be installed so as to permit equal joint angles of less than 5°.

2. Determine a suitable location for crossmembers for mounting the split shaft. Raise or lower or move the split shaft front or rear as required to reduce the joint angles to a minimum but not less than 1°.
3. Align the split shaft with the transmission and rear axle.
 - A. For the best installation and optimum performance, the input and output shafts of the split shaft should be parallel respectively within 1° to the main shaft of the transmission and the pinion shaft of the axle.
 - B. With the shafts parallel, the joint angles should be in one plane only. Make sure the offset in the horizontal or vertical planes will provide for equal joint angles of less than 3° with a short coupled joint or less than 5° with a two joint assembly.
4. Excessive angles result in a loss of speed and power. The figures shown below are approximate and any angle less than those shown will provide a better installation.

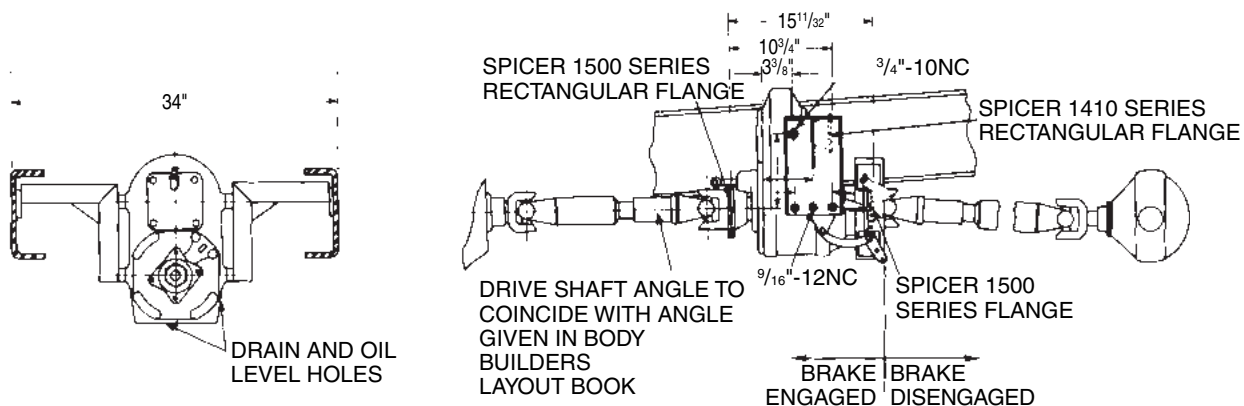
Speed	True Joint Operating Angle
5,000 RPM	3° 15'
4,000 RPM	4° 15'
3,000 RPM	5° 50'

Slight angles of 1° in each joint are necessary for the circulation of the needles.

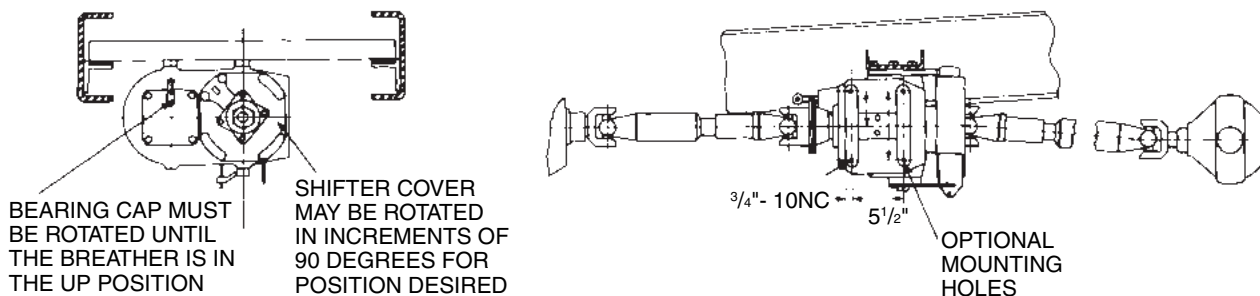
5. The front and rear shafts should be assembled, straightened, and balanced before installation.

