



Chelsea[®] Power Take-Off

489 Series Service Manual

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

Parker | Chelsea

ENGINEERING YOUR SUCCESS.

CHELSEA®

WARNING

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS 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 and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

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".

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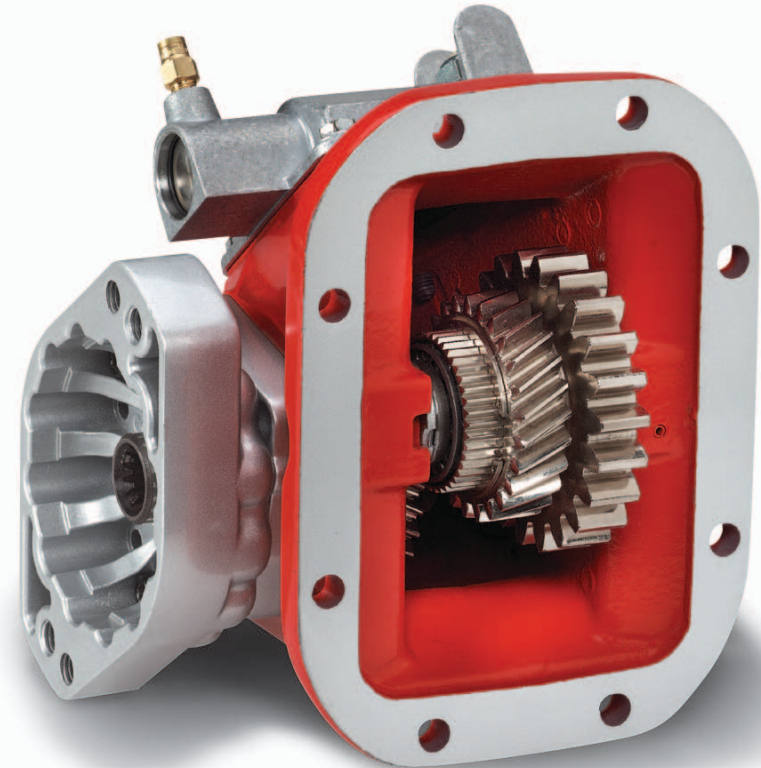
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NOTES

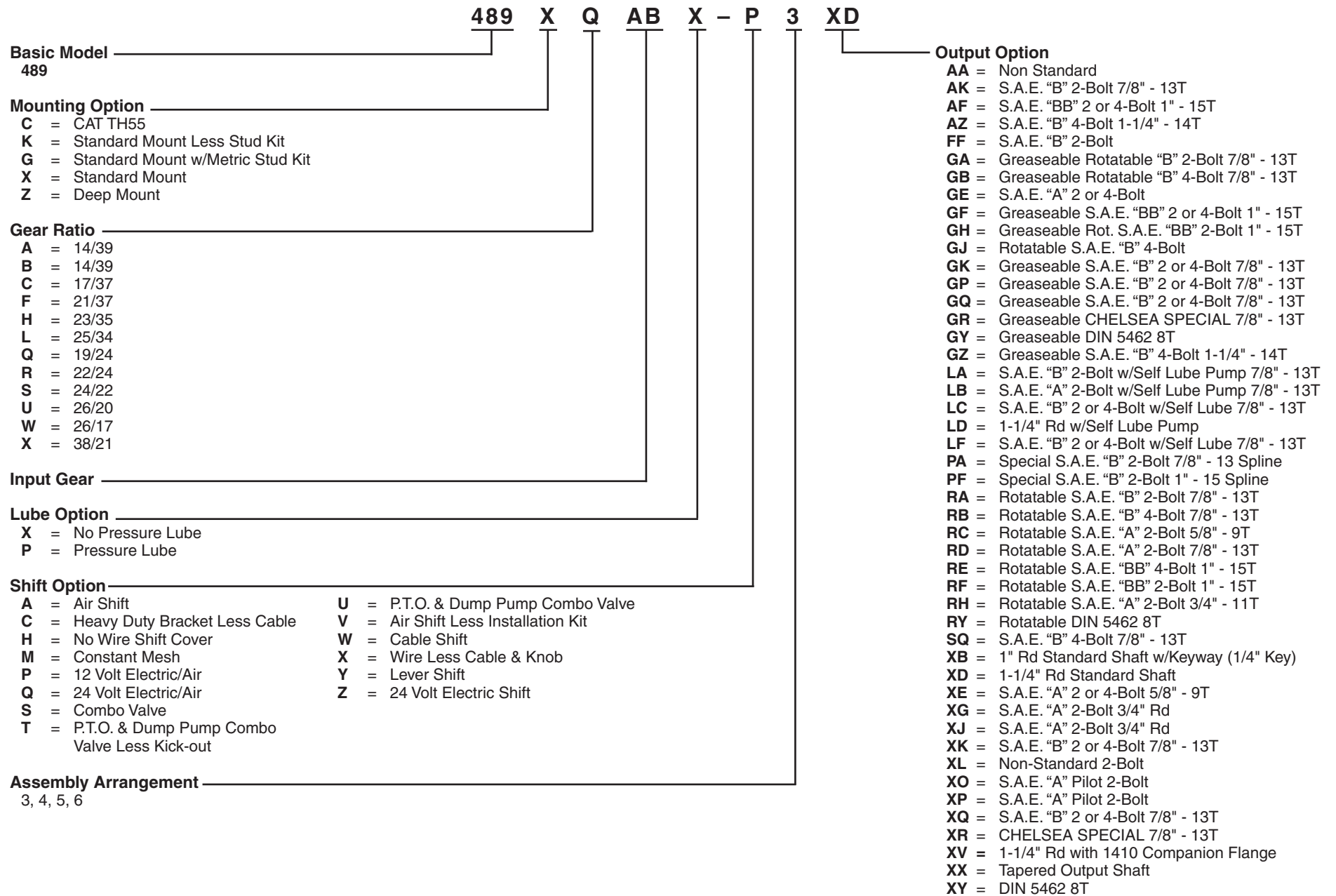
1	Visually inspect parts before assembly for flaws.
2	The item numbers identifying parts are the same item numbers used on the engineering drawings.
3	Ensure tools and fixtures are current and have the required inspection and calibration labels and/or tags.
4	The terms OUTPUT and DRIVE are used interchangeably.
5	Lubricate most bearings before assembly. Use MELCOMOL "Y", EP-2 or equal.
6	When assembling bearings, always place the bearings rounded end into the part.
7	Use Parker O-Lube or equal to lubricate O-Rings and seals before assembly.
8	When assembling O-Rings, do not roll it into their grooves. Use a O-Ring tool for assembly. O-Rings are not to be twisted or damaged.
9	Always reference the current Chelsea Parts List for part numbers and assemblies. 489 Series is HY25-2489-M1/US

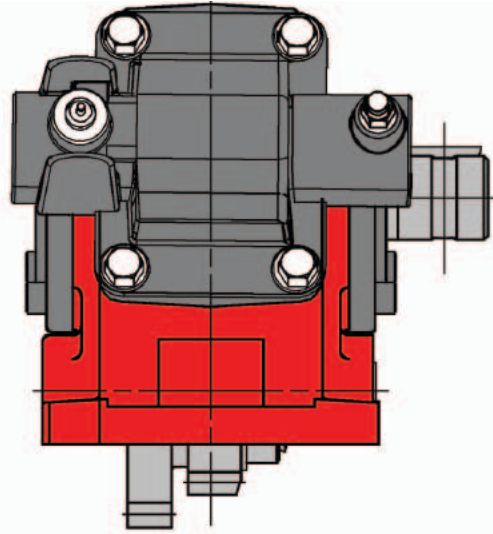


Suggested Tools			
Safety Glasses	Oil Seal Slide	Shop Press	3/16" Hex Wrench
Oil Seal Driver	Pliers	5/32" Hex Bit Driver	Hammer/Mallet
1/2" Socket	1/2" Hex Wrench		

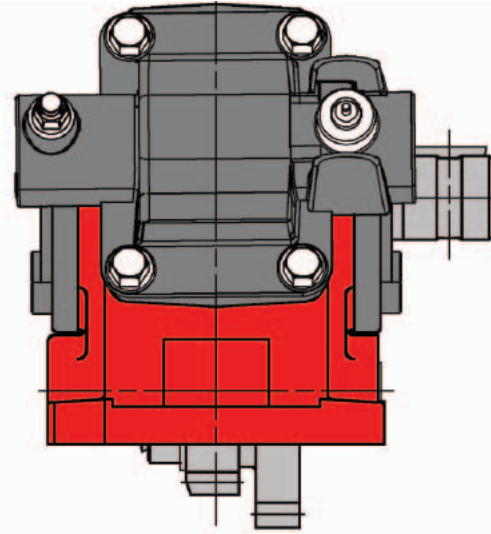
Suggested Service Kits	
Part Number	Description
329202X	Indicator Switch Connector
328356-15X	Shifter Cover Seal Kit, Cable Control
328356-67X	Gasket & Seal Kit
328356-69X	Shifter Cover Seal Kit, Cable Control "A", "B" & "C" Ratio
328356-71X	Shifter Cover Seal Kit, Air Shift
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials

