

SERVICE MANUAL  
PRICE \$2.50

---

# Velvet Drive®

## Marine Installation Manual



---

**Warner Gear**

**BORG WARNER** Transportation  
Equipment

Division of Borg-Warner Corporation  
P.O. Box 2688, Muncie, Indiana 47302  
Telephone 317/284-8411 Telex: 027-491

FORM 1131 / 8-76  
PRINTED IN U.S.A.

# 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.

PRINTED IN U.S.A.

## TABLE OF CONTENTS

SELECTING A PROPER VELVET DRIVE . . . . .	3
PROPELLER SELECTION . . . . .	4
INSTALLATION DRAWING FOR IN-LINE TRANSMISSIONS . . . . .	5
CHART SHOWING IN-LINE MODELS AND MISCELLANEOUS DATA . . . . .	6
INSTALLATION DRAWING FOR V-DRIVE TRANSMISSIONS . . . . .	7
CHART SHOWING V-DRIVE MODELS AND MISCELLANEOUS DATA . . . . .	8
INSTALLATION DRAWING FOR DROP CENTER TRANSMISSIONS . . . . .	9
CHART SHOWING DROP CENTER MODELS AND MISCELLANEOUS DATA . . . . .	10
ADAPTER HOUSING . . . . .	11
TRANSMISSION INSTALLATION . . . . .	11
TYPICAL INSTALLATIONS SHOWN PICTORIALY . . . . .	12
TRANSMISSION OPERATION . . . . .	13
PROPELLER SHAFT COUPLINGS . . . . .	14
COOLERS . . . . .	16
CONNECTING COOLER TO TRANSMISSION . . . . .	17
VIBRATION DAMPERS . . . . .	20
DAMPER APPLICATION CHART . . . . .	21
DAMPER INSTALLATION . . . . .	22
NEUTRAL SAFETY SWITCH . . . . .	23
ROUTINE CHECKS AND MAINTENANCE . . . . .	24

## TABLE OF CONTENTS

SELECTING A PROPER VELVET DRIVE .....	3
PROPELLER SELECTION .....	4
INSTALLATION DRAWING FOR IN-LINE TRANSMISSIONS .....	5
CHART SHOWING IN-LINE MODELS AND MISCELLANEOUS DATA .....	6
INSTALLATION DRAWING FOR V-DRIVE TRANSMISSIONS .....	7
CHART SHOWING V-DRIVE MODELS AND MISCELLANEOUS DATA .....	8
INSTALLATION DRAWING FOR DROP CENTER TRANSMISSIONS .....	9
CHART SHOWING DROP CENTER MODELS AND MISCELLANEOUS DATA .....	10
ADAPTER HOUSING .....	11
TRANSMISSION INSTALLATION .....	11
TYPICAL INSTALLATIONS SHOWN PICTORIALY .....	12
TRANSMISSION OPERATION .....	13
PROPELLER SHAFT COUPLINGS .....	14
COOLERS .....	16
CONNECTING COOLER TO TRANSMISSION .....	17
VIBRATION DAMPERS .....	20
DAMPER APPLICATION CHART .....	21
DAMPER INSTALLATION .....	22
NEUTRAL SAFETY SWITCH .....	23
ROUTINE CHECKS AND MAINTENANCE .....	24

# 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 counterclockwise if the engine rotates counterclockwise.

## TRANSMISSION ROTATION

Describe transmission input and output shaft rotation as clockwise or counterclockwise (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 point 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 unit or the AS3 and AS13 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.).

