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SECTION I CONDENSED OPERATING INSTRUCTIONS

Main Switch Functions:

FOLLOW-UP	Full follow-up controller activated
RUDDER INDICATOR	Rudder indicators only activated (also N.F.U. controls if fitted)
OFF	Only N.F.U. controls activated
COMPASS REPEATER	Course dial follows ship's heading
AUTO PILOT	Autopilot is operating and Course dial indicates course set

Controls

YAW (sensitivity of Autopilot)
Decrease YAW in calm seas for maximum course holding.
Increase YAW in rough seas to prevent unnecessary
rudder corrections (minus is least YAW, plus is
greatest YAW).

RUDDER (Ratio) amount of rudder applied
Decrease at high speeds to prevent oversteering.
Increase at low speeds (or with following seas, heavy
vessel loading, etc.) to give enough rudder for good
course holding.

COUNTER RUDDER (checking rudder)
Additional temporary rudder to reduce swing of vessel.
Decrease at high speeds to prevent oversteering, and
excessive rudder movements.
Increase at low speeds, following seas, etc. to help
reduce the swing of the vessel.

TRIM (Automatic Trim Control Switch)

OFF - no trim is applied (resets any previous trim).
ON - trim is computed and slowly applied as
 necessary.
SET - trim is computed and applied immediately while
 set position is held.

NOTE: For course changes in excess of 30 degrees
 the trim must first be switched "OFF". When
 the new course is reached, return trim to
 "ON" position.

DIMMER - Controls illumination of dial, and indicator
 lamps.

A GENERAL DESCRIPTION

The Wagner Autopilot type MK 4 is a complete steering control system. It incorporates the latest solid-state components and uses modular design to facilitate servicing. The control unit incorporates waterproof design, and wide range controls with manual or semi-automatic course setting. It uses proportional, integral and differential control to give accurate course holding under all conditions.

The basic system consists of a control unit, with built in course repeater - course setting dial, a rudder follow up unit and a course detector unit with magnetic compass suitable for wheelhouse or remote mounting.

Options include rudder angle indicators, full function remote controls, non follow-up and full follow-up steering controllers of several types, and provision for gyro-compass control. As the built-in DC power supply has wide range operation, the standard unit will operate from 12, 24 or 32 volt systems. Optional power supplies are available for all standard voltages (AC or DC).

B OPERATIONAL CONTROLS

The main switch incorporates the following control functions:

- 1) FOLLOW-UP: this function enables proportional controllers of the lever, wheel, or knob type to control the steering gear through the autopilot.
- 2) RUDDER INDICATOR: this function allows only the rudder indicators and non follow-up controllers to operate.

NOTE: the rudder indicators also work on all positions except "OFF". Non follow-up controls (JOG switches) will operate at any time unless switched off separately.

- 3) OFF: all autopilot functions are discounted or disabled (except NFU, see above).
- 4) COMPASS REPEATER: this function causes the course dial to continually indicate the ship's heading.
- 5) AUTO PILOT: this function enables the autopilot to steer the course indicated by the course dial. This position is used when operating the autopilot from the full function remote controls. The course steered may be manually adjusted by the course dial knob.

The front panel has controls for the following functions:

- 6) YAW control (weather control): this is used to adjust the sensitivity of the autopilot. The YAW is set at minimum (counter-clockwise or -) for good sea conditions and maximum course holding. The YAW is increased (clockwise) to avoid unnecessary steering corrections due to the natural yawing characteristic of the vessel in heavy seas. The YAW sensitivity varies from approximately $\pm 1/2$ degrees at minimum to approximately ± 12 degrees at maximum.
- 7) RUDDER CONTROL (rudder ratio): this is used to vary the amount of rudder applied for a given course error. This is adjustable to avoid over or under steering at varying vessel speeds, loading, or sea conditions. When the rudder is set to minimum (counter-clockwise or -) approximately one half degree of rudder is applied for every degree of course error. When the rudder is set to maximum (clockwise or +) approximately three degrees of rudder are applied for every degree of course error.

As a vessel's rudder is less effective at slow speeds, following sea conditions or in loaded conditions, the rudder (ratio) must be increased (towards+) to obtain proper steering response. In conditions of light loading or high speeds the rudder (ratio) must be reduced (towards -) to avoid over-steering. The correct adjustment may be obtained by advancing the rudder control until the vessel just starts to over-steer and then slightly reducing the amount applied.

- 8) COUNTER RUDDER (Checking Rudder): this also affects the amount of rudder applied and is dependent on the rate of change of course error. If the vessel falls off course quickly, a greater amount of rudder is applied than if the vessel falls off slowly. This counter rudder is applied in addition to the normal amount set by the rudder ratio control. This compensates for the momentum of the vessel and stabilizes the course steered.
When this control is in the counter-clockwise position (-), no counter rudder is applied. In the clockwise position (+) the maximum amount is applied. To set this control correctly, increase the amount applied until the vessel oversteers, or excess rudder corrections occur. Then reduce the amount slightly.
- 9) DIMMER Control: this varies the illumination of the dial and the brightness of the steering indicator lamps. Counter-clockwise (-) is minimum and clockwise (+) is maximum brightness.
- 10) TRIM (switch): this activates the automatic trim circuits (automatic permanent helm). In the OFF position no trim is applied. In the ON position any persistent course error will cause rudder to be applied to minimize the error.
In the SET position the course error that is present while the switch is held to SET will cause corrective rudder to be applied immediately. The SET position allows errors due to sudden changes in tide, wind or loading to be cancelled immediately.
- 11) REMOTE CONTROL FUNCTIONS (RC-4, etc): For these controls to operate, the Control unit must first be in the autopilot position.
- (a) ORIENT: this allows the course dial to continually follow the ship's heading. The toggle switch may be used to steer the vessel (NON-FOLLOW-UP steering function).
- (b) COURSE CHANGE (CC): this allows the toggle switch to change the course on the course dial in small increments to "fine tune" the course while the autopilot is steering.

- (c) PILOT: this allows normal operation of the autopilot with the toggle switch overriding for emergency steering (DODGING).
- (d) E.S. (Electric Steering): this places the autopilot in a standby mode. The toggle switch can then be used to steer the vessel (NON FOLLOW-UP Steering).

C INTERNAL (PRESET) CONTROLS

These controls are adjusted for the vessel's characteristics and no further adjustment is required in normal operation. See Drawing A-2-241 for control locations. See dockside test section for control adjustment procedures.

- 1) RT1 - Compass Sensitivity - used to adjust for varying types of compasses. 0 is low-sensitivity; 10 is high sensitivity.
- 2) RT2 - Counter Rudder Time Constant (CRTC) - used to adjust the time that counter rudder is applied. Larger and heavier vessels require an increased time (approximately 2 seconds to 2 minutes).
- 3) RT3 - Automatic Trim Time Constant (ATTC) - used to adjust the time over which the trim is applied. Larger and heavier vessels require an increased time. 0 is minimum; 10 is maximum time (approximately 1 minute to 8 minutes).
- 4) RT4 - Rudder Angle Indicator Meter Deflection - used to adjust the meter deflection to correspond with rudder hard over position. 0 is minimum; 10 is maximum.
- 5) RT5 - Full Follow-up Function Gain - used to adjust the sensitivity of the full follow-up amplifier so that the steering gear does not hunt. 0 is minimum gain; 10 is maximum. If the steering gear is fast, less gain is needed.
- 6) RT6 - Rudder Angle Limiting Adjustment - used to adjust the maximum rudder that may be applied while in the autopilot function - 0 is minimum angle and 10 is maximum angle (approximately 6° at minimum and in excess of 45° (NO LIMITING) at maximum.)

GENERAL RULES FOR OPTIMIZING FRONT PANEL CONTROLS

Optimization of the settings for different weather and vessel conditions requires practice. Here are a few basic rules to follow:

During calm seas lower settings (-) of the yaw control are recommended. During rough seas the yaw control must be increased (+). If the ship is oscillating too much about the course and is not yawing due to extreme sea conditions, the counter rudder setting should be increased. If the steering then responds too frequently, the yaw setting should be increased. Basically, it is necessary to test for settings which minimize rudder movement and yet, at the same time, maintain course within the desired limits of accuracy.

Under no condition should the periodic yaw movements of the ship due to swells be corrected.

Experience has shown that during harbour navigation the rudder setting should be increased to the next higher setting. In case of rough following seas, rudder response might also be necessary. Cruising at half or low speed also requires an increase of the rudder response setting.

If the ship shows a tendency to overshoot during course changes, the counter rudder is set too low (-), and if course changes are executed too slowly, then counter rudder is set too high (+). It might possibly then be necessary to increase rudder response. A loaded vessel requires more counter rudder than an unloaded vessel.

NOTE: Oscillations may occur when rudder response and yaw are set at minimum (-); especially when the rudder speed is fast. The oscillations can be cancelled out by increasing the yaw control setting.

SECTION II INSTALLATION PROCEDURE

A MOUNTING BASIC COMPONENTS

- 1) Control Unit (supplied with mounting bracket).
This unit should be mounted in the wheelhouse in a location which allows easy access for operation, wiring and servicing. Although the unit is designed to be waterproof, choose a location free from spray. Safe distance from compass is three feet.
- 2) Follow-up Unit (supplied with connecting linkage).
This unit mounts on or near the steering gear and is mechanically connected so that the follow-up shaft is driven through the same angle as the steering gear. See drawing A-2-235-1.
Note - on telemotor equipped steering gears the follow-up must be driven from the telemotor cylinder. See drawing A-184 for details.
- 3) Compass (with course detector attached).
If used as a steering compass, this unit is mounted at the helm station. If used only as an autopilot compass it should be mounted in a location free from magnetic interference, i.e. 6 to 8 feet minimum from winches, engines, large radars, fuel tanks, etc. 5 - 6 feet minimum from steering compasses, depth sounders, radio telephones, loudspeakers, etc., and 3 feet from any steel structure.

After installation, the compass should be checked for accuracy and if necessary corrected by a qualified compass adjuster.
- 4) Gyro Adapter Unit.
Used in conjunction with gyro compass, instead of magnetic compass. Mount near gyro or gyro distribution panel.
- 5) Steering Actuator (Pump Set).
Mount where convenient for connection to steering lines. Several types of pump sets are available, but in most cases these are mounted in the engine room or steering compartment.

MOUNTING INSTRUCTIONS FOR WAGNER AUTOPILOT SENSOR
ON VARIOUS MAKES OF COMPASS USING THE MK IV AUTOPILOT

1. The compass must be of the externally gimballed type.
2. In most cases the sensor is mounted on the bottom of the compass. In the event that it is mounted on the top of a compass the blue and red wires to the sensor at the Autopilot main terminals must be reversed. (Terms 1 & 2)
3. The sensor is mounted to the compass via the adapter plate supplied. This plate may be machined to fit or glued to the compass with a silicon sealant. This adapter must be placed exactly on the pivot center line of the compass (vertically).
4. After the adapter is fixed to the compass the sensor is installed with a screw and cushioning gasket. It will be noted that the sensor has a line scribed on the bottom with the letters F & A. This line should be in line with the lubber line on the compass with the F forward.
5. The Autopilot is operated in the compass repeater mode and the sensor position is rotated so that the course dial agrees with the compass heading.
6. The Autopilot is then switched to AUTOPILOT and a 10 degree course error dialed into the pilot. Using a good quality Volt Ohmmeter adjust RTI until a reading of ± 0.7 Volts is obtained reading from main Term 5 (gnd) to Term 6. It should also be noted that if the sensor is mounted too close to the card spurious nulls will result.

If adjusting RTI cannot achieve a reading of ± 0.7 Volts, then the sensor is too far from the compass card or the compass magnets are too weak. If RTI seems to be very sensitive and a setting of less than 3 results in a reading of ± 0.7 Volts the sensor is too close to the card and a spacer should be used between the sensor and the compass.

7. The compass should also be checked at this time for dragging or sticky pivots.

B MOUNTING OPTIONAL COMPONENTS

- 1) Rudder Indicator Meters.
These are mounted where required - compass safe distance, 3 feet.
- 2) Remote Control RC-4.
This unit is supplied with a fifty-foot cable which connects to the control unit.
- 3) Full follow-up controllers.
Mounted at steering positions as required. If more than one are installed or a remote control and full follow-up control are used, a controller selector switch will be required. This would normally be mounted in the wheelhouse.
- 4) Power Supplies.
These are required where 12, 24 or 32 VDC is not available. The power supply if required should be mounted in a dry, well ventilated location.
- 5) Non Follow-up Controllers (JOG switches).
Mount as required.

C INTERCONNECTING CABLES

See list of cables. These cables should be free of splices and secured so that wear, chafing or water damage cannot result. Do not use individual wires unless enclosed in conduit.

- 1) Compass Cable
A standard length of 10 feet is supplied (complete with connector for compass sensor). Longer lengths (for remote compass mounting) may be ordered. Since this cable is a special type, no substitutions or splices are recommended.
- 2) Follow-up Cable
This cable requires special attention during installation to prevent future damage from wear, chafing, cuts or water damage. In all cases where this cable passes through cargo or fish holds, it must be protected by conduit or hose. This cable connects with the control unit terminals 15, 16, 17.

- 3) Solenoid Cable
Runs from the pumpset to the control unit terminals 18,19,20 (22 also if non follow-up controllers are used).
- 4) Power Cable
This cable runs from the control unit (terminals 21 and 22) to the switch board or power supply.

Refer to list of cables for further information.

D CABLE SPECIFICATIONS

CABLE FROM CONTROL UNIT TO-			CABLE PART NUMBER
STD	Compass or gyroadapter unit	10ft normally supplied	750-124
OPT	Remote control RC-4	50ft normally supplied	750-105
OPT	TS-2 FFU lever controller	5ft normally supplied	750-102
OPT	TX-1 FFU wheel controller	5' Cable & Connector "	750-102
OPT	FFU station selector	Rear terminal strip	750-102
OPT	Rudder Angle meter type 150	30ft normally supplied	750-101
OPT	Rudder Angle meter type 201	10ft normally supplied	750-105
STD	Rudder follow up unit	5ft normally supplied	750-102
STD	Steering Actuator unit (pumpset)	Term strip or equiv.	750-103
OPT	NFU (JOG) controllers	5ft normally supplied	750-102
STD	PWR source	Terminal strip	750-102
OPT	Power supply to source	Terminal strip	750-102

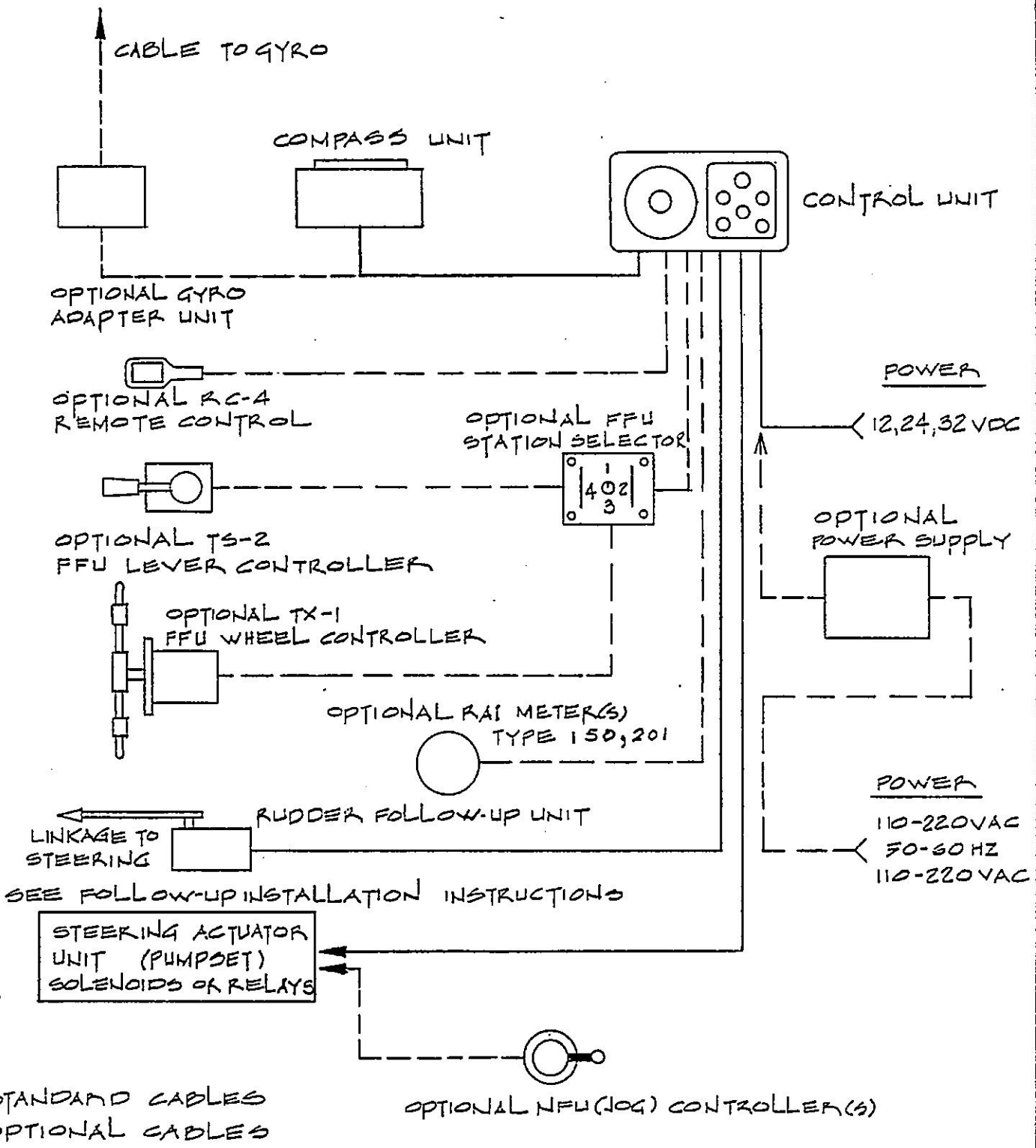
RECOMMENDED CABLE TYPE

Part No.	Belden Type	No. of Conductors	AWG
750-102	8453	3	18 (stranded) Neoprene Jacket
750-103	8454	4	18 (stranded) Neoprene Jacket
750-124	8405	5	20 (stranded) Shielded Cable
750-101	8443	3 (2 used)	22 (stranded) Vinyl Jacket
750-105	8449	9 (7 used)	22 (stranded) Vinyl Jacket

PUMP SET RECOMMENDED CABLES

Type 1A 12V	up to 10 ft.	AWG 12	Fuse for 20-30 AMPS
	over 10 ft.	AWG 10	
24, 32V	up to 10 ft.	AWG 14	Fuse for 15-20 AMPS
	over 10 ft.	AWG 12	
Type 2A 12, 24, 32V	up to 10 ft.	AWG 10	Internally Fused 40A 12, 24V 30A 32V
	over 10 ft.	AWG 8	





MK-4 AUTOPILOT CABLE DIAGRAM



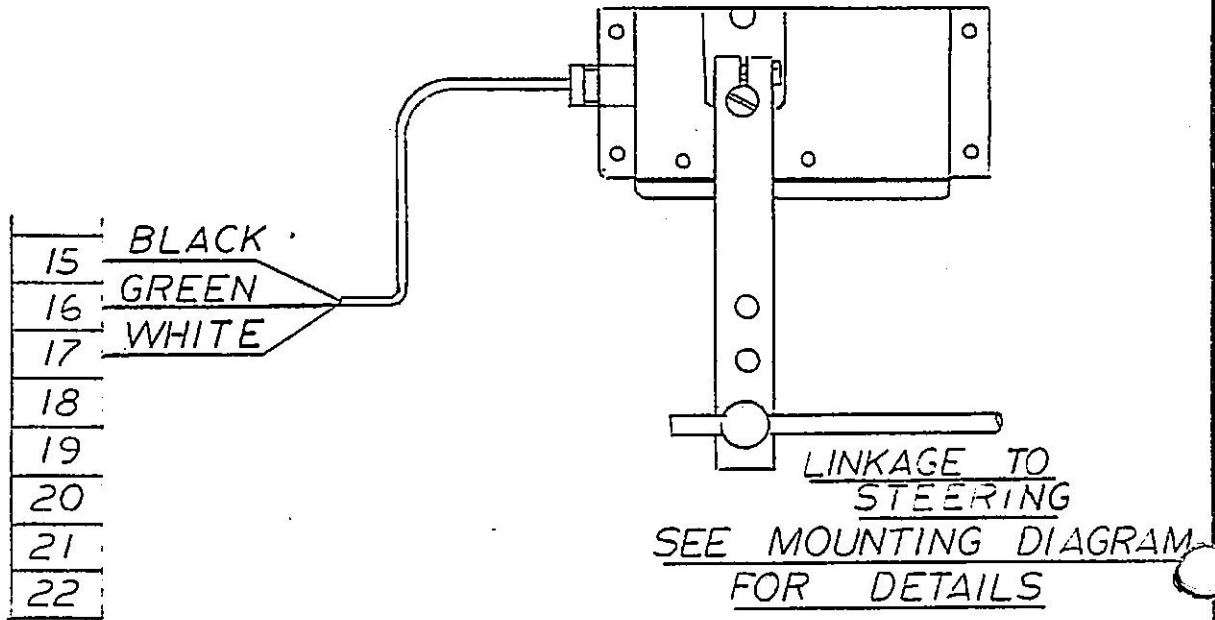
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DATE	DWG No.	REV.
NOV. 8 / 76	A-2-209	01
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TYPE 201R FOLLOW-UP UNIT
P.N. 510-065
5 FT. OF 750-102 CABLE
SUPPLIED



