Table of Contents

Owner's Responsibilities...

It is the owner's/operator's responsibility to perform the necessary safety checks to ensure that all lubrication, cooling, maintenance and recommended practices are followed for safe, enjoyable operation.

All transmission units are covered by a guarantee given by the manufacturer, therefore:

> The instructions in this manual are to be strictly observed with reference to the handling of the transmission units.

CAUTION

The manufacturer is not liable for damages caused by a faulty installation, wrong handling and deficient maintenance.
Please make sure to avoid any external forces as well as vibrations caused by torsion and bending.

The interaction between the engine, shaft equipment and propeller may lead to torsional vibrations producing a hammering noise of gears and eventually damaging the engine and transmission. HURTH ist not responsible for such torsional vibrations inherent to the installation.

The complete limited warranty conditions and procedures are found in the "Owner's Manual".

I Introduction

This manual describes the installation of the HSW 630A transmission.

When used in the manual, the terms "right-hand, front, rear, starboard, port" always refer to the installed transmission in the direction of forward movement.

Important information relating to technical dependability and operational safety are highlighted by the identifying words as follows:

WARNING

An operation or maintenance procedure, practice, condition, statement, etc., which is not strictly observed, could result in serious harm or fatal injury.

CAUTION

An operation or maintenance procedure, practice, condition, statement, etc., which is not strictly observed, could result in damage to, or destruction of, equipment.

NOTE:

Applies to technical requirements to which the user of the equipment must pay particular attention.

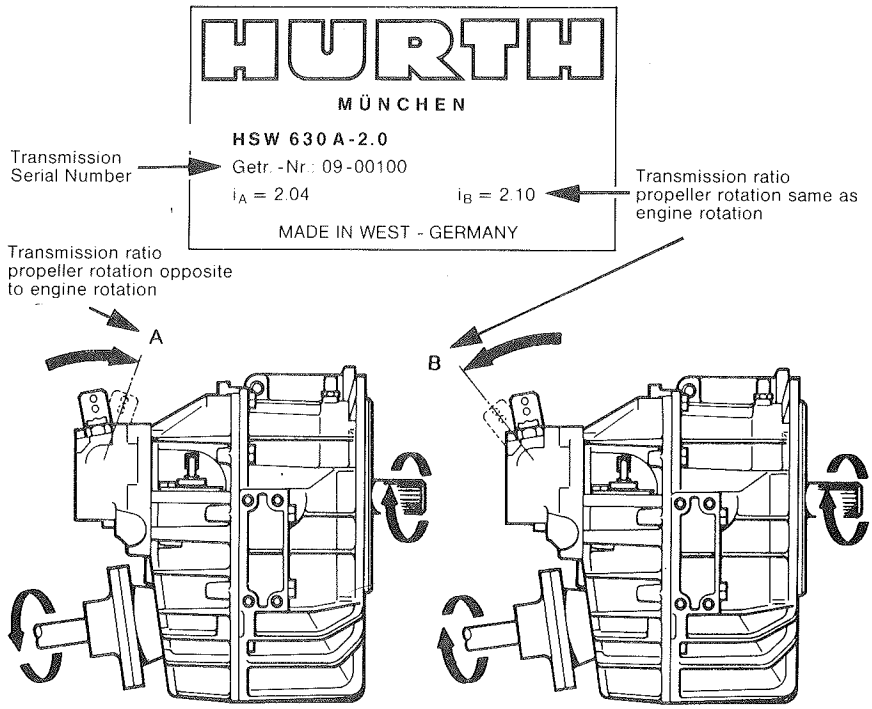
WARNINGS and **CAUTIONS** always precede the text to which they apply.

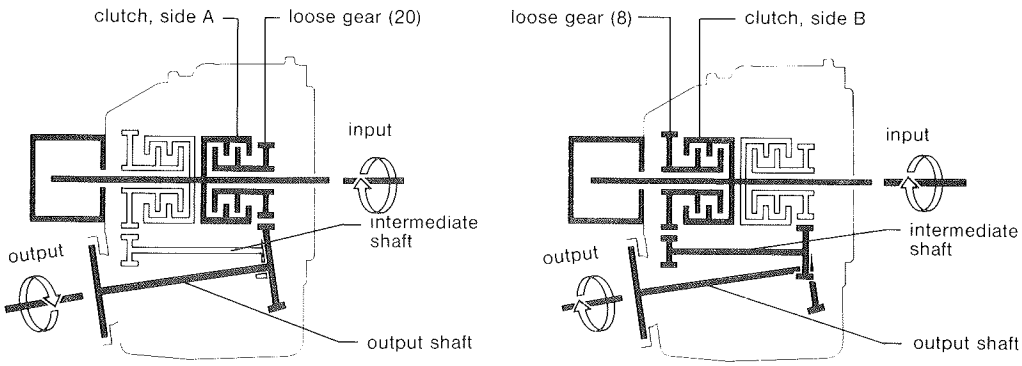
II Gear Identification

Name plate

The name plate is mounted on the transmission.

Example of name plate:





Position of shifting lever when driving forward

Propeller pitch	Propeller ratio	Shifting lever in position
Right hand	opposite to engine rotation	A
Left hand	as engine rotation	B

Significance of transmission designations:

Size of transmission — Version of transmission

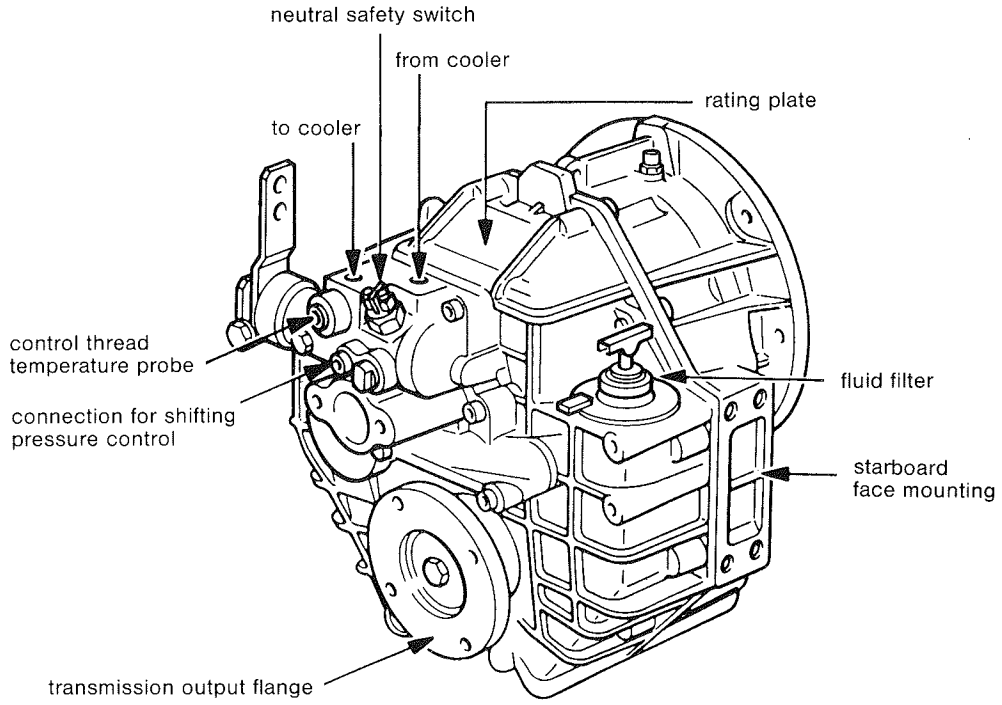
Type of transmission — Nominal transmission ratio

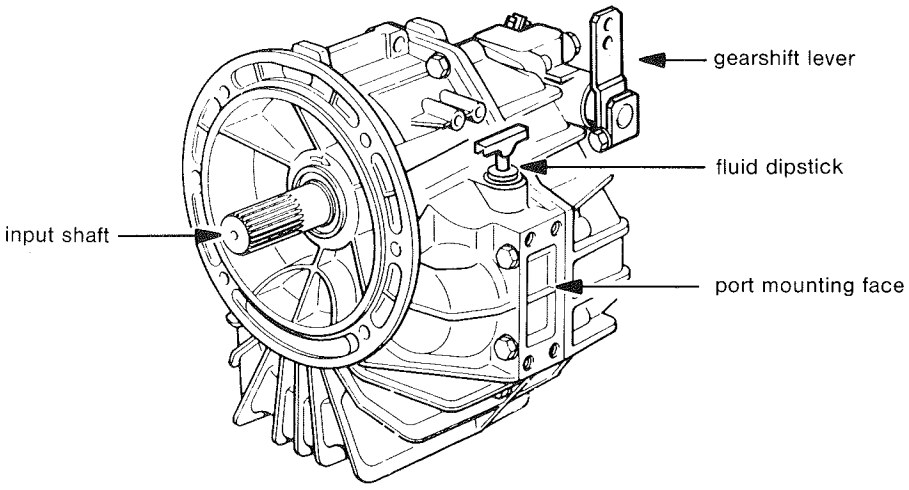
HSW 630A - 2.0

III Description

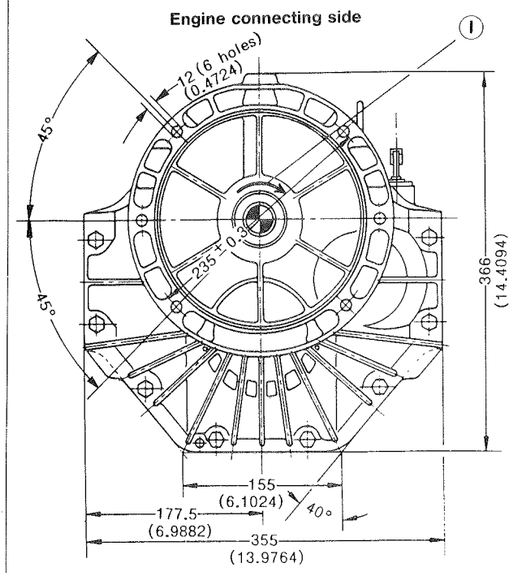
The HSW 630A marine transmission is a hydraulically activated helical gear unit, developed for use in pleasure and commercial craft and designed as a three-shaft type gearbox. Its multiple disc reversing clutch is mounted on the input shaft and is supplied with hydraulic fluid by a pump geared to the engine speed and integrated into the control block. The transmission can be reversed even at increased engine speeds, for example in emergencies.

