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# Autohelm 6000

Installation & Operating Handbook

# AUTOHELM 6000

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Autohelm 6000 is one of the first of a new generation of microprocessor controlled autopilots and is suitable for sailing and motor vessels of between 13m and 20m LOA (40' – 60'). Whilst the engineering behind the system is complex, operation has been simplified to the point where switching over to autopilot merely involves touching a single button. Complicated control knobs have given way to microprocessor automation so that steering performance is continuously optimised over the entire range of sea and vessel trim conditions.

Autohelm 6000 is simple to install and prepare for sea trials. However, sound installation is vital if the system's full performance potential and reliability are to be achieved. The installation notes should be followed carefully and in cases where special advice may be needed, you are encouraged to contact our Technical Sales Department where expert assistance is always available.

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# 1 .0 GENERAL DESCRIPTION

Autohelm 6000 is a modular automatic pilot system that can be built up to match the individual requirements of all types of sailing and power vessels. The rudder drive system may be selected from a range of rotary, linear and hydraulic systems, and the control system can be customised to suit the layout of the vessel and the owners individual requirements. All control units are watertight and may be externally mounted when necessary.

The most comprehensive installation is illustrated in (Fig. 1) and provides for up to three control units, together with a fluxgate compass and optional wind vane course sensors. Provision is also made for the addition of a Loran 'C' or Decca Radio Navigation Interface. The most basic installation would consist only of a central course computer, fluxgate compass, drive unit and a single control unit.

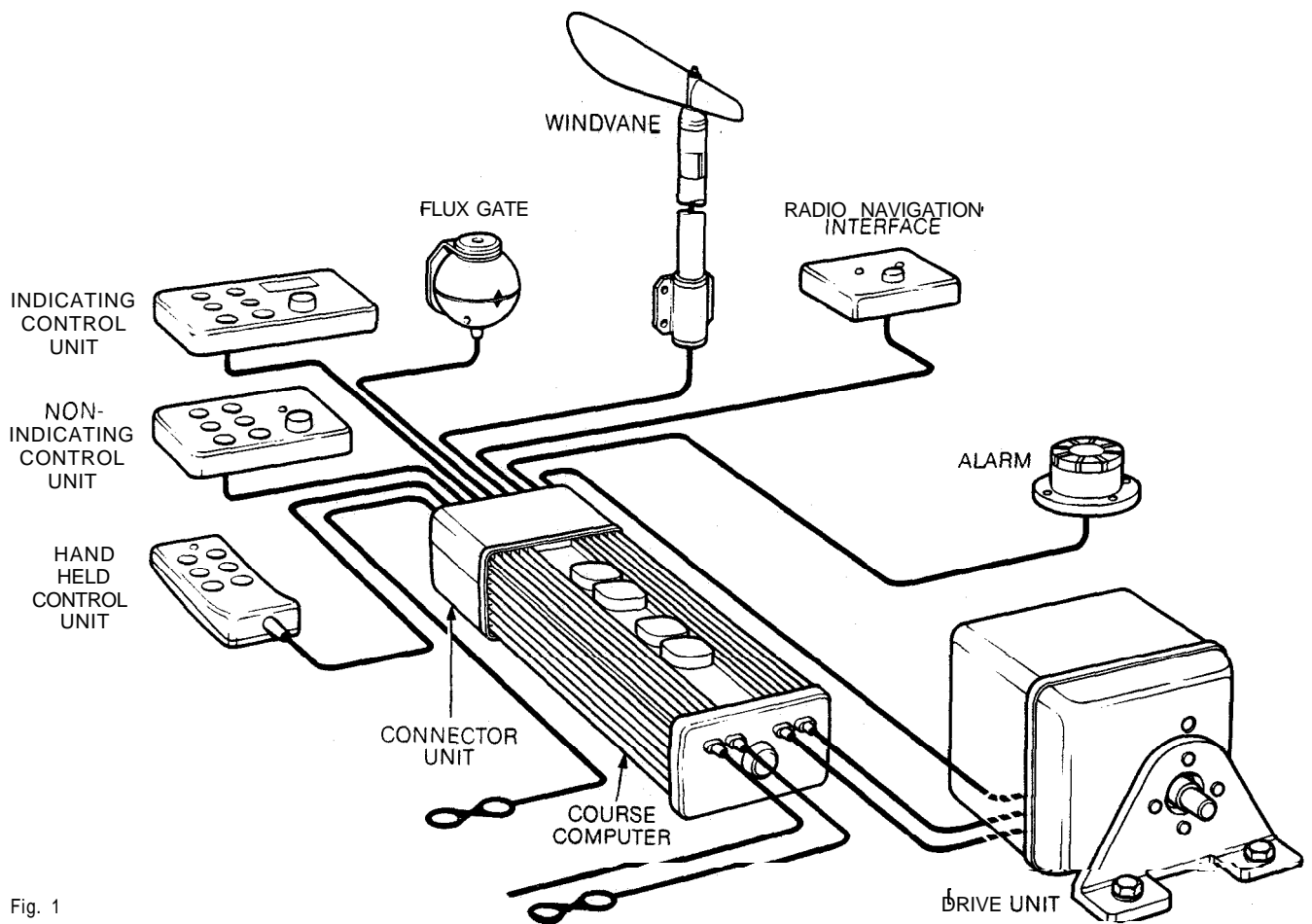
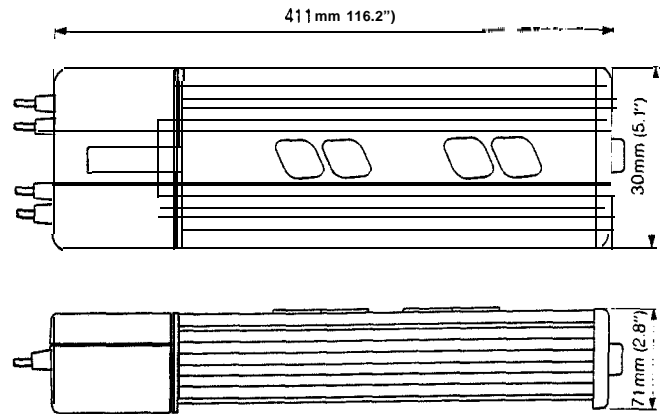


Fig. 1

## 1.1 CONTROL SYSTEM

### 1.1.1 COURSE COMPUTER

The course computer houses the central micro computer and the drive system power amplifier which confines the complete electronic system to a single module. The course computer plugs into a connector unit to which all of the control system peripheral modules are connected. The course computer is thus easily removable from the vessel for servicing by unplugging from the connector unit. The course computer is splash-proof only and must be mounted in a dry and protected position. The course computer is supplied in 12v and 24v configuration.

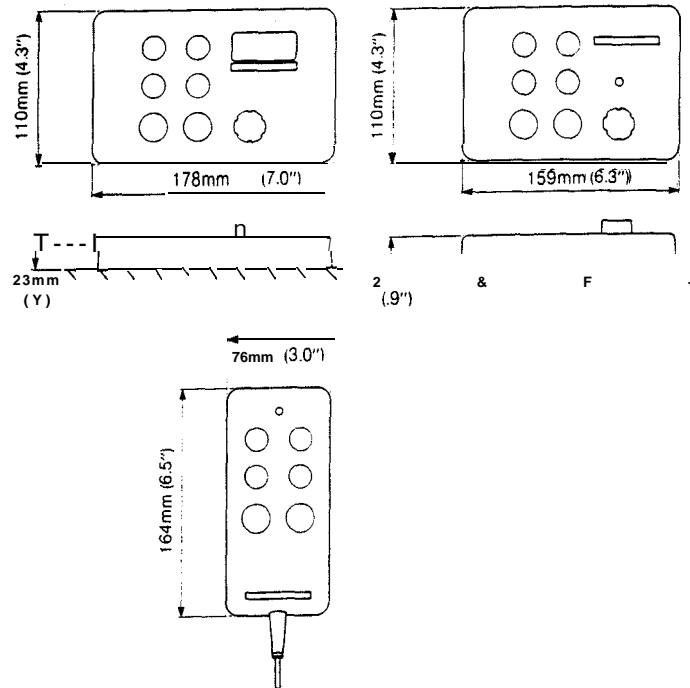


### 1.1.2 CONTROL UNITS

Non Indicating and Indicating control units are available, both of which provide full control of the autopilot. The indicating control unit has a back-lit digital course display, which also indicates cross track error when the autopilot is supervised by the Radio Navigation Interface system. Both types of control unit are designed for surface mounting, and would normally be situated adjacent to the steering position(s).

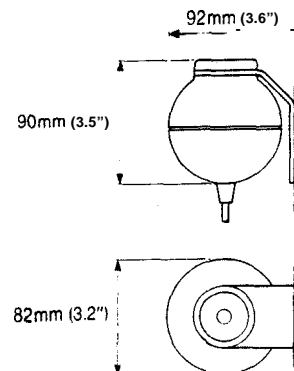
A hand-held control unit is also available to permit full control of the autopilot and power steering from any position on deck. The hand-held control unit is fitted with a 6m (19') wander lead and plugs into a bulkhead mounted waterproof socket.

All three types of control unit are fully waterproof for permanent outside location when necessary, and are connected to a common bus within the course computer connector unit.



### 1.1.3 FLUXGATE COMPASS

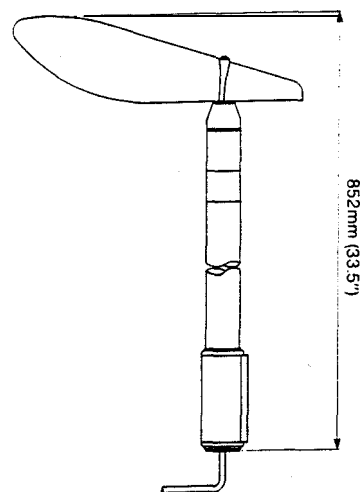
The fluxgate compass has been specially developed for marine autopilot application. It is excited and read by the system's central course computer and therefore does not contain any active electronic components. The fluxgate is gimbal mounted to permit pitch and roll movements of up to  $\pm 40^\circ$ . The compass is bulkhead mounted and connects directly to the course computer connector unit.



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### 1.1.4 WINDVANE

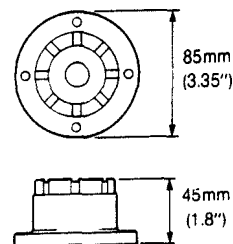
The windvane is designed for permanent attachment to the after rail where it can be sited in clear wind. The windvane interconnecting cable feeds through the deck via a waterproof gland unit and connects directly to the course computer connector unit.



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### 1.1.5 AUXILIARY ALARM

The autopilot is provided with an automatic off course alarm system which sounds from all control units and provides sufficient audible warning under most conditions. In cases where a high power alarm is necessary, an auxiliary alarm can be fitted. The auxiliary alarm is connected to the main connector unit via a two core cable.

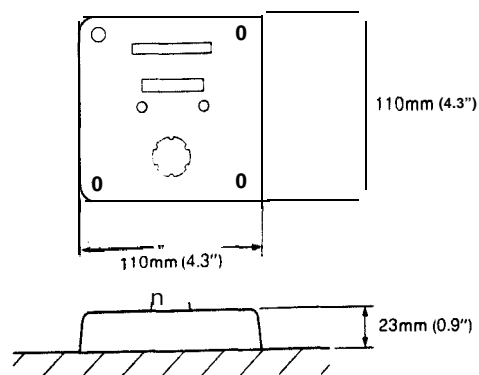


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### 1.1.6 RADIO NAVIGATION INTERFACE

The autopilot can be interfaced to any Decca or Loran 'C' system that is provided with a suitable autopilot output. The radio navigation interface unit receives cross track error information from the Decca or Loran 'C' system and computes course adjustments to enable the autopilot to steer to a selected way point. The radio navigation interface connects to the common control unit bus within the course computer connector unit. The unit is designed for surface mounting and would normally be situated in the navigation area adjacent to the Loran or Decca receiver.

Your main distributor or Nautech Technical Sales Department will be able to advise you of Radio Navigation Systems with suitable autopilot output.



## 1.2 DRIVE SYSTEMS

Mechanical steering systems may be driven by either a rotary or linear drive unit. Some steering systems are fitted with an autopilot drive shaft, and in such cases the choice of a rotary drive system is straightforward. In general, if a drive shaft exists and lost motion does not exceed 2% of total rudder movement, the rotary drive unit becomes the most economic choice. In all other cases the linear drive unit will provide the simplest installation since it may be connected directly to a tiller link on the rudder stock. Total independence

of the mechanical steering linkage also allows the linear drive unit to be used to power steer the vessel in the event of steering linkage failure, and this is an important safety feature. In addition, minimisation of working parts improves the overall efficiency of the rudder drive system and reduces lost motion to an absolute minimum.

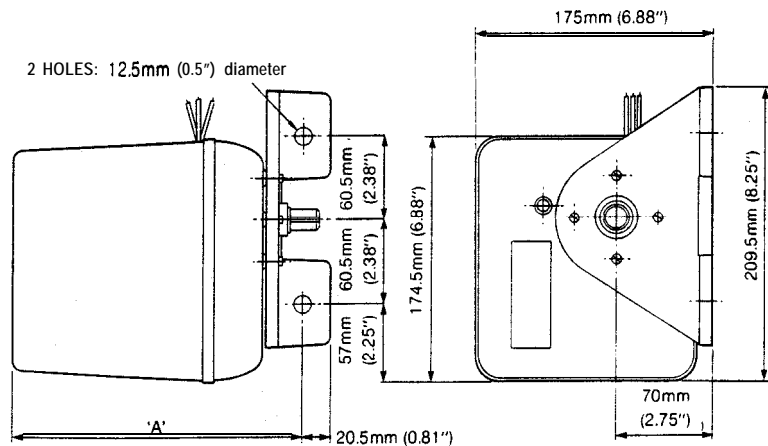
All vessels with hydraulic steering systems will require a hydraulic drive unit.

### 1.2.1 ROTARY DRIVE UNIT

The output shaft is driven by a continuously rated servo motor via an efficient reduction gearbox. The gearbox is dry lubricated to permit operation in any attitude. A fail safe friction clutch within the gear train engages automatically when the autopilot is switched to 'Auto' and will disengage

instantly even under extreme load when the autopilot is switched to 'Stand-by'. The motor is controlled by the course computer which also regulates peak armature current and eliminates the need for end limit switches.

