BORG WARNER

Velvet Drive Marine Transmission Reduction Gear Service Manual 2.57:1 & 2.91:1 Ratios

Volvo gmb

Warner Gear

Division of Borg-Warner Corporation

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—IMPORTANT—

SERIES 10-17 AND 10-18 SERVICE INSTRUCTIONS

Practically all information which has been written for the 71C and 72C Velvet Drive transmissions applies to the 10-17 and 10-18 assemblies. Use the appropriate instructions given in the 71C and 72C service manuals when servicing the 10-17 and 10-18 transmissions. Use instructions given below for assembling the bearings and output shaft into the reduction housing.

Press two bearing cups into the reduction housing. Place rear bearing cone into the rear bearing cup. Press the oil seal into the reduction housing until rear face of oil seal is flush with rear face of bore in housing. Press the front bearing cone over output shaft and against face of shaft. Assemble the bearing sleeve over shaft and against cone. Lower the reduction housing over shaft components. Grease lips of oil seal and install the coupling and nut to the output shaft.

SUBJECT: FREEWHEELING VELVET DRIVE TRANSMISSIONS

It has been determined by tests and practical experiences that all Velvet Drive marine transmissions can be freewheeled without risking damage in sailing or trolling applications. Caution should be taken to be sure that proper oil level is maintained prior to freewheeling as well as normal running.

People who sail are divided on whether there is less drag or more drag when freewheeling the propeller while sailing. The main factors involved in this issue are the shape of the hull and the size and pitch of the propeller. Therefore, the individual sailboat operator should determine whether or not he desires to freewheel.

Freewheeling one propeller of a twin engine boat at trolling speeds will not cause damage to the transmission connected to the freewheeling propeller.

Our service and installation manuals are not in agreement with our current position on freewheeling. The manuals will be revised to agree with this bulletin as they are reprinted.

CHART COMPARING NEW MODELS TO EARLY MODELS

NEW TRANSMISSION ASSEMBLY NUMBER	TEN DIGIT NUMBER FOR ORIGINAL TRANSMISSION	ORIGINAL TRANSMISSION ASSEMBLY NUMBER	INPUT TO OUTPUT SPEED RATIO		ROTATION (1)			PUMP ARROW POINTS (2)	PROP. REQ'D. (3)
			FWD.	REV.	INPUT SHAFT	Output Shaft FWD.	Output Shaft REV.		
10-17-000-011	10-04-000-046	AS14-71C	2.57:1	2.57:1	CW	CW	CCW	←	RH
10-17-000-012	10-04-000-047	AS14-71CR	2.57:1	2.57:1	CCW	CCW	CW	→	LH
10-17-000-013	10-04-000-048	AS15-71C	2.91:1	2.91:1	CW	CW	CCW	→	RH
10-17-000-014	10-04-000-049	AS15-71CR	2.91:1	2.91:1	CCW	CCW	CW	←	LH
10-18-000-009	10-05-000-042	AS14-72C	2.57:1	2.83:1	CW	CW	CCW	←	RH
10-18-000-010	10-05-000-043	AS14-72CR	2.57:1	2.83:1	CCW	CCW	CW	→	LH
10-18-000-011	10-05-000-044	AS15-72C	2.91:1	3.20:1	CW	CW	CCW	→	RH
10-18-000-012	10-05-000-045	AS15-72CR	2.91:1	3.20:1	CCW	CCW	CW	←	LH

(1) Input and output shaft rotation is described as clockwise (CW) or counter clockwise (CCW) when the observer is standing behind transmission coupling facing towards front or input shaft end of transmission.

(2) Pump rotation is described when the observer is standing in front of transmission facing the pump. The arrow located nearest the top of pump face must point in the direction pump will be driven by the input shaft. IT SHOULD BE REALIZED THAT INDEXING THE PUMP FOR OPPOSITE ROTATION DOES NOT CAUSE OUTPUT SHAFT ROTATION TO BE REVERESED, but does permit the transmission to be used behind an opposite rotating engine.

CAUTION: The pump indexing on all assemblies except 2.10:1 reduction units is the only difference between C and CR units. The planetary gears and cage assembly used in C units is different than the one used in CR units in the 2.10:1 reduction units; therefore, indexing the pump for opposite roation is not permitted on these assemblies. **No warranty claims will be allowed for failures caused by improper pump inexing on 2.10:1 reduction units.**

(3) The propeller is desribed when the observer is standing behind the boat looking forward. A right hand (RH) prop. will move the boat forward when rotated clockwise.

The forward and reversing portion of the reduction units of the 10-17 and 10-18 units is the same as the 71C and 72C units which they replaced. The reduction portion of the 10-17 and 10-18 units was changed to include a compression sleeve between the two tapered bearing components. Tightening the coupling nut causes the sleeve to be compressed, allowing the tapered bearing to be preloaded. A bearing retainer is not used and the rear oil seal is pressed into the reduction housing.

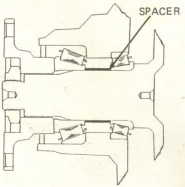
Subject: Solid Bearing Spacer now Available for Servicing Models 10-17 and 10-18 Velvet Drive Reduction Units.

CHART SHOWING THICKNESS OF NEW SPACERS

PART NUMBER	LENGTH		COLOR CODE
	INCHES	MILLIMETERS	
10-17-053-002	.820-.821	20.83-20-85	None
10-17-053-003	.829-.830	21.06-21.08	Light Green
10-17-053-004	.832-.833	21.13-21.16	Light Blue
10-17-053-005	.835-.836	21.21-21.23	White
10-17-053-006	.838-.839	21.29-21.31	Brown
10-17-053-007	.841-.842	21.36-21.39	Pink
10-17-053-008	.844-.845	21.44-21.46	Purple
10-17-053-009	.847-.848	21.51-21.54	Gray
10-17-053-010	.850-.851	21.59-21.62	Orange

One of the new solid bearing spacers is assembled between the two Timken bearing cones as shown in the figure. The length of the spacer must be selected to obtain .000-.005 inch (0.00-0.13 mm) end play of the output shaft. One method which may be used to select the length of the spacer is to first install the longest solid spacer. This will provide too much end play. Measure the end play of the output shaft and then select and install a shorter spacer to reduce the end play to the specified amount.

The collapsible spacer described in Marine Bulletin 27 will usually expand approximately .004 inch (0.1 mm) when removed from the unit. A solid spacer which is approximately the same length but not more than .001 inch (0.03 mm) longer or .003 (0.07 mm) shorter than the original collapsible spacer should provide end play which will be within the specified range.



