OPERATING MANUAL - MANUALE D'USO
BETRIEBSANLEITUNG - MANUEL DE SERVICE

IRM 312 TS

ZF MARINE
ZF PADOVA spa

32.70.312.5273
Ed. 03/2000

Thank you
for choosing a

ZF MARINE gearbox

- ***The purpose of this manual is to provide all the information necessary for proper installation, maintenance and operation of your ZF Marine Gearbox.***

- ***Also included in the manual is maintenance information that will help you obtain long service life from your ZF Marine Gearbox.***

- ***ZF Aftersales Service operates worldwide. The main service centres are listed at the end of the manual.***

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NOTES

CONTENTS

CHAPTER 1

GENERAL

1.1 MANUFACTURER'S ADDRESS AND CONTACT NUMBERS

All gearboxes supplied by ZF Padova S.p.A. are accompanied by the relative operating manual. Further copies of this manual or of other technical documentation can be obtained from:

ZF Padova S.p.A.
Ufficio tecnico
Via Penghe 48,
35030 Caselle di Selvazzano PD

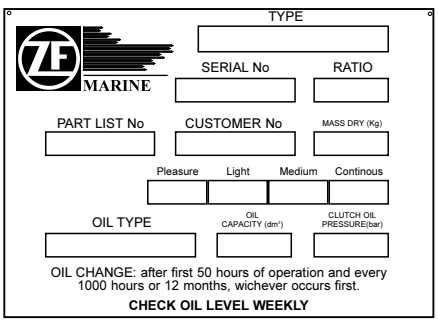
Tel. +39 - 0498299589
Fax +39 - 0498299550

1.2 GEARBOX DATA

Identification data plate

Details of the gearbox will be found on the identification data plate:

- Located on the top of the gearcase.



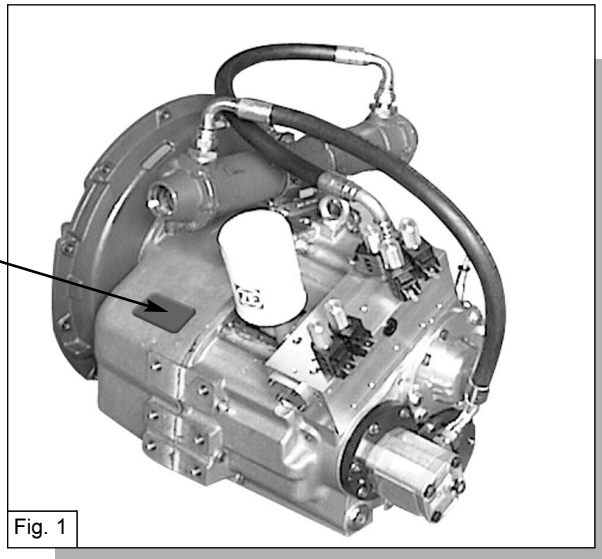


Fig. 1

1.3 *HOW TO USE THIS MANUAL*

This manual is intended for use with the corresponding ZF gearbox family as designated on the front cover.

A copy of the manual should be kept in a place where it can be found and consulted without difficulty by persons entrusted with operation and maintenance of the gearbox.

Read this manual carefully before installing the gearbox, as it contains important directions and guidelines.

ZF cannot be held liable for damage to people, property or data caused by incorrect installation, use or maintenance. All operations must be performed in accordance with the instructions given in this manual and other manuals supplied with the gearbox.

All manuals and literature published by ZF Padova are designed for ease of reference so that the operator can find specific information without difficulty.

For further information not included in this or other manuals, consult the ZF Padova technical services department direct.

1.4 *CONVENTIONAL SYMBOLS USED IN THE MANUAL*

The following symbols and indications are adopted in this manual:
Italics: Used for chapter headings, sub-headings, and in tables or figures or when refencing other publications.

When this symbol is displayed, the text alongside contains important information.

This symbol denotes a procedure that could damage the gearbox or associated equipment if not followed correctly.

This symbol denotes a procedure that could result in physical injury to the operator or to other persons in the vicinity if not followed correctly.

1.5 *DESCRIPTION OF THE GEARBOX*

The following accessories can be added to the basic specification as required: heat exchanger, flexible drive coupling (torque limiter), mounting brackets.
The gearbox and its accessory equipment are factory set by the manufacturer and require no further

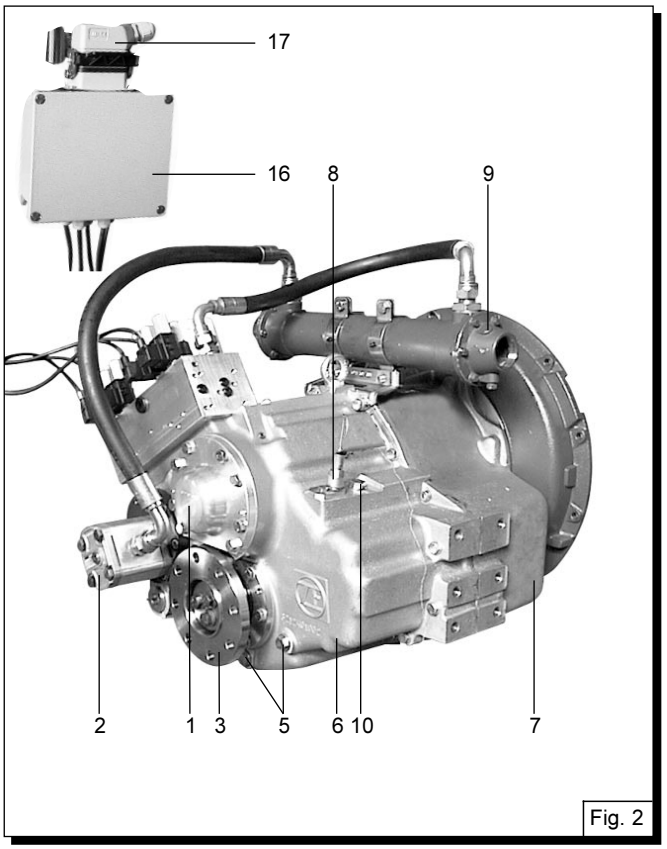


Fig. 2

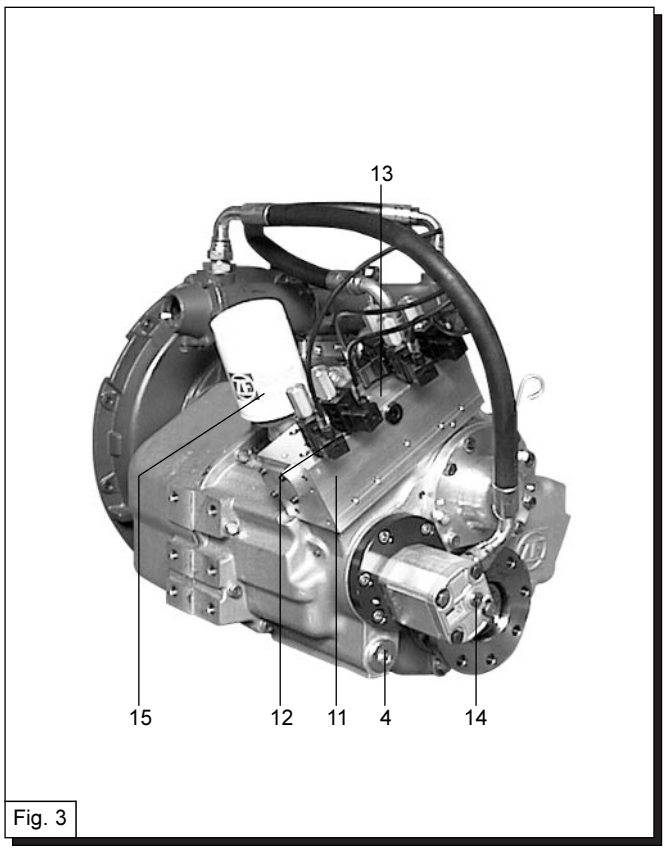


Fig. 3

Tab. 1

REF	DESCRIPTION	REF	DESCRIPTION
1	PTO cover	10	Oil filler plug
2	Oil pump	11	Control valve
3	Output shaft	12	Solenoid valves
4	Strainer / Oil filter	13	Pressure port 1/8-27 N PTF
5	Drain plugs	14	Pump pressure port M14 x 1.5
6	Rear half housing	15	Oil Filter
7	Front half housing	16	Control box
8	Dipstick and breather	17	Screened cable connector
9	Heat exchanger		

1.6 *OPERATION*

1.6.1 IRM 312 TS

A marine gearbox has three main functions:
- speed reducer, serving to match the engine and propeller speed to the propulsion requirement;
- reversing gear, allowing ahead/astern selection by way of two hydraulically operated clutches;
- neutral, allowing the engine to run without driving the propeller.