	<b>Type 1</b>	<b>Type 2</b>
Supply voltage	12 volts (24 volts optional)	12 volts (24 volts optional)
Peak output torque	240lb.in. (27Nm)	425lb.in. (48Nm)
Maximum shaft speed	18 rpm	28 rpm
Power consumption (typical average)	1.5-3 amps	4-7 amps
Overall depth 'A'	7.5in. (190mm)	8.1 in. (210mm)
Suitable for vessels up to	45ft. LOA (14m)	60ft. LOA (18m)



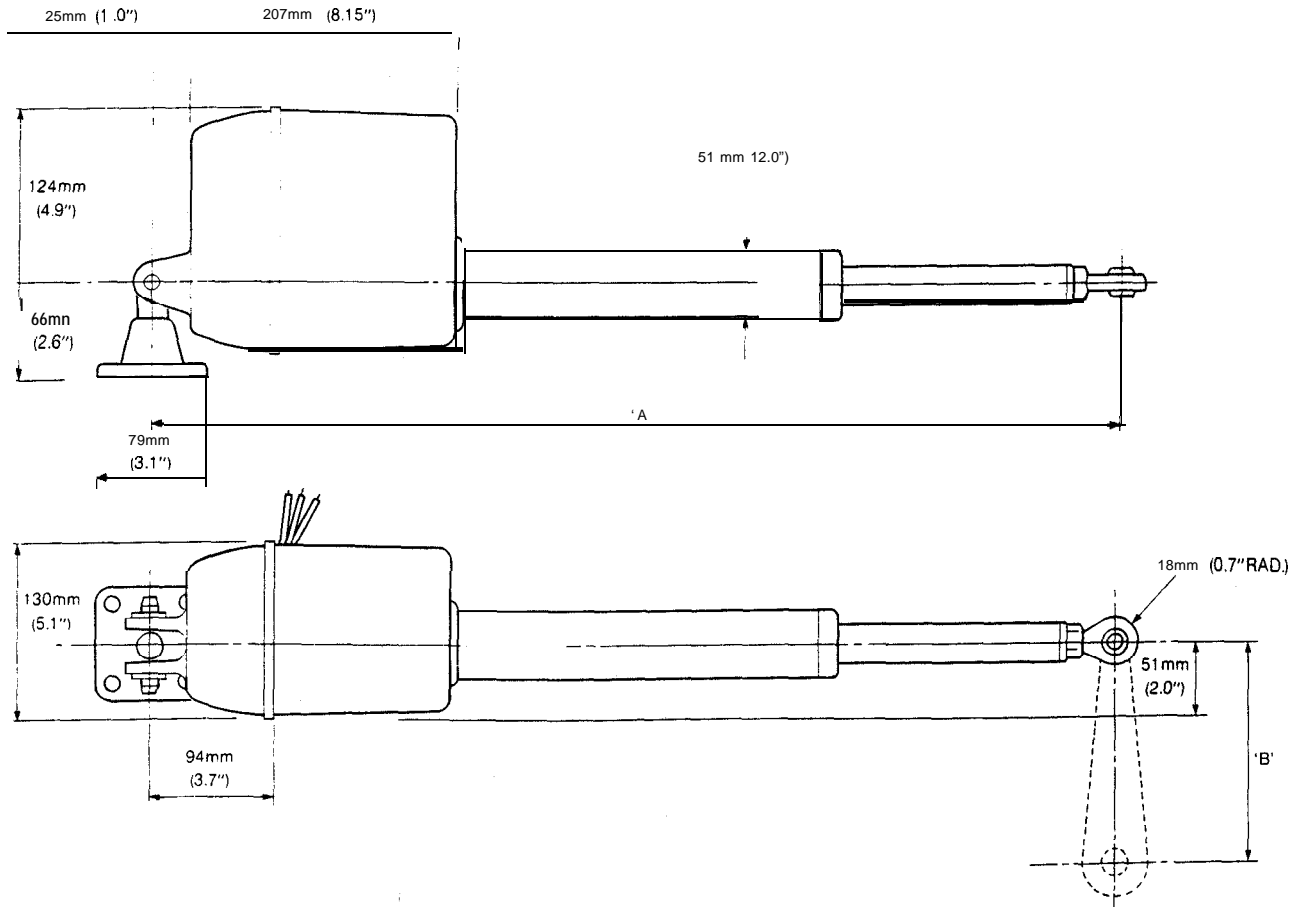


## 1.2.2 LINEAR DRIVE UNIT

The output ram of the linear drive unit is driven by a declutchable recirculating ball leadscrew which enables the drive unit to be permanently coupled to the rudder stock via a simple crank or tiller arm. The drive is automatically engaged by means of an internal friction clutch when the autopilot is

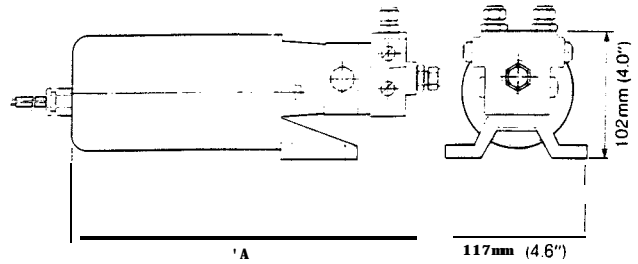
switched to 'Auto' and will disengage instantly even under heavy load when the autopilot is switched to 'Stand-by'. The motor is controlled by the course computer which regulates peak current and eliminates the need for end limit switches.

	<b>Type 1</b>	<b>Type 2</b>
Supply voltage	12 volts (24 volts optional)	12 volts (24 volts optional)
Peak thrust	550lbs (225Kg)	750lb. (340Kg)
Maximum stroke. speed	1.2in./sec. (30mm/sec.)	1.3in/sec (33mm/sec)
Maximum stroke	12in(300mm)	16in (400mm)
Overall length at mid stroke 'A'	27.5in. (700mm)	33.5in. (850mm)
Tiller arm length 'B' (±35° rudder)	1 Oin. (260mm)	14 in. (350mm)
Maximum rudder torque	5000lb.in. (570Nm)	10,500lb.in. (1200Nm)
Power consumption (typical average)	1.5-3 amps	2.75-6 amps
Suitable for vessels up to	45ft. LOA (14m)	60ft. LOA (18m)



### 1.2.3 HYDRAULIC DRIVE UNIT

The hydraulic drive unit consists of a precision gear pump with integral valve block driven by a continuously rated servo motor. A special pressure balance valve corrects the effects of hydraulic slip and isolates the pump from the steering circuit when the autopilot is not energised. The pump drive motor is connected directly to the course computer which also regulates peak pump pressure and eliminates the need for end stroke limit switches.



	<b>Type 1</b>	<b>Type 2</b>
Supply voltage	12 volts (24 volts optional)	12 volts (24 volts optional)
Regulated peak pressure	450lb.in. <sup>2</sup> (30bar)	450lb.in. <sup>2</sup> (30 bar)
Flow control	integral pilot check and pressure balance valve system	integral pilot check and pressure balance valve system
Peak flow rate (unloaded)	40in <sup>3</sup> /min (650cc/min)	80in <sup>3</sup> /min (1300cc/min)
Maximum ram capacity	15in <sup>3</sup> (250cc)	30in <sup>3</sup> (500cc)
Power consumption (typical average)	2-3.5 amps	4-8 amps
Overall length 'A'	9.5in. (240mm)	10.5in. (265mm)

## 2.0 INSTALLATION

Installation of the Autohelm 6000 is exceptionally straightforward but sound installation is vital if the system's high standard of performance and reliability is to be achieved.

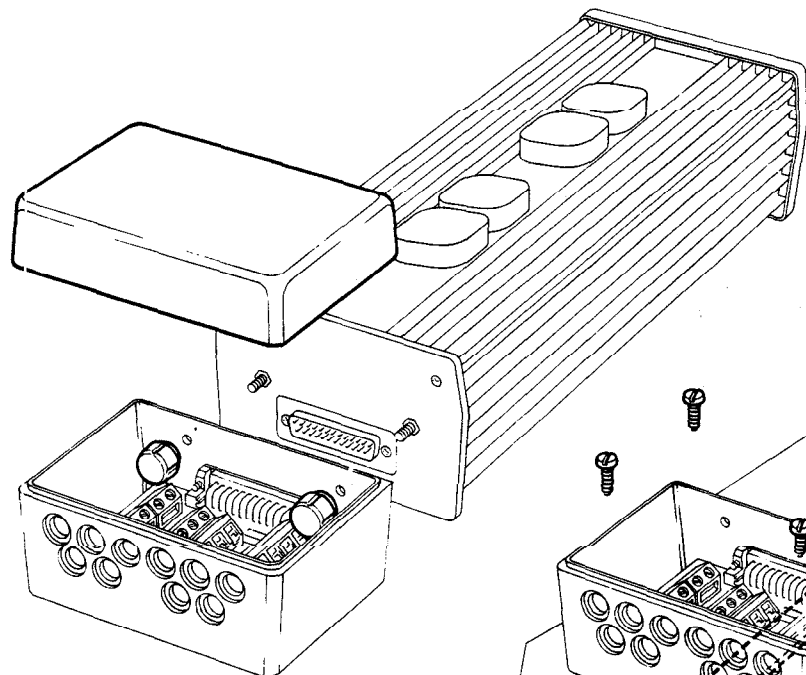


Fig. 2

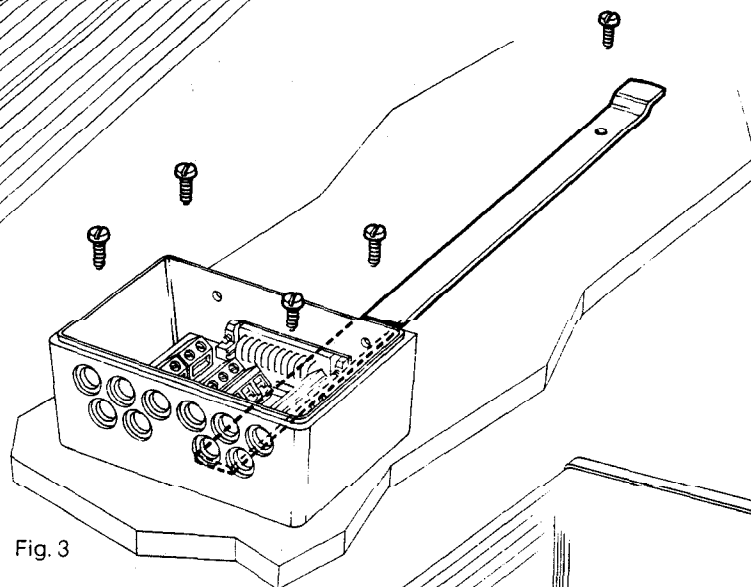


Fig. 3

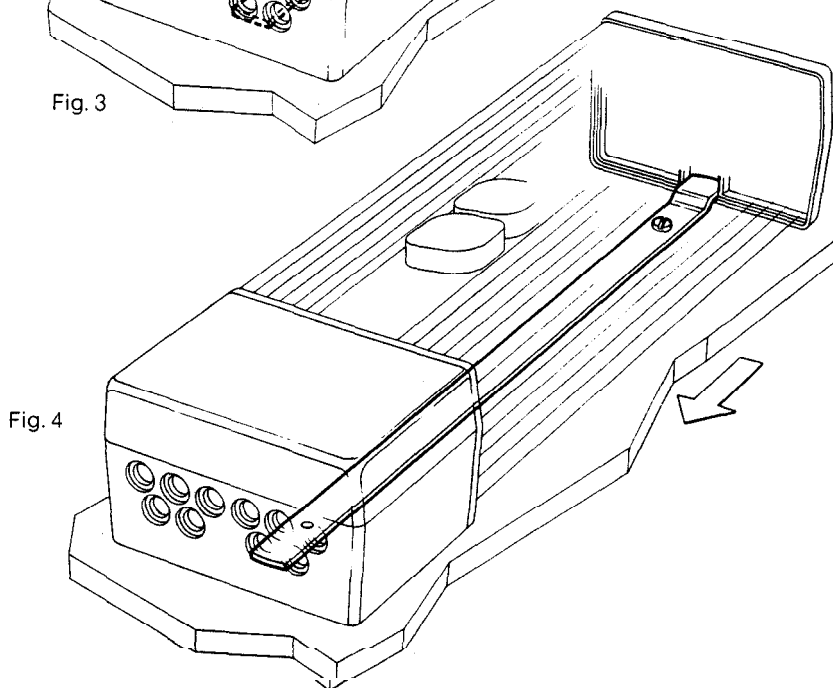


Fig. 4

### 2.1 .1 COURSE COMPUTER

The course computer must be mounted in a protected position that is reasonably free of vibration. Since the power amplifier dissipates heat when the autopilot is under load, it is also important that the mounting position should be well ventilated and clear of the engine room. Positioning will also be influenced by the requirement to reduce the total length of the power cable to a minimum (see section 2.3.2).

The course computer should first be unplugged from the connector unit after removing the terminal box lid and unscrewing the two internal retaining thumb nuts (Fig. 2). The connector unit and the mounting spine may then be screwed into position using the self tapping screws provided (Fig. 3). Finally, plug the course computer back into the connector unit to leave it ready for connection (Fig. 4).

## 2.1.2 CONTROL UNITS

Both the indicating and non indicating control units are designed for surface mounting in any position. Both are non magnetic and may be positioned near a steering compass if necessary. In all cases the control units should be placed within easy reach and view of the helmsman. As a general rule, the non indicating control unit would be most suitable for cockpit installation adjacent to the helmsman. A non indicating control unit may also be specified for the second steering position in the flying bridge of a power vessel. The indicating control unit is equally watertight and can be mounted externally if preferred. An indicating control unit can also be useful at the navigation table where course information is visible and course changes can be made directly by the navigator.

A printed template is provided to assist marking out fixing hole positions and locating the 20mm dia. drilled hole for the interconnecting cable. After threading the interconnecting cable through the 20mm dia. hole, the control unit is finally screwed into position using the four self

tapping screws provided (Fig. 5). Four blanking plugs are supplied to conceal the fixing screw recesses in the fascia and these should be firmly pressed into position to complete the installation.

The deck socket for the hand-held control unit should be situated in a reasonably protected position. Normally, the remote control socket will be mounted in the cockpit area or anywhere that a remote control facility may be required.

The remote control socket is supplied as standard with a plug attached to the interconnecting cable at the opposite end to the deck socket. For use with the Autohelm 6000 the plug (**not the deck socket**) should be cut off the cable which should be passed through a 22mm dia. hole bored through the mounting panel. The socket is then screwed into position using the four self tapping screws provided (Fig. 6).

Interconnecting cables from all control units should be led back to the connector unit of the course computer for connection to the common control unit bus (see section 2.3.1).