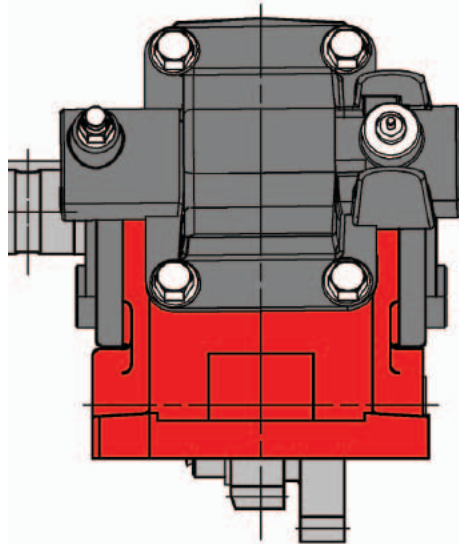




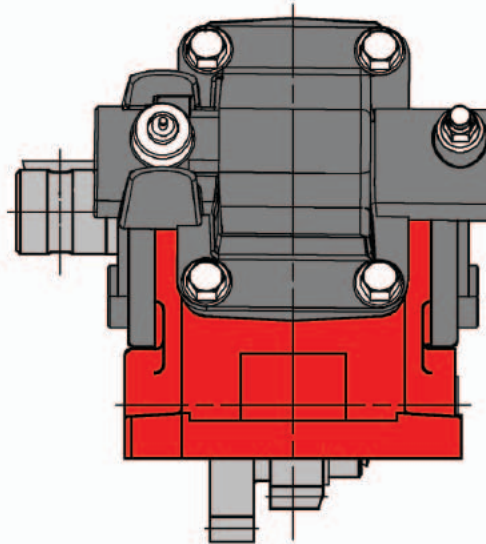
Assembly 3



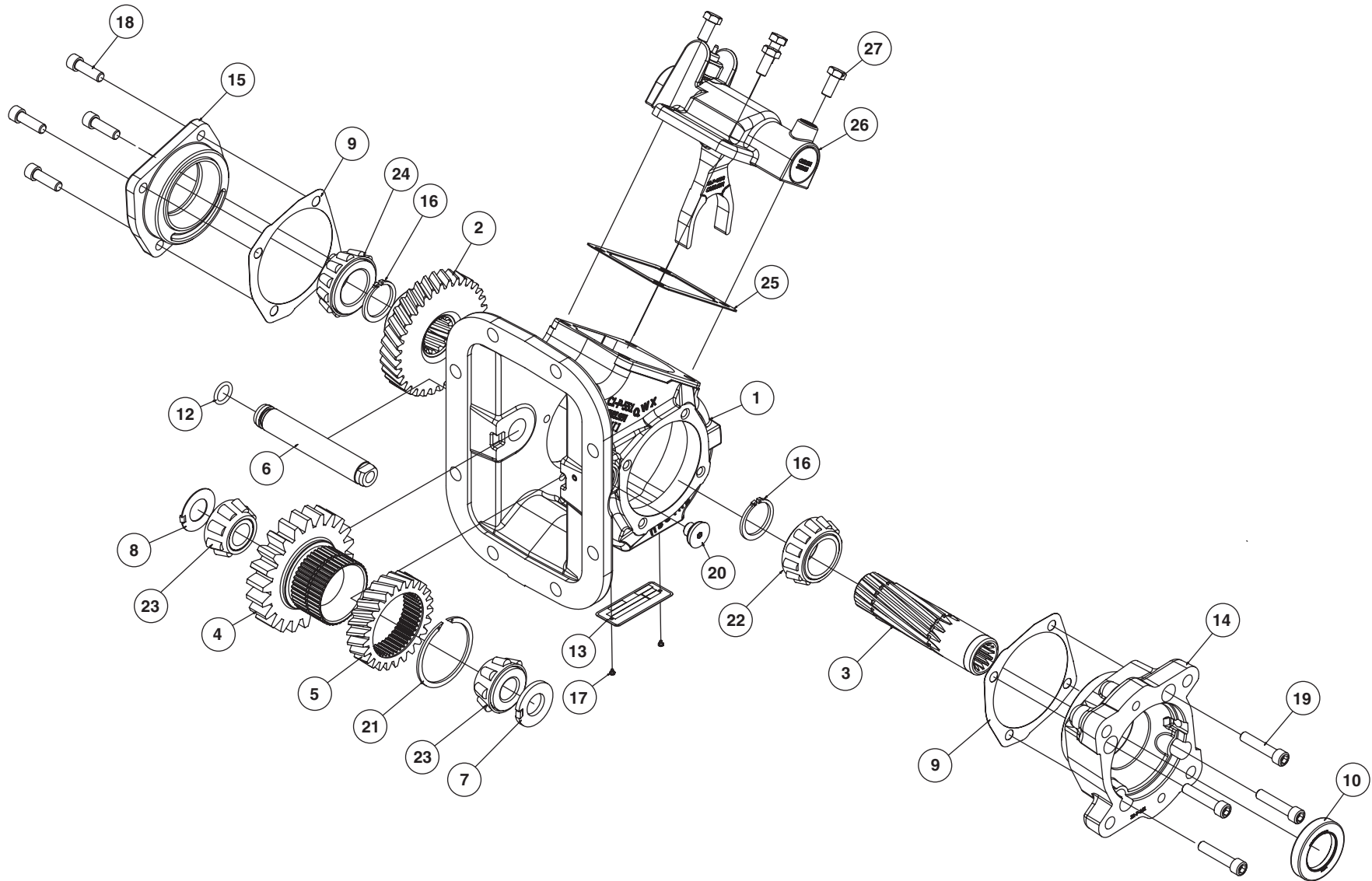
Assembly 4



Assembly 5



Assembly 6



489GLAHX-A3XP

Item	Part Number	Description	Qty.
1	1-P-552X	Housing.....	1
2	2-P-727 ⁽¹⁾	Output Gear 24T.....	1
3	3-P-282	Shaft Output Assembly.....	1
4	5-P-1004 ⁽¹⁾	Input Gear 22T.....	1
5	5-P-964 ⁽¹⁾	Input Gear Ratio.....	1
6	9-P-88	Idler Shaft .75".....	1
7	14-P-73-1	Spacer .762" x 1.500" x .149" - .151".....	1 or
	14-P-73-2	Spacer .762" x 1.500" x .152" - .154".....	1 or
	14-P-73-3	Spacer .762" x 1.500" x .155" - .157".....	1
8	31-P-102	Thrust Washer .754" x .440" x .030".....	1
9	22-P-24-1	Gasket .010".....	A.R.
	22-P-24-2	Gasket .020".....	A.R.
	22-P-24-3	Gasket .015".....	A.R.
10	28-P-216	Oil Seal 2.004" x 1.250" x .374".....	1
12	28-P-191	O-Ring .549" x .103".....	1
13	68-P-2	Name Plate.....	1
14	328328X	Pump Flange Assembly ("XP").....	1
15	328274X	Bearing Cap & Cup Assembly 6-Bolt.....	1
16	378391	Lockring.....	2
17	378422	Drive Screw.....	2

A.R. – As Required

⁽¹⁾ See [Page 26](#) for other Gear Options

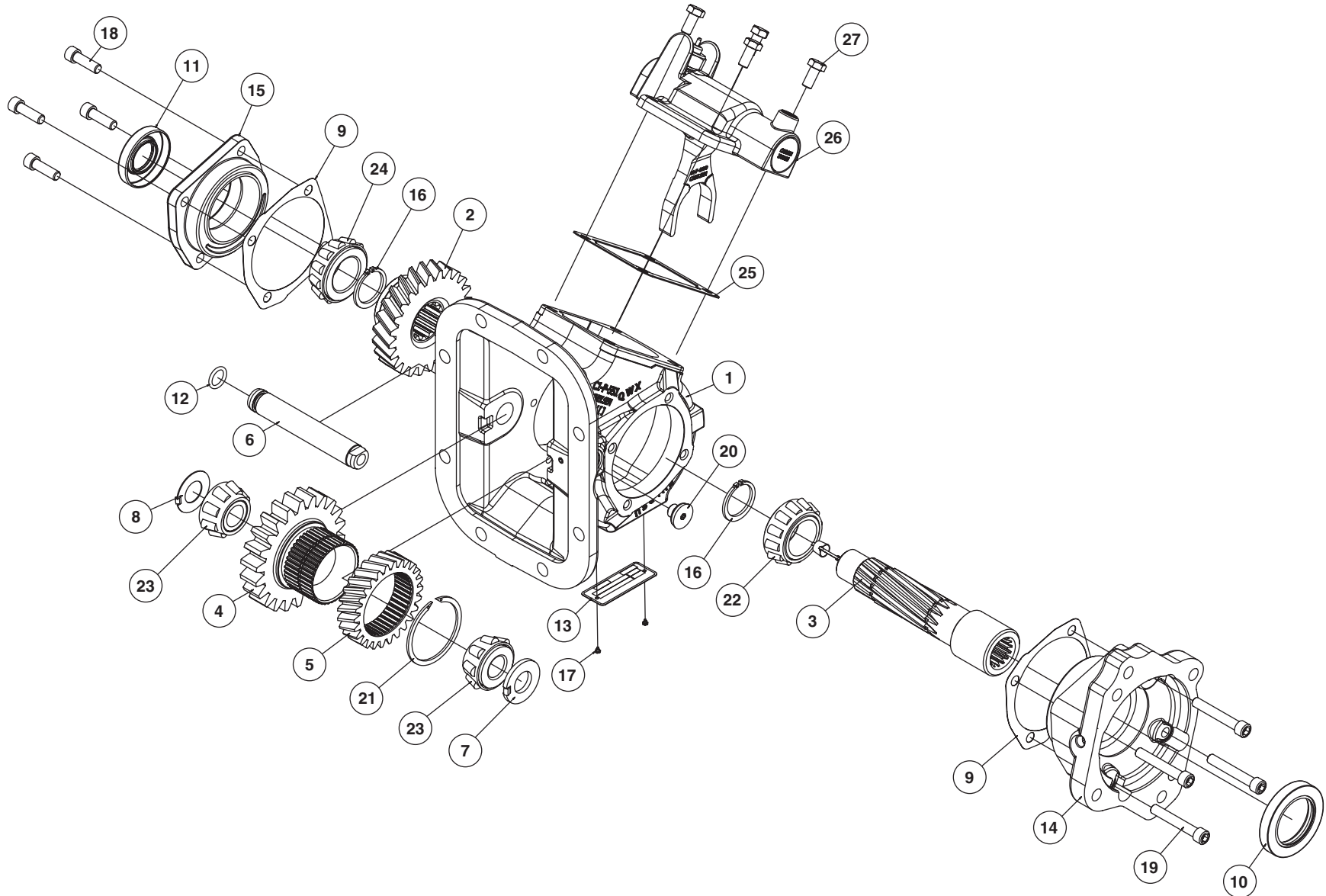
Item	Part Number	Description	Qty.
18	378447-6	Socket Head Capscrew .312" - 18 x 1.000".....	4
19	378447-8	Socket Head Capscrew .312" - 18 x 1.500".....	4
20	379672	Plug, O-Ring w/ Socket Face (NWD Plug).....	1
21	379522	Lockring.....	1
22	550397	Bearing Cone, Tapered 1.250" x .812".....	1
23	550439	Bearing Cone, Tapered .750" x .8598".....	2
24	550532	Bearing Cone, Tapered 1.18" - 11 x .8125".....	1
25	35-P-8	Shifter Cover Gasket.....	1
26	329361X	Air Shift Assembly.....	4
27	378430-9	Hex Head Capscrew .312" - 18 x.875".....	4

See [Page 21 & 23](#) for more Air Shift information

Service Kits

Part Number	Description
329202X	Indicator Switch Connector
328356-67X	Gasket & Seal Kit
328356-71X	Shifter Cover Seal Kit, Air Shift
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials



489GQAHX-A3GF

Item	Part Number	Description	Qty.
1	1-P-552X	Housing.....	1
2	2-P-559 ⁽¹⁾	Output Gear 24T.....	1
3	3-P-921X	Shaft Assembly, Greasable.....	1
4	5-P-1004 ⁽¹⁾	Input Gear 22T.....	1
5	5-P-965 ⁽¹⁾	Input Gear Ratio.....	1
6	9-P-88	Idler Shaft .75.....	1
7	14-P-73-1	Spacer .762" x 1.500" x .149 - .151".....	1 or
	14-P-73-2	Spacer .762" x 1.500" x .152 - .154".....	1 or
	14-P-73-3	Spacer .762" x 1.500" x .155 - .157".....	1
8	31-P-102	Thrust Washer .754" x .440" x .030".....	1
9	22-P-24-1	Gasket .010".....	A.R.
	22-P-24-2	Gasket .020".....	A.R.
	22-P-24-3	Gasket .015".....	A.R.
10	28-P-219	Oil Seal 2.506" x 1.625" x .375".....	1
11	28-P-268	Oil Seal 2.004" x 1.00" x .437".....	1
12	28-P-191	O-Ring .549" x .103".....	1
13	68-P-2	Name Plate.....	1
14	329088X	Flange Pump Assembly ("AF", "AW", "FF").....	1
15	328273X	Bearing Cap & Cup Assembly.....	1
16	378391	Lockring.....	2

A.R. – As Required

⁽¹⁾ See [Page 26](#) for other Gear Options

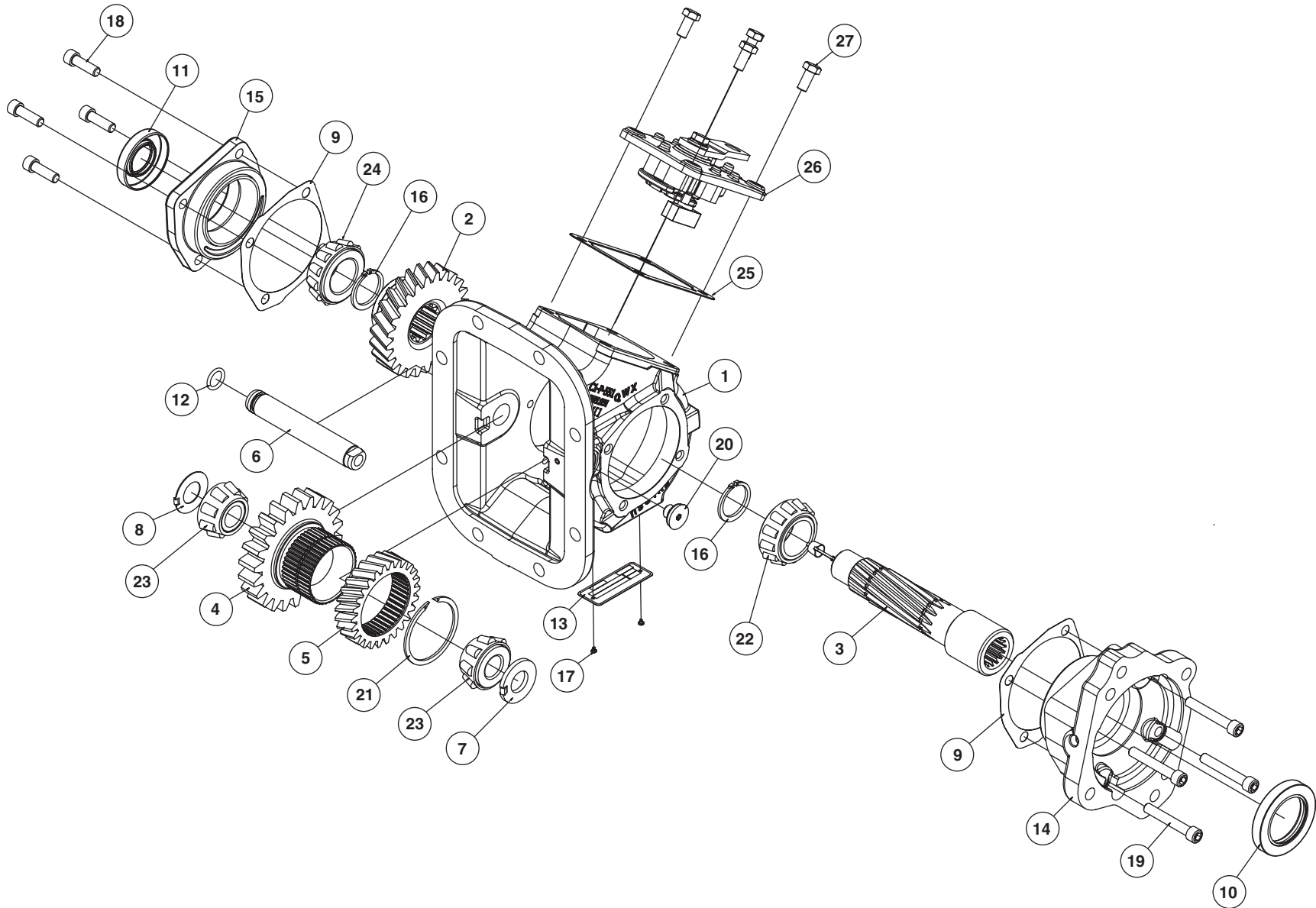
Item	Part Number	Description	Qty.
17	378422	Drive Screw.....	2
18	378447-6	Socket Head Capscrew .312" - 18 x 1.000".....	4
19	378447-10	Socket Head Capscrew .312" - 18 x 2.000".....	4
20	379672	Plug, O-Ring w/ Socket Face (NWD Plug).....	1
21	379522	Lockring.....	1
22	550397	Bearing Cone, Tapered 1.250" x .812".....	1
23	550439	Bearing Cone, Tapered .750" x .8598".....	2
24	550532	Bearing Cone, Tapered 1.1811" x .8125".....	1
25	35-P-8	Shifter Cover Gasket.....	1
26	329361X	Air Shift Assembly.....	1
27	378430-9	Hex Head Capscrew .312" - 18 x .875".....	4