Model 901 Split Shaft Installation Drawings

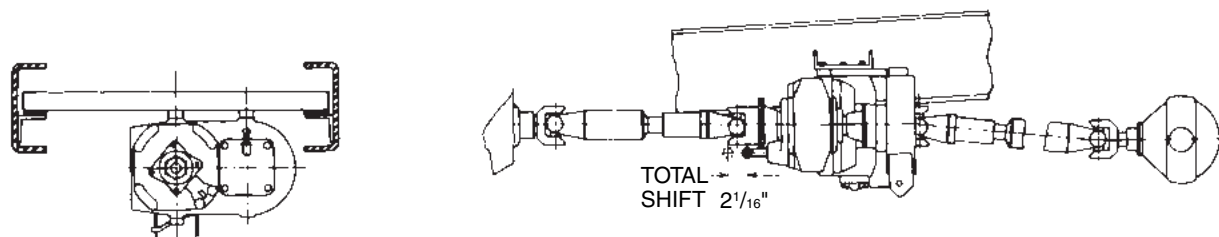
Vertical Mounting



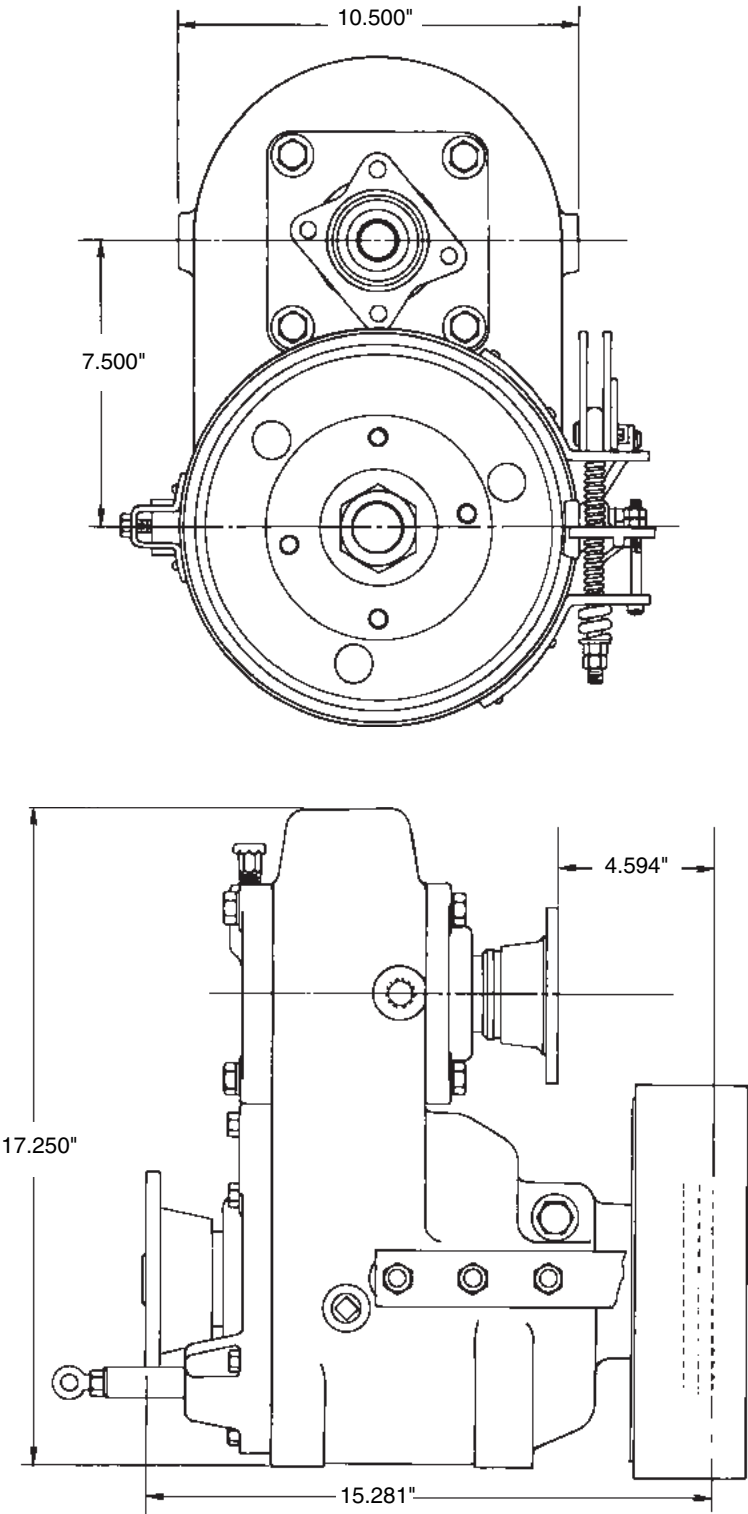
Horizontal Mounting



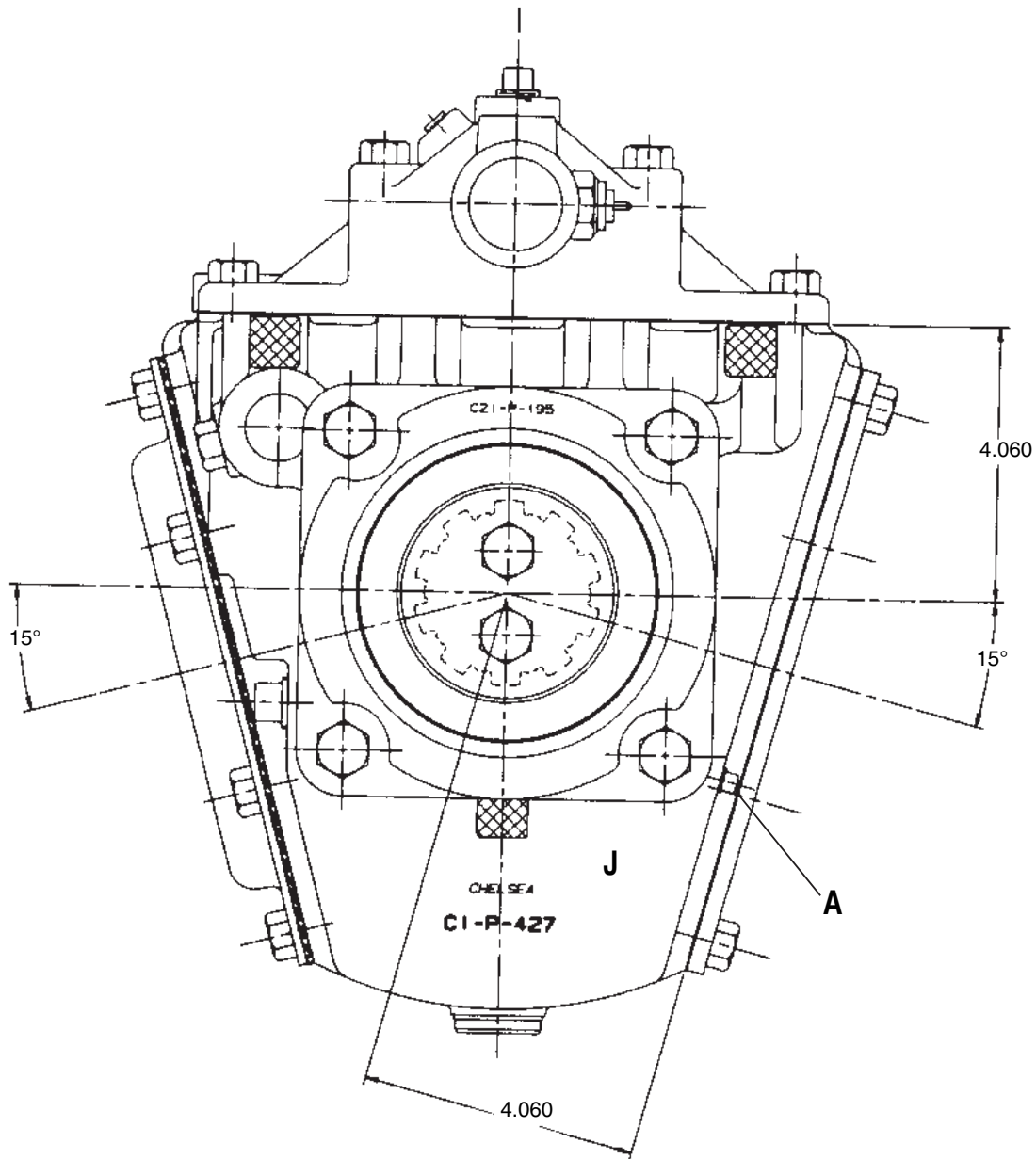
Horizontal Mounting



Model 901 Split Shaft Dimensional Drawings



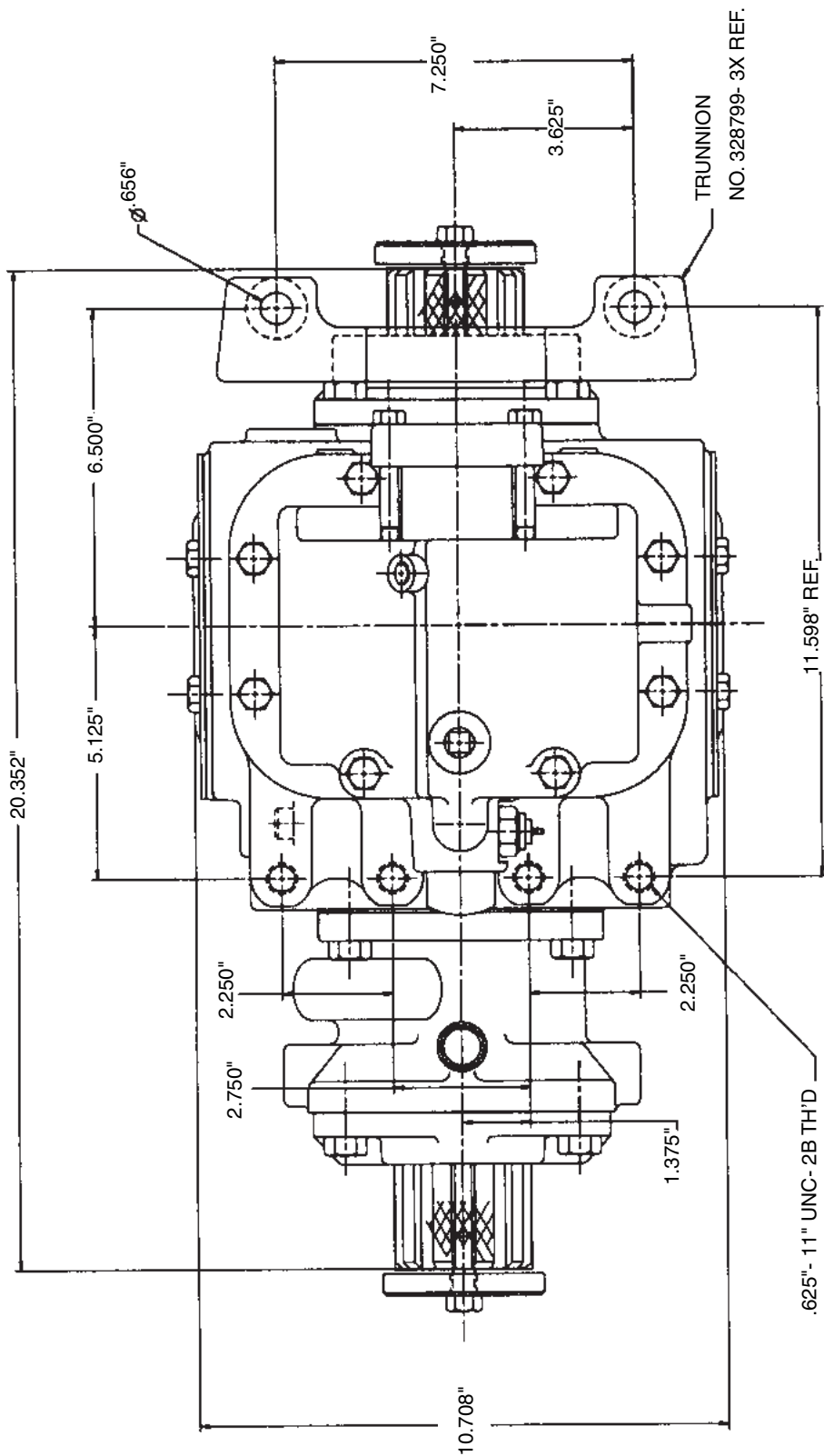
Model 912 Split Shaft Installation Drawing



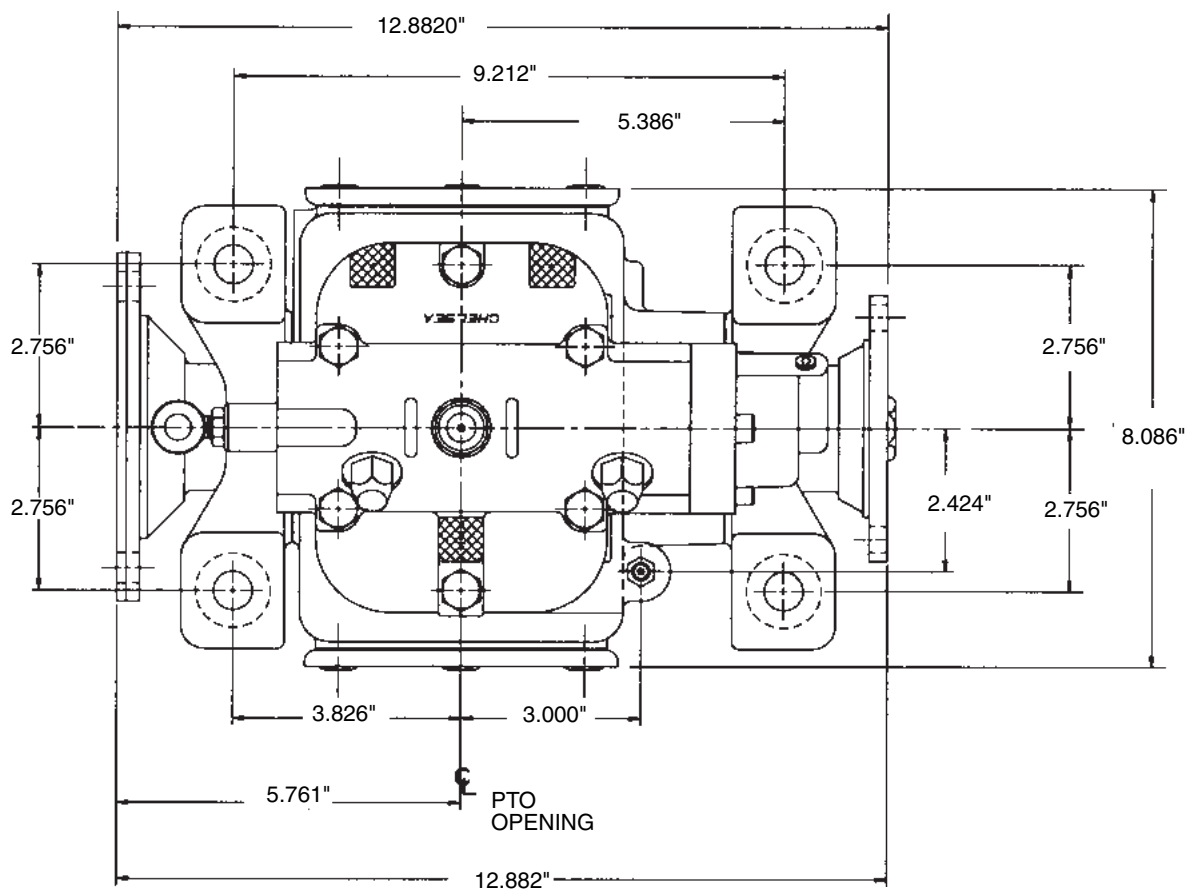
As with any geared system, it is important to fill the 912 Series split shaft unit to the proper fill level with the recommended lube. Failure to fill to the proper oil level may result in premature failure, excessive heat or oil blowing out the breather.

When filling the 912 Series split shaft with one, two or three PTOs attached, fill until the oil runs out of fill plug "A" on the right side of the 912 housing. The volume of oil will vary with different PTO models and combinations.

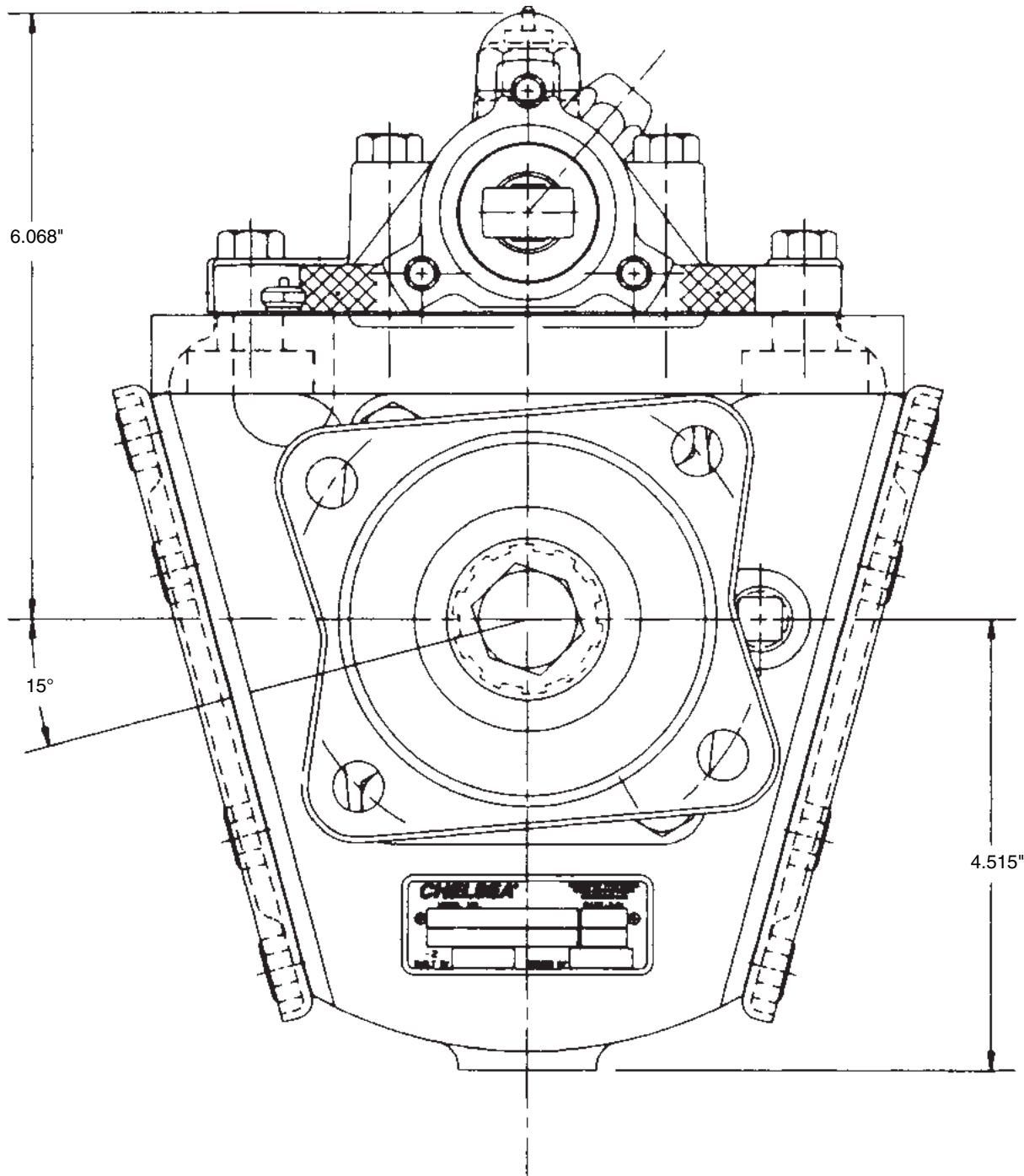
Model 912 Split Shaft Dimensional Drawing



Model 941 Split Shaft Installation Drawings



Model 941 Split Shaft Dimensional Drawings



Installation Instructions – Gear Boxes Models 2442

Gear boxes are installed very similarly to split shaft Power Take-Offs. The differences are that the gear box is driven from a Power Take-Off rather than the transmission main shaft, and the gear box drives a piece of equipment rather than the rear axle. Installation of a gear box requires fabrication of new shafts rather than cutting into the existing driveline. Listed are the necessities for a good gear box installation which are basically the same as those required for a good split shaft Power Take-Off installation. The unit itself is mounted on a plate which must be mounted to a sturdy support on the vehicle. Rubber isolation of the unit is important to prevent transmitting vibrations throughout the vehicle. Then follow the steps below:

1. Front - The short coupled joint connecting the Power Take-Off to the gear box should be installed so as to permit equal joint angles of less than 3°.