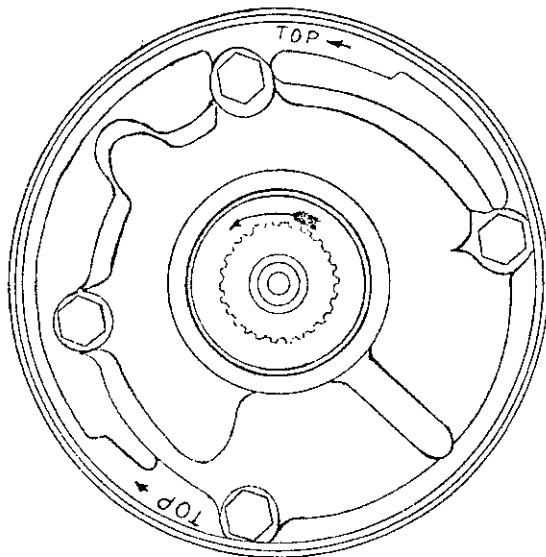


FIG. 1 VIEW FACING PUMP AND INPUT SHAFT

### 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.

**WARNING:** 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.

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

$$2000 = \text{Shaft Speed}$$

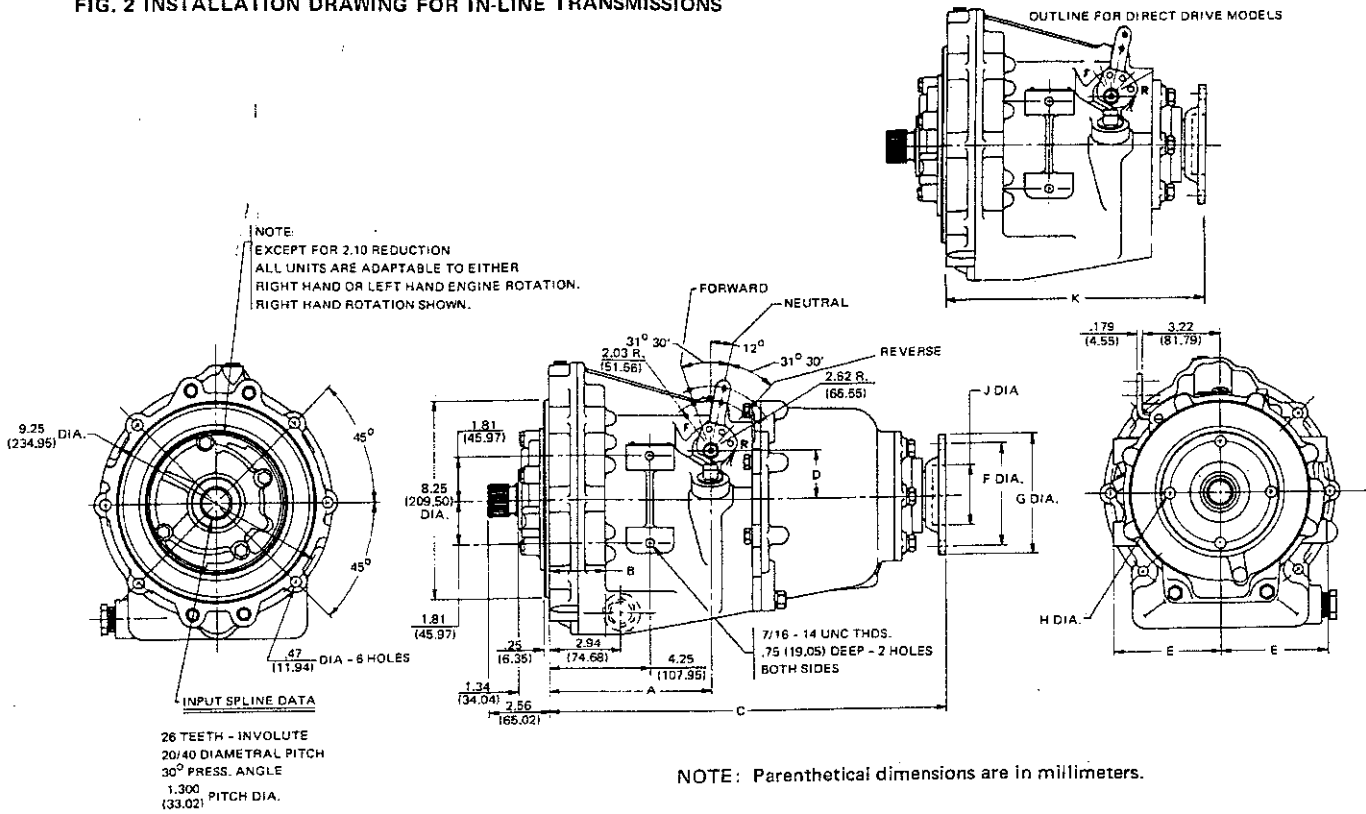
## PROPELLER SELECTION

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 ab-

normally 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.

FIG. 2 INSTALLATION DRAWING FOR IN-LINE TRANSMISSIONS



MODEL	A	B	C	D	E	F DIA	G DIA	H DIA	J DIA	K
70C	6.81 (172.97)	2.38 (60.45)	16.88 (428.75)	2.00 (50.80)	4.50 (114.30)	3.25 (82.55)	4.00 (101.60)	.39-4 holes (9.91)	2.50 (63.50)	10.50 (266.70)
71C					4.50 (114.30)	4.25 (107.95)	5.00 (127.00)	.45-4 holes (11.43)		
72C	7.75 (196.85)	2.62 (66.55)	17.81 (452.37)	2.00 (50.80)	4.50 (114.30)	4.25 (107.95)	5.00 (127.00)	.45-4 holes (11.43)	2.50 (63.50)	11.44 (290.58)
73C	7.50 (190.50)	3.08 (78.23)	19.45 (494.03)	4.38 (111.25)	4.75 (120.65)	4.75 (120.65)	5.75 (146.05)	.52-6 holes (13.21)	3.00 (76.20)	13.47 (342.14)

GENERAL SPECIFICATIONS

MODEL	MAXIMUM SAE HP INPUT		AVAILABLE RATIOS	OUTPUT ROTATION	DRY WEIGHT	
	GASOLINE	DIESEL			DIRECT DRIVE	REDUCTION
70C	180 @ 4200 rpm	75 @ 3200 rpm	1.00, 1.52, 1.91*, 2.10, 2.57, 2.91 to 1.00	ENGINE	92 lb. (41.7 kg.)	143 lb. (63.4 kg.)
71C	255 @ 4200 rpm	145 @ 3200 rpm			95 lb. (43.1 kg.)	145 lb. (65.8 kg.)
72C	380 @ 4200 rpm	185 @ 3200 rpm			109 lb. (49.4 kg.)	153 lb. (69.4 kg.)
73C	560 @ 4200 rpm	400 @ 3200 rpm	1.00, 1.50, 2.00*, 3.00 to 1.00	ENGINE	135 lb. (61.2 kg.)	185 lb. (83.9 kg.)

\* Rotation is opposite engine

OIL.....Type "A," suffix "A" or Dexron A.T.F.  
Oil capacity is dependent upon transmission and oil cooler hookup.

A line of oil coolers and other high-quality Velvet Drive accessories is also available to insure reliable and safe operation of the transmission (see form no. 1065).

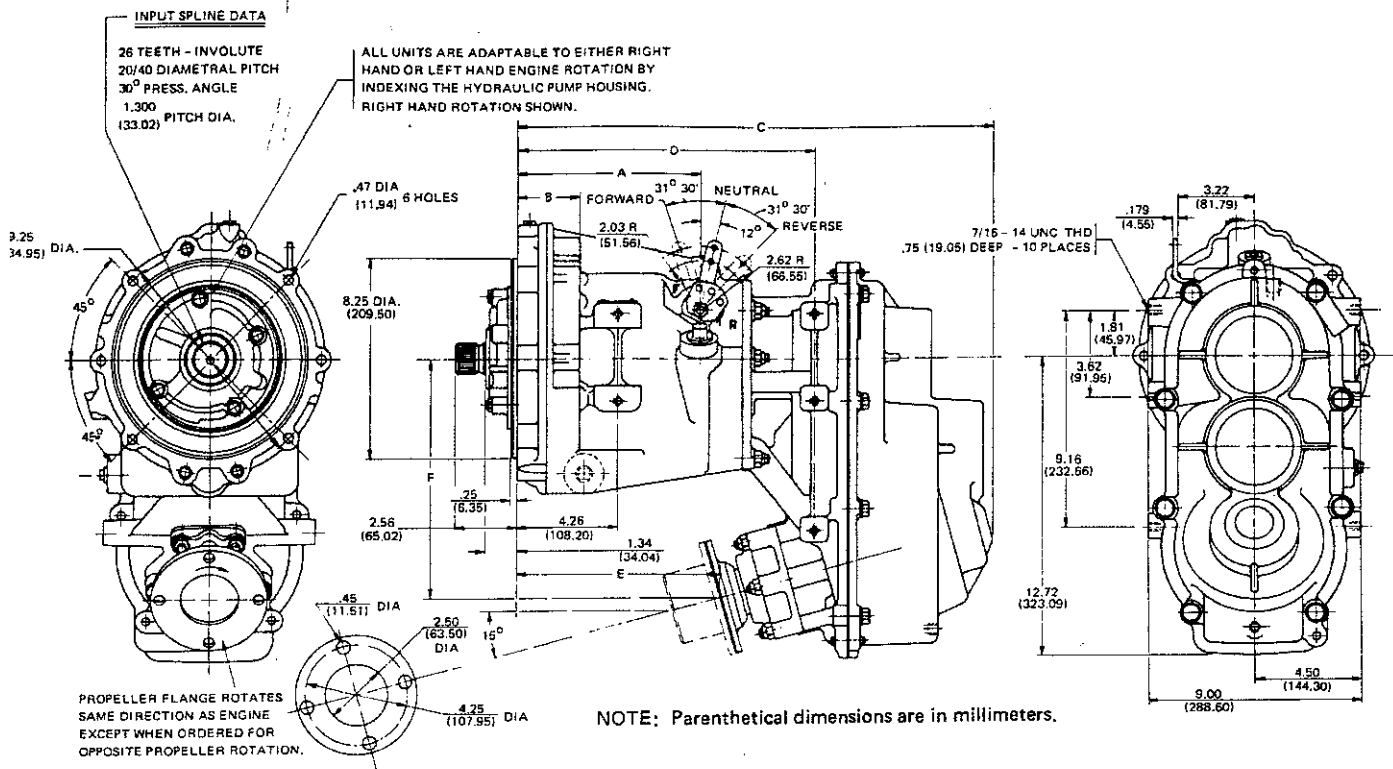
NOTE: All specifications and descriptive data are nominal and subject to change without notice. Specific installations should be referred to Warner Gear for application assistance.