MK-4 TERMINALS

NOTE WIRES TO TERMINALS 15 AND 17
MAY HAVE TO BE INTERCHANGED
SEE MANUAL (DOCKSIDE TESTS)

CONTROL UNIT TO FOLLOW-UP WIRING MK-4

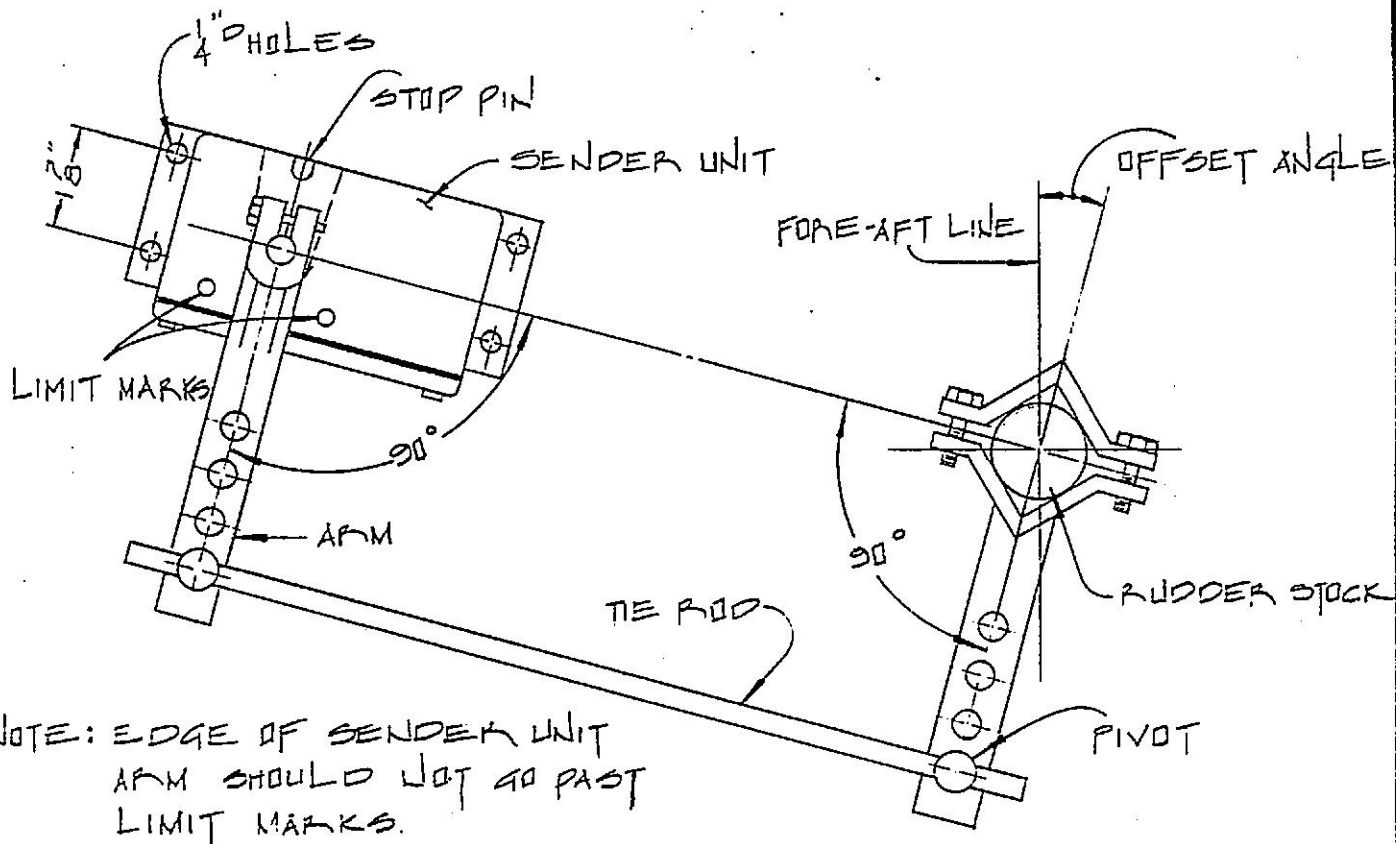


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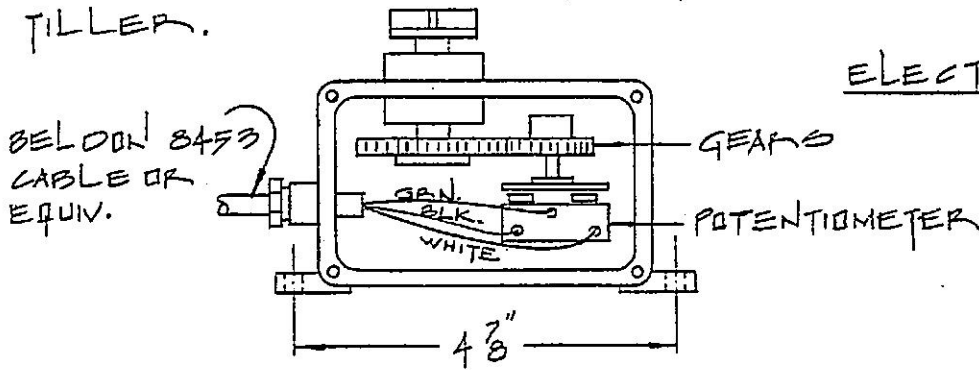
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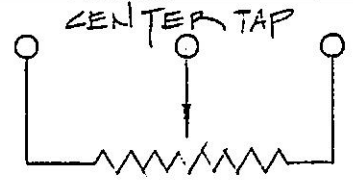


NOTE: EDGE OF SENDER UNIT ARM SHOULD NOT GO PAST LIMIT MARKS.

IN SOME CASES THE RUDDER STOCK CLAMP MAY HAVE TO BE OFFSET AS SHOWN IN ORDER TO CLEAR VARIOUS OBSTRUCTIONS IN ALL CASES, BE CERTAIN THAT THE 90° RELATIONSHIPS ARE MAINTAINED WITH THE RUDDER IN MID-POSITION. ADJUST PIVOTS SO THAT THE SENDER UNIT ARM SWEEPS 45° EACH SIDE TO THE LIMIT MARKS WHEN THE RUDDER IS MOVED FROM HARD OVER TO HARD OVER. IF THE SENDER UNIT ARM IS REMOVED OR LOOSENED, THE SHAFT CAN BE RESET BY ELECTRICALLY CENTERING THE POTENTIOMETER & RE-CLAMPING THE ARM PARALLEL TO THE RUDDER TILLER.



ELECTRICAL DESCRIPTION



201R SENDER UNIT INSTALLATION



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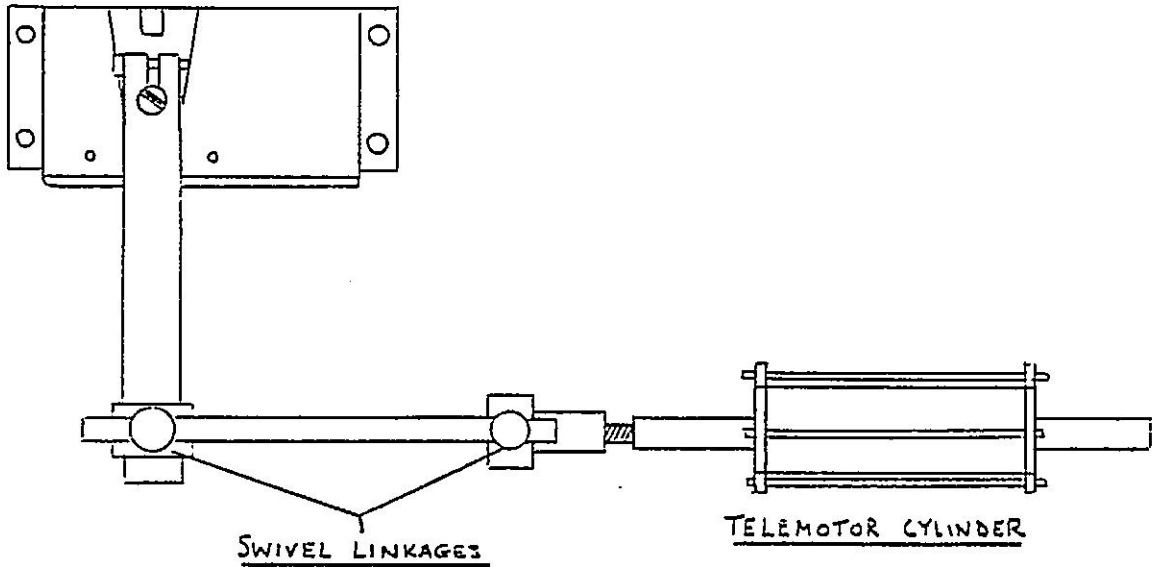
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DWG No.	REV.
A-235	02

FOLLOW-UP UNIT



LAYOUT IS SHOWN WITH TELEMOTOR CYLINDER CENTERED
FOLLOW-UP SHOULD BE ADJUSTED TO CENTER

SEE DRG. A-235 FOR DETAILS
OF FOLLOW-UP AND LINKAGE
ADJUSTMENT PROCEDURES

FOLLOW-UP TO TELEMOTOR LINKAGE



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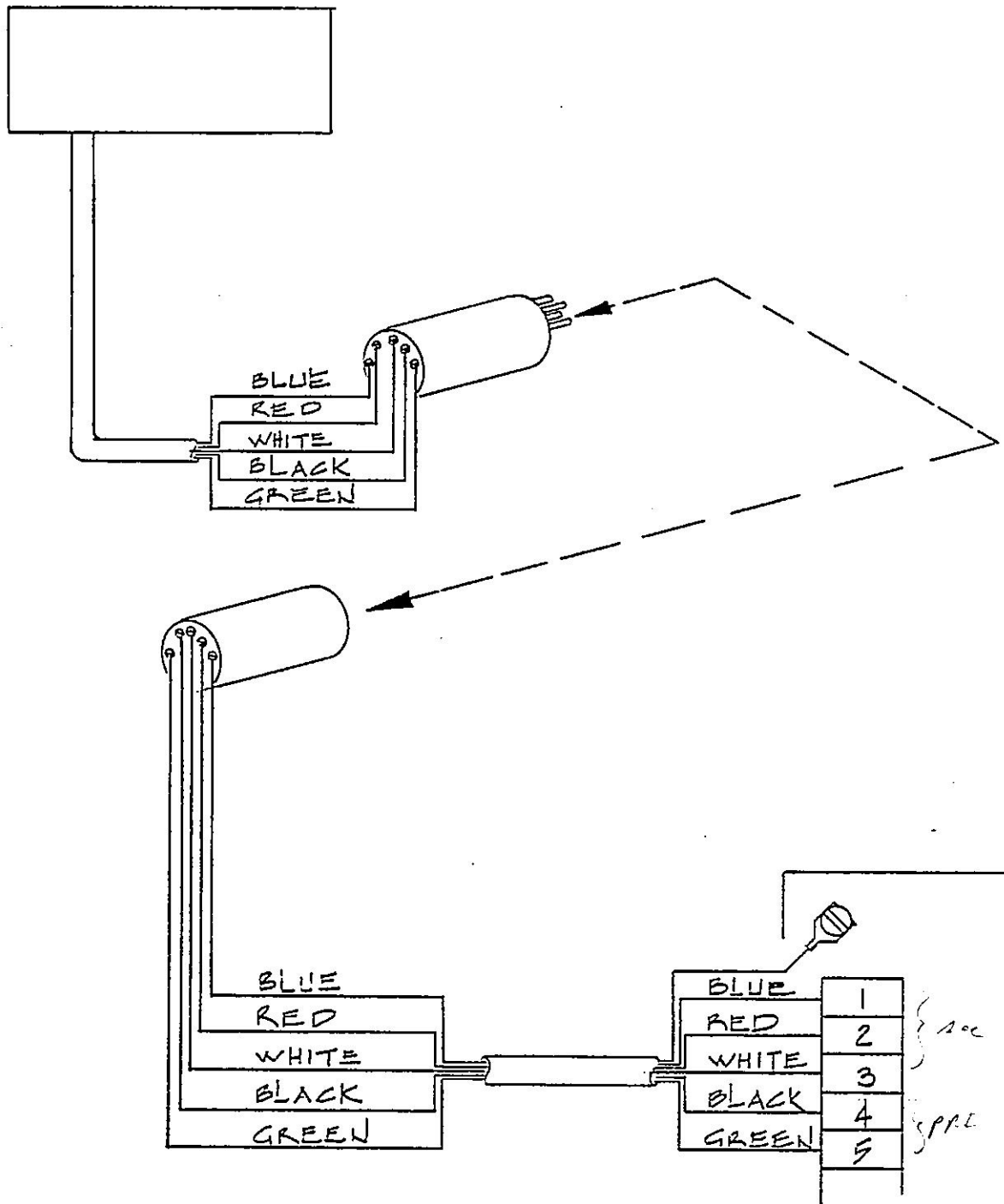
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MK-4 TO COMPASS SENSOR WIRING

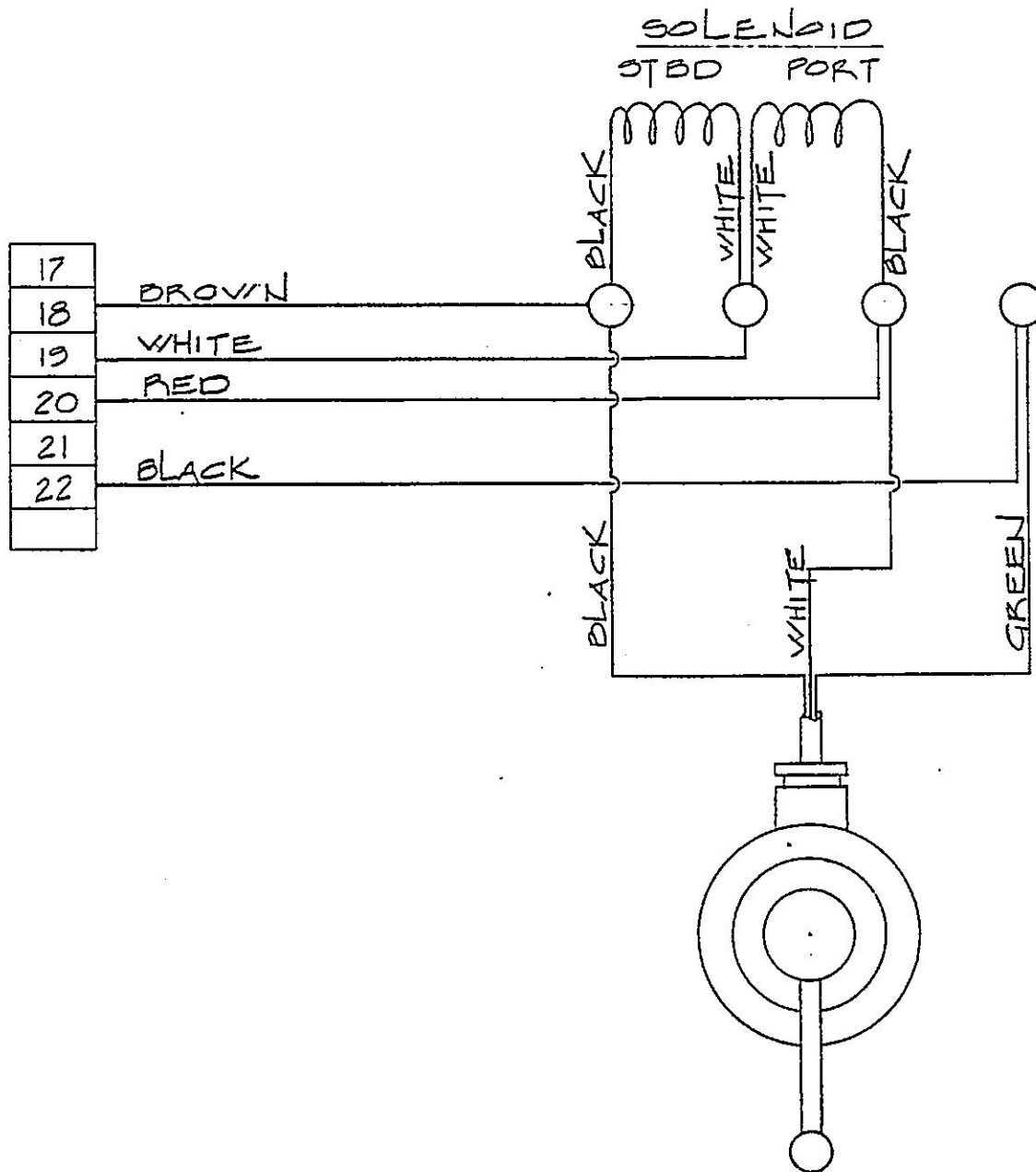


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MK-4 TO SOLENOID AND JOG WIRING



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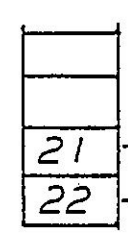
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REV

750-102 CABLE

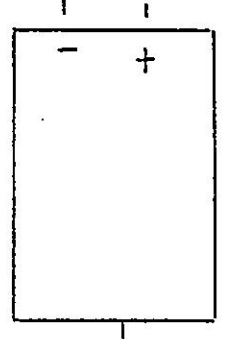
POLARITY MUST BE CORRECT
OR AUTO PILOT MAY BE
DAMMAGED



WHITE
BLACK

+ 12, 24, OR 32 VDC
- SHIP SUPPLY

MK-4 TERMINALS



OPTIONAL
POWER SUPPLY

110-220 VAC 50-60 HZ.
OR 110-220 VDC (REQUIRES RELAY BOX)

MK-4 POWER CONNECTION WIRING

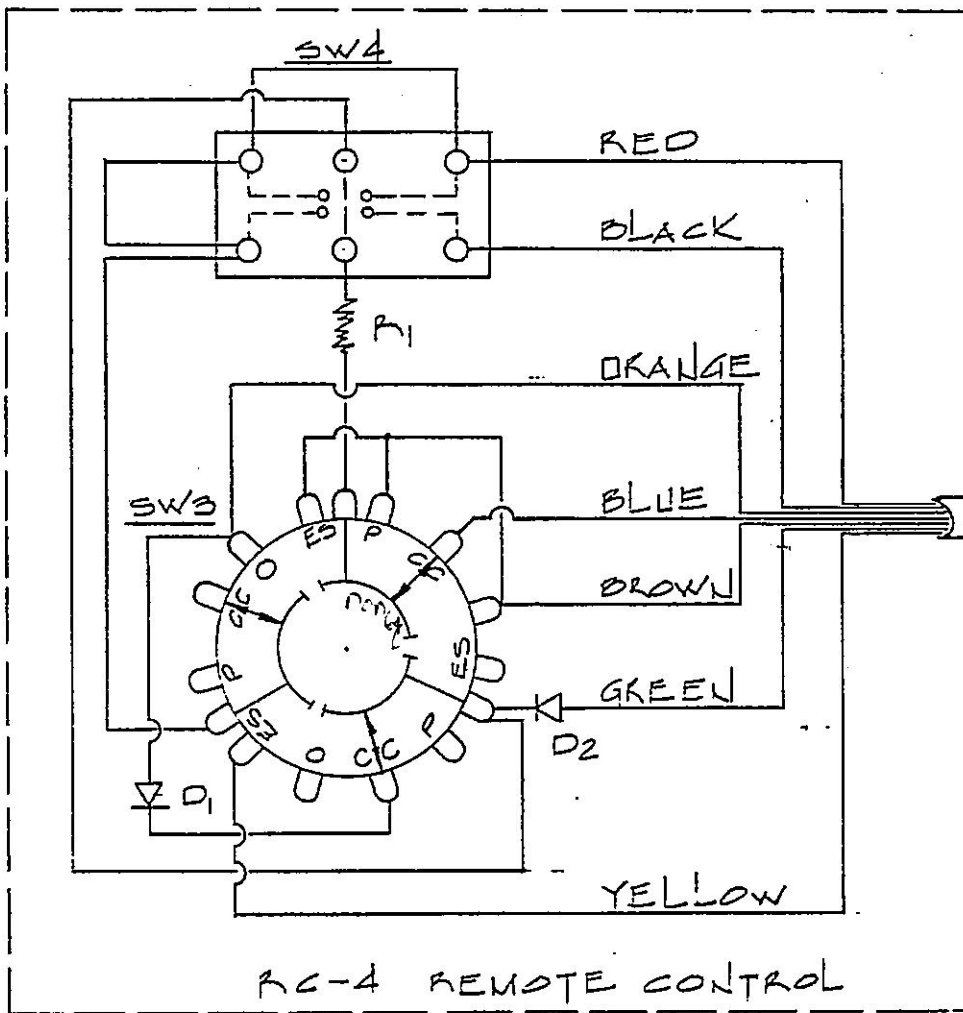


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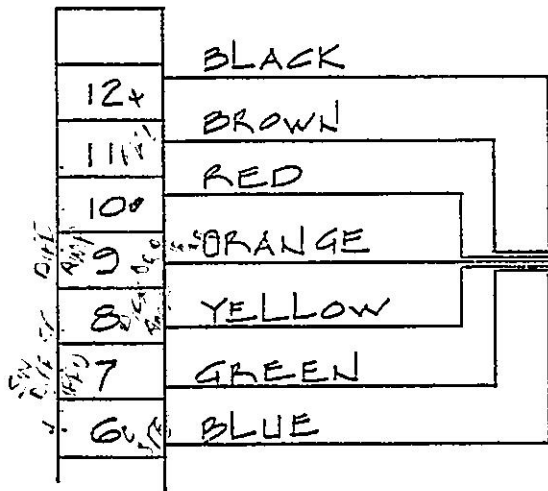
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RC-4 REMOTE CONTROL