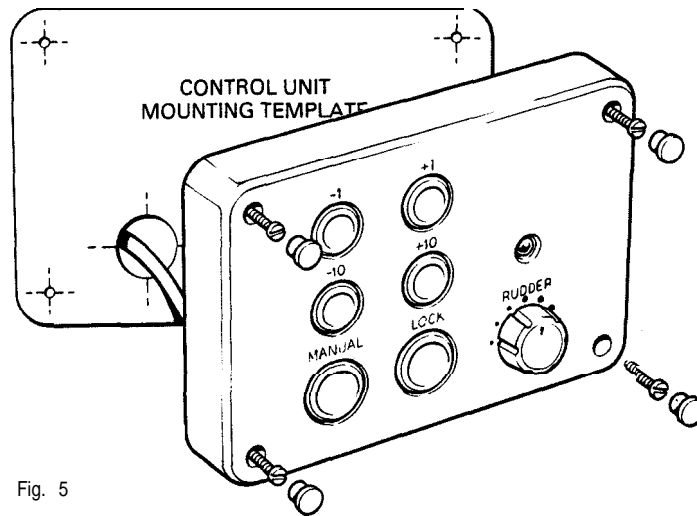


Fig. 5

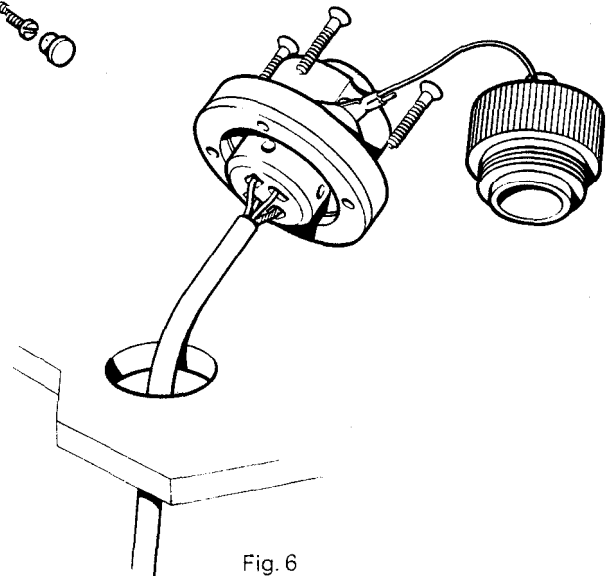


Fig. 6

### 2.1.3 FLUXGATE COMPASS

The fluxgate compass may be attached to a convenient bulkhead using the self tapping screws provided. Unscrew the top cap to release the compass housing from the mounting bracket (Fig. 7). Screw the bracket to the bulkhead using the self tapping screws provided and finally reattach the compass body to the mounting bracket.

Correct positioning of the fluxgate is crucial if ultimate performance from the autopilot installation is to be achieved. The fluxgate should ideally be positioned as near as possible to the pitch and roll centre of the vessel in order to minimise gimbals disturbance. The pitch and roll centre is generally towards the centre of the vessel, a little above waterline level. It is not always possible to position the fluxgate at the centre of pitch and roll, and if this is the case, autopilot performance will not be unduly affected.

It is, however, very important to ensure that the

fluxgate is positioned at least .8m (2'6") away from the vessel's steering compass in order to avoid deviation of both compasses. The fluxgate must also be positioned as far away as possible from large iron masses, such as the engine and other magnetic devices which may cause deviation and reduce the sensitivity of the sensor. If any doubt exists over magnetic suitability of the chosen site, the position may be surveyed using a simple hand bearing compass. The hand bearing compass should be fixed in the chosen position and the vessel swung through 360°. Relative differences in reading between the hand bearing compass and the vessel's main steering compass should ideally not exceed 5° on any heading.

When the installation is complete the fluxgate compass should be approximately aligned with the vessel's centre line by rotating the body until the arrows on the joint line face the bows (Fig. 8).

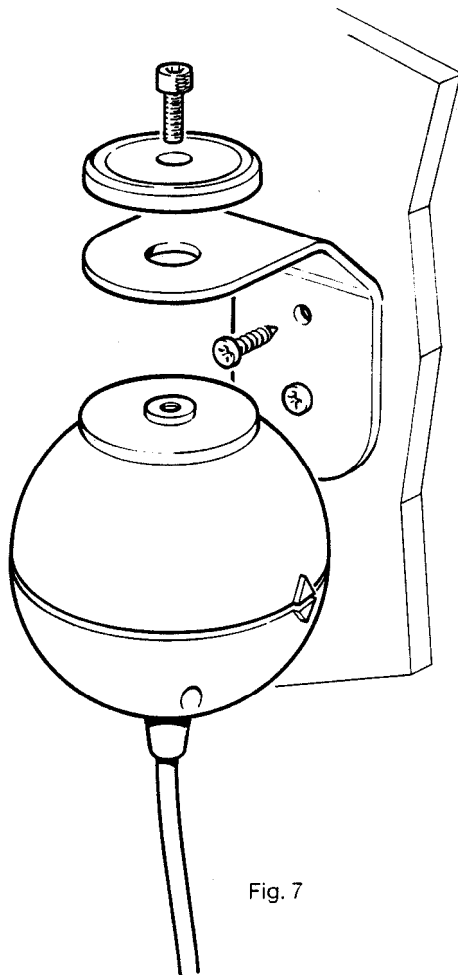


Fig. 7

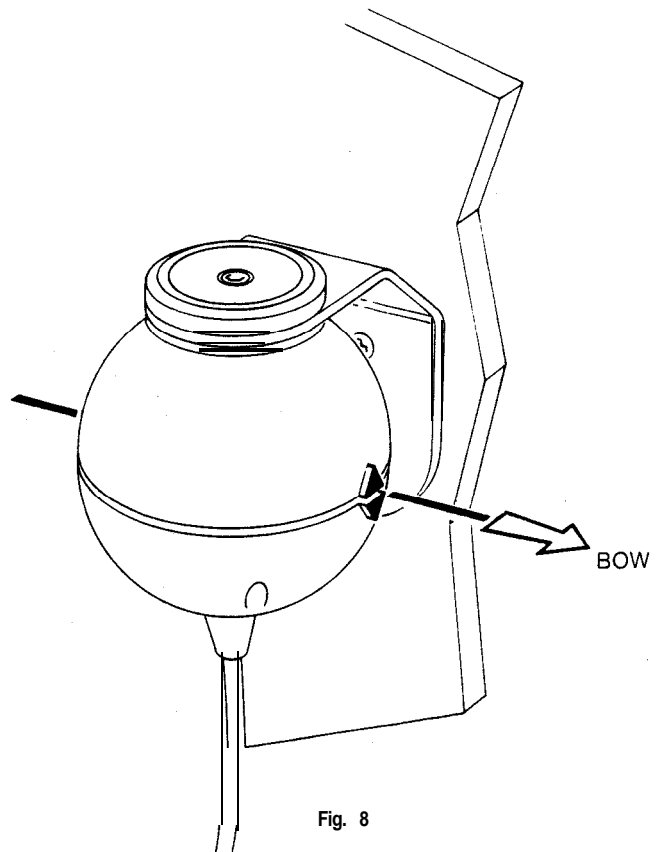


Fig. 8

#### Installation Precautions

Correct installation of the course computer and fluxgate compass is vital to the successful performance of the Autohelm 6000. The installation precautions must be heeded if poor performance or even failure of the autopilot is to be avoided.

## 2.1.4 WINDVANE

The windvane attachment is normally mounted centrally on the after rail where it can be sited in clear wind on both tacks. The windvane mounting mast is clamped to the after rail by the two 'U' bolts provided (Fig. 9). The windvane is supplied as standard with a plug attached to the interconnecting cable. For use with the Autohelm 6000 this plug should be cut off and the cable threaded through the mast. The windvane head is then plugged into the top of the mast (Fig. 10). The interconnecting cable should be passed through the deck using the waterproof deck gland. To fit the gland a 6mm dia. hole should be drilled through the deck to pass the cable through and the gland finally screwed into position using the self tapping screws provided (Fig. 11). After pulling the interconnecting cable completely through, the gland nut should be gently tightened to seal the cable. The interconnecting cable can then be led back to the course computer for final connection (see section 2.3.1).

NB. The windvane head is supplied with the vane detached for ease of packing. The vane is easily assembled to the head and secured by means of the circlip provided (Fig. 12). Care should be taken to ensure that the small circlip is correctly located in the groove.

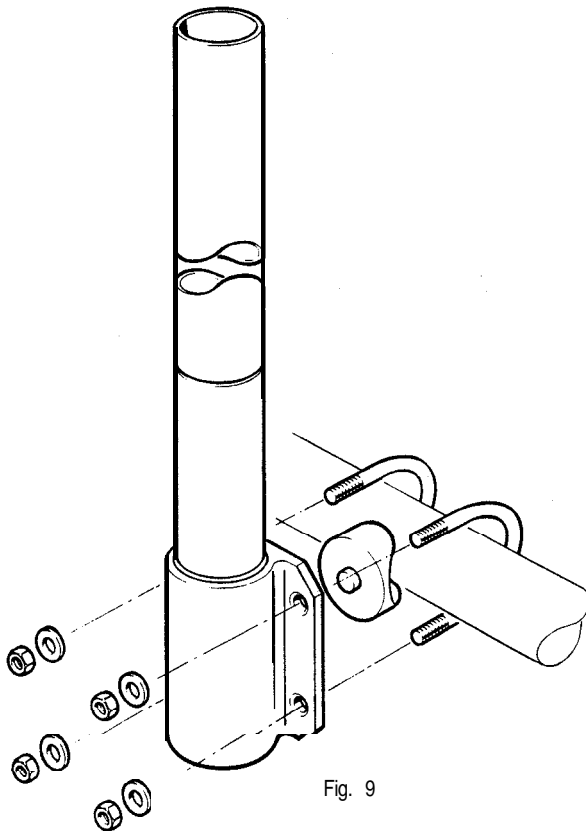


Fig. 9

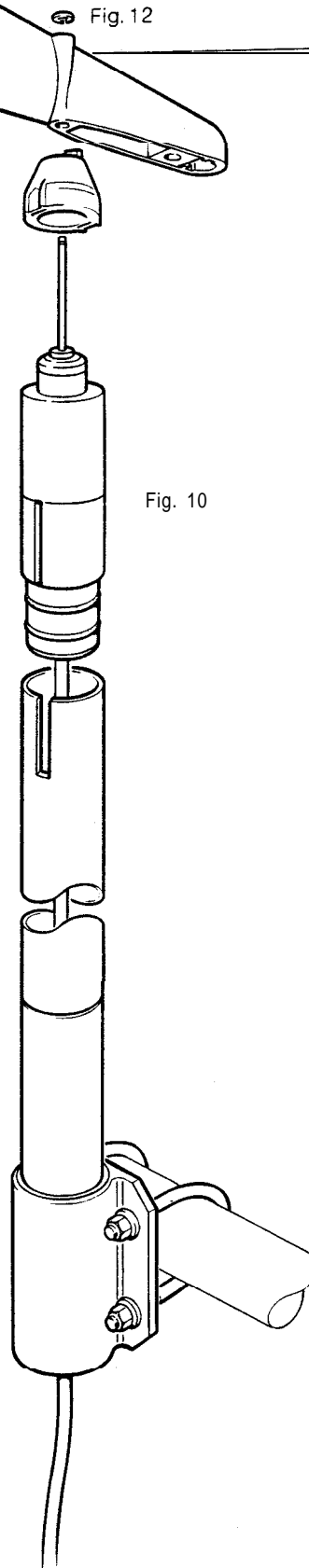


Fig. 10

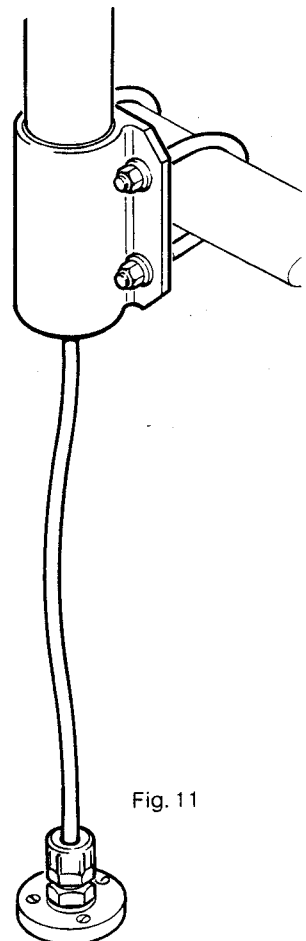


Fig. 11

Fig. 12

## 2." .5 AUXILIARY ALARM

The auxiliary alarm unit is waterproof and may therefore be mounted in any position. The alarm unit is supplied with a terminal block to connect a two core interconnection cable to the course computer. A 22mm hole should be bored through the mounting panel/deck to pass through the two way connector block and interconnecting cable (Fig. 13).

Finally, the alarm unit should be screwed into position using the four self tapping screws provided. A foam seal on the alarm mounting flange will ensure a watertight joint to the mounting surface.

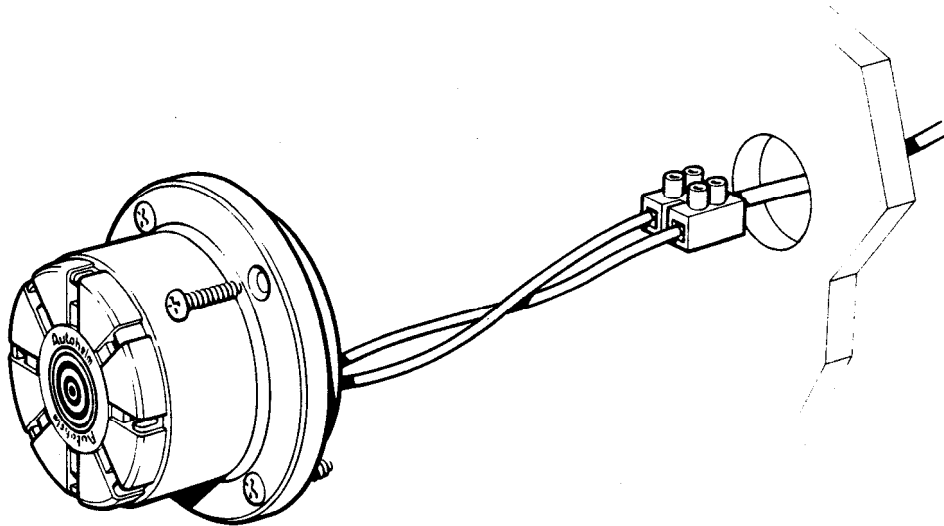


Fig. 13

### 2.1.6 RADIO NAVIGATION INTERFACE

The radio navigation interface will normally be mounted close to the radio navigation receiver (Decca or Loran) in the navstation area. It is fully waterproof and if desired may be mounted externally.