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

TRANS. ASSEMBLY NUMBER	INPUT TO OUTPUT SPEED RATIO		ROTATION (1)			PUMP SETTING (2)	PROPELLER REQUIRED (3)	OIL CAPACITY (4)				APPROX. TRANS. WEIGHT	
			INPUT SHAFT	OUTPUT SHAFT				15° INCLINED		LEVEL			
	FORWARD	REVERSE			FORWARD	REVERSE	U.S. QTS.	LITERS	U.S. QTS.	LITERS	POUNDS	KGS.	
AS1-70C	1:1	1:1	CW	CW	CCW	LH	RH	1.3	1.23	1.8	1.70	92	41.7
AS1-70CR	1:1	1:1	CCW	CCW	CW	RH	LH	1.3	1.23	1.8	1.70	92	41.7
AS2-70C	1.52:1	1.52:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
AS2-70CR	1.52:1	1.52:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
AS3-70C	2.10:1	2.10:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
AS3-70CR	2.10:1	2.10:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
AS14-70C	2.57:1	2.57:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
AS14-70CR	2.57:1	2.57:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
AS15-70C	2.91:1	2.91:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	142	64.4
AS15-70CR	2.91:1	2.91:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	142	64.4
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
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
AS10-70C (7)	1:1	1:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	95	43.1
AS10-70CR (7)	1:1	1:1	CCW	CCW	CW	RH		1.7	1.61	2.1	1.99	95	43.1
AS1-71C	1:1	1:1	CW	CW	CCW	LH	RH	1.3	1.23	1.8	1.70	95	43.1
AS1-71CR	1:1	1:1	CCW	CCW	CW	RH	LH	1.3	1.23	1.8	1.70	95	43.1
AS1-71CB (6)	1:1	1:1	CW	CW	CCW	LH	RH	1.3	1.23	1.8	1.70	95	43.1
AS1-71CBR(6)	1:1	1:1	CCW	CCW	CW	RH	LH	1.3	1.23	1.8	1.70	95	43.1
AS2-71C	1.52:1	1.52:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
AS2-71CR	1.52:1	1.52:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
AS3-71C	2.10:1	2.10:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
AS3-71CR	2.10:1	2.10:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
AS14-71C	2.57:1	2.57:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
AS14-71CR	2.57:1	2.57:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
AS15-71C	2.91:1	2.91:1	CW	CW	CCW	LH	RH	2.7	2.56	2.5	2.37	145	65.8
AS15-71CR	2.91:1	2.91:1	CCW	CCW	CW	RH	LH	2.7	2.56	2.5	2.37	145	65.8
AS7-71C	1.91:1	1.91:1	CW	CCW	CW	LH	LH	2.7	2.56	2.5	2.37	145	65.8
AS7-71CR	1.91:1	1.91:1	CCW	CW	CCW	RH	RH	2.7	2.56	2.5	2.37	145	65.8
AS20-71C (7)	1:1	1:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	98	44.5
AS20-71CR (7)	1:1	1:1	CCW	CCW	CW	RH		1.7	1.61	2.1	1.99	98	44.5
AS11-72C	1:1	1.10:1	CW	CW	CCW	LH	RH	1.7	1.61	2.1	1.99	109	49.4
AS11-72CR	1:1	1.10:1	CCW	CCW	CW	RH	LH	1.7	1.61	2.1	1.99	109	49.4
AS12-72C	1.52:1	1.68:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
AS12-72CR	1.52:1	1.68:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
AS13-72C	2.10:1	2.31:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
AS13-72CR	2.10:1	2.31:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
AS14-72C	2.57:1	2.83:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
AS14-72CR	2.57:1	2.83:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
AS15-72C	2.91:1	3.20:1	CW	CW	CCW	LH	RH	2.8	2.65	2.7	2.56	154	69.9
AS15-72CR	2.91:1	3.20:1	CCW	CCW	CW	RH	LH	2.8	2.65	2.7	2.56	154	69.9
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
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
AS20-72C (7)	1:1	1.10:1	CW	CW	CCW	LH		1.7	1.61	2.1	1.99	112	50.8
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
AS1-73C	1:1	88:1	CW	CW	CCW	LH	RH	1.5	1.42	1.6	1.51	135	61.2
AS1-73CR	1:1	88:1	CCW	CCW	CW	RH	LH	1.5	1.42	1.6	1.51	135	61.2
AS2-73C	1.5:1	1.32:1	CW	CW	CCW	LH	RH	2.2	2.08	2.0	1.89	185	83.9
AS2-73CR	1.5:1	1.32:1	CCW	CCW	CW	RH	LH	2.2	2.08	2.0	1.89	185	83.9
AS5-73C	3:1	2.64:1	CW	CW	CCW	LH	RH	2.2	2.08	2.0	1.89	185	83.9
AS5-73CR	3:1	2.64:1	CCW	CCW	CW	RH	LH	2.2	2.08	2.0	1.89	185	83.9
AS7-73C (5)	2:1	1.76:1	CW	CCW	CW	LH	LH	2.2	2.08	2.0	1.89	185	83.9
AS7-73CR (5)	2:1	1.76:1	CCW	CW	CCW	RH	RH	2.2	2.08	2.0	1.89	185	83.9

- (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 REVERSED, 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 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 AS30-72CR 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.