R1	4K7 RESISTOR
SW3	ROTARY SW.
SW4	TOGGLE SW.
D1,2	DIODE
—	

MK-4 TO RC-4 WIRING



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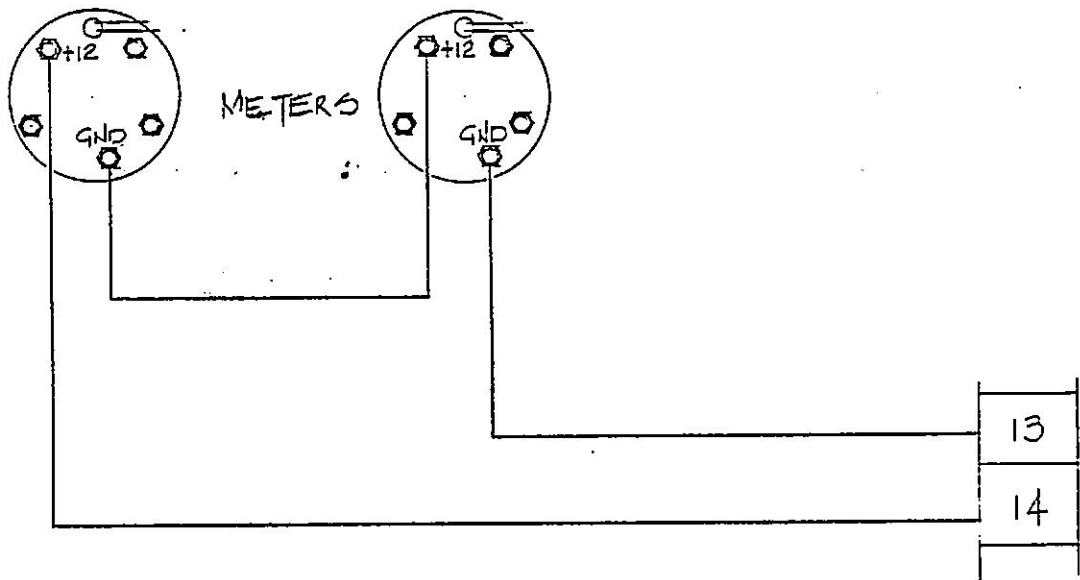
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MODEL 150
 RUDDER ANGLE INDICATOR



MK-4 CONTROL UNIT
 TERMINAL STRIP

WAGNER PART NUMBERS

MODEL 150 NON WATER PROOF METER: 510-133
 MODEL 150 WATER PROOF METER: 510-135

- NOTE: — METERS ARE CONNECTED IN SERIES
 — 30 FT. OF 790-101 CABLE IS SUPPLIED WITH EACH METER
 — A SINGLE METER IS SIMPLY CONNECTED AS FOLLOWS
 (GND) TO MK-4 TERMINAL 13
 (+12) TO MK-4 TERMINAL 14

MODEL 150 R.A.I. METERS TO MK-4 CONTROL UNIT CONNECTIONS

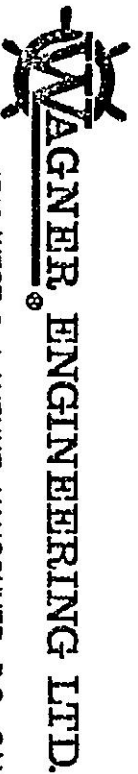


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Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

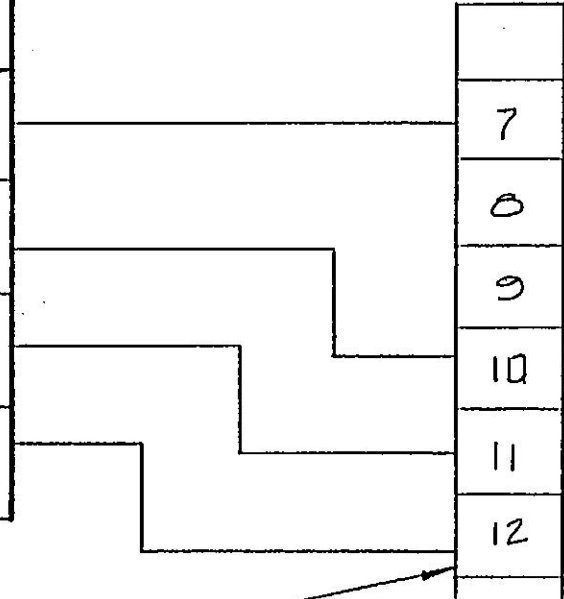


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FULL FOLLOW-UP CONTROLLER TO MK-4 CONTROL UNIT CONNECTIONS

WIRE COLORS

TX-1A	TX-1A TERMI- NAL STRIP	TS-2	TS-2-S	RC-5
NOT APPLICABLE			RED	RED
WHITE	3	WHITE	WHITE	WHITE
GREEN	2	GREEN	GREEN	BROWN
BLACK	1	BLACK	BLACK	BLACK



MK-4 CONTROL
UNIT TERMINAL
STRIP

NOTE: - ONLY THE TX-1A CONTROLLER HAS
A TERMINAL STRIP
- THE TS-2 & TS-2-S CONTROLLERS
ARE SUPPLIED WITH 5FT. OF CABLE
- THE RC-5 CONTROLLER IS SUPPLIED
WITH 50FT. OF CABLE

DATE

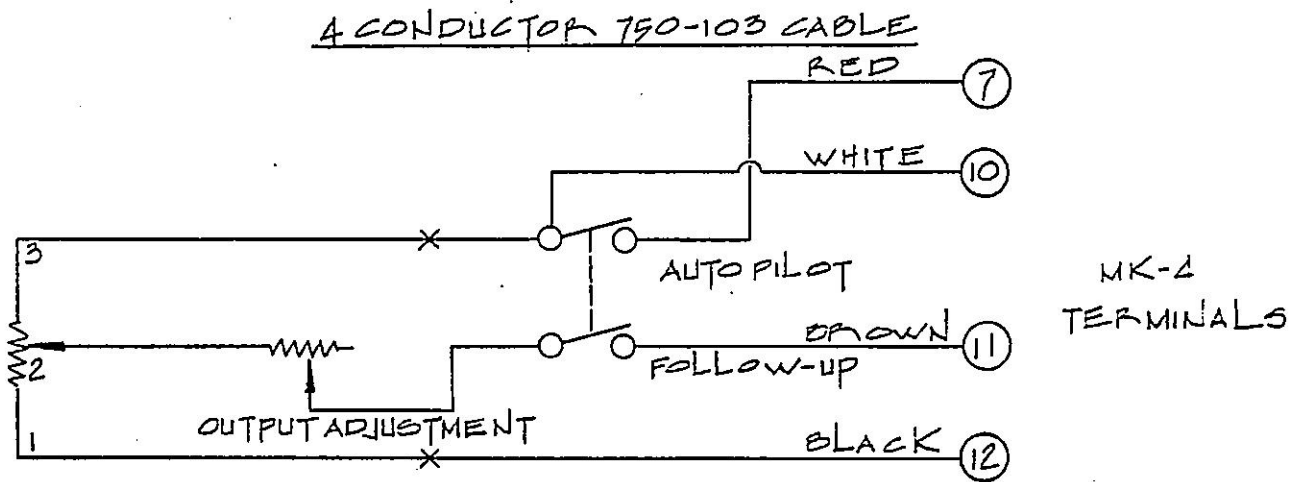
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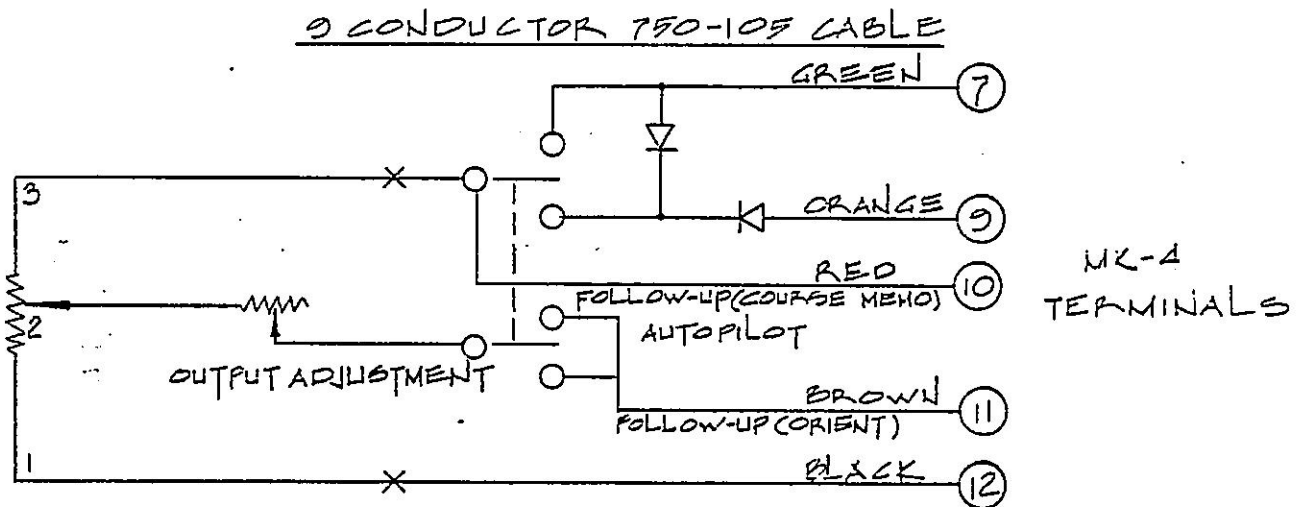
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REV



TS-2-SE RC-5-S WIRING

- USE WHEN TILLER STATION IS COMBINED WITH OTHER REMOTE CONTROLS SWITCHES TILLER ON AND AUTOPILOT FUNCTION IS CHANGED TO FOLLOW-UP FUNCTION AT TILLER STATION!



* TS-2-R - TILLER REMOTE CONTROL ALLOWS NORMAL AUTOPILOT OPERATION TO BE SWITCHED TO FOLLOW-UP WITH COURSE MEMORY OR FOLLOW-UP WITH COMPASS COURSE FOLLOWING SHIPS HEAD

NOTE: X - IF TILLER (OR KNOB) CAUSES STEERING IN REVERSE DIRECTION REVERSE OUTSIDE LEAD AT POTENTIOMETER INSIDE CONTROLLER UNIT

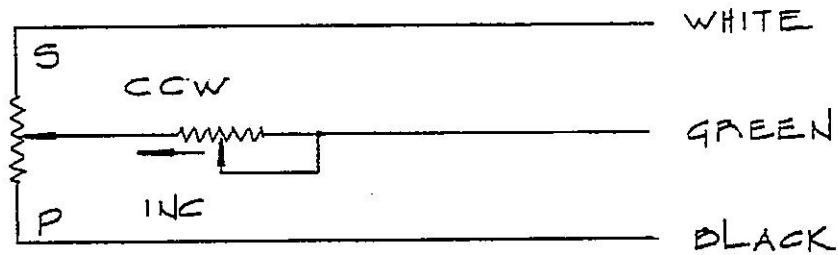
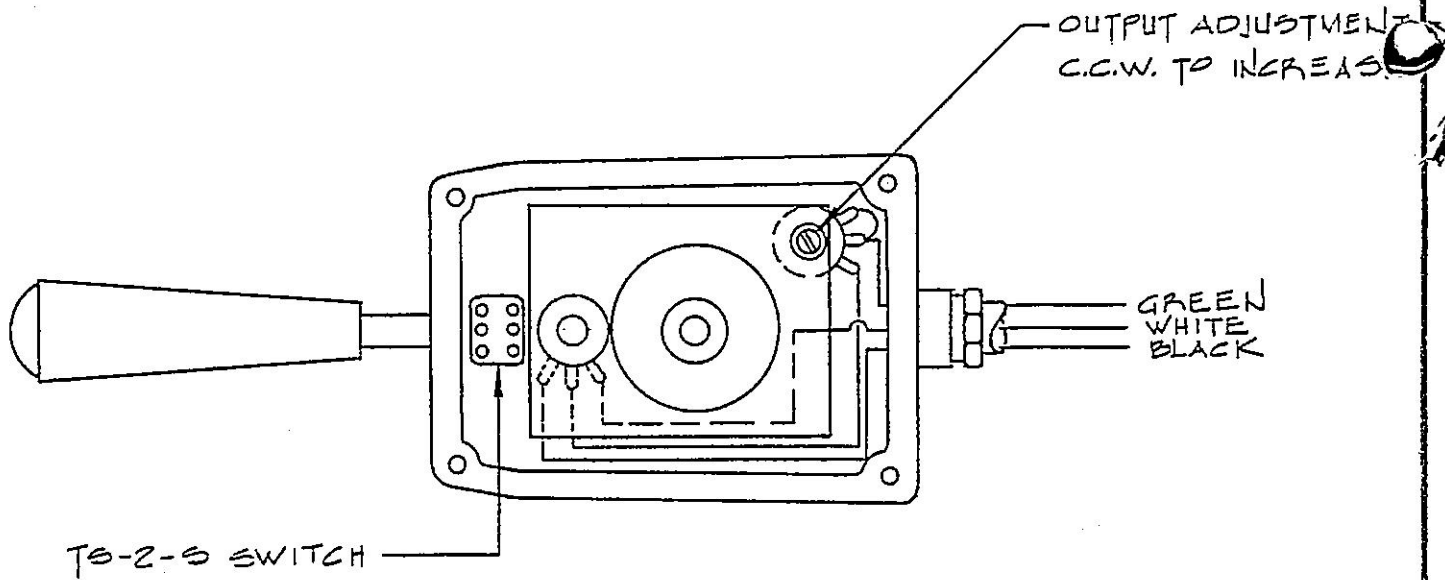
MK-4 TO RC-5-S TS-2-S AND TS-2-R WIRING



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Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

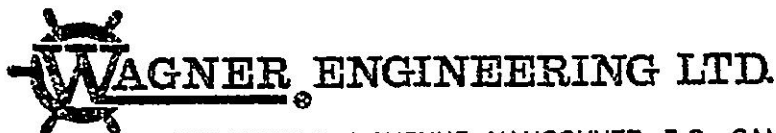
DATE	DWG No.	REV.
JAN. 19 / 77	A-2-249	
DRAWN		



MODEL TS-2 PART NUMBERS

TS-2 COMPLETE UNIT	_____	510-048
5FT. CABLE	_____	750-105
SIGNAL POTENTIOMETER		
C.W. GEAR	_____	126-001
OUTPUT ADJUSTMENT POTENTIOMETER	_____	130-012

MODEL TS-2 INTERNAL ASSEMBLY



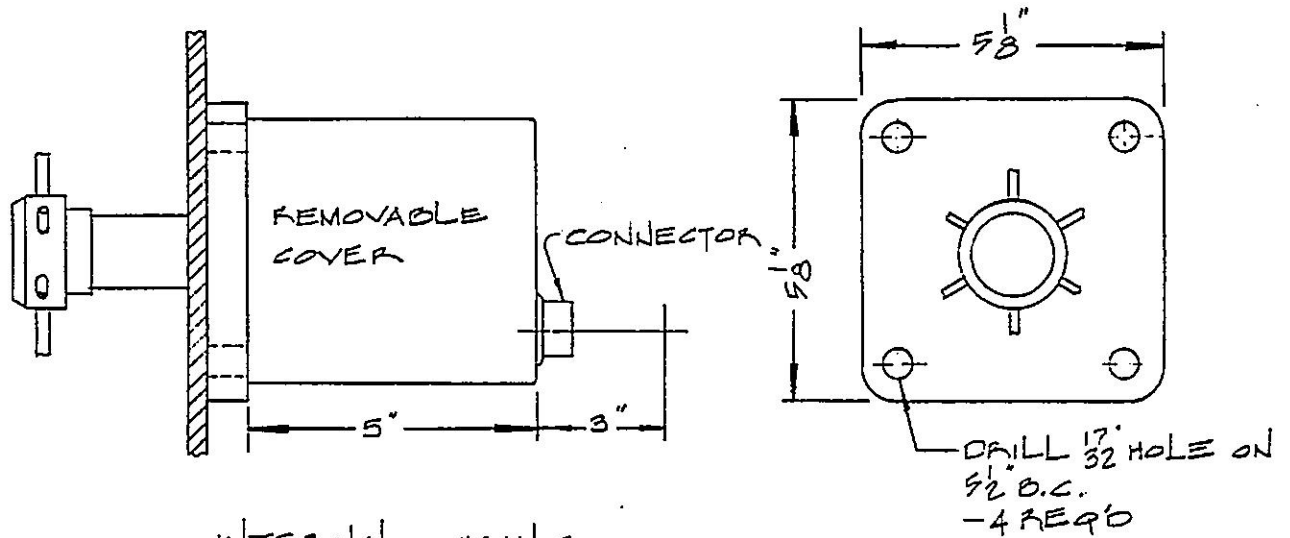
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Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

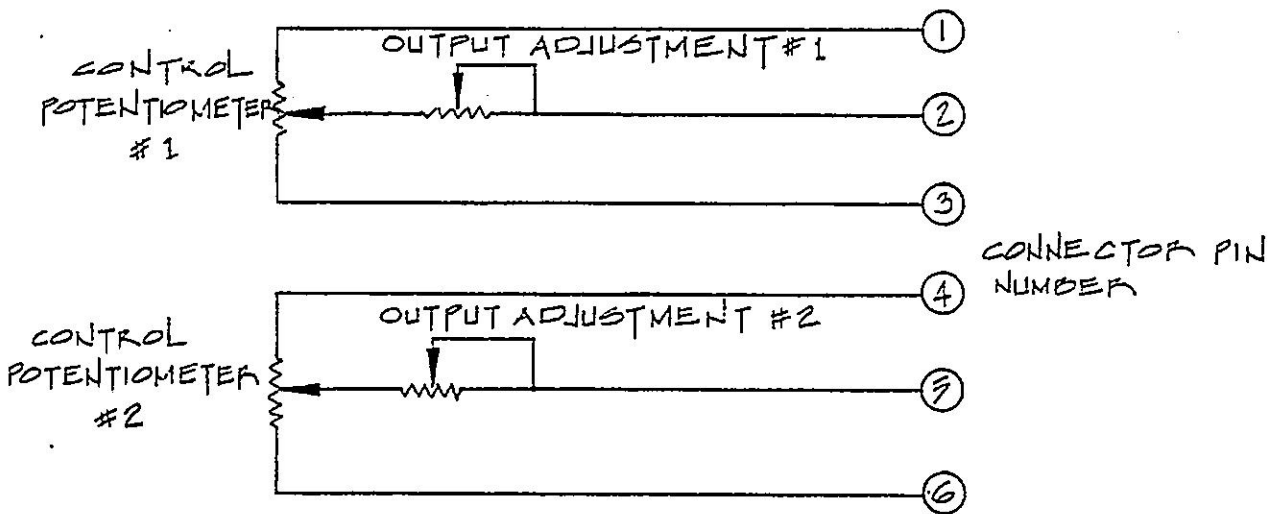
DATE	DWG No.	REV
JAN. 18/77	A-2 208	
DRAWN		

NOTE:

- ALLOW 3" FOR CABLE CLEARANCE
- CONTROL POT.#2 AND OUTPUT ADJ.#2 ONLY SUPPLIED WITH 510-081B
510-081A HAS ONLY CONTROL POT.#1 AND OUTPUT ADJ.#1
- ONE POTENTIOMETER#1 ONLY - SUPPLIED WITH MINI-TILLER 510-047
WHEEL CONTROLLER TX-1 510-081A



INTERNAL WIRING



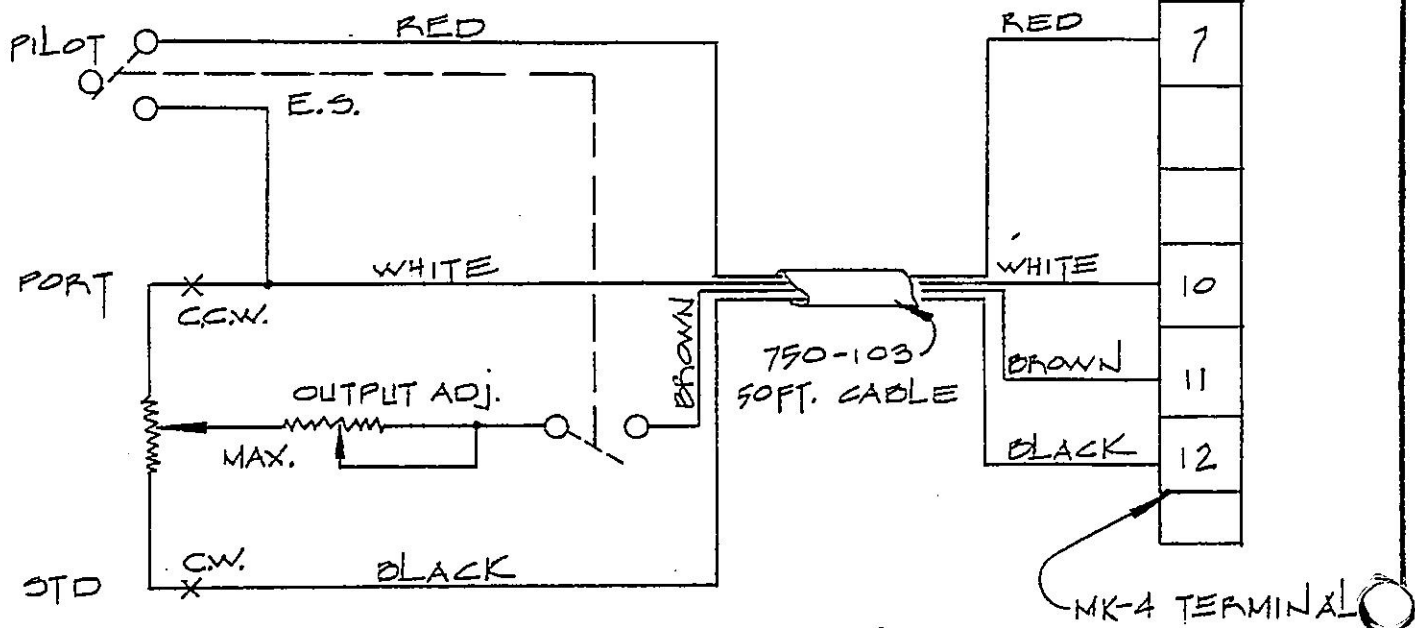
WHEEL CONTROLLER TX-1, PART NO 510-081
WIRING AND MOUNTING DETAIL



1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

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DATE	DWG No.	REV.
JAN. 20/77	A-170	01
DRAWN		



WAGNER PART No.