A printed template is provided to assist marking out fixing hole positions and the hole for the interconnecting cable. After threading the interconnecting cable through the 20mm dia. hole the interface unit is screwed into position using the four self-tapping screws provided (Fig. 14).

Four blanking plugs are provided to conceal the fixing screw recesses and these should be firmly pressed into position to complete the installation.

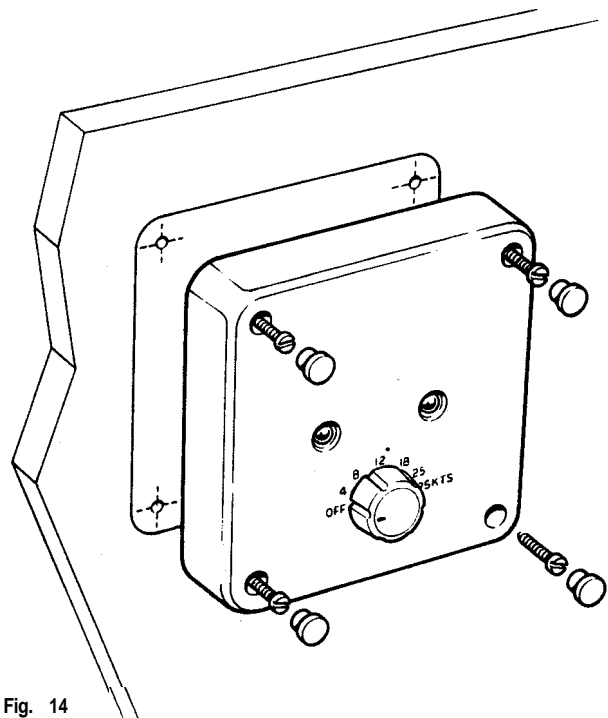


Fig. 14

## 2.2 DRIVE SYSTEM

The following notes describe the installation of both the rotary, linear and hydraulic drive units.

### 2.2.1 ROTARY DRIVE UNIT

The rotary drive unit is coupled to the steering mechanism by a simple chain drive. Most steering gear manufacturers supply special autopilot drive attachments and many include this facility as standard. Figs. 15 and 17 show the recommended rudder hardover to hardover times for both planing and displacement vessels up to 20m (60') LOA. Figs. 16 and 18 enable the optimum chain reduction ratio to be selected for both planing and displacement vessels. It is first necessary to determine the number of turns of the driven sprocket when the rudder is driven from hardover to hardover.

**Example:**

A 12m (40') LOA displacement vessel requiring two turns of the driven sprocket to drive the rudder from hardover to hardover will require a chain reduction ratio of approximately 3.0:1 (as indicated by the dotted line on the chart).

TYPE 1: HARDOVER-HARDOVER TIME RECOMMENDATIONS

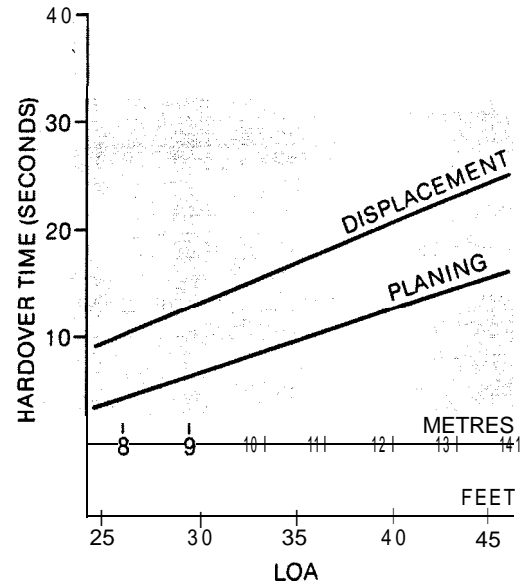
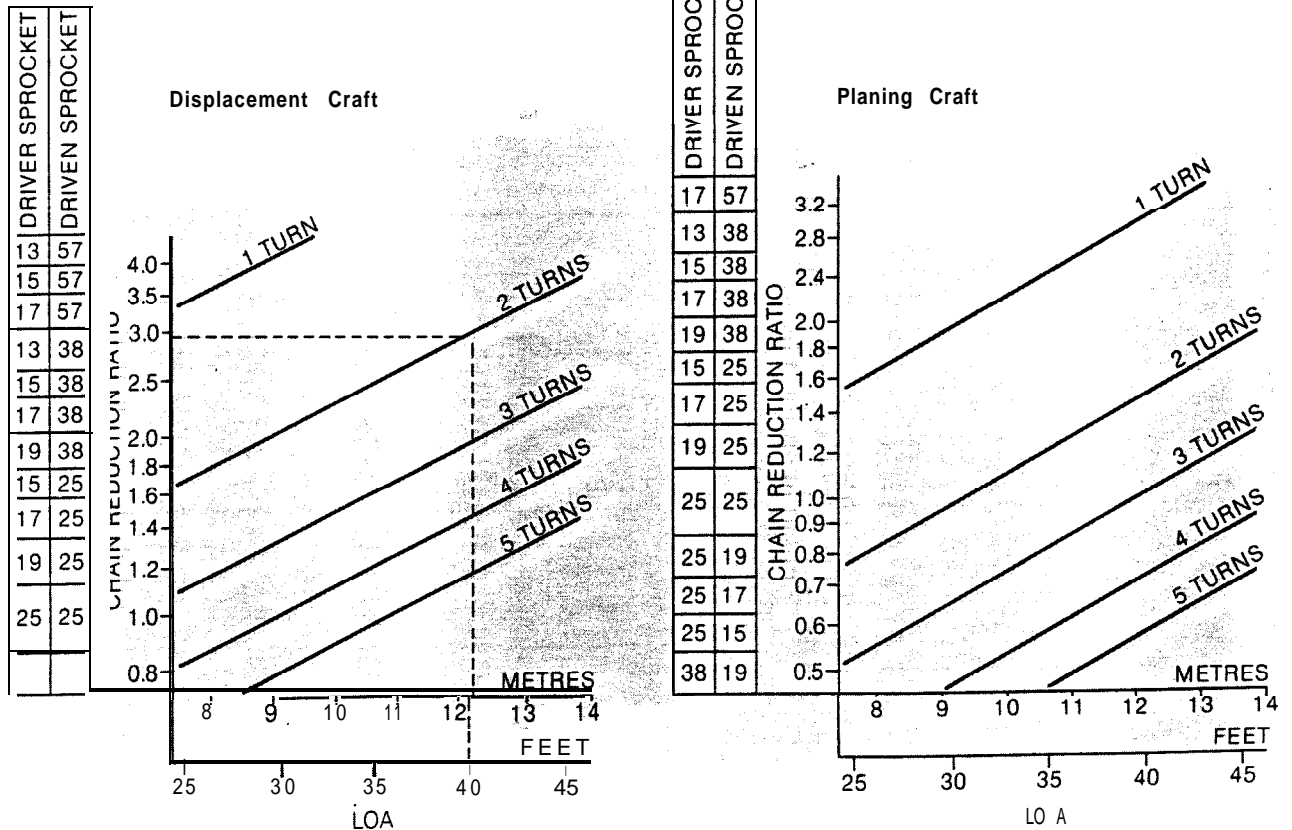


Fig. 15

NPE 1: ROTARY DRIVE CHAIN REDUCTION RATIOS





It should be borne in mind that the reduction ratios are for the average case and that vessels broadly classified by length and hull type can vary significantly in steering characteristics. Selection of the correct chain reduction ratio is not over critical however, and any mismatch can be corrected during sea trials by an adjustment to the gain control switch on the course computer. Standard  $\frac{3}{8}$ " or  $\frac{1}{2}$ " pitch chain is recommended for the chain drive and the drive sprocket ideally should not have less than 15 teeth. Bore and keyway dimensions for the drive unit sprocket are detailed in Fig. 19. It is essential that these bore and keyway dimensions are strictly adhered to. All sprockets must be keyed and grub screwed to their shaft and finally secured with 'Loctite'.

The drive unit is mounted by bolting to a substantial frame member (Fig.20). The mounting foot is secured to the drive unit by four equally spaced caphead screws and may be rotated through 90° to provide a more convenient mounting position if required (Fig. 21). In some

### TYPE 2: HARDOVER-HARDOVER TIME RECOMMENDATIONS

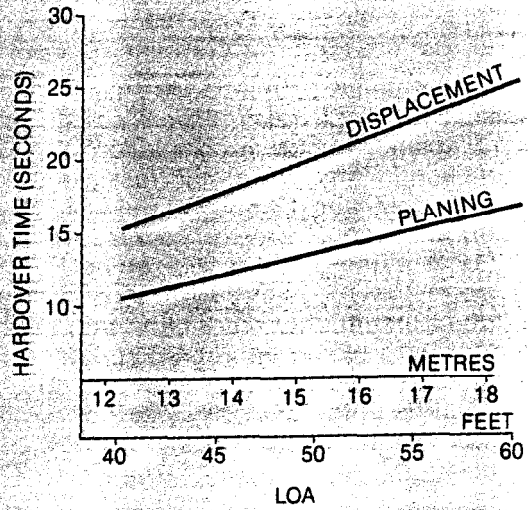
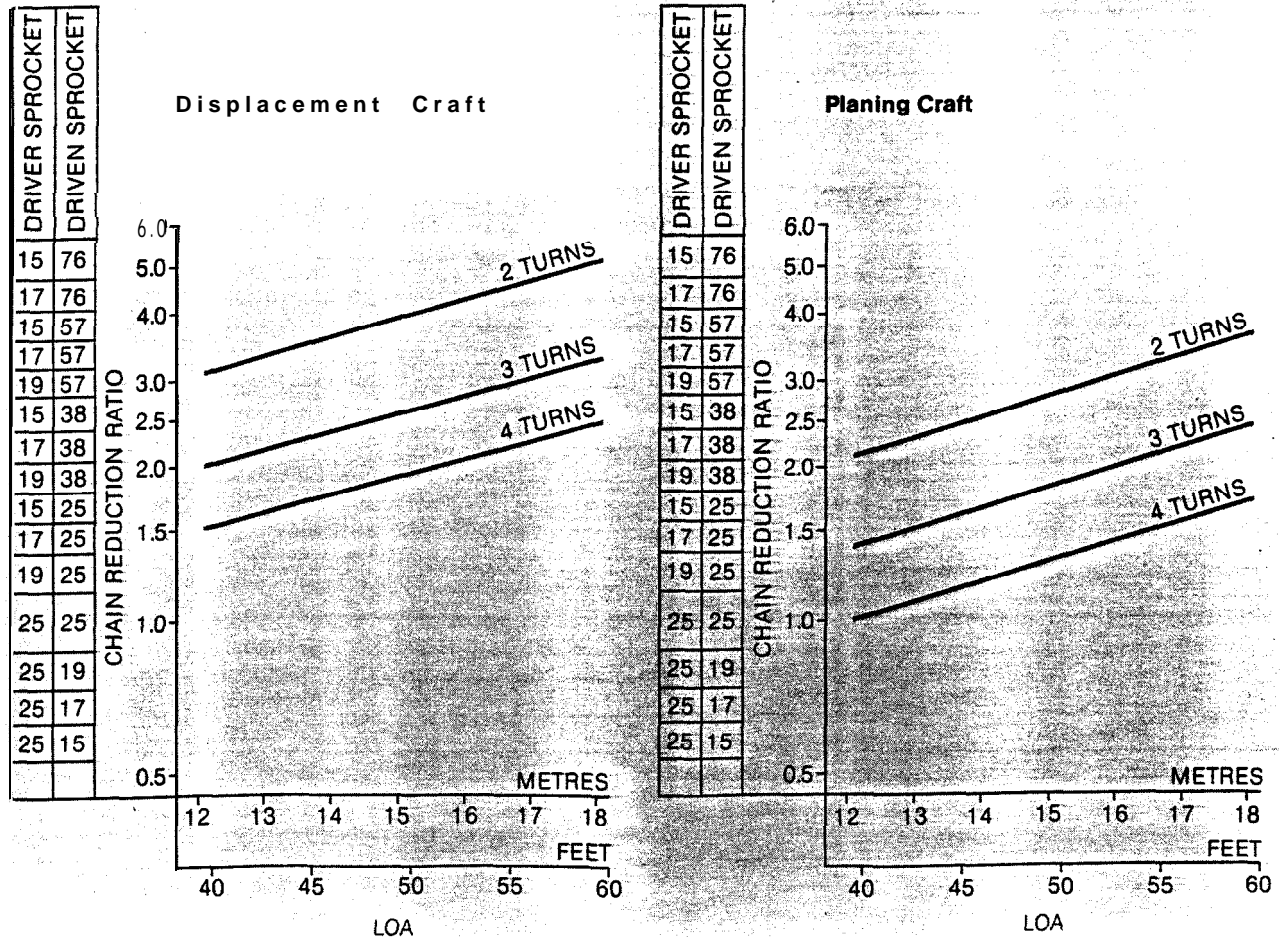


Fig. 17

### TYPE 2: ROTARY DRIVE CHAIN REDUCTION RATIOS



cases, it may be necessary to fabricate a special frame to mount the drive unit. It should be noted that chain tension can exceed 500lbs (230Kg) and thus an extremely rigid mounting structure is vital to maintain good chain alignment. Installation failures frequently occur in this area and as a general rule, it is desirable to 'over engineer' the drive unit mounting. All fastenings should be secured by lock washers.

Provision must also be made for chain adjustment which is most easily achieved by removable shims placed under the mounting foot or by elongated clearance holes in the mounting frame as illustrated in Figs. 20 and 21.

Both sprockets must be accurately aligned to run in the same plane and correct alignment must be carefully checked by means of a straight edge.

The gearbox may be mounted in any convenient attitude without risk of oil leakage. In addition, the drive sprocket may face any direction since steering sense can be corrected when the installation is complete by reversing the polarity of the drive motor connection (see section 3.3.1). Finally, the chain should be tensioned until it is just tight and contributes negligible lost motion to the drive system. Total lost motion between the driven sprocket attached to the steering system and the rudder stock should not exceed 2% of total movement under any circumstances. If lost motion exceeds this level it must be corrected. otherwise steering performance will be impaired.