The types of operation possible are illustrated below.

Power transmission.

Idle rotation, no power transmission

Neutral

Engine power is transmitted to the input and intermediate shafts only; no power is transmitted to the propeller shaft as all clutches [9-10-11-12] are disengaged.

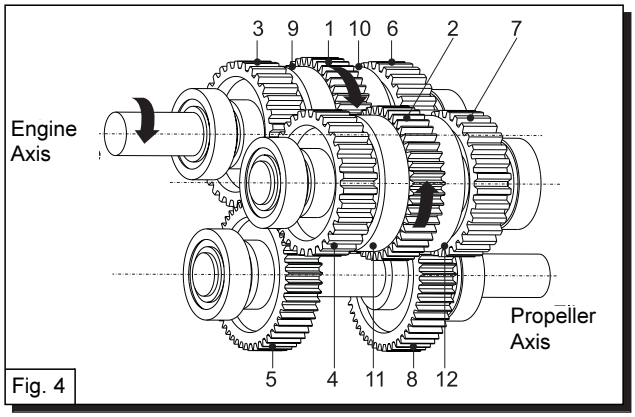


Fig. 4

Engine rotation 1st speed

Obtained by engaging a first clutch [11] on the intermediate shaft (rotating in the opposite direction to the crankshaft).
The first gear [4] on the intermediate shaft is coupled by the clutch [11] and driven by the crankshaft. This gear [4] drives a gear [5] keyed to the output shaft. The speed reduction is determined by the ratio between the two gears [4] and [5].

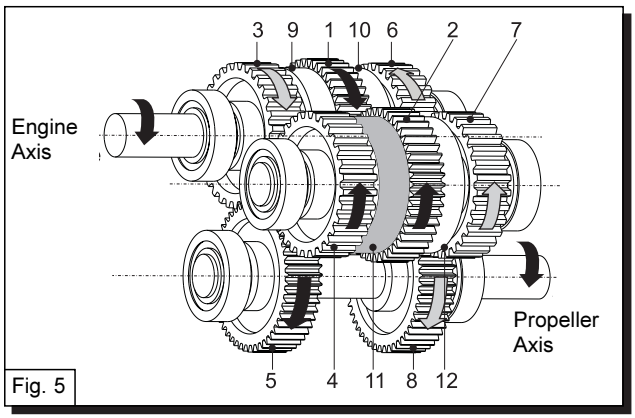


Fig. 5

Engine rotation 2nd speed

Obtained by engaging a second clutch [12] on the intermediate shaft (rotating in the opposite direction to the crankshaft).
The second gear [7] on the intermediate shaft is coupled by the clutch [12] and driven by the crankshaft. This gear [7] drives a gear [8] keyed to the output shaft.
The speed reduction is determined by the ratio between the two gears [7] and [8].

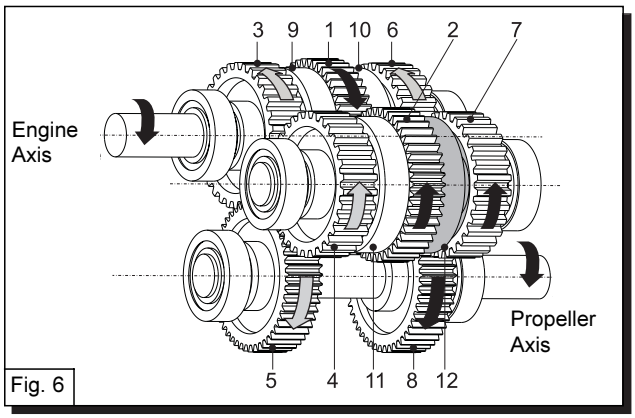


Fig. 6

Counter engine rotation 1st speed
Obtained by engaging a first clutch [9] on the input shaft (rotating in the same direction as the crankshaft).
The first gear [3] on the input shaft is coupled by the clutch [9] and driven by the crankshaft.
This gear [3] drives a gear [5] keyed to the output shaft.
The speed reduction is determined by the ratio between the two gears [3] and [5].

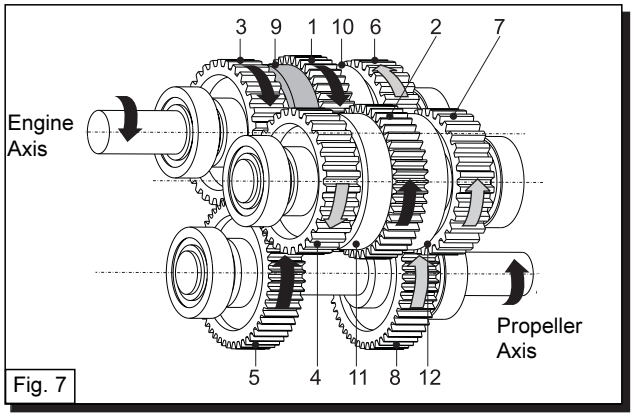


Fig. 7

Counter engine rotation 2nd speed
Obtained by engaging a second clutch [10] on the input shaft (rotating in the same direction as the crankshaft).
The second gear [6] on the input shaft is coupled by the clutch [10] and driven by the crankshaft.
This gear [6] drives a gear [8] keyed to the output shaft.
The speed reduction is determined by the ratio between the two gears [6] and [8].

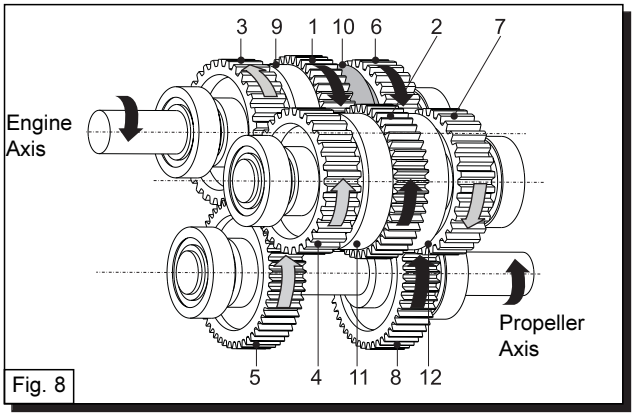


Fig. 8

The clutches are operated hydraulically.
Fig. 9 below shows a simple schematic diagram of the hydraulic circuit.

