

'PINTA' AUTOMATIC PILOT

General Description

The 'Pinta' Automatic Pilot is intended to relieve the human helmsman when making long voyages or to enable him to leave the wheelhouse for short periods in the knowledge that the desired course will be held accurately in his absence. The course should be frequently checked by the look-out.

The Pilot is a proportional control, non-hunting type for ships with direct mechanical or hydraulic steering systems. Course error information is provided by the Heading Unit having a fluid filled, gimbal mounted magnetic compass. A lamp mounted above the bowl illuminates two photo cells fixed to the mounting plate beneath the bowl. When the card is symmetrically disposed one half of the sensitive area of each cell will be illuminated (this is the 'line up' position with the ship on course). If the bowl moves, due to a change of course, one cell will increase its illuminated area and the other decrease it. The out of balance signal is conveyed to the Control Unit, which in turn controls the Steering Motor via a step-up relay system. Proportional steering is accomplished by rotating the compass bowl and gimbal assembly against the turn of the ship by way of a flexible drive from the Steering Motor. The gearing to this drive determines the amount of helm put on and is selected at installation to provide the correct amount.

A simple, robust clutch mechanism, either fitted to the steering wheel (Clutch-on-Wheel) and controlled by a hand wheel at the centre, or a Remote Clutch operated by a lever on the Remote Clutch Control Box, when engaged, provides the link between the ship's steering and the Automatic Pilot Steering Motor.

An Integrating Unit providing fully automatic standing helm to compensate for 'hydraulic slip' and change of trim, is fitted when necessary to ships with hydraulic steering systems.

The Pilot is voltage stabilised and will maintain its settings with supply variations of from minus 10% to plus 20% of nominal voltage.

'PINTA' AUTOMATIC PILOT

Method of Operation

To Set Course

Switch on the Pilot and steady the ship on approximately the required course. When the Steering Motor stops turning the Pilot has 'lined up' on course and the Clutch may be engaged. Where a Remote Clutch is fitted this condition will be indicated by the coloured light on the Remote Clutch Control Box going out.

To Engage Clutch

With a Clutch-on-Wheel the hand wheel at the centre of the steering wheel is turned clockwise until the clutch grips. With a Remote Clutch the hand lever on the Control Box is moved to the engaged position.

When the Clutch is first engaged the Pilot will maintain a course close to that desired. To make small trimming adjustment to correct the course exactly, the Clutch may be momentarily released and a small movement of the wheel, one or two 'spokes' usually, put in and the Clutch immediately re-engaged. If conditions are rough and frequent running off the Motor makes this difficult the Pilot may be switched off while the Clutch is released. The amount of adjustment is quickly found by experience and is very easily obtained.

Where the Integrating Unit is fitted to a ship with hydraulic steering, this procedure does not apply, as the Unit will automatically provide any standing helm required to keep the course at the moment of engagement.

To Make a Large Alteration of Course

The Clutch should be disengaged and the ship steered on the new course, the Pilot may then be re-engaged as above.

Avoiding Action

In order to avoid an obstruction without disturbing the clutch (course) setting the Pilot may be switched off and the ship steered by hand with the Clutch still engaged. It is necessary to ensure where a Clutch-on-Wheel type is fitted, that the Clutch is firmly engaged as if it slips during this manoeuvre the original course will not be resumed when the

Pilot is switched on again. Providing the wheel is turned slowly to reduce the effect of inertia of the Motor, the ship can be steered quite easily by hand while the avoiding action is taken. It is advisable to restore the ship to approximately the same heading before switching on the Pilot again in order to avoid making an unnecessarily sharp turn when the Pilot restores to the original course.

Remote Push Button Control

Where this is fitted avoiding action may be undertaken by switching to HAND and controlling the ship from the push buttons. When it is desired to resume course the switch on the Control is put back to AUTO and the Pilot will restore the course. Withdrawing the Remote Control lead plug from the front of the Control Unit returns the set to 'Autopilot' and care should be taken not to do this after manoeuvring on HAND as the Pilot will attempt to restore the original set course.

Sensitivity Control

A knob control is provided at the upper left hand side of the Control Unit which provides adjustable tolerance for yaw before the Steering Motor attempts correction. In smooth conditions it may be advanced clockwise to make the Pilot responsive to small errors. In rough conditions it should be turned anti-clockwise until the frequency of Motor movements is reduced to that necessary to provide an acceptable course. Current consumption and general wear can be greatly reduced by operating this control as far anti-clockwise as possible while preserving a satisfactory course.

Overload Protection

A thermal overload switch is provided to cut off the supply should the Steering Motor be stalled or overloaded. When it has operated the Motor can be restored by pressing the red button on the right hand side of the Control Unit, after a period for cooling.

'PINTA' AUTOMATIC PILOT

Quick Serviceability Checks

On switching 'on', the Motor should run until the equipment has 'lined up' with the ship's heading and stop. If it is likely that it is already 'lined up', engage the Clutch and rotate the wheel one turn, on switching the Pilot 'on' the wheel should return to about the same position as when the Clutch was engaged. If under way, the Motor should run momentarily if the course is altered, if not check as follows:-

If coloured indicator lamp on Control Unit is out check power supply and cartridge fuses.

If supply is present but no Motor action, check overload button beneath on-off switch (press to re-set) and right hand fuses.

If correct, and plug on Standard Motor is pushed home and flexible drive correctly engaged, check compass exciter lamp above compass bowl. If lamp does not light when the equipment is switched on, replace the lamp (see Heading Unit Service).

If no result is obtained when the exciter lamp is restored the relays in the Control Unit should be checked. The Motor should run when either one of the two Motor relays is closed by hand. If the Motor fails to run when this is done, the brushes and armature should be checked (see Motor Unit Service).

If the Remote Push Button Control (where fitted) operates the Motor on HAND the intermediate plug in relays are serviceable. (Note: that in 110 volt sets the upper plug in relay, which may be marked with a red spot, is rated at 100 volts and is not interchangeable with the two beneath it which are operated by a 24 volt line).

If the set does not 'line up', though all relays appear operative, the semiconductor switch may be faulty and a replacement plugged in.

If the Pilot works satisfactorily but suddenly develops a tendency to make an erratic course, check that no magnetic object (transistor radio, hand bearing compass, tools etc.) has been placed near the Heading Unit.

In case of difficulty contact the manufacturers who will be pleased to advise and service where possible.

'PINTA' AUTOMATIC PILOT

Clutch-on-Wheel

The Clutch, when fitted directly to the steering wheel, mounts a large diameter sprocket on a special boss at the back of the wheel. This sprocket is free running until pressure is applied to it from a back plate which is drawn on to it by studs passing through the steering wheel and boss and tensioned by a hand wheel, mounted in front of the steering wheel, at the centre. The drive is by chain to the large sprocket direct from a small sprocket on the Steering Motor. The Clutch disconnects the chain drive completely when disengaged. This mechanism is robust and simple and only requires occasional oiling.