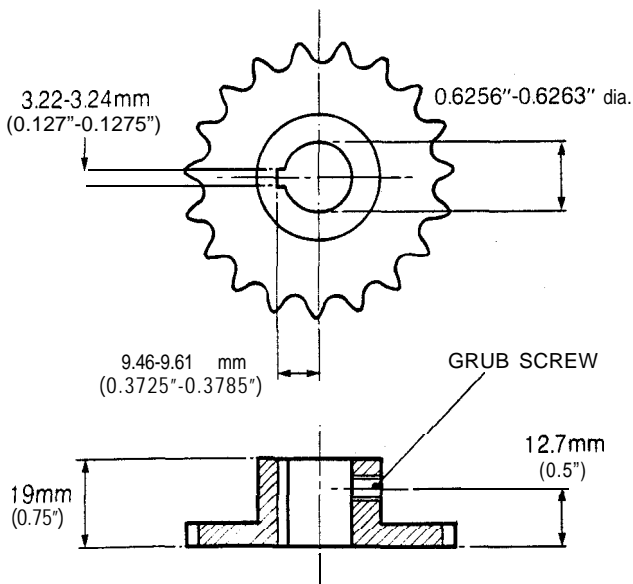


Fig. 19

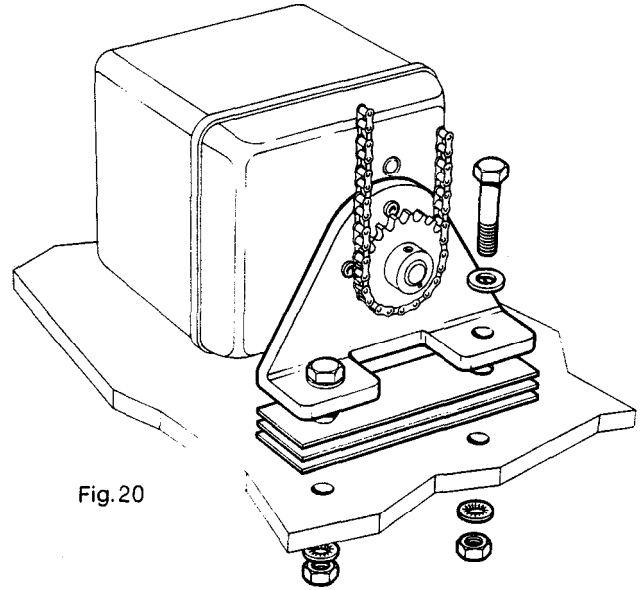


Fig. 20

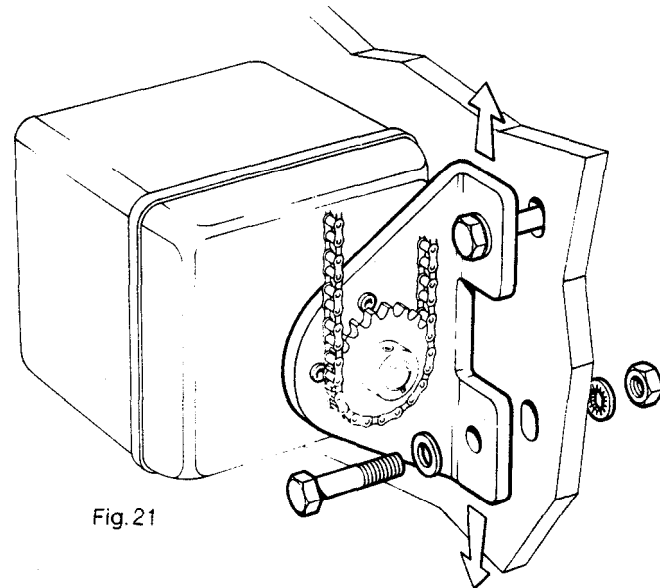


Fig. 21

## 2.2.2 LINEAR DRIVE UNIT

The linear drive unit couples directly to the rudder stock at the tiller arm radius recommended in Figs. 22 and 23. It is usually preferable to couple the linear drive unit to the rudder stock via an independent tiller arm (Edson offer a standard fitting). In certain cases, however, it may be possible to couple the pushrod to the same tiller arm or rudder quadrant employed by the main steering linkage. It is important to note that the linear drive system can exert a thrust of 750lbs. If any doubt exists about the strength of the existing tiller arm or rudder quadrant the steering gear manufacturer must be consulted.

The method of bolting the pushrod ball end to the tiller arm or rudder quadrant is illustrated in (Fig.24). The fixing bolt supplied should be assembled with its flange positioned between the ball end and the tiller arm. It is **vitaly important** that the coupling bolt is fully tightened and the nut locked by means of the locking tab provided. The standard ball end fitting will allow for a maximum angular misalignment between the pushrod and the tiller crank plane of rotation of up to 5°. Accurate angular alignment is extremely important and under no circumstances should the above extreme limits be exceeded. The body of the drive unit is mounted by bolting to a substantial frame member (Fig.25). As a general rule it is desirable to 'over engineer' the linear drive unit's mounting structure to ensure reliability and maintenance of correct alignment. An excessively flexible mount can also severely impair the steering performance of the autopilot.

It is important to ensure that the total rudder movement is limited by the rudder stops built into the vessel rather than the end stops of the linear drive output.

**TYPE 1: LINEAR DRIVE  
TILLER ARM LENGTHS**

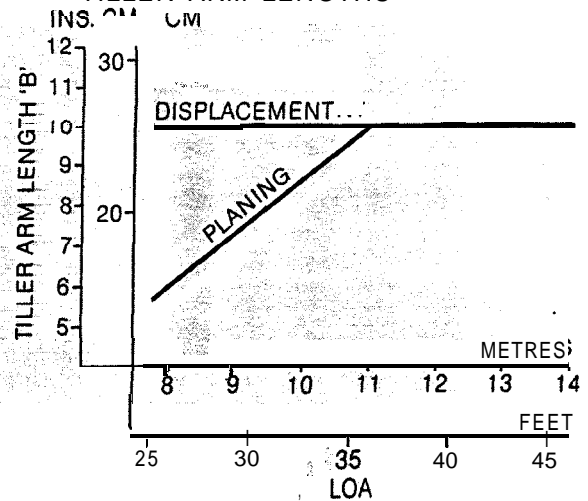


Fig. 22

**TYPE 2: LINEAR DRIVE  
TILLER ARM LENGTHS**

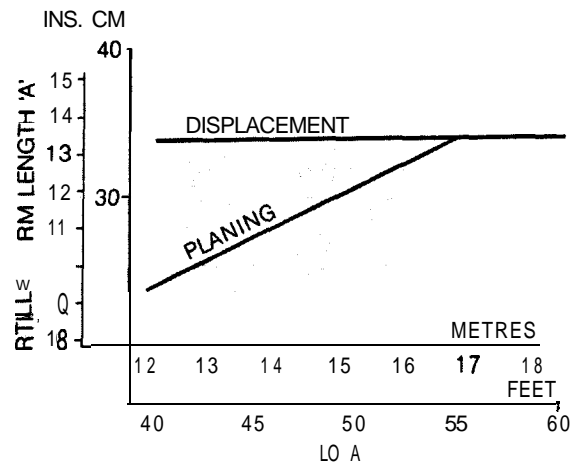


Fig. 23

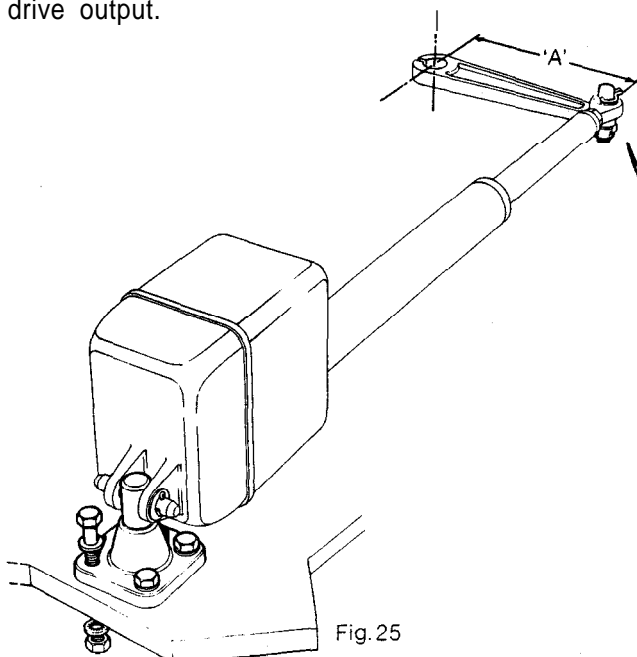


Fig. 25

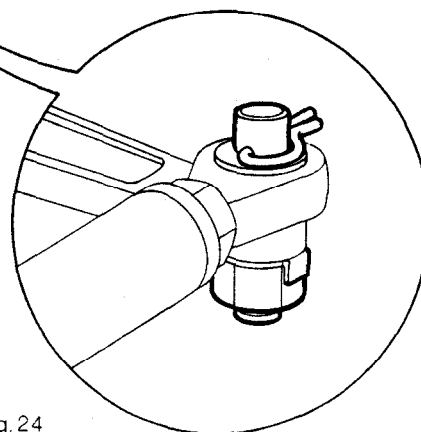


Fig. 24

### 2.2.3 HYDRAULIC DRIVE UNIT

The hydraulic drive unit should be mounted clear of spray and the possibility of immersion in water. It should be located as near as possible to the hydraulic steering cylinder. It is important to bolt the hydraulic drive unit securely to a substantial member to avoid any possibility of vibration that could damage the inter-connecting pipework.

There are three basic types of hydraulic steering system, and these are illustrated in (Fig. 26). Typical connection points for the drive unit are shown in each case. **In all cases it is strongly recommended that the steering gear manufacturer be consulted.** The drive unit valve block is tapped  $\frac{1}{4}$ " BSP to accept suitable pipe fittings and Dowty sealing washers are supplied.

Minimisation of hydraulic fluid loss during connection of the drive until will help to reduce the time and effort required later to bleed the system of trapped air. Absolute cleanliness is essential since even the smallest particle of foreign matter could interfere with the correct function of precision check valves in the steering system.

When the installation has been completed the hydraulic pump may be operated by switching the control unit to 'Auto' and operating the  $+10^\circ$  and  $-10^\circ$  course change buttons. Greater motor movements will be obtained if the gain control on the course computer is set to No. 6 and the rudder control set to maximum.

The hydraulic steering system should be bled according to the manufacturers instructions. From time to time during the bleeding process the drive unit should be run in both directions to clear trapped air from the pump and inter-connecting pipe work.

If air is left in the system the steering will feel spongy particularly when the wheel is rotated to the **hardover** position. Trapped air will severely impair correct operation of the autopilot and the steering system and must be removed.

During the installation of the system it has not been necessary to keep track of the connection sense to the hydraulic steering circuit since operating sense of the autopilot can be corrected if necessary by reversing the polarity of the pump drive motor connections (see section 3.3.1).

### CONNECTION OF HYDRAULIC LINES TO PUMP

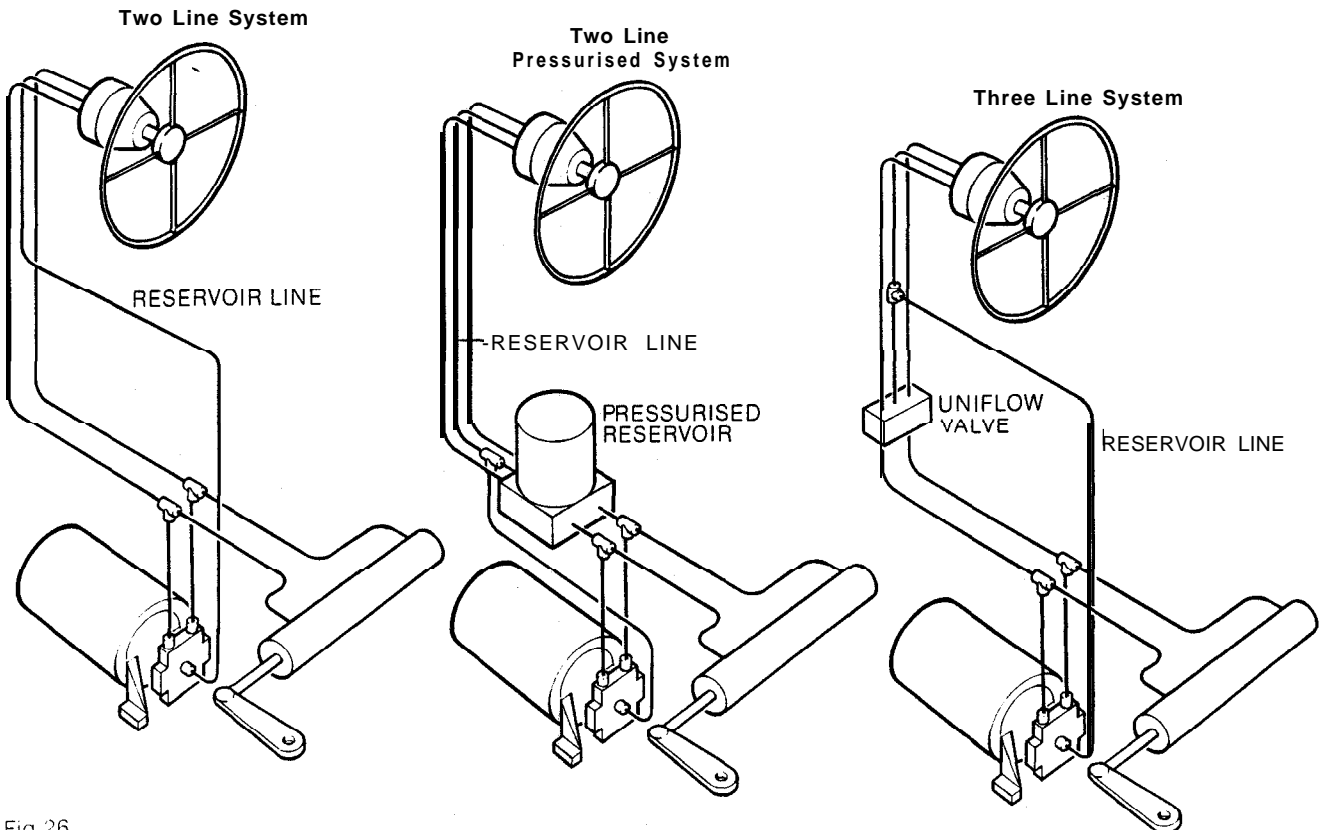
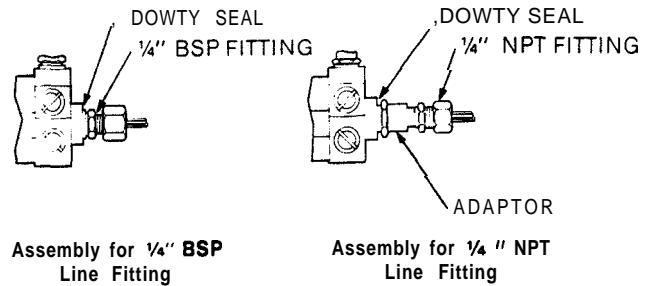


Fig. 26

## 2.3 CABLING AND POWER SUPPLIES

### 2.3.1 SIGNAL CABLING

Cable interconnections between all sub system modules are shown schematically in (Fig. 1). All peripheral units connect to the connector unit where they are permanently hard wired to colour coded connector blocks situated on a central printed circuit board (Fig. 30).