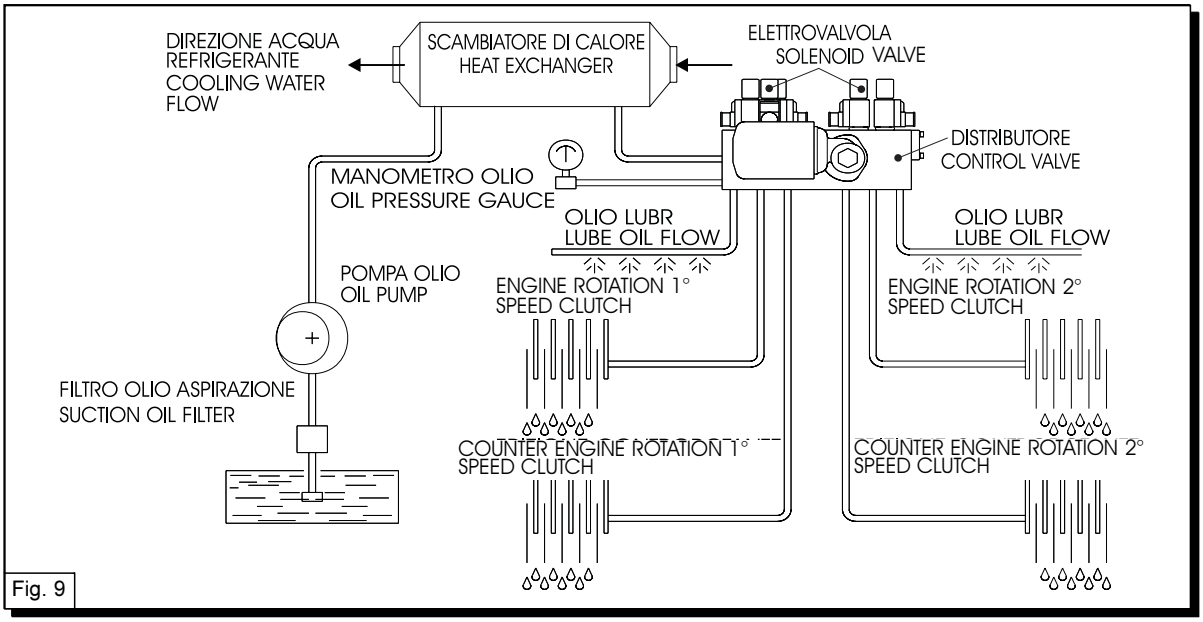


Fig. 9

1.7 *HYDRAULIC CONTROL SYSTEM*

Marine gearboxes of the 312 family are controlled by an electrohydraulic system including a directional control valve [1] and an electronic control box [2] (see Fig. 10).
The system requires a d.c. power supply of 12 V or 24 V (depending on the solenoid valves fitted).

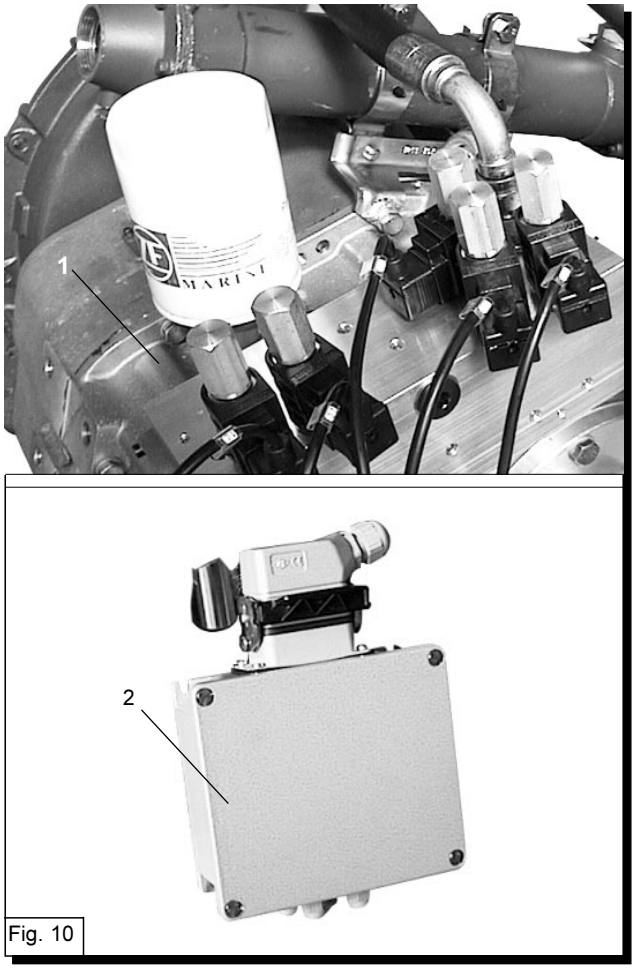


Fig. 10

1.7.1 CONTROL BOX

The control box must not be mounted to the engine or gearbox, or in any position where it could be affected by excessive vibration. Do not locate the box near to engine iginition systems, alternators, electric motors or engine exhaust manifolds.
The preferred location for the control box is normally inside the engine compartment.
If there is not sufficient room in the engine compartment, select a location affording access for connection of the electrical cables.
The electronic control box is connected to the solenoid valves by 5 electrical cables 2 metres each in length.
The box is guaranteed watertight provided that:

- The screws securing the cover and the cable clamps are all properly tightened.
- The connector of the 6-core cable is fitted and locked with the retaining lever.
- The connector of the screened cable is always connected to the base.

1.7.2 TROLLING VALVE (T.V.)

The trolling valve is a device that permits a variable control of the speed (Fig.11).

It permits to make the propeller work at a lower speed in comparison with the system without T.V.

It's used to reduce the boat speed when the engine is already at idle speed.
The trolling valve system can be used for forward and backward movements, observing the peak rpm indicated below.

Application data
The T.V. can be used only for motors which peak rotating running is higher than 2000 rpm and when the trolling is on, it is possible to modify the revolution number up to 700 rpm.

Use
Reduce the motor revolutions to the minimum, then engage the gear checking that the Trolling Valve has been excluded.
Move the T.V.lever as to obtain the desired speed.
When the trolling is on, it is possible to modify the revolution number up to 700 rpm using the required graduality

It is forbidden manoeuvring (forward - reverse and viceversa) and change of speed when in trolling mode.

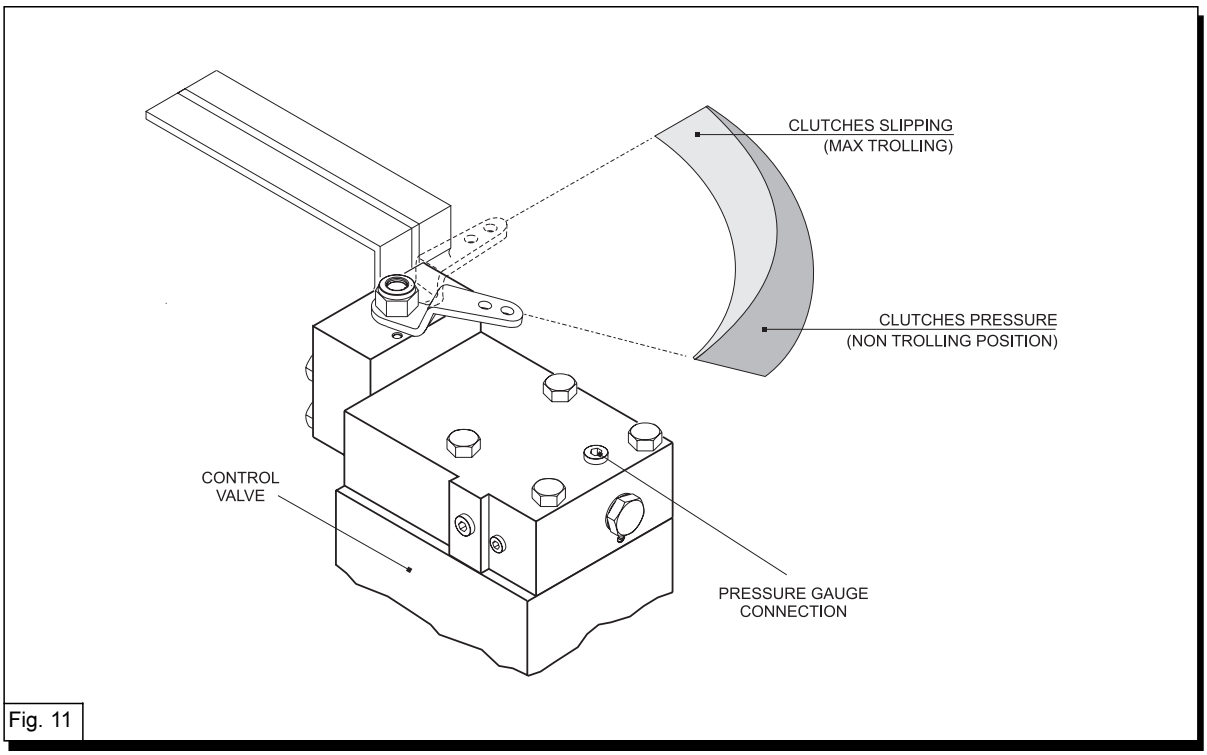


Fig. 11

1.8 *EMERGENCY CONTROL*

1.8.1

ELECTRICAL SYSTEM TROUBLE
Should a power failure occur, the gearbox will fail safe by reverting to neutral. In the event of an electrical or solenoid failure, the valves [1] can be operated mechanically, proceeding as follows and with extreme caution: disconnect the cables from all solenoid valves; determine which of the solenoids gives the direction of drive required (indicated normally on a label attached to the relative cable), and remove the cap [2] using a 22mm wrench (Fig. 12). Lift and rotate the button counterclockwise through 90°.