To dismantle the Clutch to enable the wheel to be removed, the 3 (or 4) studs must be released by slackening and taking off their lock nuts, which may be behind the back plate, or on the front housing. The Clutch operating hand wheel should not be forcibly unscrewed as its removal does not dismantle the assembly.

Remote Clutch Control for 24 V. Heavy Duty and 110 V. Motors

This is an alternative to the Clutch-on-Wheel system. Two clutch plates with a cork friction disc between (or a pair of toothed plates) are fitted to the steering motor and compressed by two clutch arms using a Bowden Cable system. Control is by a hand lever on the Remote Clutch Control Box mounted adjacent to the steering wheel.

When the Steering Motor stops running the coloured indicator lamp on the Clutch Box goes out and the Clutch may be engaged. The lever operates a micro switch when in the engaged position which disconnects the lamp. On hydraulic type steering systems where the Integrating Unit is fitted, it also changes over the Pilot from the 'set' to 'steer' condition.

The drive is by chain from a small sprocket on one clutch plate to a large sprocket fixed on the steering wheel shaft or to an intermediate shaft where more convenient.

The thrust races and linkage on the clutch plate assembly and inner Bowden Cable should be oiled occasionally.

Remote Clutch Control for 12 V. and 24 V. Standard Motors Type 6M

The Standard Motor is fitted with a pair of toothed clutch plates inside the Motor, and operated by a Bowden Cable system and hand lever on the Remote Clutch Control Box, engagement as above (paragraph 4). See also notes on Standard Motor page 6 and Drawing SM6.

The coloured indicator lamp in the Remote Clutch Control Box uses a 12 volt miniature L.E.S. lamp on all Sets.

'PINTA' AUTOMATIC PILOT
The Standard Motor Type 6M

The steering motor for 12 and 24 volt standard equipments consumes about 75 watts and is suitable for steering loads up to 30 ft/lbs at the wheel.

The bevel gears used in the Motor are connected by a flexible drive to the Heading Unit gear box and their ratio can be varied at installation to control the amount of helm applied to correct course deviation. The Motor also operates through this drive to 'line up' the compass head with the course being steered prior to the clutch being engaged.

The Motor either drives directly to a clutch mounted on the steering wheel or layshaft or has a remote operated clutch, manual or electric, mounted inside. The Motor is compound wound and fitted with radio interference suppression condensers, it is connected to the Control Unit by a 6 way cable.

To Service the Standard Motor

For access undo 4 screws holding lid. Check bevel gears are locked on their shafts and engage smoothly. Drive sprocket, internal fixed sprocket or fixed clutch plate must be securely locked to shaft with key and grub screw.

The flexible drive end should rotate freely in the brass housing, lubricate the bevels and steel flexible drive end.

With the clutch in the Motor, the free clutch plate must move easily when the Bowden Cable or Magnetic Clutch is operated and the clutch should freely fall out of engagement when released. Oil thrust race and adjacent shaft lightly.

The gear box is grease packed in its casing and requires no maintenance.

The Motor should be checked for brush wear. Worn brushes may be replaced by removing the brush cover, unscrewing the caps of the brush holders, withdrawing the old brushes and replacing with a new pair. The commutator may be cleaned with carbon tetrachloride to remove grease and soot.

If the commutator is badly worn the armature may be replaced. First remove base/feet by undoing 6 screws, the 5/8 shaft must then be taken out by undoing the end housings, 8 mm chain, fixed sprocket (or clutch plate) circlip(s) and pulling the shaft through the brush end side. Remove brush cover, unscrew connecting leads and the 3 bolts that attach the gear box. The Motor and gear box may then be slid out. Undo the 2 screws at the commutator end and pull the armature out and replace with a new one.

To replace the complete Motor, split the gear box and undo the 3 screws holding the Motor body.

Care must be taken on re-assembly that all washers/parts are put back in correct order, connections are 1 compound +, 2 field +, 3 field -, 4 armature, 5 armature, 6 compound -.

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Heading Unit Type 6

The unit utilises a fully gimballed perspex compass bowl containing a circular magnet assembly with mica shadow card damped by a low viscosity silicone fluid. The upper chamber of the bowl is an air space which allows for thermal expansion and a quantity of free fluid provides damping to reduce random movement due to horizontal acceleration. The bowl is sealed and requires no maintenance. An exciter lamp mounted on the top surface provides illumination for two Cadmium Sulphide photo cells type ORP12 mounted on a paxolin plate beneath the bowl. This also carries two brass weights which are used to balance the bowl across the diameter on which they lie. Balancing in the other horizontal axis is effected by adjustment of the position of the bowl in the inner gimbal ring by means of the brass bearing supports and locknuts. The bearings on both axes are miniature stainless steel ball races and must be set up so that side 'slop' is avoided, but must not be under axial pressure. Connector pigtailed must be carefully dressed to allow free movement and be clear of the cover dome.

The whole gimballed assembly is rotated by a worm type gearbox beneath the base plate and rotating connections are effected through a slip ring beneath the cover.

Service

Access to the unit is gained by removing the cover dome, held by a clamping ring and single tensioning bolt. Some Units have plastic covers which can be pulled off after removing the retaining clips. The exciter lamp should light when the equipment is switched on and replacement should be made as follows:-

12 volt set ... 6.5 volt	.3A	11 mm M.E.S. Lamp
24 volt set ... 12 volt	2.2 watt	11 mm M.E.S. Lamp
110 volt set ... 28 volt	2.4 watt	15 mm M.E.S. Lamp

Bearing and gearbox are lubricated for life on assembly and require no maintenance. The flexible drive shaft and coupling should be oiled annually by unscrewing the union nut and withdrawing. The nut should be only slightly more than finger tight as excessive pressure may rotate the screwed barrel and destroy the worm adjustment. The lock nut against the side of the gearbox should on no account be disturbed.

Heading Unit Type 6 continued

The compass bowl and gimbal assembly can be replaced as a whole by withdrawing the 4 pin flat connector on the slip ring cover, and releasing the gimbal assembly held by the two 5/16" brass lock nuts at the centre. If the Unit as a whole is removed, and has been adjusted by fixing magnets to the surrounding woodwork, it must be replaced in exactly the same position subsequently, otherwise the adjustment will be invalidated. The slip ring may be cleaned with petrol or silicone switch cleaner, but carbon tetrachloride or other perspex solvent must not be used. Re-lubricate lightly with Silicone grease M.S.4.

Compass Adjustment

Where the compass is subject to magnetic deviation it must be corrected by the following procedure.