The end face of the connector unit is fitted with ten blanking discs (Fig. 27), which are easily pressed out and replaced by the special rubber grommets supplied with each peripheral unit fixing kit (Fig. 28). After cutting the interconnecting cable to length (Fig. 29), it may be passed through the inserted rubber grommet and prepared for connection to the relevant connector block (Fig. 30).

Each connector block is clearly identified on the printed circuit board and each wire position is identified by coloured dots which match the

individual wire colours. The cable screen should be connected to terminals identified by a white dot.

The control units and the Radio Navigation Interface may be connected to any of the serial bus connector blocks A1 - A5.

Each peripheral unit is supplied with 6m (20') of interconnecting cable. Additional cabling can be supplied in 12m (40') cut lengths as follows:-

Cat. No. D086	Two core unscreened	Alarm, Electronic power supply and Clutch
Cat. No. D087	Three core screened	Control units, Windvane and Radio Navigation Interface
Cat. No. D088	Four core screened	Fluxgate Compass

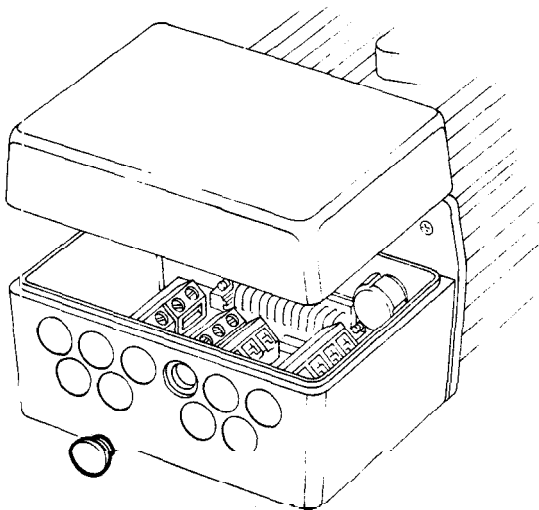


Fig. 27

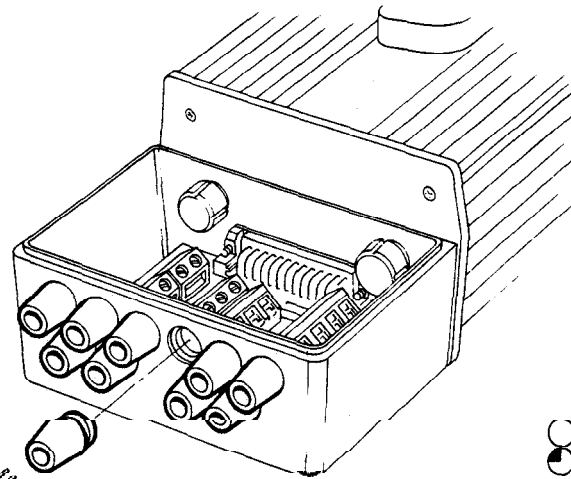


Fig. 28

Fig. 29

40mm

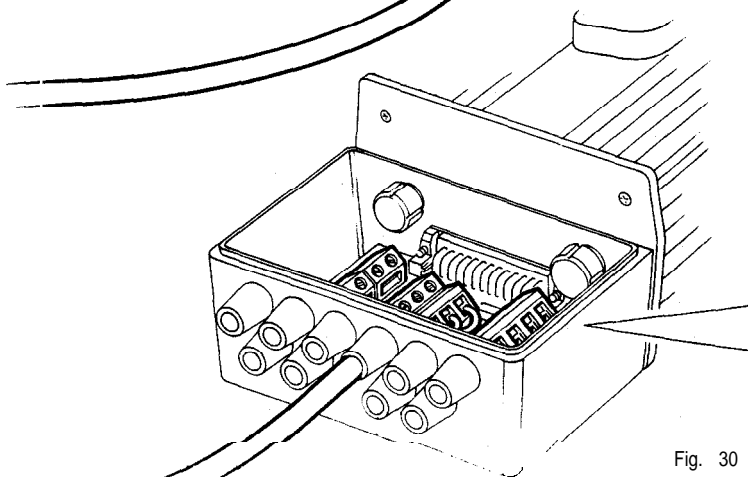
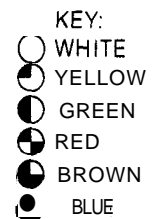
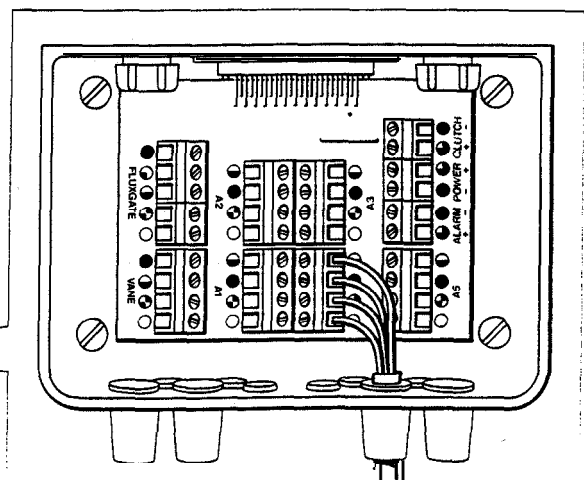


Fig. 30



The total length of screened core cable connected to the serial bus (connectors A1 - A5) should not exceed 30m (100'). Similarly, the total length of interconnecting cable to the fluxgate should not exceed 20m (60'). If it is necessary to exceed the above maximum length recommendations, please consult Nautech's Engineering Department for specific advice. In general the length of interconnecting cables should be kept to an absolute minimum to reduce the possibility of interference by other electronic equipment.

All cables should be run at least 1 m (3') from existing cables carrying radio frequency or pulsed signals, and should be clamped at 0.5m (1.5') intervals.

### 2.3.2 DC POWER SUPPLIES

Refer to (Fig. 31)

Flexible connection tails fitted with insulated spade connectors are supplied with the course computer to connect the main power supply (Blue and Brown) and drive unit motor connections (Red and Black).

All four flexible wire tails are preconnected to a four-way heavy duty terminal block for connection to the main power cabling. Similarly, the drive unit is supplied with flexible tails for both the motor power connection (Red and Black) and the clutch signal connection (Brown and Blue).

Before commencing power cabling, all interconnecting terminal blocks should be

screwed into a position where they will remain dry and protected. When planning the position of the course computer (ref. 2.1 .1), it is important to reduce the overall length of heavy power cable between the drive unit and the vessel's central power distribution panel to a minimum. It is **essential** that the copper area of the main power supply cable is equal to **1 .5mm<sup>2</sup> per metre run** between the drive unit and the distribution panel. For example, a total cable run of 1 Om would require an interconnecting cable of 1 5mm<sup>2</sup> section area per core.

The power supply must be led from the main distribution panel and protected by means of a 40 amp fuse or current overload trip switch. A separate 5 amp fuse must be fitted in the electronic power supply cable.

It is very important that both the electronic and heavy duty power supplies are isolated by a switch in the positive supply line.

When connecting the power supplies to the main distribution panel and to the course computer spade connectors, it is essential that the polarity is correct (Brown positive, Blue negative).

The drive unit earthing cable (blue) must be earthed to the **negative** terminal of the vessel's power supply with heavy duty cable (2.5mm<sup>2</sup>). This will prevent severe corrosion occurring if an electrical fault should develop. Normally the engine is connected to the negative terminal and may therefore provide a convenient earthing point.

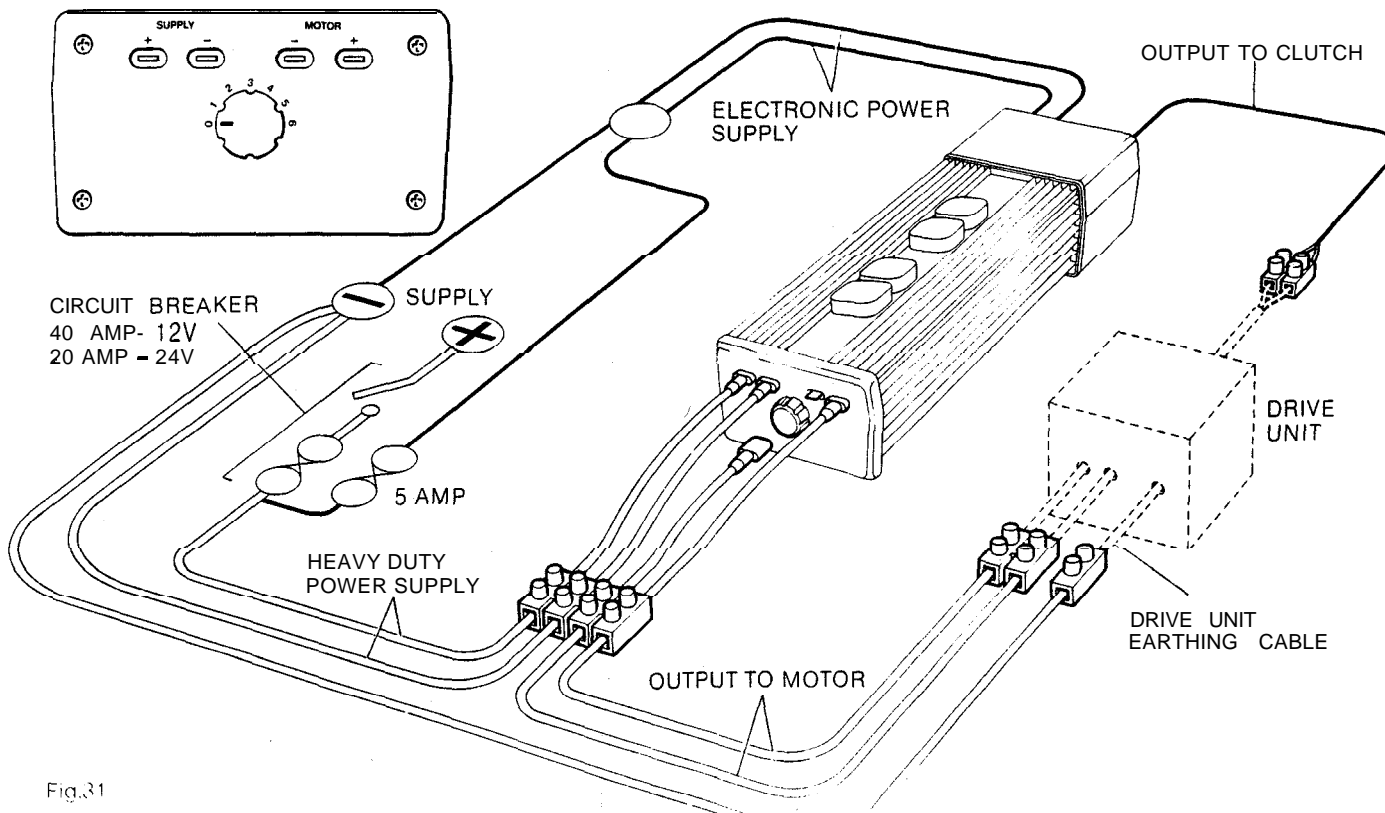


Fig.31

## 3.0 OPERATION

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### 3.1 BASIC PRINCIPLES

The following description of the Autohelm 6000's principle of operation will help you to fully understand its controls.

Deviation from course is continuously monitored by a sensitive fluxgate compass and corrective rudder is applied by the drive unit to return the vessel to course. The applied rudder is proportional to course error at any time and thus when the course is restored the rudder will be neutralised. The amount of rudder applied for a given off-course error must match both the steering characteristics of the vessel and speed through the water. A vessel with a small rudder for example, will require more corrective helm than a similar sized vessel with a larger rudder.

Similarly, a high speed power boat will require considerably less corrective helm at planing speeds than it will at lower displacement speeds.

When changes in vessel trim occur due to variations in wind pressure or engine throttle setting the course can only be maintained by the application of permanent rudder off-set (standing helm) to restore balance. If permanent rudder off-set is not applied to restore balance the vessel

will bear on to a new heading. Under these circumstances the Autohelm 6000 detects that the original course is not being restored and continues to apply additional rudder off-set in the appropriate direction until the vessel returns to the original heading. Automatic trimming capability ensures that the originally set course is held irrespective of any changes in balance that may occur during the course of a passage.

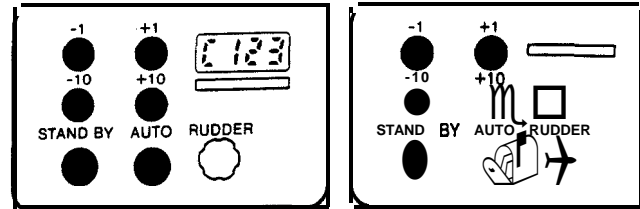
Autohelm 6000's central computer also continuously monitors the pattern of applied rudder correction and can distinguish unnecessary repetitive corrections caused by pitch and roll of the vessel from those necessary to maintain the selected heading. If unnecessary repetitive corrections continue the computer will automatically neglect them so that autopilot activity and power consumption is continuously optimised at minimum levels.

The high degree of control automation made possible by the system's central micro computer simplifies user control to a series of push button operations.






## 3.2 CONTROLS

### 3.2.1 FIXED CONTROL UNITS

Both the indicating and non-indicating control units provide full control of the autopilot via a simple six button key pad and a rotary rudder control switch.