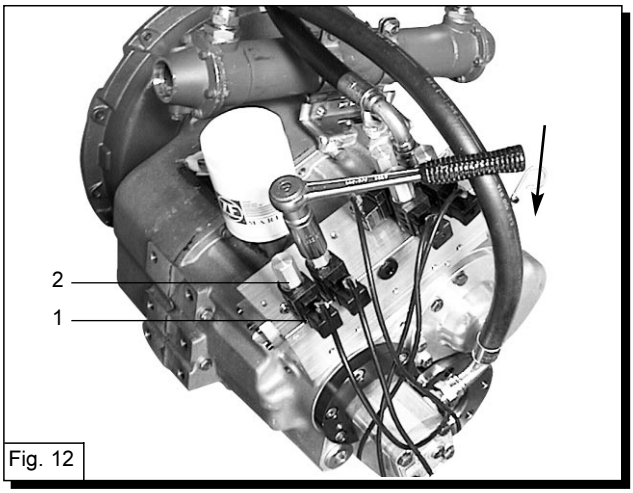


Fig. 12

Having completed the operation, ensure that the solenoid valve is positioned as shown in fig. 13.
The operation can be performed on valves 1D, 2D, 2C and 1C (Fig. 13A).

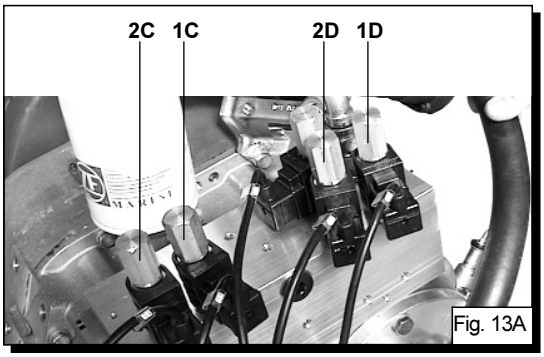


Fig. 13A

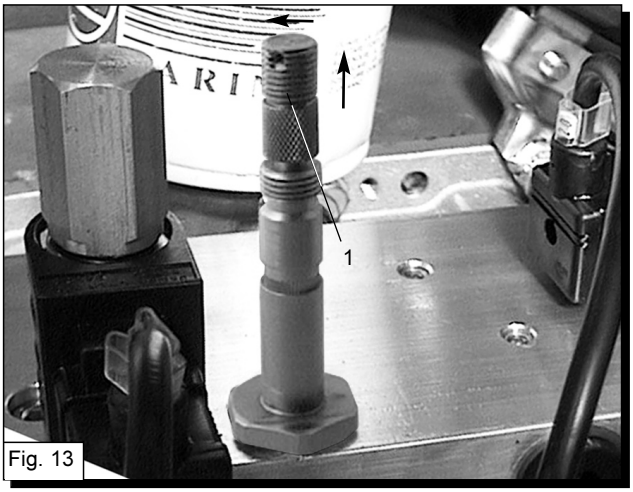


Fig. 13

Never perform this operation on two or more valves at once, as the relative clutches will engage at the same time and cause the gearbox to lock up.

A = valve closed (normal position);
B = valve open (emergency position) (drive selected).

The procedure is the same when locking the gearbox in 2nd speed

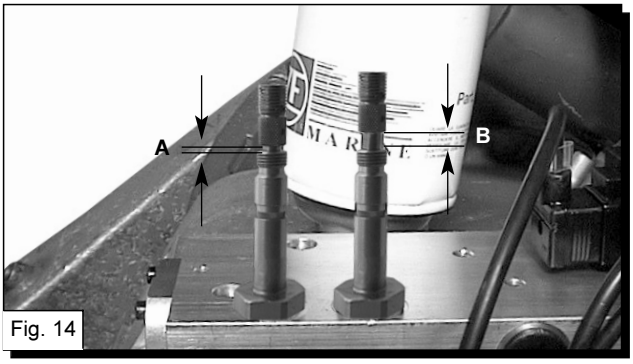


Fig. 14

Resetting: To reset the solenoid valve, rotate the button clockwise 90°.
Having completed the operation, ensure that the solenoid valve is positioned as shown in fig. 14. Replace and tighten the cap [2] (see fig. 12) using a 22mm wrench, torquing to 2-5 Nm.
In the event of the valve body (see fig. 15) being removed and refitted, use a 26mm wrench and torque to 45 Nm.

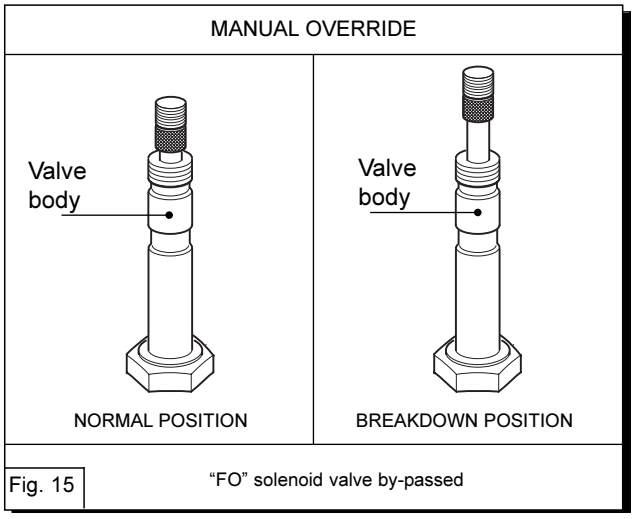


Fig. 15 "FO" solenoid valve by-passed

Important
All seals must be located in the relative seats.

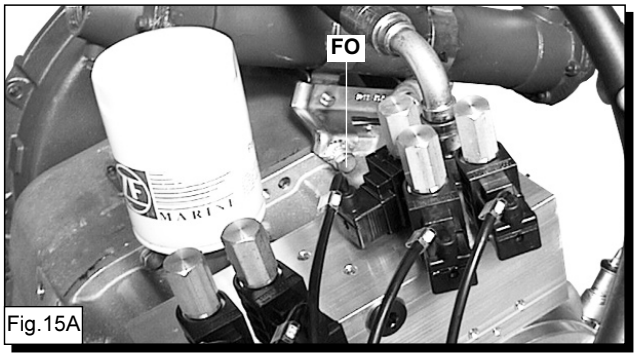


Fig.15A

2.3 *INSTALLATION OF CONTROL BOX*

The control box is connected to the solenoid valves by way of 5 electrical cables each 2 metres in length, of which the ends are fitted with DIN 43650 connectors.

Important: do not disconnect the terminals from the control box when the engine is running. Isolate the control system from the power supply by means of the control key (Fig. 4) before disconnecting it from the batteries.

Ensure that the solenoid valves fitted are suitable for the voltage of the d.c. power source.

The 5 cables must be connected as in fig. 3.

The bending radius of the 5 cables must be suitably wide (minimum bending radius 50 mm/2”).