Rear - The two joint assembly connecting the gear box to the driven equipment should be installed so as to permit equal joint angles of less than 5°. To ensure the best performance, the joint angles should be kept within a minimum of 1° to 3°.

Front & Rear - The two joint assemblies at the front and rear should be installed so as to permit equal joint angles of less than 5°.
2. Determine a suitable location for mounting the gear box. Raise or lower or move the gear box front or rear as required to reduce the joint angles to a minimum, but not less than 1°.
3. Align the gear box with the Power Take-Off and driven equipment.
 - A. For the best installation and optimum performance, the input and output shafts of the gear box should be parallel respectively with 1° to the output shaft of the Power Take-Off and the input shaft of the driven equipment.
 - B. With the shafts parallel, the joint angles should be in one plane only. Make sure the offset in the horizontal or vertical planes will provide for equal joint angles of less than 3° with a short coupled joint or less than 5° with a two joint assembly.
4. Excessive angles result in a loss of speed and power. The figures shown below are approximate and any angles less than those shown will provide a better installation.

Speed	True Joint Operating Angle
5,000 RPM	3° 15'
4,000 RPM	4° 15'
3,000 RPM	5° 50'

Slight angles of 1° in each joint are necessary to permit circulation of the needles.

5. If at all possible, the shafts front and rear should be assembled, straightened, and balanced. The various models of gear boxes offer three (or several) types of shifters. Wire shift is installed identically to a six bolt Power Take-Off installation. Linkage for lever controls must be designed and fabricated by the installer. Air shift plumbing is shown in the typical sketches on [pages 29-30](#) for a single acting air shift.

When installing a breather hose assembly on a gear box or split shaft, the top of the vent assembly must be at least 12 inches above the unit as shown in **(Fig. 1)**. **(Fig. 2)** shows an incorrect installation. When installing any vent assembly, make sure it is in the upright position.

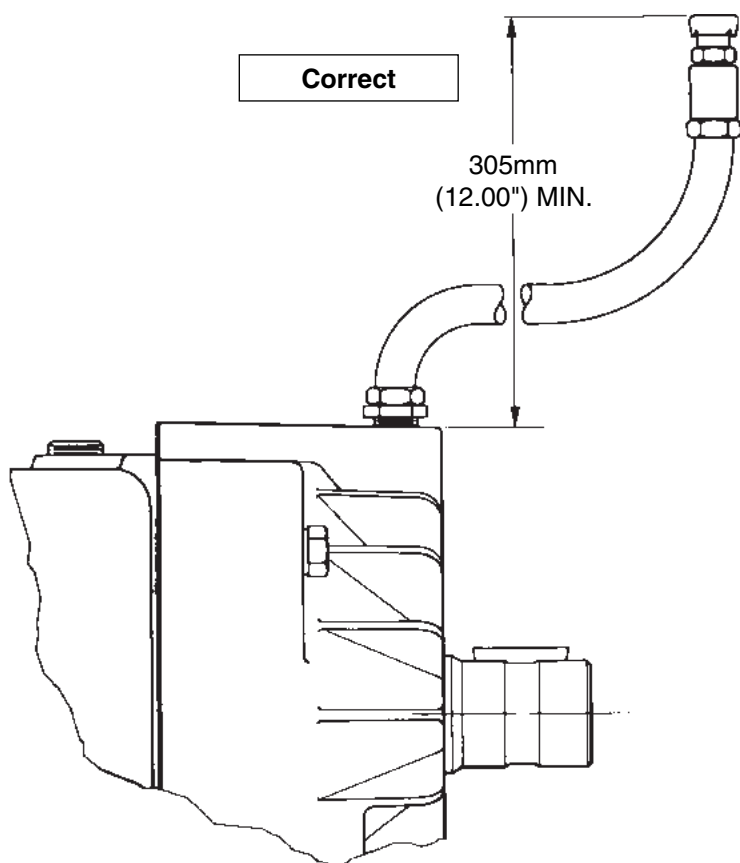


Fig. 1

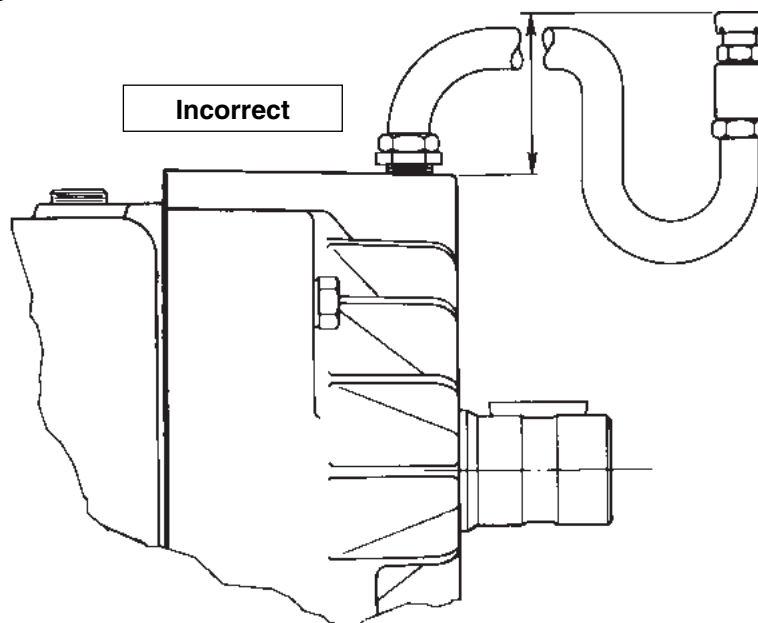


Fig. 2

PTO to Split Shaft

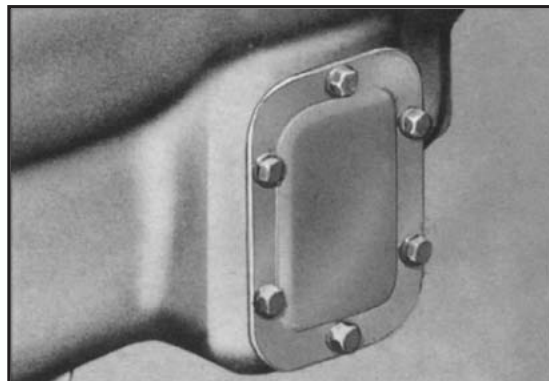
Application Questions for Installation of a PTO to Split Shaft

Specifying and mounting a PTO to the 912 & 914 Split Shaft is accomplished the same as on a transmission. There are certain application questions and installation procedures that you should follow. The next three pages will take you through these steps.

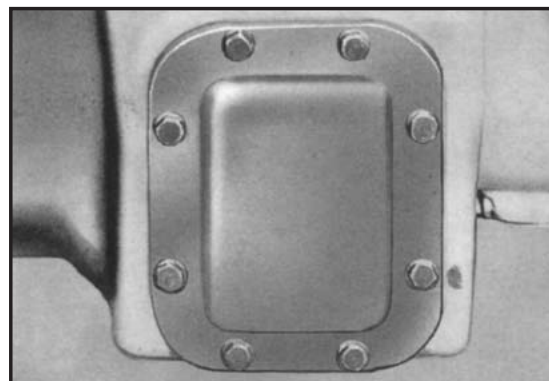
1. What is the make and model of your transmission?
2. Which PTO opening will be used?
3. What accessory is to be driven?
4. How much horsepower is required to drive the accessory?
5. What is the required rotation of the PTO?
6. What is the required PTO output shaft speed as a percent of engine speed?
7. What is the required method of shifting the PTO – cable, lever or air?

Once all the answers to these questions have been determined, a transmission mounted PTO can be selected to meet the horsepower, speed, and rotation that you require.

Having made the selection of a PTO, you are ready to start the installation.



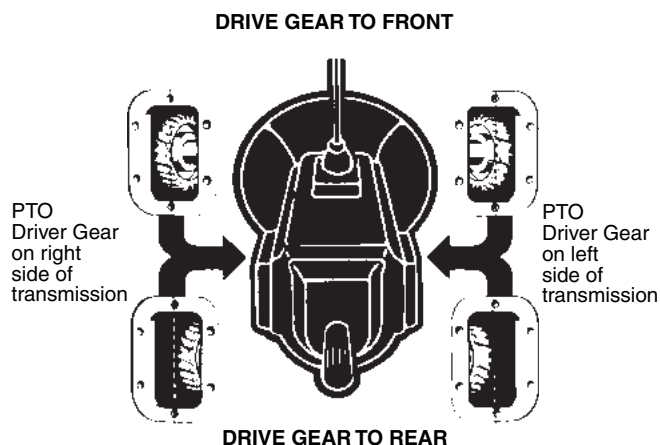
SAE 6-Bolt



SAE 8-Bolt
Standard SAE Power Take-Off Apertures

PTO Drive Gear Location

The standard location for the PTO drive gear in the transmission is 1/2" to the front or 1/2" to the rear of the vertical center line.



Mounting PTO to Split Shaft for 6 or 8-Bolt Applications

1. Drain the oil from the transmission, and remove the PTO aperture cover plate (**Fig. 3**).
2. Discard the cover plate and cover plate gasket. Clean the aperture pad using a putty knife or wire brush (**Fig. 4**).

NOTE: Stuff a rag in the aperture opening to prevent dirt from entering the transmission while you are cleaning it.

3. Using your hand, rock the PTO drive gear in the transmission (**Fig. 5**) and the driven gear in the PTO assembly (**Fig. 6**). Rocking the gears provides two important factors.
 - A. It shows you the amount of backlash that has been designed into each unit.
 - B. It is helpful in establishing the proper backlash when installing the PTO.
4. Install the proper studs in the PTO aperture pad using a stud driver (**Fig. 7**).
5. Where holes are tapped through the transmission case, use Permatex or an equivalent to prevent leaks.

NOTE: Avoid contact of Permatex with automatic transmission fluid in automatics. Always check to be sure the studs do not interfere with transmission gears.



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7

Mounting PTO to Split Shaft (Continued)

6. Install the six or eight studs until the shoulder of the stud is flush with the transmission mounting surface (**Fig. 8**).

CAUTION: Over tightening of studs or running the shoulder past the transmission mounting surface may damage the stud and/or transmission threads.

7. Place the correct number of gaskets over the studs (**Fig. 9**). Do not use Permatex between gaskets because you may want to add or subtract gaskets to obtain the proper backlash.

- When mounting a PTO, use gaskets between all mounting surfaces.
- Do not stack more than 3 gaskets together.
- Usually one thick gasket .020" (.50 mm) will be required.
- Remember the lubricant in the transmission also lubricates the PTO. Therefore, at least one gasket must always be used on either side of filler blocks, adapter assemblies, or adapter plates. More gaskets may be required when establishing proper backlash.

8. Secure PTO to the transmission. The 220 Series must always have a copper washer under its one capscrew head which goes through the inside of the housing (**Fig. 10**).

9. Fasten the PTO to the transmission. Torque the 6 bolt to 30 - 35 Lbs-ft [41 - 47 Nm] and the 8-Bolt to 45 - 50 Lbs-ft [61 - 68 Nm] (**Fig. 11**).