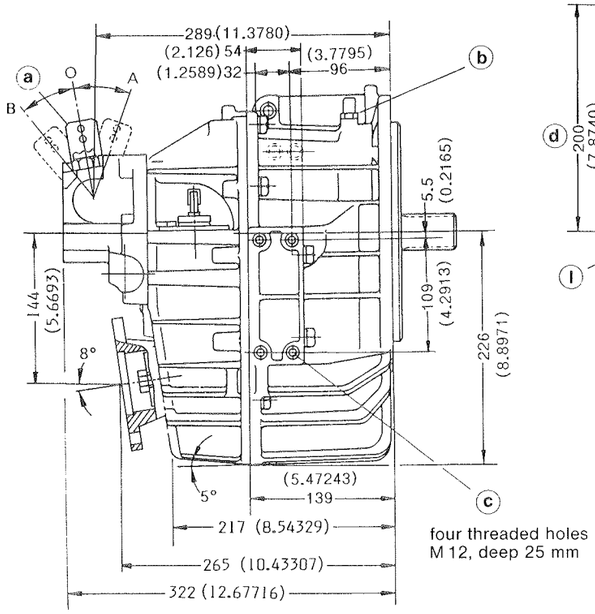
The torque transmission capacity of the transmission clutches is exactly rated by maintaining the fluid pressure constant, so as to prevent shock loads from exceeding a predetermined value and to protect the driving unit against overload. Thus the effect of a safety clutch is provided.



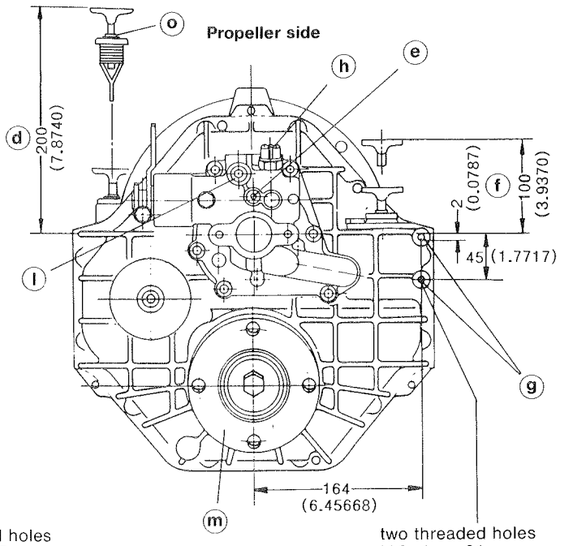


IV Installation Drawing

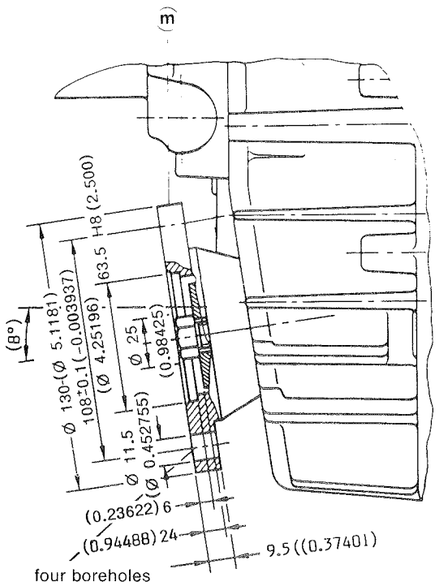


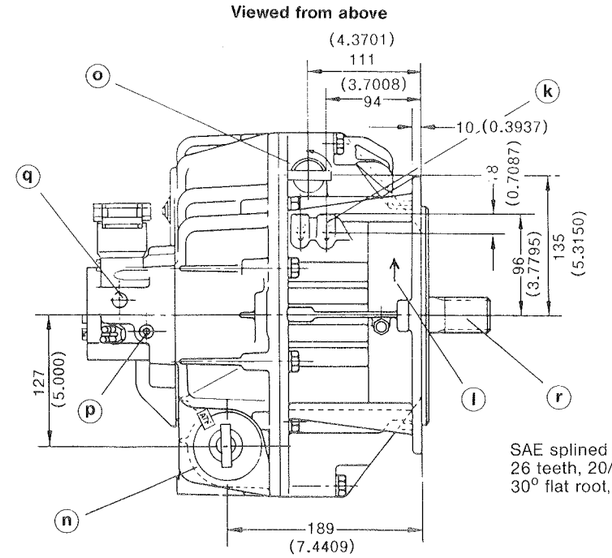


four threaded holes M 12, deep 25 mm

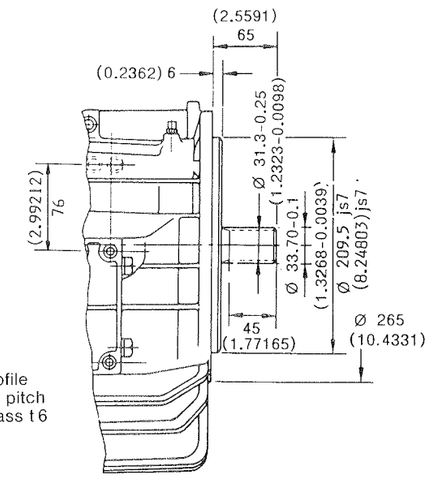


two threaded holes M 8, deep 21 mm





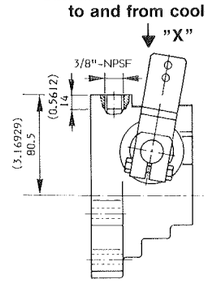
SAE splined profile
26 teeth, 20/40 pitch
30° flat root, class t 6



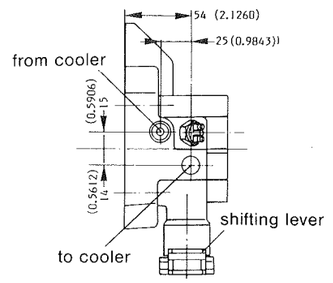
- **a.** Shifting lever
- **b.** Transmission breather
- **c.** For transmission suspension
- **d.** Space for removing dipstick
- **e.** Connection for shifting pressure gauge M 10x1
- **f.** Space for removing fluid filter
- **g.** For cooler mounting
- **h.** Neutral safety switch
- **i.** Threaded hole 3/8" NPSF for connecting temperature gauge
- **k.** Threaded hole M 8 for connecting countersupport
- **l.** Direction of input rotation
- **m.** Output flange
- **n.** Fluid filter
- **o.** Fluid dipstick
- **p.** Connection from cooler
- **q.** Connection to cooler
- **r.** Input shaft

Tolerance zone	minimum	–	maximum	
63.5 H 8	63.500	–	63.546	mm
2.500	2.500	–	2.5018	in.
209.50 js 7	209.477	–	209.523	mm
8.24803	8.2471	–	8.2489	in.

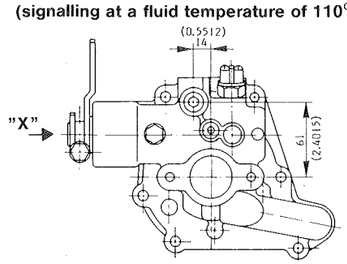
connection for fluid lines to and from cooler



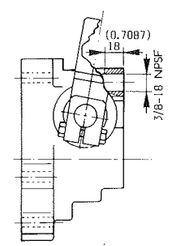
viewed in direction "X"



connection for temperature gauge on control block (signalling at a fluid temperature of 110°C)

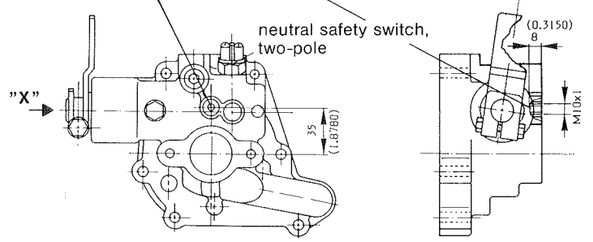


viewed in direction "X"



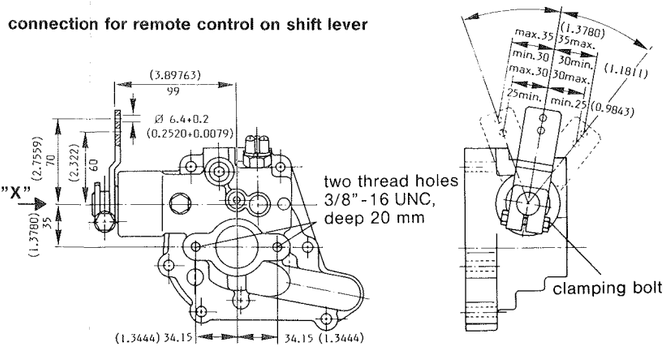
connection for shifting pressure gauge and neutral safety switch connection thread for shifting pressure gauge

viewed in direction "X"



connection for remote control on shift lever

viewed in direction "X"



5 Mounting the transmission

5.1 General remarks handling

5.1.1 Delivery condition

The HSW transmissions are shipped from the factory completely assembled. For reasons of safety during shipping, the transmissions are shipped without fluid filling. The shifting lever is fitted to the control shaft as shown on page 4. The lever can be set to any desired position.

The splined profile of the input shaft is protected by a plastic cover. The output flange is protected against corrosion during shipment and storage. The housing is chromated and thus protected against corrosion.

5.1.2 Storage

After a test run with the specified ATF, to which every transmission is submitted, a residual amount of fluid remains in the transmission. It provides an internal protection against corrosion for at least one year of storage in a dry place. Handle with care during storage.

5.1.3 Shipping

When shipping the transmission or the engine-transmission unit be sure to protect it against shocks and jolts. The input and output shafts, as well as the control block and shifting lever should be especially protected.

5.1.4 Removing the anticorrosion agent

The anticorrosion agent must be removed with a suitable solvent; never use an abrasive, as the seals and their running surfaces could be damaged.

Warning:

When using solvents, their vapors may be dangerous to your health. Observe handling instructions of manufacturer of solvent.