The basic control functions are as follows:-

<p style="text-align: center;"><b>AUTO</b></p> 	<p>Push once to engage the autopilot to maintain the current heading.</p> <p>or - if the autopilot has been disengaged</p> <p>Push twice (within 2 seconds) to return to the previous automatic heading.</p>
<p style="text-align: center;">-1                  +1</p>  <p style="text-align: center;">-10                +10</p> 	<p>Push to alter course to port (-) or starboard (+) in increments of 1 and 10 degrees.</p>
<p style="text-align: center;"><b>STAND BY</b></p> 	<p>Push once to disengage the autopilot for manual steering. (The previous automatic heading is memorised).</p>
<p style="text-align: center;"><b>RUDDER</b></p> 	<p>Provides seven levels of rudder response. Clockwise rotation increases the level of applied rudder.</p>

N.B. In cases where there are two or more fixed control units only the rudder control on the control unit engaging the autopilot will control rudder response. A safety interlock will

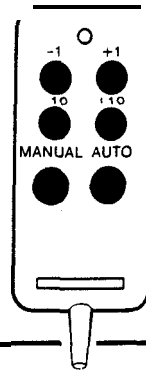
automatically disengage all other rudder controls. If it is necessary to transfer rudder control to a second steering position, this can be done by re-engaging the autopilot from the second position.



### 3.2.2 HAND HELD CONTROL UNIT

The hand held control unit provides remote proportional power steering of the vessel as well as full control of the autopilot. A safety interlock prevents use of the hand held control unit when the autopilot is disengaged by the helmsman.

The basic control functions are as follows:-



#### MANUAL



Push once to permit power steering.

-1

+1



Push once to move rudder to port (-) or starboard (+) in single fine increments.

-10

+10



Push once to move rudder to port (-) or starboard (+) in single coarse increments.

#### AUTO



Push once to reengage automatic compass heading control and maintain the current heading.

or

Push twice (within 2 seconds) to return to the previous automatic heading.

-1

+1



-10

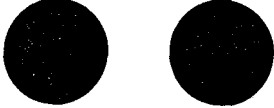
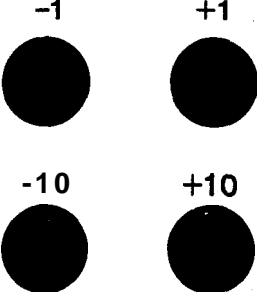


+10



Push to permanently alter course to port (-) or starboard (+) in increments of 1 or 10 degrees.

### 3.2.3 WINDVANE SYSTEM



When a windvane system is fitted, a new layer of control functions is automatically opened on all control units as follows:-

	<p>Push both red keys together once to engage the windvane and maintain the current apparent wind angle.</p> <p>or</p> <p>Push both red keys together twice to return to the previous apparent wind angle.</p>
	<p>Push once to increase (+) or decrease (-) the vessel's heading relative to the apparent wind direction in increments of 1 or 10 degrees of wind angle.</p>
<p><b>STAND BY</b></p>  <p><b>AUTO</b></p> 	<p>Push once to disengage the autopilot for manual steering. (The previous apparent wind angle will be memorised).</p> <p>or</p> <p>Push once to change over to automatic compass heading control and maintain the current heading.</p>

#### Automatic Tacking

The autopilot has an automatic tacking function which operates in windvane mode only as follows:-

To prevent accidental gybing the tack function will only operate with an apparent wind angle of less than 70°.

	<p>Press '-1' and '+1' keys together to initiate a tack. The apparent wind angle set up on the current tack will be repeated on the new tack.</p>
	<p>Repeat depression of '-1' and '+1' keys together to alternate between port and starboard tacks.</p>



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### 3.2.5 OFF-COURSE ALARM

When the autopilot is set to either 'Auto' or 'Vane' mode a built in off-course alarm is automatically set up. The off-course alarm will sound from all control units when the vessel deviates for any reason from the original course by more than 15 degrees for over 10 seconds. If an auxiliary alarm is fitted this will also be sounded after a one minute delay to allow the watchkeeper to take corrective action.

The alarm will be silenced if the vessel returns to within 15 degrees of the original course. If the vessel does not return within course limits the alarm can only be silenced by disengaging the autopilot and resetting a new course. This facility is particularly useful for sailing craft when in 'Vane' mode since an automatic warning will be given of significant wind direction changes.

### 3.2.6 RADIO NAVIGATION INTERFACE

The operating handbook for the Loran 'C' or Decca Radio Navigation Interface system is supplied with the interface unit. The interface unit connects to the control unit serial bus and supervises the autopilot in 'Auto' mode to follow a computed track. When the Radio Navigation Interface system is switched on to supervise the autopilot the course display is replaced by an indication of cross track error preceded by the mode indication pre-fix 'n' as shown in Section 3.2.4.

### 3.3 FUNCTIONAL TEST PROCEDURES

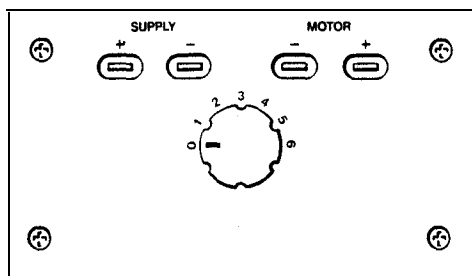
The following functional tests and set up procedures must be carried out before sea trials are attempted.

#### 3.3.1 SETTING UP

##### Switch On

Switch on the electrical supply from the main panel. All control units will emit a short beep tone to indicate that the computer is now active. The autopilot will start up in 'Stand By' mode and indicating control units will display the current heading.

##### Course Computer Gain Setting



The gain control on the course computer should initially be switched to the setting number indicated on the following table:-

LOA	GAIN SETTING	
	Planing	Displacement
12-15m (40 - 49ft.)	0	1
15-18m (50 - 60ft.)	1	2

The above setting recommendations will provide stable control for initial sea trials and may be increased if necessary later.

##### Operating Sense

The operating sense of the autopilot can be checked by switching to 'Auto' mode and depressing the '+10' key which should initiate rudder movement to starboard. If movement to port occurs, the operating sense of the autopilot must be reversed by reversing the motor connections between the course computer and the drive unit. The connection reversal should be permanently made at one of the main terminal blocks and not by reversing the spade connector flying leads to the course Computer.

##### Fluxgate Setting

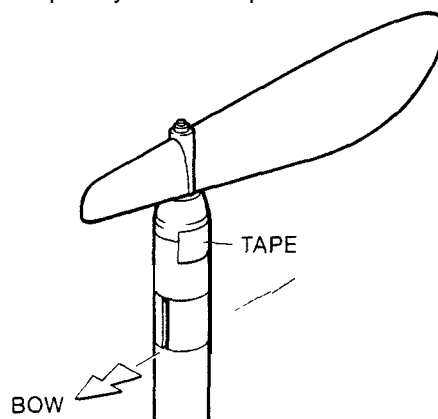
The fluxgate should have been approximately aligned with the ship's head during installation (see section 2.1.3). If an indicating control unit is fitted, the fluxgate should be more accurately aligned as follows, so that the digital course display agrees with the main steering compass.

Switch to 'Stand By' mode and gently rotate the fluxgate body until the digital display on the control unit agrees with the vessel's main steering compass on the current heading. If the fluxgate is free of deviation, the autopilot's digital display will agree with a corrected steering compass on all headings. It is, however, unlikely that both compasses are entirely free from deviation and that perfect agreement will be obtained on all headings. If significant differences in readings occur on other headings, a compass adjuster may be consulted to correct the source of deviation. In any event the main steering compass should always be used for basic navigation.

##### Windvane Setting

The windvane must be accurately aligned to the yacht's head to provide equal apparent wind angles on opposite tacks when using the Automatic Tacking system.

The windvane head should initially be aligned by rotating the mounting mast in its friction bearing until the vertical line on its body faces the yacht's bows. Then align the windvane parallel to the yacht's centre line using adhesive backed tape to temporarily fix it in position as shown.



To check correct alignment select windvane mode (depress Auto and Stand-by together). Then depress '-1' and '+1' keys together to initiate a tack (see section 3.2.3).

If the head is correctly aligned no rudder/wheel movement will occur. If movement is observed note the directions (Port or Starboard) and move the vane head by a small amount (1° or 2") in the same direction. Select 'Stand-by' and then repeat the sequence above until no rudder/wheel movement is observed.

Remove the adhesive tape on completion.



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### 3.3.4 MECHANICAL TEST PROCEDURES

Before attempting sea trials it is important to verify that the vital link between the Autohelm 6300 drive actuator and the vessel's steering system is free of obstruction and operating correctly.

It is strongly advised that the following simple checks are carried out.

#### Warning

When the steering system is being moved manually or under drive from the actuator **do not** touch any part of the system, sprockets, chains or limit stops. The forces exerted are considerable and could cause injury.

#### Rotary Drive Unit

Locate the actuator and with an assistant to turn the main steering wheel switch on the pilot.

- **Standby** mode – turn the steering wheel from hardover to hardover.
- Ensure that the chain and sprockets driving the actuator move freely and in alignment.
- Ensure that chain tension is adjusted correctly (see 2.2.1).
- Select **Auto** and key the +10 button several times to drive the rudder hard over.
- When the actuator drives the rudder onto the mechanical limit stops ensure that the mounting of the drive actuator shows no sign of movement.
- Key the -10 button several times and reverse the rudder drive to the opposite end stop. Check for any movement.

#### Current Limit and Cutout

Whilst the rudder is driven against the mechanical limit the actuator will “pulse”. This is normal. If left in this condition for 60 seconds the microprocessor will automatically cut out power to the actuator and return to **Standby**.

#### Linear Drive Unit

- Proceed as for rotary drive unit.
- Check that at no point during movement of the steering quadrant and linear drive actuator from hardover to hardover does the actuator foul any part of the quadrant, steering mechanism or yacht's structure. Any fouling under load could damage the drive actuator.

- Check that the Drive actuator operates **horizontally** and that angular movement of the ball end fitting is minimal (5° maximum).
- Select **Auto** and key the +10 button several times to drive the rudder hard over.
- When the rudder is driven hard over check that the mechanical limit stop on the vessel's steering system is reached **before** the actuator reaches **its** mechanical limit.
- When the rudder drives hard against the end stop check there is no visible movement of the actuator mounting pedestal or the structure supporting it.
- Key the -10 button and repeat the checks with the rudder driven hard over in the opposite direction.

#### Current Limit and Cutout

Whilst the rudder is driven against the mechanical limit the actuator will “pulse”. This is normal. If left in this condition for 60 seconds the microprocessor will automatically cut out power to the actuator and return to **Standby**.

#### Hydraulic System

- Proceed as for the rotary drive unit.
- Check that all unions are tight and there is no seepage of hydraulic fluid.
- Select **Auto** and key the +10 button several times to drive the rudder hard over.
- Key the -10 button to reverse and drive the rudder hard over in the opposite direction.
- Check that the steering ram moves smoothly and that there is no excessive play or jerkiness in the movement.

The performance of the Autohelm 6000 will only reach the designed levels if the installation of the actuator and steering system is correctly engineered and adjusted. It is strongly advised that these be checked **before** sea trials.

## 4.0 SEA TRIALS

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Initial sea trials should be carried out in calm conditions with plenty of sea room. The previously conducted functional test will have verified that the autopilot is operating correctly and that you are familiar with all of its controls.

Check that the gain control on the course computer is correctly set, and set the rudder control on all control units to mid position.

Initial sea trials on fast planing vessels should be conducted at no more than half engine speed under which conditions the recommended midway setting of the rudder control should provide stable steering performance.

Mid-way setting of the rudder control will also give acceptable steering performance in sailing and displacement power vessels under all conditions for initial trial purposes. Fine setting of the rudder control is discussed later.

### 4.1 FIRST SEA TRIALS

During first sea trials, the vessel will be constantly changing heading, and it is, therefore, very important to maintain a constant look-out. The following initial trial procedure is recommended:-

- Steer on to a compass heading and hold the course steady.
- Press 'Auto' to lock on to the current heading. In calm sea conditions a perfectly constant heading will be maintained.
- Alter course to port or starboard in multiple increments of 1 and 10 degrees from any control unit. Course changes should be prompt and without any sign of overshooting.
- If a hand held control unit is fitted key 'Manual' to change over to remote power steering. Practice power steering using the four course control keys.
- Press 'Auto' twice (within 2 seconds) to return to the original automatic heading.
- Press 'Stand by' to disengage the autopilot for return to hand steering.

#### Automatic Sea State Control

During the sea trial, the operation of the automatic sea state control can be observed. When the autopilot is initially engaged in 'Auto' mode the autopilot will respond to all pitch and roll movements. During the first minute of operation, it will be noticed that repetitive movements of the vessel are gradually neglected until finally the autopilot will respond only to true variations in course.

To ensure precise course adjustments the sea state control is automatically reset whenever a course change is selected.

#### Automatic Trim Control

The Autohelm 6000 automatically corrects for

Weather helm indicated by wind loads on hull or sails. No adjustment of the pilot is necessary.

After each course change the Automatic Trim is cancelled and the Autohelm 6000 will reestablish the correct trim for the new heading. This process takes approximately one second per degree of course change. It should be noted that if a large course change is keyed in (greater than 60°) the pilot will not assume the final selected course immediately. The vessel will come to within say 10° of the desired course and will only settle onto course when the Automatic Trim has been fully established.

It is recommended the following procedure is adopted for large course changes.

- Note required new heading
  - Select 'Stand-by' and steer manually
- Bring vessel onto new heading
- Select Auto and let vessel settle onto course
  - Bring to final course with  $\pm 1^\circ$  increments

It is sound seamanship to make major course changes only whilst steering manually. In this way any obstructions or other vessels may be cleared properly and due account taken of the changed wind and sea conditions on the new heading prior to engaging the pilot.

#### Windvane System

In the case of a sailing yacht fitted with a windvane system the following additional trial is recommended.

- Steer onto a constant heading approximately 10° free of close hauled.
- Press both red keys together to engage 'Vane' mode and allow the automatic wind angle heading to settle.
- Decrease the relative apparent wind angle in 1° increments using the '+1' key (if on the starboard tack) until the yacht is sailing close hauled at optimum penetration.
- Prepare to tack and then press the '+1' and '-1' keys together to initiate a tack.
- The yacht will go about and sail the same apparent wind angle on the opposite tack. If there is an observable difference in apparent wind angles on opposite tacks, this can be corrected by fine adjustment of the windvane head alignment.
- Press 'Stand-by' to disengage the autopilot and return to hand steering.



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## 4.2 RUDDER CONTROL ADJUSTMENT

The gain control switch on the course computer should have been set according to the recommendation given in section 3.3.1. This control sets the range of adjustment available on the control unit rudder control switch and normally will not need further adjustment.

Excessive rudder application results in 'oversteer' which can be recognised by the vessel swinging slowly from side to side of the automatic heading. In addition, distinct overshoot will be observed when the course is changed. This condition can be corrected by reducing the rudder control setting.

Similarly, insufficient rudder application results in sluggish steering performance which is particularly apparent when changing course. This is corrected by increasing the rudder control setting.