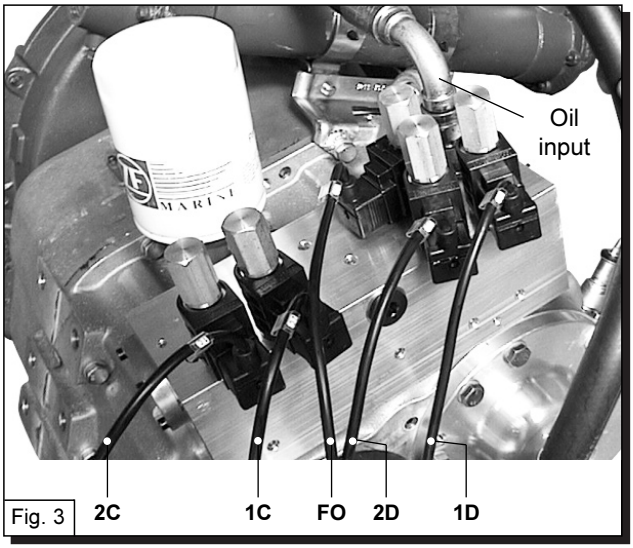


Fig. 3

FO	Neutral
1C	select 1° speed (engine rotation)
2C	select 2° speed (engine rotation)
1D	select 1° speed (counter engine rotation)
2D	select 2° speed (counter engine rotation)

The connection between the control box and the bridge must be made with a six core screened lead.

2.3.1 6-core electrical cable

The six-core screened cable must be of 10 mm external diameter and have the following specifications:

Non flame propagating	IEC 332-3A - CEI 20-22 II
Resistant to oil	CNOMO E. 03.04.15 ON - NFT 46-D13-UL 1581
Resistant to sea water	CEI 20-34 section II

1.9 TECHNICAL SPECIFICATIONS

1.9.1 OIL TYPE

OIL: all models

Tab. 2

Oil	Specification	Viscosity		v.i.	Specification
SAE 30*	SAE 30	102 cst (40°C)	12 cst (100°C)	100	MIL - L 2104C API classes MIL - L 2104D CC-CD-SC MIL - L 46152 SD-SE-SF
SAE 40**	SAE 40	145 cst (40°C)	14.5 cst (100°C)	99	MIL - L 2104C API classes MIL - L 2104D CC-CD-SC MIL - L 46152 SD-SE-SF

* = recommended ** = alternative for hot countries

Tab. 3

Oil quantity	10 litres

- Use the correct grade of oil, poured in through the filler (10 page 7).

Oil pump flow: 15 litres/min at 1000 rpm

1.9.2 PRESSURE AND TEMPERATURE

Tab. 4

OPERATING PRESSURE	23÷24 bar
OPERATING OIL TEMPERATURE	*40÷75° C*

• Pressure and temperature are measured at port 13 (see illustration on page 7).

IF THE VALUES MEASURED ARE NOT AS EXPECTED, FIRST CHECK THE ACCURACY OF THE INSTRUMENTS. IF STILL IN DOUBT, CONSULT YOUR NEAREST ZF SERVICE CENTRE OR CONTACT ZF PADOVA DIRECT.

The following instrumentation is recommended: a pressure sender (0-50 bar) mounted to the port 13 (Fig. 3 Page 7) on the control valve cover.
A temperature sensor (20-20 °C) fitted to one of the drain outlets 5 (Fig. 2 page7) and a corresponding gauge on the bridge console; the oil temperature should not stray from the normal operating value indicated in table 4.

CHAPTER 2

INSTALLATION

2.1

STANDARD GEARBOX INSTALLATION

Gearboxes of the families covered in this manual are normally flange-mounted to the engine. This ensures concentric alignment between the gearbox input shaft and the crankshaft. The entire engine and transmission assembly can then be mounted resiliently. It is good policy to include a bridging plate between the gearbox mountings and the rear engine mountings, to which the brackets for the resilient mounts are fitted. Gearboxes mounted separately from the engine and coupled by way of a universal joint can be mounted either rigidly or resiliently.The brackets carrying the mounts should be fitted to the gearbox mounting points and braced togther to form a U shape, giving added rigidity and strength. For free-standing gearboxes, the connection to the engine must be by way of a flexible coupling. Refer to the following installation drawings for more detail.

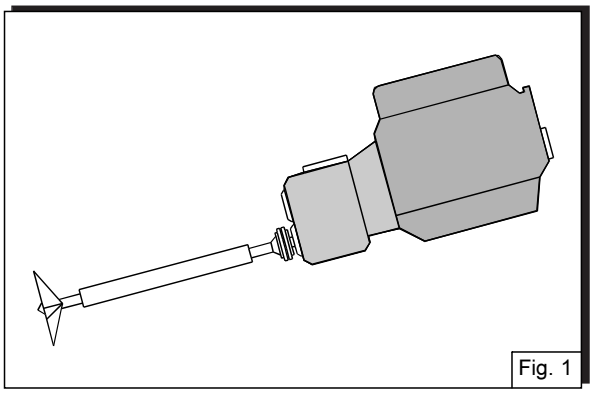


Fig. 1

When installing the gearbox, sufficient space must be allowed to ensure access for the purpose of servicing the heat exchanger, oil filter and oil pump and accessing the dipstick.

The oil drain plug must be easily accessible.

Tab. 1

PERMISSIBLE INSTALLATION ANGLES [°] (Referred to perpendicular and longitudinal axes of input shaft relative to horizontal plane)	Static angle	Transient angles	
		Pitch	Roll
	– 5 ... + 10	– 10 ... + 25	– 15 ...+ 15

2.2 CONNECTION TO PROPELLER SHAFT

Whilst the gearboxes covered by this manual are fitted with a thrust bearing, it may be necessary to add at least one further thrust bearing to the propeller shaft when axial loads on the transmission are liable to be severe or sustained. Selection of the propeller shaft dimensions and positioning of the bearings are the responsibility of the installer. Axial and radial loads on the propeller shaft impact directly on the gearbox. If there is any concern or doubt regarding connection of the propeller shaft, consult the ZF Marine Design Engineering Department.
Performance data for the propeller shaft bearing will depend on the loads applied during operation, and must be specified by the designer and builder of the craft.

X [mm]
0.05 max

Y [mm]
0.1 max

L [mm]
500 min for d < 60 mm
1000 min for d 60 - 90 mm
2000 min for d > 90 mm

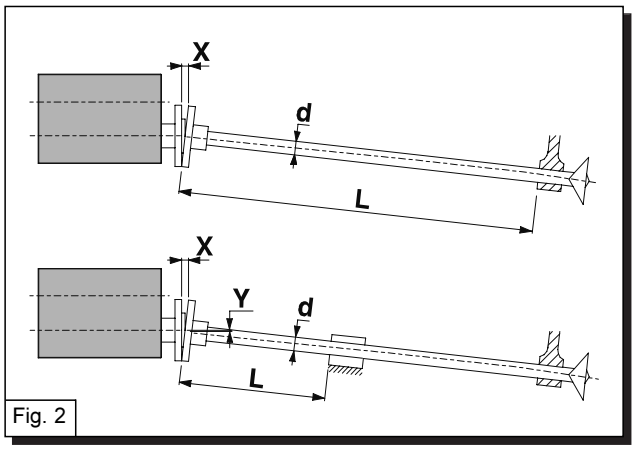


Fig. 2

It is essential that alignment be carried out before the craft is delivered to the customer, remembering that:
1) The boat must be in the water and the hull settled before final alignment of the driveline, as distortion of the hull in water can affect an alignment carried out in dry dock.
2) The propeller shaft must have sufficient freedom of movement to allow removal of the flanges.

Misalignment can cause irreparable damage to the gearbox, stern tube seals and bearings, as well as contributing to noise and vibration.
ZF Padova S.p.A. declines any liability under warranty for mechanical failure attributable to improper use or installation.