See [Page 21 & 23](#) for more Air Shift information

Service Kits

Part Number	Description
329202X	Indicator Switch Connector
328356-67X	Gasket & Seal Kit
328356-71X	Shifter Cover Seal Kit, Air Shift
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials



Bill of Materials

**Service Manual
489 Series**

489GQAHX-W3GF

Item	Part Number	Description	Qty.
1	1-P-552X	Housing.....	1
2	2-P-559 ⁽¹⁾	Output Gear 24T.....	1
3	3-P-921X	Shaft Assembly, Greasable.....	1
4	5-P-1004 ⁽¹⁾	Input Gear 22T.....	1
5	5-P-965 ⁽¹⁾	Input Gear Ratio.....	1
6	9-P-88	Idler Shaft .750".....	1
7	14-P-73-1	Spacer .762" x 1.500" x .149 - .151".....	1 or
	14-P-73-2	Spacer .762" x 1.500" x .152 - .154".....	1 or
	14-P-73-3	Spacer .762" x 1.500" x .155 - .157".....	1
8	31-P-102	Thrust Washer .754" x .440" x .030".....	1
9	22-P-24-1	Gasket .010".....	A.R.
	22-P-24-2	Gasket .020".....	A.R.
	22-P-24-3	Gasket .015".....	A.R.
10	28-P-219	Oil Seal 2.506" x 1.625" x .375".....	1
11	28-P-268	Oil Seal 2.004" x 1.00" x .437".....	1
12	28-P-191	O-Ring .549" x .103".....	1
13	68-P-2	Name Plate.....	1
14	329088X	Pump Flange Assembly ("AF", "AW", "FF").....	1
15	328273X	Bearing Cap & Cup Assembly.....	1
16	378391	Lockring.....	2

A.R. – As Required

⁽¹⁾ See [Page 26](#) for other Gear Options

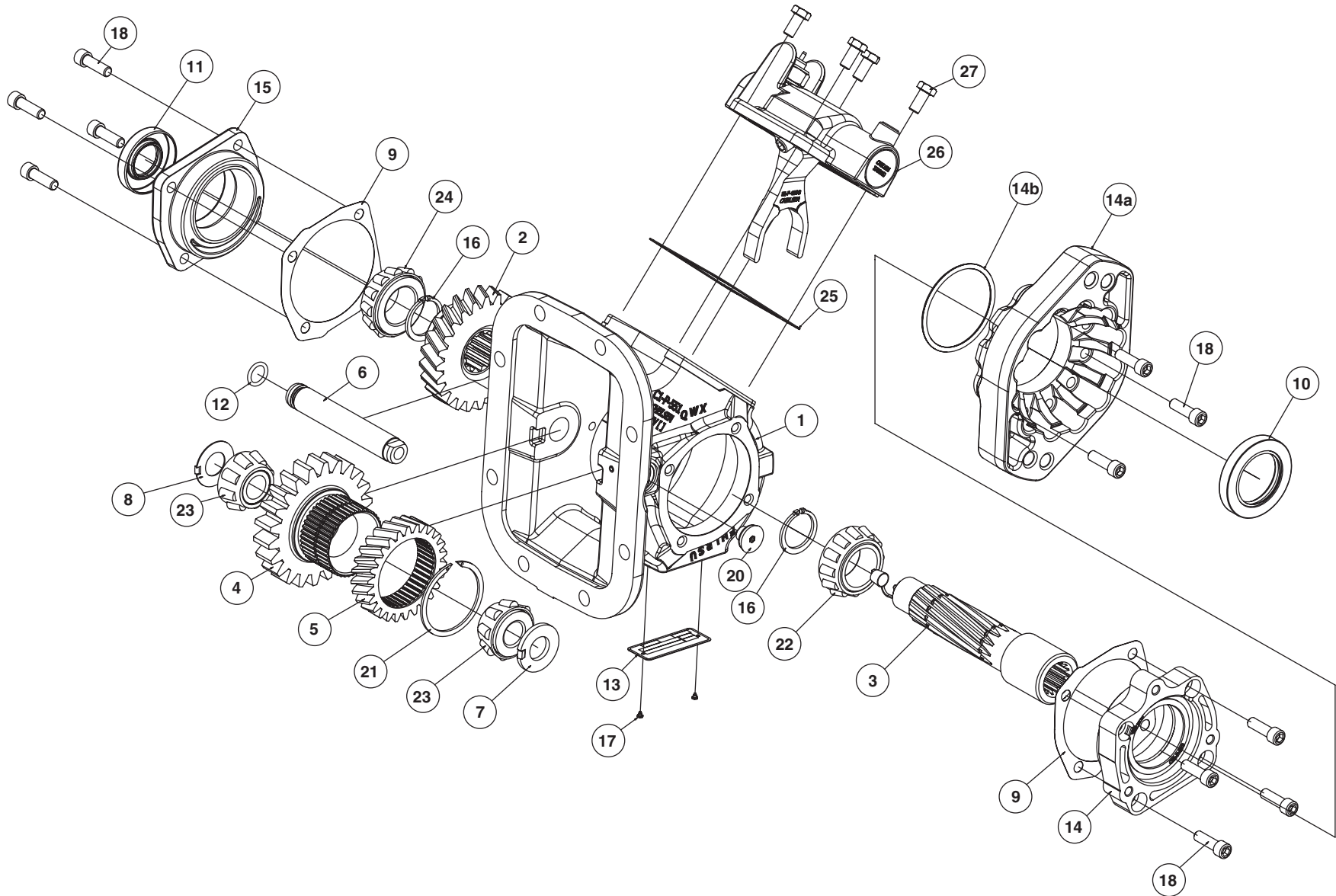
Item	Part Number	Description	Qty.
17	378422	Drive Screw.....	2
18	378447-6	Socket Head Capscrew .312" - 18 x 1.000".....	4
19	378447-10	Socket Head Capscrew .312" - 18 x 2.000".....	4
20	379672	Plug, O-Ring w/ Socket Face (NWD Plug).....	1
21	379522	Lockring.....	1
22	550397	Bearing Cone, Tapered 1.250" x .812".....	1
23	550439	Bearing Cone, Tapered .750" x .8598".....	2
24	550532	Bearing Cone, Tapered 1.1811" x .8125".....	1
25	35-P-8	Shifter Cover Gasket.....	1
26	329119-1X	Shifter Cover Assembly, Cable Control.....	1
27	378430-9	Hex Head Capscrew .312" - 18 x .875".....	4

See [Page 22](#) for more Shifter Cover Assembly information

Service Kits

Part Number	Description
329202X	Indicator Switch Connector
328356-15X	Shifter Cover Sealt Kit, Cable Control
328356-67X	Gasket & Seal Kit
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials



Bill of Materials

**Service Manual
489 Series**

489XQAHX-A3GH – Plus other 489’s with “G” or “H” Mounting, other ratios, “A” or “P” Shift Option with “3” Ass’y and “GH” Output

Item	Part Number	Description	Qty.	Item	Part Number	Description	Qty.
1	1-P-552X	Housing.....	1	17	378422	Drive Screw.....	2
2	2-P-559 ⁽¹⁾	Output Gear 24T.....	1	18	378447-6	Socket Head Capscrew .312" - 18 x 1.000".....	11
3	3-P-941X	Shaft Assembly, Greasable.....	1	20	379672	Plug, O-Ring w/ Socket Face (NWD Plug).....	1
4	5-P-1004 ⁽¹⁾	Input Gear 22T.....	1	21	379522	Lockring.....	1
5	5-P-965 ⁽¹⁾	Input Gear Ratio.....	1	22	550397	Bearing Cone, Tapered 1.250" x .812".....	1
6	9-P-88	Idler Shaft .750".....	1	23	550439	Bearing Cone, Tapered .750" x .8598".....	2
7	14-P-73-1	Spacer .762" x 1.500" x .149 - .151".....	1 or	24	550532	Bearing Cone, Tapered .1811" x .8125".....	1
	14-P-73-2	Spacer .762" x 1.500" x .152 - .154".....	1 or	25	35-P-8	Shifter Cover Gasket.....	1
	14-P-73-3	Spacer .762" x 1.500" x .155 - .157".....	1	26	329361X	Air Shift Assembly.....	1
8	31-P-102	Thrust Washer .754" x .440" x .030".....	1	27	378430-9	Hex Head Capscrew .312" - 18 x .875".....	4
9	22-P-24-1	Gasket .010".....	A.R.	See Page 21, 23 & 24 for more Air Shift information			
	22-P-24-2	Gasket .020".....	A.R.				
	22-P-24-3	Gasket .015".....	A.R.				
10	28-P-219	Oil Seal 2.506" x 1.625" x .375".....	1				
11	28-P-268	Oil Seal 2.004" x 1.00" x .437".....	1				
12	28-P-191	O-Ring .549" x .103".....	1				
13	68-P-2	Name Plate.....	1				
14	329264X	Bearing Cap Assembly (“GH”).....	1				
14a	21-P-626	Pump Flange (“GH”).....	1				
14b	28-P-271	O-Ring 2.482" x .143".....	1				
15	328273X	Bearing Cap & Cup Assembly.....	1				
16	378391	Lockring.....	2				

A.R. – As Required

⁽¹⁾ See [Page 26](#) for other Gear Options

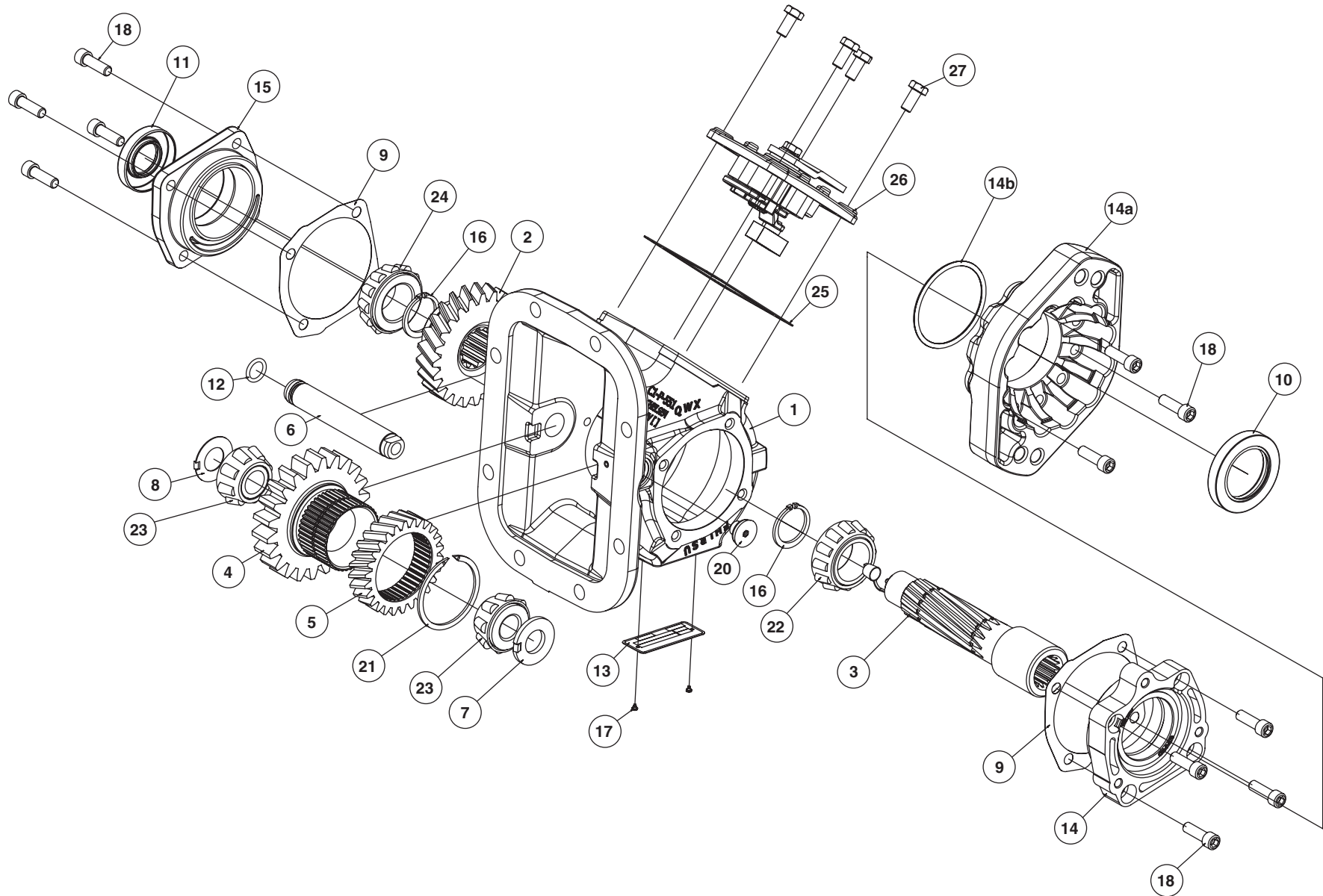
Stud Kits

Part Number	Description
328170-76X	Mounting Kit (“X” Mounting)
328170-77X	Mounting Kit (“G” Mounting)