MODEL RC-5-S ————— 510-092

50FT. CABLE ————— 750-103

NOTE: X — IF STEERING CONTROL IS REVERSED,
REVERSE WIRES AT OUTSIDE LEADS
OF CONTROLLER POTENTIOMETER

MK-4 TO RC-5-S WIRING



WAGNER ENGINEERING LTD.

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Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV
FEB. 4 / 77	A-2-214	
DRAWN		

5) Rudder Indicator Tests.

- (a) Switch to RUDDER INDICATOR position.
- (b) Move rudder manually to PORT. All rudder indicators should indicate PORT.
- (c) If one or more meters are reversed, reverse the leads at each meter to correct.
- (d) Move rudder manually to hard over PORT.
- (e) Adjust RT4 (on printed cct board) for the same indication as the hard over angle of the steering gear, e.g. 35°, or 45° etc.
- (f) Check starboard side by moving rudder manually to STARBOARD.
- (g) If the angles PORT and STARBOARD are not equal, adjust rudder follow-up linkage so that equal angles are obtained.
- (h) Reset RT4 for correct hard over indication.
- (i) Move steering gear slowly from hard over to hard over. Rudder indicators should move smoothly with no hesitation when steering is moved. They should reach hard over as the steering gear reaches its mechanical stops. If the meters stop before the steering gear does, then the rudder follow-up unit is being driven through too large an angle; (maximum $\pm 45^\circ$). If so, reduce angle and repeat steps (d) to (i).

6) Solenoid Reversal test.

- (a) Energize the pumpset.
- (b) Set the hard over to hard over time of the steering gear under power to between 14 and 28 seconds.
- (c) Set control unit to COMPASS REPEATER position; when dial stops, set control unit to AUTOPILOT position.
- (d) The rudder should center.
- (e) If the rudder goes hard over, reverse the solenoid wires to terminals 18 and 20 of the control unit.
- (f) Repeat steps (a) to (e).

7) Full follow-up controller adjustment

- (a) Set RT5 (internal control) to 10.
- (b) Center (midships) the full follow-up controller.
- (c) Switch to FOLLOW-UP on the control unit (if more than one controller is fitted, switch the controller selector to the first controller).
- (d) Rudder should center and hunt back and forth.
- (e) Reduce the setting of RT5 until hunting stops.
- (f) Move controller hard over. Rudder should move to about 2 degrees from hard over; if not, adjust internal control in controller. (Controller output and adjustment - see diagram A-2-208).
- (g) If controller is moved to PORT and rudder moves to STARBOARD, or vice versa, reverse wires 1 and 3 in the controller.
- (h) If more than one controller (FFU) is fitted, repeat for each controller.
- (i) Check for hunting of rudder at hard over PORT and STARBOARD. If necessary, reduce RT5.

8) Remote control RC4 tests.

- (a) Set control unit main switch to AUTOPILOT.
- (b) With the RC4 switch in AUTOPILOT position, move toggle switch to PORT. Rudder should move to PORT. Repeat to STARBOARD. When toggle switch is released the autopilot should return rudder to center or if there is a course error, to the rudder position corresponding.
- (c) With the RC4 switch in ES position (electric steering) the toggle switch moves the rudder to PORT or STARBOARD, but the autopilot should not return the rudder.
- (d) With the RC4 switch in CC (course change) position, the toggle switch will move the course heading dial a maximum of 10 degrees. If the toggle switch is only operated momentarily, lesser changes are achieved. When the toggle switch is released, the course error will cause the rudder to move the vessel in the corresponding direction.

- (e) With the RC4 switch in the ORIENT position the course dial should continually indicate the ship's heading and the toggle switch may be used to steer the vessel.
- (f) Turn RT6 internal control to 10.

9) Compass system tests.

- (a) When the control unit main switch is set to COMPASS REPEATER, the course dial should continuously indicate the ship's heading. If there is a constant error, then the clamps holding synchro SY-1 (mounted inside the control unit on the dial drive assembly) should be loosened and the synchro rotated until the correct heading is obtained. A varying course error of up to ± 2 degrees is normal.

NOTE: On steel vessels or on vessels with the Autopilot compass near magnetic objects, a qualified compass adjuster should adjust the compass for minimum errors.

- (b) Switch the control unit to AUTOPILOT position. Set YAW to MINUS (or MINIMUM), RUDDER to PLUS (or MAXIMUM), COUNTER RUDDER to MINUS (or MINIMUM) and TRIM to OFF.
- (c) Manually set a course error of 10 degrees off the compass heading.
- (d) Adjust RT1 (internal control) so that the rudder moves to 30 degrees. (This sets the compass sensitivity).
- (e) If a gyro compass adapter unit is fitted, the gyro must be on and aligned for this test.

NOTE: In some cases the connections from the gyro adapter unit to the gyro distribution panel may have to be reversed (normally only 2 wires reversed) to allow course dial to follow in the correct direction. See gyro manual under "remote repeater reversals".

10) Rudder limiting adjustment.

NOTE: Rudder limiting only occurs in the AUTOPILOT mode with very large course errors and large amounts of rudder.

- (a) To set the desired limiting angle, reduce RT6 (internal control) to zero.
- (b) Set control unit to AUTOPILOT.
- (c) Use course dial to give a 90 degree course error.

- (d) Slowly increase RT6 until desired limiting angle is reached (10 is maximum rudder angle or no rudder limiting).
- (e) Check rudder limiting is approximately equal by using the course dial to give large errors PORT and STARBOARD.

11) Automatic trim time constant adjustment.

- (a) RT3 (ATTC) internal control sets the time over which the automatic trim is calculated and applied.
The SET position eliminates this time delay and immediately applies all trim necessary.
RT3 should be set according to the table below.

VESSEL LENGTH	SETTING	APPROX TIME
Under 15 meters	0	1 min.
15 to 30 meters	3	1-1/2 mins.
30 to 60 meters	5	2-1/2 mins.
60 to 120 meters	7	3-1/2 mins.
Over 120 meters	10	4 mins.

To check trim time constant, use the RUDDER control and course dial to give a 10 degree rudder position. Switch TRIM ON; time until 20 degrees of rudder is applied is the trim time constant.

12) Counter rudder time constant adjustment.

This control RT2 (internal) sets the time that the counter rudder is applied for. The front panel control adjusts the amount that is applied.

The counter rudder time constant (RT2) should be set initially as per the following table:

VESSEL LENGTH	SETTING
Under 15 meters	0 - 1
15 to 30 meters	1 - 2
30 to 60 meters	2 - 4
60 to 120 meters	4 - 6
Above 120 meters	6 +

B SEA TESTS

These tests should be performed under fairly good sea conditions with minimal wind or tide. If wind or tide conditions are unavoidable, set a course for minimum effects from these causes.

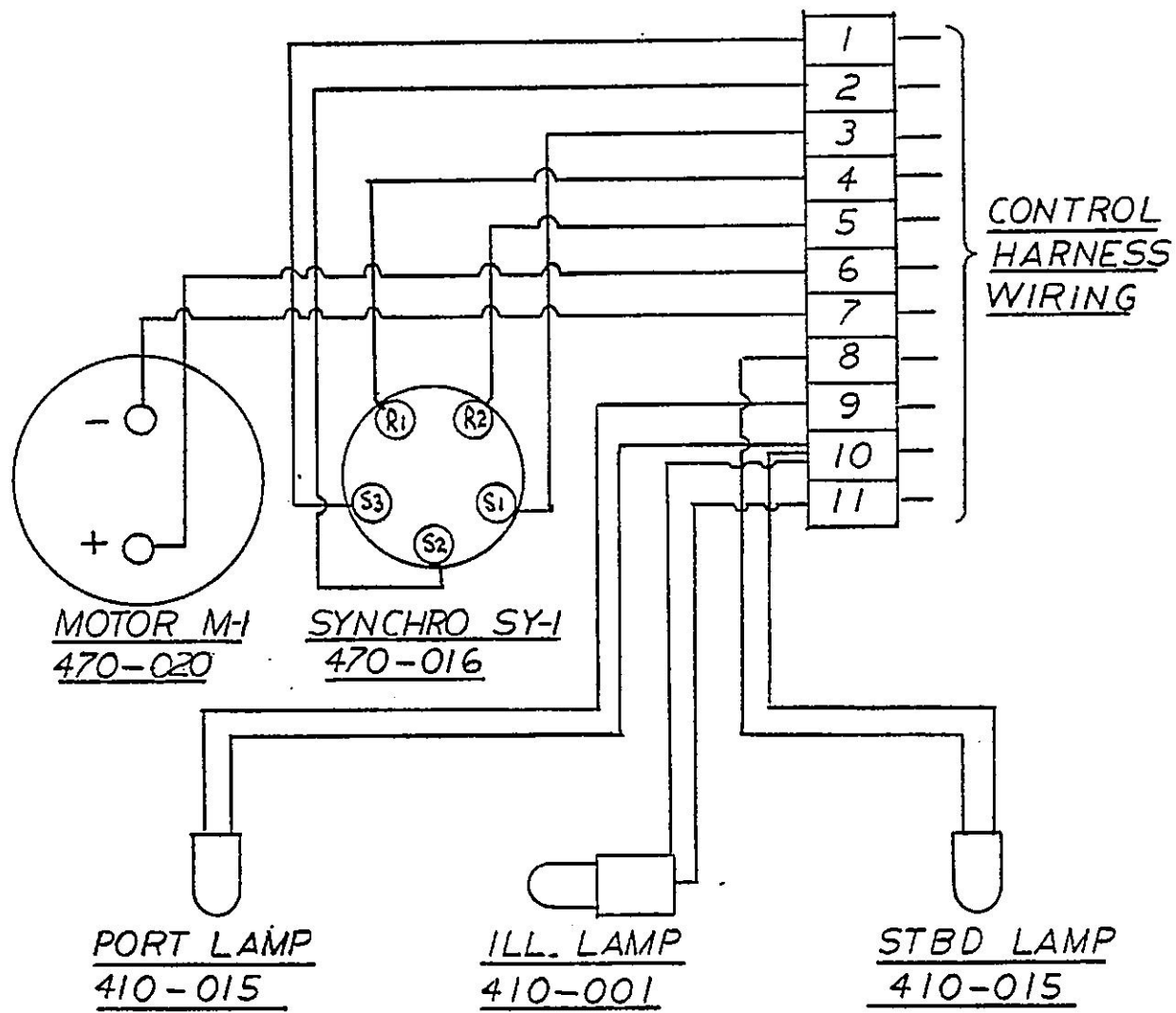
- 1) Steer the vessel by hand on a fixed heading. Turn main switch to RUDDER INDICATOR.
If the vessel requires over approximately 3 of permanent rudder or trim rudder angle to maintain a straight course, then the RUDDER FOLLOW-UP center (and indication on rudder indicator) may have to be changed so as to center the rudder indicator. This is necessary so that re-setting automatic trim at every course change is not required. If the error is less than 3 degrees, then this may be omitted.
- 2) Switch to AUTOPILOT
Use the course dial to set courses at 000, 030, 060, etc. A chart is included inside the control unit to record the actual course steered on each of these headings as a navigational aid and performance check. Note: Course repeater errors of ± 2 degrees from set course are normal. Also provided on the internal chart are tables for recording the internal control settings for future reference.
- 3) Switch TRIM to "ON", observe the course holding of the vessel for a few minutes, then switch the TRIM OFF. If the course holding improves with the trim off, then the automatic trim time constant (RT3) is set too low. Increase it.
- 4) Counter rudder settings.
As the settings of these controls depend upon the vessel speed, hull shape, rudder shape, loading and weather, the exact settings vary from those given in the table (INITIAL TEST and SET UP SECTION). Use this table for initial setting.
With the autopilot steering a course at normal cruising speed, increase the COUNTER RUDDER control. If it can be set at maximum before unnecessary steering corrections and oversteering result, then RT2 is set too low. If the COUNTER RUDDER control can only be advanced slightly before unnecessary corrections and oversteering occurs, then reduce RT2. The proper setting for the front panel COUNTER RUDDER control is just less (towards minus) than the point where the vessel oversteers or unnecessary corrections are given.

- 5) Check autopilot operation at high and low vessel speeds on various courses to check all internal settings for correct adjustments.

Note: as the speeds, courses and weather conditions change, adjustments to YAW, RUDDER, COUNTER RUDDER and TRIM will be necessary to optimize course holding.

- 6) Record all internal control settings on control unit internal chart for future reference.
- 7) Do final check on all remote controls, etc. for correct operation.

DIAL DRIVE TERMINAL STRIP



MK-4 DIAL DRIVE ASSEMBLY WIRING



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE

9.9.75

DRAWN

B.F.T.

DWG No.

A-2-223

REV.

0

D SERVICING

As the autopilot is of all-solid state construction, very little electrical maintenance is required, other than periodic performance checks. The mechanical components of the system, such as rudder follow-up linkage, should be checked periodically for wear or slack. A heavy-duty marine grease should be applied to prevent corrosion or wear. The hydraulic system should be checked monthly for fluid level. The hydraulic fluid filter should be cleaned occasionally.

E REPAIR

As this unit is extremely sophisticated, the troubleshooting section is confined to external checks. If all external operations and voltages appear normal, yet operation is not correct, then a replacement printed circuit board should be installed, or factory service representative consulted. Field Service of the printed circuit board is not recommended. Exchange parts are available from the factory or service representative.

F FAULT FINDING

The following procedure will help to locate any faults in the autopilot. If a fault is corrected, all checks preceding that section should be repeated.

NOTE: a good quality voltmeter may be necessary for some checks.

See technical section for circuit description.

(a) Power Supply Checks.

Set main switch to RUDDER INDICATOR.

Set DIMMER to +

Dial illumination should be visible. If not, check for the following:

- no power to control unit
- voltage less than 10 volts
- wrong polarity voltage
- fuse blown

- lamp burned out (LI)
- broken or loose harness wire
- defective DIMMER control
- loose printed circuit connector
- fault on printed circuit board (refer to technical description and drawings A-2-224 and A-2-225. Drawing A-2-241 shows component locations).

(b) DIMMER Control Checks.

Vary DIMMER Control from + to -.

Lamp brightness should decrease from bright to dim

- if not, check for the following:

- burned out lamp
- defective DIMMER control
- broken or loose wire in harness
- fault on printed circuit board (refer to drawing A-2-225)

(c) RUDDER INDICATOR faults.

Center the rudder - the Indicator(s) should be centered - if not, check for the following:

- correct connection of indicator wires
- correct connection of rudder follow-up wires
- rudder follow-up linkage adjustment
- fault on printed circuit board (refer to drawing A-2-232).

Move the rudder to hard over PORT. The indicator should read the PORT maximum rudder angle, if indicator reads STARBOARD, reverse wires to terminals 13 and 14, or at individual indicator to indicate PORT. If indication is not PORT maximum rudder angle, check the following:

- broken wire to rudder indicator
- indicators (if more than one) are connected in series
- incorrect adjustment of RT4
- faulty rudder follow-up linkage
- fault on printed circuit board (refer to drawing A-2-232).

Move the rudder to hard over STARBOARD. The indicators should read the same angle as hard over PORT, if not, check the following:

- incorrect rudder follow-up linkage
- fault on printed circuit board (refer drawing A-2-232).

(d) Full Follow-up Amplifier Checks.

Switch off autopilot. Remove wire to terminal 11 of printed circuit board. Start pumpset. Switch to FOLLOW-UP. Rudder should center. If not, check for the following:

- pumpset flow shut off
- broken wires to solenoids

If the rudder goes hard over to PORT with the STARBOARD lamp on, or hard over to STARBOARD with the PORT lamp on, the solenoids are reversed. Reverse wires to terminals 18 and 20 of printed circuit board.

If the rudder goes hard over to PORT with the PORT lamp on, or hard over to STARBOARD with the STARBOARD lamp on, the rudder follow-up wires are reversed. Reverse wires to terminals 15 and 17 of printed circuit board. This will cause a rudder indicator reversal so reverse wires to terminals 13 and 14.

If the rudder centers but hunts back and forth, check for the following:

- rudder speed is too fast. Set pumpset (if adjustable) to approximately 14 seconds or slower, hard over to hard over.
- air in hydraulic lines
- slack in mechanical steering linkage (if mechanical steering)
- loose rudder follow-up linkage
- adjustment of RT5 to high.

(e) Full Follow-up Controller Checks.

Re-connect wire to terminal 11 (if full follow-up controllers or remote controls are fitted).

Center controller - rudder should be centered - if not, check for the following:

- correct controller wiring (see drawing for appropriate controller)
- controller potentiometer not centered
- controller potentiometer noisy or defective.

(f) Full Follow-up Controller Range Adjustment.

Move controller hard over and adjust controller internal rheostat for a rudder angle of approximately 2 degrees less than hard over. Check both sides and, if necessary, readjust controller center and output.

(g) Compass Repeater Function Checks.

Select COMPASS REPEATER function - course dial should move to course shown by autopilot compass. Use a small magnet or swing the vessel to check other headings. If the course dial follows within approximately ± 2 degrees, then all is correct. If the indicated course is in error by an equal amount on all courses, check the following:

- compass sensor is aligned to compass bowl. For small adjustments, the synchro (SY1) may be adjusted.

If the indicated course is correct on some headings but has a large error on others, check the following:

- broken or loose wire, or connector to compass sensor
- broken wire in harness
- defective synchro (SY1)
- defective course detector or Gyro unit synchro

If the course dial hunts at correct course, check the following:

- compass sensitivity (RT1) set too high - see adjustments procedure
- defective synchro (SY1)
- fault on printed circuit board.

If the course dial has reversed rotation or a 120 degree or 240 degree error, the wires to terminals 1, 2 and 3 should be checked for correct connection.

(h) Auto Pilot Function Checks.

NOTE: Due to the complex circuitry involved in these tests, any faults on the printed circuit board should be serviced by a competent electronics technician, or by replacing the circuit board.

The following tests are a guide to determining the correct operation of the automatic steering circuits.

