



NM 692
AUTOMATIC PILOT

**INSTALLATION
& OPERATING
INSTRUCTIONS**

NECO MARINE LIMITED

Walton Road, Eastern Road, Cosham, Portsmouth, Hampshire,
England PO6 1SZ Tel: COSHAM (07018) 70988. Telex 86149.

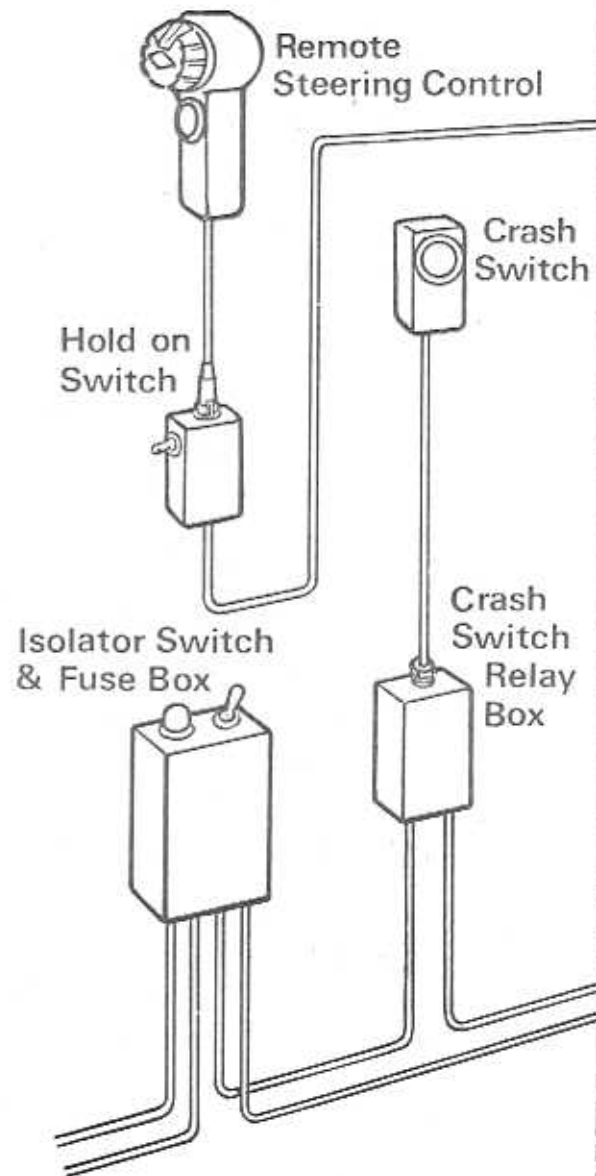
The Normand Electrical Group of Companies

INDEX TO THE NM692 AUTOMATIC PILOT INSTALLATION AND OPERATING INSTRUCTIONS.

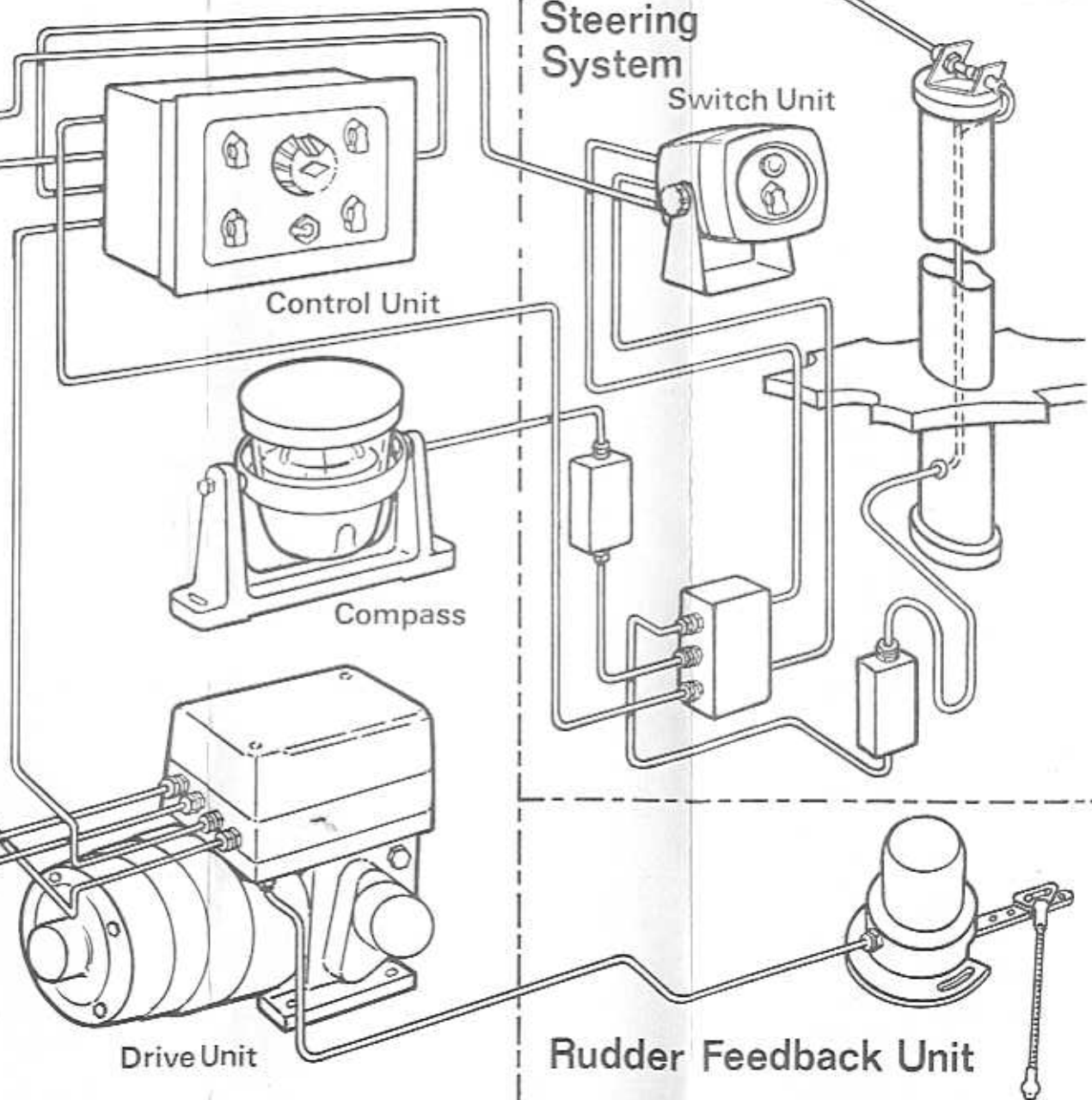
- SECTION 1 LIST OF UNITS**
1.1 - 1.4 The Basic Units
1.5 - 1.11 Optional Units
1.12 Sprocket and Chain Drive Ratios
- SECTION 2 SITING THE UNITS**
2.1 Radio Frequency interference
2.2 Earthing arrangements
2.3 Control Unit
2.4 Compass Unit
2.5 Connector Box
2.6 Drive Unit
2.7 Crash Switch
- SECTION 3 CONNECTING UP THE AUTOMATIC PILOT**
3.1 General Instructions
3.2 No. 1 Cable - Compass Cable
3.3 - 3.4 No. 3 Cable - Remote Steering Control Cable
3.5 No. 2 and 4 Cable - Drive Unit Cables
3.6 Reverse Rotation of Drive Unit
3.7 - 3.9 Power Supplies
3.10 Earth Stud
3.11 Crash Switch
- SECTION 4 LINING UP THE SYSTEM**
4.1 Lining up on Installation
4.2 Crash Switch
4.3 Resetting the Limit Switches
4.4 - 4.6 Adjusting the Compass
- SECTION 5 FUSE AND RELAY REPLACEMENT**
5.1 - 5.3 Fuse and Relay Replacement
5.4 Routine Maintenance
- SECTION 6 RUDDER FEEDBACK UNIT - INSTALLATION**
6.1 Rudder Feedback Unit Siting
6.2 Rudder Feedback Unit Wiring
6.3 Lining up with Rudder Feedback Unit fitted
- SECTION 7 SUPPLEMENT - INSTALLATION INSTRUCTIONS FOR NM 692 H AUTOMATIC PILOTS FITTED TO POWER HYDRAULIC SYSTEMS. (ISSUED ONLY WITH NM692H AUTOMATIC PILOTS).**
- SECTION 8 THE WIND VANE STEERING SYSTEM**
8.1 General Description
8.2 Description and Dimensions of Units
8.3 Siting the Units
8.4 Inter Unit Wiring
8.5 Lining up the System
- SECTION 9 OPERATING INSTRUCTIONS**
9.1 Operating Instructions
9.2 To steer by Automatic Pilot
9.3 Adjusting the Controls for optimum performance
9.4 To alter course
9.5 To steer by Remote Steering Control
9.6 Operating the Crash Switch
9.7 Operating the Wind Vane Steering System.
- SECTION 10 SERVICE DATA**

THE N.M.692 AUTOMATIC PILOT Basic Units

Optional Extras



Wind Vane Steering System



THE NECO NM 69/2 AUTOMATIC PILOT - INSTALLATION INSTRUCTIONS

SECTION 1, LIST OF UNITS

1.1 THE CONTROL UNIT. The unit is supplied with brackets (for shelf mounting) and clamping plates (for panel mounting), together with a removable neoprene bezel trim. Two long plated bolts are supplied for shelf mounting and two short bolts for panel mounting. Cables required for inter connecting with other units are supplied fitted to a plug-in connector, screwed to the rear of the control unit casing. It is normally supplied with three cables factory fitted, and two socket connections. One socket is used when a Remote Steering Control is fitted and the other when the Wind Vane Steering System is fitted. The blanking plugs should not be removed unless a Remote Steering Control and/or a Wind Vane Steering System are fitted. Care should be taken that the connectors in the plug-in unit are not damaged, and that it is always plugged in so that the cables emerge towards the centre of the control unit. Apart from panel illumination lamps, which run at battery voltage (and are accessible from the control unit panel), the unit is identical for both 12 and 24 volt D.C., supplies and may be used with a Drive Unit of either voltage. Should the unit be sited in an exposed position some arrangements should be made for covering when not in use.

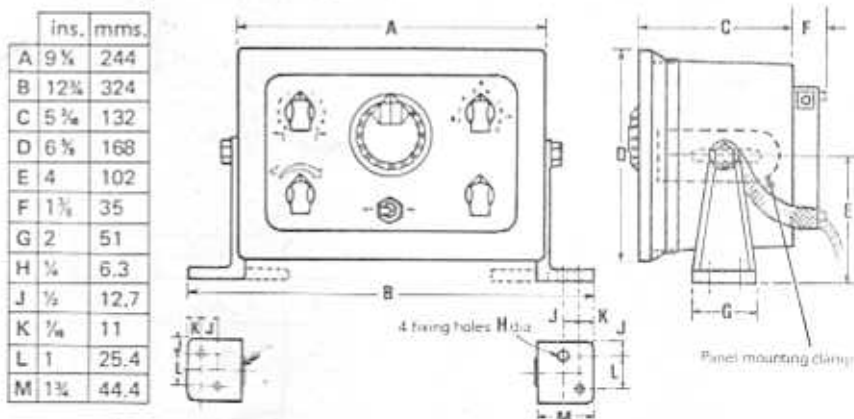
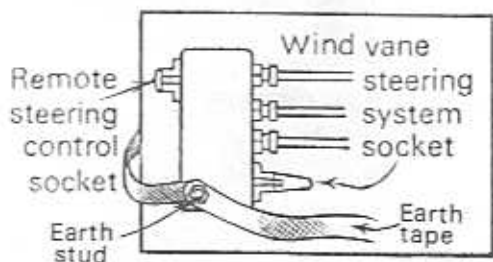


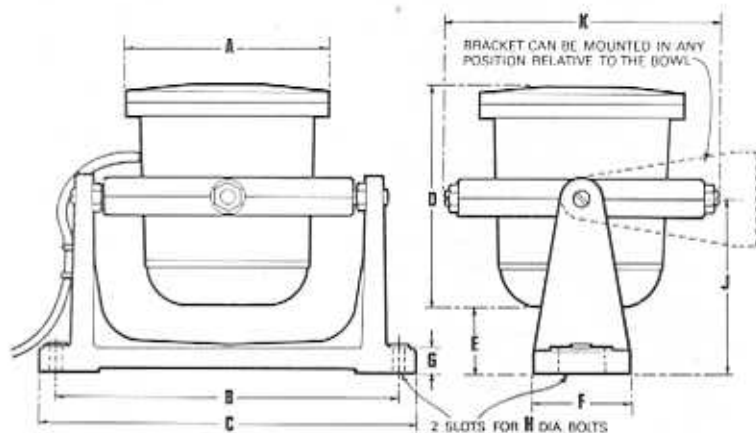
FIG.1 CONTROL UNIT DIMENSIONS



NOTE

A rubber plug is fitted to the R.S.C. socket. The specially wired plug in the wind vane socket should NOT be removed unless the wind vane system is fitted.

1.2 **COMPASS UNIT.** The Compass Unit is based on the well proven NM 3 Neco Magnetic Transmitting Compass. It can be mounted in an exposed position since the unit is watertight and tested to withstand temperatures of +60° to -20° centigrade and thus should be possible to find a suitable site where magnetic deviation will be small. The gimbal bracket has slotted holes to allow the compass to be slewed in order to compensate for coefficient 'A' deviation. 1 metre of tinsel cable is fitted to the compass, with the lead ends terminated in crimped connectors for direct insertion into a connector box. This length of cable should not be shortened.

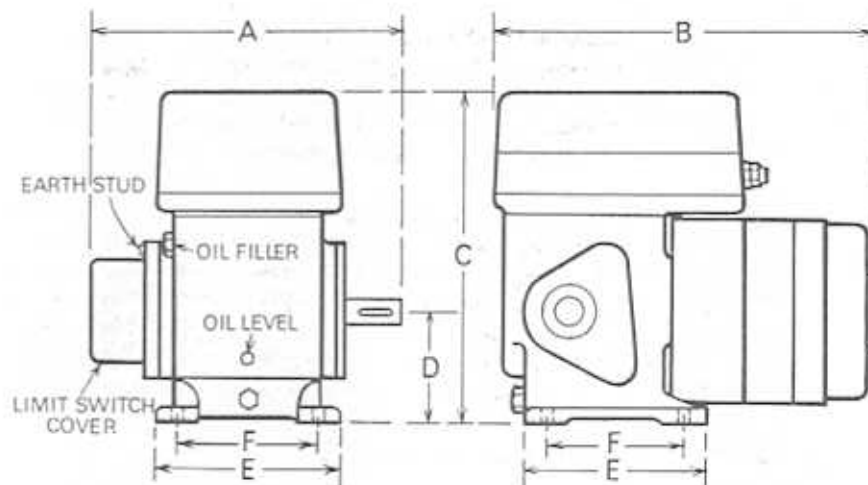


	ins	mm
A	5 1/8	130
B	8.66	220
C	9 7/16	240
D	5 1/2	140
E	1 5/8	41

	ins	mm
F	2 3/8	60
G	5/8	16
H	1/4	6
J	4 3/8	111
K	7	178

FIG.2 COMPASS DIMENSIONS

1.3 **NECO Electric DRIVE UNIT** consisting of a Neco 12 (or 24) volt DC 1/8 h.p., ventilated motor, driving a 5/8" diameter shaft at 17½ or 35 r.p.m. through a type S.W. gearbox. The shaft is milled for a 3/16" x 3/16" x 1" key. For safety in transit the gearbox is supplied drained of oil. Incorporated in the gearbox is an electro magnetic multi-tooth clutch, the feedback transmitter and limit switches. Under the top cover of the unit are located two armature relays, their suppression circuitry, all fuses and a sixteen way connection terminal block. In the 24 volt unit the motor windings are appropriate to the voltage, but a dropping diode is incorporated in the supply to the electronic units, which are common to both voltages. Motor Units are interchangeable. Battery leads are factory fitted.