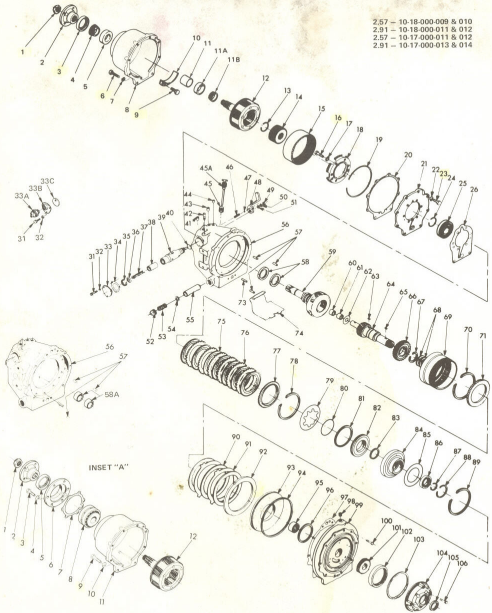
SUBJECT: SEALING RINGS ADDED TO ALL IN-LINE AND V-DRIVE ASSEMBLIES

All Velvet Drive In-Line and V-Drive assemblies have been changed to use four 4806B cast iron sealing rings. New pinion cage and output shaft assemblies having four ring grooves for the rings will be used in the forward and reverse portion of these assemblies.

The two bushings, which were pressed into the 1.989-1.990" (50.5-50.55 mm) bore at the rear of the forward and reverese transmission case are no longer required and will be removed. The case bore size will be changed to 2.000-2.001" (50.8-50.83 mm) diameter to accommodate the new sealing rings. Early units may be updated by using all three new parts as required.

Trans. Assy.	Old Case	New Case	Old Shaft	New Shaft
10-17-000-011	71-A1K	10-17-565-002	71-1A2C	10-17-659-018
10-17-000-012	71-A1K	10-17-565-002	71-1A2C	10-17-659-018
10-17-000-013	71-A1K	10-17-565-002	71-1A2C	10-17-659-018
10-17-000-014	71-A1K	10-17-565-002	71-1A2C	10-17-659-018
10-18-000-009	72-A1K	10-18-565-002	72-1A2C	10-18-659-012
10-18-000-010	72-A1K	10-18-565-002	72-1A2C	10-18-659-012
10-18-000-011	72-A1K	10-18-565-002	72-1A2C	10-18-659-012
10-18-000-012	72-A1K	10-18-565-002	72-1A2C	10-18-659-012

2.57 – 10-18-000-009 & 010
2.91 – 10-18-000-011 & 012
2.57 – 10-17-000-011 & 012
2.91 – 10-17-000-013 & 014



10-18-000-011 ILLUSTRATED

2.57 & 2.91:1.00 PARTS LIST

INDEX NO.	W.G. PART NO.	DESCRIPTION	NO. REQ.
1	10-00-148-034	Mainshaft Nut - Flanged	1
2	10-00-131-001	Coupling	1
3	10-00-131-002	Oil Seal	1
4	10-00-133-002	Bearing Cone	1
5	10-00-133-001	Bearing Cup	1
6	000017984	7/16-14 x 1-3/4 Hex Head Bolt	2
7	000010322	7/16 Lockwasher	2
8	10-17-065-001	Reduction Housing	1
9	47768	7/16-14 x 7/8 Hex Lock Bolt	2
10	10-17-036-001	Oil Baffle	1
11	10-17-053-002	Solid Spacer - .825-.821" (20.83-20.85 mm)	1
	10-17-053-002	Solid Spacer - .829-.830" (21.06-21.08 mm)	*
	10-17-053-004	Solid Spacer - .831-.832" (21.13-21.15 mm)	*
	10-17-053-005	Solid Spacer - .835-.836" (21.21-21.23 mm)	*
	10-17-053-006	Solid Spacer - .838-.839" (21.29-21.31 mm)	*
	10-17-053-007	Solid Spacer - .841-.842" (21.36-21.39 mm)	*
	10-17-053-008	Solid Spacer - .844-.845" (21.44-21.46 mm)	*
	10-17-053-009	Solid Spacer - .847-.848" (21.51-21.54 mm)	*
	10-17-053-010	Solid Spacer - .850-.851" (21.59-21.62 mm)	*
		*Use as required on 10-17 to 10-18 units--may be used to replace the 10-17-053-001 spacer	
11A	10-00-133-009	Bearing Cup (1.75 mm)	1
11B	10-00-133-010	Bearing Cone (1.75 mm)	1
12	10-17-659-007	Pinion Cage & Output Shaft (2.57 units)	1
	10-17-659-008	Pinion Cage & Output Shaft (2.91 units)	1
13	4734	Snap Ring	1
14	LA-14	Sun Gear (2.57 units)	1
	LA-104	Sun Gear (2.91 units)	1
15	L3-6	Ring Gear (2.91 units)	1
16	J-6-5	Ring Gear (2.57 units)	1
17	4833E	Lock Bolt	8
18	000011555G	7/16 Lockwasher	6
19	L6-31	Stationary Gear Plate (2.57 units)	1
	FJ-31	Stationary Gear Plate (2.91 units)	1
19	4756E	Snap Ring (2.57 units)	1
	4756	Snap Ring (2.91 units)	1
20	L4-146	Adapter Gasket - Rear	1
21	62-84	Reduction Unit Adapter	1
22	000103321	3/8 Lockwasher	6
23	000017880	3/8-16 x 1-1/4 Hex Head Bolt	6
24	4816	Snap Ring	1
25	8308AGS	Annular Bearing	1
26	L4-146	Adapter Gasket - Front	1
27	000017793	1/4-20 x 1-3/4 Hex Head Bolt (for valve cover)	3
	000017796	1/4-20 x 7/8 Hex Head Bolt (for neutral switch)	3
32	000010313	1/4 Lockwasher	3
33	71-41	Valve Cover	1
33A	10-06-840-006	Neutral Switch Assembly (Note items 33B & 33A must be used together when replacing early switch)	1
N.I.	10-00-141-046	"O" Ring for Switch	1
33B	10-16-039-001	Valve Cover	1
33C	10-16-099-001	Switch Cam	1
34	71-14	Valve Cover Gasket	1
35	4821	Snap Ring	1
36	71-246	Valve Cover Retainer	1
37	71-242	Spring	1
38	71-243	Pressure Regulator Valve	1
	71-A244A	Valve & Spring Assembly	1
39	71-244A	Forward & Reverse Shift Valve	1
40	4804H	"O" Ring	1
41	10-00-131-002	35 Plastic Shipping Plug	1
42	A4760Q	Breather - Current	1
	A7409	Breather - Early Units-Drive In	1
	AJ2-87	Breather - Early Units-Screw In	1
43	000064866	3/8-18 Pipe Plug	1
44	000044687	1/8-27 Pipe Plug	1
45	10-04-526-002	Dipstick Tube	1
45A	10-04-559-001	Dipstick (used with tube)	1
	10-04-526-001	Dipstick (tube not required)	1
46	71-42	Poppet Spring	1
47	000045233G	5/16 Steel Ball	1
48	71-798	Forward & Reverse Shift Lever	1
49	000011579	5/16-24 Hex Nut	1
50	000010879	5/16 Lockwasher	1
51	000010340	Control Lever Washer	1
52	4885B	Bushing	1
53	4-52	Spring	1
54	35-143	Flat Washer	1
55	72C-39	Oil Inlet Shield	1
56	72-A1K	Trans. Case With Bushings (72C & 10-18)	1
	72-A1L	Trans. Case With Bushings (10-17 & 10-17)	1
	71-A1L	Trans. Case With Bushings (70C)	1
	10-18-565-003	Trans. Case Without Bushings (10-18)	1
	10-17-565-003	Trans. Case Without Bushings (10-17)	1
57	71-87	Dowel Pin (70C with fiber plates)	3
	71-87A	Dowel Pin (70C with metallic plate)	3
	86-17	Dowel Pin (72C & 10-17)	3
	4622E	Dowel Pin (72C & 10-18)	3
58	4808E	Sealing Washer (10-17 & 10-18)	1
58A	A4867VV	Two Preazed Bushings (See insert "B")	1
59	71-182	Pinion Cage & Output Shaft (70C, 71C & 10-17)	1
	72-1A2C	Pinion Cage & Output Shaft (72C & 10-18)	1
	71-182-010	Pinion Cage & Output Shaft (10-17 with seal rings)	1