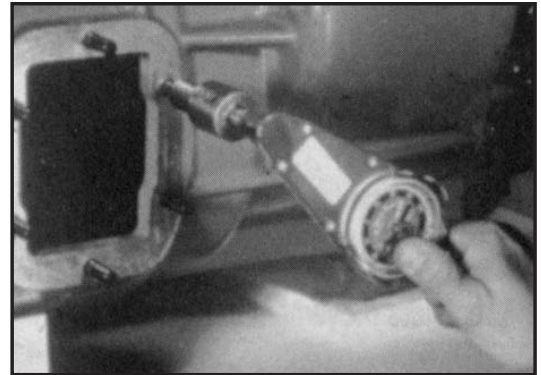


Fig. 8



Fig. 9



Fig. 10

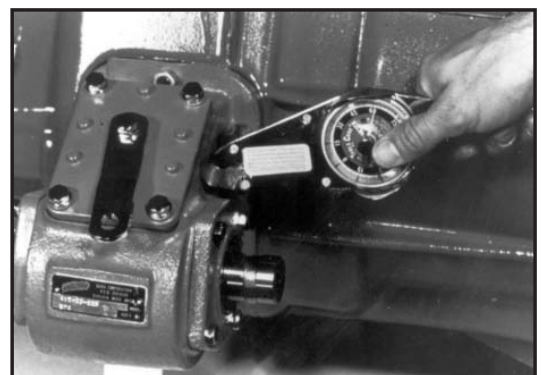


Fig. 11

Checking Backlash

To check for proper backlash on PTO with shift cover:

1. Remove the PTO shift housing and/or inspection plate.
2. Mount the dial indicator so that it registers movement in the input gear (driven gear) of the PTO (**Fig. 12**).

NOTE: For the proper location of the dial indicator's contact point. (Two common types of dial indicators are shown.) (**Fig. 13**)

3. Hold the PTO driver gear in the transmission with a screwdriver or bar, and rock the PTO input gear (driven gear) back and forth with your hand. Note the total movement on the dial indicator.
4. Establish backlash at .006" - .012" (.15 mm - .30 mm) by adding or subtracting gaskets.

NOTE: For any additional information on hooking up the shifter or installation of the PTO, please consult the Owner's Manual included with the unit.

General rule - A Chelsea .010" gasket will change backlash approximately .006." A .020" gasket changes backlash approximately .012."



Fig. 12

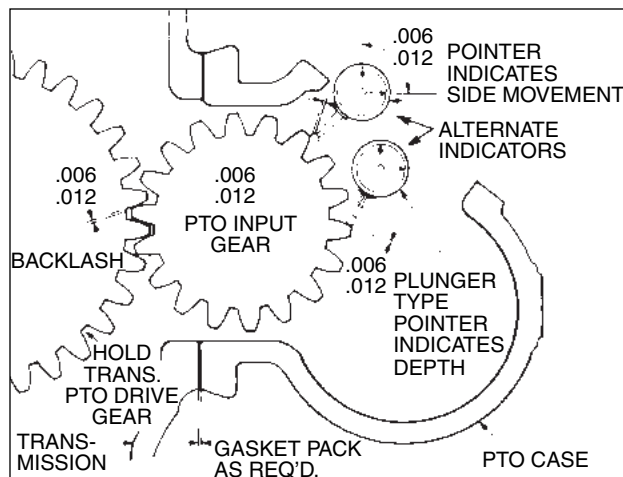
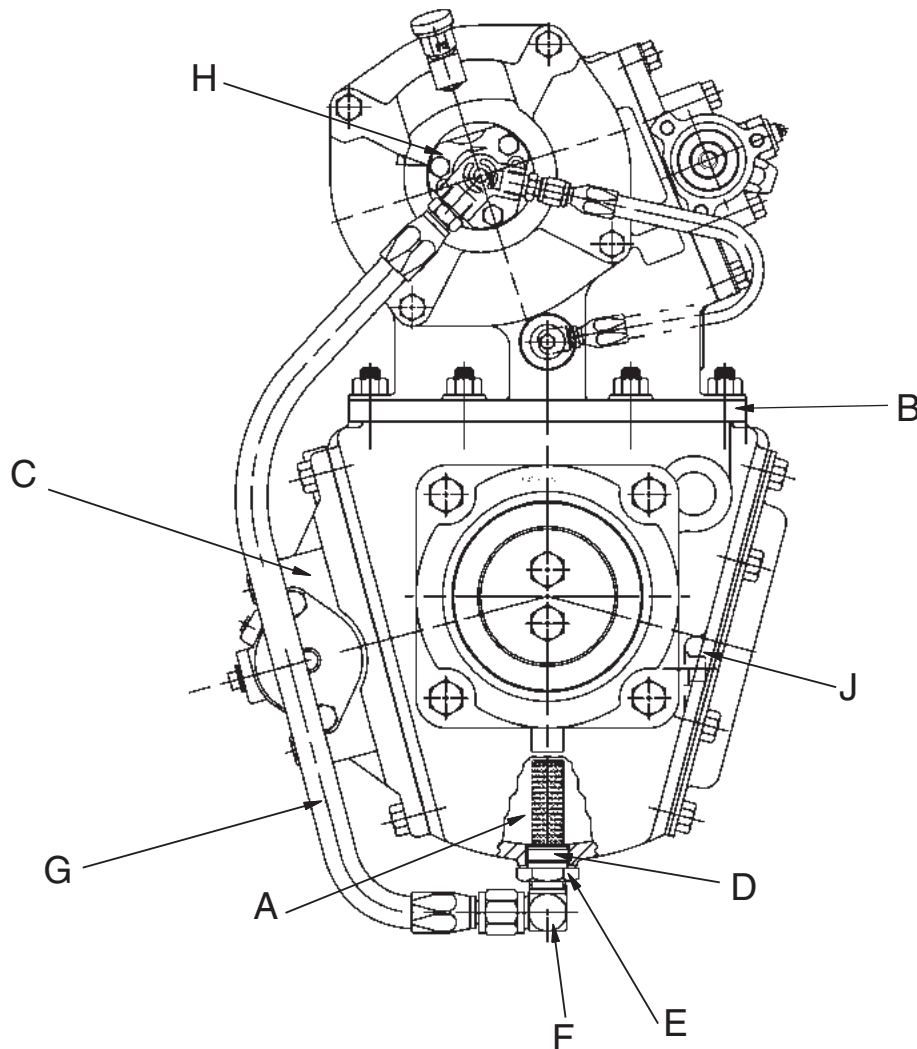


Fig. 13

912 Series Split Shaft – Top Mounted 880 w/ Self-Lube Option

1. Drain split shaft oil at drain plug **(A)**. Filter or screen oil & reuse if desired.
2. Remove top split shaft aperture cover plate at **(B)** or air shift Assembly **(C)** & reassemble to either side of split shaft in place of shipping cover. Install PTO on split shaft & set backlash at .006" to .012". (See [page 22](#) for checking proper backlash.)
3. Install copper gasket **(D)**, screened strain plug **(E)** & 90° elbow **(F)** in place of drain plug at **(A)**. Also install pressure lube hose **(G)** between elbow **(F)** and pump **(H)**. (Use pipe sealant on all pipe threads.)
4. Fill split shaft with filtered, screened or new oil at fill plug **(J)**, until oil reaches plug level, then reinstall plug.
5. Finish PTO & split shaft installation per owner's manual. Also install shaft and/or pump to be driven by PTO.
6. After brief PTO operation, remove fill plug **(J)**, add oil until it reaches plug level, then reinstall plug.

IMPORTANT: Lube pump **(H)** must rotate clockwise (engine rotation) as view from front of vehicle.



Cable Control Installation Instructions*

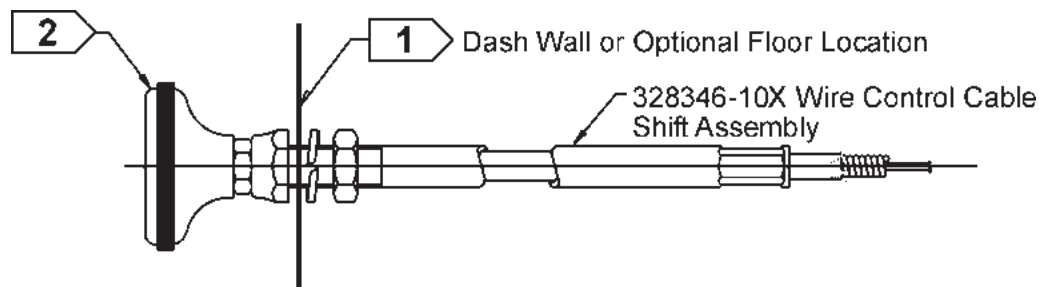
1. Find a suitable area on the dash to install the cable control (328346-10X) and the control plate (68-P-18) indicator light.

Optional Location: As an option the control cable and knob can be located through floor. Using this option the control plate and indicator light should still be located on dash, in close proximity.

NOTE: The location of the cable control and the control plate should be as close to each other as possible and easily accessible by the driver or operator, but should not be an obstacle to driver movement nor interfere with other controls, instruments, or equipment.

2. **CAUTION:** Before drilling any holes, make sure there is adequate room on both sides through dash wall, drill a 1/2" (.5") diameter hole for the control cable [1].
3. Install the control cable on the dash using the hex nuts supplied with the cable. The knob can then be screwed into place [2]. The length of cable can then run through the firewall and back to the PTO — making sure it is kept away from the exhaust, moving parts, etc.

NOTE: Do not kink the cable. In order for the cable to operate properly, there can be no bends smaller than 6 inch radius. Total bends in the cable should not exceed 360° (example - four 90° bends in cable).



4. Using the template found on [page 33](#) (SK-168) drill the necessary holes for the control plate-indicator light.
5. Install the control plate (68-P-18) stick on decal and indicator light on the dash using the hardware supplied in the 328751-1X installation kit (**Fig. 14**).

* All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

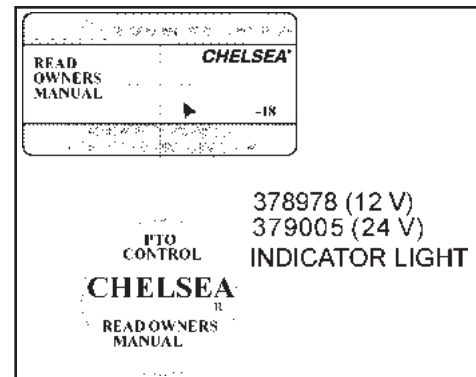


Fig. 14

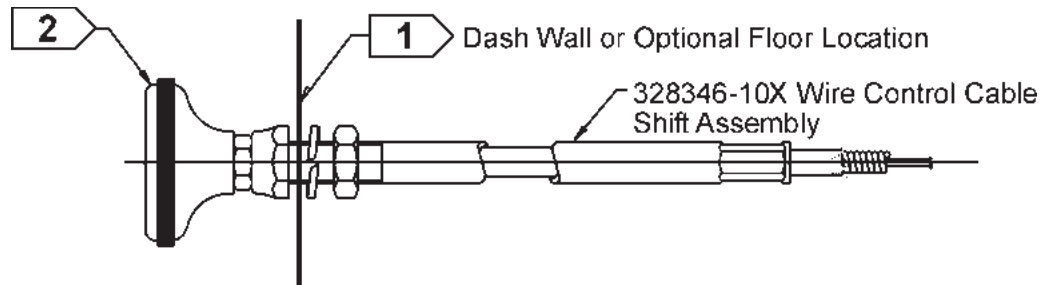
Cable Control Installation Instructions (Continued)

6. Determine from which direction the cable must come in order for the unit to be disengaged when the knob is all the way in.

NOTE: The shifter must always be installed in the following manner:

*CABLE IN: PTO DISENGAGED(6A): OUT OF GEAR POSITION

CABLE OUT: PTO ENGAGED(6B): IN GEAR POSITION



* The wire shift cable should be installed so that when the cable (knob) is pushed all the way in, the PTO has also moved the full travel of the PTO shifter, to the disengaged mode.

7. Install the wire control bracket found in either the 328380X or 328380-1X wire control parts bag [7].
8. Line the cable up with the wire control bracket and shifter lever (disengaged position) on the PTO cover assembly [8].