Switch to COMPASS REPEATER position. Allow course dial to settle, then switch to AUTOPILOT. Set YAW, RUDDER and COUNTER RUDDER to -, TRIM TO OFF, DIMMER to +. Turn on pumpset. Rudder should center and stop. If it hunts back and forth the Rudder speed is too high. On fixed speed steering gears it may be necessary to increase the YAW setting to stop hunting. Use course dial to make small (5 degrees) course changes to PORT and STARBOARD. Rudder should make movements of 1 to 2 degrees correspondingly. If the rudder moves hard over, check for the following:

- defective rudder control potentiometer
- broken wire in harness
- solenoid or follow up wiring reversed

If the rudder does not move until 10 degree course changes are made, check the following:

- defective YAW control potentiometer
- broken wire in harness
- fault on printed circuit board (see drawing A-2-231).

Set RUDDER control to +. Set course dial for a 10 degree course change. Set RT6 (rudder limiting to 0 - no rudder limiting). Rudder should move to 30 degrees. If under 30 degrees, increase RT1, if over, decrease RT1.

(i) Auto Trim Checks (see also operating instructions).

Decrease RUDDER control to -. Rudder angle should be approximately 5 degrees. Switch TRIM switch to SET and release to ON position - rudder angle should increase to 15 degrees. Switch TRIM OFF, then ON again. Rudder angle should be 5 degrees (automatic trim time constant). The time for trim to be added may be adjusted by RT3 (ATTC).

(j) Counter Rudder Checks (see also operating instructions)

Set all controls to -, except COUNTER RUDDER, which is set to + (TRIM to OFF, main switch to AUTOPILOT). Change course from actual heading by 10 degrees - rudder should move hard over and then decrease to 5 degrees. The time for this operation will vary with the COUNTER RUDDER time (RT2) constant. If the time constant is very short (RT2 at or near 0), the rudder may not reach the hard over position before returning to 5 degrees.

(k) Rudder Limiting Checks.

The rudder limiting circuit may be checked by setting the RUDDER CONTROL at + and using the course dial to control rudder position. With rudder limiting (RT6) at zero no limiting should occur. With rudder limit (RT6) at 10, rudder movements should be limited to ± 5 degrees approximately. Varying the control setting will give varying amounts of rudder limiting.
(see initial test section)

(l) Internal Switching Circuits.

(electronic switching)
These may be checked by testing that all functions of the autopilot perform normally - if one or two of the functions fail to operate, see dia. A-2-237 and technical description.

SECTION V PARTS LISTS

NOTE: When ordering parts, the autopilot model number, serial number and part number, and description are necessary.

<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>PART NUMBER</u>
	Control unit	510-070
201R	Follow-up unit	510-065
P130	5" compass unit (sensor included)	510-102
P180	7" compass unit (sensor included)	510-103
---	Compass sensor, assembly only	510-093
TS-2	Lever type FFU controller	510-048
RC-4	Remote control	510-104
JOG	Non follow-up controller	510-031
TX-1	Wheel type FFU controller	510-081
RC-5	Knob type FFU controller	510-092
---	Manual	790-007

REPLACEMENT PARTS (SEE DIAG. C-2-202)

---	Printed circuit board complete	510-070 C
---	Dial drive complete assembly	510-105 R
---	Wiring harness less controls	780-008
RV1 to 4	Main control potentiometers	125-001
SW-1	Main switch	200-013
SW-2	Trim switch	210-011
LI	Illumination lamp	410-001
L2, L3	Port and Starboard lamps	410-015
SY-1	Synchro	470-016
M1	Motor	470-020

OTHER SPARES

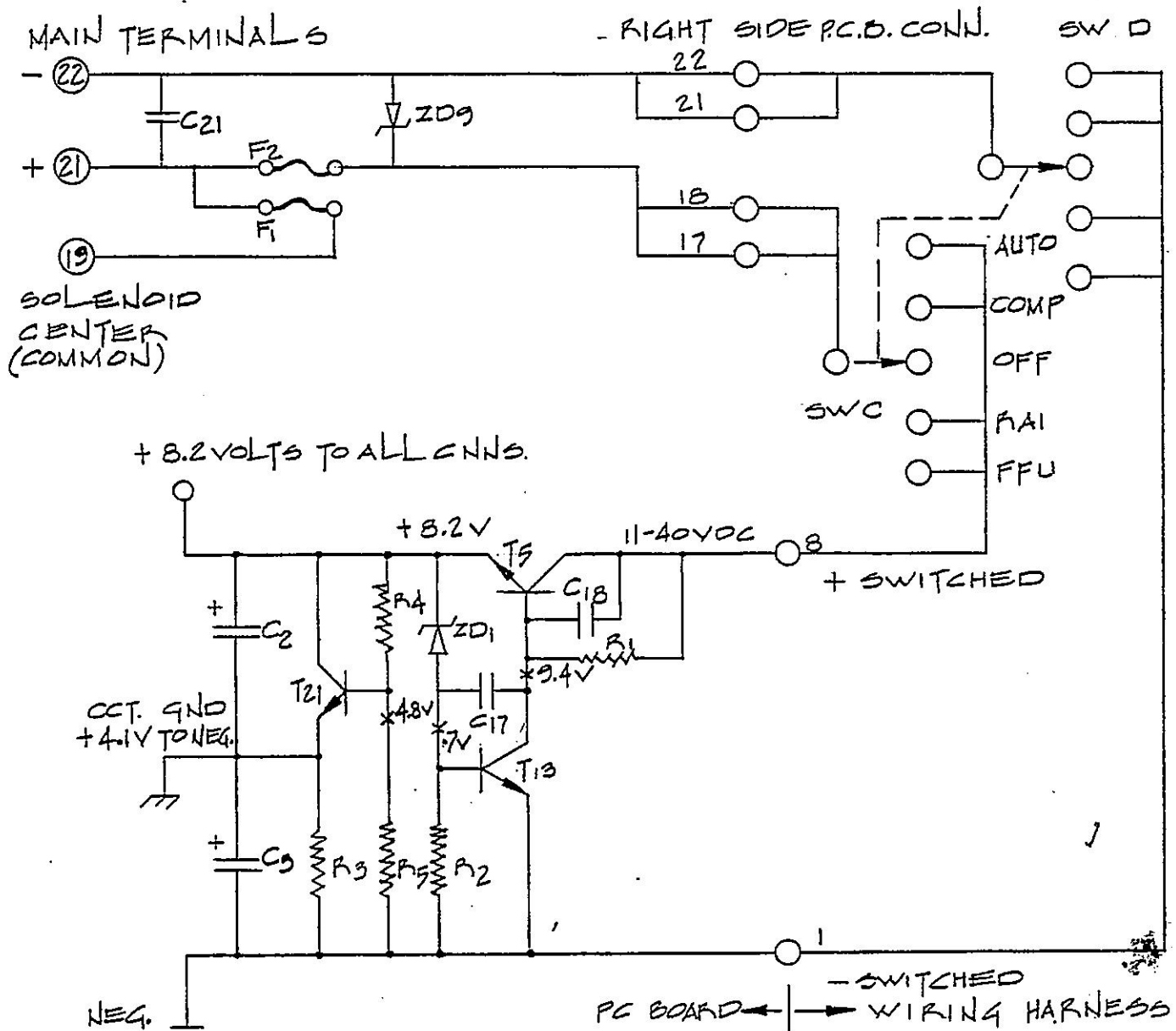
201R	Follow-up potentiometer c/w gear	126-001
TS-2	Potentiometer c/w gear	126-001
TS-2	Output rehostat	130-012
TX-1	Potentiometer	126-001
JOG	Switch micro switch (2 required)	212-001
RC4	Selector switch	200-004
RC4	Toggle switch	210-001
RC5	Toggle switch	210-006
RC5	Potentiometer	125-008

PRINTED CIRCUIT PARTS (510-070B)
(see drawing C-2-202)

<u>SYMBOL</u>	<u>DESCRIPTION</u>	<u>PART NUMBER</u>
---	Terminal strip piece (22 req'd)	430-001
---	Fuse clip (4 required)	421-005
F1	FUSE 5AMP	420-050
F2	FUSE 1AMP	420-010
T1,3,21	NPN PWR Transistor 12 watt	312-003
T2,4	PNP PWR Transistor 12 watt	313-002
T5, 6	NPN PWR Transistor 70 watt	312-002
T7, 8	NPN PWR Transistor 90 watt	312-001
T9,11,14 & T15	PNP Sig. Transistor .35 Watt	311-003
T10,12,13 16 & 17	NPN Sig. Transistor .35 watt	310-002
T18	Field effect transistor .35 watt	316-001
T19,20,22	PNP Sig. Transistor .35 watt	311-003
D1,2,3,4	1 amp diode 600 v	300-003
D5, 6	Reference diode 1.8 v	300-008
D7-D17	1 amp diode 600 v	300-003
ZD1	7.5 v. 5% zener .5 watt	302-009
ZD2	7.5v. zener .5 watt	302-009
ZD3-6	4.7 v. zener .4 watt	302-002
ZD7,8	51 v. zener 1 watt	302-010
IC1-7	Dual operational amplifier	350-001
IC8, 9	Quad electronic switch	360-001
C1,4,5,6	.047 uf capacitor 250 v.	400-001
C2,3	470 uf capacitor 6 v.	401-012
C7	1 uf capacitor 100 v.	400-004
C8	10 uf capacitor 20 v.	401-016
C9, 10	22 uf capacitor 15 v.	401-013
C11,12, C13	82 uf capacitor 10 v.	401-011
C14	.1 uf capacitor 100 v.	400-002
C16	.047 uf capacitor 250 v.	400-001
C18	.005 uf capacitor 100 v.	400-014
L4	Lamp 28 v. 40 MA	410-012
RT1	100 K Min. Potentiometer .5 watt	130-023
RT2,3	1M Min. Potentiometer .5 watt	130-022
RT4,5,6	10K Min Potentiometer .5 watt	130-021
R1	Resistor 1K2 2.5 watt	104-012
R2	Resistor 33 .25 watt	100-015
R3	" 47 3.5 watt	105-008
R4	" 91 .25 watt	100-071
R5	" 130 .25 watt	100-027
C15,19	10 uf capacitor 10 v.	401-016
C20	.01 uf capacitor 100 v.	400-015
ZD9	51 v.zener 5 watt	302-022
C17	.001 UF capacitor 50 volt	400-019

<u>SYMBOL</u>	<u>DESCRIPTION</u>			<u>PART NUMBER</u>
R6	Resistor	2K2	.25 watt	100-028
R7	"	270	"	100-020
R8,9	"	8K2	"	100-035
R10	"	1K	"	100-005
R11,12	"	2K2	"	100-028
R13,14	"	1K	"	100-005
R15	"	470K	"	100-006
R16	"	1K	"	100-005
R17,18	"	2K2	"	100-028
R19,20	"	1K	"	100-005
R21	"	4K7	"	100-062
R22	"	10K	"	100-003
R23,24	"	47K	"	100-060
R25,26	"	1M	"	100-044
R27,28	"	1K	"	100-005
R29	"	10K	"	100-003
R30	"	1M	"	100-044
R31,32	"	5M6	"	100-042
R33,35	" "	2K2	"	100-028
R34,36	"	1K	"	100-005
R37	"	470K	"	100-006
R38	"	10K	"	100-003
R39	"	47K	"	100-060
R40	"	1K8	"	100-010
R41	"	68K	"	100-021
R42	"	10K	"	100-003
R43	"	180	"	100-022
R44	"	10K	"	100-003
R45	"	47K	"	100-062
R46,47,48	"	10K	"	100-003
R49	"	4K7	"	100-062
R50	"	27K	"	100-013
R51	"	47K	"	100-060
R52,53	"	22K	"	100-008
R54	"	470K	"	100-006
R55,56	"	1K	"	100-005
R57,59	"	220	"	100-017

<u>SYMBOL</u>	<u>DESCRIPTION</u>			<u>PART NUMBER</u>
R58,60	Resistor	22	.25 watt	100-017
R61,62, 63,64	"	1K	"	100-004
R65	"	56K	"	100-007
R66	"	33K	"	100-059
R67	"	1K	"	100-005
R68	"	2K2	"	100-028
R69,70	"	1K	"	100-005
R71,72	"	10K	"	100-003
R73	"	6K8	"	100-034
R74,76	"	220	"	100-017
R75	"	150	"	100-029
R77,78, 79,80	"	10K	"	100-003
R81,82	"	150K	"	100-066
R83,84	"	4K7	"	100-062
R85,87	"	65	3.5 watt	105-003
R86	"	1K	.25 watt	100-005
R88	"	1K	"	100-005
R89-94	"	10K	"	100-003
R96	"	1K	"	100-005
R97	"	15K	"	100-068
R98	"	10K	"	100-003



- SWA, D MAIN FUNCTION SWITCHED
- F1 - SOLENOID FUSE 5A
- F2 - CIRCUIT FUSE 1A
- ZD1 - VOLTAGE REFERENCE
- ZD9 - OVERVOLTAGE PROTECTION ZENER
- T5 - 8.2 VOLTS SERIES REGULATOR
- T13 - REGULATOR DRIVER
- T21 - CONN GND SERIES REGULATOR
- C2, 3 - FILTER CAPACITORS

MK-4 POWER SUPPLY SCHEMATIC



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE

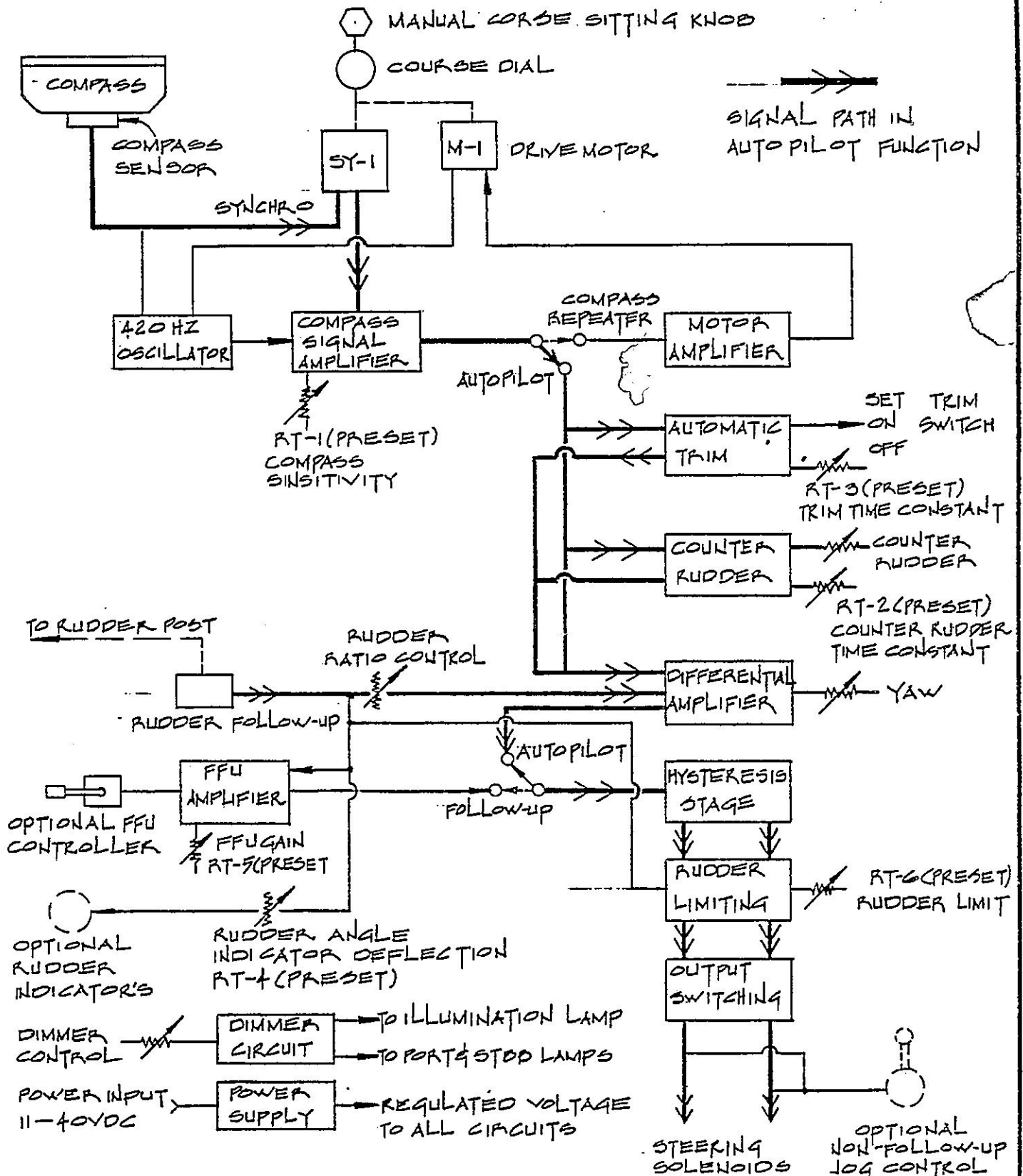
FEB 1 / 77

DRAWN

DWG No.

A-2-224

REV



MK-4 AUTOPILOT FUNCTIONAL BLOCK DIAGRAM

WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
FEB. 9/ 77	A-2-240	
DRAWN		

WAGNER HYDRAULIC PUMPING SETS

INSTALLATION AND SERVICE OF

Type 1A - This is a tight duty reversing motor type. The 1/6 HP electric motor drives a variable volume pump. This pump is set to achieve a rudder speed of approximately 14 seconds. The motor only turns when necessary and in the direction required.

This pumpset is only recommended for autopilot use on steerings up to type 250-1300 or type T10. This pumpset should be fused according to its voltage and should be switched off when not in use as the motor field winding draws a constant 1.5 AMP current.

12V - 20 AMP 24V - 15 AMP 32V - 15 AMP

Type 2A - This is a medium duty constant running type. The 1/2 HP motor drives a gear type pump. The oil flows through a flow control valve so that the steering speed may be adjusted for the type of steering gear.

This pumpset is suitable for autopilots and maneuvering.

(Internally Fused) 12V - 40 AMP 24V - 40 AMP 32V - 30 AMP

Intermittent rating 1 1/2 HP

Type 3 - This is similar to Type 2 but the pump is belt driven from the ships main engine.



NON FOLLOW-UP STEERING

Non follow-up steering is also called "time dependent steering". The longer a hydraulic valve admits oil to the steering cylinder the further over the rudder moves. The rudder angle is solely dependent on the length of time that the valve is energized. The system is in essence a helm pump which turns to the left or right on command from an electrical signal. This system is the electrical-hydraulic interface for jog and/or automatic pilots.

The basic system consists of a filter, a pump (engine driven or electric motor driven), a flow control valve (to regulate the hard over time of the steering gear), a solenoid operated 4-way valve (to direct oil into either the port or the starboard side of the steering cylinder) and a lockvalve (which isolates the non follow-up system from the main steering system). Shut off valves are plumbed directly into the lockvalve ports for use if the lockvalve should bypass oil. All of these components are mounted together on a manifold block. Two different models of manifold are used. These are "MOD" and "DG4S4". See Dwg. No. D-3080 for manifold assemblies and component parts lists.

PIPING THE SYSTEM

It is important to prevent entry of any type of contaminant into the piping. The most common contaminants are: Teflon tape, pipe fitting compound, metal filings and chips, sawdust, welding splatter and parts of cleaning rags. It is of course essential that the interior of all piping is clean before beginning the installation. Copper tubing and pipe, seamless steel tubing and galvanized pipe should be blown out with air or flushed out with diesel oil, kerosene, varsol or any other solvent compatible with mineral oil. The best procedure is to flush and then blow out the piping. Black iron pipe as delivered should never be used. It is barely acceptable after pickling followed by neutralizing (pacifying). Internal sandblasting followed by flushing and blowing if properly done is better than pickling. If any welding or brazing is done after cleaning, the resulting oxidation scale must be removed by scraping and blowing out. For this reason welding should only be done at the end of pipes where an easy visual

inspection can be made. Where exposed to salt water spray such as on decks of boats or through fish holds, stainless steel tubing or galvanized pipe should be used. Galvanized standard pipe with extra heavy fittings is quite acceptable.

To avoid contamination with pipe fitting compound such as Teflon tape or Permatex it is essential that they are applied to the male threads only. Leave the first two threads free of compound. Quite often a fitting must be removed to reposition it or to install a new one. It is important to free the female thread of all remaining compound. This is particularly important with Teflon tape as it usually shreds into small bits. If Teflon tape is used only 1/2 the tightening effort normally applied with pipe dope should be used, otherwise the female connection is likely to distort or even crack. All open piping should be well protected during installation to prevent the entry of contamination. When piping is complete, if possible, the entire system should be flushed and blown out again. To do this, a connection preferably at a high point in the system should be broken and either a wing or power pump connected to the line. This pump should be large enough to provide a fast flow of solvent through the piping to ensure a thorough cleaning. It is desirable to blow out the system after draining the solvent but a small amount of solvent remaining is harmless providing that it is oil compatible.