	A	B	C	D	E	F
ins.	9 1/4	12	10 1/4	3 1/4	5 1/2	4 1/2
mms.	235	305	261	82.6	140	114

Approximate weight:
40 lbs (18kgs)

FIG.3 DRIVE UNIT DIMENSIONS

1.4 **CONNECTOR BOXES.** One is supplied for connecting No. 1 Cable from the control unit to compass.

- 1.5 **REMOTE STEERING CONTROL** (optional extra). This unit is supplied fitted with 5 metres of trailing cable, the end of which terminates in a plug type R.P.C. 12P-6 for fitting into the Remote Steering Control Socket on the Control Unit, Plug-in connector. When an extra length of cable is required for the R.S.C. a special connector box fitted with "hold-on" switch facility is supplied with the extra cable.
- 1.6 **HOLD-ON SWITCH** (optional extra) Is supplied for use with the Remote Steering Control. The Hold-on Switch is fitted to a special connector box. The switch in the 'ON' position allows the operator to use the Remote Steering Control irrespective of the press-on switch fitted to the Remote Steering Control.
- 1.7 **RUDDER FEEDBACK UNIT** (optional extra) The Rudder Feedback Unit with mechanical linkage to the rudder arm, is available for 'sloppy' steering mechanisms and for hydraulic systems subject to slip. Electrical leads from this unit replace those from the normal feedback transmitter at the drive unit. For details of installation see separate instructions, Section 6.
- 1.8 **'CRASH' SWITCH** (optional extra) The 'Crash' Switch is an emergency device by which means the Automatic Pilot may be switched off at a remote station, for example - a flying bridge. The 'Crash' switch comprises two units, the push button unit for mounting at the remote station, and the relay unit for mounting near to the drive unit of the automatic pilot. A single operation of the push button switch will cause the relay unit to switch the pilot out of operation, a condition which will remain until the system is reset by switching 'Off' at the Control Unit. Switching 'On' at the Control Unit will restore normal pilot operation.
- 1.9 **COMPASS ADJUSTMENT AID.** This device, normally required for Compass Adjusters and Installation Contractors, is temporarily connected to the Automatic Pilot. It visually indicates when the Pilot is in its 'neutral' position. It provides a rapid method of obtaining compass headings for precise compass adjustment.
- 1.10 **ISOLATOR SWITCH BOX** (optional extra). A fused switch box, with 'On' indicator lamp for connecting the automatic pilot power supply leads to the battery supply.
- 1.11 **WIND VANE STEERING UNIT** (optional extra). This unit can be fitted to all NM 692 Systems

1.12 **SPROCKET AND CHAIN DRIVE** The Neco NM692 Automatic Pilot applies rudder by turning some rotary part of the steering mechanism by sprocket and chain driven by the Drive Unit. For normal steering installations, where the rudder movement is restricted to approximately 40° either side of amidships the ratio of sprocket teeth to pinion teeth should be such that the output shaft of the drive unit is rotated through 4½ turns (9 turns when 35 r.p.m. motor is used) or slightly more, when the rudder is moved from hard-over one way to hard-over the other way.

As the Drive Unit also contains the Feedback Transmitter and Limit Switches, it is important that when selecting the sprocket ratio the operation of the Limit Switches is taken into consideration. They are factory set to operate at 2 turns either side of the neutral position of the 17½ r.p.m., Drive Unit shaft, and 4 turns either side of the neutral position of the 35 r.p.m., Drive Unit shaft.

Thus when deciding on the sprocket ratio it is important that the chain drive arrangement is such that the drive unit shaft rotates through at least 2½ turns between the amidships position and the point at which the rudder comes against each of its stops, or 4½ turns when the 35 r.p.m. drive unit is used. Whilst the limit switches must cut off power to the drive unit before the rudder reaches its stops, it is nevertheless desirable that the switches should not be constantly overridden when steering manually.

VARIATIONS FROM NORMAL - Although 4½ turns (9 turns when a 35 r.p.m. drive unit is used) of drive motor shaft are standard there are cases where more turns may be desirable. By increasing the sprocket ratio the torque available at the rudder will increase although this will reduce the rate of application of the rudder. There is, however, a certain class of steering mechanism, designed for constant torque at the steering wheel regardless of rudder position, with which it is very desirable that the sprocket ratio should be increased. Mathway steering, for instance, is based on this principle. These systems are non-linear in operation and result in rather coarse i.e., sensitive steering in the range near amidships. It is in this range that the automatic pilot normally functions and increasing the sprocket ratio so as to give up to 6(12) drive unit turns may be beneficial. ½" Pitch Chain is recommended, particularly if the automatic pilot is called upon to work near the limit of its power. Nevertheless where space is limited, and the steering gear light 3/8" Pitch Chain has proved acceptable. See Tables A & B.

TABLE A (17½ r.p.m.)

		Steering Gear Turns (Hard over to Hard over)													
		1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4¼	4½
Number of teeth on Steering Gear Sprocket	21														
	23														
	25							13	15	17	17	19	21	23	25
	38			13	15	17	19	21	23	25					38
	57	13	15	19	21	25									
	76	17	21	25											
		— Number of teeth on Drive Unit sprocket													

TABLE B (35 r.p.m.)

		Steering Gear Turns (Hard over to Hard over)											
		1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	5	6
Number of teeth on Steering Gear Sprocket	25											13	15
	38							13	13	15	17	21	25
	57				13	15	17	19	19	21	25		
	76	13	15	17	19	21	23	25					
		Number of teeth on Drive Unit sprocket											

N.B. 1 The above tables are derived from the formula:—

No. of teeth on Drive Unit Sprocket =

$$\frac{\text{No. of teeth on Steering Gear Sprocket} \times \text{Steering Gear Turns (H.O. to H.O.)}}{9 \text{ (or } 4\frac{1}{2} \text{)}}$$

N.B. 2 A greater sprocket ratio (i.e. fewer teeth on drive sprocket and/or more teeth on the steering gear sprocket) may be required in craft with "lively" steering characteristics or with Mathway steering gear. (See page 5.)

SECTION 2 SITING THE UNITS

2.1 RADIO FREQUENCY INTERFERENCE

It is important when deciding the position of the automatic pilot units, and planning the run of inter unit and power cables that consideration should be given to the proximity of the radio transmitter and its associated cables.

Although the NM 692 is fully suppressed against any reasonable internal or external radio frequency it is possible for RF to be induced if pilot cables are run in the same loom as the radio power carrying or aerial cables, or those containing general ships wiring, as even these can act as a radio receiver aerial and cross coupling will be inevitable.

Therefore as a general rule all pilot inter unit and power cables should be run in separate looms and as far away as possible from other cables.

The following instructions are applicable to those pilots with Serial Nos. suffixed RB or S.

2.2 EARTHING ARRANGEMENTS

The importance of good earthing cannot be overstressed and it is for this reason that the following points should be carefully noted:

Control Unit.

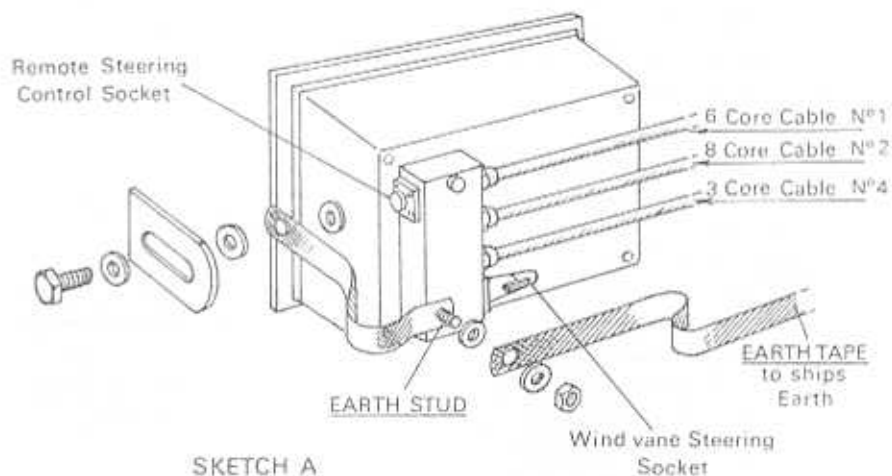
1. The entire autopilot system must be earthed by connection of a suitable earth tape to the earth stud on the back of the cable harness plug assembly.
2. The material used for the earth run should be flat copper earth tape or tinned copper braid approximately 15 mm wide. Ordinary wire can prove to be totally inadequate.
3. The length of earth run between Control Unit and Ship's Earth should be kept as short as possible.
4. Where possible, the earth run should connect directly to ship's earth and not to a common earth strap which then runs to ships earth.
5. It is imperative that the short earthing braid supplied with the control unit be securely clamped between mounting bracket and control unit, and that the other end be commoned with the main earth tape at the earth stud provided on the plug and socket assembly. (See Sketch A.)

2.3 CONTROL UNIT

This may be either bracket mounted or panel/bulkhead mounted. In the former case the clamping plates are not required and the two longer bolts should be used. For panel/bulkhead mounting the neoprene bezel trim is stripped off, and the clamping plates and shorter bolts are used.

The control unit should be reasonably accessible to the helmsman and preferably within his range of vision whilst looking out ahead. In many cases it need not actually be within reach of the steering position and the helmsman should not have to lean across the wheel in order to reach the unit. There is no restriction regarding the proximity of the unit to the steering compass.

Limits of safe distance from the Radio Transmitter are difficult to define in view of the high order of immunity to RF interference, but, as with cable routing, a realistic approach is still of importance when siting the control unit relative to the radio transmitter. For this reason, and as a general rule the greater the distance between control unit and radio transmitter the better.



SKETCH A

2.4 COMPASS UNIT

A site should be chosen, either above deck or below where:

1. Minimal deviation will be experienced.
2. There is little risk of magnetic or ferrous material being lodged in the proximity of the compass.
3. Movement of the craft is minimal. Subject to (1) this will normally be low down and near the centre line of the craft.
4. There is no restriction to the movement of the compass within its gimbals.
5. The unit is unobtrusive and unlikely to be touched by members of the crew.

2.5 CONNECTOR BOXES

These should be sited under cover. Securing holes are accessible when the cover plate is removed. One connector box is normally supplied and is used to connect No.1 cable to the compass.

- 2.6 **DRIVE UNIT.** This must be sited so that connection by roller chain to some rotary part of the steering gear is possible, with sufficient clearance around the steering gear shaft for the sprocket to be fitted. It can be orientated so that its output shaft is facing either forward or aft. Before placing the unit in position the gearbox should be filled with the lubricating oil (Castrol 'MAGNA') provided, by unscrewing the small plug on the end of the gearbox, and removing the filling plug fitted to the gearbox. Fill the gearbox until oil flows from the oil level plug, replace plugs. As supplied from the factory, the output shaft, viewed from its exposed end, rotates anticlockwise when applying starboard rudder. If reverse rotation of the output shaft is required the wiring connections should be as shown in Fig. 9. It should be noted that some parts of the steering gear shafting may rotate in a direction contrary to that of the ships wheel.

The Drive Unit should be mounted on a horizontal platform which is sheltered from rain and spray and which is reasonably accessible. There should be clearance over the top cover to permit its removal for the servicing of relays and replacement of the fuses and it is desirable that the limit switch cover should be accessible. The robustness of the platform should be commensurate with the weight and power of the drive unit. Slotted holes, or shims, to permit adjustment of chain tension, must be provided. The unit should not be finally bolted down at this stage, NOR SHOULD THE CHAIN DRIVE BE CONNECTED.

- 2.7 **'CRASH' SWITCH.** The push switch unit should be mounted in an accessible position at the remote station. If the chosen position is open to the weather, it is recommended that the lid of the unit be sealed after wiring and testing with a non-hardening, easy break sealant. The relay unit is connected into the 1mm² 32/0.20mm control power cable linking the battery with the terminals 1 and 2 on the drive unit connector block, and should be mounted in a position convenient to this cable. The unit may be mounted at any aspect, making use of the feet on the outside of the box.

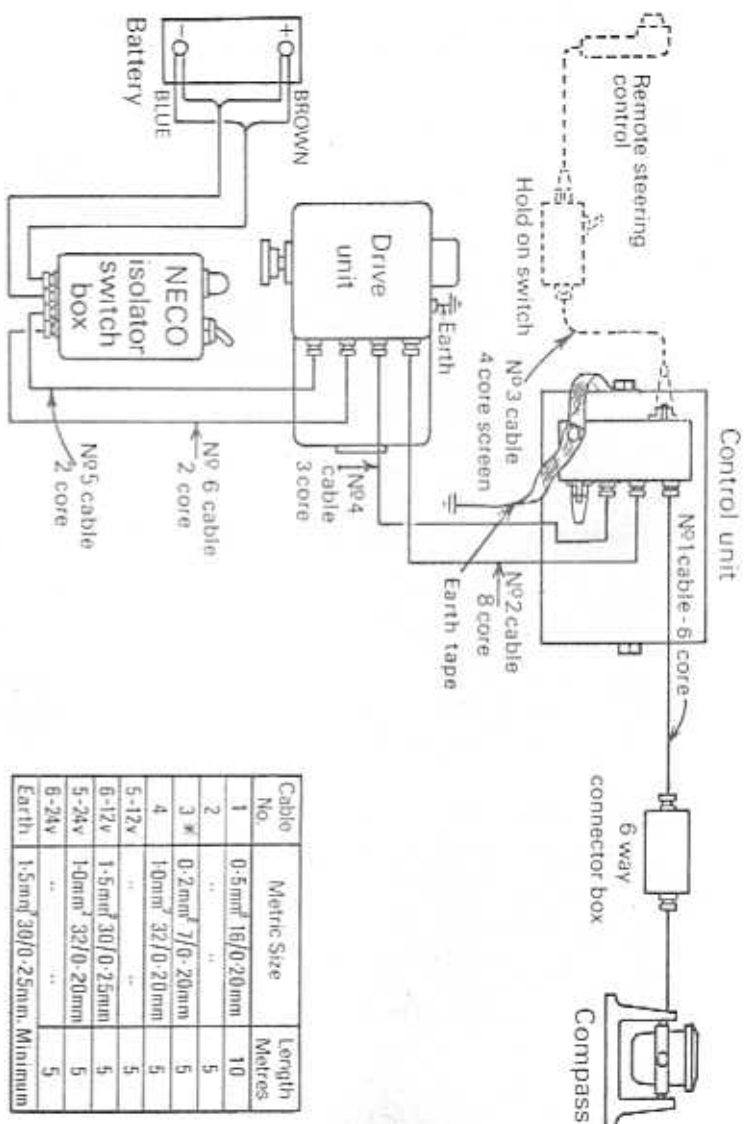


FIG 4

CABLE INTERCONNECTIONS N.M. 69/2

Cable No.	Metric Size	Length Metres
1	0.5mm ² 16/0.20mm	10
2	"	5
3 *	0.2mm ² 7/0.20mm	5
4	10mm ² 32/0.20mm	5
5-12v	"	5
6-12v	1.5mm ² 30/0.25mm	5
5-24v	10mm ² 32/0.20mm	5
6-24v	"	5
Earth	1.5mm ² 30/0.25mm. Minimum	5

SECTION 3 CONNECTING UP THE AUTOMATIC PILOT

- 3.1 **WARNING.** The Control Unit should not be 'opened up' by other than authorised servicing personnel.

