BORG WARNER

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Velvet Drive® Marine Installation Manual

Warner Gear

Division of Borg-Warner Corporation

SERVICE MANUAL
PRICE $2.50

Velvet Drive®

Marine Installation Manual

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FOREWORD

This manual covers all Velvet Drive® transmissions. Data is given to assist you in selecting the proper transmission, cooler, damper drive and propeller shaft coupling. Proper installation is a requirement for a valid warranty. Instructions for making a proper installation are included. Better service and extended product life can be expected when the recommended components are used and properly installed.

THIS CHART HAS BEEN ADDED TO HELP IDENTIFY EARLY VELVET DRIVE ASSEMBLIES.

The following are identification markings for Warner Gear Division Marine Gears:

MODEL 70 I.D. NO.*	MODEL 71 I.D. NO.	MODEL 72 I.D. NO.	FORWARD RATIO	HAND OF ROTATION
0	1	2	Direct	Both
04	14	24	1.523 to 1	Both
05	15	25	2.100 to 1	Counterclockwise
05A	15A	25A	2.100 to 1	Clockwise
06	16	26	2.571 to 1	Both
07	17	27	2.909 to 1	Both

*These numbers are stamped on serial number plates preceding the serial numbers.

10-17 & 10-18 UNITS

The 1:1 ratio units in the 10-17 and 10-18 series are identical except for the nameplate to the 71C and 72C units which they repalce. The nameplate was changed to be consistent with reduction units of these models.

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.

The reduction sun gear is pinned to the housing of 71C and 72C 1.5:1 units. The snap ring holds the sun gear to an adapter plate which is bolted to the reduction housing of 10-17 and 10-18 reduction units. An oil baffle is bolted to the reduction of 2.57:1 and 2.91:1 reduction units of the 10-17 and 10-18 series transmissions.

—— 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.

Locate reduction housing and attached parts on a suitable block placed under the carrier or other parts attached to the output shaft so that the reduction housing can be rotated as the coupling nut is being tightened. A tool should be used to hold the coupling while the output shaft nut is being tightened. A helper should rotate the reduction housing and the coupling nut should be tightened until an increase in effort required to turn the reduction housing is noted.

Lay the reduction housing on its side and use a torque wrench to turn the output shaft through the bearings to check the bearing drag caused by the bearings being preloaded. A maximum of 45 lb-ins (5.1 Nm) but perferably 15 to 30 lb-ins (1.7 to 3.4 Nm) torque should be required to rotate the output shaft through the oil seal and properly preloaded bearings. A new bearing spacer should always be used after the output shaft nut has been loosened after being properly preloaded. If the spacer must be reused, always go to a slightly higher preload than the sleeve had been torqued to previously.

IMPORTANT – SEE LATE BULLETINS ON THESE MODELS.

SELECTING A PROPER VELVET DRIVE

Optimum performance can only be obtained when all components are properly selected for the application. Applications having components which are excellent for a particular use may be completely unsuitable for another use. Basic considerations for component selection are discussed in this manual. Specific information is given for the various Velvet Drive models. Reference to various forms will be made to help you find information which is not included.

ENGINE ROTATION

Transmission selection will be simplified when the following method is used to describe engine rotation. This method may not agree with the engine manufacturers' for describing engine rotation.

Face the end of the engine on which the transmission is mounted and describe rotation as clockwise if the engine rotates clockwise. Describe the engine rotation as counterrotating if the engine rotates counterclockwise.

TRANSMISSION ROTATION

Describe transmission input and output shaft rotation as clockwise or counterrotating (counterclockwise) when standing behind the transmission coupling facing towards the input or engine end of the transmission.

All Velvet Drive units except the 2.10:1 In-Line and CR2 units may be used behind engines having either rotation; however, the pump must be indexed for the desired rotation. The reduction unit planetary carrier is different for opposite rotating 2.10:1 In-Line units and early failure will occur on these units if they are driven in the wrong direction.

The output shaft rotates in the same direction or in the opposite direction to the input shaft depending upon the transmission assembly; therefore, it is best to study the charts which show shaft rotation to determine the required model.

HYDRAULIC PUMP INDEXING

The transmission front adapter and pump housing are designed to permit the pump to be mounted in either of two positions. Each position permits oil to be pumped when pump gears are rotated in one direction only. The pump can only pump oil when any point on the gears is rotated past the inlet port first, then past the crescent shaped portion of the pump housing which separates the inlet from the outlet and then past the pump outlet.

The pump must be correctly indexed for each direction of rotation. An arrow with TOP L.H. and a second arrow with TOP R.H. can be found on early pump housings. The arrow which is located nearer the top of pump housing points in the direction the pump must rotate to pump oil. The letters L.H. and R.H. describe the required pump rotation when facing the pump and tells the same thing as the arrow points out. The letters L.H. and R.H. have been removed from current pump assemblies.

The wise mechanic will always check the pump setting prior to transmission installation to be sure that the arrow agrees with engine rotation.

Pump rotation is viewed from the opposite end of the transmission from which shaft and engine rotation is described. The arrow showing left hand rotation should be nearer the top of the units used behind clockwise rotating engines. The arrow showing right hand rotation should be nearer the top on units used behind counterclockwise rotating engines.

TO INDEX PUMP FOR OPPOSITE HAND ROTATION

CAUTION: This procedure is not applicable to CR2 units or the AS3, AS13, 10-17 and 10-18 models (2.10:1 In-Line reduction ratios) because special planetary gear mountings are used which are different for each rotation. These models must not be reindexed from the original factory settings.

1) Remove the four bolts which hold the pump to the transmission, (Fig. 1).

2) Loosen the pump housing. A rubber or plastic hammer may be used to tap the oil boss, but do not strike the bolt bosses.

3) Do not remove the pump from the shaft unless a seal protector is used to prevent the shaft splines from cutting the pump seal.

4) Care should be taken to see that the pump gasket does not stick to the pump housing during rotation, causing the gasket to be folded or torn.

5) Locate pump with the arrow indicating the proper direction of input shaft rotation nearer top of transmission.

6) Care must be taken to see that the gasket, seal and bolt bosses are kept in good condition to prevent leaks in these critical areas.

7) Torque the four bolts to 17-22 ft. lbs. (25.3-32.7 Kg/M.).

FIG. 1 VIEW FACING PUMP AND INPUT SHAFT

PROPELLER ROTATION

A right-hand propeller is a propeller which will thrust forward when turned clockwise when viewed from behind the boat looking forward.

A left-hand propeller is a propeller which will thrust forward when turned counterclockwise as viewed from behind the boat looking forward.

> **CAUTION:** Early gear failure will occur when the transmission must be operated in reverse to obtain forward when operated with a propeller having the wrong hand of rotation.

The required propeller is designated in the various charts as left hand (L.H.) or right hand (R.H.) for each transmission assembly.

TRANSMISSION RATIO SELECTION

Propeller shaft speed is determined by engine speed and transmission ratio. Every boat has a most desirable shaft speed, which has a direct relationship to boat speed. A small propeller must be used when shaft speeds are too high and this results in poor performance. A large propeller turning at high speed would overload the engine. Fast runabouts do best with direct drive units. Cruisers require reduction gears. The heavier and slower boats require correspondingly greater ratios of reduction. One hundred revolutions per minute of the propeller shaft for each mile per hour of boat speed is considered a very good rule of thumb for selecting the drive ratio.