Important: when commissioning the craft, ensure before starting up the engine that all solenoid valve “manual overrides” are deselected and in the “normal position” (see heading 1.8.1).
The “FO” (neutral) solenoid valve has no manual override.

2.3 *INSTALLATION OF CONTROL BOX*

The control box is connected to the solenoid valves by way of 5 electrical cables each 2 metres in length, of which the ends are fitted with DIN 43650 connectors.

Important: do not disconnect the terminals from the control box when the engine is running. Isolate the control system from the power supply by means of the control key (Fig. 4) before disconnecting it from the batteries.

Ensure that the solenoid valves fitted are suitable for the voltage of the d.c. power source.

The 5 cables must be connected as in fig. 3.

The bending radius of the 5 cables must be suitably wide (minimum bending radius 50 mm/2”).

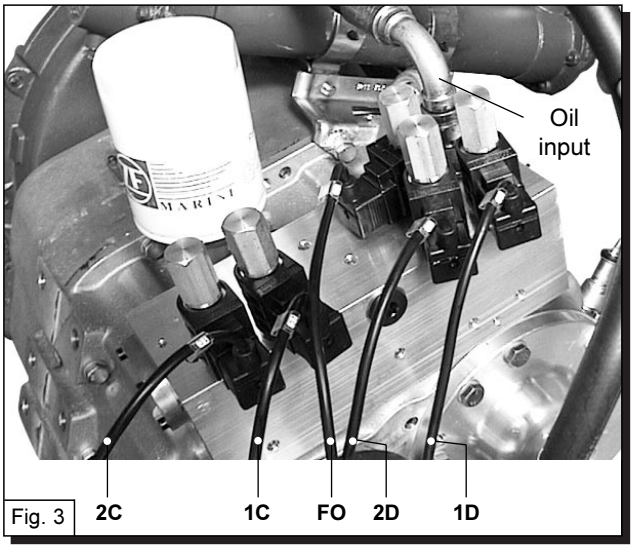


Fig. 3

FO	Neutral
1C	select 1° speed (engine rotation)
2C	select 2° speed (engine rotation)
1D	select 1° speed (counter engine rotation)
2D	select 2° speed (counter engine rotation)

The connection between the control box and the bridge must be made with a six core screened lead.

2.3.1 6-core electrical cable

The six-core screened cable must be of 10 mm external diameter and have the following specifications:

Non flame propagating	IEC 332-3A - CEI 20-22 II
Resistant to oil	CNOMO E. 03.04.15 ON - NFT 46-D13-UL 1581
Resistant to sea water	CEI 20-34 section II

2.3.2 Connection diagram

Make the connections to the terminals of the control box as indicated in the diagram.

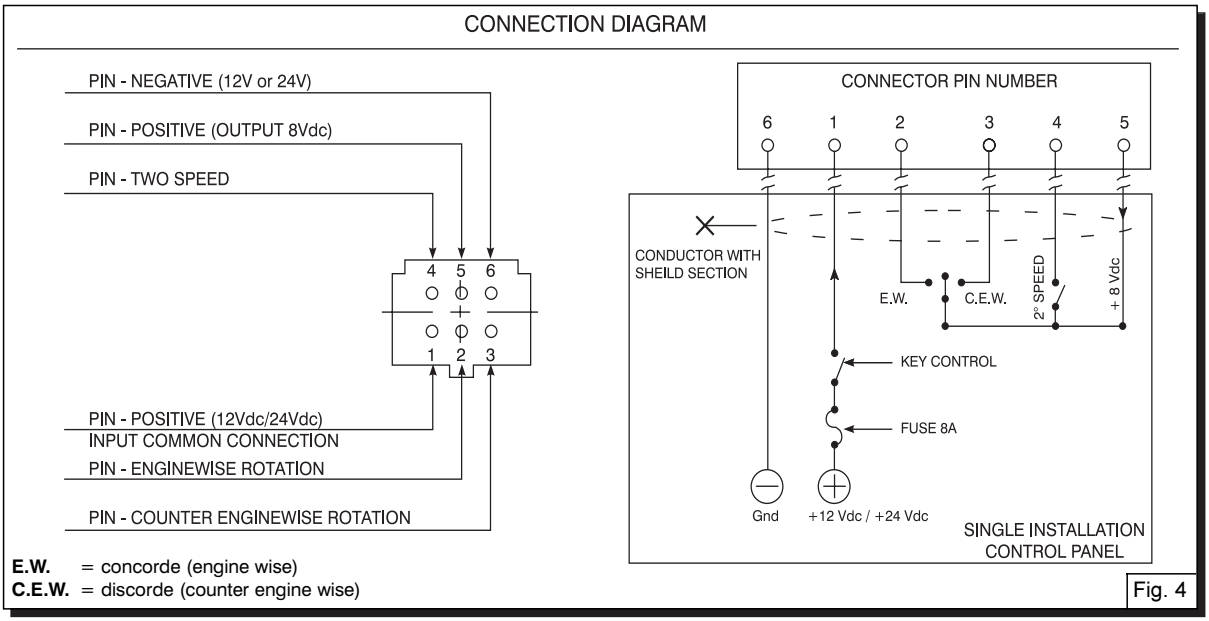


Fig. 4

The screening of the earth cable must be cut at the end of the sheath.

The diagram is valid for one gearbox installation only.

Caution: the control box must be powered up only when the engine is running. Protect the circuit with a fuse (8.0 M5x20F DIN 41661) located between the power source and the control key, as indicated in the control panel section (connection diagram).

Energizing two engine rotation and counter engine rotation solenoid valves simultaneously has the effect of activating the "FO" neutral valve.

CHAPTER 3

TROUBLESHOOTING

3.1 *SYMPTOMS CAUSES REMEDIES*

SYMPTOMS	CAUSES	REMEDIES
1) No oil pressure in main and lubrication circuits either in neutral or with drive engaged	1 - No oil in gearcase	- Fill with oil
	2 - Wrong direction of rotation	✻ - Check application specifications
	3 - Suction filter completely clogged	✻ - Remove and clean filter
	4 - Oil suction lines damaged or disconnected	✻ - Remove oil lines and inspect. Replace parts as required
	5 - Oil pump damaged or worn	✻ - Replace pump
	6 - Oil pump drive coupling failure	✻ - Remove pump and replace coupling
	7 - Input or intermediate shaft failure	✻ - Remove shaft and replace
	8 - Driveline coupling failure	✻ - Replace coupling
2) Low oil pressure with drive engaged	1 - Pressure control valve stuck in open position	- Remove valve and clean thoroughly
	2 - Low oil level	- Top up to level indicated
	3 - Clutch oil lines leaking (worn clips, damaged sub-plates, faulty piston seals)	✻ - Overhaul gearbox and replace worn parts as necessary
	4 - Suction filter partially clogged	- Remove and clean filter
	5 - Oil pump damaged or worn	✻ - Replace pump
	6 - Pressure control valve seat damaged	✻ - Remove valve, strip, and inspect seat
	7 - Pressure control valve spring worn or broken	✻ - Inspect spring and replace if worn. Readjust pressure setting
	8 - Wrong type of oil	- Drain gearbox and fill with correct grade
	9 - High oil temperature	✻ - See cause 3
	10 - “FO” solenoid valve damaged	✻ - Replace valve
	11 - Selector Trolling lever not properly set	- Adjust remote controls
	12 - Trolling control valve lever in trolling mode	- Put the lever no trolling range

✻ Operations marked with this symbol should be entrusted to a ZF Authorized Service Centre.