INDEX NO.	W.G. PART NO.	DESCRIPTION	NO. REQ.
	10-18-565-012	Pinion Cage & Output Shaft (10-18 with seal rings)	1
60	A4867DD	Two Preazed Bushings in Kit-one kit for current unit - two for early units	1
61	71-17	Thrust Washer	1
63	000012453	Woodruff Key (72C & 10-18)	1
63	000021811	Woodruff Key (70C, 71C & 10-17)	1
64	72C-2A14	Drive Gear & Plug Assy. (72C & 10-18)	1
	71C-3A16	Drive Gear & Plug Assy. (70C, 71C & 10-17)	1
65	4917	Woodruff Key	1
66	10-16-179-001	Forward Clutch Hub (72C & 10-18)	1
	71-40	Forward Clutch Hub (70C, 71C & 10-17)	1
67	4493	Snap Ring	1
68	4803E	Sealing Ring	1
69	72-6	Ring Gear (72C & 10-18)	1
	71-6	Ring Gear (70C, 71C & 10-17)	1
		SELECTIVE SNAP RINGS FOR 72C & 10-18	
	4768	.050-.052" (1.27-1.32 mm) Yellow	*
	4768A	.074-.076" (1.88-1.94 mm) Blue	*
	4768B	.098-.100" (2.49-2.54 mm) White	*
	10-00-139-018	.092-.094" (2.34-2.39 mm) Pink	*
		SELECTIVE SNAP RINGS FOR MC & 10-17	
	10-00-139-048	.033-.037" (0.84-0.94 mm) Yellow	*
	10-00-139-049	.045-.049" (1.14-1.24 mm) Pink	*
71	SL-87	Clutch Pressure Plate	1
72	71-97	Clutch Pressure Plate Spring	11
74	71-140	Oil Baffle	1
75	12-A66	Clutch Friction Plate (72C & 10-18)	7
		Clutch Friction Plate (71C & 10-17)	5
		Clutch Friction Plate (70C)	3
	5C-A66A	Bronze Clutch Plate (must be used optionally for 12-A66)	1
76	3-176	Steel Clutch Plate (72C & 10-18).	6
		Steel Clutch Plate (71C & 10-17)	4
		Steel Clutch Plate (70C)	2
77	5C-175A	Clutch Pressure Plate	1
78	4795	Clutch Spring Retainer	1
79	3-37	Clutch Spring	1
80	5C-33	Clutch Bearing Bearing Ring	1
81	5L-34	Clutch Bearing Ring	1
82	10-16-124-001	Clutch Piston	1
83	5M-127	Sealing Ring	1
84	72-72	Forward Clutch Cylinder (72C & 10-18)	1
	71-20	Forward Clutch Cylinder (71C & 10-17)	1
85	71-18B	Thrust Washer	1
86	8100A	Annular Bearing (72C & 10-18)	1
	8107A	Annular Bearing (70C, 71C & 10-17)	1
87	4894	Snap Ring (72C & 10-18)	1
	4734	Snap Ring (70C, 71C & 10-17)	1
88	47968	Snap Ring (70C & 10-17)	1
	R6A-71	Snap Ring (72C & 10-18)	1
89	4623	Ring Gear Bolt Ring	1
90	10-17-666-001	Reverse Clutch Hub (72C & 10-18)	3
		Reverse Clutch Hub (71C & 10-17)	2
	72-A66A	Bronze Clutch Plate (used interchangeably with 12-A66-001)	1
	72-A66	Two Bronze Plate (This plate is required for a few early units and two of these plates must be used with one steel plate to replace the fiber plate 71B8)	2
91	72-176	Steel Clutch Plate (72C & 10-18)	2
		Steel Clutch Plate (71C & 10-17)	1
92	71-71	Reverse Clutch Pressure Plate	1
93	71-35	Reverse Clutch Piston	1
94	4805A	Oil Seal	1
95	4840G	Needle Bearing	1
96	4804G	Sealing Ring	1
97	71-144B	Case & Adapter Gasket	1
98	000044885B	1/4 Pipe Plug	1
99	71C-A8	Forward & Reverse Adapter	1
100	4811	3/8-16 x 1-1/4 Cap Screw	4
101	Order Assembly	Pump Drive Gear	1
102	Order Assembly	Pump Driven Gear	1
103	3-61	Pump Gasket	1
104	Order Assembly	Pump Housing	1
105	10-00-044-014	Oil Seal Assembly	1
	71C-82A	Oil Seal Ring (optional with 10-00-044-014)	1
106	10-00-183-021	5/16-18 x 1-3/8 Hex Head Bolt (current units)	4
	000017862	5/16-18 x 1-3/4 Hex Head Bolt (used on early pumps)	4
		SEE INSET "A"	
	10-00-149-012	Mainshaft Nut	1
2	4812	Coupling	1
3	000017880	7/16-14 x 1-1/4 Hex Head Bolts	6
4	000010322	7/16 Lockwasher	6
5	71C-110	Oil Seal	1
6	L4-7	Bearing Retainer	1
7	L4-147	Bearing Retainer Gasket	1
8	4920	Bearing	1
9	000017884	7/16-14 x 1-3/4 Hex Head Bolt	2
10	000010322	7/16 Lockwasher	2
11	L7-1A	Reduction Housing (current)	1
		Reduction Housing (early)	1
12	L6-A2D	Pinion Cage & Driven Shaft Assy. (2.57:1 only)	1
13	L7-A5D	Pinion Cage & Driven Shaft Assy. (2.91:1 only)	1

*Use as required. N.I.-Not Illustrated

OIL CIRCULATION VARIATIONS IN 2.57 & 2.91 REDUCTIONS

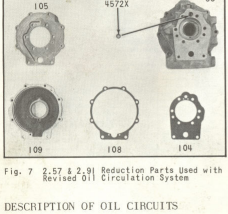


Fig. 7 2.57 & 2.91 Reduction Parts Used with Revised Oil Circulation System

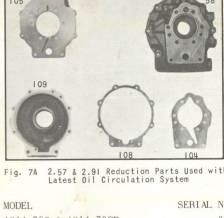


Fig. 7A 2.57 & 2.91 Reduction Parts Used with Latest Oil Circulation System

DESCRIPTION OF OIL CIRCUITS

Three different oil circulation systems in the reduction transmissions have been used to provide cooler flow and lubrication to the reduction planetary gear set and the rear bearing.