Remove the cover dome and switch on the equipment with the clutch released. When the motor has stopped the compass will be aligned to the direction of the ship. A northerly course should be steered manually, using the ship's steering compass, which should have been previously adjusted, and known to be accurate. The north south axis of the pilot compass lies on a line axial with the exciter lamp and along the gimbal arms. Magnet(s) should be placed athwartships, having the centre on the fore and aft line through the centre of the heading unit, until the gimbal arms are along the fore and aft line. The correction should be checked on a southerly course, and where a different value of correction appears necessary, the error should be halved between south and north by moving the magnet from its initial position. The procedure must be repeated on east and west, this time placing magnet(s) along a fore and aft line, have their centre on the athwartships line passing through the centre of the unit. Differences between the two directions should be halved as before. Where a magnet is mounted on the unit collar which carries the dome, the collar can be rotated relative to the base, by slackening the three 3/16" Allen grub screws at the lower edge and retightening when it is positioned correctly.

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Control Unit Type 6

Power is brought in on pins 11, (positive) and 12 (negative) of the 12 way plug and passes via the two left hand general fuses to the on-off switch. The switched supply is split and taken in one case to the Steering Motor field and in the other to a thermal overload switch in the positive line. It is then again split, one supply going to the compound winding of the Motor and the other to the lower rated fuses supplying the Heading Unit and relays.

Fuse ratings are as follows:-

12v set, 2 lt.hand side - 3 amp, 2 rt.hand side - 10 amp
24v Standard set, 2 lt.hand - 1 amp, 2 rt.hand - 5 amp
24v Heavy Duty set, 2 lt.hand - 1 amp, 2 rt.hand - 10 amp
110v set, 2 lt.hand - 1 amp, 2 rt.hand - 5 amp.

The Motor is protected on being stalled by the thermal overload switch which breaks the armature supply and also the relays and indicator lamp supplies, thus giving warning of failure. The switch may be reset by pressing in the red button after an interval for cooling.

Signals from the compass head photo cells are fed in on pin 2 (12 way) and are taken to the semiconductor switch mounted on an octal socket (input pin 1). This functions as a bridge detector, the two photo cells forming one side and a resistor network mounted above the on-off switch the other. Movement of the compass card causes a change in the relative areas of illumination of the cells, producing an out of balance current through the detector. When this exceeds a value determined by the setting of the tolerance control (upper left of the Control Unit, front view) one of the two intermediate relays is closed. This operates two circuits, one supplies current to the Motor control contactors and the other short circuits the preset delay voltage of the tolerance control causing the Motor to restore the Heading Unit approximately to the centre of the operating zone.

The Motor relays are electrically interlocked by taking the solenoid supply for each through a break contact on the other. The intermediate relays are further interlocked so that if both are operated, neither Motor relay is energised. The Motor relays supply a reversing current to the Motor armature, they also apply a brake resistance across the armature to decelerate the Motor quickly when released. A third relay mounted above the intermediate pair is energised by the E.M.F. across the Motor

Control Unit Type 6 continued

armature. This relay closes when the Motor is running and inserts a resistor in the feed to the Motor relay solenoids. This provides sufficient current to 'hold' the relay on, but not to pull it in once released. This prevents the Motor from being reversed until the back E.M.F. generated by the rotating armature has diminished sufficiently to release the third relay. The latter then applies a short circuit across the brake resistor to ensure maximum resistance of the Motor to 'creep' due to pressure on the wheel.

Regulated power supply is provided for the photo cells and exciter lamp by a power zenerdiode acting as a shunt regulator. This operates at 16 volts for the 24 volt set and 8 volts for the 12 volts set. On 110 volt supplies, two zenerdiodes are used in series, the left hand (rear view) operates at 24 volts and is at the positive end of the 110 volt supply. It provides a stable 24 volt line for the photo cells and intermediate relay operation. The right hand 20 volt regulator stabilises the supply to the exciter lamp. A chain of series resistors housed in the heat sink on the front of the Unit provides continuity to the negative line. The panel indicator lamp is shunted across one of these resistors. The heat sink also houses the brake resistors and regulator series resistors on 12 and 24 volt sets.

The semiconductor switch comprises two amplifiers sensitive respectively to positive and negative going signals and the tolerance control applies a bias which must be exceeded to cause operation of the relays. A pair of temperature sensitive resistors form part of the bias chain to compensate for increase of sensitivity with rising temperature.

A preset bias control is fitted behind the power switch to adjust the operate point and provides maximum sensitivity when the two amplifiers just do not operate simultaneously. It is normally set back (anticlockwise) until 'hunting' does not occur when the front tolerance control is at its maximum (clockwise) setting.

The Remote Push Button Control plugs into the latching socket on the front of the unit and can only be pulled out by pressing in the release tab above it, preventing accidental withdrawal. When switched to HAND, either one of the intermediate relays is energised by the push buttons, supply to the auto pilot function being cut off by a switching transistor on the B7G plug.