Attention is drawn to Section 2.1 Radio Frequency Interference.

Starting from the Control Unit all cables should be routed as described hereafter and securely cleated. Care should be taken to ensure that no undue strain is placed on the cable glands. Lengths of the cables are not critical but power-carrying leads should be no longer than necessary.

CAUTION. To avoid rotation of the cables and possible strain it is recommended that all cable glands be tightened **BEFORE** connecting up the lead-outs. Referring to the Cable Interconnections diagram Figure 4.

- 3.2 **No. 1 CABLE** (6 core 0.5mm² 16/0.20mm unscreened)

The **BLACK** lead of this cable is not used and may be cut short. The cable is 10 metres long and should be led to the 6 way connector box sited close to the Compass. The cable is cut at this position and connected through the connector box as shown in Figure 5.

The trailing lead from the Compass is 1 metre long and should *not* be shortened. The lead ends of this cable are terminated in crimped connectors for direct insertion into the 6 way connector box. The trailing lead from the Compass should *not* be connected at this stage.

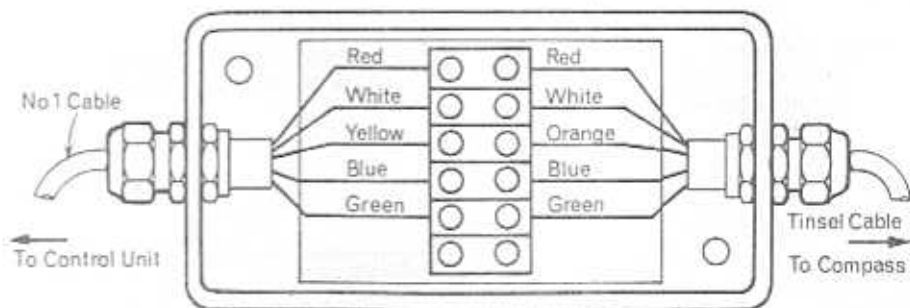
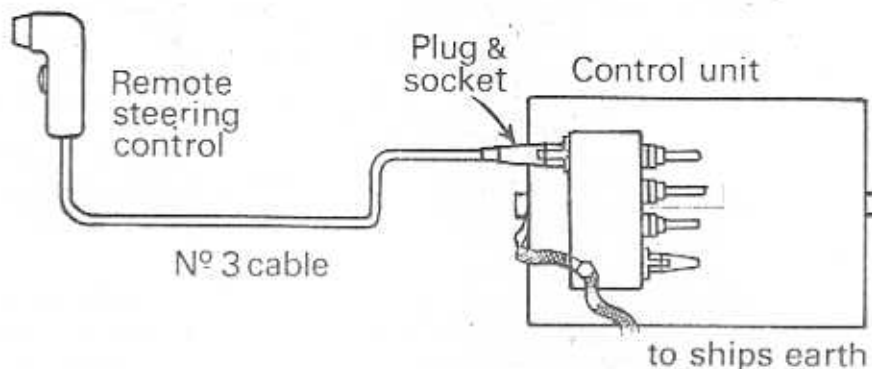


FIG.5 COMPASS CONNECTOR BOX

- 3.3 **No. 3 CABLE** (4 core 0.20mm). Only supplied when a Remote Steering Control is fitted. 5 metres of cable is supplied as standard fitted to the Remote Steering Control with the necessary plug for direct connection into the plug box on the rear of the Control Unit as shown in Figure 6.



Note: care should be taken that the R.S.C. plug is not inserted into the wind vane socket.

FIG. 6

- 3.4 If a 'hold on switch' or extra cable are provided for the Remote Steering Control a special box fitted with 'hold on switch' is supplied and is connected as shown in Figure 7.

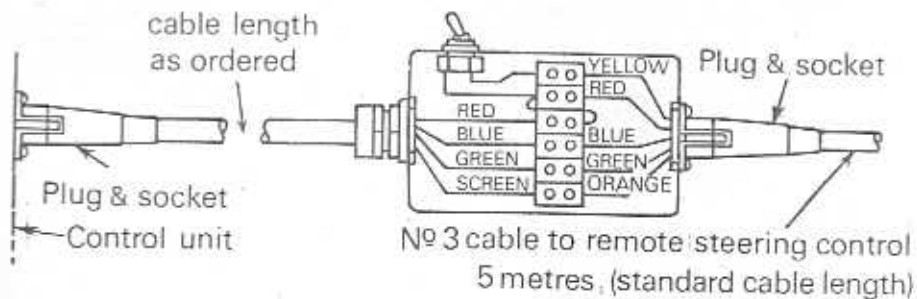


FIG. 7

- 3.5 **No. 2 CABLE** (8 core 0.5mm² 16/0.20mm) and **No. 4 Cable** (3 core 1mm² 32/0.20mm) are run to the drive unit; No. 4 cable is a power carrying cable.

Remove the top cover of the Drive Unit and cut No. 2 Cable and No. 4 Cable to the required length, leaving sufficient slack to allow the Drive Unit to be moved by small amounts when the roller chain is eventually connected. It is recommended that the lead-outs be tinned.

Decide whether standard rotation or Reverse rotation is required. ('Standard' Rotation is such that, to apply starboard rudder, the output shaft must rotate anticlockwise when viewed from its exposed end).

Figure 8 shows the order in which the lead-outs should be entered into the 16-way terminal block for standard rotation, Figure 9 for reverse rotation. If, however, a Rudder Feedback unit is to be fitted, connections should be as in Figure 8 for both Standard and Reverse rotation.

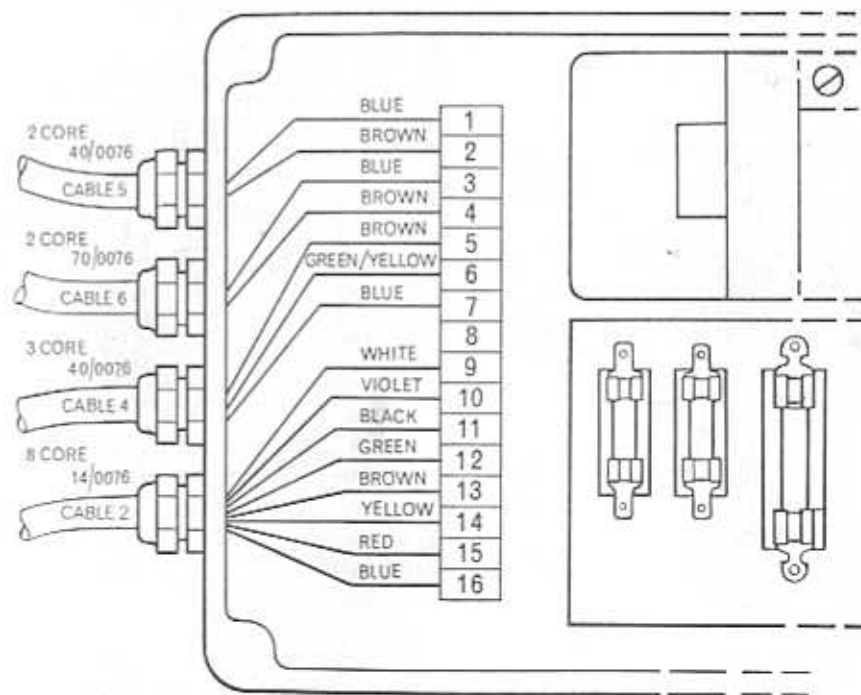


FIG. 8

Standard Rotation

3.6 **REVERSE ROTATION OF DRIVE UNIT.** In some installations it may be necessary for the Drive Unit output shaft to rotate in the reverse direction. No. 2 Cable from the Control Unit to the Drive Unit is then connected in accordance with Figure 9. This alteration may necessitate the resetting of the limit switches. These are located under the cylindrical cover adjacent to the earth stud of the Drive Unit.

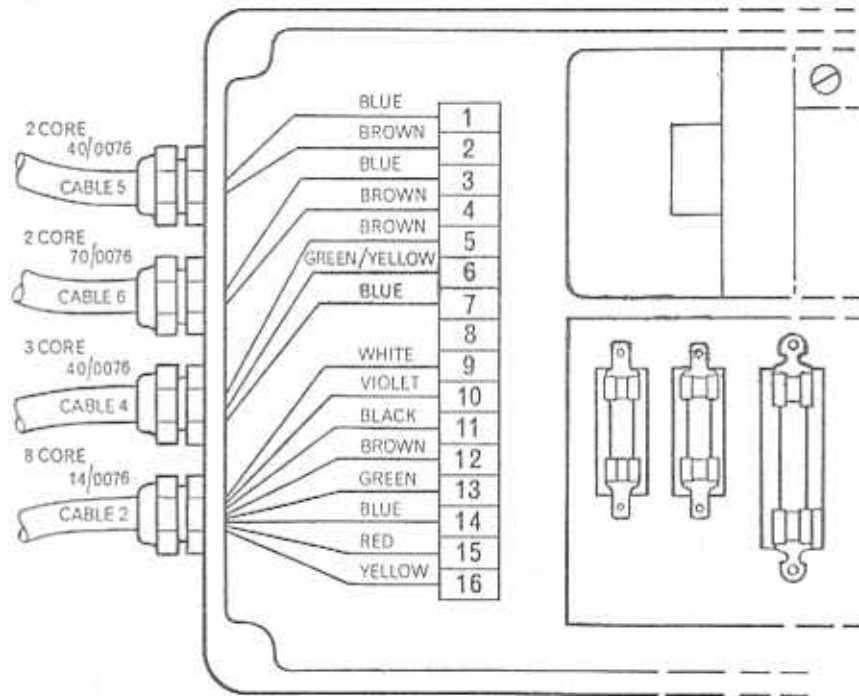


FIG.9

Reverse Rotation

3.7 **POWER SUPPLIES.** The Drive Unit is supplied with two pairs of power leads factory fitted, as shown in Figure 4. No. 5 cable – The Control Power Cable and No. 6 – The Drive Unit Power Cable. Nos. 5 and 6 cable must not be connected to independent batteries, unless either the negative or positive terminals of the two batteries are common. It is recommended that both these cables should be capable of being isolated, each with its own Isolator Switch (10 amp) An Isolator Switch Box can be supplied as an optional extra and is wired up in accordance with Figure 10.

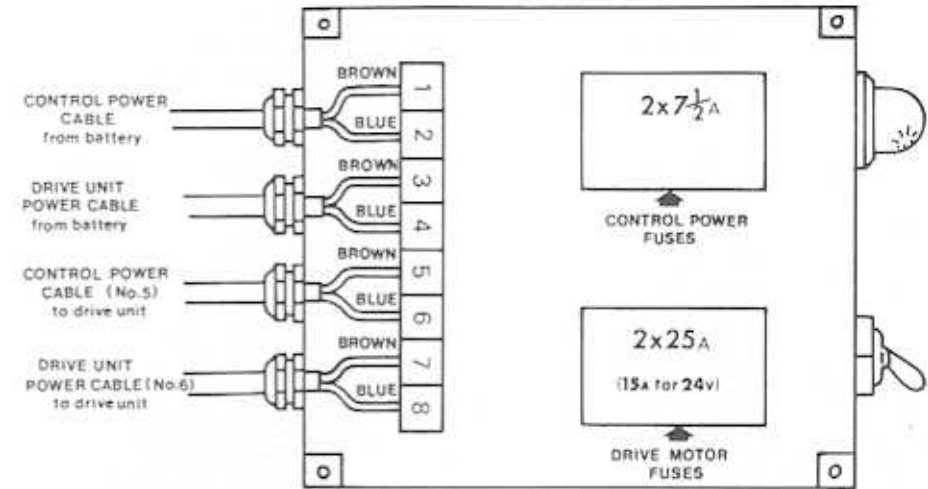


FIG.10 ISOLATOR SWITCH BOX

3.8 **No. 5 CABLE, CONTROL POWER CABLE** (2-core 1mm² 32/0.20mm) must invariably be routed direct to the battery terminals and never via a cable which is supplying power to the drive unit or other circuits, as shown in Figure 4. Failure to do this will result in poor pilot performance, as the pulse of current taken by the pilot motor by switching (together with the resistance, and possibly more important, the inductance of the cable) can produce a voltage drop of several volts for a few milli-seconds over only a short length of cable, and will cause relay flutter. The Control Unit Illumination is not controlled by the Off/On switch; this can be switched off by turning the brilliance control hard anti clockwise.

3.9 **No. 6 CABLE, DRIVE UNIT POWER CABLE** (2-core 1.5mm² 30/0.25mm for 12 volt installations) or (2-core 1.0mm² 32/0.20mm for 24 volt installations) may be run to the battery direct or through a distribution board capable of handling 30 amps (12 volts installations) or 15 amps (24 volt installations). In either case it is recommended that this be isolated by a separate switch. In the event of a relay sticking in the On position it is possible for the Drive Unit to run even with the Control Unit switched Off. By fitting the Isolator Switch in the Drive Unit Power Cable, possible damage to the Drive Unit can be prevented.

3.10 1/8th HP DRIVE UNIT EARTHING ARRANGEMENTS

The earthing stipulation for these units is mainly for reasons of electrolysis prevention rather than for RF suppression. For this reason, a length of ordinary 15 amp. insulated wire connected between the earth stud provided on the drive unit and ships' earth is sufficient.

- 3.11 'CRASH' SWITCH (if fitted) Disconnect the battery, cut the 2-core 1.0mm² 32/0.20mm cable No. 5 cable at the chosen position and connect the section of cable from the Control Unit Isolator into terminals 1 and 2 of the Relay Unit, connect the section of cable from the Drive Unit into terminals 5 and 6, and using a length of 0.5mm² 16/0.20mm link terminals 3 and 4 on the Relay Unit to terminals 3 and 4 on the Push Button Unit. Figure 11.