EXAMPLE:

A boat which runs 20 MPH has an engine which runs 4000 RPM. MPH x 100 RPM propeller shaft=optimum shaft speed, or 20 x 100=2000 RPM would be optimum shaft speed.

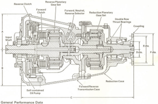
$$\frac{4000 = \text{Engine Speed}}{2000 = \text{Shaft Speed}} \text{ or } \frac{2}{1} \text{ Reduction Required.}$$

PROPELLER SELECTION

The propeller is selected to load the engine and still permit full power to be developed. The propeller must allow the engine to come up to rated speed. It is incorrect to use a propeller so large that the engine will be overloaded, because this will not only reduce the power delivered to the propeller shaft, but more importantly it will cause abnormally high loading within the engine. This can result in destructive pressures and temperatures which cause premature bearing and valve failure.

For ski towing, it is best to select a propeller which will permit the engine to maintain rated RPM when under load.

Figure 2 Installation drawing for In-Line transmissions (2.10:1.00 ratio illustrated)



General Performance Data

Model	Maximum SAE HP Input (1)		Available Ratios	Shaft Rotation	Approximate Dry Weight	
	Gasoline	Diesel			Direct Drive	Reduction
71C 10-17	255 @ 4200 rpm	145 @ 3200 rpm	1.00 1.52 1.91* 2.10 2.57 2.91 to 1.00	Outside same as Engine unless noted by asterisk (*)	95 lb. (43.1 kg.)	145 lb. (65.8 kg.)
72C 10-18	380 @ 4200 rpm	185 @ 2800 or 210 @ 3200			1.09 lb. (49.4 kg.)	153 lb. (69.4 kg.)
73C 10-06	560 @ 4200 rpm	400 @ 3200 rpm	1.00 1.50 2.00* 3.00 to 1.00	Output same as Engine unless noted by asterisk (*)	135 lb. (61.2 kg.)	185 lb. (83.9 kg.)

*Rotation is opposite engine.

Dimensions Inches and (millimeters)

Model	A	B	C(2)	D dia.	E dia.	F dia.
71C 10-17	5.63 (143.00)	5.69 (144.53)	16.89 (429.01)	2.50 (63.50)	4.25(3) (107.95)	5.00(3) (127.00)
72C 10-18	5.63 (143.00)	5.69 (144.53)	17.79 (451.86)	2.50 (63.50)	4.25 (107.95)	5.00 (127.00)
73C 10-06	5.94 (150.88)	6.88 (174.75)	19.45 (494.03)	3.00 (76.20)	4.75 (120.65)	5.75 (146.05)

Notes:

(1) The above transmission ratings are subject to change without notice and are intended only as a general guide for pleasure craft usage. For additional application information, consult a Warner Gear marine distributor.

(2) For "C" dimension—direct drive units:

71C 10-17	10.50 (266.70)
72C 10-18	11.44 (290.58)
73C 10-06	13.47 (342.14)

(3) Direct drive model 71 (only) uses 4" (101.60) coupling.

WARNING: System related noises or vibrations can occur at low engine speeds which can cause gear rattle and result in damage to the boat engine as well as the transmission. Warner Gear is not responsible for total system related torsionals of this type.

IDENTIFICATION OF VELVET DRIVE IN-LINE MODELS 70C, 71C, 72C & 73C

NEW TRANS ASSEMBLY NUMBER	TRANS ASSEMBLY NUMBER (6)	INPUT TO OUTPUT SPEED RATIO FORWARD	REVERSE	ROTATION (1) INPUT SHAFT	OUTPUT SHAFT FORWARD	OUTPUT SHAFT REVERSE	PUMP SETTING (2)	PROPELLER REQUIRES (3)	OIL CAPACITY (4) 15° INCLINED U.S. QTS.	LITERS	LEVEL U.S. QTS.	LITERS	APPROX. TRANS. WEIGHT POUNDS	KILOS
10-04-000-022*	AS1-70C	1:1	1:1	CW	CW	CCW	LH	RH	1.3	1.23	1.8	1.70	82	37.2
10-04-000-023*	AS1-70CR	1:1	1:1	CCW	CCW	CW	RH	LH	1.3	1.23	1.8	1.70	82	37.2
10-04-000-026*	AS2-70C	1.52:1	1.52:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-027*	AS2-70CR	1.52:1	1.52:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-028*	AS3-70C	2.10:1	2.10:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-029*	AS3-70CR	2.10:1	2.10:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-030*	AS14-70C	2.57:1	2.57:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-031*	AS14-70CR	2.57:1	2.57:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-032*	AS15-70C	2.91:1	2.91:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-033*	AS15-70CR	2.91:1	2.91:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-034*	AS7-70C (5)	1.91:1	1.91:1	CW	CCW	CW	LH	LH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-035*	AS7-70CR (5)	1.91:1	1.91:1	CCW	CW	CCW	RH	RH	2.7	2.56	2.5	2.37	142	64.4
10-04-000-024*	AS10-70C (7)	1:1	1:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	95	43.1
10-04-000-025*	AS10-70CR (7)	1:1	1:1	CCW	CCW	CW	RH		1.7	1.61	2.1	1.99	95	43.1
10-17-000-001*	AS1-71C	1:1	1:1	CW	CW	CCW	LH	RH	1.3	1.23	1.8	1.70	95	43.1
10-17-000-002*	AS1-71CR	1:1	1:1	CCW	CCW	CW	RH	LH	1.3	1.23	1.8	1.70	95	43.1
10-17-000-003	AS1-71CB (6)	1:1	1:1	CW	CW	CCW	LH	RH	1.3	1.23	1.8	1.70	95	43.1
10-17-000-004	AS1-71CBR (6)	1:1	1:1	CCW	CCW	CW	RH	LH	1.3	1.23	1.8	1.70	95	43.1
10-17-000-005	AS2-71C	1.52:1	1.52:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-006	AS2-71CR	1.52:1	1.52:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-009	AS3-71C	2.10:1	2.10:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-010	AS3-71CR	2.10:1	2.10:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-011	AS14-71C	2.57:1	2.57:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-012	AS14-71CR	2.57:1	2.57:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-013	AS15-71C	2.91:1	2.91:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-014	AS15-71CR	2.91:1	2.91:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-007	AS7-71C	1.91:1	1.91:1	CW	CCW	CW	LH	LH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-008	AS7-71CR	1.91:1	1.91:1	CCW	CW	CCW	RH	RH	2.7	2.56	2.5	2.37	145	65.8
10-17-000-015*	AS20-71C (7)	1:1	1:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	98	44.5
10-17-000-016*	AS20-71CR (7)	1:1	1:1	CCW	CCW	CW	RH		1.7	1.61	2.1	1.99	98	44.5
10-18-000-001	AS11-72C	1:1	1.10:1	CW	CW	CCW	LH	RH	1.7	1.61	2.1	1.99	109	49.4
10-18-000-002	AS11-72CR	1:1	1.10:1	CCW	CCW	CW	RH	LH	1.7	1.61	2.1	1.99	109	49.4
10-18-000-003	AS12-72C	1.52:1	1.68:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-004	AS12-72CR	1.52:1	1.68:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-007	AS13-72C	2.10:1	2.31:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-008	AS13-72CR	2.10:1	2.31:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-009	AS14-72C	2.57:1	2.83:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-010	AS14-72CR	2.57:1	2.83:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-011	AS15-72C	2.91:1	3.20:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-012	AS15-72CR	2.91:1	3.20:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-005	AS17-72C (5)	1.91:1	2.10:1	CW	CCW	CW	LH	LH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-006	AS17-72CR (5)	1.91:1	2.10:1	CCW	CW	CCW	RH	RH	2.8	2.65	2.7	2.56	154	69.9
10-18-000-013	AS20-72C (7)	1:1	1.10:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	112	50.8
10-18-000-014	AS20-72CR (7)	1:1	1.10:1	CCW	CCW	CW	RH		1.7	1.61	2.1	1.99	112	50.8
	AS30-72C (7)	1:1	1.10:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	116	52.6
	AS30-72CR (7)	1:1	1.10:1	CCW	CCW	CW	RH		1.7	1.61	2.1	1.99	116	52.6
10-06-000-004	AS1-73C	1:1	.88:1	CW	CW	CCW	LH	RH	1.5	1.42	1.6	1.51	135	61.2
10-06-000-005	AS1-73CR	1:1	.88:1	CCW	CCW	CW	RH	LH	1.5	1.42	1.6	1.51	135	61.2
10-06-000-006	AS2-73C	1.5:1	1.32:1	CW	CW	CCW	LH	RH	2.2	2.08	1.8	1.69	185	83.9
10-06-000-007	AS2-73CR	1.5:1	1.32:1	CCW	CCW	CW	RH	LH	2.2	2.08	1.8	1.69	185	83.9
10-06-000-008	AS5-73C	3:1	2.64:1	CW	CW	CCW	LH	RH	2.2	2.08	1.8	1.69	185	83.9
10-06-000-009	AS5-73CR	3:1	2.64:1	CCW	CCW	CW	RH	LH	2.2	2.08	1.8	1.69	185	83.9
10-06-000-010	AS7-73C (5)	2:1	1.76:1	CW	CCW	CW	LH	LH	2.2	2.08	1.8	1.69	185	83.9
10-06-000-011	AS7-73CR (5)	2:1	1.76:1	CCW	CW	CCW	RH	RH	2.2	2.08	1.8	1.69	185	83.9