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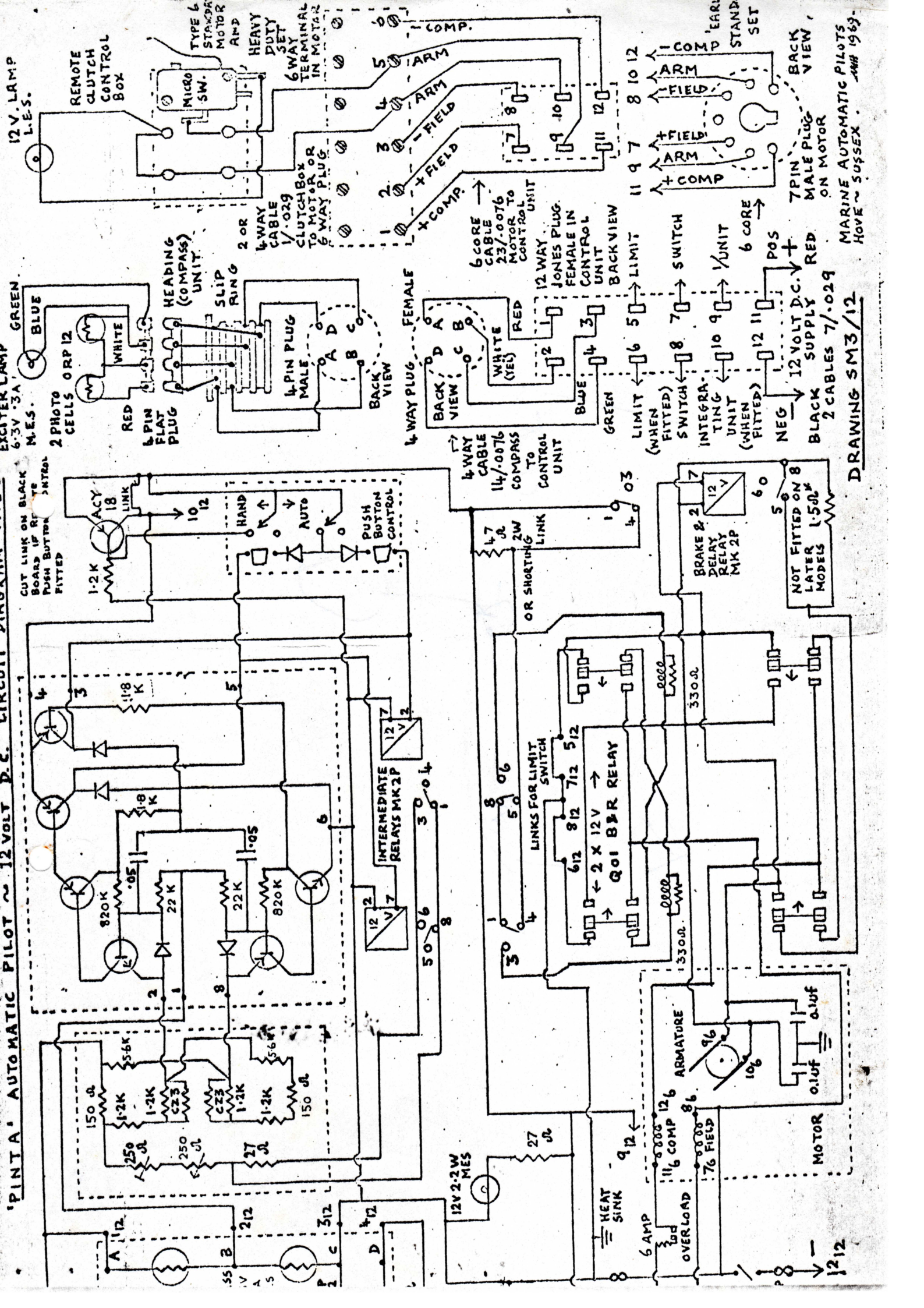
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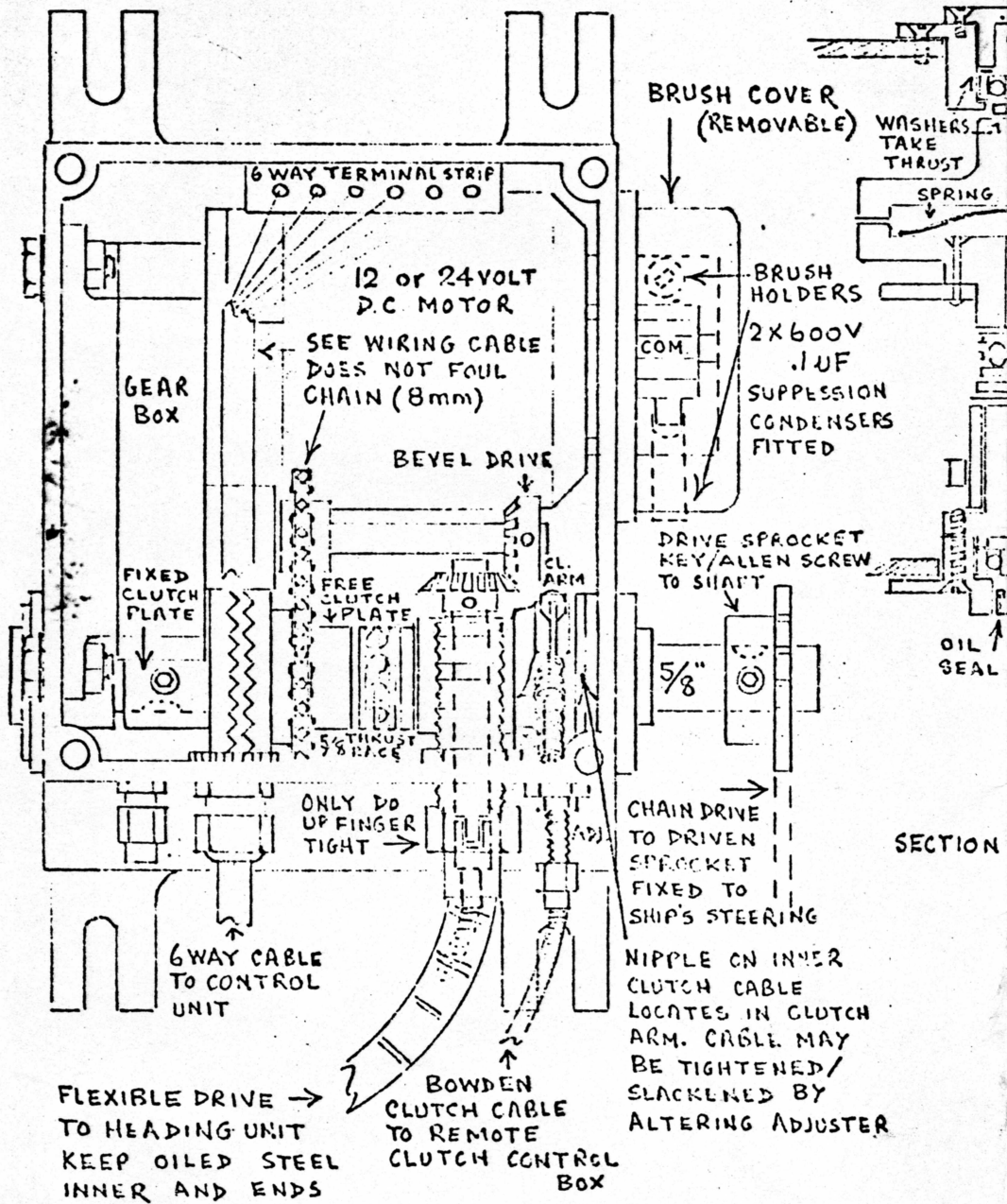
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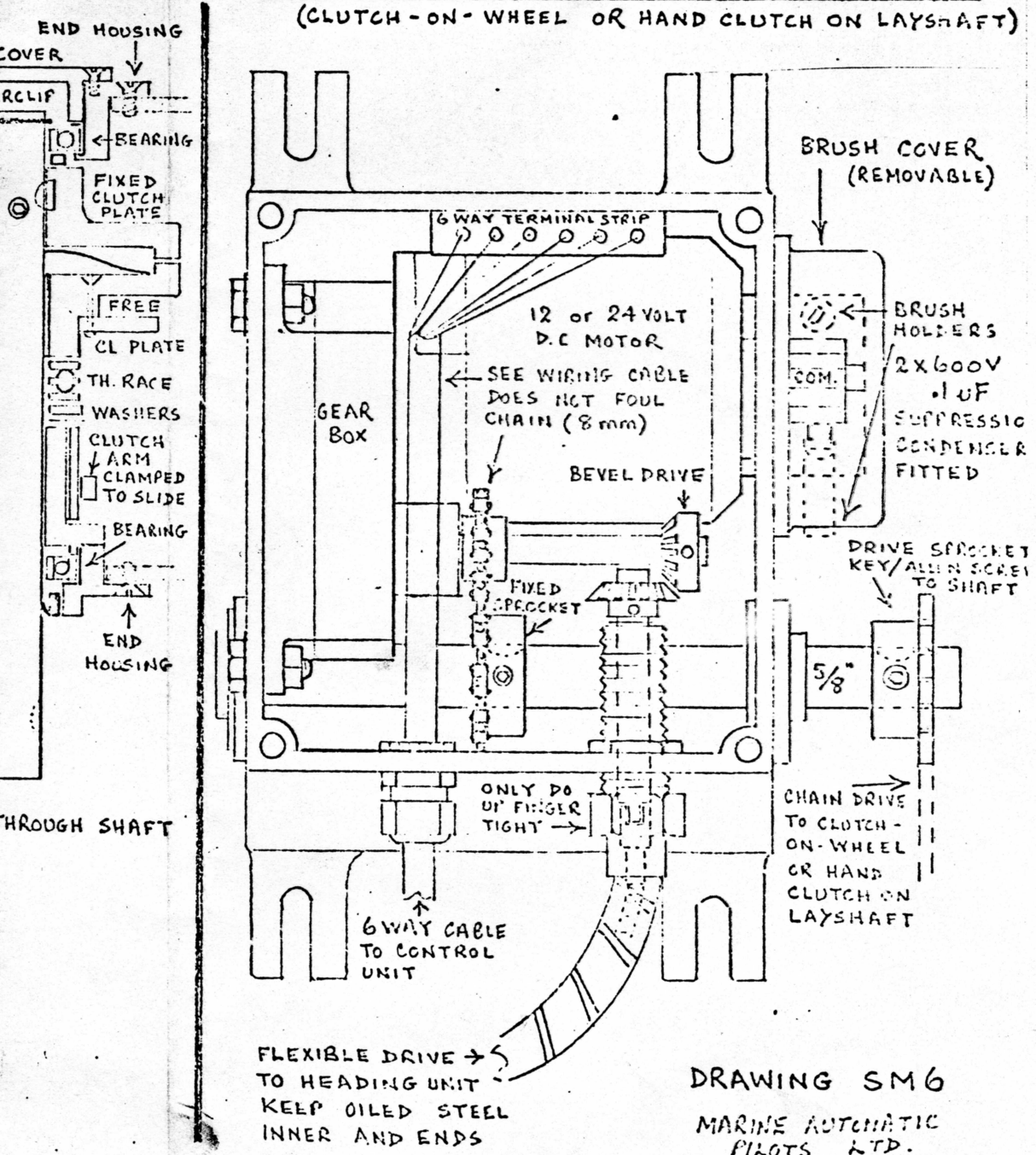
Tel. Torcross 369