The earliest circulation system, with parts shown in (Fig. 8), returned the cooler oil to the reduction housing (Figs. 1 and 12). External identification of this system can be quickly made by examining the transmission reduction housing for a tapped hole in the reduction housing for the cooler oil return. If the reduction housing has no tapped hole, and the cooler oil must be returned to the lower front of the forward and reverse transmission case (Figs. 1 and 11) the transmission has one of the two latest oil circulation systems. These last two oil circulation systems can be differentiated after disassembly by comparing the oil passages with those shown in (Figs. 7 and 7A). The current design (Fig. 7A) is the only one of these two systems for which service parts will be available. When any transmission containing parts as identified in (Fig. 7) is serviced it should be rebuilt with parts as shown in (Fig. 7).

The effective serial numbers of the reduction transmissions revised to the latest oil circulation system are as follows:

MODEL	SERIAL NO.
AS14-70C & AS14-70CR	312
AS14-71C & AS14-71CR	5539
AS14-72C & AS14-72CR	11281
AS15-70C & AS15-70CR	1119
AS15-71C & AS15-71CR	1058
AS15-72C & AS15-72CR	2623

Any transmission with a serial number prior to those shown above which has been rebuilt to the latest circulation system at our plant, has the letter "Z" hand stamped in the lower right hand corner of the name plate opposite the name of Warner Gear Division.

PART DIFFERENCES IN REDUCTION UNIT DESIGN

1. With the introduction of the oil circulation characterized by (Fig. 7) the forward and reverse transmission cases were changed, but the part number remained the same. This new case can be used as a replacement for all reduction transmissions, of the various circulation systems, with the same part number. However the old forward and reverse transmission cases cannot be used with a transmission with the revised oil circulation system characterized by the cast oil passage in the reduction unit adapter as shown in (Fig. 7).

   The new version of the case has additional metal added to the upper and right side as shown in (Fig. 7)

to accommodate the pressure lubrication system to the reduction planetary gear set and rear bearing. With the relocation of the pressure lubrication passage to a location where the annular groove in the outside diameter of the bearing is utilized as an oil passage, the newer version of the case is not required.

NOTE: WHEN THE PARTS ARE ASSEMBLED AS SHOWN IN (FIG. 7A) THE BALL BEARING SHOULD ALWAYS BE INSTALLED SO THAT THE GROOVE ON ITS OUTSIDE DIAMETER IS ALWAYS TO THE REAR, VISIBLE FROM THE BACK OF THE TRANSMISSION AFTER INSTALLATION.

With the introduction of the latest oil circulation system, characterized by the parts illustrated in (Fig. 7A), the 4572X orifice plug has been removed from the 3/4" O.D. hole in the rear face of the transmission case. This plug should also be removed from any transmission, represented by parts illustrated in (Fig. 7), when it is rebuilt to the newer version shown in (Fig. 7A).

2. Both adapter gaskets (L4-145 and L4-146) front and rear, respectively, have been changed, but the part numbers remain the same. The new gaskets (Fig. 7A) can be used on all reduction transmissions, but the earlier gaskets (Fig. 8) can only be used in reduction transmissions with the old oil circulation system.

3. Reduction unit adapter (L7-8A) is used on these reduction transmissions with the new circulation system and replaces part (L7-8) used with the old circulation system. These parts are not interchangeable and care must be exercised in ordering the correct part for the transmission. The new adapter may be identified by its oil lubrication passage with drilled .12 hole to supply lubrication to the rear bearing, (Fig. 7A).

4. Reduction housing (L7-1A) is used on the reduction transmissions with the new circulation system and replaces part (L7-1) used with the older circulation system. These parts are not interchangeable and care must be exercised in ordering the correct part for the transmission. The new housing (L7-1A) may be identified by the absence of the tapped hole where the cooler oil previously returned to the reduction housing (Figs. 11 and 12).

5. The new reduction transmission oil circulation system returns the oil to the cooler return bushing at the front of the forward and reverse transmission case in the same manner that has been used on the Model 72C direct drive. The oil strainer assembly and related parts required in this new system are illustrated in (Fig. 9).

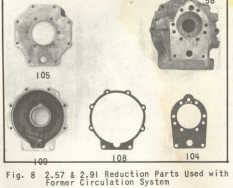


Fig. 8 2.57 & 2.91 Reduction Parts Used with Former Circulation System

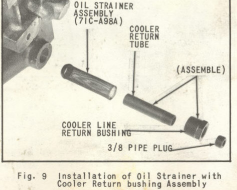


Fig. 9 Installation of Oil Strainer with Cooler Return bushing Assembly

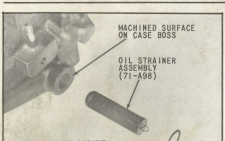


Fig. 10 Installation of Oil Strainer as Used with Drain Plug and Annular Gasket

NOTE: CAUTION SHOULD BE OBSERVED NOT TO USE OIL STRAINER ASSEMBLY 71-A98, WITH THE CLOSED END AND WIRE RING, IN A REDUCTION TRANSMISSION WITH THE NEW OIL CIRCULATION SYSTEM AS IT WOULD BLOCK THE FLOW OF THE COOLER RETURN OIL.

6. The replacement parts for the old circulation system are illustrated in (Fig. 10). Oil strainer assembly 71C-A98A has now replaced the old oil strainer assembly 71-A98, but these two parts are fully interchangeable in this oil circulation system.
7. Some of the reduction transmissions with the old circulation system require the use of an annular gasket and oil drain plug with a different thread than presently used. These assemblies can be easily identified by the machined surface on the transmission case boss which mates with the annular gasket (Fig. 10).

DESCRIPTION

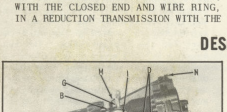


Fig. 11 Right Side View of Current Production Transmission

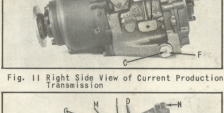


Fig. 12 Right Side of Transmission (Early)

The 2.57 or 2.91 to 1 reduction gear box operates in conjunction with any of the following models: Model 70, 70R, 70C, 70CR, 71, 71R, 71C, 71CR, 72, 72R, 72C, and 72CR. Each consists of a planetary gear set which reduces the input revolutions by a fixed 2.57 or 2.91 to 1 ratio.