The size of the piping should not be smaller than recommended on the piping diagram. Hydraulic hose should only be used in short lengths at the pump or cylinder ports to facilitate movement or vibration. Long lengths are very detrimental to performance causing stiff steering, sponginess and overeating in power systems. If pipes are small and short in a power system, overheating may result. The minimum length of return line to the power pump is 15 feet. For minor heating problems it is usually sufficient to use a longer large diameter return line (coiled if space is limited). More severe problems require the use of a heat exchanger. A good oil to air exchanger is finned tubing such as used in hot water base board heaters. The system is too hot if a hand cannot be held comfortably on any line for 1/2 a minute (about 160°F - 71°C) maximum.

All piping should be done with a minimum of sharp bends and fittings. All pipes should be clamped so that vibration or pressure surges will not cause wear or noise. Clamping is essential at any pipe end which connects to a hose. "Goosenecks" in piping should be avoided. If this is not possible, provision for venting at the high points should be made. This venting provision is not important with power systems where the oil flows in one direction only at a relatively high velocity and carries trapped air along. It is important in hand hydraulic systems having a closed circuit where oil flows at low speed in both directions keeping the same oil and air flowing back and forth over a short distance. This keeps air trapped at the high points. It is also extremely important that all fittings are air tight. If any connections show a trace of leaking oil, air is sure to enter the system at this point. Vent or filling lines to a header tank should be installed with a steady rise to ensure that the system will be self venting because air may occasionally enter through shaft and piston rod seals. It is extremely important to remember that trapped air can only be removed from lines where the oil velocity is low, through self venting, by installing the piping with a steady rise.

FILLING THE SYSTEM

The main steering lines from the helm pump(s) to the steering cylinder must be filled first. The header tank should be vented to atmosphere and always be kept full to avoid sucking air and forcing it into the system. If more than one helm pump is in the system, start with the highest and work progressively down toward the lowest. Begin by turning the highest wheel continually in one direction only until the system starts to become relatively solid. The helm pump should now be turned steadily in the opposite direction until it is also solid. Continue this same sequence with each successively lower helm pump. The lines from the helm pump(s) should be sufficiently full at this point to continue filling the rest of the system.

The power pump should never be run until the system is filled with oil. Crack the fitting at the pump suction to ensure ample oil has flowed from the header tank. Note that the suction port is larger in diameter than the pressure port. When oil has reached the suction port

it is permissible to start the pump. "Pulse" start the pump for ten seconds at a time if possible to allow oil to flow from the header tank to the pump suction to avoid "starving" and damaging the pump. The pump could be extremely noisy at this stage because of the oil and air mixture.

When the power pump becomes quieter this indicates that a steady flow of oil is now being circulated. The 4-way solenoid valve may be manually or electrically operated to both port and starboard to fill the non-follow-up system. It will take time for all of the air to be expelled from the system. Working the system and then allowing it to rest for a few hours is the fastest method of removing the air. The steering gear will not be smoothly responsive until most of the air, is removed.

RECOMMENDED OILS

Gulf Harmony AW 43

Gulf HV1 47

Imperial Esso Nuto H 38

Imperial Esso Univis N 42

Shell Tellus 25

Shell Tellus T 27

Chevron OC Turbine Oil No. 11

NOTE: In cold climates use:
Imperial Univis N 42
Imperial Univis Arctic

If none of these recommended oils or their equivalents are available, use any oil suitable for hydraulic winch drives or an SAE 10 non-detergent oil, or automatic transmission fluid type "A".

MAINTENANCE PROCEDURE

The pressure line filter should be cleaned after the first hour of operation. Thereafter, occasional inspection should be considered routine.

The pressure compensated flow control valve has a built-in relief valve which limits the non follow-up system pressure. This valve is

factory pre-set. If this relief valve is removed from the main valve body, care should be taken in replacing it in order to achieve the same setting. If oil is not flowing through this valve, either the piston (424-0004) or the relief ball (21-300004) is held open by contamination. The valve must then be cleaned (the piston must slide freely in its bore). The flow adjusting knob is stamped with numbers 0-5. Setting number 0 will stop the oil flow. Setting number 5 will allow maximum delivery (fastest rudder speed).

The lockvalve should be inspected and cleaned if the steering cylinder does not respond when the helm pump is turned. A temporary solution (and a check) is to close the shut off valves on the lockvalve ports.

The solenoid operated 4-way valve can be operated manually by pushing a slender rod into either end of the valve.

TROUBLE SHOOTING THE NON FOLLOW-UP SYSTEM

The symptoms below are usually caused by failure of the components on the manifold. See Dwg. No. D-3080.

A. Steering gear goes hard over and cannot be returned to midships.

SOLN: The solenoid 4-way valve may be jammed in an energized position.

B. Jog switches or autopilot do not operate

SOLN: 1. The voltage on the 4-way solenoid valve coil may be too low. Manually operate the valve by pushing a slender rod in either end of the valve to test.

2. The piston or the relief valve in the flow control valve may be jammed with contamination. Clean and return the pressure adjusting screw to the same position by measuring its height above the valve body before removing. The piston should slide freely in its bore.

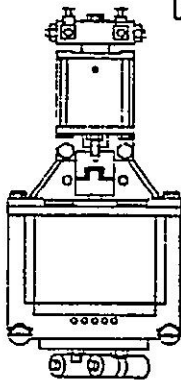
3. The flow control knob on the flow control valve could be set in the off (0) position. Adjust the knob.

4. Check the direction of rotation of the power pump. This should be clockwise - viewed from the shaft end.

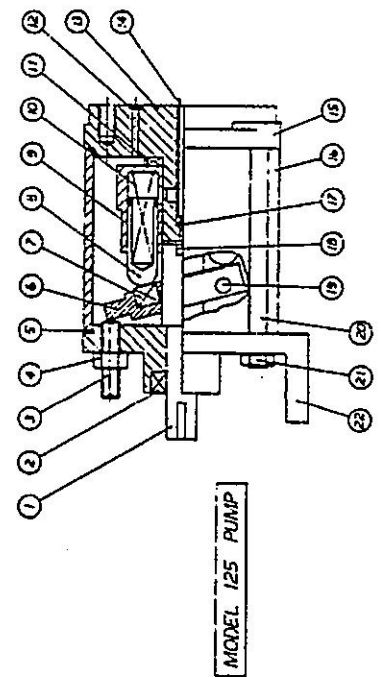
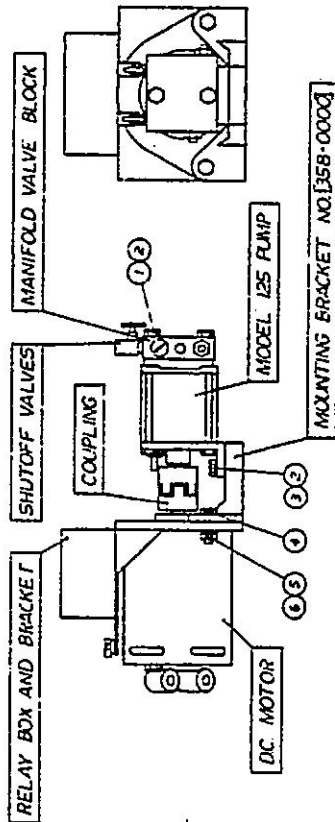
C. Steering gear moves very slowly when jog switch or autopilot is operated.

SOLN:1.The voltage on the 4-way solenoid valve coil may be too low. Manually operate the valve by pushing a slender rod in either end of the valve to test.

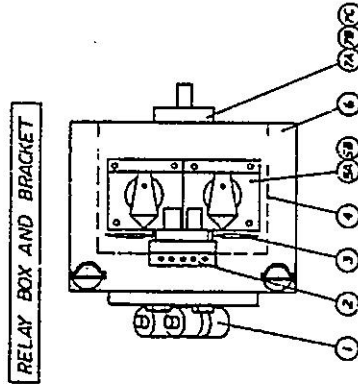
2.The piston or the relief valve in the flow control valve may be jammed with contamination. Clean and return the pressure adjusting screw to the same position by measuring its height above the valve body before removing. The piston should slide freely in its bore.



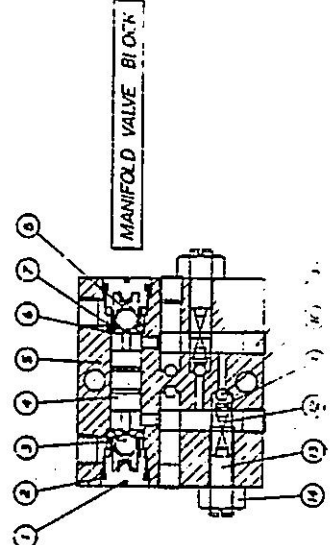
TYPE 1A
PUMPSET
ASSEMBLY



MODEL 125 PUMP



RELAY BOX AND BRACKET



MANIFOLD VALVE BLOCK

TYPE 1A PUMPSET ASSEMBLY

1	1	430-0001	END INSENT
2	1	11-06114	D RING
3	2	21-300010	BALL
4	1	430-0001	SPACER
5	1	11-061015	O RING
6	2	430-0003	BALL SEAT
7	2	31-100003	SPRING
8	1	41-100001	PLUG
9	2	21-300002	BALL CUP
10	2	31-100007	SPRING
11	2	31-100002	SPRING
12	2	31-100002	SPRING
13	2	31-100002	SPRING
14	2	31-100002	SPRING

RELAY BOX AND BRACKET

1	2	430-0002	CAPACITOR
2	1	310-010	TERMINAL STRIP
3	2	104-000	RESISTOR (1/2 WATT)
4	1	104-000	RESISTOR (1/2 WATT)
5	2	430-0002	COIL
6	2	430-0002	COIL
7	1	430-0002	COIL
8	1	430-0002	COIL
9	1	430-0002	COIL
10	1	430-0002	COIL
11	1	430-0002	COIL
12	1	430-0002	COIL
13	1	430-0002	COIL
14	1	430-0002	COIL

MANIFOLD VALVE BLOCK [NO. 458-0003]

1	2	430-0002	END INSENT
2	1	11-06114	D RING
3	2	21-300010	BALL
4	1	430-0001	SPACER
5	1	11-061015	O RING
6	2	430-0003	BALL SEAT
7	2	31-100003	SPRING
8	1	41-100001	PLUG
9	2	21-300002	BALL CUP
10	2	31-100007	SPRING
11	2	31-100002	SPRING
12	2	31-100002	SPRING
13	2	31-100002	SPRING
14	2	31-100002	SPRING

MODEL 125 PUMP [NO. 357-0003]

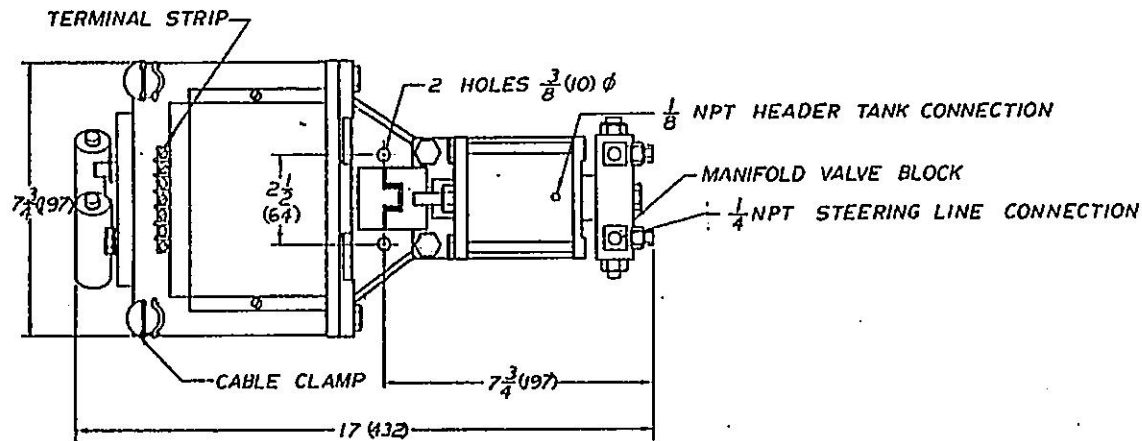
1	1	357-0002	SHAFT
2	1	11-061008	SEAL
3	1	357-0004	ADJUSTING SCREW
4	1	31-100001	SEAL NUT
5	2	11-061011	O RING
6	1	357-0007	SHAFT PLATE
7	1	21-00000	BEARING
8	1	357-0002	PISTON
9	1	357-0010	ROTOR
10	1	31-100008	SPRING
11	1	11-061008	BEARING
12	1	11-061008	O RING
13	1	11-061008	O RING
14	1	357-0017	WIRE SPACER
15	1	357-0016	BACK PLATE
16	1	357-0011	HOUSING
17	2	21-300009	BALL
18	1	31-100003	KEY
19	2	357-0010	PISTON
20	4	357-0004	NUT
21	4	31-80004	WASHER
22	1	357-0008	FRONT PLATE

ITEM QTY PART NO. DESCRIPTION

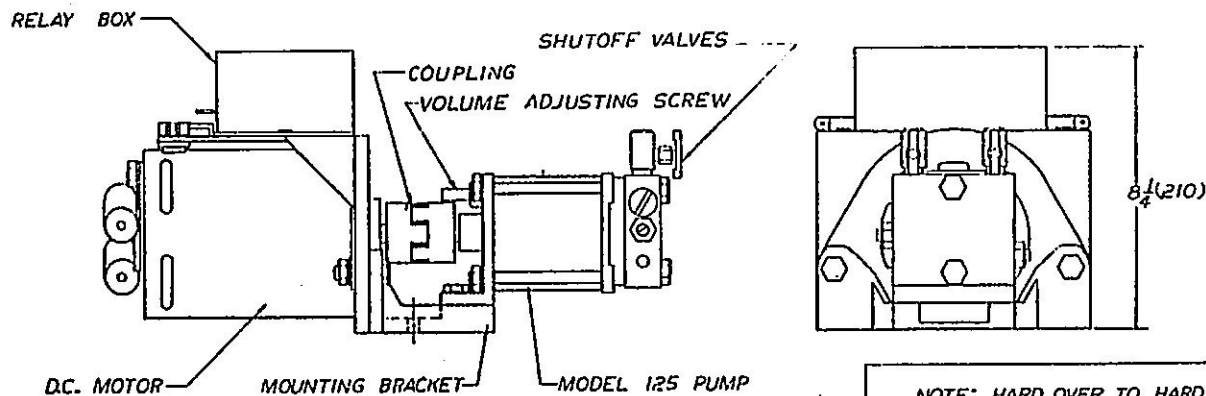
WAGNER ENGINEERING LTD.
100 West End Avenue, Scarborough, Ont., Canada
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PARTS LIST FOR
TYPE 1A PUMPSET

DATE: 11/28/72
DRAWN BY: []
CHECKED BY: []
D-3125



NOTE:
 -EXTRA CLEARANCE WILL BE REQUIRED FOR INSTALLING OR SERVICING THE PUMPSET
 -PUMPSET MUST BE MOUNTED HORIZONTALLY

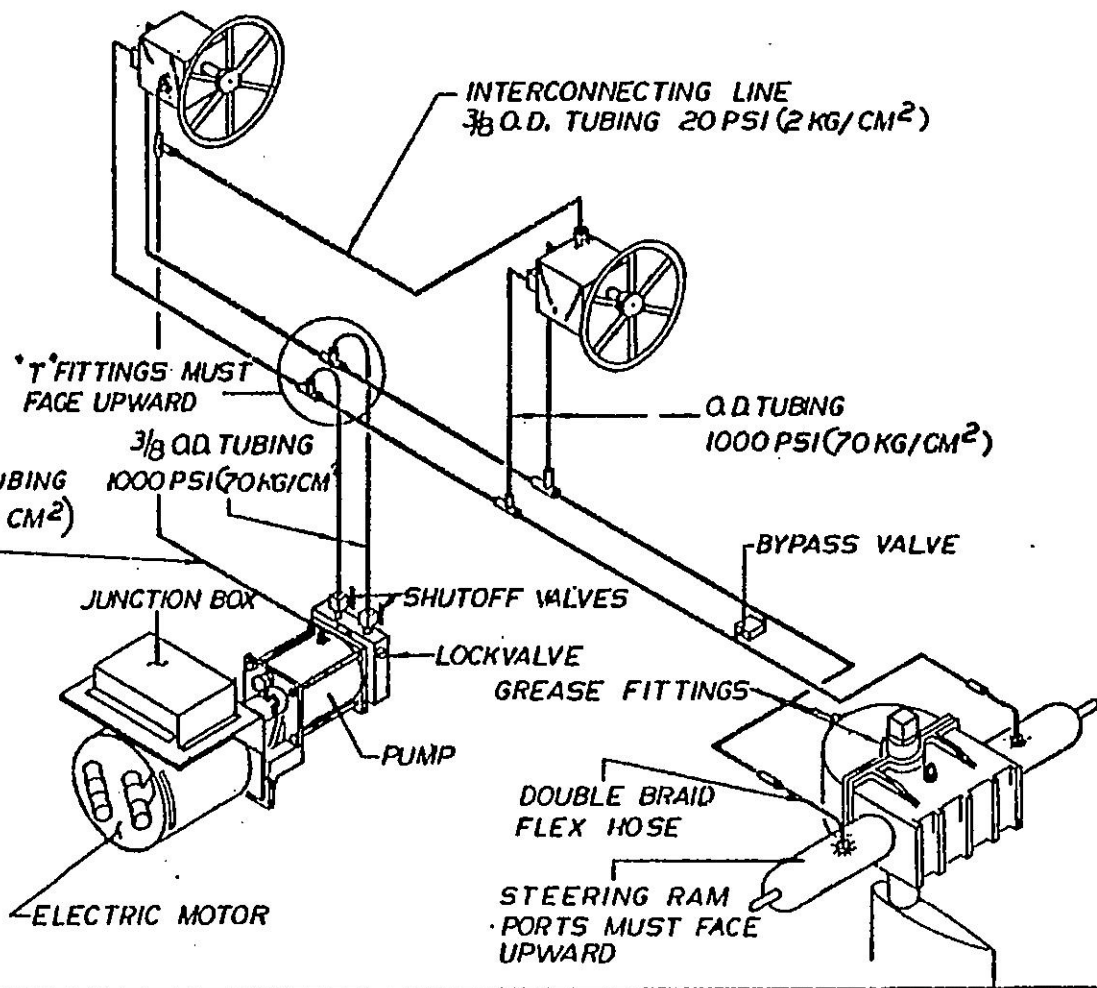


NOTE: HARD OVER TO HARD OVER SPEED OF CYLINDER/RAM SHOULD BE APPROX. 14 TO 18 SECONDS FOR AUTOMATIC PILOT OPERATION.