*Discontinued Models

(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, IN SOME CASES, THE PUMP FOR OPPOSITE ROTATION DOES NOT CAUSE OUTPUT SHAFT ROTATION TO BE REVERSED, but does permit the transmission to be used behind an opposite rotating engine. AS11-70C units have pump settings for opposite rotation.

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 rotation is not permitted on these assemblies. No warranty claims will be allowed for failures caused by improper pump indexing on 2.10:1 reduction units.

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

(4) Transmission oil capacity only is given. Additional oil will be required for filling oil cooler and cooler lines.

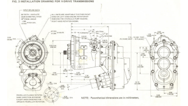
(5) All AS7 and AS17 reduction units are counter-rotating, i.e. the output shaft turns opposite to input shaft when the transmission is operated in forward.

(6) The AS1-71CB and AS1-71CBR units are for heavier reverse duty and diesel applications.

(7) Warner Gear supplies AS10-70C, AS10-70CR, AS20-71C, AS20-71CR, AS20-72C, AS20-72CR, AS30-70C and AS30-72C units for use with stern drives. V-Drives or other auxiliary reduction gears. Contact the manufacturer of the supplementary gearing for details of the complete assembly.

(8) All Model 70C units have been discontinued.

FIG. 3 INSTALLATION DRAWING FOR V-DRIVE TRANSMISSIONS



NOTE: Parenthetical dimensions are in millimeters.

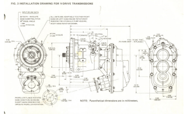
MODEL	A	B	C	D	E	F	REDUCTION
71C SERIES							
10-04	6.83 (173.48)	2.38 (60.45)	19.15 (486.41)	11.65 (295.91)	7.64 (194.06)	10.19 (258.83)	.96:1, 1.21:1, 2.49:1, 3.14:1
						10.14 (257.56)	1.51:1, 1.99:1
72C SERIES							
10-05	7.76 (197.10)	2.64 (67.06)	20.06 (509.52)	12.59 (319.79)	8.58 (217.93)	10.19 (258.83)	.96:1, 1.21:1 2.49:1, 3.14:1
						10.14 (257.56)	1.51:1, 1.99:1

GENERAL SPECIFICATIONS

MODEL	MAXIMUM SAE HP INPUT		AVAILABLE RATIOS	OUTPUT ROTATION	DRY WEIGHT
	GASOLINE	DIESEL			
10-04	255 @ 4200 rpm	145 @ 3200 rpm	0.96, 1.21, 1.51, 1.99, 2.49, 3.14 to 1.00	OPTIONAL	190 lb. (86.2 kg.)
10-05	380 @ 4200 rpm	185 @ 2800 rpm 210 @ 3200 rpm			203 lb. (92.1 kg.)

NOTE: All specifications and descriptive data are nominal and subject to change without notice. Specific installations should be referred to Warner Gear for application assistance.

FIG. 3 INSTALLATION DRAWING FOR V-DRIVE TRANSMISSIONS



NOTE: Parenthetical dimensions are in millimeters.

MODEL	A	B	C	D	E	F	REDUCTION
71C SERIES							
10-04	6.83 (173.48)	2.38 (60.45)	19.15 (486.41)	11.65 (295.91)	7.64 (194.06)	10.19 (258.83)	.96:1, 1.21:1, 2.49:1, 3.14:1
						10.14 (257.56)	1.51:1, 1.99:1
72C SERIES							
10-05	7.76 (197.10)	2.64 (67.06)	20.06 (509.52)	12.59 (319.79)	8.58 (217.93)	10.19 (258.83)	.96:1, 1.21:1 2.49:1, 3.14:1
						10.14 (257.56)	1.51:1, 1.99:1

GENERAL SPECIFICATIONS

MODEL	MAXIMUM SAE HP INPUT		AVAILABLE RATIOS	OUTPUT ROTATION	DRY WEIGHT
	GASOLINE	DIESEL			
10-04	255 @ 4200 rpm	145 @ 3200 rpm	0.96, 1.21, 1.51, 1.99, 2.49, 3.14 to 1.00	OPTIONAL	190 lb. (86.2 kg.)
10-05	380 @ 4200 rpm	185 @ 2800 rpm 210 @ 3200 rpm			203 lb. (92.1 kg.)

NOTE: All specifications and descriptive data are nominal and subject to change without notice. Specific installations should be referred to Warner Gear for application assistance.