FIG. 3 INSTALLATION DRAWING FOR V-DRIVE TRANSMISSIONS



MODEL	A	B	C	D	E	F	REDUCTION
71C SERIES						10.19 (258.83)	.96:1, 1.21:1, 2.49:1, 3.14:1
10-04	6.83 (173.48)	2.38 (60.45)	19.15 (486.41)	11.65 (295.91)	7.64 (194.06)	10.14 (257.56)	1.51:1, 1.99:1
72C SERIES						10.19 (258.83)	.96:1, 1.21:1, 2.49:1, 3.14:1
10-05	7.76 (197.10)	2.64 (67.06)	20.06 (509.52)	12.59 (319.79)	8.58 (217.93)	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 @ 3200 rpm			203 lb. (92.1 kg.)

OIL.....Type "A," suffix "A" or Dexron A.T.F.  
 Oil capacity is dependent upon transmission and oil cooler hookup.

A line of oil coolers and other high-quality Velvet Drive accessories is also available to insure reliable and safe operation of the transmission (see form no. 1065).

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.

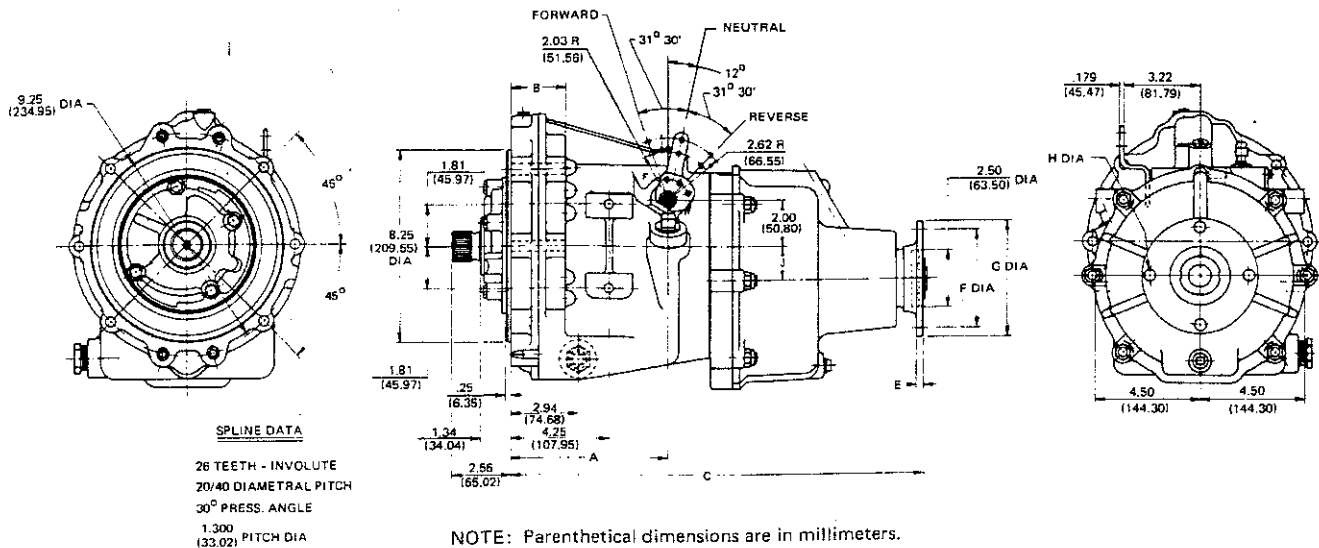
## V-DRIVE ASSEMBLIES

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

C - CLOCKWISE

CC - COUNTER CLOCKWISE

FIG. 4 INSTALLATION DRAWING FOR DROP-CENTER TRANSMISSIONS



MODEL	A	B	C	E	F DIA	G DIA	H DIA	REDUCTION	J OFFSET DIMS. OUTPUT ROTATION	
									ENGINE	OPPOSITE
71C SERIES								1.58	1.23 (31.24)	1.06 (26.92)
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)	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								1.58	1.23 (31.24)	1.06 (26.92)
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)	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)

GENERAL SPECIFICATIONS

MODEL	MAXIMUM SAE HP INPUT		AVAILABLE RATIOS	OUTPUT ROTATION	DRY WEIGHT
	GASOLINE	DIESEL			
10-13	255 @ 4200 rpm	145 @ 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 @ 3200 rpm			175 lb. (79.4 kg.)

OIL.....Type "A," suffix "A" or Dexron A.T.F.  
 Oil capacity is dependent upon transmission and oil cooler hookup.

A line of oil coolers and other high-quality Velvet Drive accessories is also available to insure reliable and safe operation of the transmission (see form no. 1065).

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.

**CR2**  
(DROP CENTER ASSEMBLIES)

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

ASSEMBLY NUMBER	REDUCTION RATIO		SHAFT ROTATION (1)			PUMP SETTING (2)	PROPELLER REQUIRED (3)	NAME PLATE STAMPED
	FORWARD	REVERSE	INPUT (4)	OUTPUT				
				FORWARD	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.

### MOUNTING ENGINE AND TRANSMISSION

Follow the engine manufacturer's recommendations for mounting engine and transmission.

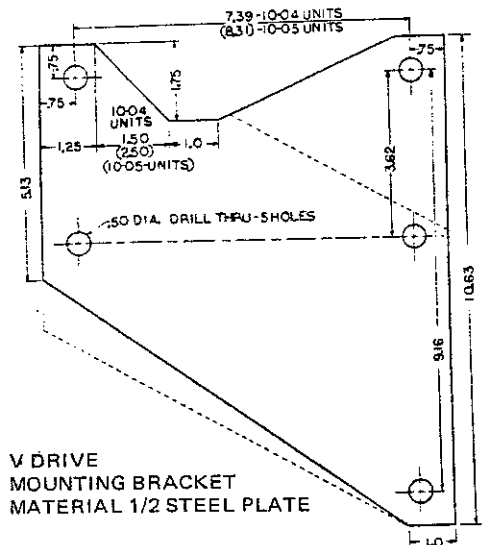


FIG. 5 MOUNTING BRACKET

A mounting plate similar to the one illustrated should be fabricated and bolted to each side of the V-Drive assembly. The rear engine mounts should be attached to these plates.

The plates may be made from 1/2 inch thick steel plate. The dotted line shows an alternate slope for the plate when made from 6 or 6-1/2 inch bar stock.