NOTE: It may be necessary to change the position of the shifter lever on the PTO. To do this, remove the shifter cover from the unit. This will prevent the possible loss of the poppet and/or spring into the transmission if the shifter post assembly should be pushed through the cover when reinstalling the lever.

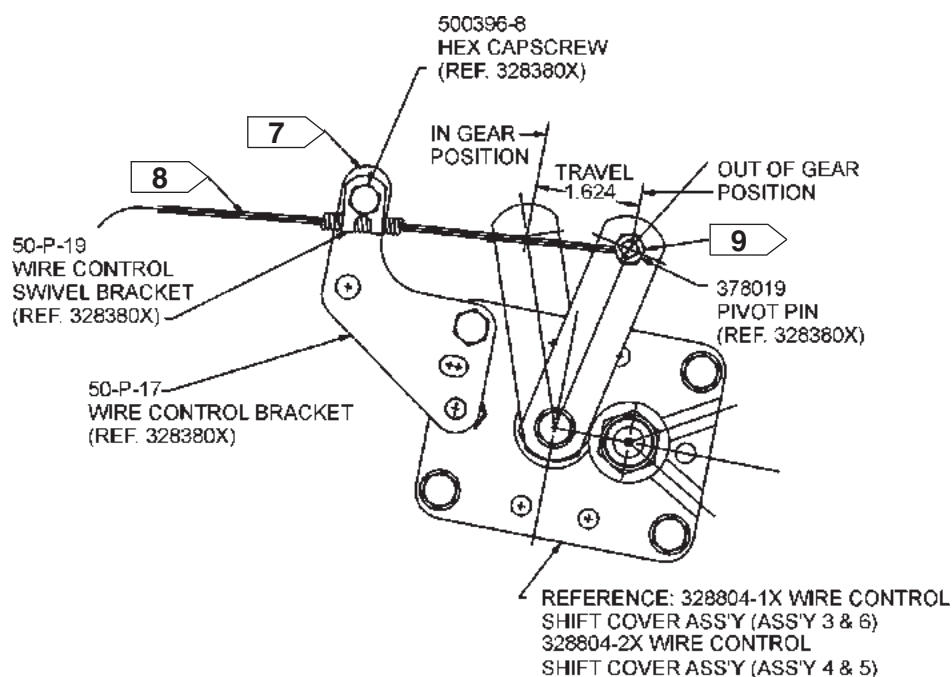
9. Shift the PTO to the engaged position to see how much of the cable casing must be cut to allow the lever enough travel to shift in and out completely. The casing need only go just beyond the bracket, whereas, the wire must be long enough to go through the swivel pin in the shifter lever [9].

NOTE: In some instances the cable control may not be long enough. Chelsea has available four longer lengths than the standard ten-foot cable. These come in five foot increments (i.e., 328346-15X = 15-foot cable).

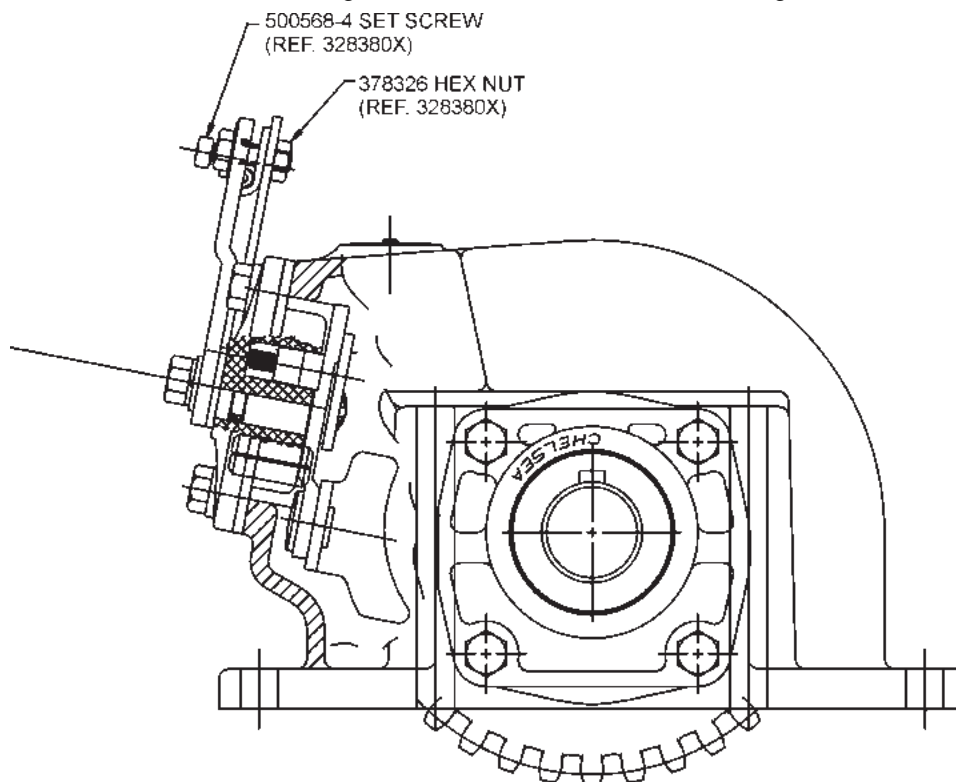
10. When the length of the casing has been determined, pull the wire back through until the case can be cut without cutting the wire. Use a hacksaw or heavy pair of side cutters to cut the casing.

NOTE: The cable can be held by a bench vise as long as the jaws are not tightened to the point where the case mushrooms. If a vise is not accessible, a pair of vise grips will do the job.

Cable Control Installation Instructions* (Continued)

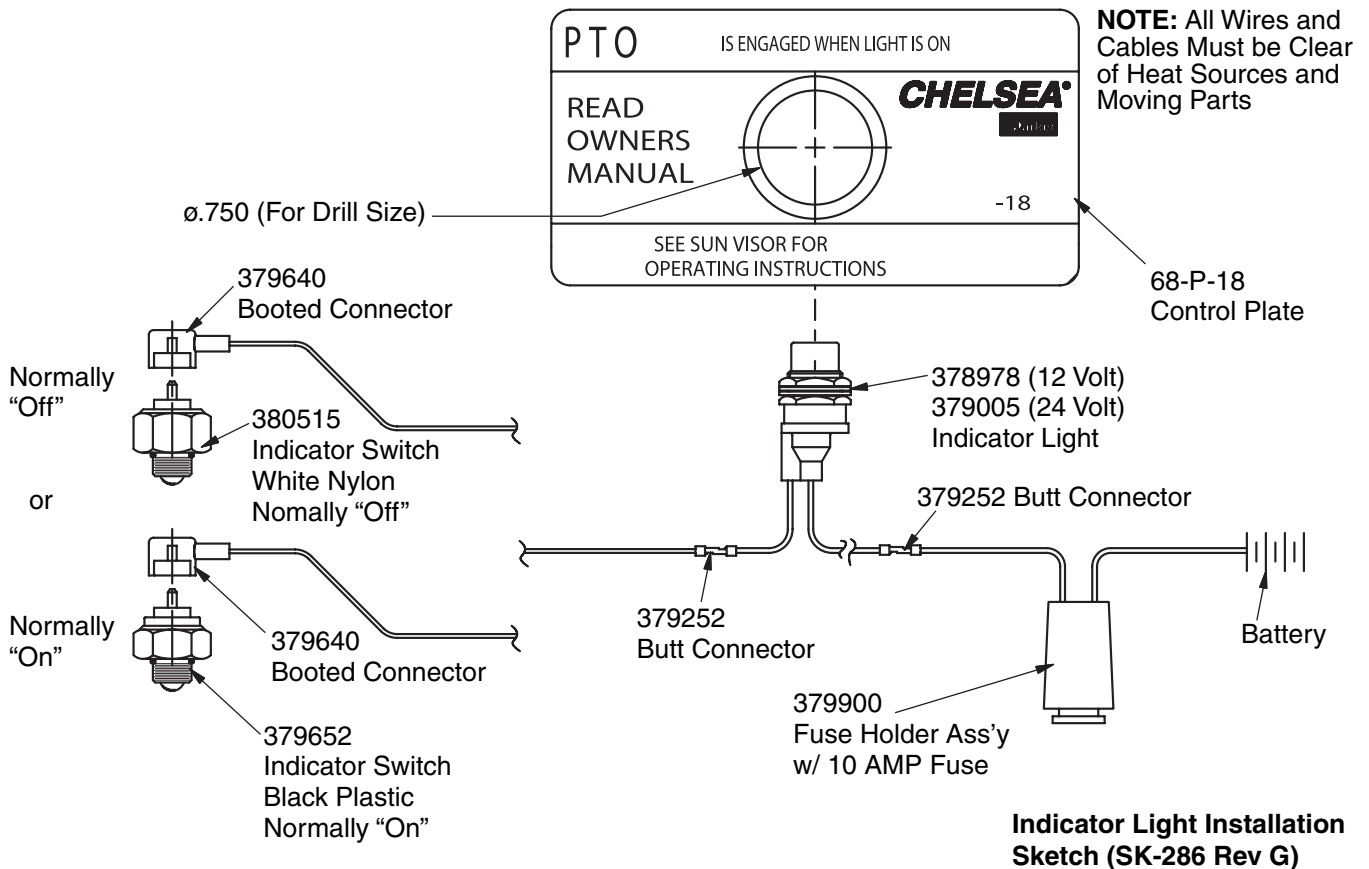


11. Push the wire back through and install the cable using the hardware from the previously mentioned wire control parts bag (328380X).
12. Cut the excess wire after the cable casing and wire have been installed and tightened.



* All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

Cable Control Installation Instructions* (Continued)



CAUTION: Indicator switches are capable of 0.5 amps maximum.

NOTE: All wires and cables must be clear of heat source and moving parts.

13. Shift the PTO to ensure enough casing has been removed to allow full gear engagement.

14. Install the wiring for the indicator light using the schematic above (SK-286 Rev G).

NOTE: Check both the cable and indicator light wires to be certain that they are not near the exhaust system or any moving parts. Carefully fasten to stationary parts of the vehicle if necessary.

15. Shift the PTO The following should be adhered to:

[15A] **CABLE IN:** PTO DISENGAGED: LIGHT OUT

[15B] **CABLE OUT:** PTO ENGAGED: LIGHT ON

NOTE: The PTO should be checked for continuity as per the instructions in this manual.

NOTE: Cable must be rigidly mounted-possibly to the transmission within 12-24" of the PTO.