Service Kits

Part Number	Description
329202X	Indicator Switch Connector
328356-67X	Gasket & Seal Kit
328356-71X	Shifter Cover Seal Kit, Air Shift
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials



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**Service Manual
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489XQAHX-W3GH

Item	Part Number	Description	Qty.
1	1-P-552X	Housing.....	1
2	2-P-559 ⁽¹⁾	Output Gear 24T.....	1
3	3-P-941X	Shaft Assembly, Greasable.....	1
4	5-P-1004 ⁽¹⁾	Input Gear 22T.....	1
5	5-P-965 ⁽¹⁾	Input Gear Ratio.....	1
6	9-P-88	Idler Shaft .75".....	1
7	14-P-73-1	Spacer .762" x 1.500" x .149" - .151".....	1 or
	14-P-73-2	Spacer .762" x 1.500" x .152" - .154".....	1 or
	14-P-73-3	Spacer .762" x 1.500" x .155" - .157".....	1
8	31-P-102	Thrust Washer .754" x .440" x .030".....	1
9	22-P-24-1	Gasket .010.....	A.R.
	22-P-24-2	Gasket .020.....	A.R.
	22-P-24-3	Gasket .015.....	A.R.
10	28-P-219	Oil Seal 2.506" x 1.625" x .375".....	1
11	28-P-268	Oil Seal 2.004" x 1.00" x .437".....	1
12	28-P-191	O-Ring .549" x .103".....	1
13	68-P-2	Name Plate.....	1
14	329264X	Bearing Cap Assembly ("RF").....	1
14a	21-P-626	Pump Flange Assembly ("RF").....	1
14b	28-P-271	O-Ring 2.482" x .143".....	1
15	328273X	Bearing Cap & Cup Assembly.....	1
16	378391	Lockring.....	2

A.R. – As Required

⁽¹⁾ See [Page 26](#) for other Gear Options

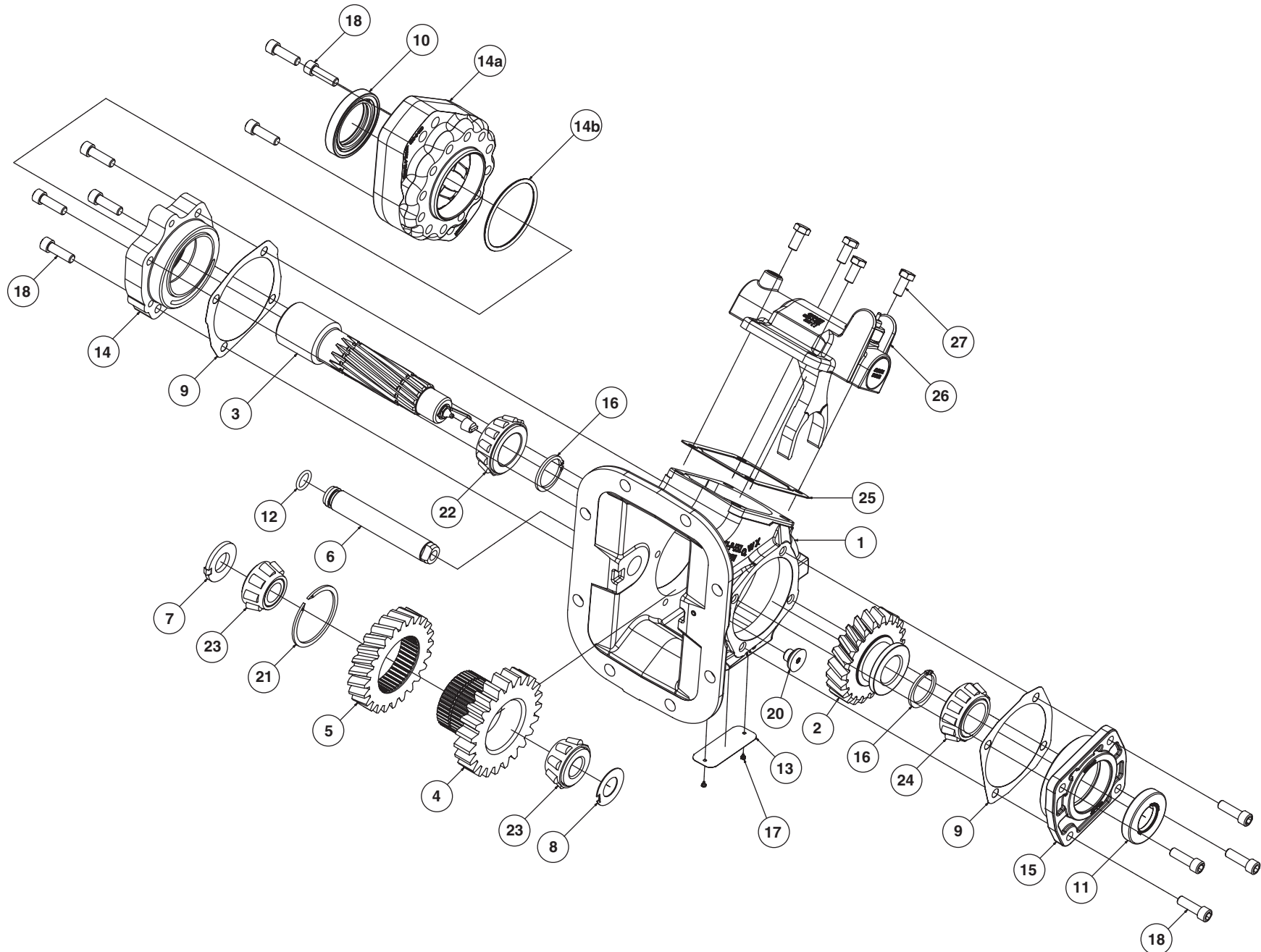
Item	Part Number	Description	Qty.
17	378422	Drive Screw.....	2
18	378447-6	Socket Head Capscrew .312" - 18 x 1.000".....	11
20	379672	Plug, O-Ring w/ Socket Face (NWD Plug).....	1
21	379522	Lockring.....	1
22	550397	Bearing Tapered Cone 1.250" x .812".....	1
23	550439	Bearing Tapered Cone .750" x .8598".....	2
24	550532	Bearing Tapered Cone 1.1811" x .8125".....	1
25	35-P-8	Shifter Cover Gasket.....	1
26	329119-1X	Shifter Cover Assembly, Cable Control.....	1
27	378430-9	Hex Head Capscrew .312" - 18 x .875".....	4

See [Page 22](#) for more Shifter Cover Assembly information

Service Kits

Part Number	Description
329202X	Indicator Switch Connector
328356-15X	Shifter Cover Seal Kit, Cable Control
328356-67X	Gasket & Seal Kit
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials



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489ZSDAX-P5GH

Item	Part Number	Description	Qty.
1	1-P-562X	Housing Assembly Deep Mount.....	1
2	2-P-637 ⁽¹⁾	Output Gear 22T.....	1
3	3-P-941X	Shaft Assembly, Greasable.....	1
4	5-P-1037 ⁽¹⁾	Input Gear 23T.....	1
5	5-P-966 ⁽¹⁾	Input Gear 24T.....	1
6	9-P-88	Idler Shaft .75".....	1
7	14-P-73-1	Spacer .762" x 1.500" x .149" - .151".....	1 or
	14-P-73-2	Spacer .762" x 1.500" x .152" - .154".....	1 or
	14-P-73-3	Spacer .762" x 1.500" x .155" - .157".....	1
8	31-P-102	Thrust Washer .754" x .440" x .030".....	1
9	22-P-24-1	Gasket .010.....	A.R.
	22-P-24-2	Gasket .020.....	A.R.
	22-P-24-3	Gasket .015.....	A.R.
10	28-P-219	Oil Seal 2.506" x 1.625" x .375".....	1
11	28-P-268	Oil Seal 2.004" x 1.00" x .437".....	1
12	28-P-191	O-Ring .549" x .103".....	1
13	68-P-51	Name Plate.....	1
14	329264X	Bearing Cap Assembly ("RF").....	1
14a	21-P-626	Flange Pump ("RF").....	1
14b	28-P-271	O-Ring 2.482" x .143".....	1
15	328273X	Bearing Cap & Cup Assembly.....	1

A.R. – As Required

⁽¹⁾ See [Page 26](#) for other Gear Options

Item	Part Number	Description	Qty.
16	378391	Lockring.....	2
17	378422	Drive Screw.....	2
18	378447-6	Socket Head Capscrew .312" - 18 x 1.000".....	11
20	379672	Plug, O-Ring w/ Socket Face (NWD Plug).....	1
21	379522	Lockring.....	1
22	550397	Bearing, Tapered Cone 1.250" x .812".....	1
23	550439	Bearing, Tapered Cone .750" x .8598".....	2
24	550532	Bearing, Tapered Cone 1.1811" x .8125".....	1
25	35-P-8	Shifter Cover Gasket.....	1
26	329361X	Air Shift Assembly.....	1
27	378430-9	Hex Head Capscrew .312" - 18 x .875".....	4

See [Page 21 & 24](#) for more Air Shift information

Service Kits

Part Number	Description
329202X	Indicator Switch Connector
328356-67X	Gasket & Seal Kit
328356-71X	Shifter Cover Seal Kit, Air Shift
328594-13X	Bearing and Spacer Kit, Non Pressure Lube

See [Page 36](#) for Kits Bill of Materials

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489 Series Disassembly

1. Observe and make notes
 - 1.1. Observe and note the Bearing Cap position.
 - 1.1.1. Note relation of closed end Bearing Cap (15) arrow to ratio letters on Housing (1).
 - 1.1.2. Note and mark Output Flange (14) (open end) to correct ratio on Housing (1).
 - 1.2. The Hub of the Output Gear (2) is positioned above the Input Gear (4).
 - 1.3. Observe and note the position of the Shift Fork (26).
 - 1.4. The Bearing Shims are on the same side as the Ratio Gear (7).
 - 1.5. Observe and note the Assembly Arrangement position.
 - 1.6. Ratio Gear (5) tooth round faces the Output Gear (2) not the Input Gear. (4)
 - 1.7. Do not reuse Snap Rings (16).
2. Disassembly
 - 2.1. Shifter Cover (26)
 - 2.1.1. Using a 1/2" socket remove the four bolts (27) on the Shifter Cover (26).
 - 2.1.2. Remove the Shifter Cover and the Gasket.
 - 2.1.3. Inspect the condition of the Gasket (25).
 - 2.2. Input Gear Section
 - 2.2.1. Remove the NWD plug (20) from the Idler Shaft (6) using a 3/16" Hex Wrench.
 - 2.2.2. Remove Idler Shaft (6) while holding the Input Gear section (4).
 - 2.2.3. Remove complete Input Gear section.
 - 2.2.4. Inspect Gears and Bearings.
 - 2.3. Closed End Bearing Cap (15)
 - 2.3.1. Remove the four Cap Screws (18) on the closed end Bearing Cap (15) using a 1/2" Hex Wrench.
 - 2.3.2. Remove the Bearing Cap (15) and Gaskets (9).
 - 2.3.3. Inspect condition of Gaskets (9) and keep together.
 - 2.4. Disassembly – Output (Open) End (14)

NOTE: To remove the Rotatable Flange option, remove the three Capscrews (18), Flange (14a) and O-Ring (14b).

 - 2.4.1. Using a 1/2" Hex Wrench remove the four (4) open end Hex Head Cap Screws. (18) or (19)
 - 2.4.2. Remove Open end Bearing (14) Cap and Gaskets (9).
 - 2.4.3. Inspect condition of Gaskets and keep together.
 - 2.5. Driveshaft Removal
 - 2.5.1. Using a Bearing Puller Set, remove the closed end Bearing (24) from the Output Shaft (3).
 - 2.5.2. Remove closed end Snap Ring (16) on the Output Shaft. DO NOT REUSE.
 - 2.5.3. Slide shaft (3) out of housing and remove the output gear (2).
 - 2.5.4. Inspect open end bearing (22) on shaft. Remove Snap Ring and press bearing off shaft if replacing.