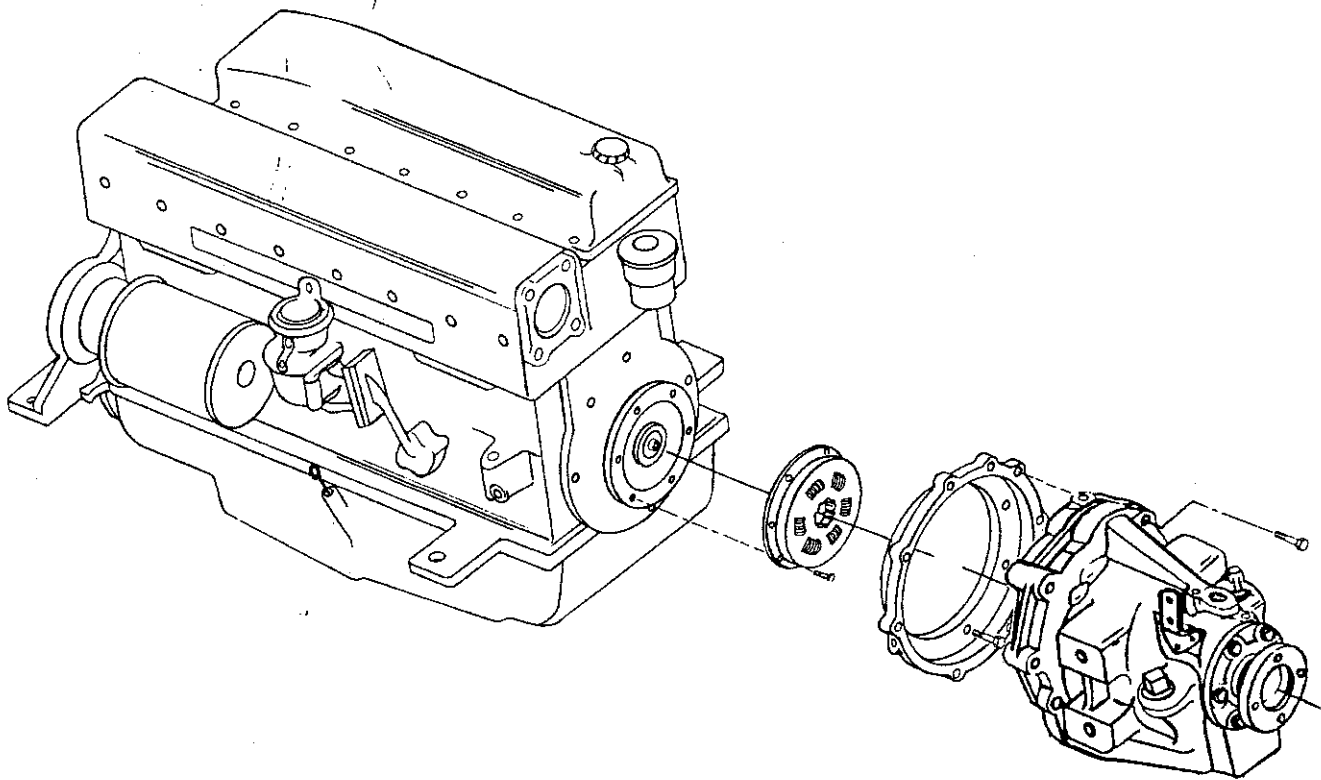


FIG. 6 TYPICAL TIMING GEAR END INSTALLATION

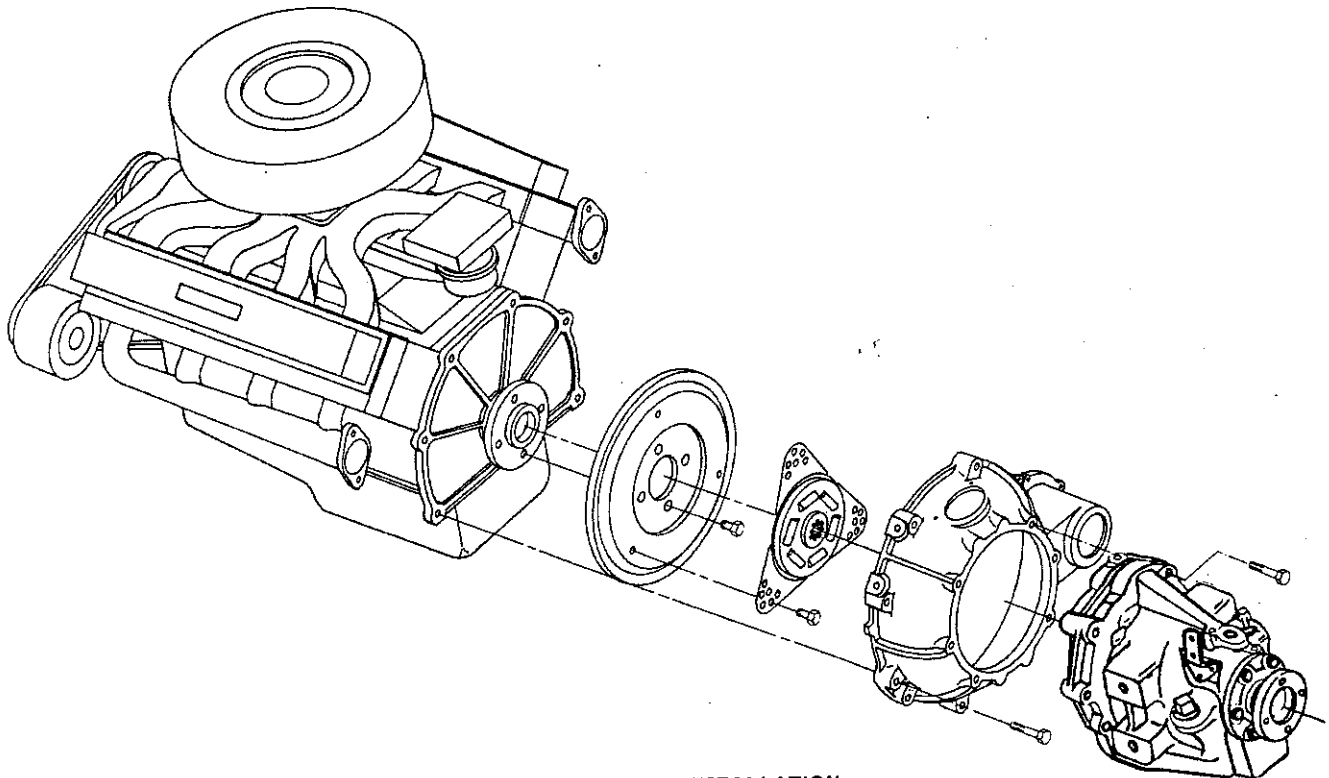


FIG. 7 TYPICAL FLYWHEEL END INSTALLATION

## 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.

## HYDRAULIC FLUID

Improper oil may cause foaming, overheating, or improper lubrication. Dexron Automatic Transmission fluid has been thoroughly tested in these transmissions and is recommended; however most automatic transmission fluids will give satisfactory performance. SAE No. 30 diesel engine oil may be used if engine speed will not exceed 3000 RPM and oil is cooled with engine jacket water. The use of transmission oil additives is not recommended.