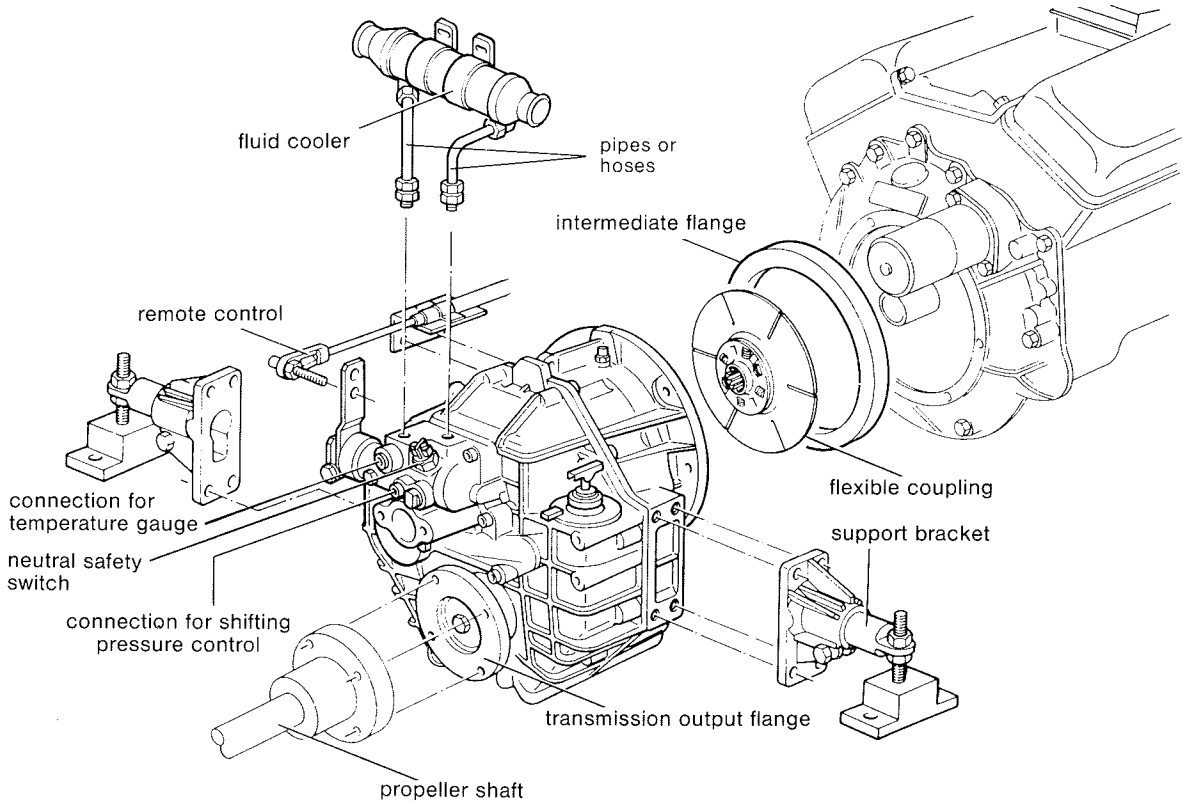
Before filling the transmission with fluid for the first time, it is recommended that it be flushed with the specified ATF, subsequently drained, especially after a long storage period.

5.1.5. Painting the transmission

Before painting, cover the input shaft, all mounting faces and the shaft seals of the input and output shaft. The breather must not be covered with paint; the fluid plate and the name plate must remain clearly legible.

Be sure to protect the seat of the dipstick and the filter cover during painting to maintain their operability.

5.1.6 Connection areas



5.2 Connecting the transmission to the engine

Required Tools: Wrench size: 17 mm (0.6693 in.)
Torque wrench: 40-50 Nm (29.50 – 36.88 ft. lb.)

Note:

Connecting bolts and tightening torque should be used according to the engine manufacturer's specifications.

If the engine flywheel housing has been appropriately designed, the transmission should be bolted either directly to the engine housing or indirectly using suitable intermediate flanges.

In order to prevent inadmissible torsional and tensile stresses and consequential damages on the housing of the transmission due to thrust of the propeller, the following items should be observed:

1. The mating surface of the transmission flange must rest on the whole circumference.
   The connecting parts on the motor side must be rigid so as to assimilate the thrust of the propeller without deformations affecting the transmission.

2. When mounting the motor and transmission unit on elastic bearing make sure the distance "H" (Figure 1) between the propeller shaft and elastic bearing is kept as small (maximum 100 mm/3.937 in.) as possible.

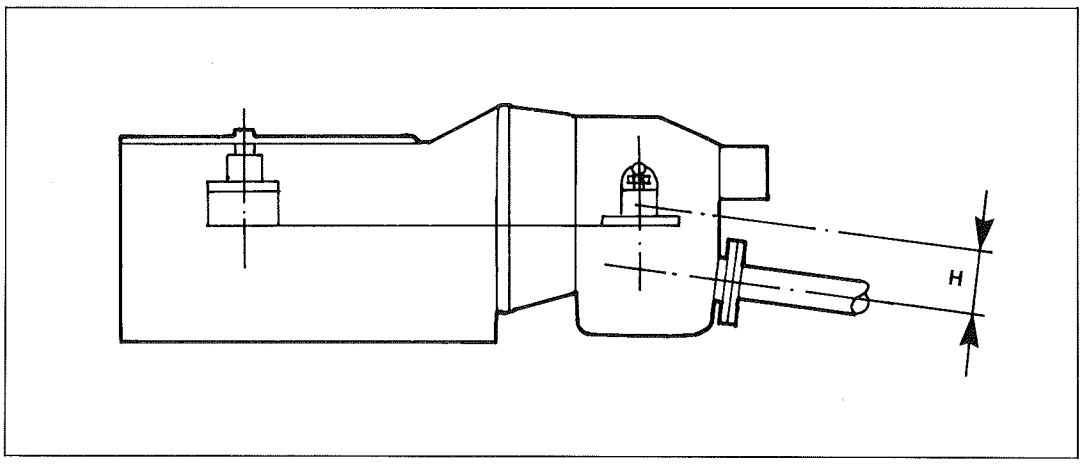


Figure 1

5.2.1 Connecting the transmission directly to the flywheel housing

1. Observe the technical data for the coupling.

CAUTION

The torsion-elastic coupling must be able to compensate for any alignment tolerances of the shafts (radial and angular) to prevent any undue additional forces from acting on the input shaft of the transmission.

2. Mount a torsion-elastic coupling (Figure 2, item 1) to the engine flywheel.

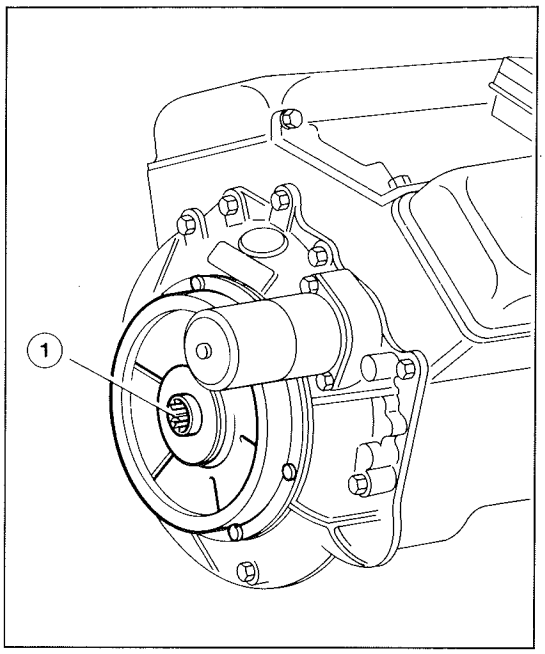


Figure 2

3. Checking the radial axial tolerances of the connection between transmission and engine.

CAUTION

The specified tolerances must not be exceeded.

3. Axial tolerances

- Attach caliper linkage (Figure 3, item 1) to damperplate
- Apply base of caliper at right angles to plane surface of flywheel housing.
- Pretension the gauge and set to "0".
- Turn flywheel slowly. The gauge reading must not exceed 0.1mm.

"X" – Mounting surface of engine flywheel housing.

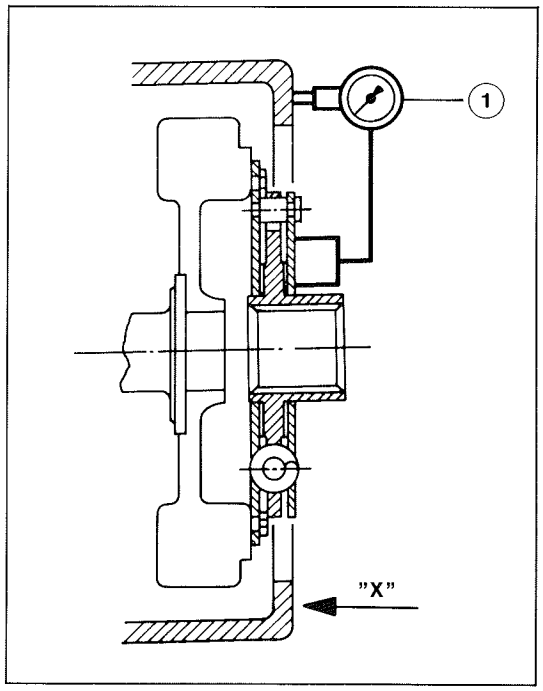


Figure 3

CAUTION

If a rubber type coupling is used, it is important that the coupling is ventilated. Make sure that openings for this purposes are available. Otherwise refer to engine supplier.

b. Radial tolerances

- Attach caliper linkage (Figure 8, item 1) to damper plate.
- Apply base of caliper at right angles to entering surface of flywheel housing.
- Pretension the gauge and set to "0".
- Turn flywheel slowly. The gauge reading must not exceed 0.1 mm.

"X" – Mounting surface of engine flywheel housing.