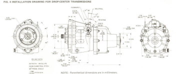
V-DRIVE ASSEMBLIES

MODEL NUMBER & TYPE		ASSEMBLY NUMBER *	INPUT TO OUTPUT SHAFT RATIO		ROTATION			PUMP SETTING	PROPELLER REQUIRED
			FORWARD	REVERSE	INPUT SHAFT	OUTPUT SHAFT FORWARD	OUTPUT SHAFT REVERSE		
10–04 / 13–08	GEAR DRIVE UNITS	10-04-000-002	1.99:1	1.99:1	C	C	CC	←	LH
		(13-08-410-002)			CC	CC	C	→	RH
		10-04-000-005	2.49:1	2.49:1	C	C	CC	←	LH
		(13-08-410-005)			CC	CC	C	→	RH
		10-04-000-007	3.14:1	3.14:1	C	C	CC	←	LH
		(13-08-410-007)			CC	CC	C	→	RH
		10-04-000-009	0.96:1	0.96:1	C	C	CC	←	LH
		(13-08-410-009)			CC	CC	C	→	RH
		10-04-000-011	1.51:1	1.51:1	C	C	CC	←	LH
		(13-08-410-011)			CC	CC	C	→	RH
		10-04-000-012	1.21:1	1.21:1	C	C	CC	←	LH
		(13-08-410-012)			CC	CC	C	→	RH
	CHAIN DRIVE UNITS	10-04-000-003	1.98:1	1.98:1	C	CC	C	←	RH
		(13-08-410-003)			CC	C	CC	→	LH
		10-04-000-004	2.50:1	2.50:1	C	CC	C	←	RH
		(13-08-410-004)			CC	C	CC	→	LH
		10-04-000-006	3.10:1	3.10:1	C	CC	C	←	RH
		(13-08-410-006)			CC	C	CC	→	LH
		10-04-000-008	0.97:1	0.97:1	C	CC	C	←	RH
		(13-08-410-008)			CC	C	CC	→	LH
		10-04-000-010	1.53:1	1.53:1	C	CC	C	←	RH
		(13-08-410-010)			CC	C	CC	→	LH
		10-04-000-013	1.21:1	1.21:1	C	CC	C	←	RH
		(13-08-410-013)			CC	C	CC	→	LH
10–05 / 13–08	GEAR DRIVE UNITS	10-05-000-002	1.99:1	2.19:1	C	C	CC	←	LH
		(13-08-410-002)			CC	CC	C	→	RH
		10-05-000-005	2.49:1	2.74:1	C	C	CC	←	LH
		(13-08-410-005)			CC	CC	C	→	RH
		10-05-000-007	3.14:1	3.45:1	C	C	CC	←	LH
		(13-08-410-007)			CC	CC	C	→	RH
		10-05-000-009	0.96:1	1.06:1	C	C	CC	←	LH
		(13-08-410-009)			CC	CC	C	→	RH
		10-05-000-011	1.51:1	1.67:1	C	C	CC	←	LH
		(13-08-410-011)			CC	CC	C	→	RH
		10-05-000-012	1.21:1	1.33:1	C	C	CC	←	LH
		(13-08-410-012)			CC	CC	C	→	RH
	CHAIN DRIVE UNITS	10-05-000-003	1.98:1	2.17:1	C	CC	C	←	RH
		(13-08-410-003)			CC	C	CC	→	LH
		10-05-000-004	2.50:1	2.75:1	C	CC	C	←	RH
		(13-08-410-004)			CC	C	CC	→	LH
		10-05-000-006	3.10:1	3.41:1	C	CC	C	←	RH
		(13-08-410-006)			CC	C	CC	→	LH
		10-05-000-008	0.97:1	1.07:1	C	CC	C	←	RH
		(13-08-410-008)			CC	C	CC	→	LH
		10-05-000-010	1.53:1	1.68:1	C	CC	C	←	RH
		(13-08-410-010)			CC	C	CC	→	LH
		10-05-000-013	1.21:1	1.33:1	C	CC	C	←	RH
		(13-08-410-013)			CC	C	CC	→	LH

C – CLOCKWISE
CC – COUNTER CLOCKWISE

* The (13-08-410) number below the number for the V-Drive assembly is the part number for the V-Drive portion only. 10-04-410-001 is the part number for the Front Box only (forward and reverse transmission) for the 10-04 units and 10-05-410-001 is for the 10-05 units.

FIG. 4 INSTALLATION DRAWING FOR DROP-CENTER TRANSMISSIONS



NOTE: Parenthetical dimensions are in millimeters.

MODEL	A	B	C	E	F DIA	G DIA	H DIA	REDUCTION	J OFFSET DIMS. OUTPUT ROTATION	
									ENGINE	OPPOSITE
71C SERIES										
10-13	6.82 (173.23)	2.39 (60.71)	18.42 (467.87)	.31 (7.87)	4.25 (107.95)	5.00 (127.00)	.45 (11.43)	1.58	1.23 (31.24)	1.06 (26.92)
								2.03	1.66 (42.16)	1.49 (37.85)
								2.47	1.95 (49.53)	1.77 (44.96)
								2.93	2.16 (54.86)	1.99 (50.55)
72C SERIES										
10-14	7.76 (197.10)	2.64 (67.06)	19.36 (491.74)	.31 (7.87)	4.25 (107.95)	5.00 (127.00)	.45 (11.43)	1.58	1.23 (31.24)	1.06 (26.92)
								2.03	1.66 (42.16)	1.49 (37.85)
								2.47	1.95 (49.53)	1.77 (44.98)
								2.93	2.16 (54.86)	1.99 (50.55)

GENERAL SPECIFICATIONS

MODEL	MAXIMUM SAE HP INPUT		AVAILABLE RATIOS	OUTPUT ROTATION	DRY WEIGHT
	GASOLINE	DIESEL			
10-13	255 @ 4200 rpm	130 @ 3200 rpm	1.58, 2.03, 2.47, 2.93 to 1.00	OPTIONAL	162 lb. (73.5 kg.)
10-14	380 @ 4200 rpm	185 @ 2800 rpm 210 @ 3200 rpm			175 lb. (79.4 kg.)

NOTE: The above transmission ratings are subject to change without notice and are intended only as a general guide. Specific applications should be referred to Warner Gear for engineering assistance.

NE=NON-AUTOMOTIVE ENGINE
E=AUTOMOTIVE ENGINE
O=AUTOMOTIVE OPPOSITE

CR2
(DROP CENTER ASSEMBLIES)

ASSEMBLY NUMBER	REDUCTION RATIO		SHAFT ROTATION (1)			PUMP SETTING (2)	PROPELLER REQUIRED (3)	NAME PLATE STAMPED
	FORWARD	REVERSE	INPUT (4)	OUTPUT FORWARD	OUTPUT REVERSE			
10-13-000-001	1.58:1.	1.58:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-1.6
10-13-000-002	1.58:1	1.58:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-1.6
10-13-000-003	2.03:1	2.03:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-2.0
10-13-000-004	2.03:1	2.03:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-2.0
10-13-000-005	2.47:1	2.47:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-2.5
10-13-000-006	2.47:1	2.47:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-2.5
10-13-000-007	2.93:1	2.93:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-3.0
10-13-000-008	2.93:1	2.93:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-3.0
10-13-000-009	1.58:1	1.58:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-1.6
10-13-000-010	2.03:1	2.03:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-2.0
10-13-000-011	2.47:1	2.47:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-2.5
10-13-000-012	2.93:1	2.93:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-3.0
10-14-000-001	1.58:1	1.74:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-1.6
10-14-000-002	1.58:1	1.74:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-1.6
10-14-000-003	2.03:1	2.23:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-2.0
10-14-000-004	2.03:1	2.23:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	E-2.0
10-14-000-005	2.47:1	2.72:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-2.5
10-14-000-006	2.47:1	2.72:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-2.5
10-14-000-007	2.93:1	3.22:1	L.H.	ENGINE	OPPOSITE ENGINE	→	L.H.	E-3.0
10-14-000-008	2.93:1	3.22:1	L.H.	OPPOSITE ENGINE	ENGINE	→	R.H.	O-3.0
10-14-000-009	1.58:1	1.74:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-1.6
10-14-000-010	2.03:1	2.23:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-2.0
10-14-000-011	2.47:1	2.72:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-2.5
10-14-000-012	2.93:1	3.22:1	R.H.	ENGINE	OPPOSITE ENGINE	←	R.H.	NE-3.0