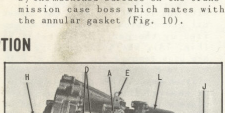


Fig. 13 Left Side of Current Transmission

The following list identifies the important features of the various model transmissions in (Figs. 11, 12 and 13).

A. Oil Filler Cap
B. Oil Output Opening to Cooler
C. Oil Inlet Opening from Cooler
D. Mounting Pads and Mounting Bolt Holes
E. Shift Lever
F. Oil Drain Plug
G. Breather
H. Drive Gear
I. Valve Cover
J. Coupling
K. Oil Pump
L. Reduction Gear Box
M. Main Line Pressure Tap
N. Reverse Clutch Pressure Tap

The direction of rotation of the splined output shaft of the reduction gear box is the same as engine rotation and is coaxial with the input shaft of the main unit. Lubrication pressure is supplied by the pump in the main transmission.

The following are the identification markings for the Warner Gear "VELVET DRIVE"® Marine Transmissions.

"A" MODEL	HAND OF ROTATION	"A" MODEL	HAND OF ROTATION	"B" RATIO	"C" COLOR	WEIGHT EMPTY
*AS14-72C	CLOCKWISE	*AS14-72CR	COUNTER CLOCKWISE	2.57:1	GREEN	154
AS14-72	CLOCKWISE	AS14-72R	COUNTER CLOCKWISE	2.57:1	GREEN	154
*AS14-71C	CLOCKWISE	*AS14-71CR	COUNTER CLOCKWISE	2.57:1	RED	146
AS14-71	CLOCKWISE	AS14-71R	COUNTER CLOCKWISE	2.57:1	RED	146
*AS14-70C	CLOCKWISE	*AS14-70CR	COUNTER CLOCKWISE	2.57:1	BLUE	143
AS14-70	CLOCKWISE	AS14-70R	COUNTER CLOCKWISE	2.57:1	BLUE	143
*AS15-72C	CLOCKWISE	*AS15-72CR	COUNTER CLOCKWISE	2.91:1	GREEN	154
AS15-72	CLOCKWISE	AS15-72R	COUNTER CLOCKWISE	2.91:1	GREEN	154
*AS15-71C	CLOCKWISE	*AS15-71CR	COUNTER CLOCKWISE	2.91:1	RED	146
AS15-71	CLOCKWISE	AS15-71R	COUNTER CLOCKWISE	2.91:1	RED	146
*AS15-70C	CLOCKWISE	*AS15-70CR	COUNTER CLOCKWISE	2.91:1	BLUE	143
AS15-70	CLOCKWISE	AS15-70R	COUNTER CLOCKWISE	2.91:1	BLUE	143

The hand of rotation referred to above is when viewed from stern of boat looking forward.
*TRANSMISSION ASSEMBLIES PRESENTLY IN PRODUCTION.

LUBRICATION RECOMMENDATIONS

THE PROPERTIES OF THE OIL USED IN THE TRANSMISSION ARE EXTREMELY IMPORTANT TO THE PROPER FUNCTION OF THE HYDRAULIC SYSTEM. THEREFORE, IT IS EXTREMELY IMPORTANT THAT THE RECOMMENDED OIL, AUTOMATIC TRANSMISSION FLUID (ATF), TYPE "A", SUFFIX "A" OR DEXRON BE USED.

For other important information pertaining to filling of the transmission with oil, checking oil level, or changing transmission oil, refer to section "Lubrication Recommendations", of the appropriate 70C & 71C, or 72C direct drive manuals.

MODEL	TRANSMISSION OIL CAPACITY (QUARTS)	
	15° INCLINED	LEVEL
AS14-70C or CR	2.7	2.5
AS14-71C or CR	2.7	2.5
AS14-72C or CR	2.8	2.7
AS15-70C or CR	2.7	2.5
AS15-71C or CR	2.7	2.5
AS15-72C or CR	2.8	2.7

NOTE: OIL CAPACITY DOES NOT INCLUDE CAPACITY NEEDED FOR TRANSMISSION COOLER AND OIL LINES, WHICH MAY IN MANY CASES REQUIRE AN ADDITIONAL AMOUNT GREATER THAN IN ABOVE TABLE.

TRANSMISSION INSTALLATION PRECAUTIONS & OPERATION

It is recommended that all installations using a reduction gear have a suitable locking device or brake to prevent rotation of the propeller shaft when the boat is not under direct propulsion. If the marine gear is not in operation and the forward motion of the boat causes the propeller shaft to rotate, lubricating oil will not be circulated through the gear because the oil pump is not in operation. Overheating and damage to the marine gear may result unless rotation of the propeller shaft is prevented.

Except in an emergency, shift from forward to reverse drive through neutral at engine speeds below 1000 rpm to prevent damage to the engine, or marine gear.

For other important information refer to sections, "Installation Precautions" and "Transmission Operation", of the appropriate 70C & 71C, or 72C direct drive manuals.

DISASSEMBLY OF TRANSMISSION

REMOVE REDUCTION HOUSING FROM FORWARD AND REVERSE TRANSMISSION

1. Place transmission right side up on a clean bench and loosen the main shaft nut.

2. Place an inch thick block under the rear of forward and reverse transmission just forward of reduction unit adapter so that reduction unit will clear bench.

3. Remove the two 7/16 bolts and lock washers, which fasten the reduction housing and the reduction adapter to the forward and reverse transmission case, and the 3/8 bolts, which fasten the reduction adapter to the reduction housing. Slide the reduction housing and pinion cage and driven shaft assembly from the forward and reverse transmission.

DISASSEMBLE STATIONARY GEAR PLATE, RING GEAR AND REDUCTION UNIT ADAPTER

4. Remove snap ring and sun gear from output shaft (Fig. 24).

5. Remove the six nylock bolts and lock washers and stationary gear plate and ring gear assembly as shown in (Fig. 23).

6. Remove the reduction unit adapter (Fig. 22). Tap gently on the exposed edges of reduction unit adapter while exerting a pull until adapter is free of snap fit on bearing O.D.

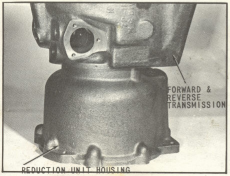


Fig. 14 Reduction Housing Used as Stand

7. Remove the snap ring and separate the stationary gear plate and ring gear, (Fig. 20).

REMOVAL OF MAIN SHAFT, COUPLING, AND BEARING FROM REDUCTION HOUSING

8. Remove main shaft nut and coupling as shown in (Fig. 30).

9. Remove main shaft and pinion cage assembly from reduction housing as shown in (Fig. 29).

10. Remove the six hex head bolts and lock washers and then remove the bearing retainer, as shown in (Fig. 28).

11. Remove the rear tapered roller bearing cone from outer race.

12. Place the reduction housing, rear face down, on a clean flat surface in an arbor press. Place a suitable tool against the forward face of forward tapered roller bearing cone and press remaining parts of the bearing out through the rear of housing.