**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.

## FILLING AND CHECKING THE HYDRAULIC SYSTEM

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.

## FREE WHEELING

Short periods of free wheeling are permissible. Extended periods of free wheeling at high speeds may cause the transmission to overheat; therefore, it is recommended that transmission sump temperature be monitored and free

wheeling discontinued whenever 230°F. or 111°C. is reached. A temperature alarm kit, for installation in transmission sump, is available from your Velvet Drive dealer. The transmission may be cooled by operating the engine to circulate the transmission oil and cooler water. Free wheeling can be continued after the transmission has been cooled to a safe temperature. The transmission should be in good condition and full of fluid anytime free wheeling is permitted.

A suitable propeller shaft locking device may be found advantageous on installations requiring extended periods of free wheeling at high speeds.

## 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

### 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). For model 70, 71 and 72 transmissions, the line pressure should be 117 p.s.i. to 130 p.s.i. (8.27-9.14 kg/Cm<sup>2</sup>) at 450 RPM and 125 p.s.i. to 140 p.s.i. (8.79-9.84 kg/Cm<sup>2</sup>) at 2,000 RPM. Higher pressure will occur at higher RPM or when temperature is lower.

For model 73 transmissions, the clutch pressure should be 115 p.s.i. to 140 p.s.i. (8.09-9.84 kg/Cm<sup>2</sup>) at 2,000 RPM with an oil temperature of 140°F. to 190°F. (60°C-88°C).

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

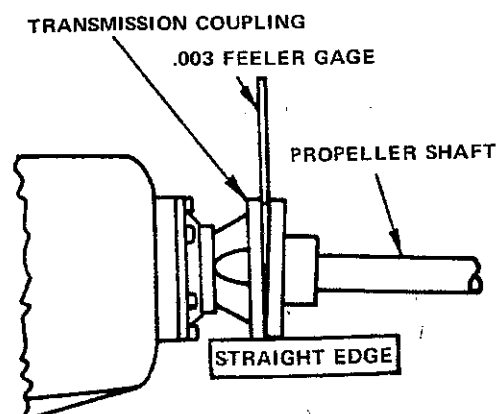


FIG. 8 CHECKING COUPLING ALIGNMENT

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.

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 60c and 88c. 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.

## COOLER LINES

Hydraulic hose with a minimum of 13/32 inch or 10.32mm inside diameter, using 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 fatigue crack when subjected to vibrations.

## WARNER GEAR COOLERS

Warner Gear coolers are designed to give optimum heat transfer at reasonable cost. They are single-pass coolers, with the water flowing through the tubes and the oil flowing through the shell around the tubes where it is baffled to obtain maximum heat transfer. The 150 p.s.i. or 10.55 kg/Cm<sup>2</sup>. maximum operating pressure rating for these coolers provides a safe margin over the normal 40 p.s.i. or 2.81 kg/Cm<sup>2</sup>. cooler inlet oil pressure.

Warner Gear Division makes oil coolers of one diameter and three lengths (5" or 127 cm, 9" or 228.6 cm, and 12" or 304.8 cm.) The longer the cooler, the more cooling capacity it has.

Standard coolers are available with end fittings for standard water hose sizes, see Form 1050/9-70. Special diameters and elbow end fittings may be available upon request.

## 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 WARNER GEAR 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 43c, 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 43c.

## OTHER COOLERS

Coolers are available from other 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 the recommended limits.

## WATER FLOW RATE

Warner Gear coolers are designed for water flow rates of from 10 to 20 U.S. G.P.M. or .63 to 1.26 liter/seconds.

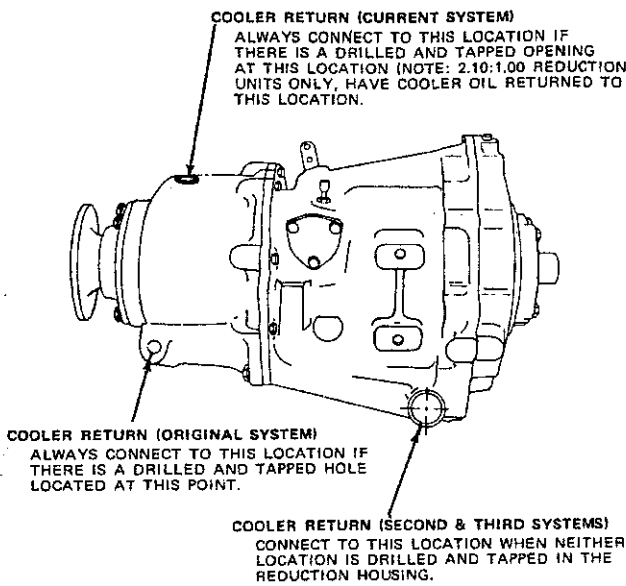
## WATER TEMPERATURE TO COOLER

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

# CONNECTING COOLER TO TRANSMISSION

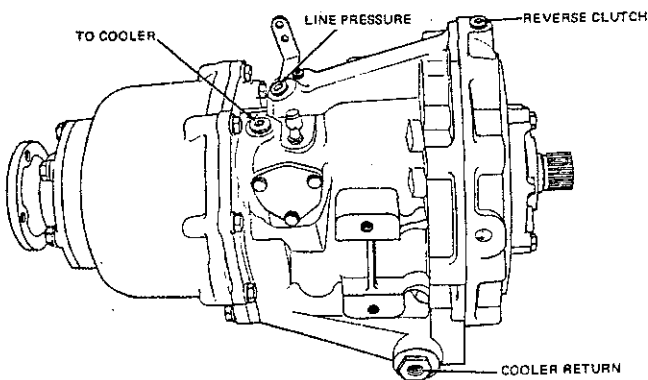
**WARNING:** You must always determine the transmission to cooler and cooler return location for connecting lines to and from coolers for the particular transmission which is being installed. Several different circulation systems have been used. Failure to make the proper connections is sure to cause 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.*