(1) VIEWED FROM BEHIND COUPLING FACING ENGINE
(2) VIEWED FROM IN FRONT OF TRANSMISSION INTO PUMP
(3) VIEWED FROM BEHIND BOAT
(4) L.H. – LEFT HAND OR COUNTERCLOCKWISE
R.H. – RIGHT HAND OR CLOCKWISE

CAUTION: Engine rotation must be the same as shown on the chart (input shaft rotation). Failure to comply can result in premature gear damage.

ADAPTER HOUSING

Adapter housings for mounting the transmission to the engine are normally manufactured by the engine manufacturer or marine engine converter. The rear face of the adapter and the adapter rear bore should have a total indicator reading of less than .005 of an inch when checked for run out. All Velvet Drive transmissions which are currently available may be mounted to the same sized bell housing.

Warner Gear does manufacture and have available the following adapters:

71C-1½ for flywheel end mounting to the Ford V-8 engines which have 239, 256, 272, 292, and 312 cubic inch displacement.

71C-1½B for flywheel end mounting to the Ford of England engines which have 220 and 330 cubic inch displacement diesel engines.

71C-1½C for flywheel end mounting to Mercury, Edsel, and Lincoln engines of 383, 410, and 430 cubic inch displacement, and Ford, Edsel, and Mercury engines of 332 and 352 cubic inch displacement.

TRANSMISSION INSTALLATION

INSTALLING TRANSMISSION TO ENGINE

The transmission may be installed to either the flywheel or timing gear end of the engine. A suitable damper assembly should be selected and installed to either the flywheel or to an adapter, which is attached to timing gear end of the crankshaft.

A transmission adapter should be purchased or manufactured to adapt the transmission to the engine. The adapter or spacers must be selected to cause the input shaft splines to make full engagement with the damper drive hub. Check for interference between the various parts as they are assembled.

Damper and transmission adapter alignment should be held to .005 inch total indicator reading for both bore and face readings.

Lubricate the input shaft and damper hub splines as the transmission is assembled to the engine.

Two studs should be screwed into center mounting bolt holes to insure transmission alignment and to support transmission weight to insure that damper will not be damaged as transmission is assembled to engine.

INSTALLATION ANGLE

The transmission and engine should be installed so that the maximum angle relative to horizontal does not exceed 15° when the boat is at rest, and should not exceed 20° when operating at the worst bow high condition. A higher angle of installation along with low oil level can permit pump cavitation when operating in rough water where pitching and rolling tends to throw the oil away from the pump inlet.

TRANSMISSION FLUID

Type F, Dexron® and other hydraulic fluids which meet the Detroit Diesel Allison Division of General Motors Corporation specifications for type C3 oils are recommended for use in all Velvet Drive marine gears.

Lubricating oils which are recommended for use in diesel engines and fall within Allison specifications for C3 oils may be used in all Velvet Drive marine gears if the engine RPM does not exceed 3000. SAE #30 is preferred. SAE #40 is acceptable if high operating temperatures are anticipated. Multi-visosity oils such as 10W-40 are not acceptable. The first choice is SAE-API service class "CD" oils. The second choice is SAE-API service class "CC" oils.

The equivalent DOD mil specs are:

CD MIL-L-2104B
CC MIL-L-45199

Detroit Diesel Allison Division of General Motors developed the C3 specifications for oils to be used in their hydraulic automatic and power shift transmissions used in heavy duty or severe service conditions. These oils are very well suited for use in all Velvet Drive marine gears.

Each oil company will provide information and specifications on their products which fall in the above specifications.

NOTE: Be sure the cooler is properly installed and the transmission contains oil before cranking or starting the engine.

CHECKING OIL LEVEL

The oil level should be maintained at the full mark on the dipstick. Check oil level prior to starting the engine.

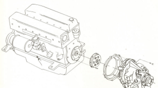


FIG. 6 TYPICAL TIMING GEAR END INSTALLATION

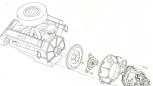


FIG. 7 TYPICAL FLYWHEEL END INSTALLATION

FILLING AND CHECKING THE HYDRAULIC SYSTEM

Check oil daily before starting engine. The Velvet Drive hydraulic circuit includes the transmission, oil cooler, cooler lines and any gauge lines connected into the circuit. The complete hydraulic 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 cooler 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.

TRANSMISSION OPERATION

STARTING ENGINE

Place transmission selector in neutral before starting engine. Shifts from any selector position to any other selector position may be made at any time and in any order if the engine speed is below 1000 RPM; however, it is recommended that all shifts be made at the lowest feasible engine speed.

NEUTRAL

Move the shift lever to the center position where the spring loaded ball enters the chamfered hole in the side of the shift lever and properly locates lever in neutral position. With shift lever so positioned, flow of oil to clutches is blocked at the control valve. The clutches are exhausted by a portion of the valve and complete interruption of power transmission is insured.

FORWARD

Move the shift lever to the extreme forward position where the spring loaded ball enters the chamfered hole in the side of the shift lever and properly locates lever in forward position.

REVERSE

Move transmission shift lever to the extreme rearward position where the spring loaded ball enters the chamfered hole in the side of the shift lever and properly locates it in the reverse position.

FREEWHEELING

Under sail with the propeller turning, or at trolling speeds with one of two engines shut down, the design of the Velvet Drive gear maintains adequate cooling and lubrication.

PRESSURE TESTS

For detailed checks of the hydraulic system, a pressure gauge should be installed in the hydraulic line. The transmission should be run until the oil temperature is 155°F to 165°F. (68°C-74°C). Pressure specifications are available in the repair manuals.

PROPELLER SHAFT COUPLINGS

COUPLING TO SHAFT ASSEMBLY

See form 1044 for specifications of couplings available from Warner Gear.

The propeller shaft coupling must be keyed to the propeller shaft. The key should be a close fit with keyway sides, but should not touch the top of the keyway in the coupling hub. The coupling should be a light press fit on the shaft, and may be warmed in hot oil to permit easier assembly.

> **NOTE:** Propeller shaft coupling distortion may occur when the propeller shaft is a few thousandths under the size required for the particular coupling, thus permitting the coupling to cock and distort as the set screws are tightened. A blank coupling should be machined to fit an undersize shaft. Distorted coupling may be refaced in a lathe.