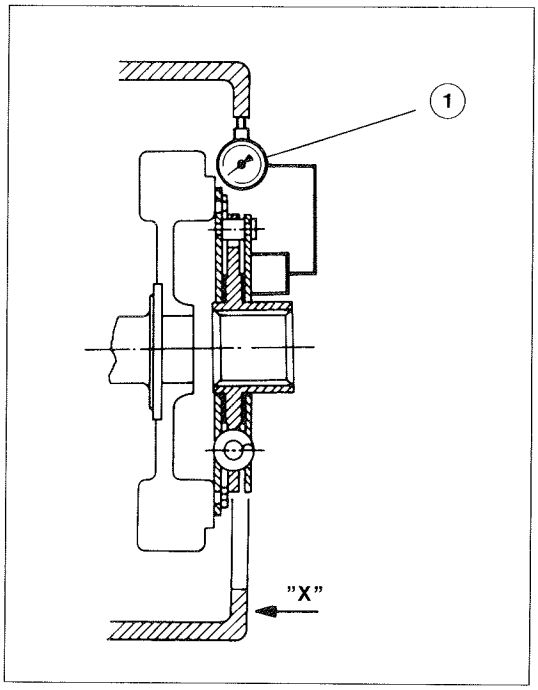


Figure 4

5.2.2 Connecting transmission to flywheel housing using intermediate flanges

Note:

Should the mounting dimensions of the bell housing not match those of the transmission, please contact engine manufacturer for suitable adapter flange (Figure 5).

1. Mount intermediate flange to transmission.

Note:

Check whether the centering and connecting surface are clean and undamaged. If necessary smooth them with a suitable fine file or an oil stone.

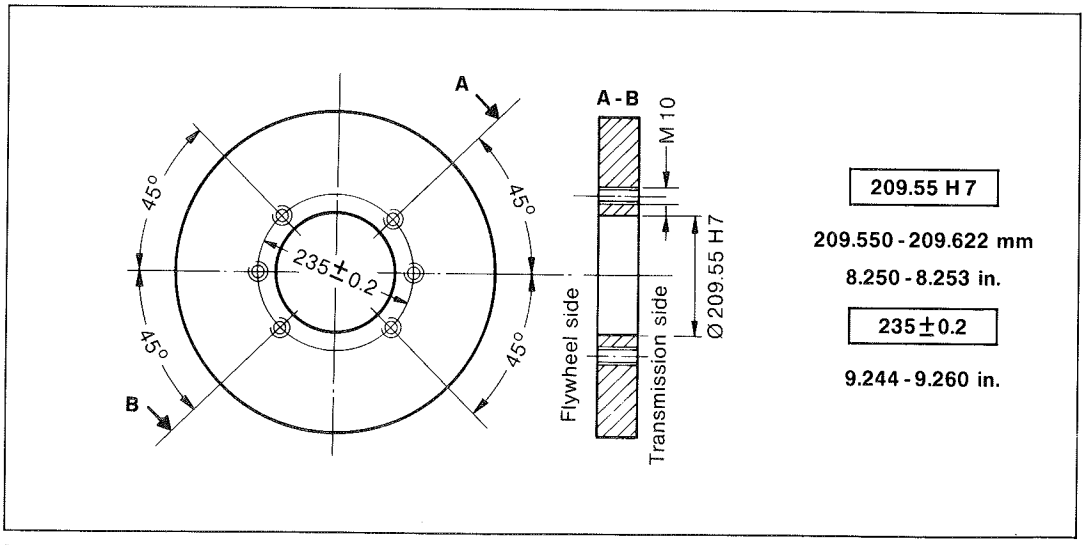


Figure 5

2. Locate the intermediate flange (Figure 6, item 1) on the flywheel housing.

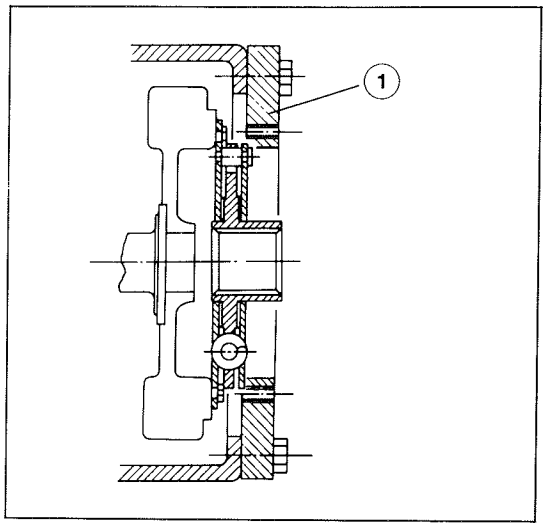


Figure 6

3. Checking the radial and axial tolerances of the intermediate flange.

a. Check Concentricity

- Attach caliper linkage (Figure 7, item 1) to the damper plate (Figure 7, item 2).
- Apply base of caliper at right angles to centering surface of intermediate flange (Figure 7, item 3).
- Pretension the gauge and set to "0".
- Turn flywheel slowly.
  The gauge reading must not exceed 0.15 mm (0.006 in.).

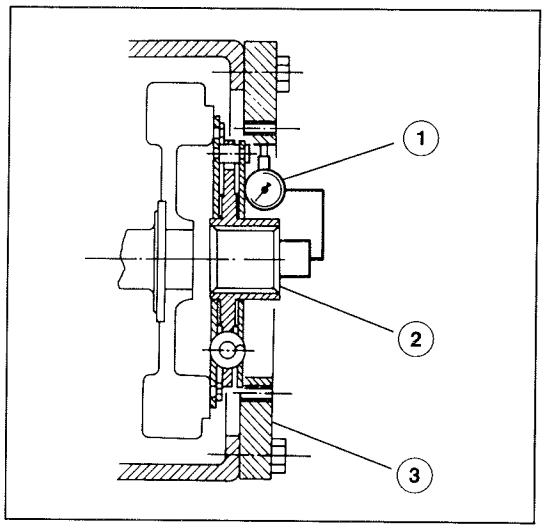


Figure 7

b. Check Parallel Running

- Attach caliper linkage (Figure 8, item 1) to the damper plate (Figure 8, item 2).
- Apply base of caliper at right angles to plane surface of the intermediate flange (Figure 8, item 3).
- Turn flywheel slowly.
  The surface deviation must not exceed 0.05 mm per 100 mm diameter (0,0005 in. per 1 in. dia.).

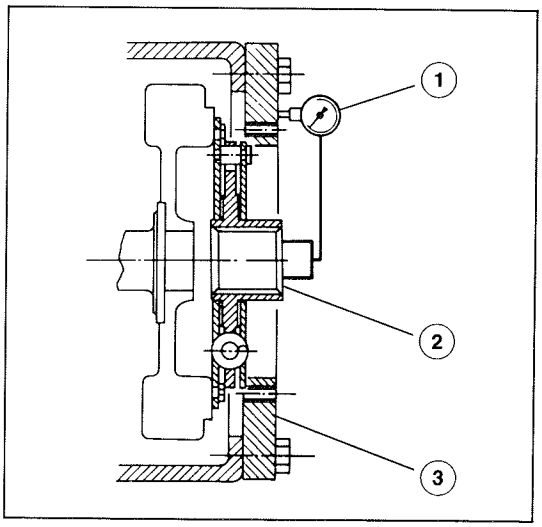


Figure 8

5.2.3 Mount transmission to the engine/intermediate flange

CAUTION

Before mounting the transmission on the engine, make sure the direction of rotation of the engine matches with the specified direction of input shaft rotation of the transmission.

Arrow (Figure 9, item 1) on the transmission housing shows direction of rotation.

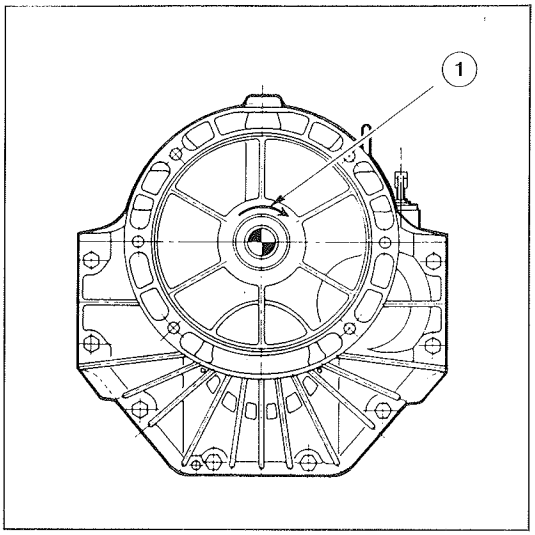


Figure 9

a. Fit the transmission to the engine. Tighten carefully observing engine manufacturer's specifications.

b. Fit the transmission to the intermediate flange.
Use 6 hex bolts M 10 (Figure 10, item 1) material property according to class 8.8 acc. to DIN or equivalent.
Tightening torque is 44 Nm (32.5 ft. lb.).

CAUTION

Assure clearance of axial clearance crankshaft according to drawing (Figure 10).

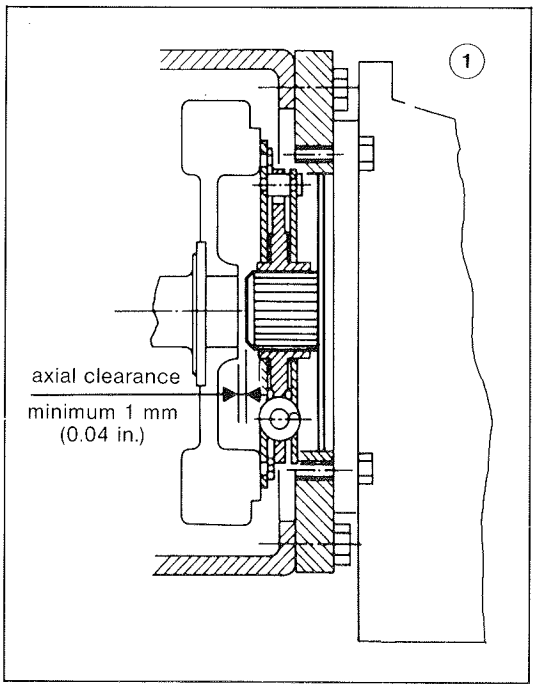


Figure 10

5.3 Mounting the power pack in the boat

The mounting inclination of the transmission input shaft (Figure 1, item 1) should not exceed an angle of 12° (meaning: max. incline of output shaft 20° (Figure 1, item 2).