Terminal 7 is used only with Solenoid Valve-operated Hydraulic Systems. (See section 7)

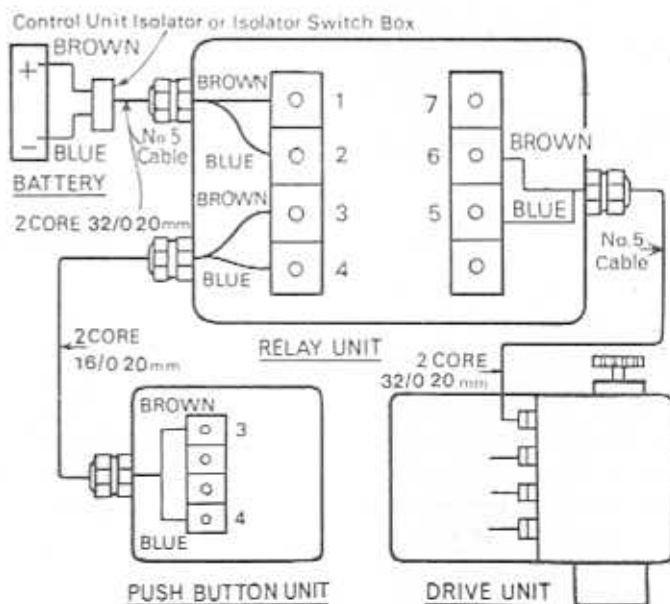


FIG. 11 CONNECTIONS FOR CRASH SWITCH MK.2.

SECTION 4 LINING UP THE SYSTEM

4.1 LINING UP ON INSTALLATION with Feedback unit installed in the Drive Unit – see separate instructions for Rudder Feedback Units.

1. Ensure that the chain drive is disconnected from the Drive Unit.
2. Check that (a) No. 1 cable from the Control Unit is connected into the appropriate connector boxes as shown in Figure 5.
(b) That the 'trailing' cable from the Compass has NOT been connected into the connector box.
3. Position the Controls as follows –

Sensitivity – Maximum (fully clockwise)	}	See Figure 12
Rudder Control – 10		
Trim Control – 0		
4. Ensure that the Drive Unit output shaft is free to rotate. Switch 'ON' the Drive Unit and Control Unit Isolator switches. Switch 'ON' the Automatic Pilot at the Control Unit.
5. The Drive Unit output shaft should now run to its 'neutral' position. Using the Trim Control, check the direction of rotation, return to 0. Mark the output shaft so that it can be returned to this position if inadvertently rotated. It is vital that the controls be set exactly as stated in 3 above.
6. Switch 'OFF' the pilot at the Control Unit and switch 'OFF' both Isolator Switches. Lock the rudder exactly at amidships. Connect up the roller chain to the Drive Unit pinion, with shaft in its 'neutral' position, and the steering gear sprocket drive.
Bolt the Drive Unit hard down so that the chain tension is similar to that in a new bicycle chain. Manually check operation of the limit switches. See Section 4.3
7. Free the steering gear and then close the Isolator switches and Control Unit switch. The electro-magnetic clutch should then engage and lock the pilot and steering gear in the amidships position. Move the Trim Control and Check that the rudder moves accordingly.
8. Switch 'OFF' the pilot at the Control Unit.
9. Now connect the trailing cable from the Compass into the 6 way terminal block as shown in Figure 5. It should be noted that these leads are terminated in crimped connectors for direct insertion into the 6 pin connector box. It is NOT recommended that this length of cable be shortened.

- Check that the craft is in a berth not subject to magnetic interference, e.g., is not alongside a steel hulled vessel, steel pontoon, etc., and set the Course Setter on the Control Unit to ship's head magnetic. Set the Rudder Control to 10 and Trim Control to 0. If the drive unit moves the rudder, slew the Compass Unit until the drive unit returns the rudder to its amidship position. Bolt the Compass Unit hard down.

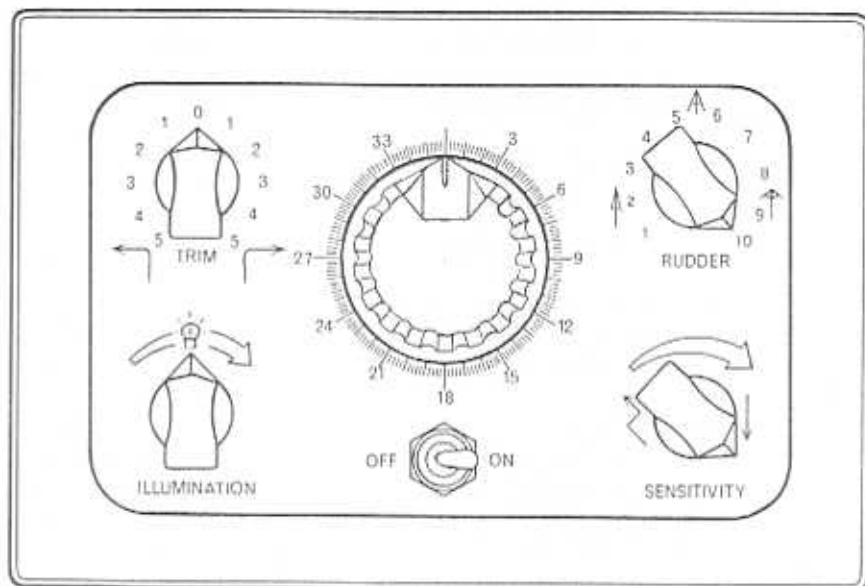


FIG.12 CONTROL PANEL SETTINGS FOR INSTALLATION ALIGNMENT

4.2 TO CHECK INSTALLATION OF 'CRASH' SWITCH

- Reconnect the Battery.
- Switch 'ON' both Isolator Switches.
- Put the OFF/ON switch on Control Unit to 'ON' and check the Automatic Pilot for normal operation, this may be done by operating the Trim Control alternately Port and Starboard.
- Operate the 'Crash' Switch push button.
- Check that the Automatic Pilot is inoperative by moving the Trim Control to Port and Starboard.
- Put OFF/ON switch on the Control Unit to OFF, by now switching 'ON' at the Control Unit, normal pilot operation will be restored.

4.3 RESETTING THE LIMIT SWITCHES (Systems NOT fitted with Rudder Feedback Unit).

In some installations and where reverse rotation of the Drive Unit output shaft is required the Limit Switches may have to be reset.

This should be carried out as follows:

- Put the Control Unit and Isolator Switches to 'OFF'.
- Remove the Limit Switch cover plate from the side of the Drive Unit. This will expose the two limit switches and their respective operating cams.
- Manually operate the steering gear until the rudder comes onto its physical stop, it will be noticed that as the steering gear is operated one of the cams moves towards its respective limit switch.
- Manually turn the steering gear in the opposite direction until the rudder is clear of its physical stop (the position in which the Limit Switch is required to operate) reset the cam determined in 3, so that it operates the Limit Switch. The cams are secured in place by a 6 BA socket set screw.
- Repeat 3 and 4 with the rudder on its opposite physical stop.
- Manually operating the steering gear, check by observation, that when the rudder is applied the Limit Switches operate before the rudder stops are reached in either direction.

4.4 ADJUSTING THE COMPASS. Provided the compass has been installed in a position free from disturbance to the earth's magnetic field and trim correctly adjusted, the course set and that actually steered will be in close agreement.

If there are differences of more than very few degrees it is likely that the compass unit is subject to deviation errors and it will require correcting by a qualified compass adjuster. The following methods enable compass headings to be obtained so that these corrections may be effected. Both take advantage of the fact that, when the pilot Drive Unit is in its "neutral" position, the course setter is effectively a compass repeater.

4.5 METHOD A using the COMPASS ADJUSTING AID (CAA)

1. Remove the top cover of the Motor Unit.
2. Remove both 25 amp. (15 amp) fuses. This will render Drive Unit and clutch inoperative when the control unit is switched on, and thus permit manual steering.
3. Remove the Violet, green, brown, yellow, red and blue leads colour for colour, into the terminals 10, 12, 13, 14, 15, and 16 on the gland side of the terminal block (see Fig. 8) but do not disturb the glands.
4. Connect the exposed green, brown, yellow, red and blue leads, colour for colour, into the terminal block of the CAA. The flying orange lead on the CAA should be connected into terminal 10 on the Drive Unit terminal block. It is recommended that the bare end of the disconnected orange lead (see 3 above) be covered with adhesive tape until the pilot wiring is reconnected normally.
5. Set the Switch on CAA to pilot voltage. Set Sensitivity and Rudder Control fully clockwise. Set Trim to "zero".
6. Bring the craft to the desired heading and adjust the Course Setter to this heading.
7. Switch on at the Control Unit and allow a few seconds for the system to settle. Re-adjust the Course Setter as indicated by the CAA lights – increase reading with the green light and vice versa. When both lights go out the system is balanced and the Course Setter then reads within $\pm \frac{1}{2}^{\circ}$ of Compass Unit heading.

- 4.6 METHOD B. This is somewhat less accurate and calm water and steady wind conditions are necessary. Nevertheless it is adequate and useful when no CAA is available. No disturbance to any wiring is required. Compass adjustment is carried out underway with the pilot switched on.

The craft is brought on to the required headings with the course Setter and for each heading Trim is re-adjusted (see "Operation" section). If this adjustment is made with care and conditions are steady the Course Setter reading will provide a close indication of compass heading.

Using normal compass adjustment techniques compensating magnets should be placed and, if necessary, the Compass Unit slewed to minimise differences between course set and magnetic course steered. Residual differences should be tabulated in the form of a Deviation Table.

SECTION 5. FUSE AND RELAY REPLACEMENT.

- 5.1 **FUSES**, situated under the top cover of the Drive Unit and from (see Fig. 13.) the 16 way terminal block are:

- 1 – 5 amp BS 646
- 1 – 2 amp BS 646
- 2 – 25 amp (12 volt installation)
- or
- 2 – 15 amp (24 volt installation)

Situated in Isolator Switchbox

- 2 – 7½ amp
- 2 – 25 amp (12 volt installation)
- or
- 2 – 15 amp (24 volt installation)

Before replacing fuses – Switch Drive Unit and Control Unit Isolator Switches to OFF.

- 5.2 **PANEL ILLUMINATION**. These midjet lamps push fit into the slotted caps which screw into the Control Unit Panel. They are: Thorn Bendix 'Atlas' type L.1004 (28 Volt rating for 24 volt installations, 14 Volt rating for 12 volt installations) When replacing panel lamps care should be taken to avoid distorting or otherwise damaging the rubber seals.

- 5.3 **REPLACEMENT OF RELAYS**. (Potter and Brumfield Type PR5DY). It is important that the Drive Unit and Control Unit Isolators are switched OFF, or alternatively the battery connections are disconnected. Access to the Relays may be gained by removing the top cover from the Drive Unit. See Figure 13. The relays are each secured to the base plate by means of 2 – 4 BA screws and washers. The relay connections are made to a terminal block located beneath the fuse and suppression panel. The latter held by 2 – 2 BA nuts and washers and 1 – 6 BA screw and washer in the positions shown in Figure 13, and removal will allow the fuse board to be hinged aside on its wiring in a direction towards the 16 way connector block. Note the position of the wiring where it emerges from beneath the relay base. Disconnect the relays and remove, taking care not to strain the small leaf springs in the connector block when disconnecting.

The new relays should be screwed into position with the wiring in the position noted for the originals, and care should be taken that all wires are free to move and not trapped. Ensure that the loop of insulated wire connected to the armature of the relay is clear of obstruction and free to move. Connect the relays to the terminal block as shown in Figure 13 coiling excess wire neatly, and refit the fuse board. During the latter operation it is especially important to ensure that the wiring connections beneath the fuse board are not trapped between it and the terminal block, to avoid possible puncture of the insulations by the terminal pins in the board.

5.4. ROUTINE MAINTENANCE

1. Regularly lubricate the roller chain drive between the Drive Unit and steering gear.
2. Once a season check the oil level in the Drive Unit gearbox by slacking back on the oil level screw plug, situated on the end of the gearbox. Oil should seep from the gearbox. If not, top up with Castrol 'Magna' through the filling plug, which is adjacent to the earth connection on the side of the Drive Unit gearbox.
3. The Rudder Feedback Unit (if fitted) should be inspected at regular intervals to ensure that loose gear is not likely to foul the linkage system. The ball and socket joints should be greased occasionally and linkage fastenings checked.
4. To clean the Control Unit panel wash with detergent and rinse with fresh water. Dry off with a soft cloth.
5. Relay contacts. These should not be touched unless symptoms indicating dirty contacts occur. A typical symptom would be the cessation of operation of the pilot, with the rudder at a fixed angle. This may temporarily be remedied by switching the autopilot OFF and then ON again, but the relays should be cleaned at the first subsequent opportunity.

To clean the Relays:

It is important that before any service operations are carried out, that the Drive Unit be isolated from the battery by opening both Isolator Switches, or alternately disconnecting the battery connections. Access to the Relays may be gained by removing the top cover from the drive unit.

The contacts should be cleaned using preferably a solvent cleaner fluid such as Arklone, Inhibisol or Sprayclene, but in the absence of any of these, any good domestic dry cleaning fluid should suffice. The cleaner should be worked between the contacts using a piece of smooth surfaced card such as postcard, until all traces of blacking are removed. The relays may be manually operated to facilitate this and the subsequent greasing operations. Repeat the operation for both pairs of contacts and allow time for the excess solvent to evaporate. On no account should any abrasive or file ever be used on the contacts.

The contacts should then be treated with a protective coat of Electrolube 2G grease. This may be applied by lightly coating the end of a feeler gauge or similar tool with the grease and wiping between each pair of contacts in turn, recoating the feeler gauge as necessary.

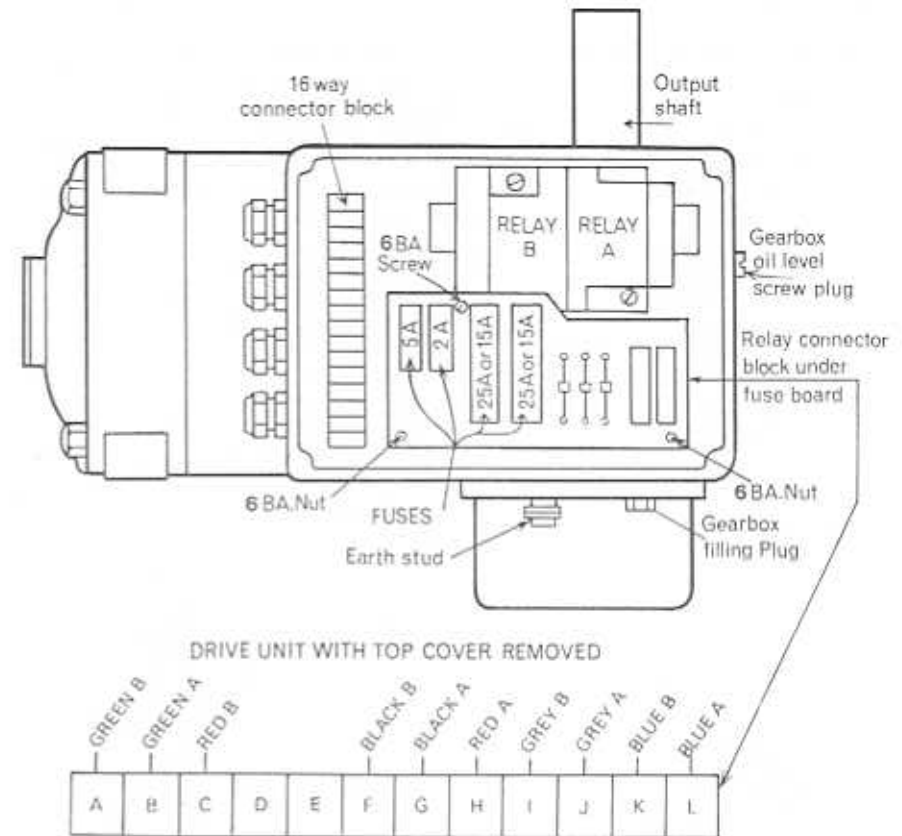


FIG.13 RELAY CONNECTOR BLOCK

SECTION 6.