Two optional methods for fastening the coupling to the propeller shaft are used. Type 1 couplings are pilot drilled through one side only, and the shaft and opposite side of the coupling must be drilled with the coupling in position on the propeller shaft. A 1/4 inch (6.35 mm) stainless steel spring pin must then be driven into the coupling and shaft to retain these parts. The spring pin should be selected so that it will be the same length as the coupling hub diameter and should be approximately flush with the coupling when assembled.

Type 2 couplings are drilled and tapped for set screws which are used to retain these parts. Some propeller shaft couplings are drilled and tapped for set screws, and are also pilot drilled for spring pin installation.

TRANSMISSION COUPLING TO PROPELLER SHAFT COUPLING ALIGNMENT

Vibration, gear noise, loss of RPM and premature oil seal and bearing failure can be caused by misalignment of the transmission coupling and propeller shaft coupling. The propeller shaft is usually fixed in the boat structure, and alignment is achieved by adjusting the engine mounts or by changing engine mount shims.

Preliminary alignment of the coupling faces should be carefully made prior to installing the engine and transmission hold-down bolts. A final alignment check should be made after the boat has been placed in the water. The fuel tanks should be filled and a normal load should be in position when making the final shaft alignment check.

It is common for a boat to change with age or various loads. An alignment check should be made at the beginning of each boating season.

Check coupling alignment with all bolts removed from the couplings. Hand hold couplings together with the snap fit engaged and check to determine the maximum clearance between couplings. Rotate the propeller shaft and then rotate the transmission coupling through at least one complete turn, stopping at 90° intervals and using a feeler gage (see figure 8) to check the air gap between the two flanges. Note any changes in the position where the air gap occurs. A bent shaft or coupling will cause the position of the air gap to move around the flanges as each shaft is rotated.

Alignment is satisfactory when shafts and couplings are on the same line of centers and the coupling faces are within .003 inch (0.076 mm) of parallel.

> **CAUTION:** Do not lift or pry against the transmission coupling to move the engine, as this can distort the coupling. Bent or distorted couplings can be refaced in a lathe.

USE OF FLEXIBLE COUPLINGS

Flexible couplings are used to reduce noise and for vibration dampening. Most boats are rigid enough to permit direct coupling of the propeller shaft coupling to transmission coupling, and this is recommended. Hulls which are not rigid enough to prevent undue twisting in heavy seas will permit shifting of engine and transmission with respect to propeller shaft. A suitable flexible coupling may be used when this condition exists.

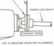


FIG. 8 CHECKING COUPLING ALIGNMENT

The alignment of the propeller shaft to the transmission output shaft should always be maintained even when flexible couplings are used.

Unbolt couplings to prevent bending of the shaft when boats are trailered or dry docked.

SHIFT LEVER

The oil flow to the hydraulic clutches is controlled by a barrel valve which is operated by the shift lever. To make the clutches function properly, the shift lever must be in the exact positions dictated by the detent ball and spring. Connect the push-pull cable to the shift lever so that proper travel and positioning will be obtained at the transmission when the control lever is shifted at the boat operator's station.

The warranty is jeopardised if the shift lever poppet spring and/or ball is permanently removed, or if the control lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift does not have sufficient travel in both directions.

MOUNTING BRACKETS

Removing bolts in order to mount brackets, clamps, etc. can create leaks at gasketed joints.

Removing and reinstalling bolts over brackets can weaken the thread engagement. Proper bolt length and quality are required.

When brackets are bolted to the output shaft bearing retainer and seal mount, oil leaks tend to occur in this area.

Failure of the transmission due to loss of oil thru external causes is not covered by the warranty.

PAINTING

The cast iron transmission should be painted to prevent severe rusting. The color and painting procedure will be similar to that used on the engine.

Care must be taken to keep paint away from areas which have precision dimensions or mating parts. Masking tape or grease should be placed on these parts to prevent paint from sticking. Paint must be kept from the following areas:

1) The pilot diameter of the mounting face that mates with engine bell housing.

2) The input shaft spline which mates with the vibration damper hub.

3) The output shaft coupling flange which mates with the propeller shaft coupling half.

4) The shift lever detent ball and spring. An accumulation of paint here will prevent proper action of the detent.

5) The name plate should not be painted, otherwise the serial and model numbers may be impossible to read and this information should be available for ordering parts.

COOLERS

TRANSMISSION COOLING REQUIREMENTS

WARNING: The transmission must never be operated without a cooler or by-pass tube connected into the cooler circuit.

The pressure regulator system depends upon cooler flow to exhaust a certain amount of oil, otherwise line pressure will become excessively high when a cooler is not connected in the cooler circuit. The transmission may be operated with a cooler bypass tube connected in the cooler circuit when an emergency exists and the transmission must be operated or when short tests are required; however, overheating is apt to occur.

Better efficiency and extended gear life will result when the transmission sump temperature is maintained between 140°F. and 190°F. or 60°C and 88°C. Transmission pressures are dependent upon cooler flow. It is important to select a cooler which has suitable flow characteristics as well as proper cooling capacity. Cooler back pressure affects line and cooler pressure. Low cooler pressure after an extended period of hard running indicates the need for a cooler which has more cooling capacity and possibly more back pressure. High cooler pressure after an extended period of hard running indicates the need for a cooler which has less back pressure.

COOLER LINES

Hydraulic hose with a minimum of 13/32 inch or 10.32mm inside diameter, standard pipe or flare fittings, should be used. Fittings should be large enough to avoid restricting the oil flow. Copper tubing should be avoided due to its tendency to loosen fittings and fatique crack when subjected to vibrations.

WARNER GEAR COOLERS

The coolers built and sold by Warner Gear have been discontinued. These coolers were of the single pass type and were approximately 2 inches (5.08 cm) in diameter. The 5, 9 & 12 in the chart refers to the length in inches of the main body of these coolers. This information should be helpful in determining the size of cooler to select for use with the Velvet Drive assemblies.

COOLER SIZE

The cooler size must be matched to the cooler circuit and the size and type of engine and transmission. The amount of cooling required depends upon the input power (which also governs transmission size) and the reduction ratios.

RECOMMENDATIONS FOR SIZING COOLERS

COOLER SIZE		TRANS. MODEL	TRANSMISSION RATIO
INCH	cm.		
5	127	70C	DIRECT DRIVE
5	127	71C	DIRECT DRIVE
9	228.6	70C	ALL REDUCTION RATIOS
9	228.6	71C	ALL REDUCTION RATIOS (EXCEPT 2.1:1)
9	228.6	72C	DIRECT DRIVE
9	228.6	10-04	ALL V-DRIVE
12	304.8	71C	2.1:1 RATIO
12	304.8	72C	ALL REDUCTION RATIOS
12	304.8	73C	ALL RATIOS
12	304.8	10-05	ALL V-DRIVE

The recommendations given above are based on typical marine engine installations which have a maximum water temperature at the cooler inlet of 110°F or 43°C and a minimum water flow of 10 U.S. gallons per minute or .63 liters/seconds. A larger sized cooler will be required when water entering the cooler has a temperature in excess of 110°F. or 43°C.

Coolers are available from many sources. Each cooler design has its own characteristics of cooling ability and oil flow resistance. **Since these characteristics affect transmission performance, the cooling system should be tested after installation to determine that temperature and pressures fall within recommended limits.**

WATER FLOW RATE

Water flow rates of from 10 to 20 U.S. G.P.M. or .63 to 1.26 liter/seconds are suitable for cooling any Velvet Drive transmission.