Oversteer and understeer tendencies are most easily recognised in calm sea conditions where wave action does not mask basic steering performance.

The rudder control adjustment should be tested by steering the vessel onto a southerly course (N. hemisphere). With the pilot engaged and the rudder control on the **control unit** at minimum there should be no course wandering. Increasing the rudder control to maximum should not induce course wandering.

Repeat the check on a northerly heading (N. hemisphere). At minimum rudder control setting there should be no major course wandering.

As maximum rudder control is reached the course may wander and the pilot become unstable. Reducing the rudder control to near minimum should return the pilot the normal course accuracy.

- If the pilot is **unstable** on northerly heading at **minimum** rudder control setting **reduce** the gain control switch at the **course computer** by **one** division and repeat the test.
- If the pilot is **stable** on northerly headings at **maximum** rudder control setting. increase the gain control switch at the **course computer** by **one** division and repeat the test.

NOTE: IN SOUTHERN HEMISPHERE READ NORTH FOR SOUTH IN THE ABOVE TESTS.

The adjustment technique for the rudder control varies significantly between planing and displacement craft as described on the next page:

### Planing Craft

Planing craft operate over a wide speed range. Rudder effectiveness increases significantly at high hull speeds and it is always necessary to reduce the rudder control setting as speed increases to avoid oversteer. The rudder control setting would normally be reduced to minimum at maximum planing speed and increased towards maximum at minimum displacement speeds. Oversteer can be extremely violent at planing speeds and it is thus essential to reduce the rudder setting before opening the throttle.

### Displacement Power Vessels

The rudder control setting is much less critical on this type of vessel, and it is normally unnecessary to change the setting at different engine speeds. As a general guide, initial testing should be carried out at mid-setting and reduced as much as possible consistent with good heading control to minimise wear and tear on the steering system.

### Sailing Craft

Mono-hull sailing craft average hull speeds do not vary greatly and thus the rudder control setting will normally remain fixed most of the time.

Initial testing should be carried out at mid-setting.

Sailing craft are particularly stable when sailing close hauled and under these conditions, it is usually possible to reduce the rudder control setting to minimise rudder movement and hence power consumption. Conversely, when sailing down wind, stability is least and improved course holding will result by increasing the rudder setting. When running down wind in high wind velocities and in breaking sea conditions, instantaneous hull speeds when descending breaking seas can be extremely high. Under these conditions course heading can sometimes be improved by **reducing** the rudder control setting. The optimum range of adjustment is easily found by experiment.

### Semi-Planning Power Vessels

Some types of semi planning power craft may display significant changes in-steering characteristics with speed change. It may be necessary to **increase** the rudder control when reducing hull speed.

## 5.0 OPERATING HINTS

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Autohelm 6000's central course computer continuously optimises automatic steering performance eliminating the need for operator supervision.

It is, however, very important to understand the effect of sudden trim changes on steering performance. When a sudden change in trim occurs the automatic trim compensation system requires approximately 20 seconds to apply the necessary rudder off-set to restore the automatic heading. In gusting conditions, therefore, the course may tend to wander slightly, particularly in the case of a sailing yacht with badly balanced sails. In the latter case, a significant improvement in course keeping can always be obtained by improving sail balance. Bear in mind the following important points:-

- Do not allow the yacht to heel excessively.
- Ease the mainsheet traveller to leeward to reduce heeling and weather helm.
- If necessary reef the mainsail a little early.

It is also advisable whenever possible to avoid sailing with the wind dead astern in very strong winds and large seas. Ideally, the wind should be brought at least 30° away from a dead run and in severe conditions it may be advisable to remove the mainsail altogether and sail under boomed headsail only. Providing these simple precautions are taken the autopilot will be able to maintain competent control in gale force conditions.

It may be noticed that the autopilot tends to be a little less stable on northerly headings in the higher latitudes of the norther hemisphere (and conversely southerly headings in the southern hemisphere). This is caused by the increasing angle of dip of the earth's magnetic field at higher latitudes which has the effect of amplifying rudder response on northerly headings. The tendency towards northerly heading instability is usually more obvious in higher speed craft and when it occurs can be corrected by reducing the rudder control setting.

Passage making under automatic pilot is a very pleasant experience which can lead to the temptation of relaxing permanent watch. This must always be avoided no matter how clear the sea may appear to be.

Remember, a large ship can travel two miles in five minutes – just the time it takes to make a cup of coffee!

### 5.1 UNSATISFACTORY STEERING PERFORMANCE

If the Autohelm 6000 has been correctly specified, installed in accordance with the instructions and adjusted correctly it will provide outstandingly good steering precision over a very wide range of wind and sea conditions.

If the performance falls below your expectations and the pilot appears to be working correctly the fault will normally be found by carrying out the simple checks outlined below. Before reporting your difficulties to an Autohelm specialist, please check the following:-

- Have the test procedures and adjustments detailed in Sections 3.3 and 4.0 been carried out correctly? Check again
- Has the fluxgate compass been installed in an area free from large magnetic deviation? If in doubt use a hand bearing compass to check
- If performance has changed recently has a magnetic influence been introduced near the fluxgate compass? – anchor/chain/radio equipment/loudspeaker/tools/AC. generator etc.
- Is battery voltage correct? 12v or 24v
- Are fuses intact and of correct rating?
- Are circuit breakers engaged
- Is wiring of correct diameter and are screw connectors firmly tight
- If pilot fails to hold course – check gain setting at course computer and control units

#### **If vessel wanders under pilot control**

- Verify that drive actuator size is correct for size and type of vessel
- For rotary actuator – check that reduction ratio is correct for steering system of vessel
- For linear actuator – check tiller arm length is correct
- For hydraulic actuator – check steering ram and actuator are of compatible type and bleed system to remove air

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## 5.2 PILOT FAILS TO DISENGAGE ON SELECTING STAND-BY

The drive actuators of the Autohelm 6000 are designed to 'Fail Safe' - When power is disconnected the drive unit will always disengage leaving the steering system free for manual control.

When Stand-by is selected the actuator will Disengage leaving the steering Free.

It is remotely possible that a fault could develop which could cause the actuator to remain engaged even when Stand-by is selected - if this happens

- DISCONNECT THE MAIN CIRCUIT BREAKER TO THE AUTOPILOT- THE STEERING WILL IMMEDIATELY BE FREE.

or

- IN AN EMERGENCY THE ACTUATOR CLUTCH CAN NORMALLY BE OVERRIDDEN BY TURNING THE STEERING WHEEL HARD

It is emphasised that this fault is extremely unlikely and can be immediately corrected as described.

If preferred a separate 'OVERRIDE' switch can be fitted close to the steering position which will break the actuator drive circuit for EMERGENCY USE.

## 6.0 MAINTENANCE

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The autopilot is one of the most used and hardest working items of equipment on board, and therefore must receive its fair share of attention and routine maintenance. The working parts of the drive system are sealed and lubricated for life during manufacture and therefore do not require servicing.

Regular inspection of the installation is recommended in the following areas where applicable.

1. Check tension and alignment of the drive chain and lubricate with good quality waterproof light grease.
2. Check for the development of excessive lost motion (backlash) in the steering gear and correct if necessary. Lost motion at the wheel should not exceed 2% of the total wheel movement from lock to lock. This does not apply to the Linear or Hydraulic drive systems which are normally directly coupled to the rudder stock.
3. Check that Hydraulic Steering systems are free from leaks and trapped air. Bleed when necessary to remove air from the system.
4. Check that all inter-connecting cable terminals are fully tightened and corrosion free.
5. Check that external waterproof sockets are capped when not in use and periodically spray with WD40 (or similar) to protect from corrosion.
6. Check that the heavy power supply cable connections are tight and free from corrosion.

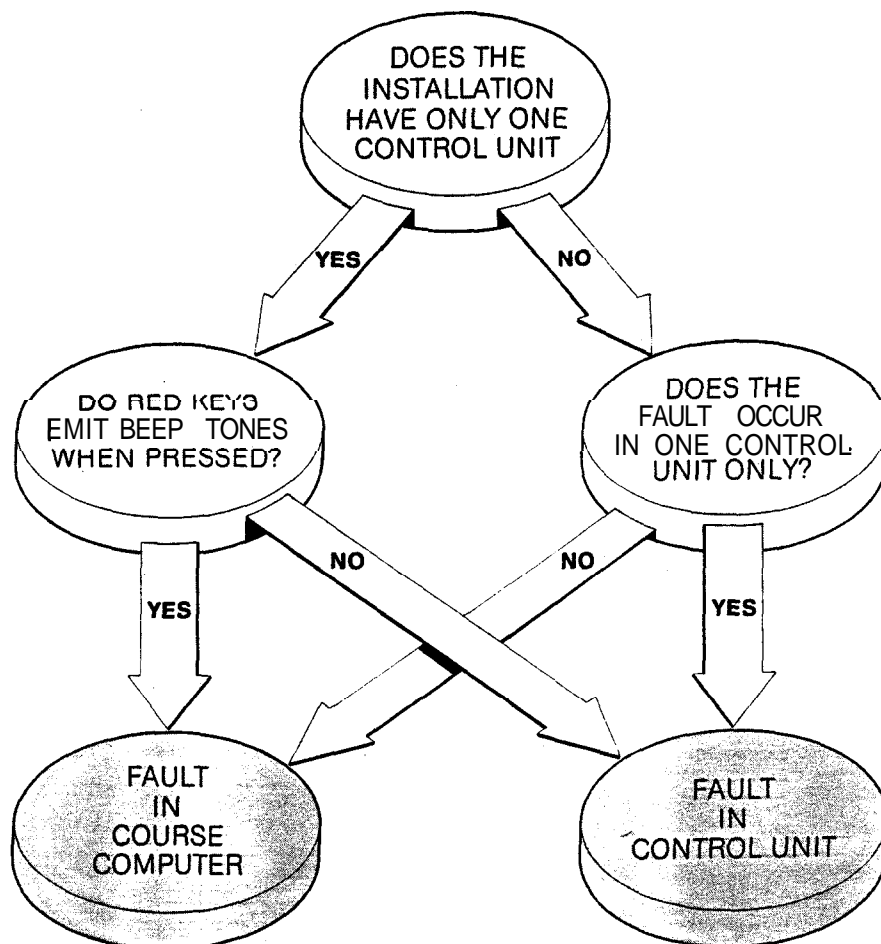
# 17.0 FAULT LOCATION PROCEDURE

Autohelm 6000 has been designed to achieve very high standards of reliability combined with ease of servicing.

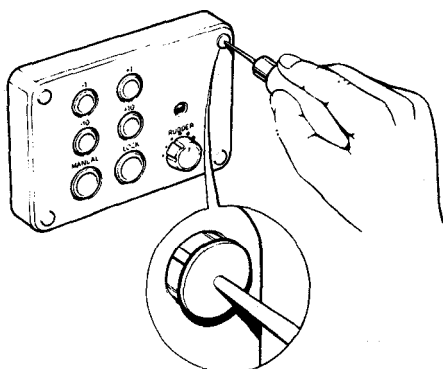
If a fault should appear, please double check that all connections in the connector unit are sound and that the heavy power cable connections are tight and free from corrosion. If you are satisfied that all connections are sound,

the simple check procedure tabulated below will assist you to locate the most likely fault area.

In the case of a sailing yacht fitted with a windvane system if a fault occurs only in vane mode then it is likely that a fault has developed in the vane head or the interconnection system.



Since the course computer houses the majority of the electronic control system there is a high probability that if an electronic fault has occurred it will be located in this area. The



course computer unplugs easily for servicing. (Section 2.1 .1).

Control units are removed by withdrawing the four blanking plugs and unscrewing from the mounting face. (Section 2.1.2). The blanking plugs can be removed without damaging the case by piercing with a small spike and easing out. Disconnect from the connector unit and withdraw the interconnecting cable (Section 2.3.1). The control unit will be returned after servicing with replacement blanking plugs and fixing screws.

The faulty unit should be removed and returned to your nearest service agent.

If any difficulties arise, please consult Nautech's Technical Sales Department in the U.K. of your own National distributor who will also be able to provide expert assistance.

# 8. WARRANTY

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## LIMITED WARRANTY

Nautech or its appointed Distributors or Service Centres will, subject to the conditions below, rectify any failures in this product due to faulty manufacture which become apparent within twelve months of its purchase date.

Equipment used in the country of purchase should be sent directly to the authorised Distributor for that country or its appointed Service Centres. The product will then be serviced free of charge and returned promptly direct to the sender.

Equipment used outside the country of purchase can be either:-

- a. Returned to the Distributor or Dealer in whose country or from whom the equipment was originally purchased - it will then be serviced free of charge and promptly returned direct to the sender, or
- b. The product can be returned freight prepaid to the authorised Distributor or its appointed

## FULL INTERNATIONAL WARRANTY

Nautech or its appointed Distributors or Service Centres will, subject to the conditions below, rectify any failures in this product due to faulty manufacture which become apparent within twelve months of its purchase date wherever the vessel and the product may be operated.

### CONDITIONS

1. The product must be installed aboard the vessel in the country of purchase.
2. The product must be installed in accordance with the recommendations issued by Nautech Ltd.
3. The installation must be carried out by an installer approved by Nautech: alternatively the installation must have been inspected and approved by Nautech or its approved installer.
4. The Warranty Registration Card must be completed by:-
  - The Owner or User
  - The Dealer supplying the product
  - The Installer

Service Centres in the country in which the product is being used. It will then be serviced and returned direct to the sender on the basis that the Distributor or Service Centre will supply any parts used free of charge but the sender will be invoiced for the necessary labour and return shipment at the local rate.

### CONDITIONS

The warranty is invalid if:-

- a. The product has been misused, installed or operated not in accordance with the standards defined in this manual.
- b. Repairs have been attempted by persons other than Nautech approved Service personnel.

5. The Full International Warranty is invalid if:-
  - (a) The product has been misused, or installed or operated not in accordance with standards defined in this handbook.
  - (b) Repairs have been attempted by persons other than Nautech approved Service personnel.
  - (c) The warranty card has not been completed correctly or is not accompanied by proof of purchase.

### CLAIM PROCEDURE

1. The product should be sent direct to Nautech or its appointed Distributor or Service Centre nearest to the vessel. The completed Warranty Card and proof of purchase must accompany the claim. The product will then be serviced free of charge and returned promptly direct to the sender.
2. Nautech, its Distributors and Service Centres, are not liable for any charges arising from visits to the vessel to attend to the product, whether under warranty or not, nor for seal trials or any other work associated with the installation. The right is reserved to charge for any such services at the local rate.