Assembly

3. Assembly

3.1. Output Section

- 3.1.1 If output bearing (22) was removed press bearing onto shaft and install new Snap Ring (16).
- 3.1.2. Make sure the Output Gear (2) matches the correct Assembly Arrangement of the P.T.O.
- 3.1.3. The Output Gear (2) Shift Hub is positioned above the Input Gear (4) in the engaged position.
- 3.1.4. Slide Output Shaft (3) into Housing and slide Output Gear (2) onto the Shaft.
- 3.1.5. "U", "W" & "X" ratios will slide through the opening as an assembly.
- 3.1.6. Using a Snap Ring Slide or Snap Ring Pliers install the closed end Snap Ring (16) onto the Shaft.
- 3.1.7. Make sure that the Snap Ring (16) is seated into the groove on the Output Shaft (3).
- 3.1.8. Install Bearing (24) onto closed end.
- 3.1.9. Reminder: Make sure the Bearing (24) is seated against the Snap Ring. Forgetting to do this can affect shaft end play.
- 3.1.10. Install Gaskets (9).
- 3.1.11. Install closed end Bearing Cap (15). Make sure the offset of the Bearing Cap is positioned correctly for the P.T.O. Ratio.
- 3.1.12. Using 1/2" Hex Wrench tighten and torque Cap Screws to 24 - 28 Lbs. ft. [33 - 38 N.m.].
- 3.1.13. **NOTE:** Always use a crossing pattern when tightening bolts.
- 3.1.14. Using a seal slide, install Open End Cap/Pump Flange (14) and Gaskets (9) onto housing. Using a 1/2" hex wrench tighten and torque cap screws to 24-28 Lbs. ft. [33-38 Nm]
- 3.1.15. **NOTE:** The narrow portion of the open end Bearing Cap matches the position of the arrow on the closed cap.
- 3.1.16. If the P.T.O. has a rotatable flange, this can be installed at this time or when installing on the vehicle. See Chart on [page 25](#) for correct torque specifications.
- 3.1.17. Tighten and torque fasteners 24 - 28 Lbs. ft. [33 - 38 N.m.].
- 3.1.18. **NOTE:** Always use a crossing pattern when tightening the bolts.
- 3.1.19. Check end play is set correctly between .001" - .005".
- 3.1.20. Can the shaft be turned by hand?

3.2. Input Gear Section

- 3.2.1. Place the Ratio Gear (5) on the splined surface of the Input Gear (4).
- 3.2.2. **NOTE:** The rounded edge of the Ratio Gear (5) should be away from the Input Gear (4).
- 3.2.3. Use a Snap Ring Slide and Driver or Snap Ring Pliers to install the Snap Ring (21) in the groove of the Input Gear.
- 3.2.4. **NOTE:** Be careful to not over stretch the snap ring.
- 3.2.8. Insert the Thrust Washer (8) next to the Input Gear (4), Place Bearing shims (7) on the same side as the Ratio Gear (5).
- 3.2.9. **NOTE:** Tabs on washer and shims are placed in pocket on housing.
- 3.2.10. Note position of Output Gear (2) in the 'engaged' position.
- 3.2.11. Shifter hub should be over P.T.O. input gear.
- 3.2.12. Using a idler guide tool, insert complete input section into housing.
- 3.2.13. Install O-Ring (12) on Idler Shaft (6), be careful not to nick or cut the O-Ring.
- 3.2.14. Slide the notched end of the shaft (6) into the housing (1), aligning notch with roll pin.
- 3.2.15. Install NWD Plug (20) on Idler Shaft (6) and Torque: 120 - 156 in-lb. (13.56 - 17.53 N.m.)
- 3.2.16. Position Output Gear (2) in the disengaged position.
- 3.2.17. Position gasket and shift cover onto the P.T.O. housing.
- 3.2.18. Slide the shift block or Fork onto the hub of the output gear.
- 3.2.19. Install capscrews (27) and torque (16 - 20 Lbs. ft. [22 - 27 N.m.])
- 3.2.20. Do not over tighten you can break the shift cover or housing.
- 3.2.21. Last function test the shifter and indicator switch. (80 - 90 PSI).
See [page 31](#).
- 3.2.22. Place P.T.O. on flat surface and "spin" the input gear.
- 3.2.23. Gear should spin with-out lifting up housing.

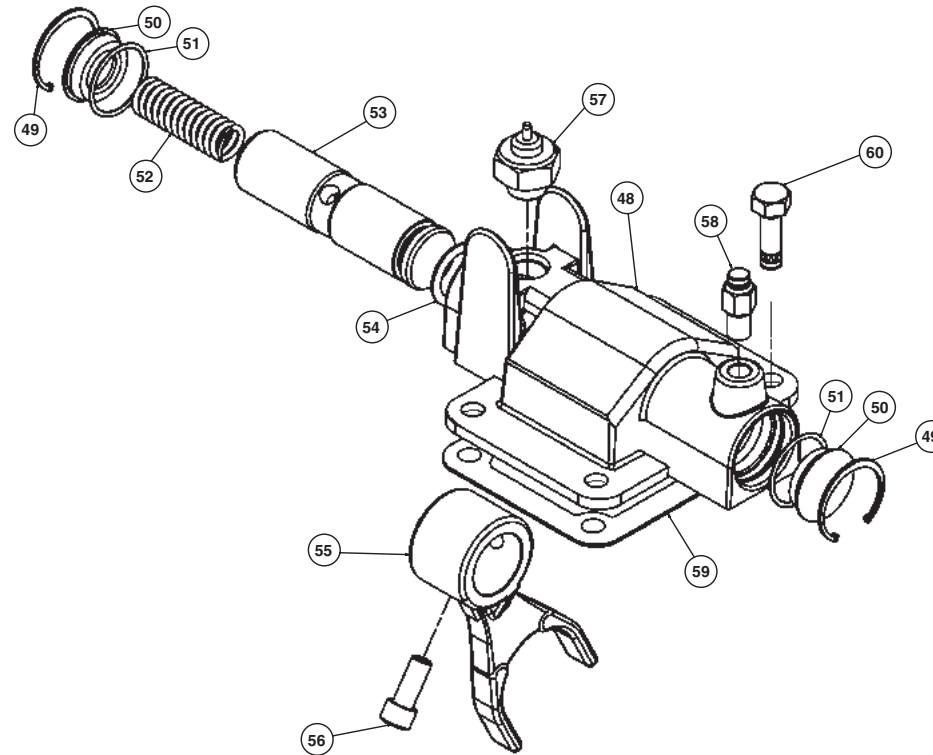
4. Final Check

- 4.1.1. Re-label P.T.O.
- 4.1.2. All Bolts & Cap screws proper Torque
- 4.1.3. Testing
- 4.1.4. Function Test Shifter
- 4.1.5. Test Indicator Switch
- 4.1.6. Check End Play of Output Shaft
- 4.1.7. Check Input Gear Bearings
- 4.1.8. Ready to install
- 4.1.9. Refer to [page 28](#) for installation instructions

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Air Shift Cover Assembly



Item	Part Number	Description	Qty.
	329361X	Air Shift Shifter Cover Assembly (Includes Items 48-57)	1
48	34-P-130	Shifter Cover	1
49	378316	Snap Ring	2
50	378315	Cover Plug	2
51	28-P-42	O-Ring	2
52	37-P-21	Shifter Spring	1
53	11-P-75	Shaft, Shifter	1
54	28-P-41	O-Ring	1
55	32-P-180	Shifter Fork	1
56	378447-4	Socket Head Capscrew, w/lockpatch .312" - 18 x .750"	1
57	379639	Indicator Switch (Normally OFF)	1
58	379904	Push Connect, for 1/4" tubing	1

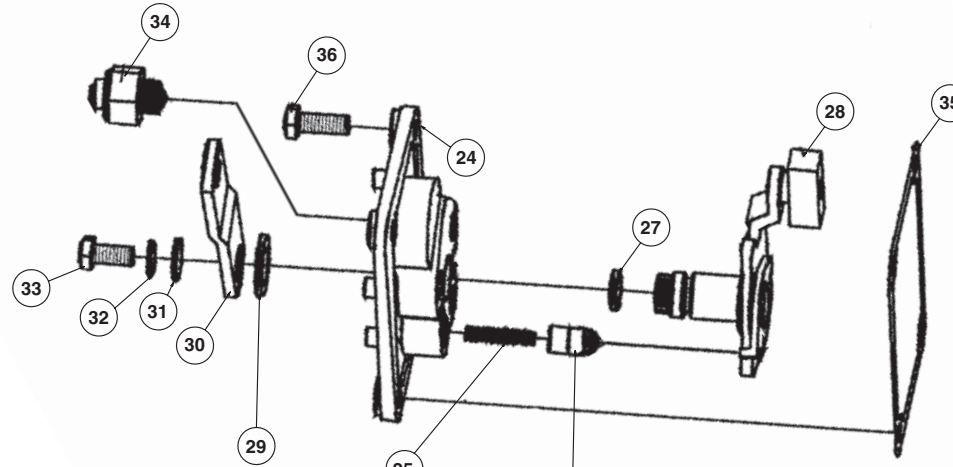
Item	Part Number	Description	Qty.
59	35-P-8	Gasket, Shifter Cover	1
60	378430-9	Hex Head Capscrew .312" - 18 x .875"	4
AIR SHIFT CONVERSION KITS			
	328390-117X	Lever or Cable to Air	1
	328390-119X	Lever or Cable to Electric/Air, 12V	1
	328390-120X	Lever or Cable to Electric/Air, 24V	1

Service Kit

Part Number	Description
328356-71X	Shifter Cover Sealt Kit, Air Shift

See [Page 36](#) for Kits Bill of Materials

Cable Control Assembly



Item	Part Number	Description	Qty.
24	34-P-39	Cover Plate, Shifter - Constant Mesh	1
	34-P-74	Cover Plate, Shifter	1
25	37-P-19	Spring	1
26	63-P-16	Poppet Pin	1
27	28-P-191	O-Ring	1
		Ratios "Q" & "W" & "X"	
28	329118-1X	Post and Plate Assembly, (Ass'y 3 & 6).....	1
28	329118-2X	Post and Plate Assembly, (Ass'y 4 & 5).....	1
		Ratios "F", "H", "L", "R", "S" & "U"	
28	329120-1X	Post and Plate Assembly, (Ass'y 3 & 6).....	1
28	329120-2X	Post and Plate Assembly, (Ass'y 4 & 5).....	1
		Ratios "A", "B" & "C"	
28	329265-1X	Post and Plate Assembly, (Ass'y 3 & 6).....	1
28	329265-2X	Post and Plate Assembly, (Ass'y 4 & 5).....	1
29	378004	Flat Washer	1
30	51-P-22	Shifter Lever	1
31	500365-22	Flat Washer	1
32	500356-10	Lockwasher	1
33	500409-6	Cap screw, Hex Head (.312" - 24 x .625").....	1
34	379639	Indicator Switch, Pin Style (Normally Off)	1
35	35-P-8	Gasket, Shifter Cover	1

P.T.O. Assembly Arrangement	P.T.O. Ratio Gear	Shifter Cover Assembly	Post & Plate Assembly
3 & 6	Q, W, X	329271-1X	329265-1X
4 & 5	Q, W, X	329271-2X	329265-2X
3 & 6	F, H, L, R, S & U	329121-1X	329120-1X
4 & 5	F, H, L, R, S & U	329121-2X	329120-2X
3 & 6	A, B & C	329119-1X	329118-1X
4 & 5	A, B & C	329119-2X	329118-2X

Correct shifter cover number is determined by the P.T.O. model number ratio & assembly designators.