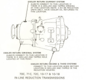
WATER TEMPERATURE TO COOLER

Raw water should be fed directly to cooler, otherwise the 110°F. (43°C) maximum water inlet temperature may be exceeded. Water temperature above 110°F. (43°C) is permissible only if larger sized coolers are used to maintain recommended transmission sump temperature.

CONNECTING COOLER TO TRANSMISSION

WARNING: You must always determine the transmission to cooler and cooler return location for connecting lines to and from coolers for the particular transmission which is being installed. Several different circulation systems have been used. Failure to make the proper connections is sure to cause early transmission failure. Cooler return and to cooler locations may be found on the various installation drawings, which may be found in this manual, and also in the various service manuals. Be aware for future changes or differences which occur as new products are introduced.

NOTE: Transmissions are currently being shipped with plastic plugs installed in the to cooler and cooler return openings to identify their location.



70C, 71C, 72C, 10-17 & 10-18
IN-LINE REDUCTION TRANSMISSIONS

FIG. 9

ALL CURRENT 70C, 71C AND 72C REDUCTION UNITS EXCEPT 2.10:1.00 RATIOS

FIG. 10

DRAWING OF A CURRENT 2.10:1.00 REDUCTION UNIT

FIG. 11

RIGHT SIDE VIEW OF 73C REDUCTION TRANSMISSION

FIG. 12

LOCATION OF SEVERAL TRANSMISSION DETAILS ARE SHOWN BELOW:

- B. To cooler outlet
- C. Cooler return outlet
- D. Reverse clutch pressure tap
- E. Mounting bolt holes
- F. Drain plug
- I. Breather
- J. Input shaft
- N. Adapter
- O. Lube pressure tap
- P. Line pressure tap

COOLER OUT LOCATION

Cooler out is the oil leaving the transmission.

The cooler out location for all 70C, 71C and 72C series In-Line transmissions is located just behind the selector valve at the top rear of the forward and reverse transmission case.

The cooler out location for all 73C series transmissions is directly over the selector valve.

The cooler out location on V-Drive units is located just behind the selector valve at the top rear of the forward and reverse transmission case.

The cooler out location on the Drop-Center units is located just behind the selector valve at the top rear of the forward and reverse transmission case.

COOLER RETURN LOCATION

Cooler return is the oil returning to the transmission.

The cooler return location for all direct drive units of the 70C, 71C, 72C, 10-17 and 10-18 series transmissions is the drain plug opening in the transmission sump.

Early reduction units of the 70C, 71C, 72C, 10-17 and 10-18 series transmissions have the cooler oil returned to the lower side of the reduction housing, (figure 9). All units having the reduction housing drilled and tapped at the lower right side must have cooler oil returned to this location.

Reduction units of the 70C, 71C, 72C, 10-17 and 10-18 series, which do not have the reduction housing tapped in any location, must have the cooler oil returned to the sump fitting on the lower right side of the forward and reverse transmission case.

The 2.10:1 reduction transmissions of the 70C, 71C, 72C, 10-17 and 10-18 In-Line series are currently being drilled and tapped to return cooler oil to the top of the reduction housing, (figure 9). Any 2.10:1 reduction housing which is drilled and tapped for a ⅛-18 pipe fitting at this location must have cooler oil returned to this point.

All model 73C transmissions are currently manufactured to have cooler oil returned to either one of the two locations at the right top front end of the forward and reverse transmission case, (figure 12). The other cooler return opening should be plugged.

V-Drive units have cooler oil returned to an opening which is located at the lower rear of the V-Drive case.

Drop-Center reduction units have cooler oil returned to the sump fitting on the lower right side of the forward and reverse transmission case.

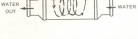
Better cooling efficiency will be obtained when oil and cooling water flow in opposite directions. A larger sized cooler may be required where oil and water flow in the same direction through the cooler.

MOUNTING COOLER

Air can be trapped above the oil in a cooler unless the cooler out fitting is located at the highest point on the cooler. Trapped air reduces cooling capacity, causes foaming, pump cavitation, loss of oil through the breather, and erratic oil level indication.

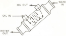
Horizontal mounting is preferred because it prevents oil from draining from the cooler. Drain back from a cooler which is mounted higher than the transmission sump will give a misleading high reading of the sump oil level; therefore, it is best to mount the cooler at sump level, i.e. at or below transmission centerline.

FIG. 13 COOLER MOUNTED HORIZONTALLY



Oil coolers which are mounted on an angle should have cooler lines connected for oil to flow into the lower oil fitting and out of the higher oil fitting.

FIG. 14 COOLER MOUNTED ON AN ANGLE



Cooler problems may be the result of failure to observe hose size recommendations or proper plumbing practices. The flexible oil hoses and fittings used to connect the cooler to the transmission must have an inside diameter of sufficient size to prevent restricting the oil flow. The oil lines should not be too short or engine roll or shifting could stretch and possibly break such hoses. Secure all hoses to prevent shifting and chafing. Sharp bends should be avoided because possible hose damage and restrictions can be caused by such practices.

It is possible for cross leaks to occur inside the cooler, permitting oil to flow into the water or water flow into the oil.

VIBRATION DAMPERS

TRANSMISSION REQUIREMENTS

The splined input shaft on all Velvet Drive marine transmissions, is designed to slide into the hub of a vibration damper. Vibration dampers may be attached to the engine crankshaft at either the flywheel or timing gear end.

The damper prevents engine torsional or cyclic vibrations from being transmitted to the transmission. The most severe engine vibrations are generated by the firings in the cylinders. These vibrations can exceed the spring capacity of the vibration damper and result in gear rattle and may cause transmission failure. Raising the idle speed slightly will usually quiet this vibration.

The diesel engine with its high compression ratio has stronger vibration pulses than a gasoline engine. Compression ratio and the number of cylinders have a direct bearing on engine vibration frequency and amplitude.

The firing order, compression ratio, number of cylinders, displacement, engine inertia, flywheel inertia, loading, speed in RPM, weight of propeller shaft, type of propeller and many other variables all have a bearing on determining the correct damper for the particular application.

Failures due to improper choice of the damper are more frequent in boats which are used for trolling and other fishing activities where the engine is run for many hours at or near idle RPM. Many types of transmission failures, such as broken gear teeth, broken shafts and clutch plates are the result of improper choice of damper.

SELECTION

Each engine has its own characteristics of vibration and inertia. The application engineer must select the specific damper most suitable for the particular model of engine.

Some dampers, due to the particular elements of their design, may be suitable for one engine rotation only. Refer to damper charts on page 21.

Warner Gear does not assume the responsibility for recommending the proper engine flywheel and damper drive for the installation of our transmission. Warner Gear will supply all assistance and information which is available to permit a total torsional system analysis.

The following procedure is recommended for selecting a suitable engine flywheel and damper drive when a suitable damper is not available.

1) If possible, select a flywheel with a moment of inertia as nearly equal to one which is being successfully used in other automotive or industrial applications of the engine. If this is impossible, select a flywheel with a slightly greater moment of inertia. Never select a flywheel with less inertia if it can be avoided as the lighter wheel usually contributes to more severe low RPM torsional problems.