A. WITH REMOTE CLUTCH INSIDE MOTOR



B. WITH DIRECT DRIVE TO EXTERNAL CLUTCH
(CLUTCH-ON-WHEEL OR HAND CLUTCH ON LAYSHAFT)



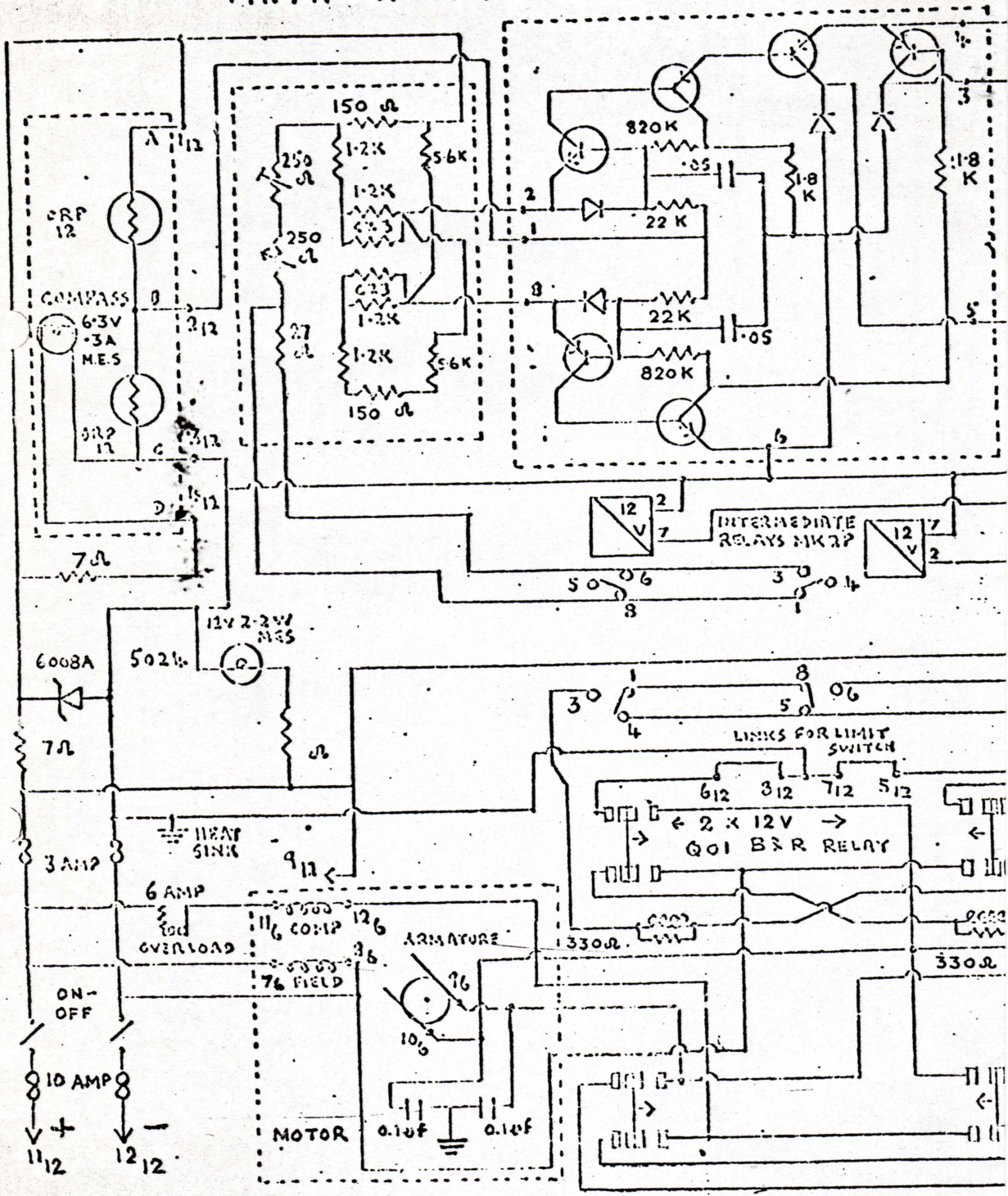
DRAWING SM6

MARINE AUTOMATIC PILOTS LTD.