RUDDER FEEDBACK UNIT -- INSTALLATION

6.1 **RUDDER FEEDBACK UNIT.** This unit is essential when the autopilot is installed with hydraulic systems, since these are liable to some degree of slip and when this occurs a feedback unit, connected to the output shaft of the drive unit, can no longer signal the true position of the rudder to the autopilot.

For the same reason, a rudder feedback unit may be beneficial in any mechanical steering system when there is a significant amount of backlash or 'sloppiness'.

The Unit when fitted should be mounted adjacent to the rudder head so that the feedback arm can be connected (with the threaded rod supplied) to the rudder tiller, to enable the feedback arm to move in sympathy with the rudder.

When first installed the connecting rod should be set up so that length 'X' is approximately twice length 'Y'. See Figure 14. Where space permits, it is convenient for the layout to be as shown in Figure 14, but if necessary the unit may be mounted upside down, or so that the tiller/quadrant and feedback arm 'face' each other.

The unit should be lightly bolted down using the slotted fixing holes in its base.

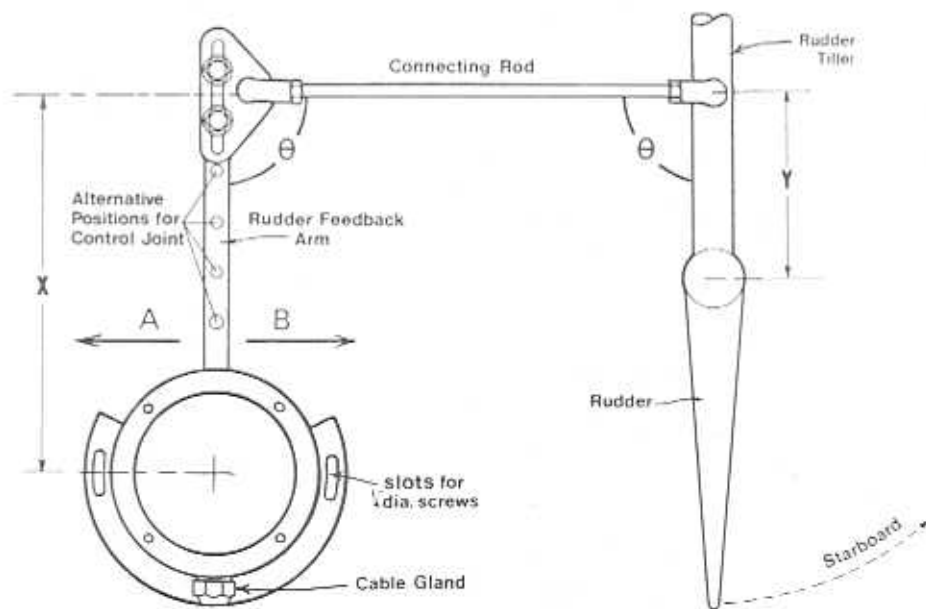


FIG. 14 RUDDER FEEDBACK UNIT

NOTE: When lengths of arms X and Y have been finally decided after sea trials, the Rudder Feedback Unit should be bolted down so that with the rudder amidships, right angles are formed between each arm and the connecting rod.

6.2 **WIRING UP THE RUDDER FEEDBACK UNIT.** (Systems using the Electric Drive Unit, driving Mechanical or Hand Hydraulic Steering Gear.) There are 4 combinations of feedback arm movement (referred to as direction A or B - see Fig. 14) and drive unit output shaft rotation as viewed from its exposed end, for a given direction of rudder:-

Condition	Rudder Direction	Feedback Arm Movement	Drive Unit Output Shaft Rotation
1.	Starboard	Direction A	Anti clockwise
2.	Starboard	Direction B	Anti clockwise
3.	Starboard	Direction A	clockwise
4.	Starboard	Direction B	clockwise

On initial installation, when the rudder is put to Starboard, note:-

- (a) The movement of the Feedback arm - Direction A or Direction B.
- (b) The rotation of the Drive Unit output shaft - Anti clockwise, or clockwise.

Decide which of condition 1,2,3, or 4 above applies and connect No. 7 cable in accordance with Figure 15.1, 15.2, 15.3, or 15.4.

No. 7 cable (8 core 0.5mm²) for connecting into the feed-back unit is factory fitted to the Drive Unit and emerges from the underside of the Relay box. The cable should be routed to the feedback unit.

Remove the domed cover from the feedback unit, which is held by 4 screws in its base. This will expose the terminal blocks feedback potentiometer and limit switches. Cut No. 7 cable to the required length. The WHITE lead is not used and may be cut short. Pass the end through the gland in the base of the unit and connect the leads as determined above.

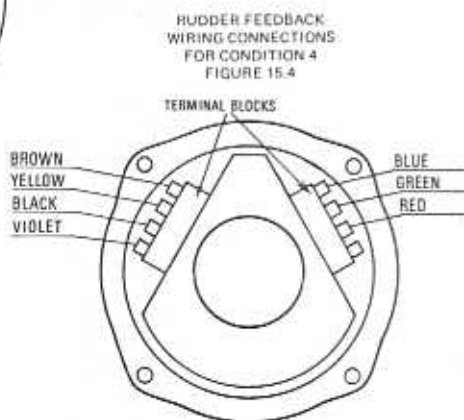
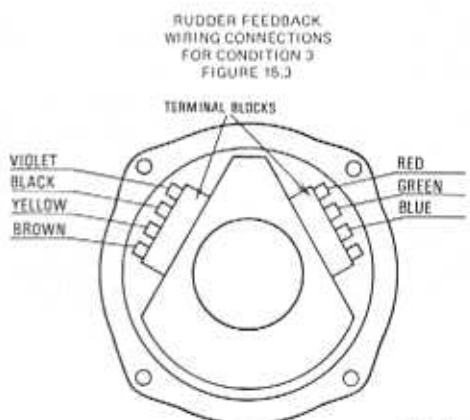
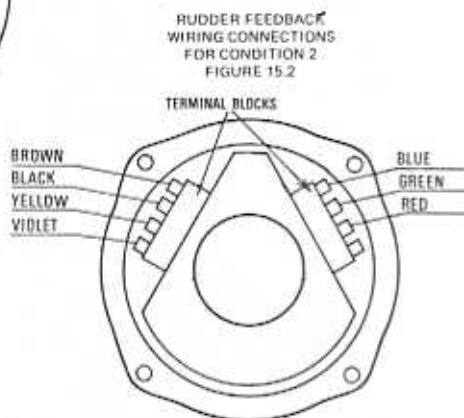
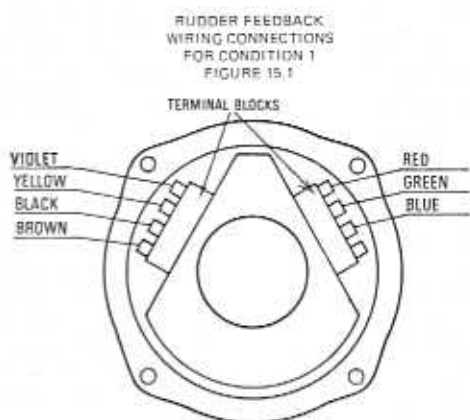


FIG.15 RUDDER FEEDBACK CONNECTIONS

LINING UP THE SYSTEM & SETTING LIMIT SWITCHES WITH RUDDER FEEDBACK UNIT.

1. Ensure that the chain drive is disconnected from the drive unit and steering gear.
2. Lock the steering gear so that the *rudder* is exactly at amidships.
3. Check that:
 - (a) No. 1 cable from the Control Unit is connected into the appropriate connector box.
 - (b) That the trailing cable from the Compass has NOT been connected into the connector box.
4. Position the Controls on the Control Unit as follows:

Trim Control	0	} See Figure 12
Rudder Control	10	
Sensitivity	Maximum (fully clockwise)	
5. Slacken back the holding down bolts of the Rudder Feedback Unit so that the unit can be rotated about the slotted fixing holes.
6. Check that the Drive Unit is free to rotate.
Switch ON the Isolator Switch (Switches).
Switch ON the Autopilot at the Control Unit.
7. The Drive Unit output shaft should now start running, unless the Rudder Feedback Arm is at the extremes of its travel (when the limit switches come into operation) or, in its centre of travel (when the autopilot will be in its 'neutral' amidships state).
8. Rotate the Feedback Unit about its holding down bolts until this 'neutral' state is reached, when the drive unit will stop running. Now tighten the holding down bolts so that the Feedback Unit is rigidly secured.
9. Switch OFF the Autopilot at the Control Unit.
Switch OFF the Isolator Switch (Switches).
Now fit the roller chain to the Drive Unit output shaft pinion and the steering gear sprocket, with the output shaft in its 'neutral' position, and the rudder amidships. Bolt the Drive Unit hard down, and check that the chain is at the correct tension.
Free the steering gear.

10. The limit switch cams should now be adjusted as follows:

Remove the Rudder Feedback Unit cover, it is held in place by 4 screws. This will expose the two limit switches and their respective cams, See Figure 16.

Manually operate the steering gear to starboard until the rudder comes onto its mechanical stop, noting the direction of movement of the Rudder Feedback Arm – Direction A or B. Adjust the appropriate limit switch cam to operate its limit switch just before the hard over position is reached.

When the Rudder Feedback Arm moves in Direction A – adjust the Yellow/Violet limit switch cam; Direction B – adjust the Black/Brown limit switch cam.

The cams are secured in place by 6 BA socket set screws, an Allen key is supplied for carrying out this adjustment.

Repeat this procedure for hard over Port.

11. Switch ON the Isolator Switch (Switches).
Switch ON the Autopilot at the Control Unit.
The electro-magnetic clutch should now engage and lock the pilot and steering gear in the amidships position.
Move the Trim Control to Port and Starboard and check that the rudder moves accordingly.
12. Switch OFF the Autopilot at the Control Unit.
13. Now connect the trailing cable from the Compass Unit into the 2 entry 6 way connector box as shown in Figure 5.
14. Check that the craft is in a berth not subject to magnetic interference, e.g., is not alongside a steel hulled vessel, steel pontoon, etc., and set the Course Setter on the Control Unit to ship's head magnetic. Set the Rudder Control to 10, Trim Control to 0, Sensitivity to Maximum.
Switch ON the Autopilot at the Control Unit.
If the Drive Unit moves the rudder away from amidships, slew the Compass Unit until the Drive Unit returns the rudder to its amidships position.
Bolt the Compass Unit hard down.

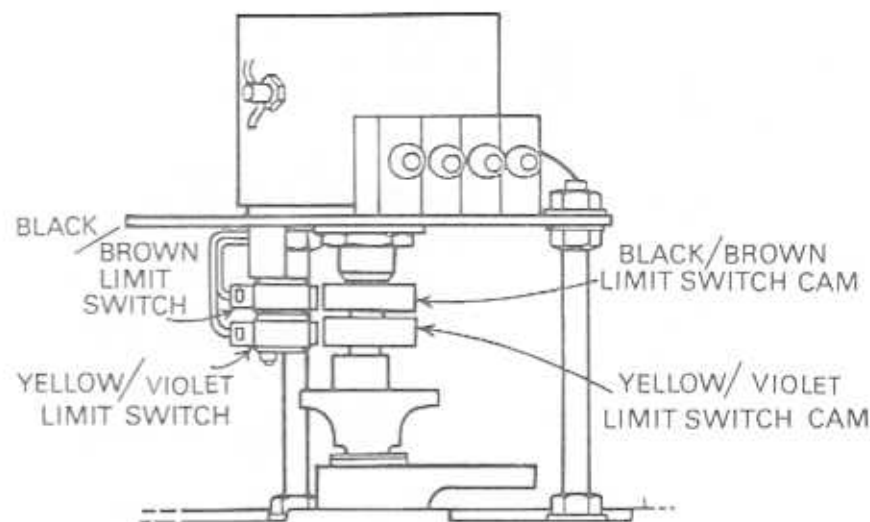


Figure 16

SECTION 8 THE WIND VANE STEERING SYSTEM

8.1 GENERAL DESCRIPTION

1. The Wind Vane Steering System has been developed to meet the requirements of the yachtsman who requires the choice of either steering by compass when under power or wind vane when sailing to windward
2. The system can be applied to all Neco Marine Type 692 or 692H Automatic Pilots, and according to the supply voltage of the pilot for 12 or 24 volts D.C., supply. In later models the plug in connector is fitted with a socket connection for the Wind Vane Steering System. This socket connection is normally supplied fitted with a plug suitably shorted so that the autopilot will operate when not fitted with the Wind Vane. This plug is removed when fitting the Wind Vane Steering System.
3. The system consists of the following units:—
 - (a) The Wind Vane Masthead Unit, with 20 metres, 6-core screened cable fitted.
 - (b) The Switch Unit.
 - (c) 2 entry, 6 way connector box for connecting wind vane cable at base of mast.
 - (d) 5 entry, 16 way connector box for connecting the Wind Vane Steering System to the Automatic Pilot.
4. The mode of operation of the automatic pilot can be selected by the operator by switching the Switch Unit to either Compass or Wind. When switched to Compass, the required course is set on the Control Unit Course Setter. When switched to Wind, the Control Unit Course Setter is set to the angle on the bow of the Relative Wind required, as shown diagrammatically in Figure 26. The Trim Control should be set to 0, Rudder Control and Sensitivity Control to their optimum settings as described in the operating instructions. A Delay Control incorporated in the Switch Unit enables the operator to increase or decrease the delay setting to compensate for oscillation of the wind vane due to small changes in wind direction.