Note:

Align the unit carefully with regard to the propeller shaft to ensure that any distortions which might damage the transmission are definitely prevented.

Note:

The transmission should be easily accessible for maintenance work.

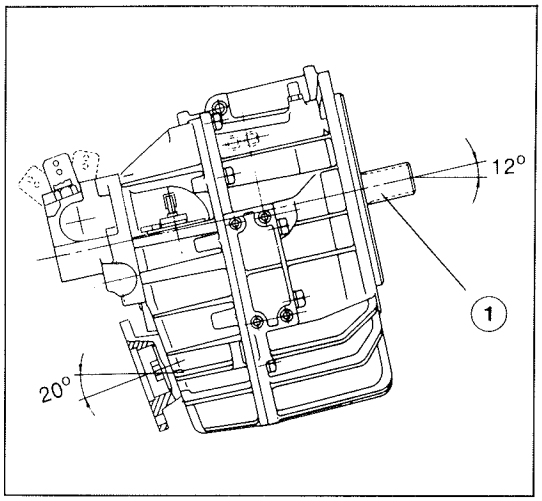


Figure 1

5.3.1 Mounting lateral support brackets

Note:

Depending on installation situation the rear supports can be mounted either to the engine or to the transmission.
If transmission mounting is requested this section is applicable.

1. Locate support brackets (Figure 2, item 1) on the transmission left and right side and fasten with 4 hex head bolts (Figure 2, item 2) with thread M12, material property according to class 8,8 acc. to DIN or equivalent.

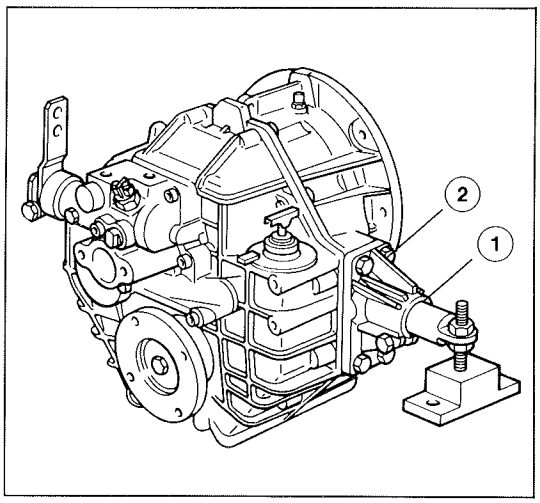


Figure 2

CAUTION

Choose length of bolts so that length of engaged thread is approx. 22-24 mm (0.875 in.).

2. Tighten hex head bolts with a torque of 76 Nm (56 ft. lb.).

5.3.2 Connecting the propeller shaft with an elastically mounted power pack and a rigid stern tube, a flexible coupling (Figure 3, item 1) should be provided between the transmission output flange (Figure 3, item 2) and the propeller shaft connecting flange (Figure 3, item 3).

Note:

Even with a rigidly mounted power pack and a rigid stern tube, a flexible coupling is recommended.

Since the propeller thrust is supported by the transmission bearing, a special propeller thrust bearing is not necessary.

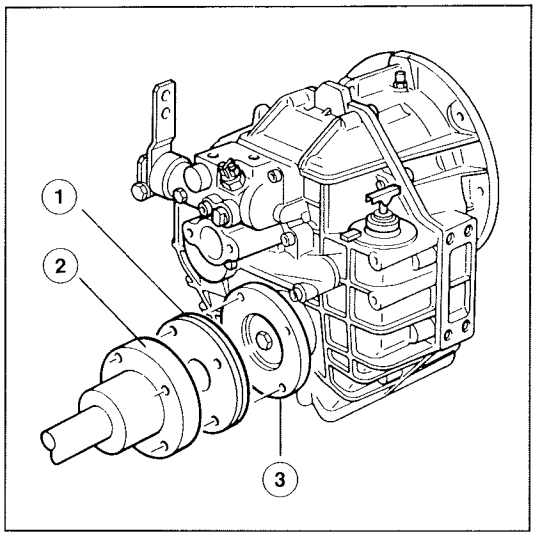


Figure 3

When selecting the flexible propeller shaft coupling, make sure that it can transmit the propeller thrust ahead and astern.

CAUTION

Additional loads on the output shaft, such as driving a shaft generator are not permissible.

CAUTION

When the power pack is on flexible mountings, it should be considered that the propeller thrust may lead to misalignment between power pack and propeller shaft. This should be considered when selecting the mounting points and the coupling.

CAUTION

Note that final alignment checks and corrections should be made when the boat is in the water.

Marine drive units may generate natural frequencies produced by the engine and propeller. This may lead to sympathetic vibrations which could damage the installation. Such torsional vibrations might become apparent by a "clattering" noise in the transmission.

It is recommended therefore, to calculate the torsional vibrations before designing a drive package. They will dictate a suitable method to prevent critical torsional vibrations. As a rule, the choice of a suitable torsional elasticity of the elastic coupling will be sufficient.

Torsional vibrations can be calculated by the manufacturers of engines, couplings and transmissions.
The transmission data required can be inferred from chapter VI.

CAUTION

It should be especially noted that torsional vibrations may occur.

Note:

When using a universal joint shaft, the mounting instructions of its manufacturer should be observed. The shaft must be mounted in all details according to the instructions issued by the manufacturer of the universal joint.

CAUTION

Even if the unit is mounted on flexible support brackets, the transmission must be carefully aligned with regard to the propeller shaft.

CAUTION

Inadequately mounted universal joint shafts will generate torsional vibrations and additional external forces, which may cause damage to the engine and transmission.

5.3.3 Mounting the propeller shaft and checking clearance and run-out

Pull the propeller shaft into the centering of the transmission output flange (Figure 4, item 1) until a clearance remains between the two flange surfaces that permits measurement with a feeler gauge.

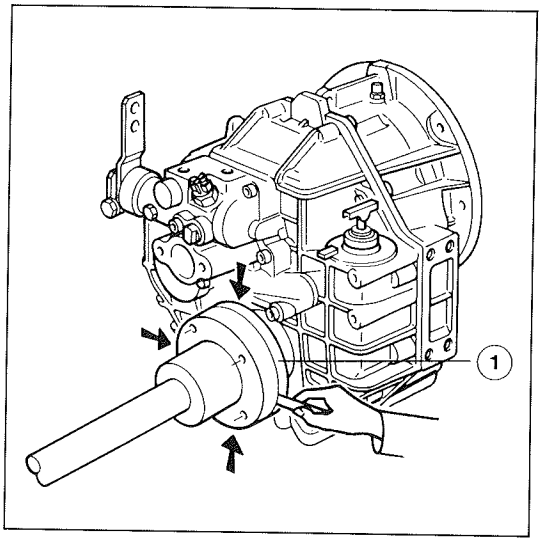


Figure 4

CAUTION

With measurements made at four opposite points (see Figure 4), the clearance must not deviate by more than 0.05 mm per 100 mm (0.0005 in. per 1 in.) of measured diameter.

The maximum permissible radial run-out between the output shaft of the transmission and the propeller shaft is 0.1 mm (0.004 in.) with a rigid connection of the propeller shaft (Figure 5).

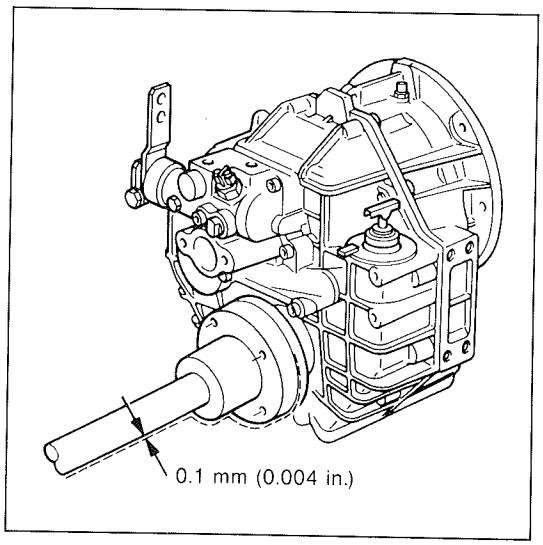


Figure 5

The same alignment should be carried out with an elastically mounted power-pack.

Note:

If a flexible coupling of the propeller shaft is used, the permissible deviation might be greater according to the characteristics of the flexible coupling and the design.

CAUTION

Observe the instructions issued by the manufacturer of the flexible coupling.

After completion of the measurement operation, connect the propeller shaft to the output shaft of the transmission and bolt with four bolts and nuts. Tighten the bolts and lock with Loctite 242.

5.4 Connecting the fluid cooler

5.4.1 General

CAUTION

For the fluid cooler to function properly, the temperature of the input seawater should not exceed 35°C (95°F).

Normally the cooler should be connected to the outboard water circuit (outer circuit) of the engine as well as on the pressure-side of the water pump (Figure 1).

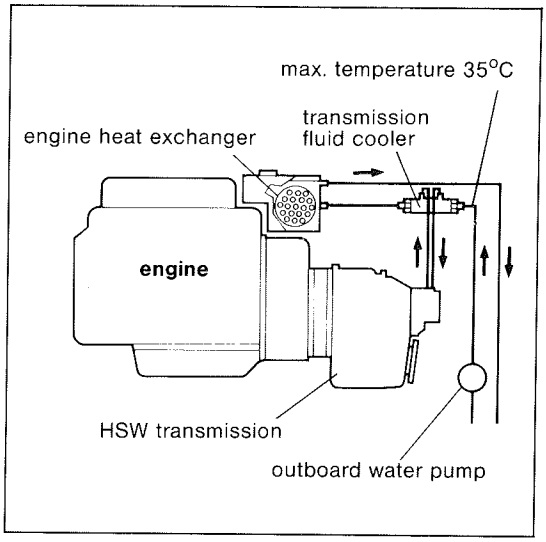


Figure 1

If the amount of cooling water delivered exceeds the capacity of the cooler, the cooler must be fitted with a bypass (Figure 2).

Note:

The transmission fluid and cooling water should flow in opposite directions.
For connecting dimensions see installation drawing.