HH. MAY 1970

'PINTA' AUTOMATIC PILOT ~ 12 VOLT D.C. CIRCUIT

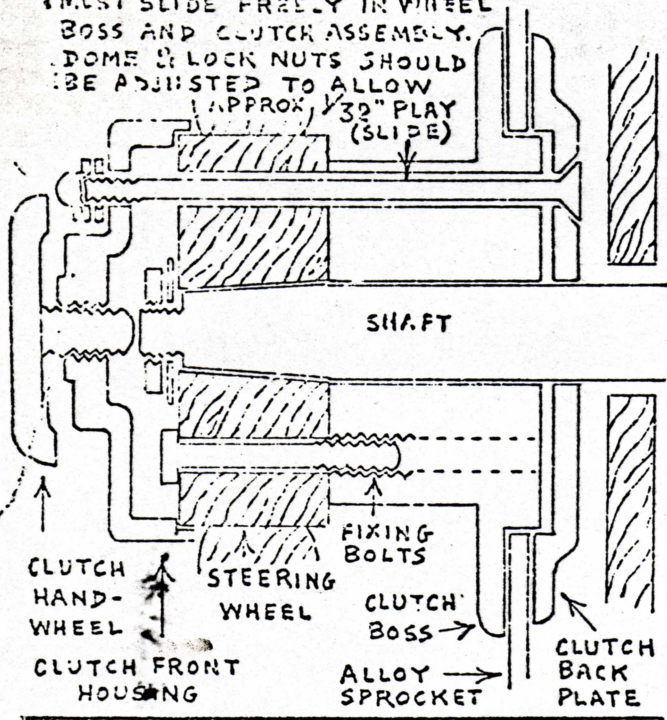
SM 3/12



DRAWING SM2.

CLUTCH BOLTS ~ THESE MUST SLIDE FREELY IN WHEEL BOSS AND CLUTCH ASSEMBLY. DOME & LOCK NUTS SHOULD BE ADJUSTED TO ALLOW APPROX. 1/32" PLAY (SLIDE)

CLUTCH-ON-WHEEL

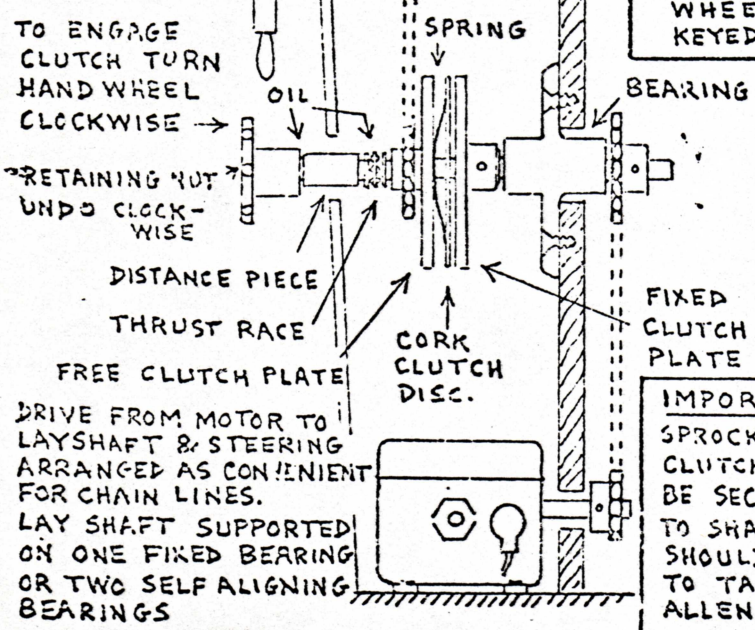


THE CLUTCH BOSS FITTED WITH A FREE RUNNING ALLOY SPROCKET IS MOUNTED BEHIND THE WHEEL AND BOLTED TO IT. BEHIND THE SPROCKET IS THE BACK PLATE, A CLUTCH HANDWHEEL AND HOUSING ARE ON THE FACE OF THE WHEEL.

WHEN THE HANDWHEEL IS TURNED CLOCKWISE IT BEARS AGAINST THE SHAFT AND THE CLUTCH BOLTS PULL THE BACK PLATE AGAINST THE SPROCKET AND BOSS ~ ENGAGING THE CLUTCH.

THE STEERING WHEEL MAY BE REMOVED BY UNDOING THE DOME/LOCK NUTS, REMOVING HANDWHEEL AND FRONT HOUSING AND UNDOING FIXING BOLTS. TO RE-ASSEMBLE SEE ALL PARTS LINE UP AND CLUTCH BOLTS SLIDE FREELY IN WHEEL AND CLUTCH. OIL LIGHTLY. WHEEL/CLUTCH BOSS WILL BE KEYPED/ALLEN SCREWED TO SHAF