*All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

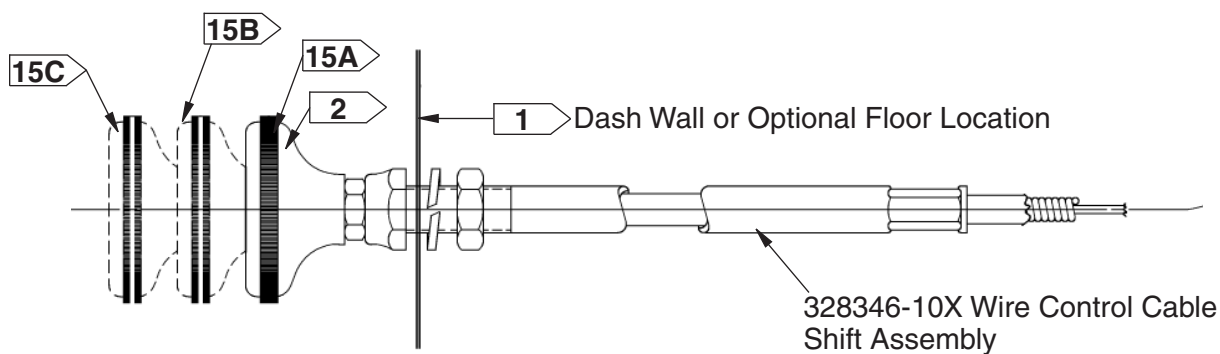
Cable Control Installation Instructions (Continued) (Reversibles, dual shift units, and some gear boxes)

1. Use steps #1-#5 from previous instructions.
2. In step #6 the cable can come from either direction since the PTO will always be engaged when all the way in or out.
3. Follow step #7 and #8.
4. In step #9 shift the PTO from forward to reverse or vice versa to determine the amount of travel needed and the length of casing to be cut.
5. Follow step #10-#14.
6. Step #15 will show the folding:

CABLE IN: PTO ENGAGED: LIGHT ON [15A]

CABLE OUT (1st position): PTO DISENGAGED: LIGHT OUT [15B]

CABLE OUT (2nd position): PTO ENGAGED: LIGHT ON [15C]

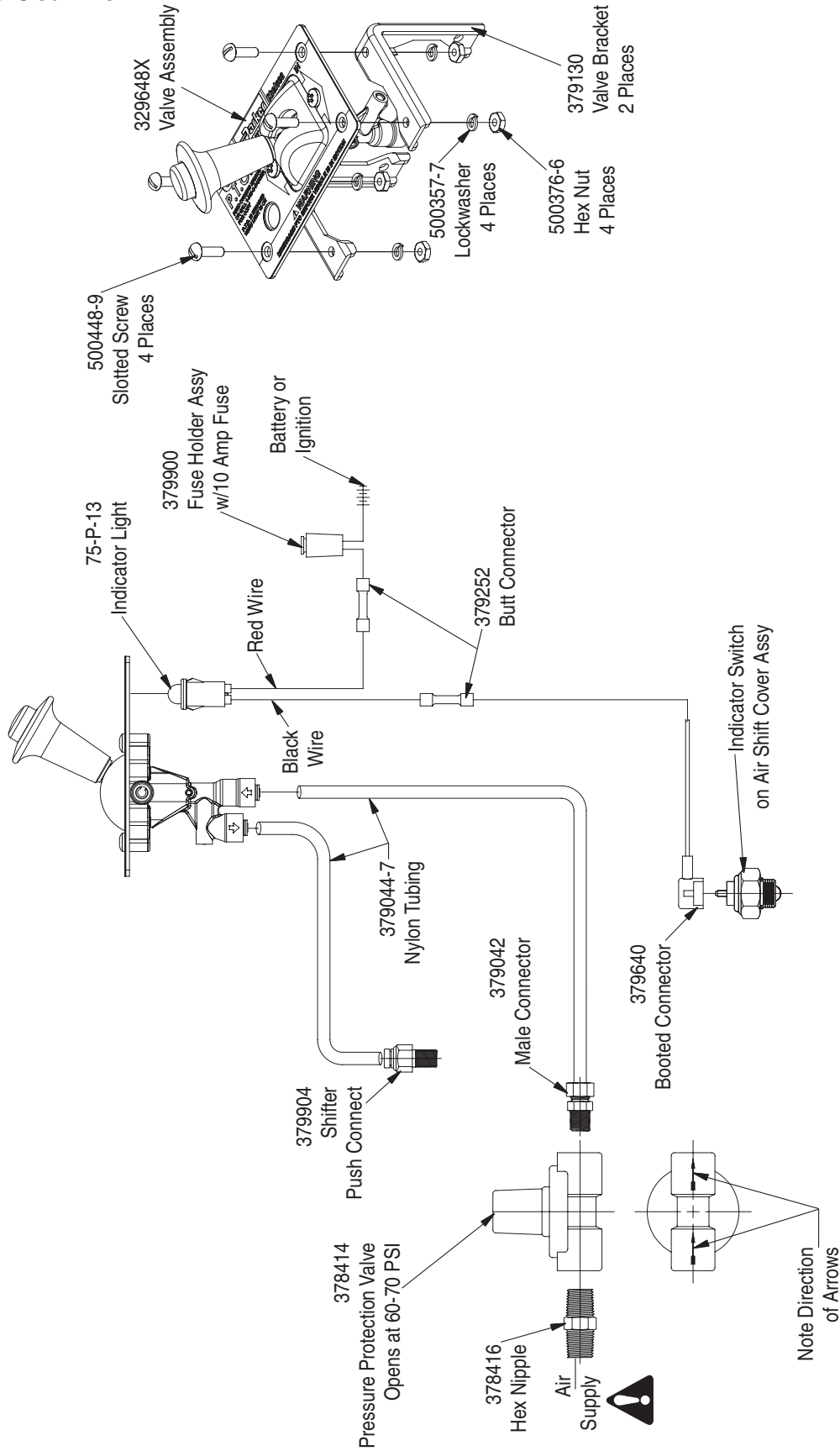


Shift Option "A"

2442 Series Gear Box

328388-98X Installation Kit
See SK-204 Drilling Template for Control Plate

NOTE: When this installation is used on vehicles with automatic transmissions the P.T.O. drive must be stopped before shifting.



WARNING: Connect directly to the air supply. Do not use tubing between the air supply and the pressure protection valve.

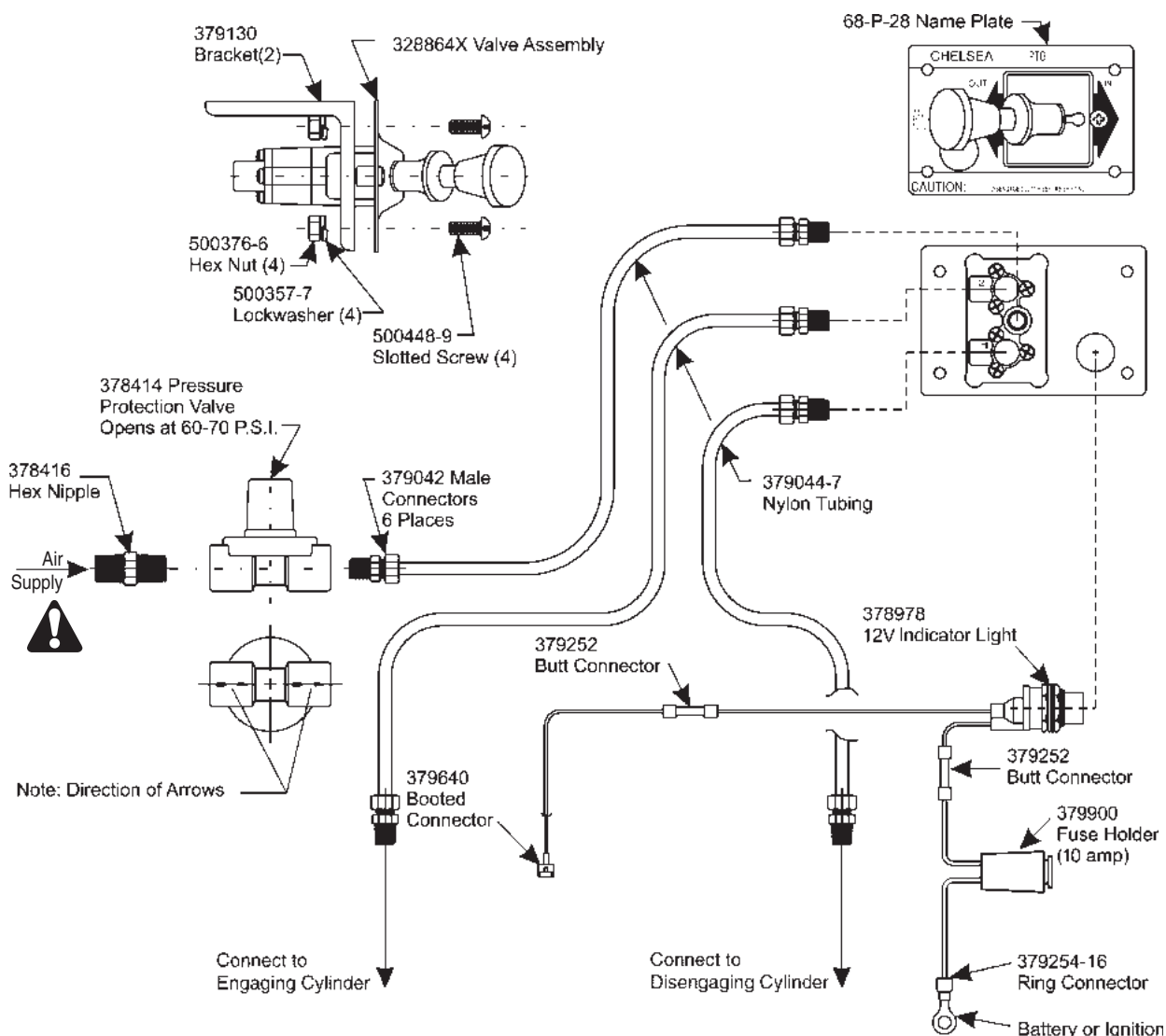
CAUTION: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

(SK-462)

Shift Option "A" 901, 912, and 941 Split Shafts

(SK-276 Rev G)

328388-61X Installation Kit



WARNING: Connect directly to the air supply. Do not use tubing between the air supply and the pressure protection valve.

Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

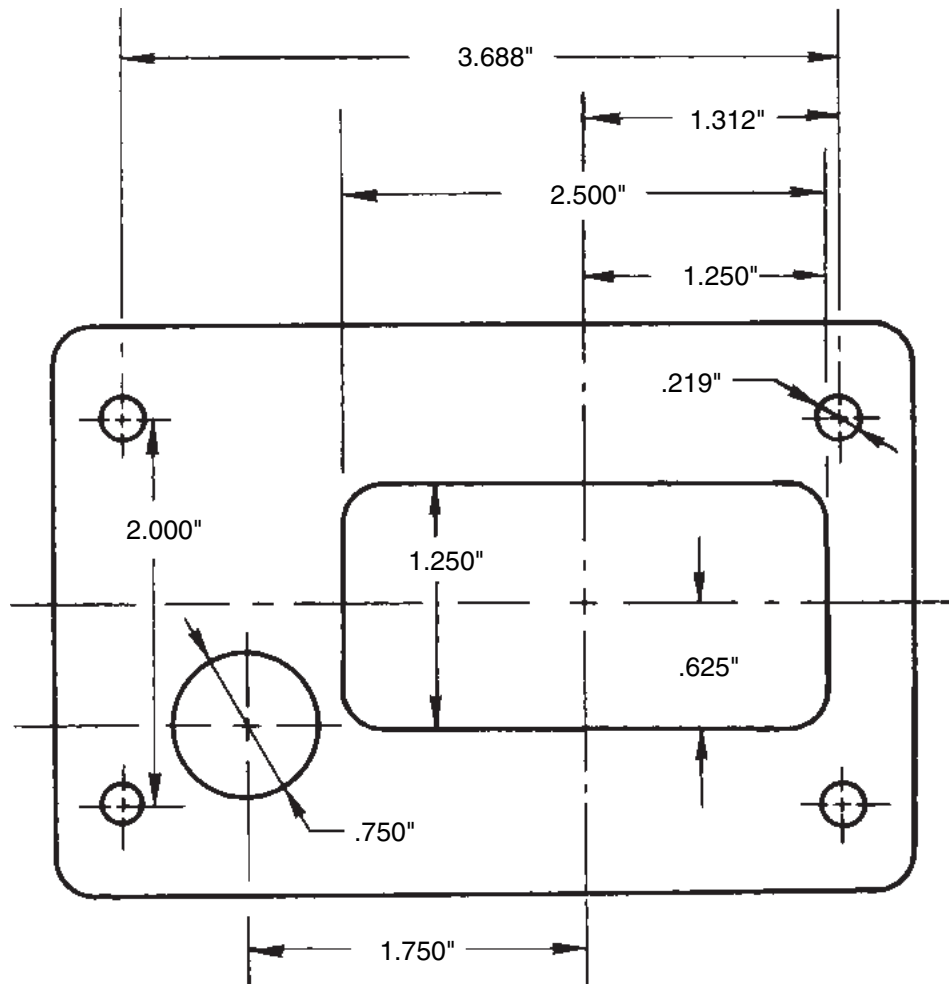
Important: When this installation is used on vehicles with automatic transmissions, the PTO drive gear must be stopped before shifting.