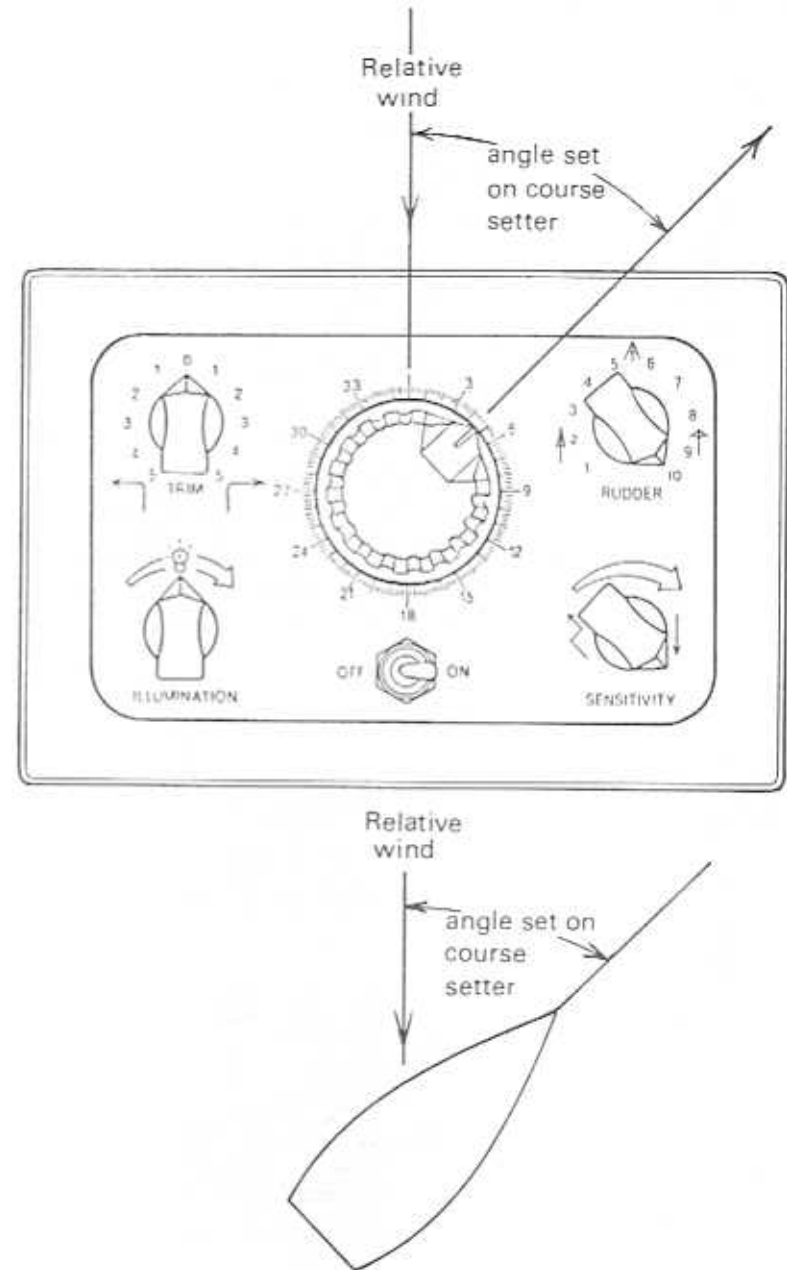


Figure 26

8.2 DESCRIPTION AND DIMENSION OF UNITS

1. WIND VANE UNIT

NOTE: If the Wind Vane Unit is mounted facing AFT, see note on page 37, section 8.4.7.

It is supplied with 20 metres of 6-core screened cable fitted to socket C. A suitable position should be found on the masthead, offer up the complete assembly and visually align the bracket and arm so that the arm will point forward. Having determined the position, separate the arm and wind vane from the sub-assembly as follows:—Unscrew completely the stainless steel nut A. Separate the plug and socket by unscrewing part B, which will allow the plug to move away from socket C, when the arm and wind vane are unplugged the socket should be protected by the blanking cap provided. When B and C have separated, withdraw the arm by sliding it axially in the direction of the arrow. This will free collar D, note that it has two small locating pins which engage the mating holes in the sloping stainless steel plate E.

To gain access to the fixing holes in the mast plate, remove nuts F and lift off plate E. Align the mast plate as near as possible in the fore and aft line. Adjustment of up to $\pm 10^\circ$ is obtainable for final setting up. Plate E should now be repositioned over the two locating studs and nuts F fitted without finally tightening. Final adjustment should be carried out with the mast stepped. See Figure 27.

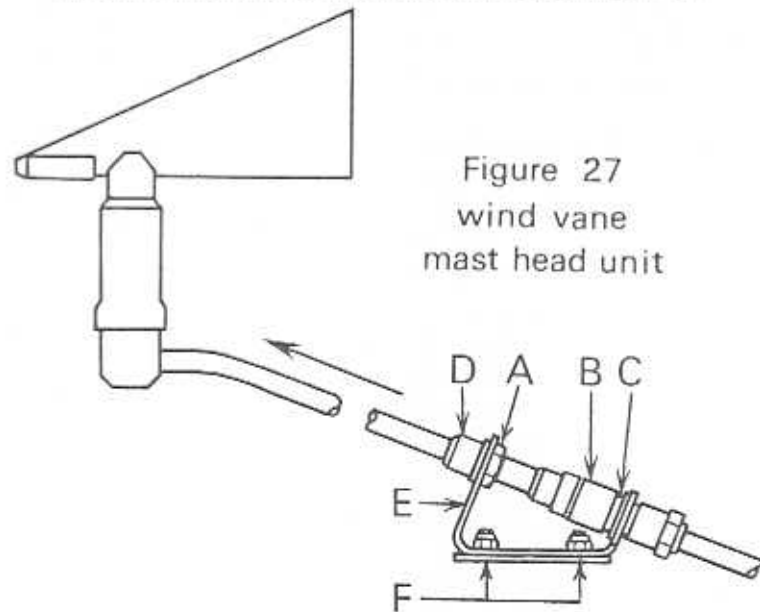


Figure 27
wind vane
mast head unit

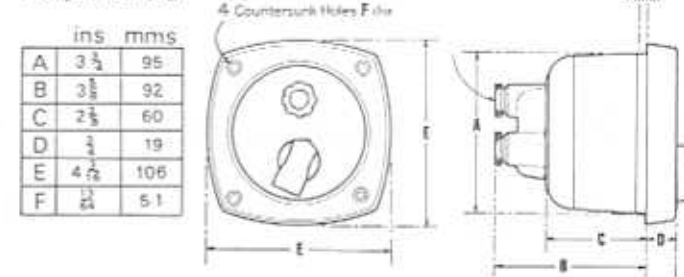
2. THE SWITCH UNIT

This unit should be mounted in a position accessible to the operator and for convenience close to the Autopilot Control Unit. It can be panel mounted, or if preferred a Neco Pod can be supplied as an extra.

3 Cables are fitted, each 2 metres long, which emerge from the cable glands on the rear of the unit. See Figure 28. Note:— The unit is voltage conscious and is supplied for either 12 or 24 volt D.C., supply, according to the pilot supply voltage.

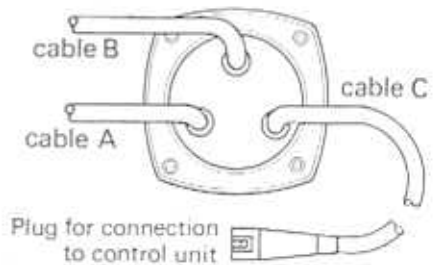
SWITCH UNIT

Panel Mounted



Rear view

Cables A, B and C
are factory fitted,
2 metres long.



Pod Mounted

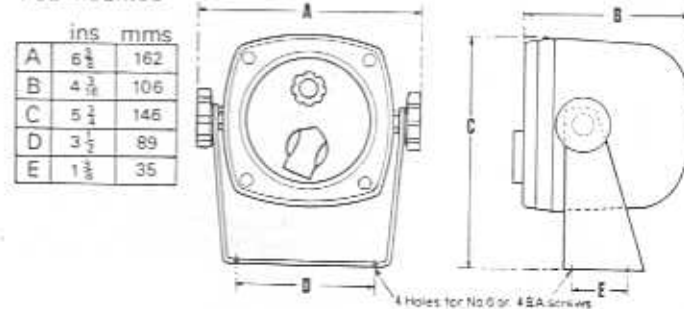


Figure 28

3. CONNECTOR BOXES

The following connector boxes are supplied for inter connection of the units, they should be used as follows:—

- (a) 1 - 2 entry 6 way connector box.
Sited adjacent to the mast step for linking cable E at the base of the mast.
- (b) 1 - 5 entry 16 way connector box.
Sited close to Control Unit and Switch Unit for linking the Wind Vane System to Autopilot.

8.3 SITING THE UNITS (NEW INSTALLATIONS)

1. Units should be sited as follows:—
Control Unit as in 2.3
Compass Unit as in 2.4
Drive Unit as in 2.6
Wind Vane Unit as in 8.2.1
Switch Unit as in 8.2.2
Connector Boxes as in 8.2.3

8.4 INTER UNIT WIRING

1. Starting from the Control Unit all cables should be routed as described hereafter and securely cleated. Care should be taken to ensure that no undue strain is placed on the cable glands. Lengths of cable are not critical but power carrying cables should be no longer than necessary. CAUTION to avoid rotation of the cables and possible strain, it is recommended that all cable glands are tightened BEFORE connecting up the lead ends, and that the lead ends are tinned. Refer to the Cable Interconnection Diagram Figure 29.

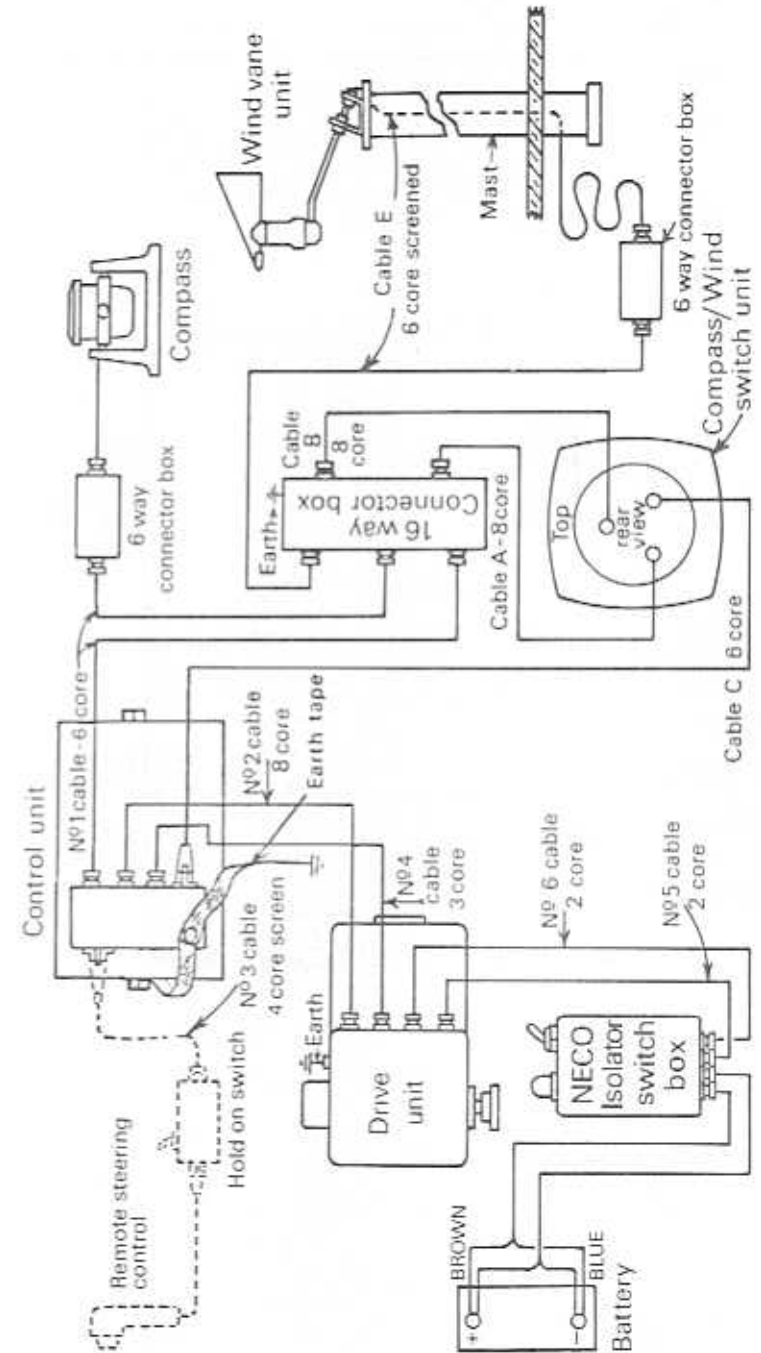


Figure 29
Inter unit wiring

2. **No. 1 CABLE (6-CORE).**

The cable is 10 metres long and is led from the control unit to the 5 entry 16 way connector box and cut at this position. The BLACK lead of this cable is not used and may be cut short. Connect the remaining leads in the 16 way connector box as shown in Figure 30. The surplus length of cable is also connected into the 16 way connector box as shown in Figure 30 and led to the 2 entry 16 way connector box which has been sited adjacent to the Compass and connected as in Section 3.1 Figure 5.

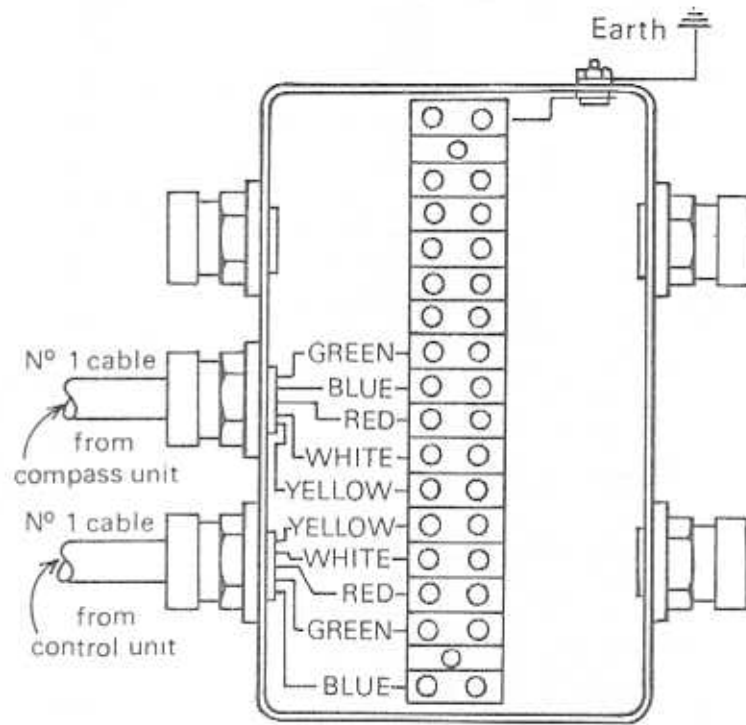


Figure 30

3. **No. 3 CABLE (4-CORE SCREENED)**
(Fitted only when a Remote Steering Control is supplied)
As in Section 3.3 or 3.4.

4. **No. 2 CABLE (8-CORE) & No. 4 CABLE (3-CORE)**
As in Section 3.5 or 3.6.

5. **CABLE A (8-CORE) & CABLE B (8-CORE)**
Cable A and Cable B are led from the Switch Unit to the 16 way connector box and connected as shown in Figure 31.