SYMPTOMS	CAUSES	REMEDIES
3) High oil pressure	1 - Pressure control valve stuck in closed position	- Remove valve and clean thoroughly
	2 - Internal oil lines and/or pipelines obstructed	✻ - Overhaul gearbox and clean oil ways
4) High oil temperature	1 - Heat exchanger too small	✻ - Replace present heat exchanger with one of suitable capacity
	2 - Insufficient flow of water to heat exchanger	✻ - Replace valves and pipelines with others of larger internal diameter
	3 - Heat exchanger dirty	✻ - Clean heat exchanger
	4 - Oil level too high or too low	- Restore normal level
	5 - Wrong type of oil	- Drain gearbox and fill with correct grade
	6 - Clutches slipping	- Check operating pressure
	7 - Cavitation in oil pump	- Add oil and/or inspect suction lines
	8 - Bearings incorrectly preloaded, or damaged	✻ - Check preload or replace bearings
	9 - Clutch piston seized	✻ - Remove clutches and overhaul
	10 - Clutch discs warped	✻ - Overhaul clutches and replace discs
	11 - Insufficient oil flow to the cooler	✻ - Check oil pump
5) Excessive noise	1 - Cavitation in oil pump	- Tighten all fittings and/or replace damaged pipelines; check filter and O-rings
	2 - Incorrect bearing adjustment (excessive end float)	✻ - Check bearing end float and correct with shims as necessary
	3 - Bearings damaged	✻ - Overhaul gearbox and replace damaged parts
	4 - Worn gear teeth	✻ - Overhaul gearbox and replace worn gears
	5 - Flexible coupling wrong type or damaged	✻ - Remove coupling and replace with a suitable type
6) No neutral	1 - Clutch discs warped	✻ - Overhaul gearbox and replace discs
	2 - Clutch piston seized	✻ - Remove clutch and overhaul

✻ **Operations marked with this symbol should be entrusted to a ZF Authorized Service Centre.**

SYMPTOMS	CAUSES	REMEDIES
7) Drive difficult or impossible to engage	1 - Air in hydraulic circuit	- Check oil level. Correct air leaks in pipelines, drain aerated oil and replace with fresh oil
	2 - Clutch piston seized	✻ - Remove clutch and overhaul
	3 - Pressure modulation system defective	✻ - Check control valve
	5 - Internal oil leak	- Check oil circuit
	6 - Incorrect oil temperature	- Check heat exchanger and water flow
	7 - Drive difficult or impossible to engage with pressure of ≥ 5 bar	- Check external fuse (near control key) and replace if necessary. - Check that the 6-pin connector is plugged in correctly to the control box (reconnect if not). - Check the integrity of the cable and if damaged use the emergency manual override. Call out an approved service technician. - Check the connections from control box to control panel and viceversa.
	8 - Drive does not engage within acceptable space of time.	- Check that the manual override is in the correct position. - Check that the solenoid valve connector is correctly (and securely) plugged in. - Make certain that defective installation has not resulted in partial oxidation of the electrical contacts at the solenoid valve affected. (Clean contacts, or replace the connector and the solenoid valve as necessary). - have specialist technicans check the neutral overlap time (if fault occurs when reversing direction). - have specialist technicans check the speed selection overlap time.
	9 - When reversing the drive direction (holding neutral for at least 0,5 seconds with pressure registering higher than 15 bar), the gearbox begins to respond jerkily, kicking strongly every time the direction is reversed.	- Check connections, look for oxidation of electrical contacts in the FO solenoid valve control circuit. Replace the solenoid valve or the connector, or both, as necessary. - have specialist technicans check the neutral overlap time.
	10 - During a standard reversing manoeuvre the gearbox begins to respond too slowly.	- Check oil level, locating leaks if any; repair leaks, top up oil level. - Check position of manual overrides; return to normal electrical control position. - have specialist technicans check the neutral overlap time.
	11 - Selector Trolling lever not properly set	- Put the lever no trolling range

✻ **Operations marked with this symbol should be entrusted to a ZF Authorized Service Centre.**

SYMPTOMS	CAUSES	REMEDIES
8) External oil leakage	1 - Seals or shaft sealing surface worn	✻ - Replace seals and/or shafts
	2 - Breather blocked	- Clean or replace breather and inspect seat
	3 - Oil dipstick leaking	- Replace dipstick
	4 - Plugs and fittings loose	- Tighten all round
	5 - Pipelines damaged	- Replace pipelines
	6 - Gearcase leaking	✻ - Replace gaskets or sealant and torque bolts to correct setting
9) Oil level fluctuating	1 - Inefficient or erratic oil/water heat exchange	✻ - Replace oil cooler

✻ **Operations marked with this symbol should be entrusted to a ZF Authorized Service Centre.**

CHAPTER 4

MAINTENANCE

4.1 *MAINTENANCE SCHEDULE*

Tab. 1

Annually / 500 hours	Six-monthly / 250 hours	Daily	After 50 hours operation	MAINTENANCE OPERATIONS
✓	✓	✓		Check for oil leaks
✓	✓	✓		Check oil level
✓	✓		✓	Tighten all external threaded fasteners
✓	✓		✓	Inspect suction filter
✓	✓			Clean transmission externally
✓			✓	Oil change
✓				Replace oil filter
✓				Inspect flexible coupling
✓				Inspect resilient mounts
✓				Check instruments and indicators
✓				Replace zinc anodes
✓				Service heat exchanger
	✓			Inspect electrical cables

4.2 ROUTINE MAINTENANCE OPERATIONS

4.2.1 AFTER 50 HOURS OPERATION

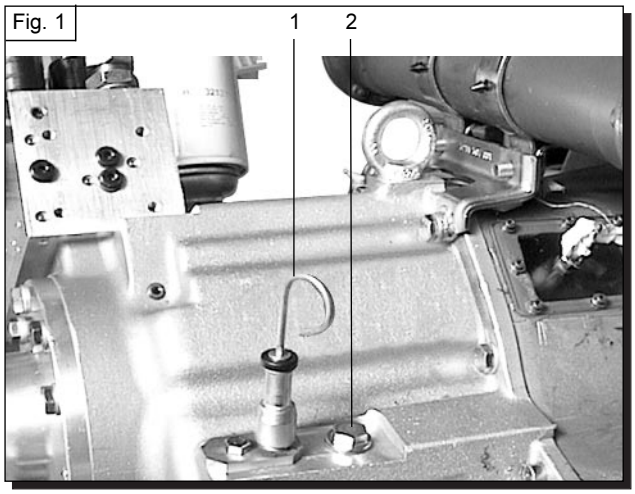
- **Tighten all external threaded fasteners**

- **Shift control linkage** (for Trolling Valve version)
  With the engine off, remove the pin connecting the control cable to the lever of the Trolling Valve, then shift the lever to “non Trolling” position.
  Select the same direction with the bridge console T.V. lever and check that the positions of the respective couplers (lever/cable) coincide.

- **Oil change**

  Draw out the dipstick [1] and remove the filler plug [2] (fig 1).

Fig. 1



Remove the drain plug [1] (fig. 2), taking care not to lose the seal, and allow the oil to run off.
Collect the spent oil in a receptacle and arrange for disposal in accordance with local environmental regulations.
Replace the plug [1] with its seal and torque to 90 Nm, then fill with fresh oil. Finally, replace the filler plug [2] (fig. 1) and torque to 80 Nm.

Having filled the gearbox and checked the level, start up the engine and run the transmission in neutral at idling speed for several minutes. Then stop the engine and check the oil level again.