442 X Q ES X - W 3 XK
 Ratio Assembly

Service Kits

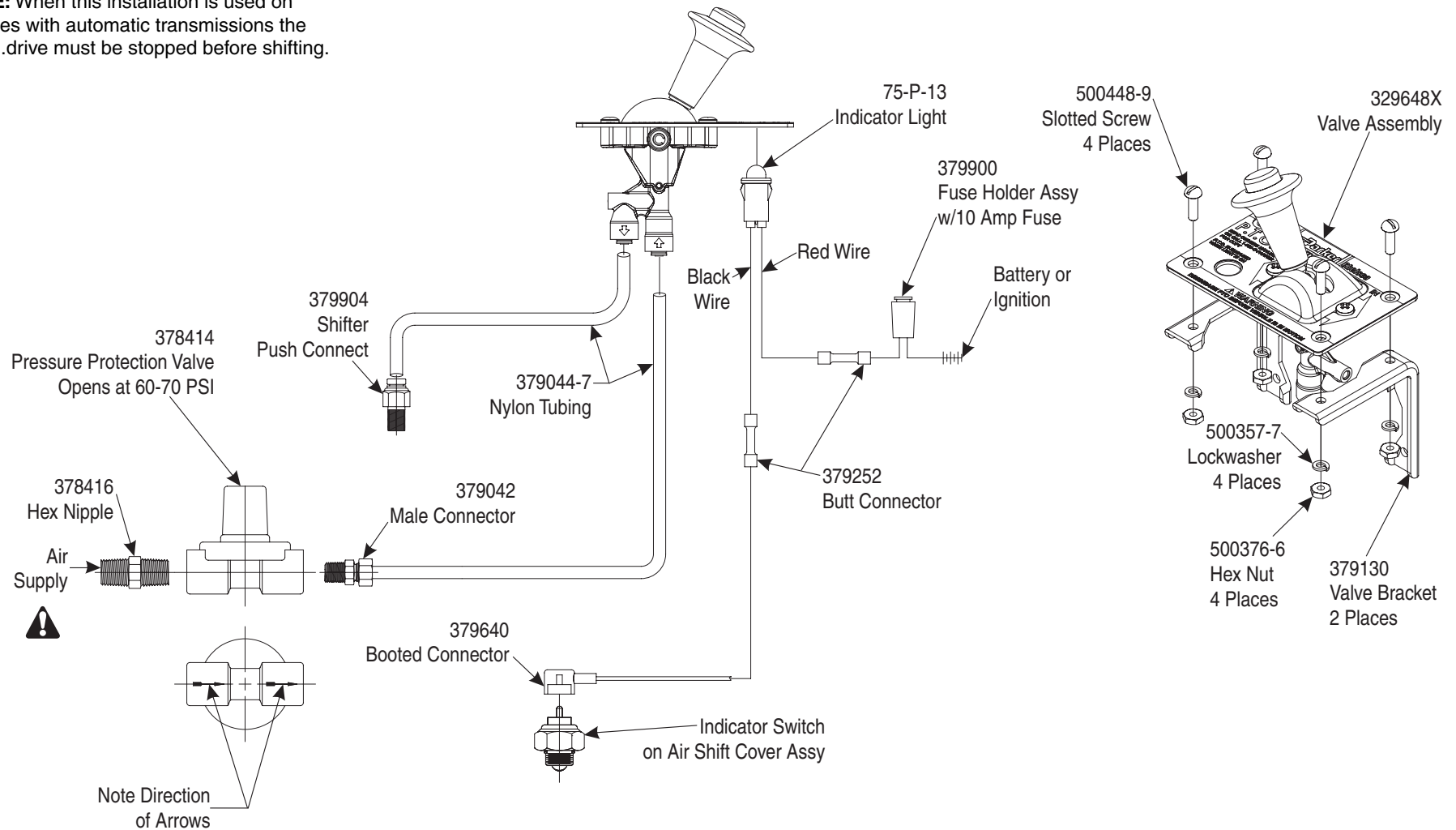
Part Number	Description
328356-15X	Shifter Cover Seal Kit, Cable Control
328356-69X	Shifter Cover Seal Kit, Cable Control "A", "B" & "C" Ratio

See [Page 36](#) for Kits Bill of Materials

Air Shifter Installation Sketch for (SK-462)

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.



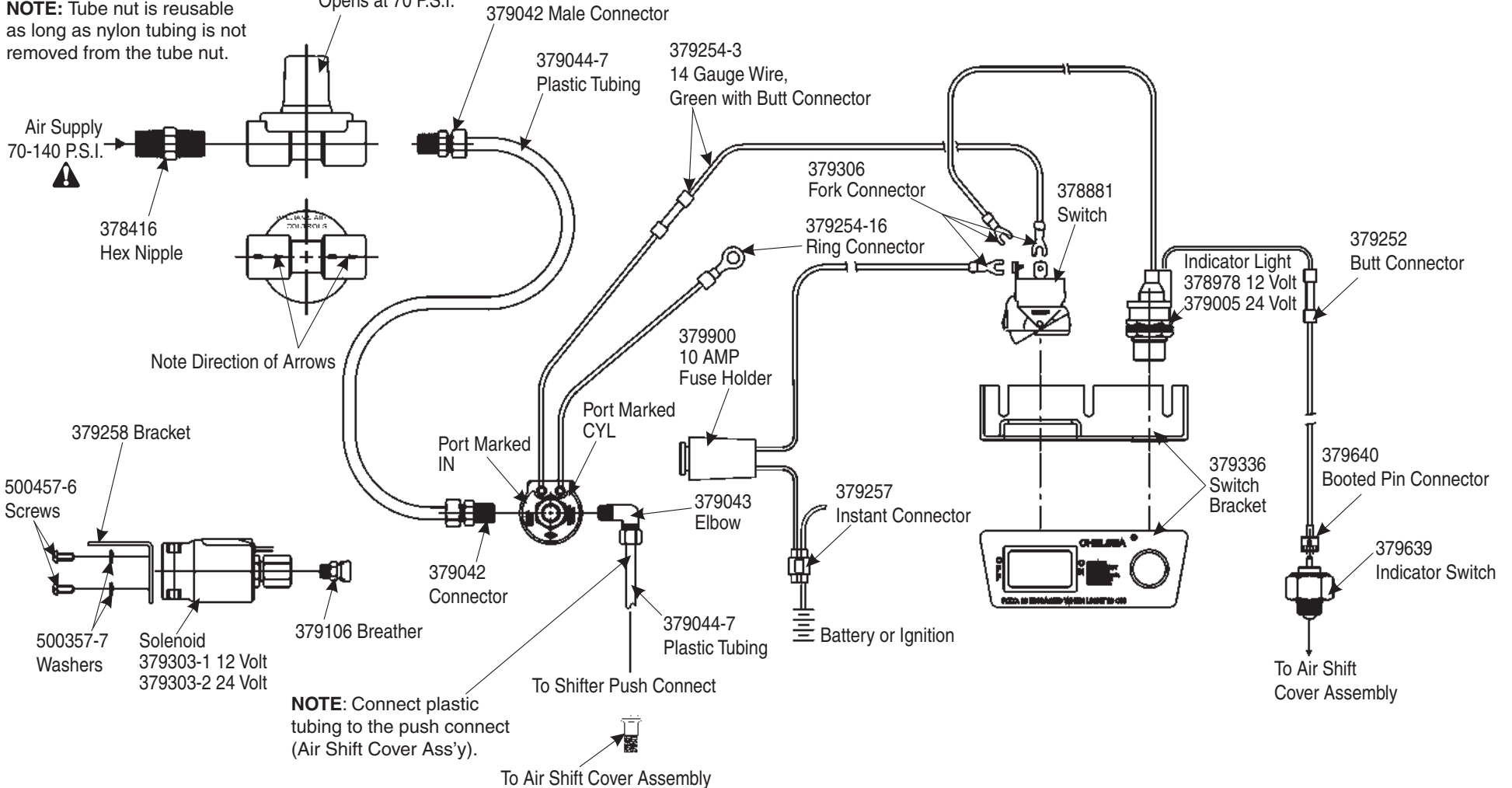
Warning: Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.
Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

Electric Over Air Shift Installation Sketch (SK-238 Rev H)

328388-47X - 12V Installation Kit
328388-48X - 24V Installation Kit

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

378414 Pressure Protection Valve Opens at 70 P.S.I.



Warning: Connect directly to air supply. Do not use tubing between air supply and 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 P.T.O. drive gear must be stopped before shifting.

Torque Chart**Service Manual
489 Series**

Location	Torque (English)	Torque (Metric)
NWD Plug	120 - 156 In. Lbs.	14 - 18 N.m.
Bearing Cap Closed/Open	24 - 28 Lbs. ft.	33 - 39 N.m.
Rotatable Flanges		
"GA", "GB", "PA", "PF", "RA", "RB", "RE" and "RF" (378447-6) (Qty. 3)	16 - 20 Lbs. ft.	22 - 27 N.m.
"RC", "RD", and "RH" (378446-4) (Qty. 6)	8 - 12 Lbs. ft.	11 - 16 N.m.
"RJ" (Qty. 6), and "RY" (Qty. 3) (379740-6)	35 - 40 Lbs. ft.	47 - 54 N.m.
Zerk Fitting – Greasable Shafts	Finger Tight - Plus Two (2) full turns with a wrench	
Shift Covers	16 - 20 Lbs. ft.	22 - 27 N.m.
Shaft Nut "XX" (501181)	75 - 85 Lbs. ft.	102 - 115 N.m.

Gear Chart

Service Manual
489 Series

Model Number	Gear Part Number	Gear Type	No. Teeth A Input Gear	No. Teeth Ratio Gear	No. Teeth Output Gear
489**AH	5-P-1004	SPUR	22		
489**DA	5-P-1037	SPUR	23		
Input Gears "A" Ratio Only					
489*AAH	5-P-1280	SPUR	22	14	
489*ADA	5-P-1284	SPUR	23	14	
Input Gears "B" Ratio Only					
489*BAH	5-P-1418	SPUR	22	14	
Input Gears "C" Ratio Only					
489*CAH	5-P-1287	SPUR	22	17	
489*CDA	5-P-1291	SPUR	23	17	
Input Gears "F" Ratio Only					
489*FAH	5-P-1077	SPUR	22	21	
489*FDA	5-P-1085	SPUR	23	21	
Input Gears "H" Ratio Only					
489*HAH	5-P-1364	SPUR	22	23	
489*HDA	5-P-1365	SPUR	23	23	
Input Ratio Gears					
489*L	5-P-964			25	
489*Q	5-P-965			19	
489*R	5-P-1214			22	
489*S	5-P-966			24	
489*U	5-P-967			26	
489*W	5-P-968			26	
489*X	5-P-969			38	
Output Gears					
489*A	2-P-791				39
489*B	2-P-833				39
489*C	2-P-792				37
489*F	2-P-726				37
489*H	2-P-802				35
489*L	2-P-727				34
489*Q	2-P-559				24
489*R	2-P-559				24
489*S	2-P-637				22
489*U	2-P-560				20
489*W	2-P-561				17
489*X	2-P-728				21

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Mounting the P.T.O. on the Transmission

- Place the correct number of gaskets over studs (Fig. 1). Do not use Permatex between gaskets because you may want to add or subtract gaskets to obtain proper backlash.
 - When mounting a P.T.O. use gaskets between all mounting surfaces.
 - Do not stack more than 3 gaskets together.
 - Usually one thick gasket .020 (.50mm) will be required.
 - Remember the lubricant in the transmission also lubricates the P.T.O. 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.
- Secure P.T.O. to the transmission.
 - Use Self Locking nuts provided with P.T.O. (Fig. 2).

NOTE: Self Locking nuts do not require lockwashers.

- Fasten the P.T.O. to the transmission (Fig. 3). Torque the set of locking nuts to their proper specifications.
 - 379745 7/16" - 20 for 8-Bolt applications 55 - 60 Lbs. ft. (7.59 - 8.28 kg meters)
 - Torque capscrews to their proper specifications.
 - 8-Bolt to 45 - 50 Lbs. ft. (6.22 - 6.91 kg meters)



Fig. 1

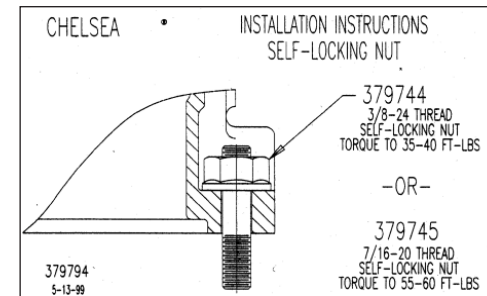


Fig. 2



Fig. 3

Checking Backlash

To check for proper backlash on P.T.O.s with shift cover

1. Remove the P.T.O. shift housing and/or inspection plate.
2. Mount the dial indicator so that it registers movement of the input gear (driven gear) of the P.T.O. (Fig. 10).

NOTE: See Figure 11 for proper location of dial indicator contact point. (Two common type dial indicators shown).

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

General rule: A Chelsea .010" gasket will change backlash approx. .006". A .020" gasket changes backlash approx. .012".
5. Replace the shift housing and/or inspection plate and retorque capscrews to 30-37 Lbs. ft. (41-50 N.m.).

NOTE: Apply a drop of Loctite 290 on each capscrew before reinstalling. Capscrews that are furnished with a conversion kit and are being installed for the first time do not require the drop of Loctite.