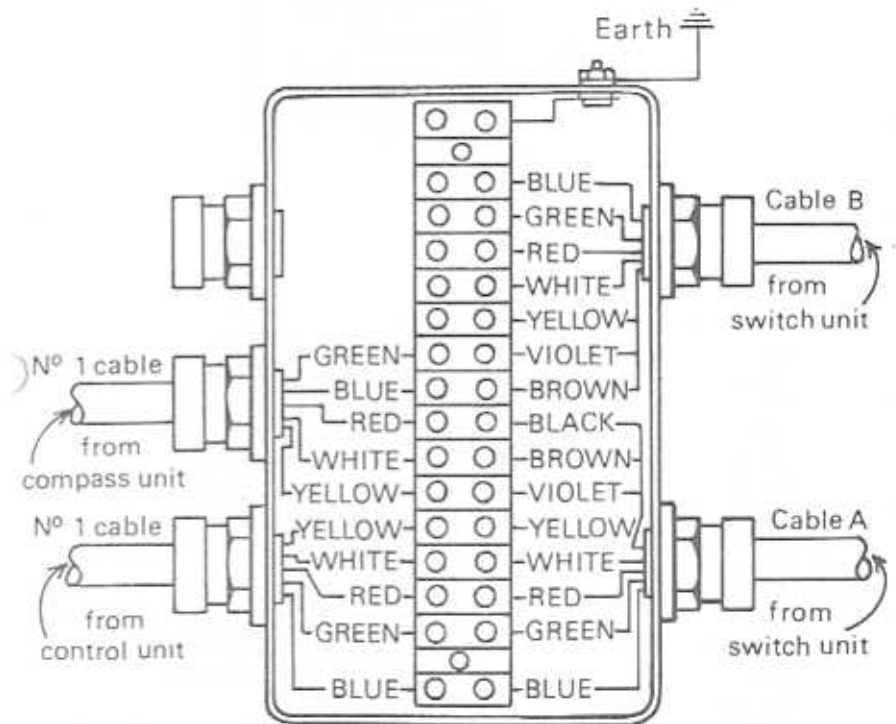


Figure 31

6. **CABLE C (6-CORE).**

Cable C from the Switch Unit is fitted with a plug type RPC 12 P6. This is connected directly into its socket on the control unit plug-in connector as shown in Figure 32.

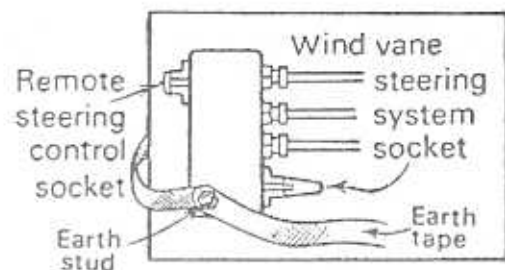


Figure 32

7. **CABLE E (6-CORE SCREENED)**

20 metres is normally supplied fitted to the plug and socket of the Wind Vane, extra length can be supplied on request. The free end is led down through the mast, cut to the required length, (leaving a loop between mast and connector box) and connected into the 2 entry 6 way connector box sited adjacent to the mast step.

Grommets should be fitted where the cable enters and leaves the mast to prevent chafing. One end of the surplus 6 core cable is then connected like colour to like colour, screen to screen in the connector box as shown in Figure 33.

NOTE: If the Wind Vane Unit is mounted facing AFT the RED and WHITE leads from the Wind Vane should be interchanged in the 2 entry, 6 way connector box at the base of the mast.

The other end is led to the 5 entry 16 way connector box and connected as shown in Figure 34.

The BLACK lead of this cable is not used and may be cut short. It should be noted that the screen of Cable E is connected to the earth terminal in the 16 way connector box, which should be connected to the Ship's Earth or to the terminal of the battery, which is connected to the Ship's Earth.

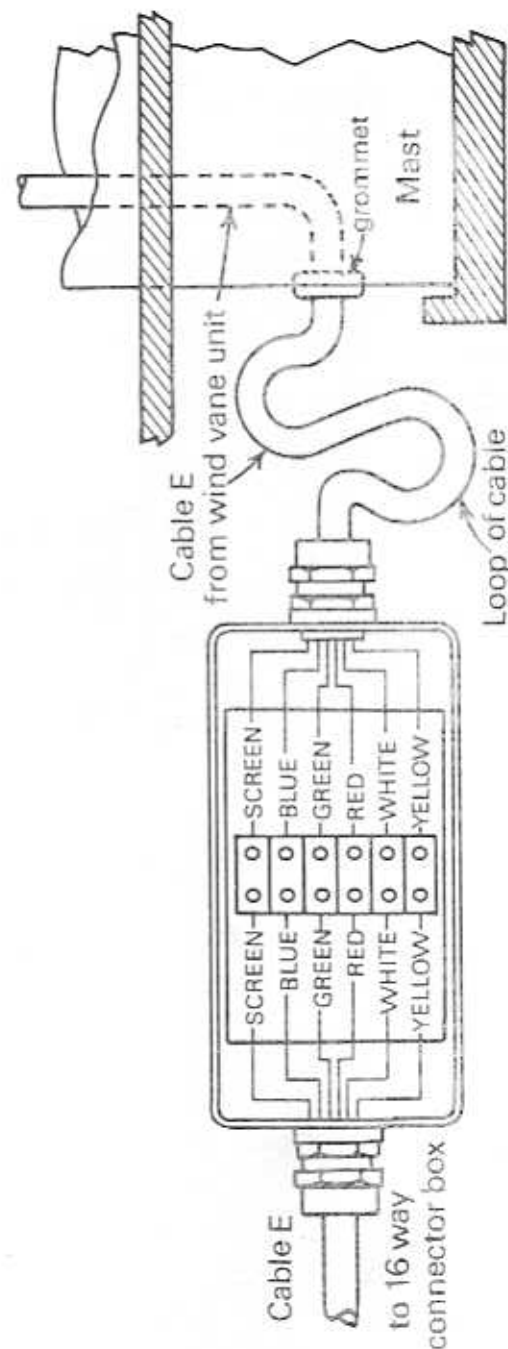


Figure 33 showing connection of cable E at base of mast

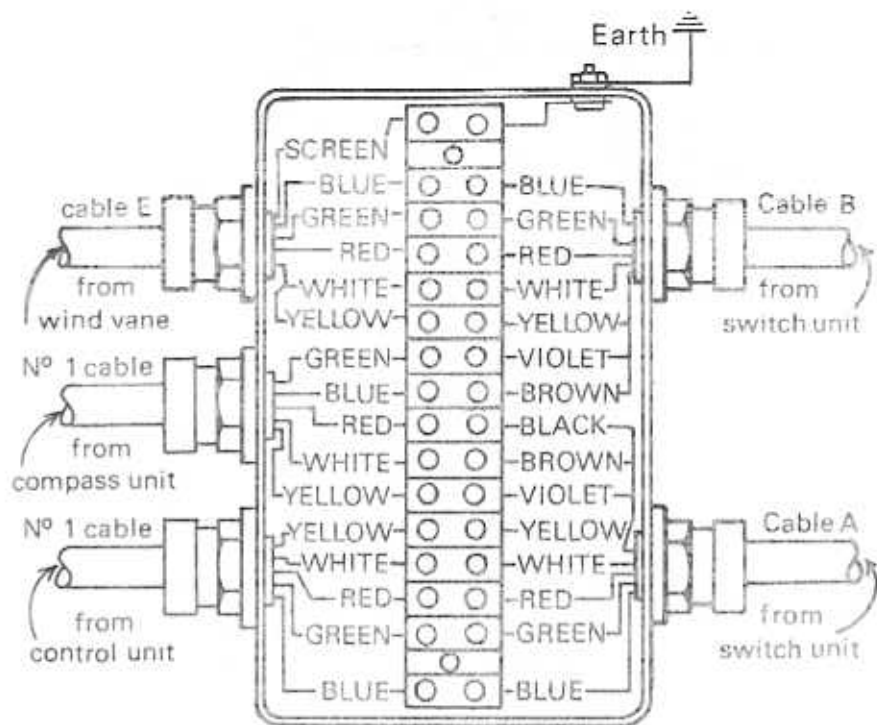


Figure 34

8. **POWER SUPPLIES - No. 5 & No. 6 CABLES**
The remaining cables No. 5 and No. 6 are connected as in Section 3.7 to 3.10.
9. **POWER HYDRAULIC SYSTEMS**
If the system is power hydraulic, Cables 7, 8 and 9 are connected as described in Section 7.

8.5 LINING UP THE SYSTEM (ALL CATEGORIES)

1. Put the Wind Vane Steering System, Switch Unit, Compass/Wind Switch to Compass.
Then proceed as in:-
Section 4 for Normal Mechanical Systems.
Section 6 for Systems fitted with Rudder Feedback Unit.
Section 7.16 for Power Hydraulic Systems.
2. Providing the Wind Vane Masthead Unit has been correctly aligned to the fore and aft line of the craft, and the setting up procedure defined in the relevant section of 8.5.1 has been adhered to, then no further alignment should be required. With the Switch Unit set to Wind, Trim to 0, and Course Setter to 0, then with the wind dead ahead and the pilot switched on the rudder should run to and be held at amidships. Movement of the Course Setter to the right should command starboard rudder and to the left port rudder. Small errors may be adjusted by slewing the wind vane bracket.

SECTION 9

9.1 OPERATING INSTRUCTIONS

Switch ON the Isolator Switch (or Switches).
The autopilot is now available for immediate use.

9.2 TO STEER BY AUTOMATIC PILOT

Set: The Course Setter to the Course to be steered.
Trim Control to 0.
Rudder Control to 5.
Sensitivity Control to its Mid position (12 o'clock).
Ensure that the steering gear is free.

Put the ON/OFF switch on the Control Unit to ON. The drive unit magnetic clutch will now engage and the craft will be steered by the automatic pilot to the course set.

9.3 ADJUSTING THE CONTROLS FOR OPTIMUM PERFORMANCE

1. RUDDER CONTROL

Adjust the Rudder Control at the lowest setting which gives the most satisfactory steering. If the control is set too high, excessive rudder is applied the craft will oversteer and weave about the set course. With too low a setting, rudder applied may be insufficient to bring the craft onto the set course.

2. TRIM CONTROL

This applies rudder irrespective of the position of the Course Setter and Rudder Control.
To set the Trim Control:
Check that the Trim Control is at 0.
Set the Rudder Control to 10 or highest setting which gives a reasonably steady course, note the mean course actually steered. Then set the Rudder Control to 1. If the mean course steered alters — adjust Trim Control to regain course. Reset the Rudder Control to 5. The amount of Trim setting required is likely to vary with alterations in speed and/or relative wind speed and direction.

3. SENSITIVITY

Adjust the Sensitivity Setting to reduce yawing. With a low setting the craft may yaw to some degree but battery consumption will be reduced.

9.4 TO ALTER COURSE.

Reset the Course Setter to new course to be steered. It is not necessary to switch off the pilot when altering course. (It should be noted that for a course alteration of more than 180°, the autopilot will apply rudder to turn in the most direct direction towards the new course).
Reassess Trim Setting.

9.5 TO STEER BY REMOTE STEERING CONTROL (IF FITTED).

Depress the switch on the Remote Steering Control Handle and maintaining the pressure, turn the Control Knob for the required amount of rudder. All controls except Trim on the Control Unit are inoperative while the Remote Steering Control Switch is depressed.
When the R.S.C. switch is released, the craft will regain the course set on the control unit. If a 'Hold On' switch is fitted the R.S.C., is operative whenever this switch is in the ON position.

9.6 OPERATING THE CRASH SWITCH (IF FITTED).

Push the Crash Switch Push Button. This will switch OFF the Autopilot and disengage the drive unit from the steering gear. To reset and steer by autopilot, switch OFF at the Control Unit. Then switch ON at the Control Unit and the craft will then regain the course set.

9.7 OPERATING THE WIND VANE STEERING UNIT (IF FITTED).

1. Switching from Compass to Wind.

Note the angle on the bow of Relative Wind that the craft is required to steer. Put the Trim Control to 0. Set the Switch Unit to Wind and immediately set the course setter to the angle on the bow of the Relative Wind. (See Figure 26).

The Sensitivity Setting should be left set to the setting determined for the prevailing conditions as in 9.3.4.

The Delay setting should be adjusted to damp fluctuations of the Wind Vane due to small changes in wind direction, bearing in mind that the higher the delay setting (clockwise) the more battery consumption is reduced. No change in Rudder setting should be necessary.

2. Switching from Wind to Compass.

Note the Compass course required to steer. Set the Switch Unit to Compass and immediately set the Course Setter for the course required.

Readjust the Control Settings as in 9.3.

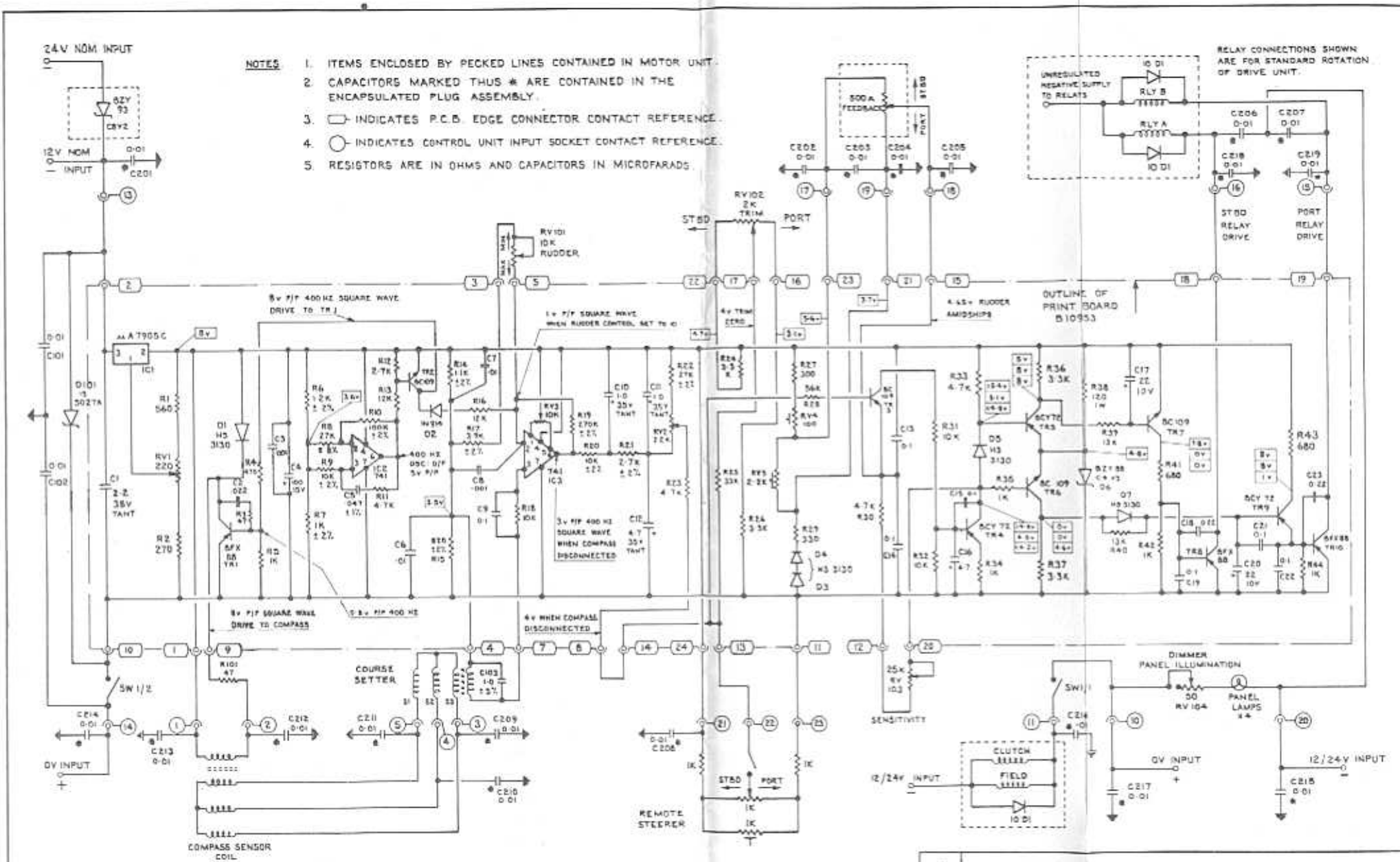
SECTION 10

SERVICE DATA. DESCRIPTION OF THE CIRCUIT FUNCTION THE CONTROL CIRCUIT – SCHEMATIC DIAGRAM B10971

Applicable to units with Control Unit Serial No's that have the suffix S.