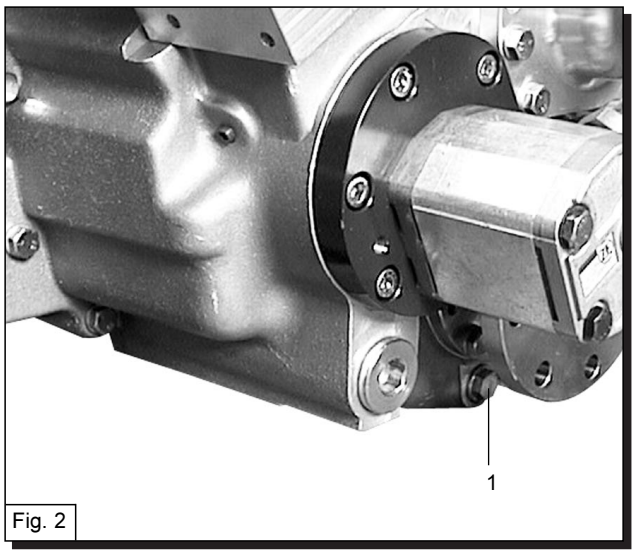
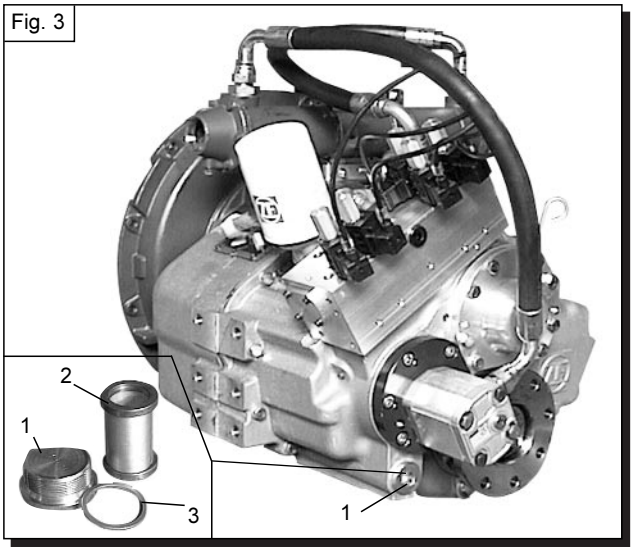


Fig. 2

- **Suction filter**
  The oil suction filter should be inspected and cleaned after 50 hours operation, then every six months or every 250 hours, whichever is sooner.
  The filter is located on the inlet side of the oil pump.
  Removal procedure:
  - remove the plug [1] (fig. 3);
  - remove the filter [2] and the copper seal [3], clean, and refit with a new seal;
  - refit the plug and torque to 100 Nm.

Fig. 3



4.2.2 DAILY

- **Check for oil leaks**
  Start the engine and verify that there are no external leaks from fittings or other parts.

- **Check oil level**

  The oil level must be checked only with the engine off, and at least 2 minutes after the crankshaft has stopped rotating.

  The correct level is between the MAX and MIN marks on the dipstick (fig. 4).
  Following the first oil change, and after carrying out repairs or servicing the filter, remember that there will be a certain amount of oil left in the heat exchanger, pipelines and filter which does not flow back into the gearcase. Accordingly, run the transmission for a few minutes, then switch off the engine, wait 2 minutes at least, and check the dipstick again.

  Remove the dipstick only when the engine is off, otherwise hot oil could splash out and scald.

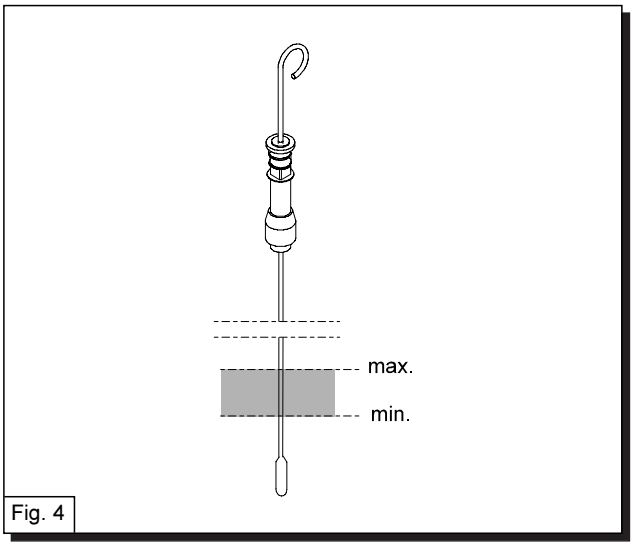


Fig. 4

4.2.3 AFTER SIX MONTHS OR 250 HOURS

- **Check for oil leaks**
- **Check oil level**
- **Tighten all external threaded fasteners**
- **Inspect suction filter**
- **Check the electrical cables of the control box and the terminals for signs of corrosion or loose connections.**

  External parts of the transmission should be cleaned thoroughly, using proprietary chemicals.

  Caution: do not use chemicals on rubber components.
  Check that all threaded parts are tight.

- **Lubricate external moving parts**
  Lubricate the moving parts of the shift linkage periodically as indicated by the manufacturer.

4.2.4

ANNUALLY OR EVERY 500 HOURS

- **Check for oil leaks**
- **Check oil level**
- **Tighten all external threaded fasteners**
- **Inspect suction filter**
- **Clean transmission externally**
- **Lubricate external moving parts**
- **Oil change**
- **Inspect flexible coupling**
  Make a chalk mark on the coupling for reference purposes, then crank the engine slowly by hand while scrutinizing rubber parts for any signs of cracking, embrittlement and overheating or oil contamination.

Caution: remove the ignition key before cranking the engine.

- **Inspect resilient mounts**
  Verify the integrity of the mounts and check that they are securely anchored.
- **Check instruments and indicators**
  The accuracy and reliability of these components must be checked at least once a year.
- **Replace zinc anodes**
  Zinc anodes are fitted near the raw water inlet and outlet of the heat exchanger. Inspect at least once a year or every 500 hours, whichever is sooner, and replace the anodes if water has leaked.
- **Service heat exchanger**
  The heat exchanger needs inspecting at least once a year and cleaning if necessary, especially in severe or abnormal operating conditions.

CHAPTER 5

WARRANTY

The identification plate fixed to the gearbox shows important information and must not be tampered with or removed; any such interference will automatically invalidate the warranty.

The details marked on the plate must be quoted in all correspondence with Service Centres.

WARRANTY

ZF PADOVA S.p.A. assumes liability, for the duration of the period specified on the warranty card, for any defects discovered in component parts of new equipment acknowledged as being attributable to substandard materials and or workmanship, whilst declining any liability for defects resulting from difficulties connected with installation or wrong operation, inexpert or insufficient maintenance and accidents. Neither is any liability assumed by ZF PADOVA S.p.A. for components such as oil seals, gaskets, drive belts, boots, guards and diaphragms or other parts in rubber which by reason of their structural composition are subject continuously to stresses and premature wear, except where the defect is indisputably attributable to the substandard fitment, application or origin of the component.
Assemblies and their component parts must be installed in accordance with ZF PADOVA S.p.A. specifications or in any event with the express approval of ZF PADOVA S.p.A, Design Engineering or Applications Department. Assemblies or parts acknowledged as being defective will be either replaced by ZF PADOVA S.p.A. or repaired at the factory or at a ZF-Service workshop, free of charge, all relative shipping costs being payable in advance by the owner of the boat or vehicle. All expenses involved in enabling ZF PADOVA S.p.A. authorized technicians to gain access to the assembly or its components parts are chargeable in full to the owner of the boat or vehicle.
ZF PADOVA S.p.A. declines any liability for damages, expenses and claims of whatever nature in connection with the warranty and will not reimburse the claimant in respect of unauthorized expenses.
In the event of repairs of modifications being carried out on the assembly or its component parts without prior approval of ZF PADOVA S.p.A. or by persons not authorized by ZF PADOVA S.p.A. or utilizing parts other than genuine ZF spares, the warranty is automatically invalidated.
In signing the attached warranty card the User agrees to comply with the foregoing terms and conditions and with the company's General Conditions of Sale.
Emergency manoeuvres when performed routinely and repeatedly will overload and/or damage the transmission. Mechanical failure resulting from this type of operation or other similar abuse can under no circumstances be considered as covered by the manufacturer's Warranty.

NOTE: THE DURATION OF THE WARRANTY IS SPECIFIED ON THE WARRANTY CARD, WHICH SHOULD BE KEPT TOGETHER WITH THE BOAT DOCUMENTS.

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** MANUFACTURING LOCATIONS*
*** ZF HURTH REPRESENTATIVE*

CHAPTER 6

SERVICE HISTORY

Hours work

Date, stamp, signature

Hours work

Date, stamp, signature

Hours work

Date, stamp, signature

Hours work

Date, stamp, signature

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