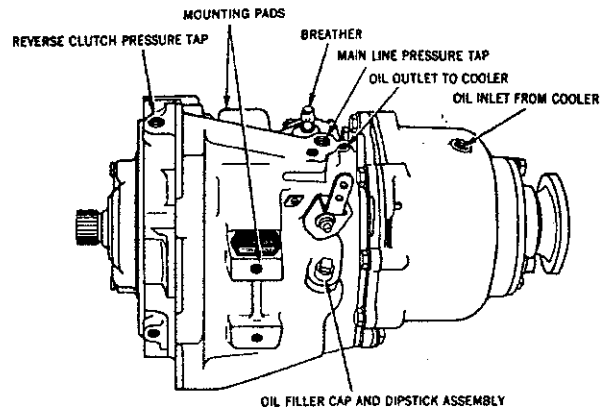
70C, 71C AND 72C IN-LINE REDUCTION TRANSMISSIONS

FIG. 9



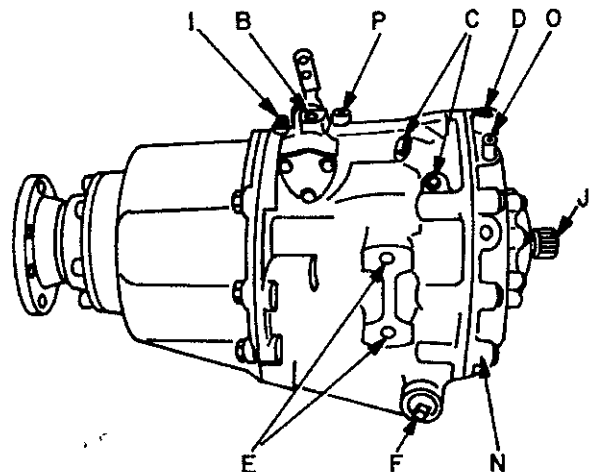
ALL CURRENT 70C, 71C AND 72C REDUCTION UNITS EXCEPT 2.10:1.00 RATIOS

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            | I. Breather          |
| C. Cooler return outlet        | J. Input shaft       |
| D. Reverse clutch pressure tap | N. Adapter           |
| E. Mounting bolt holes         | O. Lube pressure tap |
| F. Drain plug                  | 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 and 72C series transmissions is the drain plug opening in the transmission sump.

Early reduction units of the 70C, 71C and 72C 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, and 72C 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 and 72C 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 3/8-18 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.

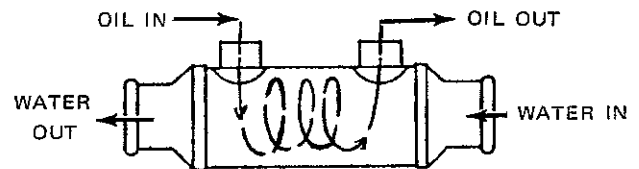
Better cooling efficiency will be obtained when oil and cooling water flow in opposite directions. A larger sized cooler may be required where oil and water flow in the same direction through the cooler.

## 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.

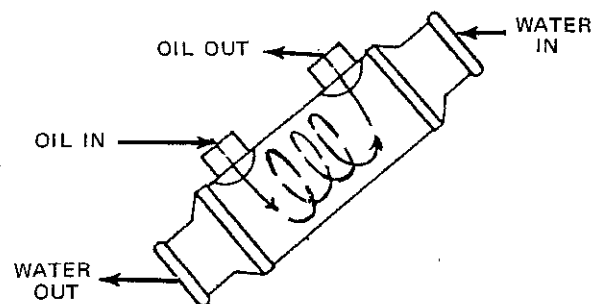
Horizontal mounting is preferred because it prevents oil from draining from the cooler. Drain back from a cooler which is mounted higher than the transmission sump will give a misleading high reading of the sump oil level; therefore, it is best to mount the cooler at sump level, i.e. at or below transmission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

FIG. 13 COOLER MOUNTED HORIZONTALLY



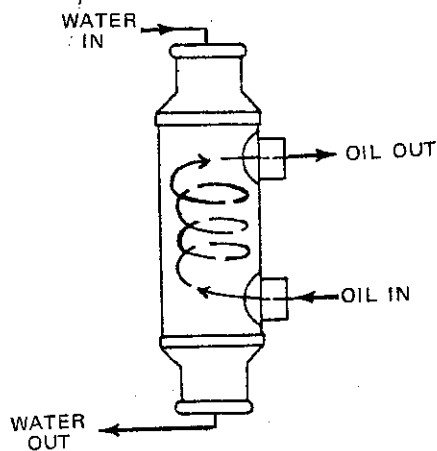
Oil coolers which are mounted on an angle should have cooler lines connected for oil to flow into the lower oil fitting and out of the higher oil fitting.

FIG. 14 COOLER MOUNTED ON AN ANGLE



Vertically mounted oil coolers should have the oil inlet located nearest the bottom of the cooler and the oil outlet located nearest the upper end of the cooler.

FIG. 15 COOLER MOUNTED VERTICALLY



A check valve may be installed in the oil cooler circuit to prevent cooler drain back. The check valve should be of sufficient size to prevent restricting the cooler oil flow. Coolers mounted below transmission center line will not drain into transmission.

#### TESTING COOLER CIRCUIT

The cooler size affects the oil temperature and lubrication pressures within the transmission; therefore, a test run should be made to insure that the transmission sump oil temperature falls between 140°F (60c) and 190°F (88c). The 190°F maximum sump temperature should not be exceeded when running at full throttle for an extended period of time. Overheating can cause transmission failure.

An accurate thermometer may be used to check the oil temperature by removing the dipstick and placing the thermometer directly in the sump oil. It is recommended that the engine be shut off while checking the temperature to prevent the possibility of catching the thermometer in the rotating gears. Continuous monitoring of sump temperatures is possible when a thermocouple is installed in the cooler out circuit near the transmission. The thermocouple should always be placed in the oil circuit so the oil passes over the sending unit.

Cooler pressures can be checked by connecting a pressure gage in the cooler out circuit near the transmission. When operating the engine at 2000 RPM, the normal cooler pressure at operating temperature should be approximately 40 p.s.i. or 2.81 kg/Cm<sup>2</sup>.

#### WATER DRAIN PLUG

Coolers are usually supplied with a drain plug which may be used to drain the water to prevent damage, which would occur in freezing weather. The plug should be located so that complete drainage of the cooler will occur when the drain plug is removed. Prior to ordering a cooler, consider the oil inlet location and drain plug location so that an assembly, which will satisfy all recommendations, may be ordered. Consider hose size and the angle of the hose connection so that the most direct cooler hook-up may be made.

#### COOLER BRACKETS

Two pair of cooler brackets are available for mounting the Warner Gear type coolers. Mounting bracket (upper) number 4876A and mounting bracket (lower) number 4875A are used together and mounting bracket (upper) number 4876B and mounting bracket (lower) 4875B are used together.