2) Obtain information concerning the damper drive springs and their operating radius, as assembled in the clutch plate used with the above flywheel, so that Warner Gear may determine if it has available a damper drive which has similar characteristics.

3) If a damper drive cannot be furnished by Warner Gear from its production assemblies, based upon information from part 2, trial installations will have to be made using a take-a-part damper drive assembly. This will allow the determination of a proper damper by experimenting with various springs.

DAMPER APPLICATION CHART
AND
DAMPER ASSEMBLIES WHICH ARE CURRENTLY AVAILABLE FROM WARNER GEAR

The following chart gives suggested maximum torques and engine displacements for for which these dampers are designed. Due to wide variations between individual torsional systems, all applications must be tested by the user to insure satisfactory operation.

SERIES	ASSEMBLY NUMBER	MAX. CU. IN. DISPL.	MAXIMUM FOOT POUNDS ENGINE TORQUE							
			GASOLINE				DIESEL			
			8 CYL.	6 CYL.	4 CYL.	1-3 CYL.	8 CYL.	6 CYL.	4 CYL.	1-3 CYL.
K1C (1)	AS12-K1C (7)	175	89	83	72	61	78	67	55	44
	AS1-K1C (7)	250	128	120	104	88	112	96	80	64
	AS4-K1C (7)	330	248	232	202	170	217	186	155	124
	AS5-K1C (8)	370	348	325	283	239	304	261	217	174
	AS7-K1C (8)	430	400	375	325	275	350	300	250	200
	AS14-K1C (8)	430	400	375	325	275	350	300	250	200
K2C (2)	AS12-K2C(3)(7)	175	89	83	72	61	78	67	55	44
	AS1-K2C (3)(7)	250	128	120	104	88	112	96	80	64
	AS4-K2C (3)(7)	330	248	232	202	170	217	186	155	124
	AS8-K2C (4)(7)	330	248	232	202	170	217	186	155	124
	AS5-K2C(3)(8)	370	348	325	283	239	304	261	217	174
	AS7-K2C (3)(8)	430	400	375	325	275	350	300	250	200
	AS10-K2C(5)(8)	430	400	375	325	275	350	300	250	200
	AS3-K2 C (6)(7)	500	520	487	422	357	455	390	325	260
	10-04-650-001	500	520	487	423	357	455	390	325	260
	10-04-650-003		406	380	330	279	355	304	254	203
	10-23-650-003(9)		148	139	121	102	130	111	93	74
	10-23-650-002(9)		148	139	121	102	130	111	93	74

(1) K1C series dampers are usually installed to the timing gear end of the engine.

(2) K2C series dampers are usually installed to the flywheel end of the engine.

(3) Will fit most of the bolt circles for Borg & Beck and Long clutch cover plate locations.

(4) Will fit most of the bolt circles for Borg & Beck and Long clutch plate locations, which are under 12.25 inch diameter.

(5) Has a 10.625 inch bolt circle with six .31375 diameter bolt holes in a 11.36 inch diameter mounting plate.

(6) Fits some flywheels for larger Rockford, Long and Borg & Beck clutches for domestic engines.

(7) These assemblies have full capcity in both directions.

(8) These assemblies are for L.H. engines; however, may be used for R.H. engines when derated 30-40%.

(9) For use with series 1000 transmissions only.

DAMPER INSTALLATION

INSTALLATION DRAWINGS

Damper installation drawings are available from Warner Gear and may be referred to for hub spline data, mounting bolt hole locations and other data which may be required for making an installation. See form 1109.

SPLINE ENGAGEMENT

The engine builder must check the bell housing design and damper design to be sure that the transmission input shaft splines have full engagement into the damper hub splines. There should also be adequate clearance between the damper and transmission case. (The pump bolts have been overlooked and have caused interference in a few installations.) Rotate the engine slowly by hand after completing the installation to verify non-interference. The splines of the input shaft should be lubricated and fit freely into splines of damper hub.

DAMPER BOLTS

Body fit bolts must be used to attach the damper to the engine adapter or flywheel. Torsional reversals tend to "work" and loosen common bolts.

DAMPER HUB

Damper drives for timing gear end installations require a flanged hub to connect the crank shaft with the damper assembly.

EARLY DAMPER SPLINES

The early Velvet Drive transmission input shaft has 10 splines instead of the 26 splines which are currently being supplied. Early damper assemblies were supplied with ten splines to mate with the early transmission input shaft splines. These ten spline damper assemblies may still be purchased for servicing early installations; however, these assemblies may be discontinued as field requirements diminish.

DAMPER PROBLEMS

An unusually rough engine can cause the damper to rattle. This noise usually will go away as the engine speed is increased above 1000 to 1200 RPM. The „rattle„ is caused by the springs in the damper bottoming out or going solid.

A damper which is not correct for the particular engine will rattle even though the engine runs properly.

A noise will sometimes develop after a transmission overhaul. This noise is usually caused by a distorted damper. The damper may be distorted during transmission removal or assembly when the transmission input shaft splines are still engaged and the rear of the transmission is permitted to drop down, thus placing a bending load on the damper hub.

Transmission gears will sometimes rattle when a damper problem exists. Gear rattle is usually the result of an improper or a defective damper, and is not normally caused by faulty transmission parts.

A new neutral switch kit (part number 10-04-420-052) is now available and will replace the earlier kit number 71-1A4A.

Kit 10-04-420-052 contains hte following parts:

1	10-04-539-001	Switch and body assembly
1	10-00-640-004	Switch and "O" ring assembly
1	10-00-140-007	Switch
1	10-00-141-046	"O" Ring
1	10-16-039-001	Valve cover
1	10-16-009-001	Switch cam
3	179796	1/4-20 Hex head bolt
3	103319	1/4 Lockwasher
1	71-14	Valve cover
1	71-14	Valve cover gasket
1	OF1340	Instruction sheet

The new switch and valve cover have a 9/16-18 UNF-2A thread. An "O" ring is used to seal between valve cover and switch. This kit is supplied on all new Velvet Drive assemblies. The complete kit is required for servicing the earlier Kit 71-1A4A.

TRANSMISSION ALARM KIT A4867HN

This is the recommended method for monitoring transmission functions. The temperature will rise to indicate low oil level, low pressure or mechanical problems quicker than a pressure gauge will indicate a drop in line pressure.

TRANSMISSION ALARM KIT A4867HS

This kit is used in conjunction with the A4867HN kit. This kit provides extra components for making a dual station installation.

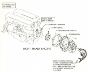


FIGURE 16 TYPICAL TIMING GEAR END INSTALLATION

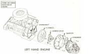


FIGURE 17 TYPICAL FLYWHEEL END INSTALLATION

FIGURE 18 TWIN INSTALLATIONS – Showing inboard & outboard turning props. Outboard turning props are preferred.

FIGURE 19 SINGLE PROP INSTALLATION – Showing right and left hand prop rotation. Right hand propellers are used more often than left hand propellers.

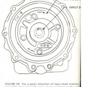


FIGURE 20 For a given direction of input shaft rotation, assemble oil pump with arrow at top pointing in the sa direction. Looking into pump the arrow points to your le on above unit, however this unit would be described as having clockwise rotation when standing behind unit wh describing shaft