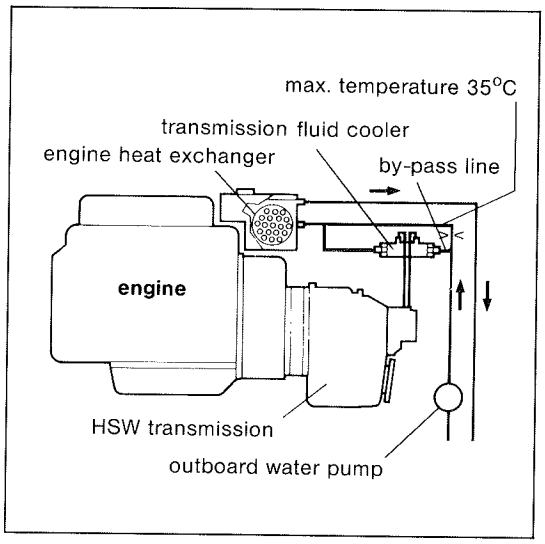


Figure 2

5.4.2 Mounting the fluid cooler

Use two clamps (Figure 3, item 1) and fasten the cooler for example at the flywheel housing.

Slide hose connections (Figure 3, item 2) over the cooler connections and tighten hose clamps (Figure 3, item 3).

Mount fluid lines (Figure 3, item 4 and 5) between transmission and cooler.
For simple mounting hoses are recommendable. Connection threads at transmission see page 4.
Connection threads at cooler ask supplier.
Packing of fittings ask supplier.
Directions of flows see arrows in Figure 3.

Note:

Minimum inside diameter of fittings, hoses respectively pipes is 9 mm (0.36 in.).

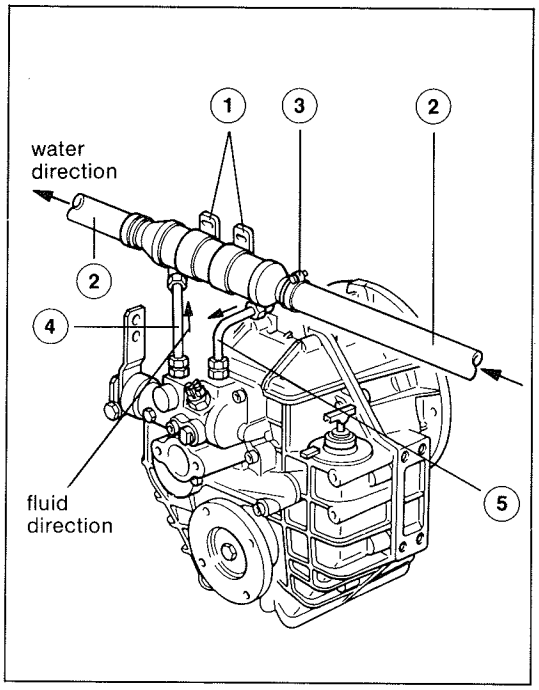


Figure 3

CAUTION

When mounting the cooler, make sure that no dirt gets into the fluid circuit.

CAUTION

During initial start-up check connecting points at transmission and cooler for leakage.
In case of leakage do not operate transmission.

CAUTION

Check whether oil and water are mixed when existing cooler. If so, do not operate transmission and locate point of leakage.

5.5 Connecting and adjusting the shifting lever

5.5.1 The transmissions are designed for mechanical remote control.
After loosening the clamping screw (Figure 1, item 1), the shifting lever may be set to any position required for actuating the control (Bowden cable or linkage) and fixed in that position.

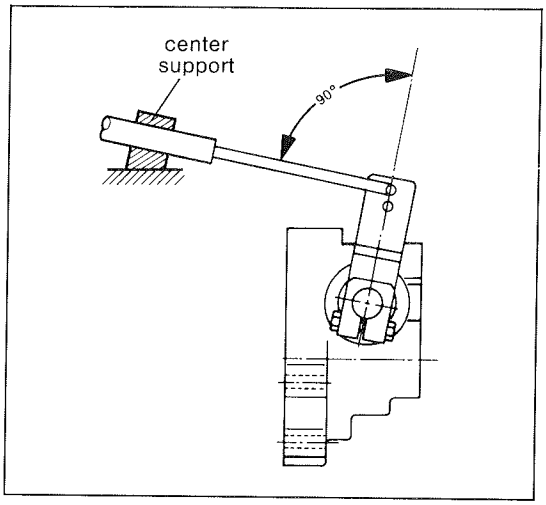


Figure 1

CAUTION

The Bowden cable or linkage must form an angle of 90° in any position with regard to the neutral position of the shifting lever (Figure 1).

CAUTION

The neutral position of the lever (Figure 2, item 1) on the control panel must match the neutral position of the shifting lever (Figure 2, item 2) on the transmission.

The shifting lever is provided with two 6.4 mm diameter holes for connecting the remote control. (Figure 3, item 1).

If connection is made to the outer hole of the shifting lever, the remote control must permit a lever travel from the locked idle position to switching positions A and B of 30 to 35 mm each.

At the inner articulation of the shift lever, a lever travel of 25 to 30 mm must be possible on both sides (Figure 3).

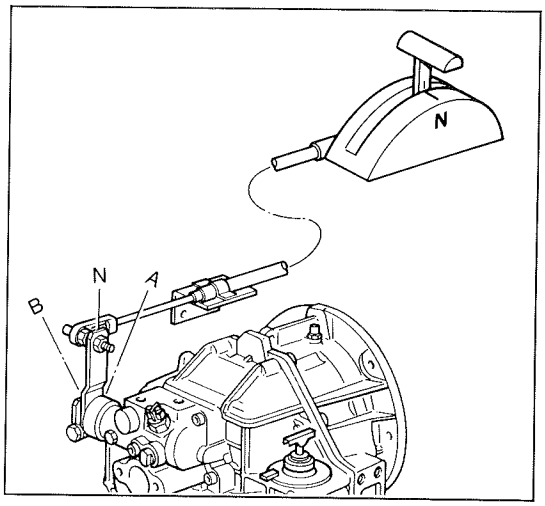


Figure 2

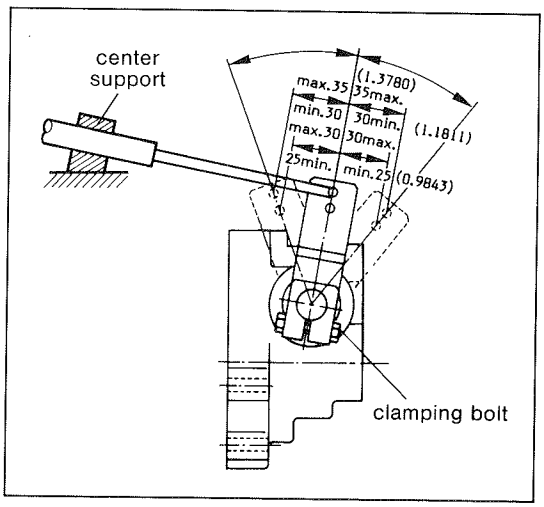


Figure 3

Note:

Lever in excess of the maximum values specified is not possible since the control unit of the transmission is provided with a stop.

Note:

Shorter lever travel than the minimum values specified are not permissible, since they might not be sufficient to shift the gears.

CAUTION

Make sure the shifting operation is not impaired by stiff operation of the equipment of the Bowden cable or linkage, or due to insufficient bending radii of the cable.

The shifting power required on the outer connection of the shifting lever is approx. 30 N (6.7 lb.), for shifting in and out.

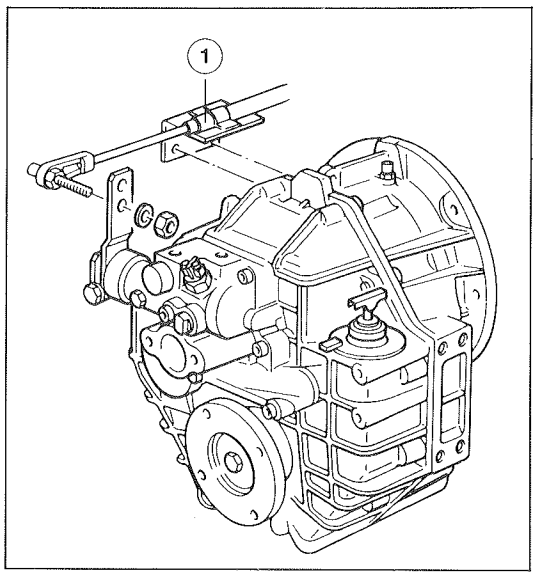


Figure 4

5.6 Connecting the remote control

Two threaded holes M 8, 12 mm (0.4724 in.) deep are provided on the transmission for attaching the countersupport for the Bowden cable (Figure 4, item 1).

Mount guide (Figure 5, item 1) for the shifting linkage or Bowden cable on the transmission housing.

Attach Bowden cable or shifting linkage to shift lever (check for neutral position) and fasten.

CAUTION

The shift lever must move freely over the complete range.

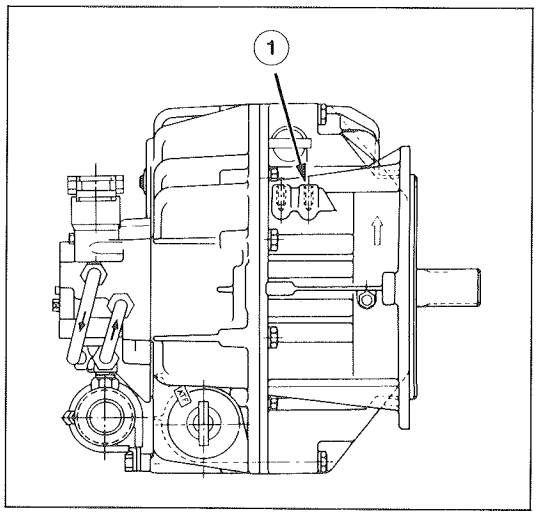


Figure 5

5.7 Neutral safety switch

The control block comes with a neutral safety switch to enable the engine to be started only with the shifting lever set to "N".
The switch is closed in the "N" position in the control circuit and can be electrically connected to the actuating mechanism of the starter (Figure 1).