HAND CLUTCH ON LAY SHAFT



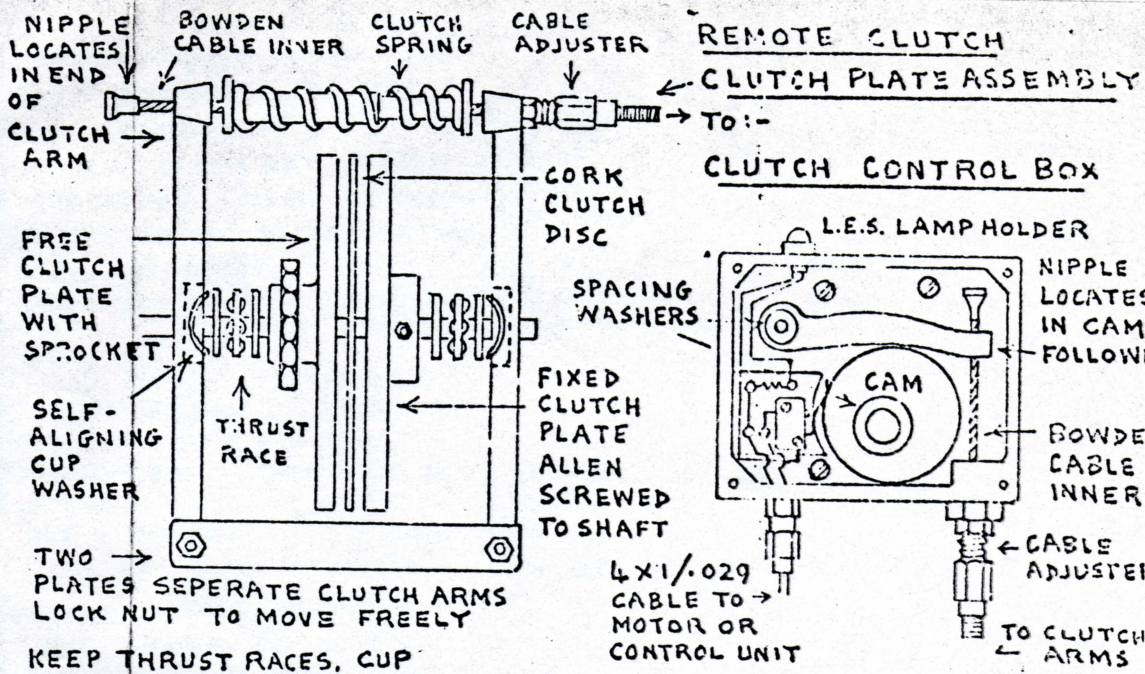
12 AND 24 VOLT STANDARD MOTOR

ENSURE BEVELS WELL LOCKED TO SHAFTS BY GRUB SCREWS AND MESH CORRECTLY

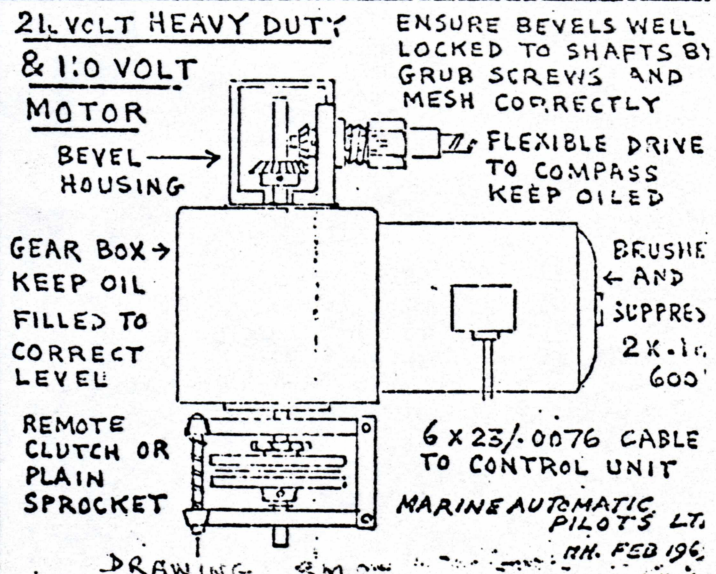
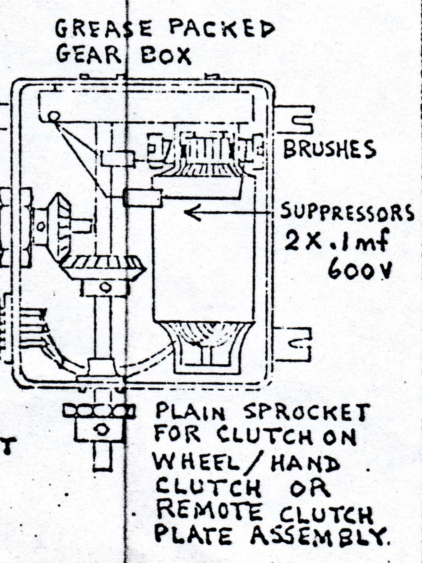
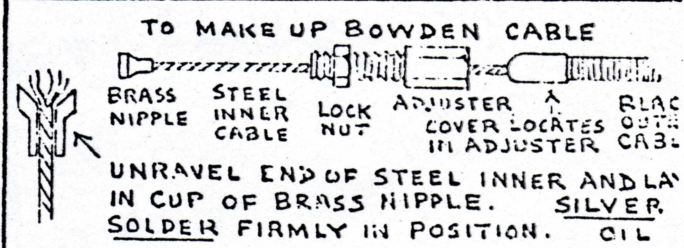
FLEXIBLE DRIVE TO COMPASS KEEP OILED

IMPORTANT ~ ALL SPROCKETS & FIXED CLUTCH PLATES MUST BE SECURELY LOCKED TO SHAFTS, WHICH SHOULD BE DRILLED TO TAKE POINT OF ALLEN SCREW.

7 PIN MALE PLUG
6X23/0076
CABLE TO CONTROL U



KEEP THRUST RACES, CUP WASHERS, SEPERATER PLATE BOLTS WELL GREASED. BOWDEN CABLE OILED. CABLE MAY BE TENSIONED TO INCREASE PRESSURE ON CLUTCH PLATES BY SCREWING ADJUSTERS OUT. OIL CAM, FOLLOWER & SHAFTS ENSURE SPACING WASHERS ARE REPLACED CORRECTLY