- A. LOSSEN VOLUME ADJUSTING SCREW, LOCKING NUT.
- B. 1. TO INCREASE CYLINDER/RAM SPEED, TURN SCREW COUNTER CLOCKWISE.
 2. TO DECREASE CYLINDER/RAM SPEED, TURN SCREW CLOCKWISE.
- C. TIGHTEN LOCKING NUT


NOTE: DRAWING REDUCED TO A SIZE

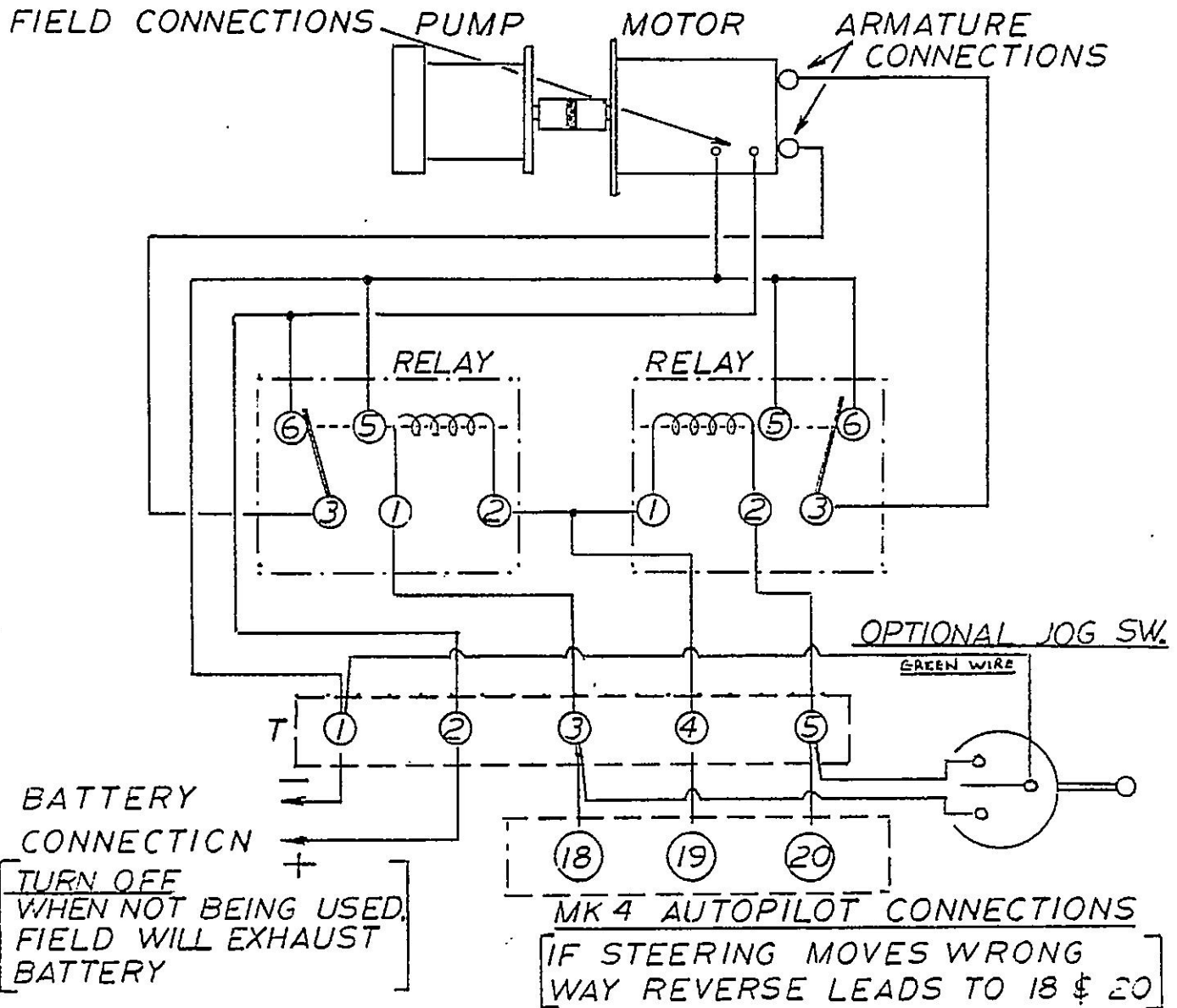
DETAIL	QUANTITY	DESCRIPTION	MATERIAL
WAGNER ENGINEERING LTD.			
1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS			
TITLE OVERALL DIMENSIONS FOR TYPE 1A PUMPSET			
DRAWN A.M.	DATE AUG 19/76	SCALE ---	QUOTE NO
REVISION NOTES C1-NOTE ADDED			DRAWING NO C-2164
			REV. 01



NOTE

- PUMPSET MUST BE MOUNTED HORIZONTALLY AS SHOWN
- ALL PIPING AND FITTINGS SUPPLIED BY YARD
- T-MODEL HOUSING MUST BE COMPLETELY PACKED WITH GREASE, SEE INSTALLATION INSTRUCTION FOR DETAILS

DETAIL	QUANTITY	DESCRIPTION	MATERIAL
 WAGNER ENGINEERING LTD. 1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA <small>Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS</small>			
TITLE MANUAL HYDRAULIC WITH TYPE 1A PUMPSET			
DRAWN F. C.	DATE AUG. 1976	SCALE —	QUOTE NO —
PREVIOUS NOTES			DRAWING NO B-1-955
			REV. —



RECOMMENDED WIRE SIZE FOR THE FOLLOWING DISTANCES FROM THE BATTERY TO T1 & T2

VOLTAGE	FUSE	10 FT	10-20 FT	20-40FT	OVER 40 FT
12 VOLT	20 A	# 14	# 12	# 10	NOT RECOMMENDED
24	15	# 16	# 14	# 12	NOT RECOMMENDED
32	15	# 16	# 14	# 12	NOT RECOMMENDED

TYPE 1A PUMPSET TO MK 4 AUTOPILOT CONNECTIONS



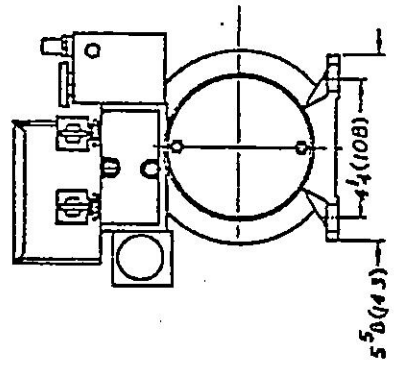
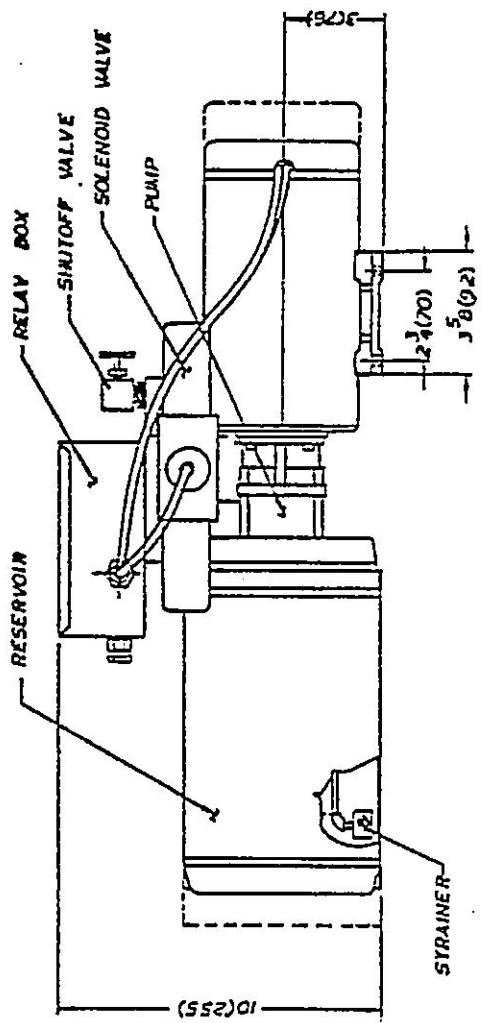
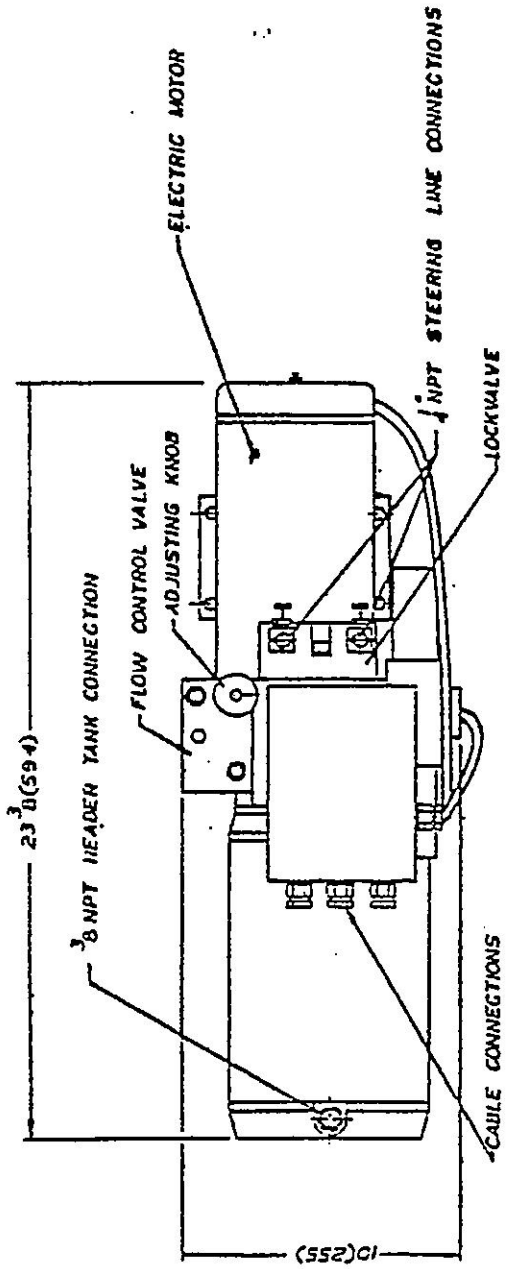
WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

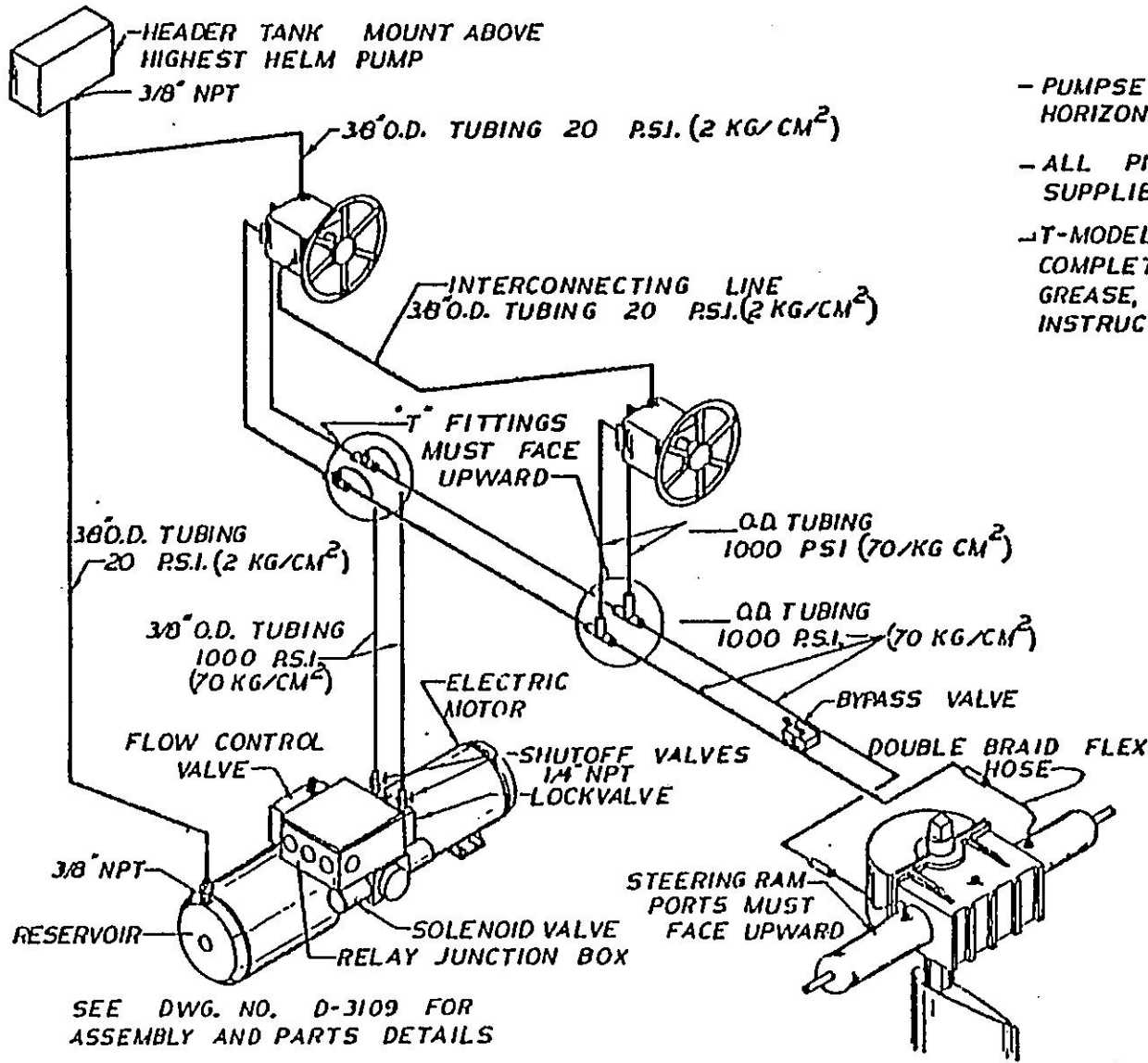
DATE
24 OCT 77
DRAWN
JK

DWG No. REV
A-2-265 02




NOTE:
 - EXTRA CLEARANCE WILL BE REQUIRED FOR INSTALLING OR SERVICING THE PUMSET.
 - PUMP MUST BE MOUNTED HORIZONTALLY

QUANTITY	DESCRIPTION	REVISION
WAGNER ENGINEERING LTD.		
1115 WEST 2ND AVENUE, VANCOUVER, B.C., CANADA		
Manufacturers of All kinds of Hydraulic Steering Gear and Automatic Pilot		
TITLE		
OVERALL DIMENSIONS		
TYPE 2A PUMSET		
DATE	SCALE	QUOTE NO
F C	AUG 07/76	
SYNCH NOTES		DATE
		REV
		J-2163



NOTE:

- PUMPSET MUST BE MOUNTED HORIZONTALLY AS SHOWN
- ALL PIPING AND FITTINGS SUPPLIED BY YARD
- T-MODEL HOUSING MUST BE COMPLETELY PACKED WITH GREASE, SEE INSTALLATION INSTRUCTION FOR DETAILS

DETAIL	QUANTITY	DESCRIPTION	MATERIAL
 WAGNER ENGINEERING LTD. 1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA <small>Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS</small>			
TITLE MANUAL HYDRAULIC WITH TYPE 2 A PUMPSET			
DRAWN A.M.	DATE JUNE 976	SCALE	QUOTE NO
REVISION NOTES			DRAWING NO B-1954
			REV.

SEE DWG. NO. D-3109 FOR
ASSEMBLY AND PARTS DETAILS

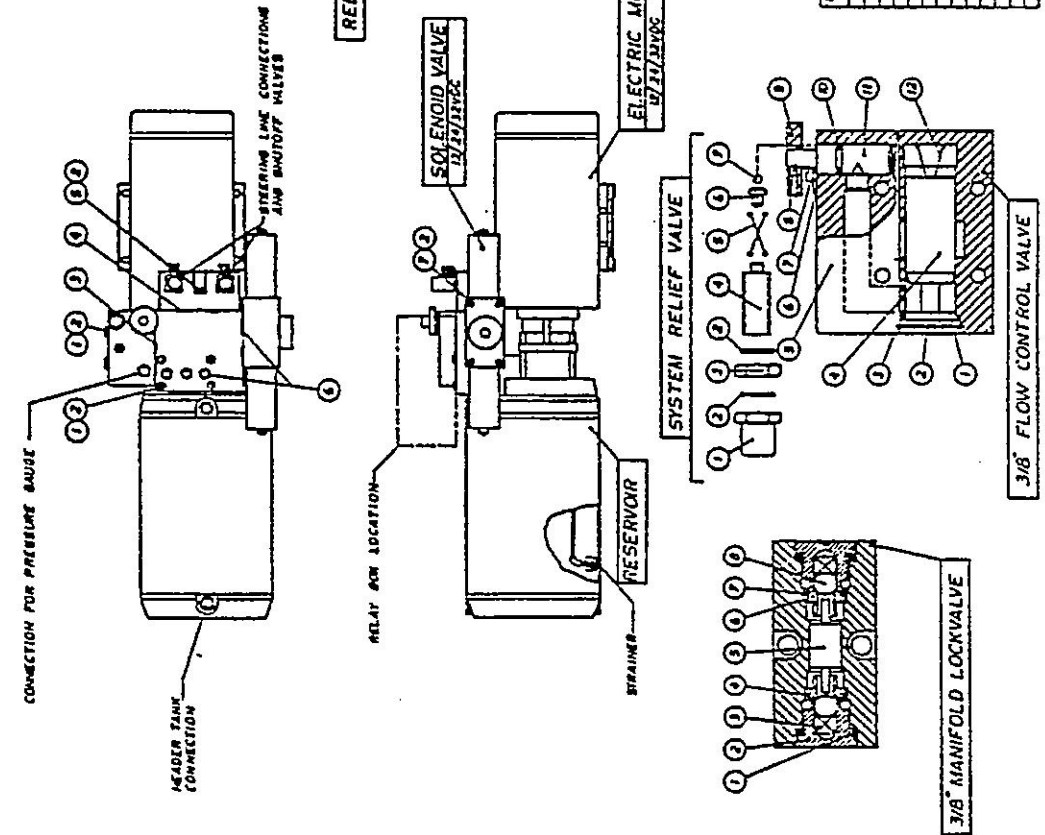
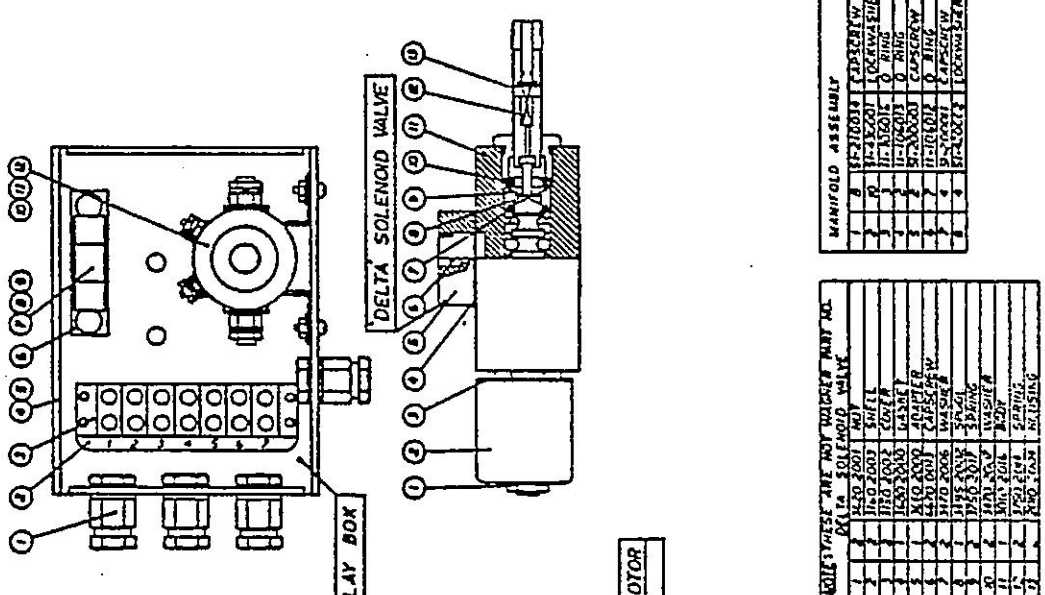
RELAY BOX (M14-0000)	
1	410-008 CIRC FITTING
2	410-011 NUTS
3	410-020 TERMINAL STRIP
4	420-054 BOX
5	420-055 LID
6	421-004 FUSE HOLDER
7	430-101 FUSE 10 A 250VDC
8	430-101 FUSE 20 A 250VDC
9	430-101 FUSE 15 A 250VDC
10	440-014 RELAY 12 VDC
11	440-015 RELAY 24 VDC
12	450-004 RELAY 32 VDC

3/8" MANIFOLD LOCKVALVE (M0-400000)	
1	11-101020 O RING
2	420-0302 BALL GAGE
3	11-100001 SPRING
4	120-0304 BUSH
5	21-100001 PISTON
6	21-100006 BALL SEAL
7	11-101018 O RING
8	11-100001 BALL

3/8" FLOW CONTROL VALVE (M1-0000)	
1	11-100001 END FIT
2	11-101001 SHAP RING
3	11-101018 O RING
4	11-100001 PISTON
5	11-100006 BALL SEAL
6	11-101001 SET SCREW
7	11-100001 CONTROL ANOD
8	11-101018 O RING
9	11-100001 CONTROL SPRING

SYSTEM RELIEF VALVE	
1	11-100001 SCREW NUT
2	11-100001 O RING
3	11-100001 LOCK NUT
4	11-100003 ADJUSTING SCREW
5	11-100000 SPRING
6	11-100001 BALL COP
7	11-100001 BALL

MANIFOLD ASSEMBLY	
1	11-100001 LOCKWASHER
2	11-100001 O RING
3	11-100001 CAPSCREW
4	11-100001 O RING
5	11-100001 CAPSCREW
6	11-100001 LOCKWASHER



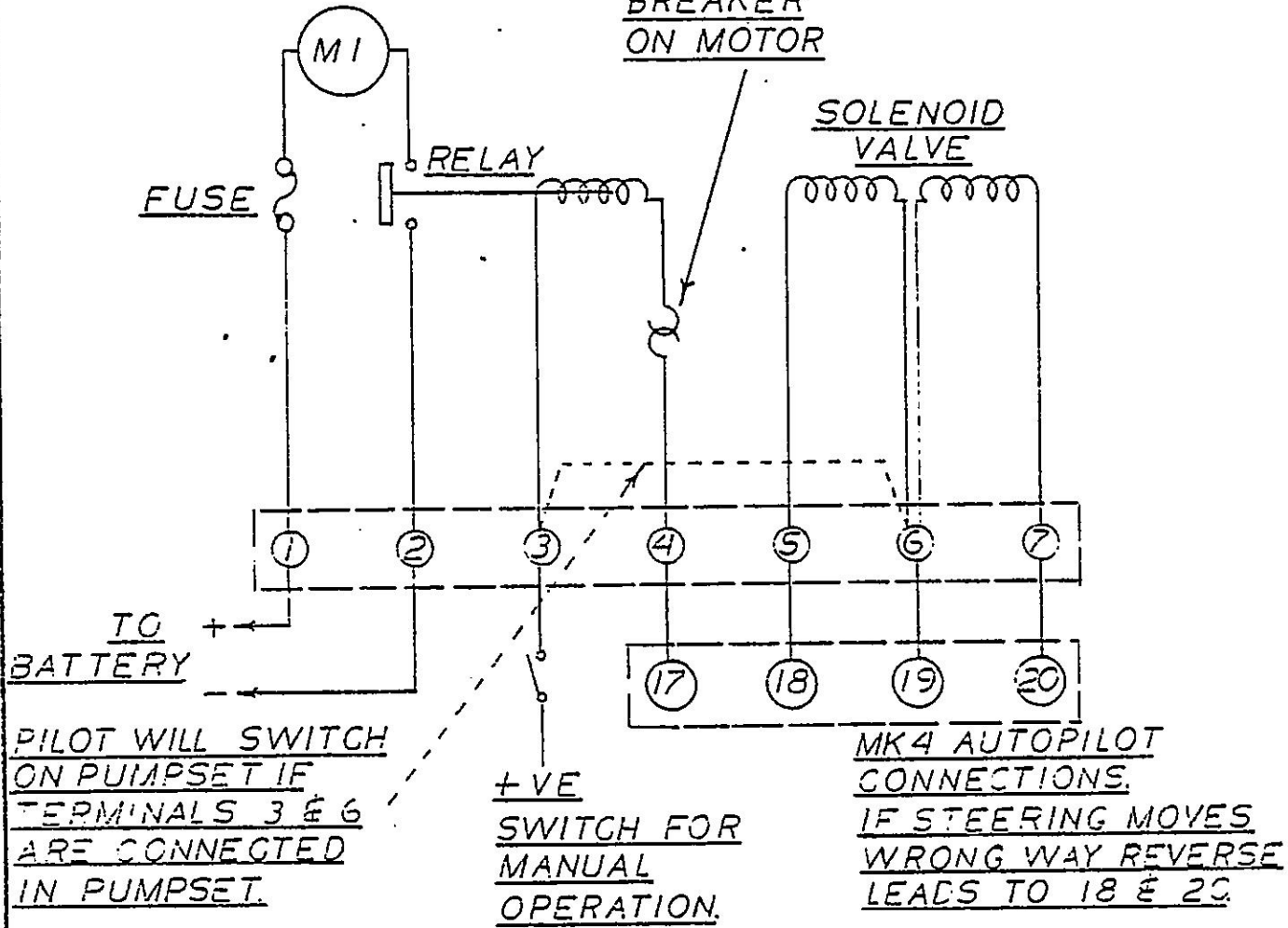
SOLLENSOID AND MOTOR PART NO.	
1	11-100001 SCREW NUT
2	11-100001 O RING
3	11-100001 LOCK NUT
4	11-100003 ADJUSTING SCREW
5	11-100000 SPRING
6	11-100001 BALL COP
7	11-100001 BALL

MANIFOLD ASSEMBLY	
1	11-100001 LOCKWASHER
2	11-100001 O RING
3	11-100001 CAPSCREW
4	11-100001 O RING
5	11-100001 CAPSCREW
6	11-100001 LOCKWASHER

MOTOR

THERMAL
BREAKER
ON MOTOR

SOLENOID
VALVE



PILOT WILL SWITCH
ON PUMPSET IF
TERMINALS 3 & 6
ARE CONNECTED
IN PUMPSET.