Switch to carry 20 AMPS continuous at 14 VDC.

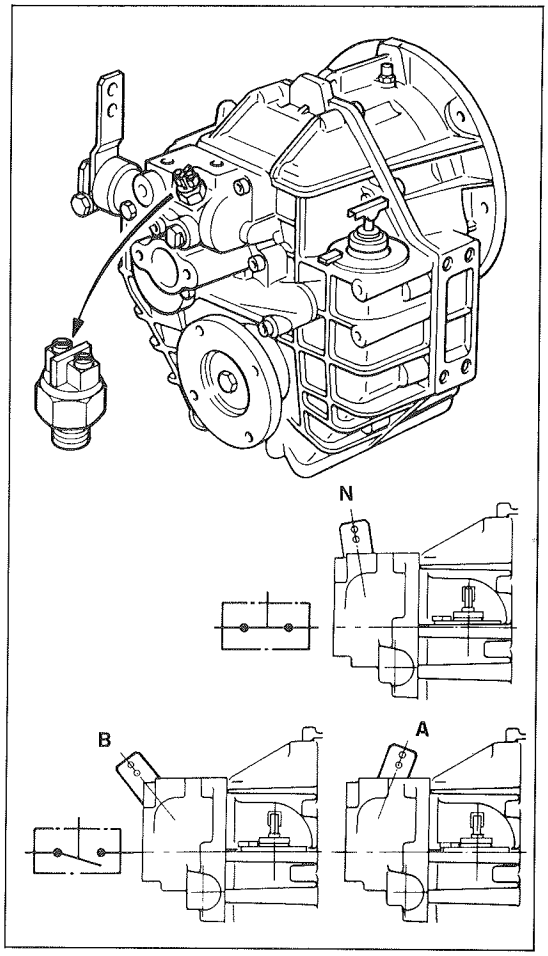


Figure 1

5.8 Connection for temperature gauge

The control block has a threaded hole R 3/8" NPSF for connecting a temperature gauge to check the temperature of the transmission fluid (Figure 2, item 1). The threaded hole is closed by a plug at time of delivery of the transmission.

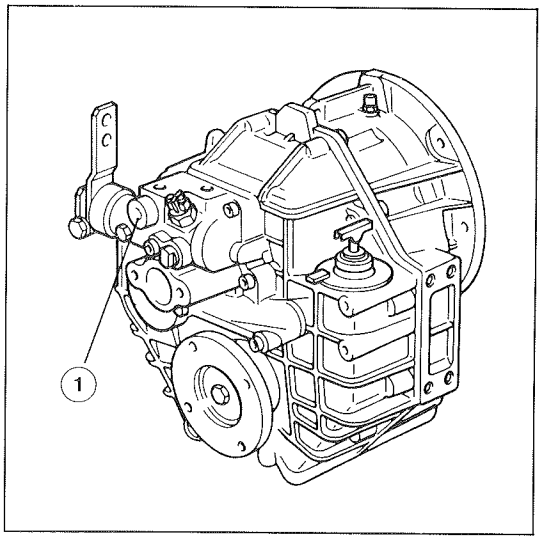


Figure 2

5.9 Connection for monitoring the shifting pressure

A threaded hole M 10x1 to connect a pressure gauge is provided on the control block (Figure 1, item 1). This hole is closed by a plug and seal when the transmission is delivered.

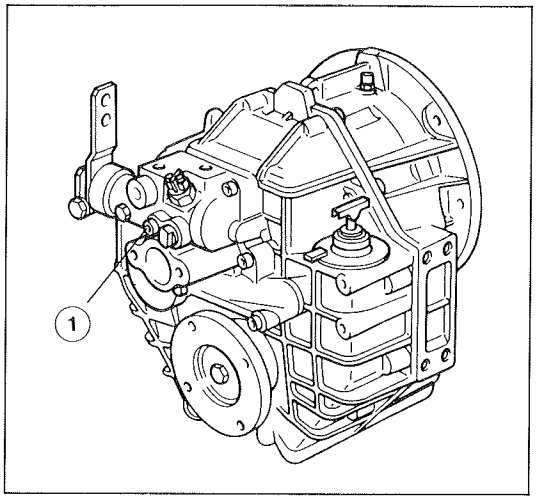


Figure 1

5.10 Shifting pressure-speed diagram

The shifting pressure is dependent on the engine speed to ensure that the max. torque of 630 Nm (465 ft. lb.) can be transmitted already at an engine speed of 1800 rpm and over with a 1.2-fold safety.

A pressure gauge (0-30 bar (0-440 psi) may be connected to the measuring point provided, to monitor the shifting pressure (Figure 1, item 1).

The measured values above line on the diagram below show that the hydraulic circuit of the transmission is working faultlessly.
Measured values below line of the diagram may be caused by a dirty filter or a too low fluid level; this should be remedied.

Note:

Detect cause of failure according to Repair Manual (Section VIII) and remedy the problems.

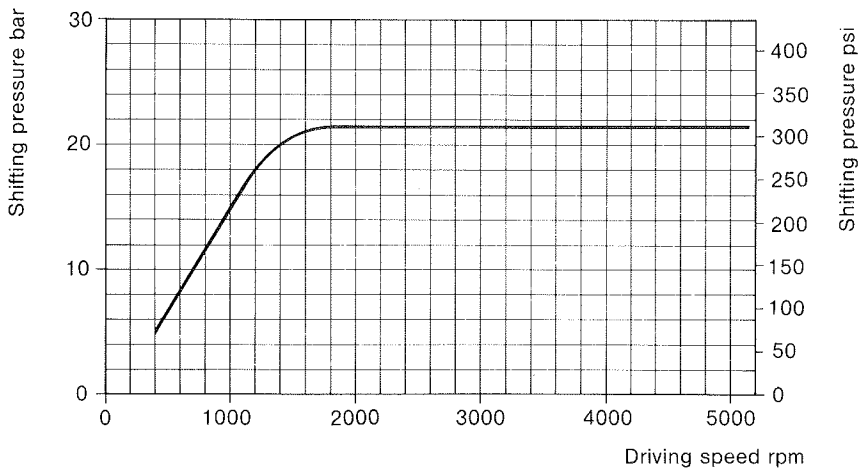


Fig. 2 Shifting pressure at transmission fluid temperature of 70-80°C (158-176°F).

5.11 Transmission fluid, filling procedure

CAUTION

Before the first start up, the transmission must be filled with transmission fluid.

1. Turn grip or filter cover (Figure 2, item 1) counterclockwise and pull.

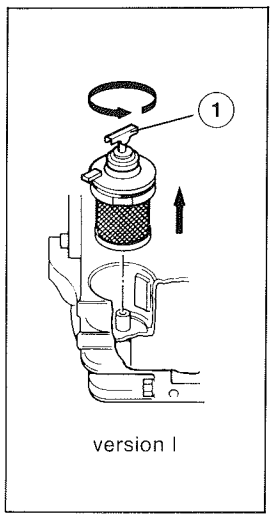


Figure 1

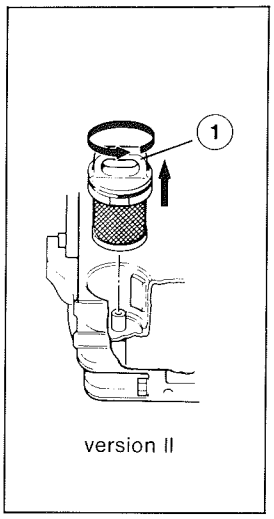


Figure 2

2. Fill with 4.0 liters (4.2 qts.) of Automatic Transmission Fluid (ATF) (Figure 2).

   Plus amount required for cooler and pipelines.

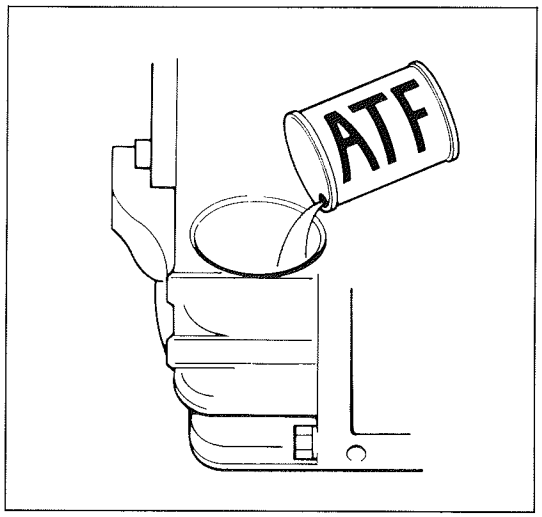


Figure 3

CAUTION

Only use automatic transmission fluid as specified in the technical data (Chapter VI).

3. Lock filter cover in place by turning grip (Figure 4, item 1) or cover (Figure 5, item 1) clockwise and pushing.

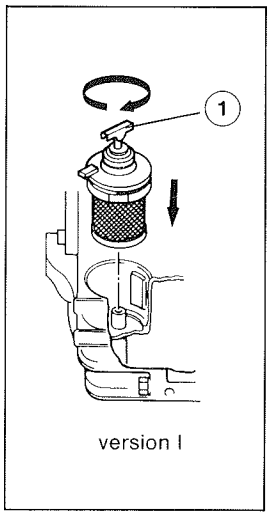


Figure 4

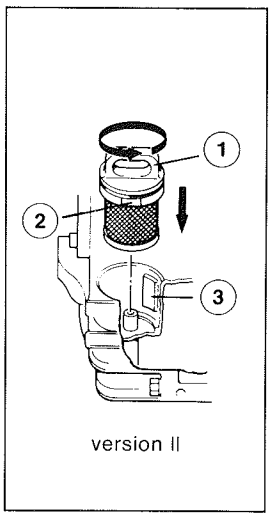


Figure 5

CAUTION

Version II only: When inserting the filter cover make sure that the flat side of cover (Figure 5, item 2) matches with lug (Figure 5, item 3) in the filter.

4. For operating procedures see Owner's Manual, Chapter IV, Operation.

5. Let engine run at idle speed with shifting lever in neutral position until fluid cooler and all pipelines are filled with fluid.