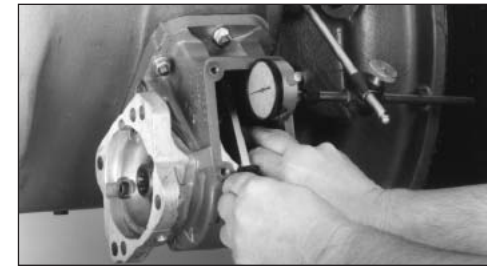


Fig. 10

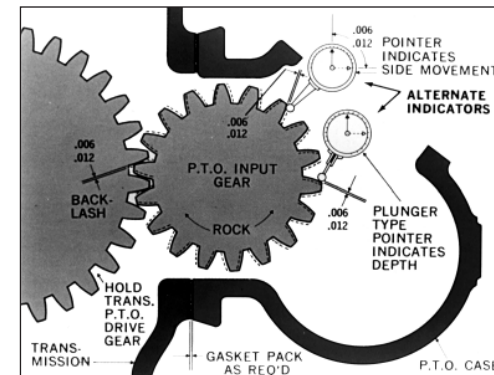


Fig. 11

Lubricant in Transmission/Inspect Installation

1. Remove the filler plug from the transmission and add recommended transmission lubricant to the level prescribed by the transmission or truck manufacturer (Fig. 12).

NOTE: If the P.T.O. is mounted below oil level, additional lubricant will be required.

2. Run the P.T.O. for 5-10 minutes and check for oil leaks and noise.
3. Should a quiet P.T.O. become noisy after the universal joint connection is made, check the P.T.O. driveline components for an out of phase condition, excessive or unequal joint angles or possibly worn parts in the driven accessory.
4. Re-torque all mounting bolts, nuts, cap screws and set up inspection routine of the P.T.O. driveline components and the driven auxiliary equipment.

NOTE: Anticipate slight increase in P.T.O. noise level as oil thins out at operating temperatures.

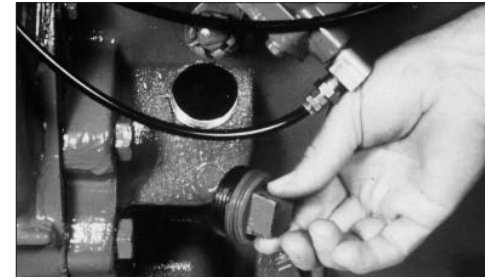


Fig. 12

Continuity Check 379639 and 379652 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 379639 or 379652 Indicator Switch.

Note: Make sure 379639 and 379652 Indicator Switches in the P.T.O. shifter or housing are torqued to 10 - 15 Lbs. ft. (1.38 - 2.07 kg meters).

2. With the other probe, make contact with the shifter cover or housing (Fig. 13).
3. Actuate shifting device and the meter or light* should be actuated when P.T.O. gear is engaged (Fig. 14).
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.

CAUTION: Indicator switches are capable of 0.5 amps maximum.

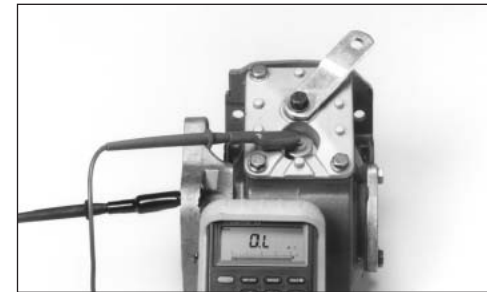


Fig. 13

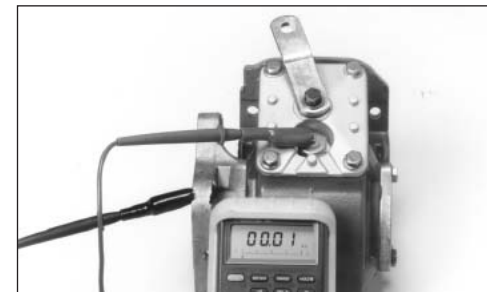
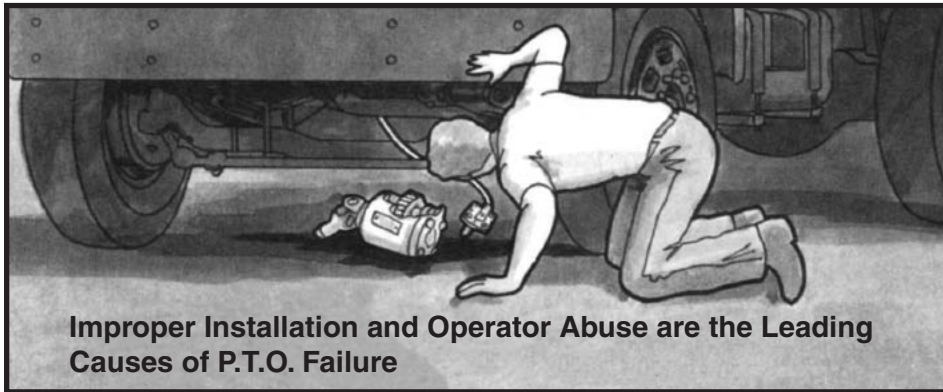


Fig. 14

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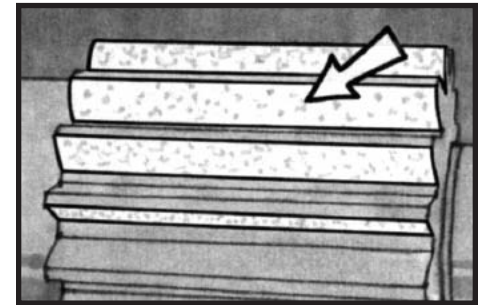
The Chelsea P.T.O. is designed and built to meet the rugged demands of the Mobile Equipment Industry. With proper use and maintenance, the Chelsea P.T.O. will provide a long service life, both on-highway and off. Yet, if a problem does arise, it is important to diagnose its causes and correct it at once.

The first place to look when troubleshooting a P.T.O. failure is in the application itself. Repeated or premature failure may be a sign of an incorrect application. This can be discovered by using the Chelsea HY25-3001/US General Information Catalog or HY25-3000/US Applications Catalog. Check to see if the proper P.T.O. was specified for the transmission, then find out if the torque handling capabilities of the P.T.O. are satisfactory for the job being done. A P.T.O. works best when it is properly specified for the transmission and job requirement.

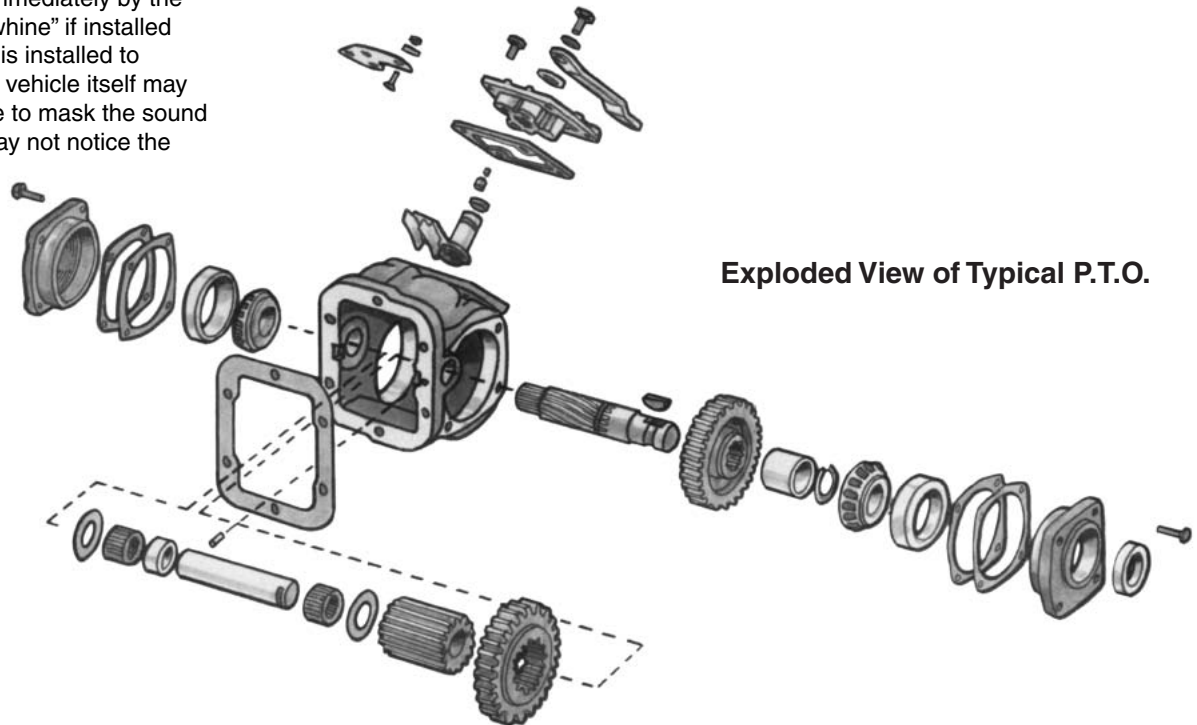
If the P.T.O. was correctly specified and then failed prematurely, there are two likely causes: improper installation and/or operator misuse. These are tough problems because they involve people as well as product. An improperly installed P.T.O. can normally be identified immediately by the sound it makes. It will “whine” if installed too tightly, or “clatter” if it is installed too loosely. Sometimes, the vehicle itself may contribute enough noise to mask the sound of the P.T.O. and one may not notice the problem.

If a problem is allowed to continue, then damage to the P.T.O. will result. A unit that has been mounted too loosely could result in broken gear teeth. A unit that is mounted too tightly could result in premature wear to the gear teeth. Also, when a P.T.O. is installed without enough filler blocks, spacers, or gaskets between it and the transmission, a deep wear pattern will occur on the gear teeth. These patterns will lead to fatigue and early tooth failure. To help prevent this from occurring, always test the P.T.O. for noise just after it is installed.

Whatever the reason for a P.T.O. failure, there will be confusion over who, or what, is at fault. More than likely the product will be blamed. Although the P.T.O. cannot defend itself, its failed parts will tell a story.



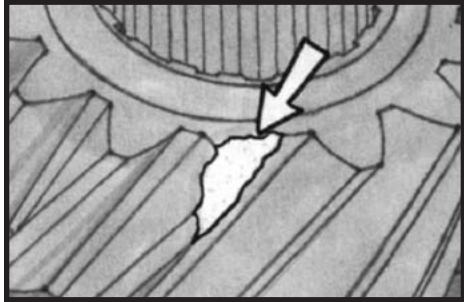
The first parts to inspect should be the gears. Check the surface of the gear teeth for signs of pitting . . . pitting is a normal wear pattern in most cases. However, contaminants in the oil or an installation that is too tight will cause severe pitting.



Exploded View of Typical P.T.O.

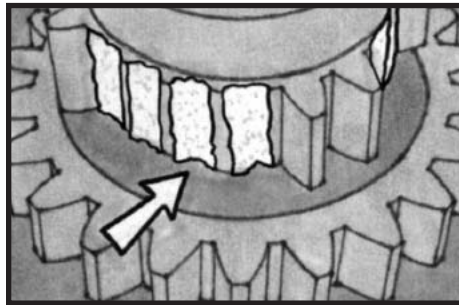
Troubleshooting

Once pitting of the gear surfaces has begun, there is nothing that can stop it. Severe pitting will eventually lead to gear tooth failure, therefore the damaged gear should be replaced when a P.T.O. is repaired or rebuilt.

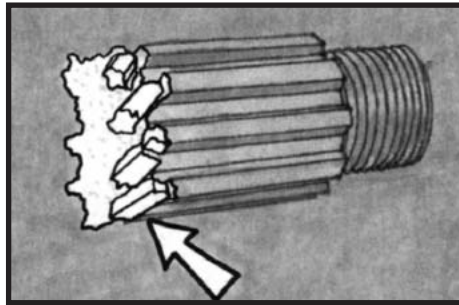


Sometimes a gear will chip a tooth because of mishandling or improper shifting. Even though a P.T.O. may continue to run with a chipped tooth, the damaged gear should be replaced immediately. It will damage the other teeth it comes in contact with during operation, not to mention the possible damage which could result from the loose chip. If the problem is allowed to continue, then failure to other parts in the P.T.O. or transmission could result.

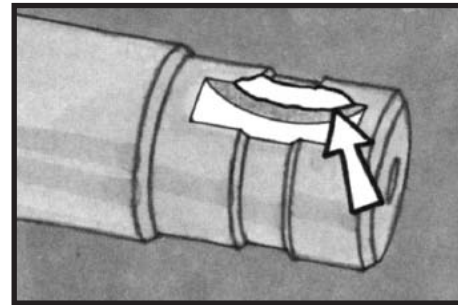
Another possible problem during vehicle operation is "shock load." This occurs when the torque demands on a P.T.O. are suddenly greater than it was designed to take. "Shock load" could be caused by torque overloads, improper shifting, equipment failure, or excessive loads over a short period of time. If this happens, the P.T.O. is likely to fail immediately. The vehicle operator may not even be aware of the reason for the P.T.O. failure.



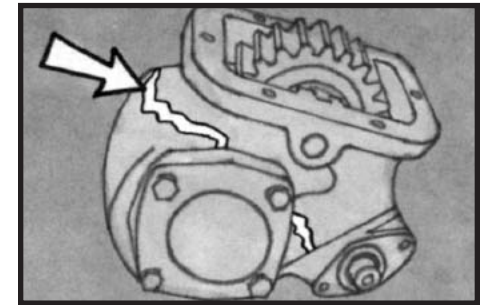
Worn gears can easily be affected by "shock load." If the worn gears are not replaced, they can eventually lead to broken gear teeth. This is the most severe form of P.T.O. failure. Worn or damaged gears are likely to break because of their reduced load carrying capacity. To prevent the possibility of broken gear teeth, always inspect auxiliary equipment for possible freeze-up. Also, recheck P.T.O. application, operating conditions and P.T.O. installation.