NOTE: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

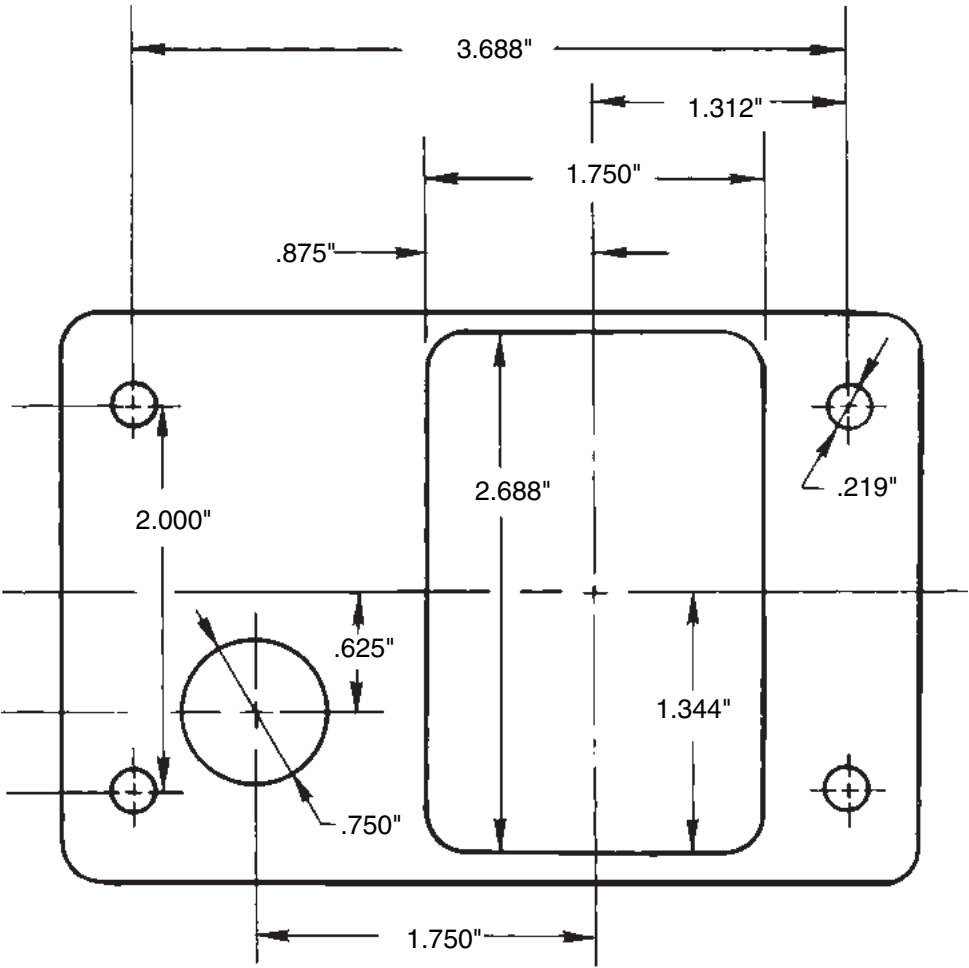
NOTE: The template for the control plate is on [pages 31-33](#).

Dash Drilling Template for 2442 Series Gear Box Air Shift Control

(SK-204 Rev C)

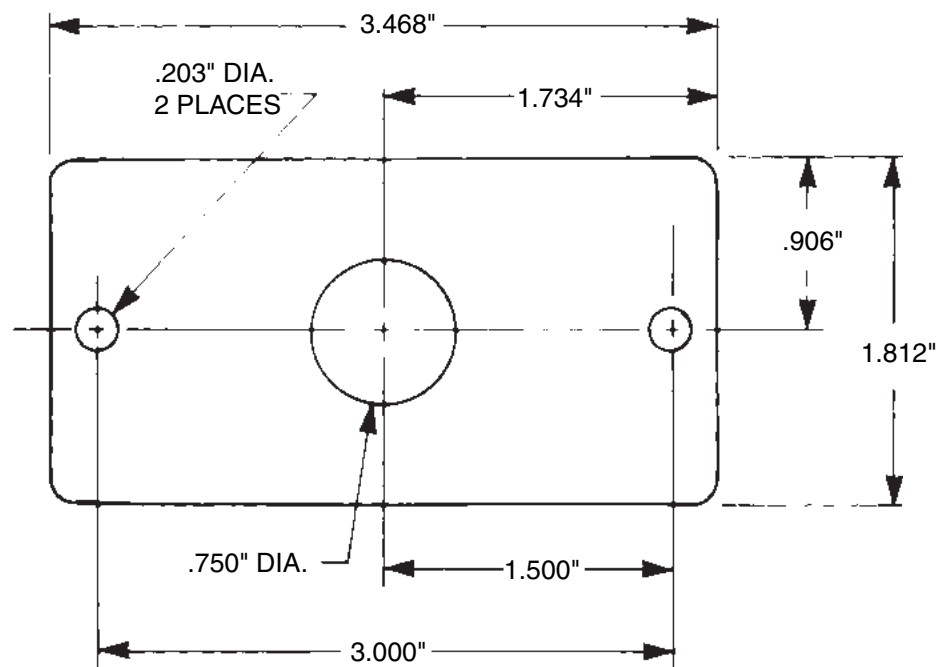


Dash Drilling Template for 901, 912, and 941 Split Shafts Air Shift Controls (SK-204 Rev C)



Dash Drilling Template for Wire and Lever Controls

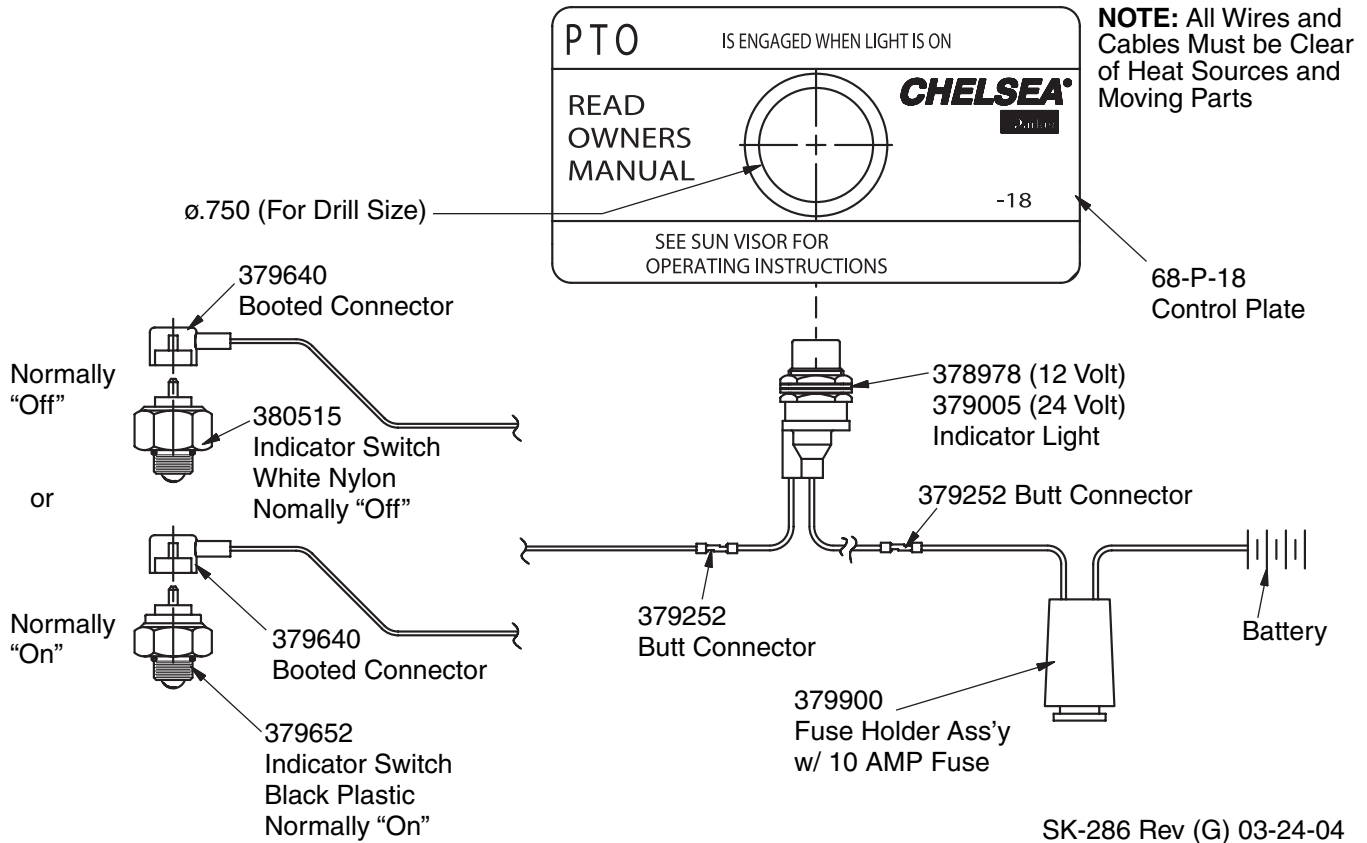
(SK-168)



Indicator Light Installation

(SK-286 Rev G)

For wire and lever shift option on the 901, 912, 931, 941 and 2442 gear boxes.



CAUTION: Indicator switches are capable of 0.5 amps maximum.

NOTE: All wires and cables must be clear of heat source and moving parts.

Indicator Switches

In order to ensure that the switch is functioning properly, the following procedure can be used with the unit on a bench, or installed.

1. Use a continuity checker, battery type, either meter or light. Attach one (1) probe to the screw on the Indicator Switch.

NOTE: Make sure Indicator Switches in the PTO shifter or housing are torqued to 10-15 (1.38-2.07 kg meters).

2. With the other probe, make contact with the shifter cover or housing (**Fig. 15**).
3. Actuate shifting device and the meter or light* should be actuated when PTO gear is engaged (**Fig. 16**).
4. Shift unit out of gear and the meter or light* should return to normal as shown.

This test procedure can be used to check Chelsea wire, lever, and air shifter covers, although an air source would be necessary for the latter.

* If a meter is not available the light in the 328751-1X can be used. A six volt battery is all that is necessary for a power source.

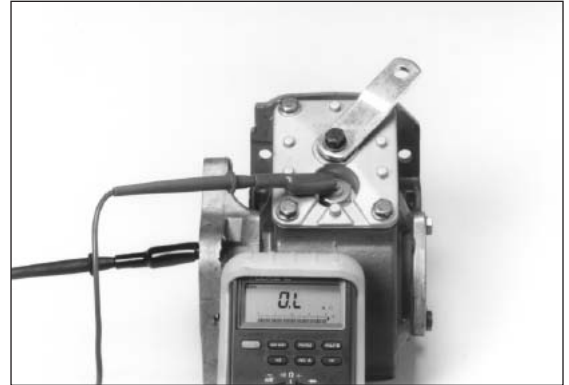


Fig. 15

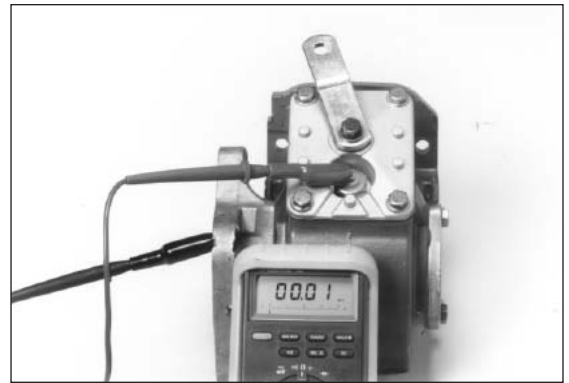


Fig. 16

CAUTION: Indicator switches are capable of 0.5 amps maximum.

Driver Training: One of the major causes of bearing and gear failures in the auxiliary unit is poor driving habits. Drivers should be taught to always use the Lo Speed or reductions available in the auxiliary unit and keep the front box in the higher ratios not vice versa.

Worn and pitted gears, as well as worn and pitted bearings are usually caused by excessive use of the auxiliary overdrive gears with the main box in lower gear ratios.

Broken teeth in the auxiliary unit are usually caused by drivers trying to start their vehicles with the auxiliary unit in the high ratio while the big reduction is made in the front box. Frogging or quick release of clutch gives a jump start which is also noted for breaking teeth.