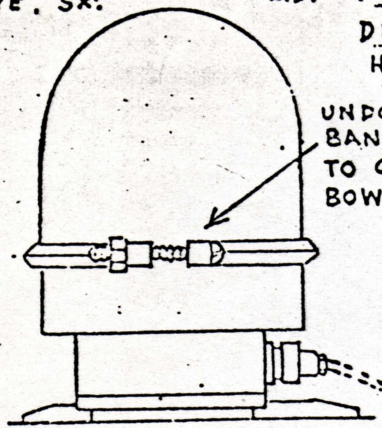


DRAWING 3M2

HEADING UNIT ~ TYPE 6 COMPASS

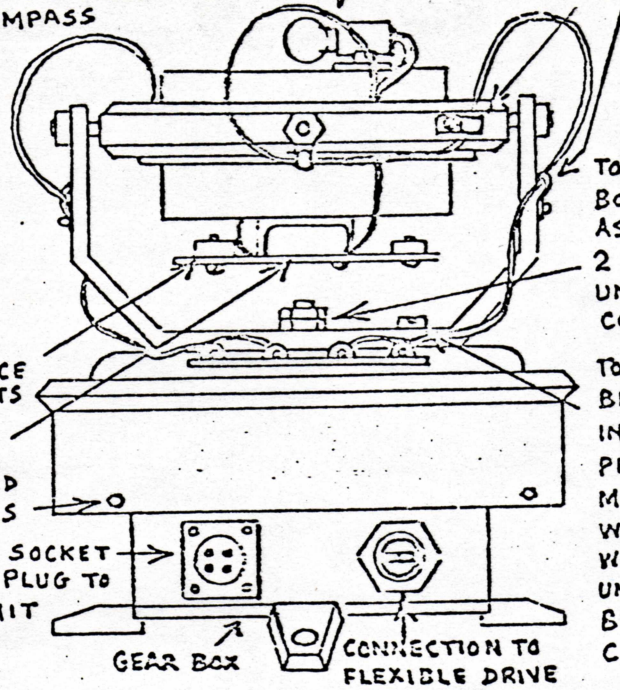
DELICATE INSTRUMENT
HANDLE WITH CARE

ENSURE LEADS ARE
FIXED BEHIND CLIPS
BUT ARRANGED SO
THE BOWL SWINGS
FREELY



UNDO CLAMPING
BAND FOR ACCESS
TO COMPASS
BOWL

EXCITER
LAMP



TO REMOVE COMPASS
BOWL AND GIMBAL
ASSEMBLY, UNDO
2 LOCKNUTS AND
UNPLUG 4 PIN
CONNECTOR

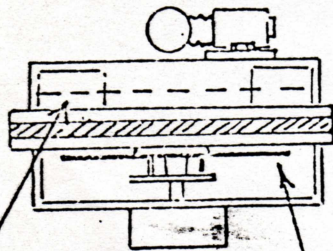
TO REFIT: ~ ENSURE
BRASS PEG LOCATES
IN GREY COVER AND
PERSPEX SLIPRING.
MAKE SURE NO RED
WHITE BLUE GREEN
WIRES ARE TRAPPED
UNDER GIMBAL ARM
BEFORE TIGHTENING
CENTRE LOCKNUTS

BALANCE
WEIGHTS
PHOTO
CELLS
COMPASS COLLAR HELD
ON BY 3 GRUB SCREWS
4 PIN MALE SOCKET
FOR CABLE PLUG TO
CONTROL UNIT

GEAR BOX

CONNECTION TO
FLEXIBLE DRIVE

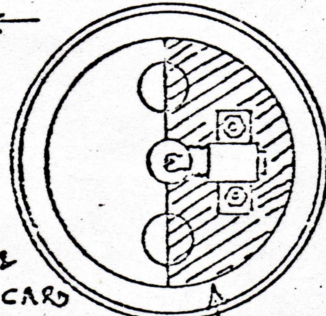
'PERSPEX' COMPASS BOWL



BOWL IS FILLED
WITH SILICON
FLUID TO APPROX.
THIS LEVEL

MAGNET &
COMPASS CARD
ASSEMBLY ~ CARD
SHOULD HANG LEVEL

N ←



POSITION OF CARD WHEN COMPASS
IS LINED UP

OUTER RIM OF
AGAINST BAL
THREADED H
UNTIL THER
SHAFT BUT
BETWEEN T
TIGHT, LOC

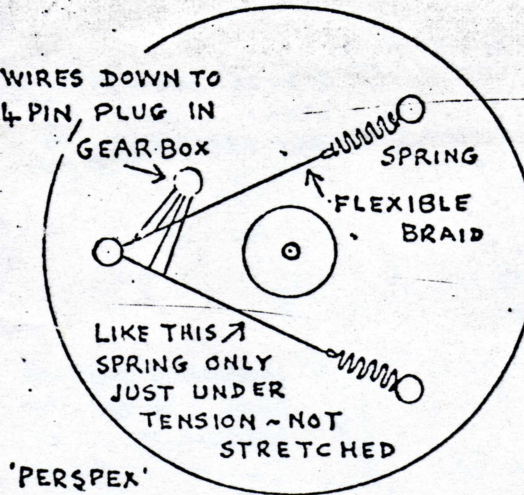
THE WORM & WORM
TURNS SMOOTHLY/EAS

TO MAKE UP
FLEXIBLE DRIVE: ~

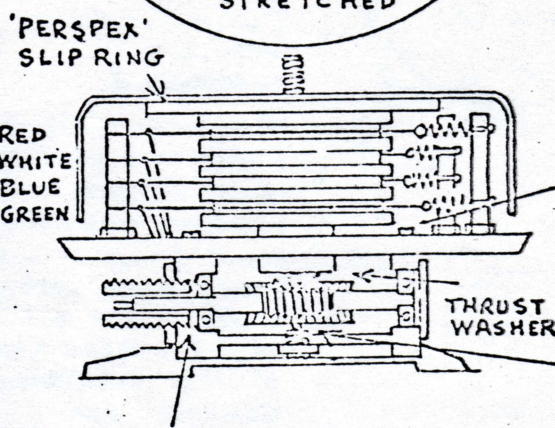
IMPORTANT

WELL OIL INNER
CABLE & STEEL
ENDS BEFORE
FITTING TO MOTOR
& COMPASS

DRAWING SMI.



MOVING CONNECTIONS ARE MADE VIA A SLIPRING. TO CHECK, REMOVE COMPASS BOWL & GIMBAL ASSEMBLY AND FLAT GREY COVER. IF A FLEXIBLE BRAID NEEDS RENEWING, TAKE OFF SLIP RING & SOFT SOLDER NEW BRAID IN PLACE. REPLACE SLIP RING MAKING SURE ONE BRAID ONLY IS IN EACH GROOVE. WELL LUBRICATE WITH SILICONE GREASE.

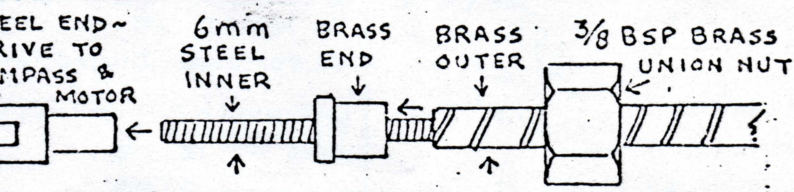


COMPASS BASE HELD TO GEAR BOX WITH 4 X 2BA SCREWS ~ THESE GIVE THE SIDE ADJUSTMENT BETWEEN WORM AND WORMWHEEL.

DOMED STEEL WASHER RESTS RACE, INNER RIM AGAINST USING WHICH IS SCREWED IN IS NO SLOP IN THE WORM NOT SO FAR AS TO NIP THE SHAFT THE BALL RACES AND MAKE IT IN POSITION WITH LARGE NUT.

1/8 STEEL BALL LOCATES IN CENTRE OF WORM WHEEL AND STEEL STUD IN WEB ACROSS GEAR BOX STUD LOCKED IN POSITION WITH NUT. THIS IS THE UP AND DOWN ADJUSTMENT BETWEEN WORM & WORMWHEEL

WHEEL SHOULD BE ADJUSTED SO THAT THE WORM SHAFT IS BY HAND. THE PLAY ON THE VERTICAL SHAFT: 1/2° MAX.



SECURELY SOFT SOLDER ENDS OF STEEL CABLE INTO STEEL DRIVES & BRASS OUTER TO BRASS ENDS. USE RESIN FLUX HOT ACID WHICH RUBS STEEL INNER.

HL10223-4-6

DRAWING SMI