6. Shut down engine and check fluid level again. If necessary, top up to the marking on the dipstick (Figure 6).

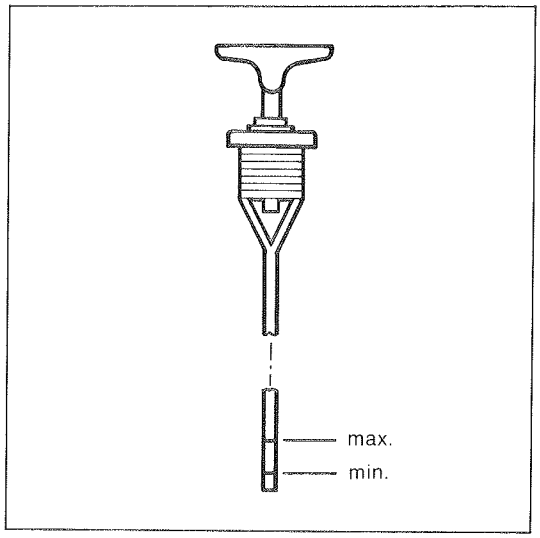


Figure 6

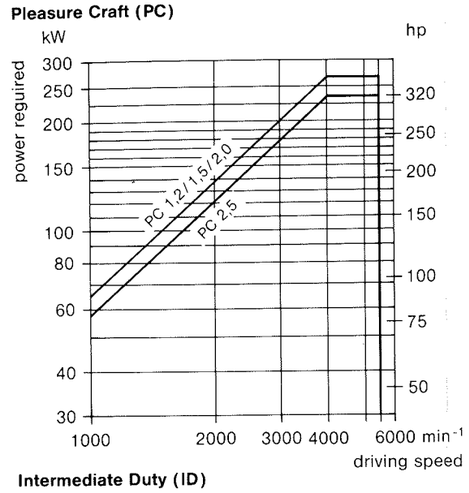
VI. Technical data

Type	HSW 630 A	1.2	1.55	2.0	2.5
*Rated input torque	PC Nm (ft. lb.)	630 (465)			560 (413)
	ID Nm (ft. lb.)	500 (370)			450 (332)
	CC Nm (ft. lb.)	450 (332)			400 (295)
Max. input power	PC kW (hp)	265 (360)			235 (320)
	ID kW (hp)	210 (290)			190 (260)
	CC kW (hp)	190 (260)			170 (230)
Max. propeller thrust	N (lb.)	18000 (4050)			16000 (3600)
Shifting pressure	bar (psi)	21.5 - 23.5 (312 - 341)			
Max. input speed	1/min. (r.p.m.)	5500			
Weight without fluid and fluid cooler	kg (lb.)	44 (97)			
Type of fluid	ATF (Automatic Transmission Fluid) e.g. DEXRON II - D; FORD M 2 C - 33 G; ALLISON C - 3 no other fluids unless authorized by HURTH				

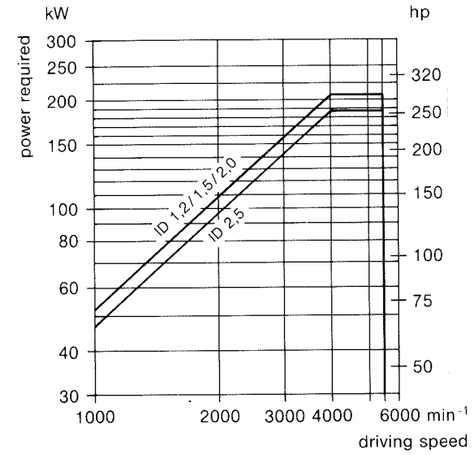
* Maximum input torque is not exceed 10% above the rated input torque.

Nominal transmission ratio	1.2	1.55	2.0	2.5
Transmission ratio Shifting position "A" (forward gear)	1.22	1.56	2.04	2.52
Transmission ratio Shifting position "B" (reverse gear)	1.22	1.58	2.10	2.54

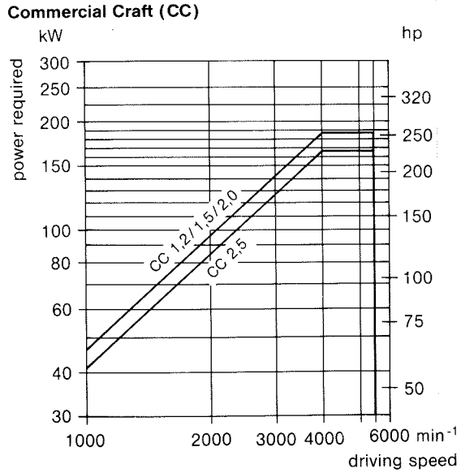
Pleasure Craft (PC)



Intermediate Duty (ID)



Commercial Craft (CC)



Applications of transmissions

Speedboats and launches for use as pleasure craft and sail boats.

Full-load operation (DIN 6270 B) for 15% max. of complete duty time.
Normal operation under partial speed.

Annual operating hours not to exceed 300 hrs.

Pleasure craft for charter operation to be assigned to Commercial Craft.

Examples:

Speed boats.

Speedboats and launches for commercial use.

Full-load operation (DIN 6270 B) for 30% max. of total duty time.

Annual operating hours not to exceed 1000 hrs.

Examples:

Official launches. life-boats, motor cruisers.

All displacement craft and all boats designed for a continuous duty at full load (DIN 6270 A).

All charter boats.

Examples:

Fishing boats, supply boats, commercial craft, ferries, party fishing boats, motor yachts.

VII. Technical data

Selection of cooler size per cooler manufacturer.
The table below shows amount of heat to be dissipated.

	Engine speed rpm	2000		3000		4000		5000	
	Shifting position (for forward)	A	B	A	B	A	B	A	B
		Heat to be dissipated in kW							
Rated torque of engine	630 Nm (465 ft. lb.)	3.3	4.0	5.4	6.0	8.6	10.0	11.9	12.6
	560 Nm (413 ft. lb.)	2.9	3.5	5.3	5.8	8.4	9.4	11.9	12.6
	500 Nm (370 ft. lb.)	2.9	3.4	5.0	5.7	8.4	8.9	11.9	12.6
	450 Nm (332 ft. lb.)	2.6	3.3	4.9	5.7	7.5	8.8	11.8	12.4
	400 Nm (ft. lb.)	2.5	2.8	4.7	5.0	7.5	8.8	11.0	11.5

1 kW = 57.7 BTU per minute

Delivery rate of transmission fluid pump

The gear pump in the control block delivers the following minimum amounts of fluid at approx. 80°C fluid temperature.

Engine speed, rpm	2000	3000	4000	5000
Delivery rate				
Liter/minute	8	14	20	24.5
Gallon/minute	2.5	3.7	5.3	6.5

The operating temperature of the transmission should not exceed 80°C (176°F).
Temperature sensor as an optional.
At wide open throttle operating fluid temperature may reach 105°C (220°F).

VIII. Data for Calculating Torsional Vibrations

Transmission Diagram

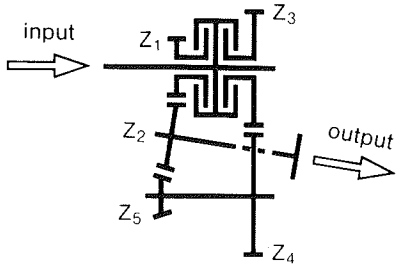


Diagram of Masses Shifting Position "0" (Idling)

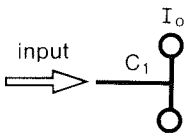


Diagram of Masses Shifting Position "A" (Prop. rotating counter engine)

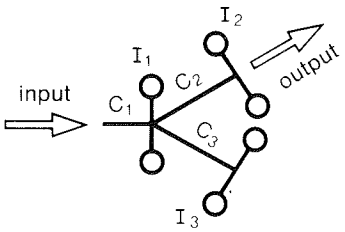
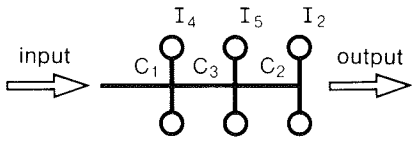


Diagram of Masses Shifting Position "B" (Prop. rotating as engine)



Torsional Rigidities

C_1 = input shaft
C_2 = output shaft
C_3 = intermediate shaft

Mass Moments of Inertia

I_0 = Input shaft + clutch primary

I_1 = Input shaft + clutch primary
+ clutch secondary side A
+ helical gear Z_1 helical gear Z_2
+ proportion of output shaft
+ helical gear Z_5 + proportion of intermediate shaft

I_2 = Proportion of output shaft + output flange

I_3 = Proportion of intermediate shaft
+ helical gear Z_4
+ helical gear Z_3
+ clutch secondary side B

I_4 = Input shaft + clutch primary
+ clutch secondary side B
+ helical gear Z_3
+ helical gear Z_4
+ proportion of intermediate shaft

I_5 = Proportion of intermediate shaft
+ helical gear Z_5 + helical gear Z_2
+ proportion of output shaft
+ helical gear Z_1 + clutch secondary side A

Lever pos.	Transmission type		Torsional rigidity 10^4 Nm/rad.			Moment of inertia of masses 10^{-3} kgm^2						Number of teeth				
			C_1	C_2	C_3	I_0	I_1	I_2	I_3	I_4	I_5	Z_1	Z_2	Z_3	Z_4	Z_5
A	HSW 630A	1.2	6.6	28.9	23.4	–	36.7	3.0	8.8	–	–	37	45	49	45	34
		1.5		17.5	23.5	–	33.2	1.9	8.9	–	–	32	50			29
		2.0		10.3	23.8	–	30.8	1.1	8.9	–	–	27	55			24
		2.5		6.7	24.2	–	29.2	0.7	9.0	–	–	23	58			21
B	HSW 630A	1.2	6.6	29.2	32.7	–	–	3.0	–	32.0	13.5	37	45	49	45	34
		1.5		17.2		–	–	1.9	–	31.9	10.2	32	50			29
		2.0		9.8		–	–	1.1	–	31.9	7.8	27	55			24
		2.5		6.7		–	–	0.7	–	31.9	6.3	23	58			21
0	all transmissions		6.6	–	–	23.0	–	–	–	–	–	–	–	–	–	–

All data have been reduced to the input shaft.