DISASSEMBLY OF FORWARD AND REVERSE TRANSMISSION

13. If necessary to disassemble forward and reverse section of transmission, remove the snap ring, behind bearing, from output shaft assembly, (Fig. 19).

14. Place reduction housing on front face and place forward and reverse transmission assembly, rear face, on rear face of reduction housing, (Fig. 14).

15. Follow disassembly procedure given in Service Manual "Velvet Drive" Hydraulic Transmission either Model 70C, 71C or 72C as required for disassembly of forward and reverse transmission.

INSPECTION AND GENERAL INSTRUCTIONS

1. Cleanliness is absolutely necessary during assembly to insure proper functioning of transmission. Transmission case passages should always have plugs removed to allow for thorough cleaning. When available, use compressed air to dry parts before they are assembled. Do not wipe parts with rags to clean or dry them as lint from the cloth may cause erratic valve action.

2. Inspect all parts for damage or wear. Replace defective parts.

3. All gaskets, oil seals and rubber sealing rings should be replaced except in relatively new units. Judgement should then be exercised as to need for replacing these parts.

4. Oil seals and bearings are best installed by using an arbor press, suitable fixtures, and tools to properly align parts being assembled. Hammering seals and bearings into position can severely damage parts.

5. Automatic transmission fluid, type "A" suffix "A" or Dexron should be used to lubricate parts as they are assembled. Petroleum jelly may be used on gaskets or other parts that must be held in position during assembly. All Parts will assemble more freely if lubricated.

6. Tighten all bolts and screws evenly to the recommended torque.

7. Reduction pinion cage service instructions are covered under Planetary Service Kits in this manual, (Page 18).

ASSEMBLY OF TRANSMISSION

INSTALLATION OF PINION CAGE AND OUTPUT SHAFT ASSEMBLY AND BEARING INTO TRANSMISSION CASE

1. Mount the pinion cage and output shaft assembly on the same clutch and planetary assembly fixture as would be used for a direct drive transmission on an arbor press.

   NOTE: Pinion cage and output shaft assemblies (71-1A2C) and (72-1A2C) have been supplied with three oil grooves and without oil grooves as shown in (Fig. 15). The grooved shafts may be used in transmission cases having bronze bushings and in transmission cases without bronze bushings. The ungrooved shafts may be used only in transmission cases which have bushings installed.

2. Place the transmission case over the pinion cage and output shaft assembly so transmission case rests squarely on arbor press table which is supporting assembly tool (Fig. 16).

3. Inspect the bearing bore for possible dirt or burrs.

Fig. 15 Ungrooved and Grooved Model Pinion Cage and Output Shafts

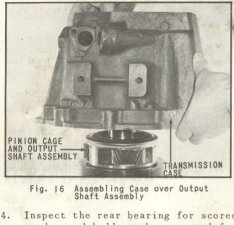


Fig. 16 Assembling Case over Output Shaft Assembly

4. Inspect the rear bearing for scored or damaged balls and races and for loose or cracked ball retainer. Replace the bearing with a new part if damage is detected.

5. Inspect the bearing for presence of dirt. If dirt is present, wash bearing until clean and lubricate with automatic transmission fluid, type "A", suffix "A" or Dexron, before assembly.

6. With the groove on the outside diameter of the bearing located toward the rear of the transmission, as shown in (Fig. 17), place the bearing over the projecting output shaft and squarely in the bearing bore.

7. Using an assembly tool designed to press evenly on the bearing outer and inner races, press bearing down until seated against shaft or case shoulder, (Fig. 18).

Fig. 17 Output Shaft Bearing Properly Positioned for Assembly

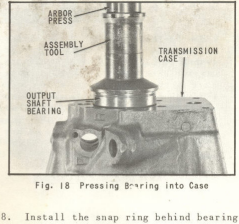


Fig. 18 Pressing Bearing into Case

8. Install the snap ring behind bearing and into the exposed groove of output shaft (Fig. 19).

9. Complete forward and reverse transmission assembly by following instructions given in either Service Manual for Model 70C & 71C, or 72C "Velvet Drive" Hydraulic Transmission as required.

ASSEMBLING STATIONARY GEAR PLATE AND RING GEAR

10. Install the stationary gear plate into the ring gear until it rests against the shoulder as shown in (Fig. 20).

11. Install the snap ring firmly into groove of the ring gear (Fig. 20).

Fig. 19 Installing Snap Ring on Output Shaft

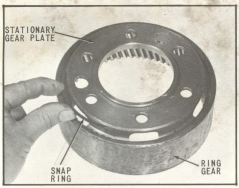


Fig. 20 Assembling Stationary Gear Plate and Ring Gear

INSTALLATION OF REDUCTION UNIT ADAPTER AND RING GEAR ASSEMBLY ON THE FORWARD AND REVERSE TRANSMISSION ASSEMBLY

12. Support the forward and reverse transmission assembly on its forward face on a clean surface using suitable blocks.

13. Place the reduction unit adapter gasket-front in position on rear face of transmission (Fig. 21). Gasket may be coated with petroleum jelly for easier assembly.

14. Install the reduction unit adapter on rear of the transmission case locating on the outer diameter of bearing (Fig. 22).

15. Install the parts assembled in steps 10 and 11, locating hub of the stationary gear plate in bearing pilot bore of the reduction unit adapter (Fig. 23).

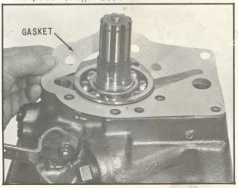


Fig. 21 Assembling Gasket

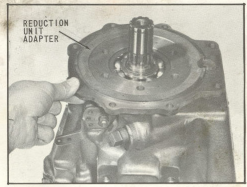


Fig. 22 Assembling Reduction Adapter

16. Install the six 7/16-14 x 1-1/4 nylock bolts and 7/16 lock washers (Fig. 23). Install the two 7/16-14 x 1-3/4 hex head bolts to insure alignment of all bolt holes. Tighten evenly to specified torque the nylock bolts and then remove the two 7/16-14 x 1-3/4 hex head bolts.

ASSEMBLING SUN GEAR ON OUTPUT SHAFT

17. Install the sun gear on the output shaft until it is seated against the shoulder and then assemble the snap ring firmly into groove (Fig. 24).

ASSEMBLING BEARING INTO REDUCTION HOUSING

18. Place the reduction housing on an arbor press resting the front face on a clean flat surface. The position of the bearing parts are shown in (Fig. 25).