1. Integrated Circuit IC1 is an internally referenced Closed Loop Voltage Regulator, the output of which is adjusted to 8v by means of RV1.
2. IC2 is wired as a 400Hz square wave oscillator, positive feedback to maintain oscillation being derived by the feedback chain comprising R11 and C5. The output from the oscillator drives transistors TR2 and TR1, the latter driving the compass excitation coil with an 8v peak to peak square wave via the current limiting resistor R101. Waveform pattern No. 1 shows the waveform developed across the excitation winding and departs from the square wave drive due to the inductive nature of the winding. The switching speed of the transistor TR1 is degraded by resistor R3 and capacitor C2 connected base to collector and radiated R.F.I. on the compass lines is held to an acceptable level. The effect of the excitation current and the compass magnet combined, upon the core of the compass coil is to produce a change of magnetic flux which generates voltage waveform pattern No. 2 on page 5a across any pair of the three output terminals. Each of the three voltages so obtained is variable in amplitude, dependent upon compass magnet position, and phase displaced from its neighbours. Thus a unique pattern is obtained for every position of the compass magnet.
3. The three voltages are fed to the stator of a synchro control transformer and develop a voltage in the rotor of similar waveform. The amplitude of the rotor voltage is dependent upon the relative angular displacement between the compass magnet and the control transformer rotor, with respect to the null or 'on course' position at which the rotor output goes through zero and an 180 degree phase change with respect to the energising square wave. Two such zero output states occur during rotation of the synchro rotor or the compass through 360 degrees, only one of which will allow stable autopilot operation due to the function of the phase sensing part of the circuit.

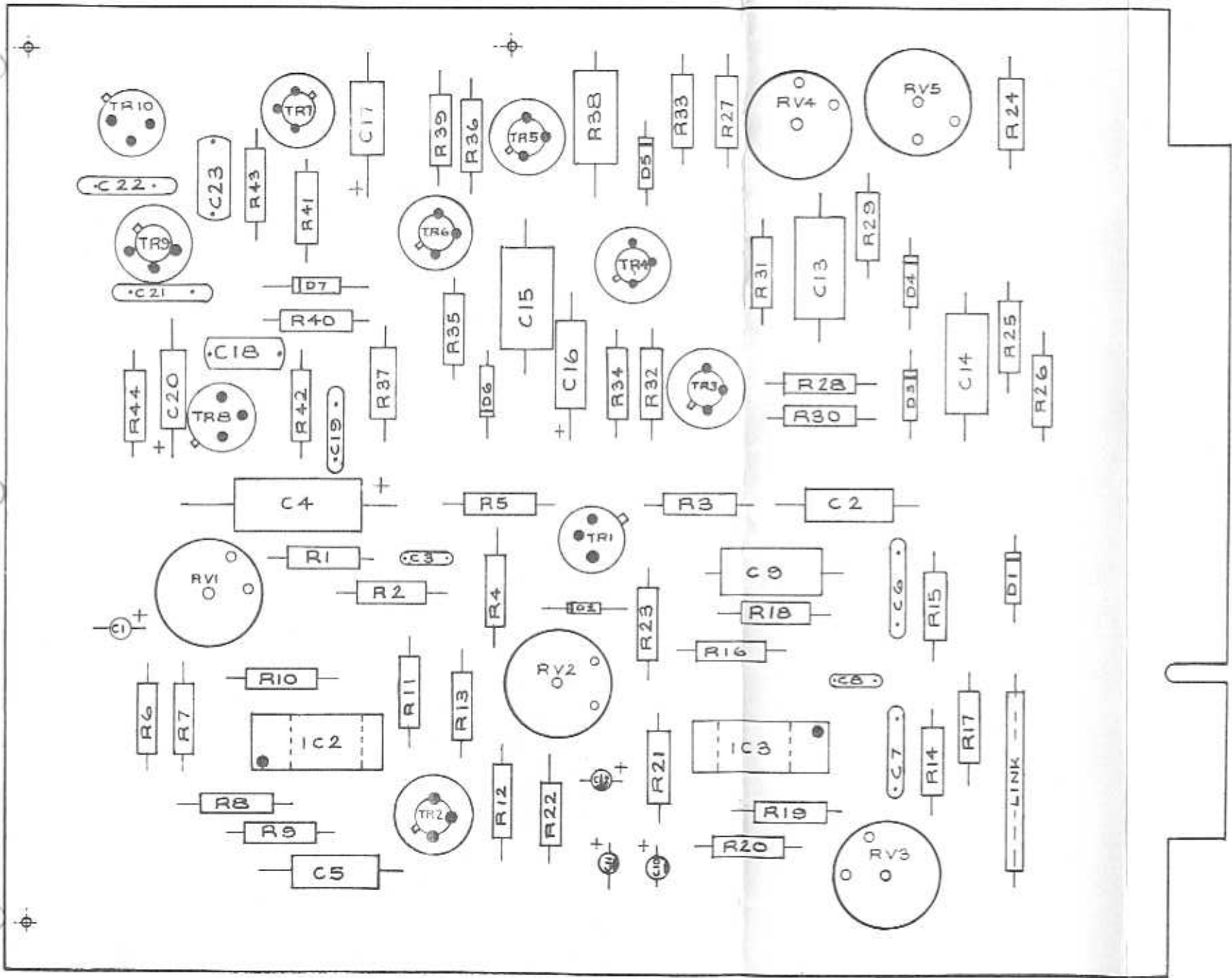
4. Thus for every angular setting of the synchro control transformer in the course setter, there will be a unique compass heading on which the system will zero and be stable. To obtain a useful output from the rotor, the latter is tuned to 400Hz by a 1 mfd capacitor to give the output shown by waveform pattern No. 3 on page 5a. This waveform is fed to and amplified by the decoder IC3, the amplification function being modified by the action of TR2 via diode D2 which impresses a 400Hz negative going square wave onto the inverting input of IC3. The effect is to saturate the amplifier, driving the output positive during the 'on' time of TR2, thus preventing amplification of the synchro output during this time. The amplifier output will be a series of negative going pulses of amplitude dependent upon the synchro output as shown by waveform pattern No. 5 on page 5a. It may be seen that the effect of the superimposed square wave is to render the decoder sensitive to the phase of the synchro output, in one state amplifying the negative going half cycles and in the other state, the positive. The rudder control, which sets the amount of rudder applied to correct for a given course error, adjusts the gain of the decoder IC3.
5. The network comprising R20, R21, R22, C10, C11, C12 and RV2 smooth the amplified output giving a variable amplitude d.c. at the wiper of RV2, which is set such that its output is midway between the 8v regulated lines with zero output from the synchro rotor, i.e. when compass disconnected. An adjustable d.c. level is obtained from the trim control network R24, R26 and the 2 kohm potentiometer to provide a steady bias on the rudder to counter wind, propeller effects, etc.
6. The two signals, so far obtained, are summed algebraically in the network formed by resistors R23 and R25 and the resultant signal fed to the base of TR3, the comparator transistor; in which it is compared with the voltage obtained from the rudder position feedback potentiometer. Diodes D3 and D4 in the feedback chain provide compensation for temperature drift in the comparator TR3. In the 'rudder stationary' state the output from TR3 is such that transistor TR4 is biased to a condition in which both transistors TR5 and TR6 are 'off', the emitters for both TR5 and TR6 being held at 4.8v by the zener diode D6. When a change in rudder position is commanded, the comparator will change the bias on TR4 causing either TR5 or TR6 to switch 'on', driving the amplifiers TR7 or TR9, and, in turn switching the relay driving transistors TR8 or TR10, respectively.
7. Variation of autopilot sensitivity to course error is achieved by varying the overall gain of TR3 and TR4, using a negative feedback network consisting of R30 and the 25 kohm sensitivity potentiometer.



- NOTES**
1. ITEMS ENCLOSED BY PECKED LINES CONTAINED IN MOTOR UNIT.
 2. CAPACITORS MARKED THIS * ARE CONTAINED IN THE ENCAPSULATED PLUG ASSEMBLY.
 3. □ INDICATES P.C.B. EDGE CONNECTOR CONTACT REFERENCE.
 4. ○ INDICATES CONTROL UNIT INPUT SOCKET CONTACT REFERENCE.
 5. RESISTORS ARE IN OHMS AND CAPACITORS IN MICROFARADS.

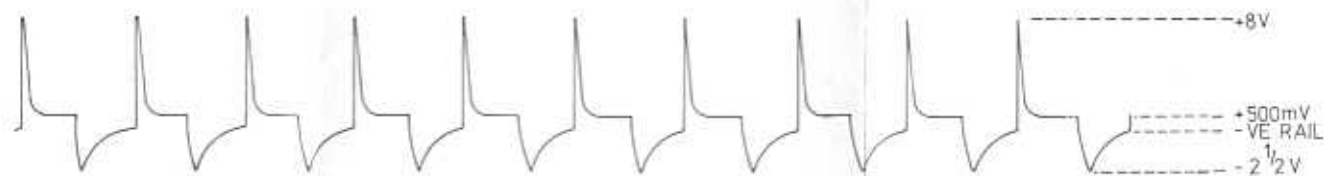
- NOTES**
6. $\overline{\text{---}}$ INDICATES SUBSTANTIALLY STEADY VOLTAGE OF VALUE SHOWN AT THIS POINT.
 7. $\overline{\text{---}}$ INDICATES VOLTAGE AT THIS POINT WITH STARBOARD RUDDER DEMAND
 --- ZERO
 --- PORT
 8. DC VOLTAGE MEASUREMENTS TO BE TAKEN WITH A VOLTMETER OF 20 K Ω /V SENSITIVITY & ARE WITH RESPECT TO POSITIVE LINE

A	NM 692(s) CONTROL UNIT CIRCUIT DIA.
ORIGINAL ISSUE	
26	
11	B 10971
76	



NM 692 (S)
 CONTROL UNIT
 P.C.B. ASSEMBLY
 B 10953

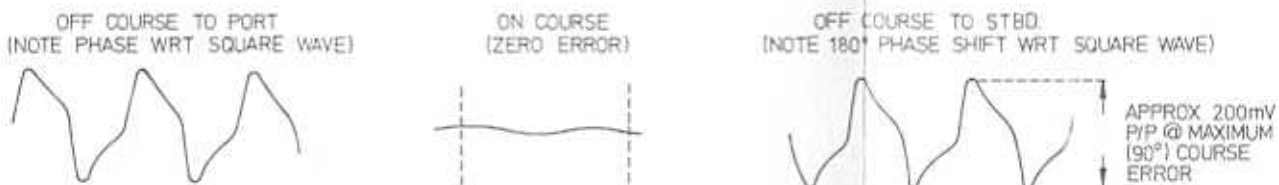
① 400 HZ PULSE TRAIN GENERATED BY IC2 AND APPLIED TO COMPASS EXCITATION WINDING VIA TR1.



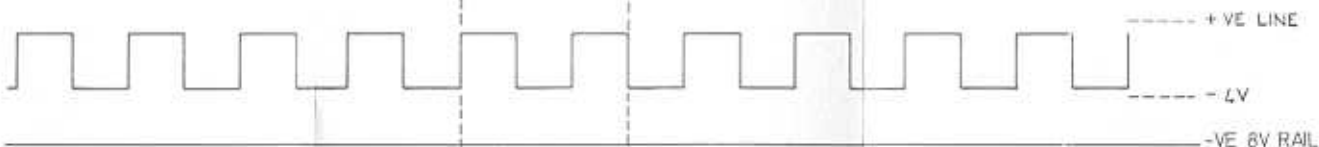
② WAVEFORM APPEARING ACROSS COMPASS OUTPUT WINDINGS. COLOUR CODE ORANGE/GREEN, GREEN/BLUE, OR ORANGE/BLUE IN COMPASS CONNECTOR BOX. AMPLITUDE IS VARIABLE AND DEPENDENT UPON COMPASS HEADING.



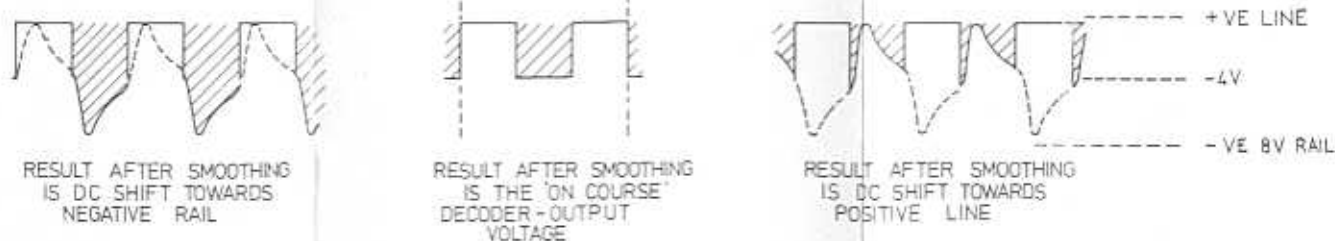
③ WAVEFORM ACROSS CONTROL TRANSFORMER OUTPUT WINDING, CONNECTIONS 1, 6, 7 ON CONTROL BOARD EDGE CONNECTOR. OUTPUT IS VARIABLE IN AMPLITUDE AND PHASE AND IS DEPENDENT UPON COURSE ERROR.



④ DECODER OUTPUT, IC3 PIN 6, DUE TO REFERENCE SQUARE WAVE THIS WAVEFORM APPEARS WHEN COMPASS IS DISCONNECTED OR WHEN THERE IS ZERO COURSE ERROR.



⑤ RESULTANT WAVEFORM AT DECODER OUTPUT, IC3 PIN 6, WHEN INPUTS COMPRISING COURSE ERROR WAVEFORM ③ AND REFERENCE SQUARE WAVE ARE APPLIED SIMULTANEOUSLY TO IC3 AND ALGEBRAICALLY SUMMED.



COMPASS AND CONTROL BOARD DECODER WAVEFORMS	A
B11033	ORIGIN ISSUE L12. 76.

REFER TO CIRCUIT DIAGRAM No. B10971