Noisy Operation: Noise is usually very elusive and generally not the fault of the auxiliary; therefore, mechanics should road test to determine if the driver's complaint of noise is actually in the auxiliary. Remember that auxiliary units act as sounding boxes and in numerous instances, drivers have insisted that the noise was in the auxiliary. However, investigations revealed the noise to be caused by one of the following conditions:

- A. Fan out of balance or bent blades.
- B. Defective vibration dampers.
- C. Crankshafts out of balance.
- D. Flywheels out of balance.
- E. Flywheels mounting bolts loose.
- F. Engine rough at idle producing rattle in gear train.
- G. Clutch assembly out of balance.
- H. Engine mounts loose or broken.
- I. PTO gear not fully engaged or housing not properly shimmed.
- J. Universal joints worn out.
- K. Propeller shafts out of balance.
- L. Universal joint angles out of plane or at an excessive angle.
- M. Center bearings in driveline dry, not mounted properly, etc.
- N. Wheels out of balance.
- O. Tire treads humming or vibrating at certain speeds.
- P. Air leaks on suction side of induction system—especially with turbo-chargers.

Mechanics should try to locate and eliminate noise by means other than auxiliary removal, or overhaul. However, if the noise appears to be in the auxiliary, try to break it down into the following classifications. If possible, determine what position the gear shift lever is in when the noise occurs. If the noise is evident in only one gear position, the cause of the noise is generally traceable to the gears in operation.

- A. Growling and humming or, more serious, a grinding noise. These noises are caused by worn, chipped, rough, or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.
- B. Hissing or, more serious, a thumping or bumping type noise. Hissing noises can be caused by bad bearings. As bearings wear and retainers start to break up, etc., the noise could change to a thumping or bumping.
- C. Metallic rattles within the auxiliary usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch, which may be amplified and transmitted to the auxiliary through the connecting propeller shaft. In heavy duty equipment, clutch discs with vibration dampers are not used, so a rattle, particularly in neutral, is common with diesel equipment. In general, engine speeds should be 600 RPM or above to eliminate objectionable rattles and vibration during the idle. Always leave the main box in neutral and the auxiliary unit in gear when idling. A defective or faulty injector would cause a rough or lower idle speed and a rattle in the auxiliary. Rattle could also be caused by excessive backlash in PTO unit mounting.
- D. Improper lubricants or lack of lubricant can produce noises. Auxiliaries with low oil levels sometimes run hotter than normal, as there is insufficient lubricant to cool and cover the gears.

- E. Squealing, particularly when the auxiliary is operating at higher speeds, could be caused by one of the free running gears seizing on the thrust face or fluted diameter temporarily and then letting go. In general, a mild seizure will clear itself up and the auxiliary will continue to operate satisfactorily without this defect being known. See "G."
- F. Gear seizure at High Speed, usually accompanied with a loud squealing noise, is readily apparent to the driver, since the truck will suddenly slow down as if the brakes were being applied. If the truck continues to move ahead, even though the gear shift lever is placed in neutral, it would indicate the floating gear on the main shaft had seized. Depressing the clutch should interrupt the driving torque. The seized gear could be checked quite readily by depressing the clutch and checking the action with the gear shift lever progressively in all shift positions. If releasing the clutch tends to kill the engine, then this gear position has not seized. In other words, the auxiliary would be in two gears at the same time. By a process of elimination, the gear at fault can be readily identified. See "G."
- G. Vibration. Gear seizures on thrust faces or fluted diameters are usually caused by vibrations in the power train. This could be engine, propeller shafts, joint angles, rear axles, differentials, etc.

Due to the normal and sometime severe torsional vibrations that Power Take-Off units experience, operators should follow a set maintenance schedule for inspections. Failure to service loose bolts or Power Take Off leaks could result in potential auxiliary Power Take-Off or transmission damage.

Periodic PTO MAINTENANCE is required by the owner/operator to ensure proper, safe and trouble free operation.

Daily: Check all air, hydraulic and working mechanisms before operating PTO Perform maintenance as required.

Monthly: Inspect for possible leaks and tighten all air, hydraulic and mounting hardware, if necessary. Torque all bolts, nuts, etc. to Chelsea specifications. Ensure that splines are properly lubricated, if applicable. Perform maintenance as required.

With regards to the direct mounted pump splines, the PTO requires the application of a specially formulated anti-fretting, high pressure, high temperature grease. The addition of the grease has been proven to reduce the effects of the torsional vibrations, which result in fretting corrosion on the PTO internal splines as well as the pump external splines. Fretting corrosion appears as a "rusting and wearing" of the pump shaft splines. Severe duty applications, which require long PTO running times and high torque may require more frequent regreasing. Applications such as Utility Trucks that run continuously and are lightly loaded also require frequent regreasing due to the sheer hours of running time. It is important to note that service intervals will vary for each and every application and is the responsibility of the end user of the product. Chelsea also recommends that you consult your pump owners manuals and technical services for their maintenance guidelines. Fretting corrosion is caused by many factors and without proper maintenance; the anti-fretting grease can only reduce its effects on components.

Chelsea offers the grease to our customers in two packages. The first is a 5/8 fluid ounce tube (379688), which is included with every applicable PTO, and the second is a 14-ounce grease cartridge (379831). Chelsea also offers greaseable shafts for select output designators.

Warranty: Failure to comply entirely with the provisions set forth in the appropriate Owner's Manual will result in voiding of ALL Warranty consideration.

Parker Hannifin Corporation – Chelsea Division

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The items described in this document and other documents and descriptions provided by Parker Hannifin Corporation, its subsidiaries and its authorized distributors ("Seller") are hereby offered for sale at prices to be established by Seller. This offer and its acceptance by any customer ("Buyer") shall be governed by all of the following Terms and Conditions. Buyer's order for any item described in its document, when communicated to Seller verbally, or in writing, shall constitute acceptance of this offer. All goods, services or work described will be referred to as "Products".

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3. Delivery Dates; Title and Risk; Shipment. All delivery dates are approximate and Seller shall not be responsible for any damages resulting from any delay. Regardless of the manner of shipment, title to any products and risk of loss or damage shall pass to Buyer upon placement of the products with the shipment carrier at Seller's facility. Unless otherwise stated, Seller may exercise its judgment in choosing the carrier and means of delivery. No deferment of shipment at Buyer's request beyond the respective dates indicated will be made except on terms that will indemnify, defend and hold Seller harmless against all loss and additional expense. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions.

4. Warranty. Seller warrants that all products sold, other than the 590 Series, conform to the applicable Parker Chelsea standard specification for the lesser period of 2 years (24 Months) from date of service or 2-1/2 years (30 Months) from date of build (as marked on the product name plate). Seller warrants that the 590 Series will conform to the applicable Seller standard specification for the lesser period of 2 years (24 Months) from date of service or 2000 hours of usage. The prices charged for Seller's products are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **DISCLAIMER OF WARRANTY: THIS WARRANTY COMPRISESTHE SOLE AND ENTIRE WARRANTY PERTAINING TO PRODUCTS PROVIDED HEREUNDER. SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS AND IMPLIED, INCLUDING DESIGN, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon delivery. No claims for shortages will be allowed unless reported to the Seller within 10 days of delivery. No other claims against Seller will be allowed unless asserted in writing within 30 days after delivery. Buyer shall notify Seller of any alleged breach of warranty within 30 days after the date the defect is or should have been discovered by Buyer. Any action based upon breach of this agreement or upon any other claim arising out of this sale (other than an action by Seller for an amount due on any invoice) must be commenced within 12 months from the date of the breach without regard to the date breach is discovered.

6. LIMITATION OF LIABILITY. UPON NOTIFICATION, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE A DEFECTIVE PRODUCT, OR REFUND THE PURCHASE PRICE. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR AS THE RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR FOR ANY CHARGES OR EXPENSES OF ANY NATURE INCURRED WITHOUT SELLER'S WRITTEN CONSENT, EVEN IF SELLER HAS BEEN NEGLIGENT, WHETHER IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS.

7. User Responsibility. The user, through its own analysis and testing, is solely responsible for making the final selection of the system and Product and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application and follow applicable industry standards and Product information. If Seller provides Product or system options, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products or systems.

8. Loss to Buyer's Property. Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, will be considered obsolete and may be destroyed by Seller after two consecutive years have elapsed without Buyer ordering the items manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Special Tooling. A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture Products. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the Products, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

10. Buyer's Obligation; Rights of Seller. To secure payment of all sums due or otherwise, Seller shall retain a security interest in the goods delivered and this agreement shall be deemed a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect its security interest.

11. Improper use and Indemnity. Buyer shall indemnify, defend, and hold Seller harmless from any claim, liability, damages, lawsuits, and costs (including attorney fees), whether for personal injury, property damage, patent, trademark or copyright infringement or any other claim, brought by or incurred by Buyer, Buyer's employees, or any other person, arising out of: (a) improper selection, improper application or other misuse of Products purchased by Buyer from Seller; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, plans, drawings, or specifications furnished by Buyer to manufacture Product; or (d) Buyer's failure to comply with these terms and conditions. Seller shall not indemnify Buyer under any circumstance except as otherwise provided.

12. Cancellations and Changes. Orders shall not be subject to cancellation or change by Buyer for any reason, except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage. Seller may change product features, specifications, designs and availability with notice to Buyer.

13. Limitation on Assignment. Buyer may not assign its rights or obligations under this agreement without the prior written consent of Seller.

14. Force Majeure. Seller does not assume the risk and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter "Events of Force Majeure"). Events of Force Majeure shall include without limitation: accidents, strikes or labor disputes, acts of any government or government agency, acts of nature, delays or failures in delivery from carriers or suppliers, shortages of materials, or any other cause beyond Seller's reasonable control.

15. Waiver and Severability. Failure to enforce any provision of this agreement will not waive that provision nor will any such failure prejudice Seller's right to enforce that provision in the future. Invalidation of any provision of this agreement by legislation or other rule of law shall not invalidate any other provision herein. The remaining provisions of this agreement will remain in full force and effect.

16. Termination. Seller may terminate this agreement for any reason and at any time by giving Buyer thirty (30) days written notice of termination. Seller may immediately terminate this agreement, in writing, if Buyer: (a) commits a breach of any provision of this agreement (b) appoints a trustee, receiver or custodian for all or any part of Buyer's property (c) files a petition for relief in bankruptcy on its own behalf, or by a third party (d) makes an assignment for the benefit of creditors, or (e) dissolves or liquidates all or a majority of its assets.

17. Governing Law. This agreement and the sale and delivery of all Products hereunder shall be deemed to have taken place in and shall be governed and construed in accordance with the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to this agreement.

18. Indemnity for Infringement of Intellectual Property Rights. Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Section. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets ("Intellectual Property Rights"). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that a Product sold pursuant to this Agreement infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If a Product is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using the Product, replace or modify the Product so as to make it noninfringing, or offer to accept return of the Product and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to Products delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any Product sold hereunder. The foregoing provisions of this Section shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

19. Entire Agreement. This agreement contains the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter are herein merged.

20. Compliance with Law, U. K. Bribery Act and U.S. Foreign Corrupt Practices Act. Buyer agrees to comply with all applicable laws and regulations, including both those of the United Kingdom and the United States of America, and of the country or countries of the Territory in which Buyer may operate, including without limitation the U. K. Bribery Act, the U.S. Foreign Corrupt Practices Act ("FCPA") and the U.S. Anti-Kickback Act (the "Anti-Kickback Act"), and agrees to indemnify and hold harmless Seller from the consequences of any violation of such provisions by Buyer, its employees or agents. Buyer acknowledges that they are familiar with the provisions of the U. K. Bribery Act, the FCPA and the Anti-Kickback Act, and certifies that Buyer will adhere to the requirements thereof. In particular, Buyer represents and agrees that Buyer shall not make any payment or give anything of value, directly or indirectly to any governmental official, any foreign political party or official thereof, any candidate for foreign political office, or any commercial entity or person, for the purpose of influencing such person to purchase products or otherwise benefit the business of Seller.

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