P.T.O. shafts are also vulnerable to operating abuse. If the shaft break is irregular, this usually indicates a torsional overload. Bending fatigue failure usually shows up as a smooth, flat break. To correct a P.T.O. shaft problem replace the failed shaft and check the speed and operating angle of the universal joint. Also, make sure the P.T.O. driveshaft is properly phased, (yokes in-line with each other). If a driveline is improperly installed it will cause vibration, which may lead to P.T.O. driveshaft or driven equipment problems.

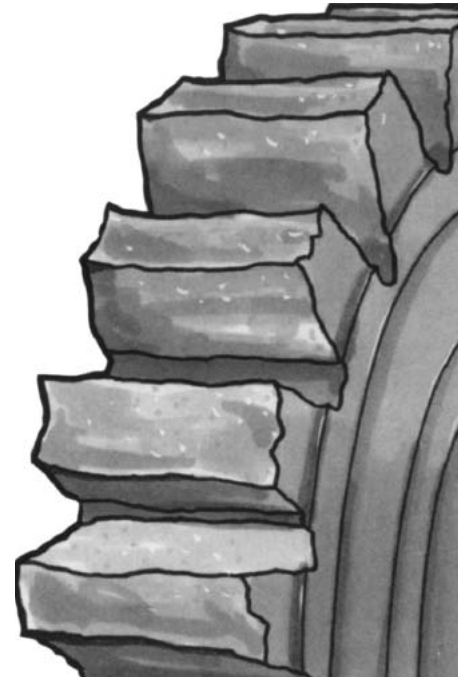


When inspecting a P.T.O. output shaft, always inspect the keyway. Sometimes a P.T.O. will fail because of a displaced keyway on the shaft caused by a loose fitting yoke or equipment freeze-up. Proper maintenance on auxiliary equipment and replacing a worn yoke and/or P.T.O. driven shaft will prevent this problem.

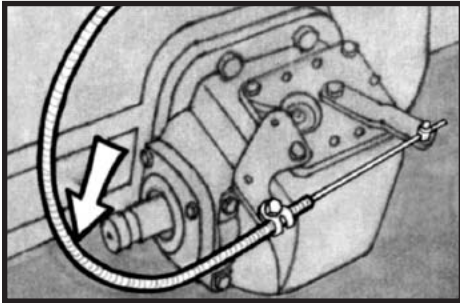


One of the most serious problems a P.T.O. can suffer is a cracked case. This condition can lead to oil loss and eventual transmission failure. Improper installation, poorly torqued bolts, or an unsupported direct mount pump can cause such a problem. A P.T.O. case can also be damaged by foreign objects meshing between the gear teeth, severe shock load, or even hitting an obstacle in the road.

Prevention is the best cure for P.T.O. case damage. Therefore, always torque the P.T.O. flange bolts in sequence and the proper specifications. Also, be sure to check the weight of the direct mount pump and, if it is over forty pounds, make a support bracket for it.

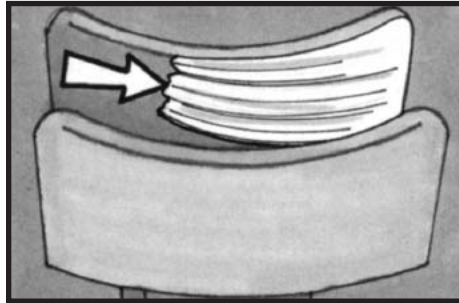


Deep Mesh Pattern Caused by Improper Backlash Adjustment

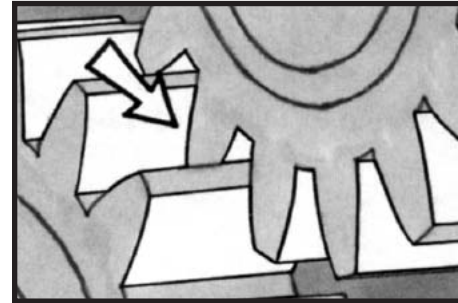


Shifting problems are sometimes a complaint an operator will have about his P.T.O. A P.T.O. that is hard to shift may be caused by a tight bend in the shifter cable, poor leverage, a gear that is installed backwards, or too tight of an installation. Many of these problems can be solved by inspecting the P.T.O. installation and making the proper adjustments regarding cable length, gear position, or shift lever.

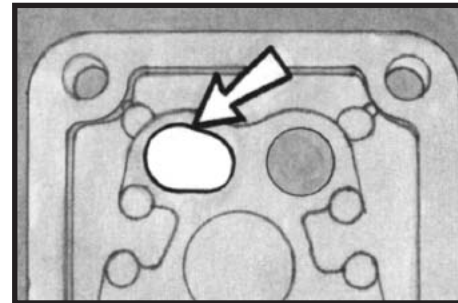
Remember, a lever-operated shift linkage should not be connected to a wire shift cover. The mechanical advantage of the lever is often too great for the wire shift cover and could severely damage it. Also inversely, don't use a cable with a lever shift cover. The cable isn't capable of transmitting the force necessary to shift a lever mechanism.



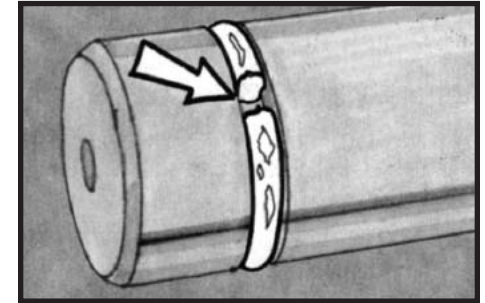
Most shifting complaints are caused by improper shifting procedure or incorrect linkage installation. Both of these situations will cause premature wear on the shift pad or fork and the shift rod or rail. To prevent this premature wear, avoid overshifting or undershifting the P.T.O. Overshifting causes the shifter fork to press against a P.T.O. gear during operation. This results in unnecessary friction and wear.



Undershifting allows incomplete gear tooth contact with the driver gear. This means only part of the tooth width is transmitting the torque and R.P.M. during P.T.O. operation. This situation can lead to gear failure or it could cause the P.T.O. to jump out of gear. These two problems can be overcome by checking linkage adjustments and proper operator training.



Shifting problems can also be caused by a worn or elongated shifter poppet hole. This causes the P.T.O. to jump out of gear and the parts in the shifter assembly to break or become loose. If this happens, replace those parts that are worn.



Seals and O-Rings may cause special problems in P.T.O. operations. Improper installation or heat build-up can cause O-Rings and seals to fail prematurely. Once seals or O-Rings fail, they should be replaced. The proper procedure for installing these parts is to lubricate them first so they will easily slide on the shaft.

Kits Bill of Materials

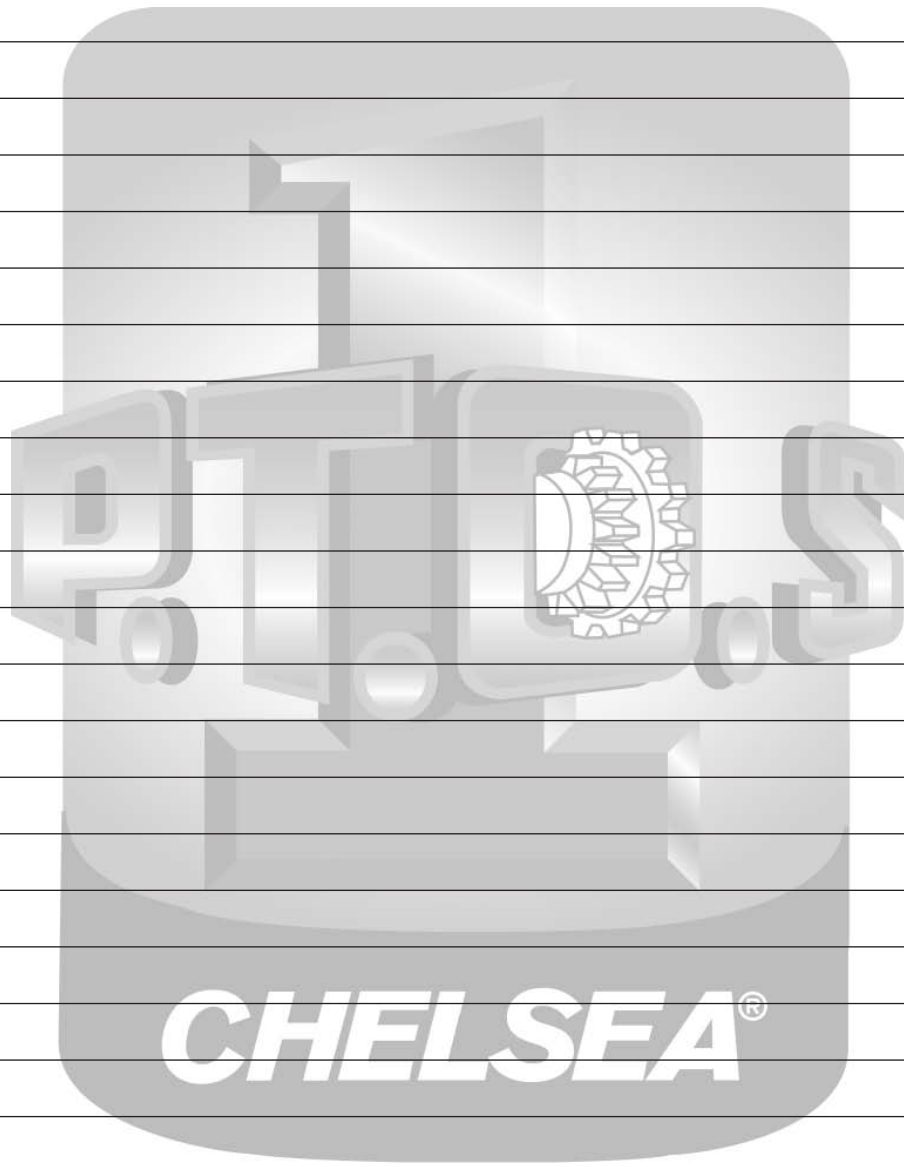
**Service Manual
489 Series**

328170-76X	Stud Kit, Standard	
379423-15	Stud .375".....	6
379744	Flange Nut.....	6
328170-77X	Stud Kit, Deep Mount	
379744	Flange Nut.....	3
378431-11	Hex Capscrew.....	3
379423-12	Stud .375".....	3
378774	Tablock Washer.....	3
329202X	Indicator Switch Connector Service Kit	
379252	Butt Connector.....	1
379639	Switch Indicator.....	1
379640	Booted Connector.....	1
328356-15X	Shifter Cover Seal Kit (Cable Control)	
22-P-69	Gasket.....	1
28-P-191	O-Ring.....	1
28-P-226	Oil Seal.....	1
35-P-8	Gasket, Shifter Cover.....	1
35-P-9-1	Gasket, Housing.....	2
35-P-9-2	Gasket, Housing.....	2
328356-67X	Gasket & Seal Kit	
22-P-127-1	Gasket, Bearing Cap.....	4
22-P-127-2	Gasket, Bearing Cap.....	4
22-P-127-3	Gasket, Bearing Cap.....	4
28-P-191	O-Ring.....	2
28-P-216	Oil Seal.....	1
35-P-8	Gasket, Shifter Cover.....	1
35-P-9-1	Gasket, Housing.....	2
35-P-9-2	Gasket, Housing.....	2

328356-69X	Shifter Cover Seal Kit (Cable Control "A", "B" & "C" Ratio)	
22-P-69	Gasket.....	1
28-P-191	O-Ring.....	1
28-P-226	Oil Seal.....	1
5-A-188	Spacer.....	1
35-P-9-1	Gasket, Housing.....	2
35-P-9-2	Gasket, Housing.....	2
328356-71X	Shifter Cover Seal Kit (Air Shift)	
28-P-41	O-Ring.....	1
28-P-42	O-Ring.....	2
378316	Retainer.....	2
35-P-8	Gasket, Shifter Cover.....	2
35-P-9-1	Gasket, Housing.....	1
35-P-9-2	Gasket, Housing.....	1
328594-13X	Bearing and Spacer Kit (Non-Pressure Lube)	
14-P-73-1	Spacer, Idler Gear (.149" - .151").....	1
14-P-73-2	Spacer, Idler Gear (.152" - .154").....	1
14-P-73-3	Spacer, Idler Gear (.155" - .157").....	1
28-P-191	O-Ring.....	1
31-P-102	Thrust Washer, Bearing.....	1
379672	NWD Plug.....	1
550439	Bearing.....	2
9-P-88	Shaft, Idler.....	1







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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 deferral 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.

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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, SERVING, 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) appointments 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.

02/12

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