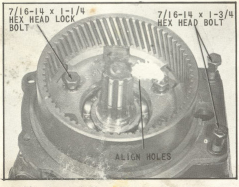


Fig. 23 Bolting Reduction Unit Adapter

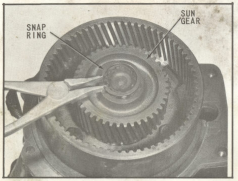


Fig. 24 Installing Snap Ring

NOTE: Bearings are received in matched sets and match marks must check. One bearing cone will have a number with an "A" suffix, the other will have the same number without the "A" suffix. The outer race will have the same number with the suffix "A" on one end and no number on the other end. The parts with the "A" suffix should be placed together (Fig. 26) and the end of the outer race with no number should be placed with the bearing cone without the "A" suffix.

19. Install the first row of the tapered bearing so that the outer ring rests against the shoulder in the reduction housing.

20. Lubricate the outer diameter of outer race with automatic transmission fluid and press it into the reduction housing, using a suitable tool as shown in (Fig. 27), until the outer race is seated firmly against the shoulder in the reduction housing.

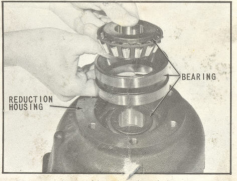


Fig. 25 Assembling Bearing into Reduction Housing

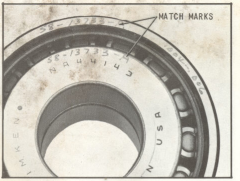


Fig. 26 Inspecting Bearing Match Marks

21. Install the rear set of tapered rollers and check again for agreement of match marks.

ASSEMBLING BEARING RETAINER AND GASKET ONTO REDUCTION HOUSING

22. Place the bearing retainer gasket on the reduction housing, aligning the slot in the gasket with the oil hole in the housing (Fig. 28).

23. Inspect the rubber lip of oil seal for cuts, cracks, or other damage that could cause leakage, and replace if necessary. Assemble the bearing retainer on the reduction housing, aligning the oil passages as shown in (Fig. 28).

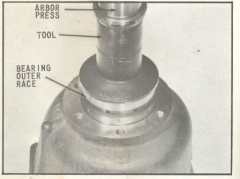


Fig. 27 Installing Outer Bearing Race

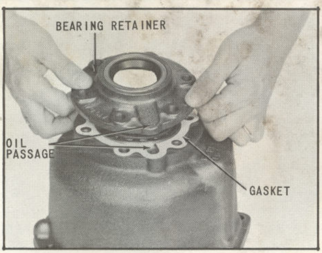


Fig. 28 Installing Bearing Retainer and Gasket

24. Install the six 7/16-14 x 1-1/4 hex head bolts and six 7/16 lock washers and tighten to specified torque.

ASSEMBLING MAIN SHAFT, COUPLING AND MAIN SHAFT NUT TO REDUCTION HOUSING

25. Install pinion cage and main shaft assembly into the bearing as shown in (Fig. 29). If the shaft does not assemble completely into rear bearing, do not use force. The shaft may be pulled fully into the bearing as the main shaft nut is assembled.

26. Inspect the coupling sealing diameter to make sure that there are no burrs or sharp edges, which might damage the seal or prevent proper sealing. Lubricate the sealing diameter and the internal splines with automatic transmission fluid. Align the splines of the coupling to those of the main shaft and press the coupling down until contact with the bearing inner race is made.

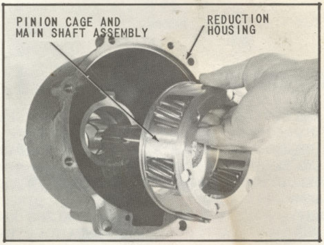


Fig. 29 Assembling Pinion Cage and Main Shaft Assembly

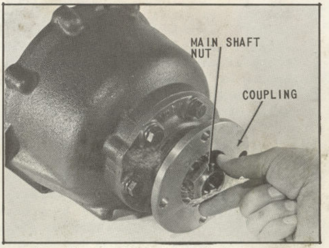


Fig. 30 Installing Coupling and Nut

27. Assemble the main shaft nut on output shaft (Fig. 30) and tighten to specified torque.

ASSEMBLY OF REDUCTION HOUSING, AND PINION CAGE AND MAIN SHAFT ASSEMBLY TO THE FORWARD AND REVERSE TRANSMISSION ASSEMBLY

28. Supporting the parts previously assembled in steps 1 through 17 on their front face on a clean flat surface or block, install the reduction housing adapter gasket-rear on the adapter as shown in (Fig. 31).

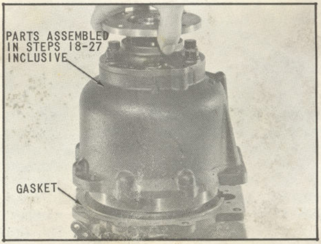


Fig. 31 Assembling Reduction Unit to Forward and Reverse Transmission

29. Install the parts assembled in steps 18 to 27 over the parts assembled in steps 1 through 17, by engaging the teeth of the sun gear and ring gear. Assemble until reduction housing bore is engaged with the pilot diameter of the reduction unit adapter. The bolt holes should be properly aligned in the completed assembly.

30. Install the two 7/16-14 x 1-3/4 hex head bolts and 7/16 lock washers, the six 3/8-16 x 1-1/8 hex head bolts and 3/8 lock washers as shown in (Fig. 32). Tighten bolts to specified torque.

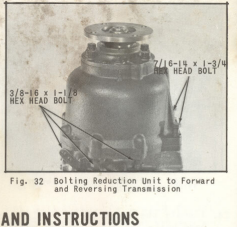


Fig. 32 Bolting Reduction Unit to Forward and Reversing Transmission

SPECIAL INFORMATION AND INSTRUCTIONS 2.57 & 2.91 REDUCTIONS

OUTPUT SHAFT VARIATIONS

Two output shaft and planetary cage assemblies have been used with the 2.57 and 2.91 reduction transmissions.

The present production shaft assemblies (L6-A2D and L7-A2D), having 24 involute splines and an outside diameter of 1.4908-1.420, replaced the earlier assemblies (L6-A2A and L7-A2A), having 10 straight sided splines and an outside diameter of 1.147-1.162.

Present production parts (L6-A2D and L7-A2D) and related parts are shown in parts list on (Page 7). Replacement parts for earlier transmissions having the 10 spline shafts must be ordered from the following parts list.

PARTS LIST FOR UNITS HAVING 10 SPLINED SHAFTS			
INDEX NO.	PART NO.	PART NAME	NO. REQ'D.
116	L6-A2A	PINION CAGE ASSEMBLY (2.57 ONLY)	1
	L7-A2A	PINION CAGE ASSEMBLY (2.91 ONLY)	1
49	47751	MAIN SHAFT NUT	1
50	45479A	COUPLING (6") STD.70-71 OPT.72	1
	45479Y	COUPLING (5") STD.72 OPT. 70-71	1
113	49204	BEARING (FORMERLY X3372)	1

VARIATIONS IN BREATHER ASSEMBLIES

The breather assembly, now located in the forward and reverse transmission case, was formerly located in the reduction housing. At this former location two different assemblies were used. 4740B (.498-.502 dia. hole) was a drive-in type, and AJ2-87 was a screw-on type for a 3/8 pipe thread.