#### COOLING PROBLEMS

Water passages inside of the cooler will sometimes become clogged, and this will reduce cooling capacity and cause overpressuring. Back flushing of the cooler will sometimes help to flush the foreign material from the cooler passages. The cooler and hose should be thoroughly flushed or replaced in the event a failure has occurred. Metallic particles from the failure tend to collect in the case of the cooler and gradually flow back into the lube system. Replace oil cooler to prevent contamination of the new transmission.

Water hoses may collapse and reduce or completely shut off all flow to the cooler. Collapsed hoses are usually caused by aging of the hoses or improper hose installation. Hose installation should be made with no sharp bends. Hoses should be routed so there is no possibility for engine shifting to cause hoses to pull loose or become pinched. A visual inspection of hoses while under way will sometimes allow detection of faulty hoses.

Reduction or complete loss of water flow can be caused by a faulty water pump. A rubber water pump impeller will sometimes fail and after such a failure the cooler passages may be restricted by the particles of rubber from the failed impeller. Water pump cavitation may be caused by improper or faulty plumbing or an air leak on the inlet side of the pump. The water pump may not prime itself or may lose its prime when inlet plumbing is not properly installed.

Cooler problems may be the result of improperly connecting the cooler to the transmission. Reports from the field indi-

cate that the proper transmission plumbing locations have not always been used for connecting the cooler to the transmission. It is therefore suggested that a thorough study be made of the various cooler inlet and outlet locations for the various models as detailed at the introduction of this section on page 17.

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. DSPL.	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-K2C (6)(7)	500	520	487	422	357	455	390	325	260
	10-04-650-001	500	520	487	423	357	455	390	325	260

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

# 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 forms 1109/8-71, 1110/8-71, 1111/8-71, 1112/8-71 and 1116/8-71.

## 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.

## 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.

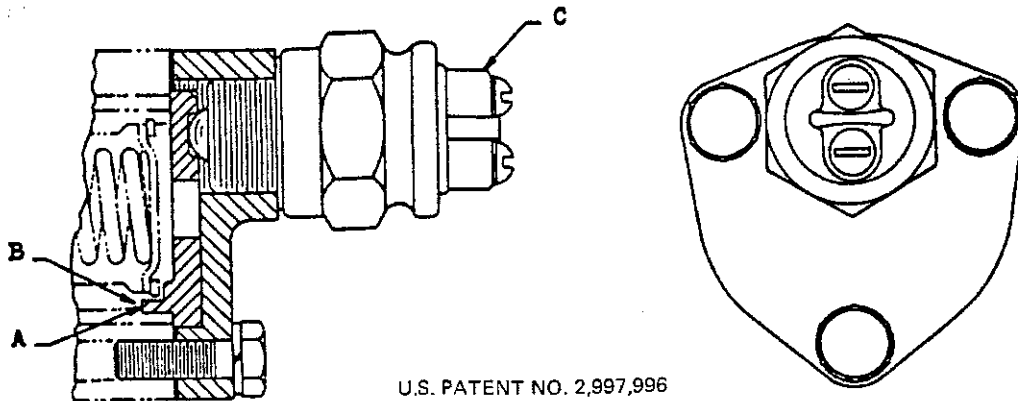
A noise will sometimes develop after a transmission overhaul. This noise is usually caused by a distorted damper. The damper may be distorted during transmission removal or assembly when the transmission input shaft splines are still engaged and the rear of the transmission is permitted to drop down,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

# NEUTRAL SAFETY SWITCH

In the interest of safety, it is recommended that the Neutral Safety Switch, Part 71-1A4A, be installed. This easily installed electrical switch makes it necessary for the transmission

to be in neutral before the engine can be started. This switch is wired in series with the starter switch.



## INSTALLATION OF NEUTRAL SWITCH KIT

- 1) On side of the case opposite the shifting lever, remove and discard the valve cover screws, lockwashers, valve cover and valve cover gasket.
- 2) Shift gear into neutral and assemble tang "A" on plate

in slot "B" in end of valve. Assemble cover with switch "C" between upper two screws in gear box.

- 3) When tightening the three cap screws, move control lever to extreme positions to insure free operation and assemble starter solenoid wires to switch.

# ROUTINE CHECKS AND MAINTENANCE

## ANNUAL CHECKS

### 1) PROPELLER AND OUTPUT SHAFT ALIGNMENT

This check should also be made anytime the propeller strikes a heavy object and after any accident where the boat is stopped suddenly. Shaft alignment should also be checked after the boat has been lifted by a hoist or moved on a trailer.

### 2) SHIFT LEVER POSITIONING

The selector controls must position the shift lever exactly in F, N, and R selector positions with the ball poppet centered in the shift lever hole for each position.

### 3) BOLT TORQUE

Check all bolts for tightness.

### 4) COOLER CONNECTIONS

Check water lines, oil lines and connections for leakage. Make sure lines are securely fastened to prevent shifting.

### 5) TRANSMISSION FLUID

Change transmission fluid once each season. Check and clean the oil screen each time the fluid is drained.

## DAILY CHECKS

- 1) Check transmission oil level.
- 2) Check for any signs of oil leakage in the bell housing, at gasket sealing surfaces, or at the output shaft oil seal.
- 3) A quick visual check of the general condition of the equipment may cause faulty equipment to be detected.
- 4) Listen for any unusual noises and investigate to determine the cause of any such noises.

## WINTER STORAGE

- 1) Drain water from the transmission oil cooler. This will prevent freezing in cooler climates, and prevent harmful deposits from collecting.

## GENERAL CHECKS

- 1) Check coupling alignment each time a transmission is replaced in the boat.
- 2) Check shift linkage adjustment to insure that the transmission shift lever is positioned so that the spring loaded ball enters the chamfered hole in the side of the shift lever.
- 3) Connect an oil cooler into the cooler circuit before cranking or starting the engine. Various cooler circuits have been used and the correct cooler connections should be found from service literature prior to making the cooler installation.
- 4) Use a cooler of sufficient size to insure proper cooling.
- 5) Check engine rotation and transmission pump setting and the propeller rotation prior to assembling the transmission to engine.
- 6) Check oil pressure and temperature when transmission function indicates that a problem exists.
- 7) Use the recommended fluid for filling the transmission.
- 8) Fill the transmission prior to starting the engine.
- 9) Check oil level immediately after the engine has been shut off.
- 10) Use a clean container for handling transmission fluid.
- 11) Flush cooler and cooler line after a transmission failure, prior to installing a new or rebuilt transmission.
- 12) Check fluid level at operating temperature.