SPECIAL SERVICE PARTS

NOTE: SPECIAL SERVICE KITS ARE AVAILABLE TO THE ORIGINAL EQUIPMENT MANUFACTURER FOR DISTRIBUTION TO THEIR VARIOUS DEALERS. THESE KITS OFFER CONVENIENCE IN REPAIRING THE VARIOUS 70, 71 AND 72 FORWARD AND REVERSE GEAR TRANSMISSIONS FOR WHICH OUR STANDARD MARINE WARRANTY HAS EXPIRED. THIS SECTION COVERS ONLY THE SPECIAL SERVICE KITS FOR REPAIR OF THE FIXED REDUCTION PORTION OF THE 2.57 AND 2.91 RATIO FORWARD AND REVERSE GEAR TRANSMISSIONS. FOR SPECIAL SERVICE KIT INFORMATION PERTAINING TO THE FORWARD AND REVERSE SECTION OF THE 2.57 AND 2.91 REDUCTION TRANSMISSIONS REFER TO THE APPROPRIATE 70C and 71C, or 72C DIRECT DRIVE MANUAL. ONLY THOSE DEALERS WHO ARE WELL QUALIFIED IN THE REPAIR OF THE MARINE TRANSMISSION SHOULD BE PERMITTED TO SERVICE PLANETARY GEAR SETS.

PLANETARY SERVICE KITS

These repair kits make possible the replacement of individual pinions and related parts of the planetary gear sets and eliminate the necessity of replacing the entire planetary assembly.

THE PARTS SHOWN IN KIT NUMBER A4867QQ (Fig. 33) SHOW THE PARTS REQUIRED TO REPLACE ONLY ONE PINION IN THE 2.57 REDUCTION PLANETARY ASSEMBLY. THE PARTS SHOWN IN KIT NUMBER A4867LL (Fig. 34) SHOW THE PARTS REQUIRED TO REPLACE ONLY ONE PINION IN THE 2.91 REDUCTION PLANETARY ASSEMBLY. IN EACH PLANETARY ASSEMBLY THE PROPER SEPARATE KITS MUST BE ORDERED FOR EACH PINION WHICH IS TO BE REPLACED.

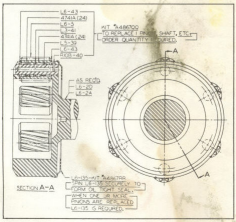
NOTE: In disassembling the individual gear sets the pinion shaft pin retaining the pinion pin should be removed intact after the removal of the oil collector ring. The pinion shaft pin should not be removed by pounding on the end of the pinion pin to break the retaining pin, as this distorts the immediate area of the pinion carrier and will produce a damaged thrust surface and improper pinion end clearance when the planetary is reassembled.

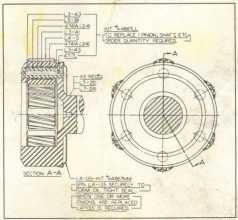
OIL COLLECTOR RING KIT

After assembly of the individual pinions in the planetary, the oil collector ring must be assembled and securely fastened to the planetary carrier. The oil collector ring which was removed to repair the planetary assembly should always be discarded and replaced with a new part, (A4867MM) or (A4867RR) as required.

NOTE: WHERE NEEDED ASSEMBLY INSTRUCTION SHEETS ARE INCLUDED IN THE SERVICE KITS.

NOTE: Kit for repairing carrier assemblies are no longer available. Parts may be ordered individually.





TORQUE SPECIFICATIONS

PART NO.	DESCRIPTION	APPLICATION	LBS. FT.	Nm
179840	3/8-16 x 1-1/8 HEX HEAD BOLT	REDUCTION UNIT ADAPTER TO REDUCTION HOUSING	27-32	36.6-43.4
179860	7/16-14 x 1-1/4 HEX HEAD BOLT	BEARING RETAINER TO REDUCTION HOUSING	42-50	56.9-67.8
179864	7/16-14 x 1-3/4 HEX HEAD BOLT	REDUCTION HOUSING AND ADAPTER TO CASE	42-50	56.9-67.8
48536	7/16-14 x 1-1/4 HEX HEAD BOLT, LOCKING	STATIONARY GEAR PLATE & RED. ADAPTER UNIT TO CASE	60-70	81.3-94.9
4775G	1-20 NUT	OUTPUT SHAFT NUT	100-200	135.5-271.2
10-00-149-034	1-20 NUT	OUTPUT SHAFT NUT	200-260	271.2-352.5

SUBJECT: FILLING, CHANGING AND CHECKING OIL LEVEL IN ALL VELVET DRIVE UNITS.

FILLING

The Velvet Drive hydraulic circuit includes the transmission, oil cooler, cooler lines and any gauge lines connected into the circuit. The complete circuit must be filled when filling the transmission and this requires purging the system of air before the oil level check can be made. The air will be purged from the system if the oil level is maintained above the pump suction opening while the engine is running at approximately 1500 RPM. The presence of air bubbles on the dipstick indicates that the system has not been purged of air.

New applications or a problem installation should be checked to insure that the oil does not drain back into the transmission from the coooler and cooler lines. Check the oil level for this drain back check only, immediately after the engine is shut off and again after the engine has been stopped for more than one hour (overnight is excellent). A noticeable increase in the oil level after this waiting period indicates that the oil is draining from cooler and cooler lines. The external plumbing should be changed to prevent any drain back. See our Installation Manual.

CHECKING OIL LEVEL

Check the oil level daily before operating the engine. Oil level should be maintained at the full mark.

CHANGING OIL

It is recommended that the transmission oil be changed once each season. Work boats require more frequent changes. Change oil anytime the oil becomes contaminated, changes color, or becomes ranced smelling.

TRANSMISSION FLUID

Dexron® II, Type F, and other hydraulic transmission fluids which meet the Detroit Diesel Allison Type C3 specifications are recommended for use in all Velvet Drive® marine transmissions.

Lubricating oils which are recommended for use in diesel engines and also meet the Detroit Allison Type C3 specifications may be used if the engine does not exceed 3000 RPM. SAE #30 is preferred, SAE #40 is acceptable if high operating temperatures are to be encountered. Multiviscosity oils such as 10W-40 are not acceptable. The first choice is an oil which falls in the SAE-API service Class "CD." The second choice would be an oil which falls in the SAE-API service Class "CC."

The equivalent DOD mil specs are:

"CD" Mil-L-2104B

"CC" Mil-L-46199

The new C3 specifications were developed by Detroit Diesel Allison Division of General Motors to outline the requirements of an oil suitable for use in their heavy duty hydraulic automatic and powershift transmissions. The oil companies should be able to provide information as to the suitability of their product for use in a given application.