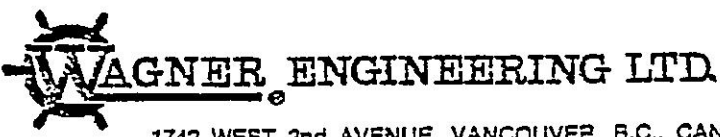
+VE
SWITCH FOR
MANUAL
OPERATION.

MK4 AUTOPILOT
CONNECTIONS.
IF STEERING MOVES
WRONG WAY REVERSE
LEADS TO 18 & 20.

RECOMMENDED WIRE SIZE FOR THE FOLLOWING DISTANCES FROM THE BATTERY TO T1 & T2

VOLTAGE	FUSE	10FT	10-20FT	20-30FT	OVER 30 FT
12 VOLT	40 A	# 10	# 8	# 6	NOT RECOMMENDED
24 VOLT	40 A	# 10	# 8	# 6	NOT RECOMMENDED
32 VOLT	30 A	# 12	# 10	# 8	NOT RECOMMENDED

TYPE 2A PUMPSET TO MK4 AUTOPILOT CONNECTIONS



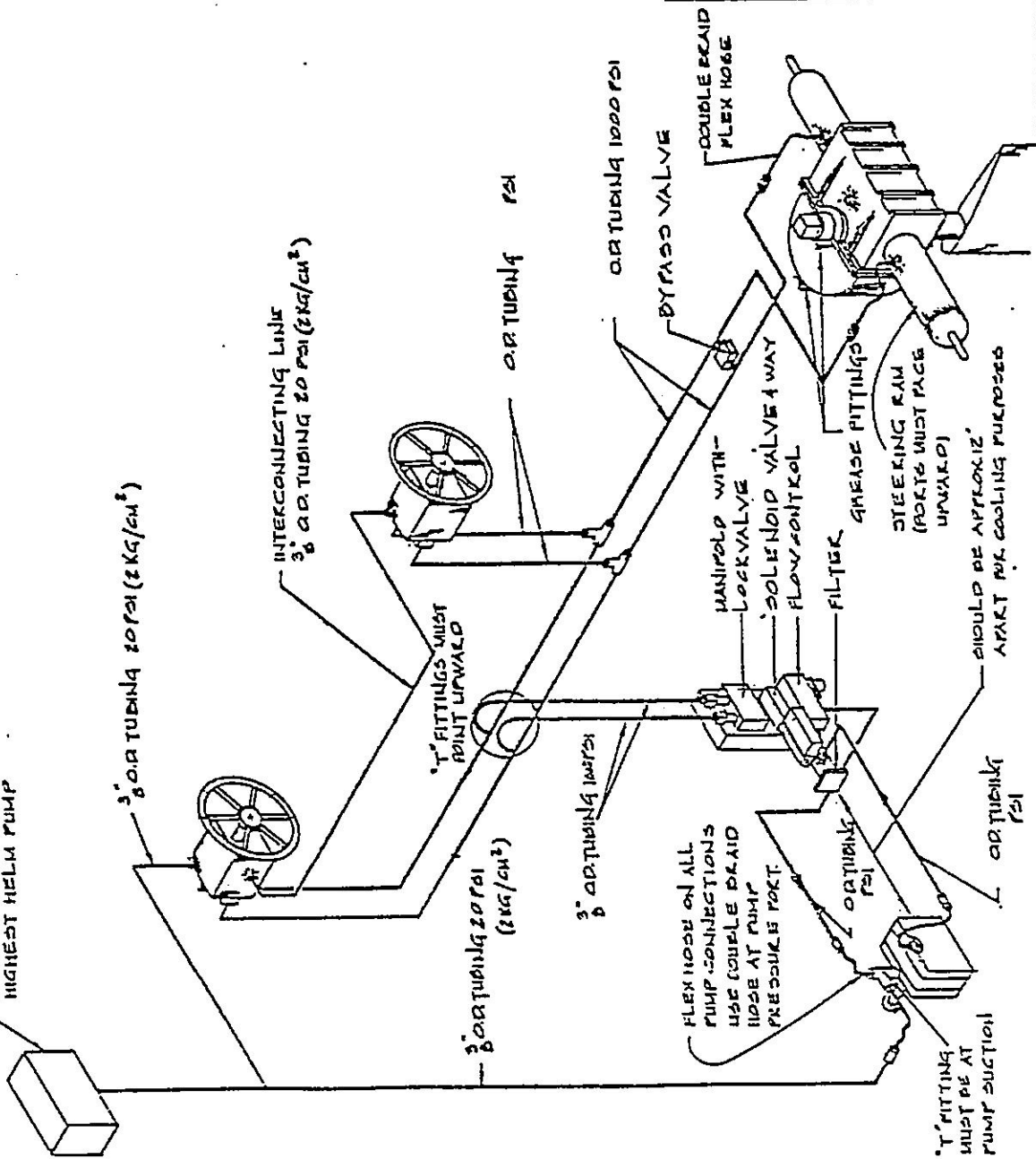
1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA


Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
15-11-77	A-2-262	2
DRAWN		
C.D.S.		

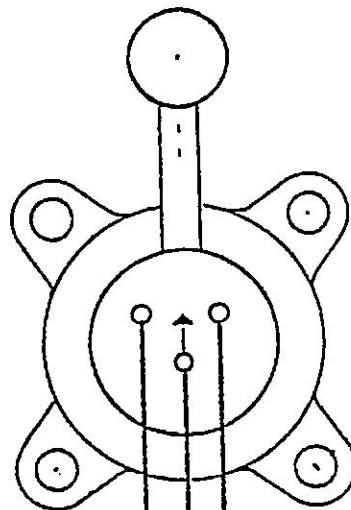
HEADER TANK MOUNT ABOVE
HIGHEST HELM PUMP

- NOTE:
- MANIFOLD MUST BE MOUNTED AS SHOWN, SO THAT A LINE DRAWN THROUGH THE LENGTH OF THE 4-WAY VALVE IS HORIZONTAL.
 - T-MODEL HOUSING MUST BE COMPLETELY PACKED WITH GREASE, SEE INSTALLATION INSTRUCTION FOR DETAILS.
 - ALL PIPING AND FITTINGS SUPPLIED BY YARD

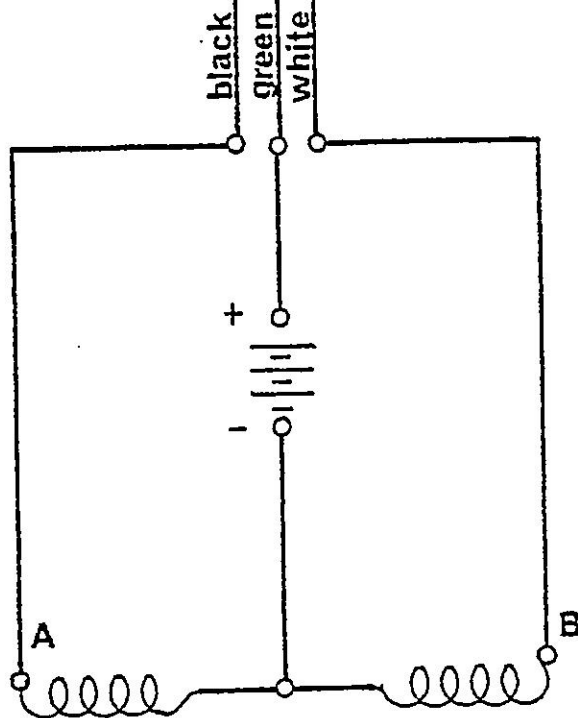


DATE	QUANTITY	DESCRIPTION	MATERIAL
 WAGNER ENGINEERING LTD. 1742 WEST 2ND AVENUE, VANCOUVER, B.C., CANADA <small>Manufacturers of MARINE HYDRAULIC STEERING GEARs and AUTOMATIC PILOTS</small>			
DATE	SCALE	QUOTE NO	REV.
OCT 29/73	—		B-1932
DRAWN F.C.		REVISION NOTES	

**MANUAL HYDRAULIC WITH
NON-FOLLOW-UP POWER.**



Wagner Jog Switch



four-way valve solenoids. reverse A&B
for opposite rudder.

Additional Stations are Wired
in Parallel.

JOG SWITCH (NON FOLLOW-UP) WIRING DIAGRAM

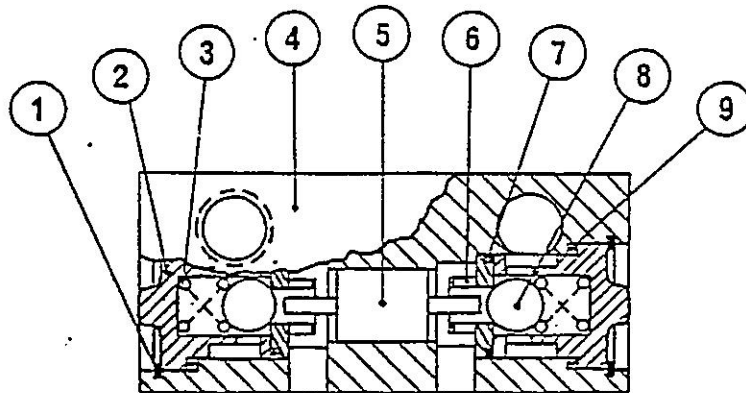


WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
MAY 23/69		
DRAWN		
O.Z.	A-2-238	



- | | | | |
|---|-----------|---|-----------|
| 1 | Snap Ring | 6 | Ball Seat |
| 2 | Ball Cage | 7 | O Ring |
| 3 | Spring | 8 | Ball |
| 4 | Body | 9 | O Ring |
| 5 | Piston | | |

The 3/8" manifold lockvalve is mounted on the back of the Model A-W and A1-W helm pumps to prevent rudder feedback to the helm pump and lock the rudder hydraulically in position as well as isolate one helm pump from another in a multiple station system. It is also used on a manifold for power steering or autopilot drive units to prevent the rudder from moving at a faster rate than the power pump can deliver oil. The threaded ports are connected to the steering gear. A leaking lockvalve is indicated if the rudder tends to creep with the forces exerted on it by the propeller wash or, if one helm pump turns another instead of the rudder in a multiple station system. In a new installation, leaking is invariably caused by contamination of the system oil by pipe fitting compound, scale, chips, etc. Both ball seats (6) must then be cleaned. The piston (5) should also be cleaned so that it slides freely and the entire system should be flushed, and then filled with new oil. Eventual wear will also cause leakage and an exchange lockvalve should be installed.

3/8 MANIFOLD LOCKVALVE

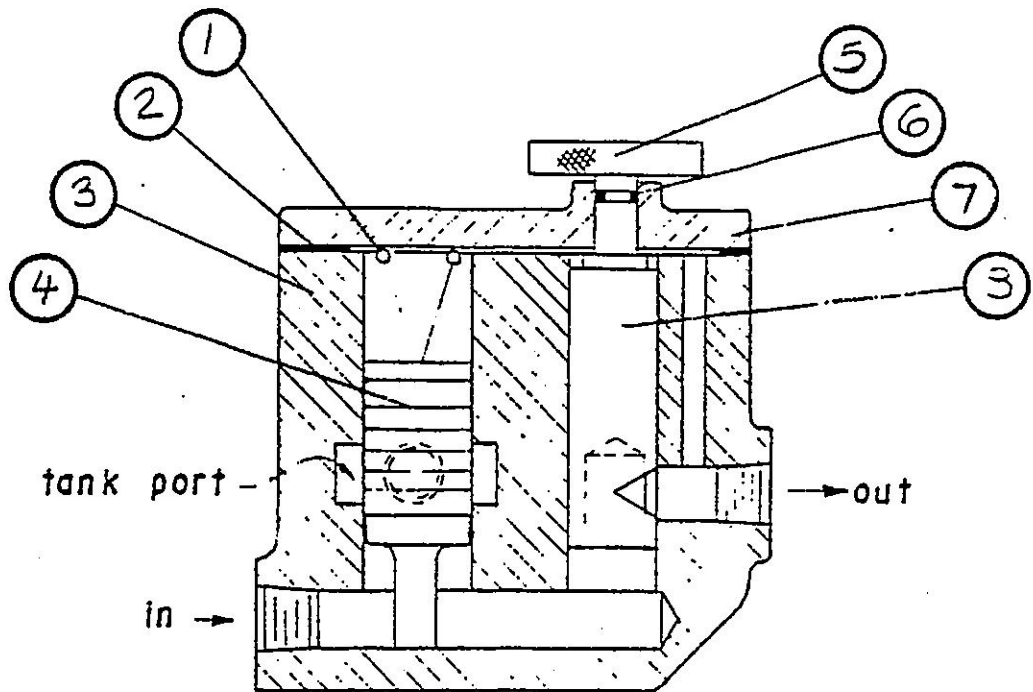


WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV
NOV. 26, 1973		
DRAWN		
B.A.S.	A-M032	



- 1 Spring
- 2 Gasket
- 3 Valve Body
- 4 Flow Control

- 5 Adjusting Knob
- 6 O Ring
- 7 Cover
- 8 Throttle Valve

THE PURPOSE OF THIS VALVE IS TO AUTOMATICALLY KEEP OIL DELIVERY FROM THE OUTLET PRACTICALLY CONSTANT, DESPITE VARYING OIL FLOW INTO THE VALVE. IT CAN ALSO BE ADJUSTED FOR DIFFERENT AMOUNTS OF OIL FLOW TO THE WORK, WITH CONSTANT OR VARYING FLOW INTO THE VALVE. THE OIL FLOW TO THE WORK CAN ALSO BE COMPLETELY SHUT OFF BY THIS VALVE, BY TURNING THE ADJUSTING KNOB (S) WITH THE ZERO TOWARD THE OUTLET PORT. IF THE POWER PUMP IS ENGINE DRIVEN, SET VALVE AS FOLLOWS: FIRST SET THE ADJUSTING KNOB WITH NO. 1 TOWARD THE OUTLET, OPERATE THE POWER STEERING GEAR FROM HO TO HO AND COUNT THE SECONDS (USE WATCH WITH A SECONO HAND). IF TOO SLOW, TURN THE ADJUSTING KNOB TO NO. 2 OR FURTHER IF NECESSARY TO OBTAIN THE SUGGESTED HO TO HO TIME.

ABOUT THE ONLY DIFFICULTY THAT CAN ARISE WITH THIS VALVE IS THAT THE PISTON (4) IS BEING HELD OPEN BY GRIT ETC., IN WHICH CASE NO OIL WILL BE DELIVERED FROM THE VALVE. TO REMEDY THE TROUBLE, CLEAN PISTON (4) AND MAKE SURE IT SLIDES FREELY IN ITS BORE.

FLOW CONTROL VALVE "E"



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE

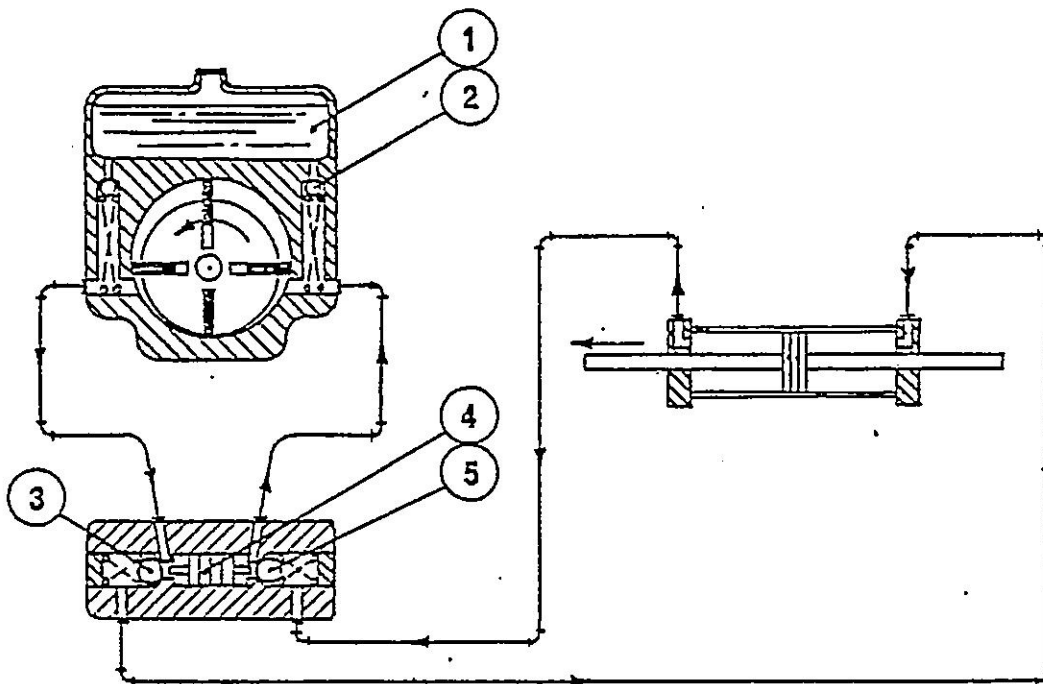
Dec 2, 1944

DRAWN

d.w.

DWG No.

A-M004



- | | | | |
|---|--------------|---|------------|
| 1 | Reservoir | 4 | Piston |
| 2 | Suction Ball | 5 | Check Ball |
| 3 | Check Ball | | |

When the helm pump is turned to the left, oil is sucked from the right side of the pump and pumped out of the left. If a vacuum occurs on the suction side of the pump, ball (2) opens admitting oil from the pump reservoir (1) into the system. The oil travels down the left side to lift ball (3) off its seat and moves the lockvalve piston (4) to the right, pushing ball (5) off its seat. Return oil from the cylinder can now pass by ball (5) and return to the pump. When the steering wheel is stationary, both check balls (3) and (5) are closed. Therefore forces from the rudder cannot feed back to the helm pump. If a second helm pump with its lockvalve is added, it is simply tee'd between the first lockvalve and the cylinder

NOTE: Wagner helm pumps are axial piston pumps. A vane pump is shown to ease illustration.

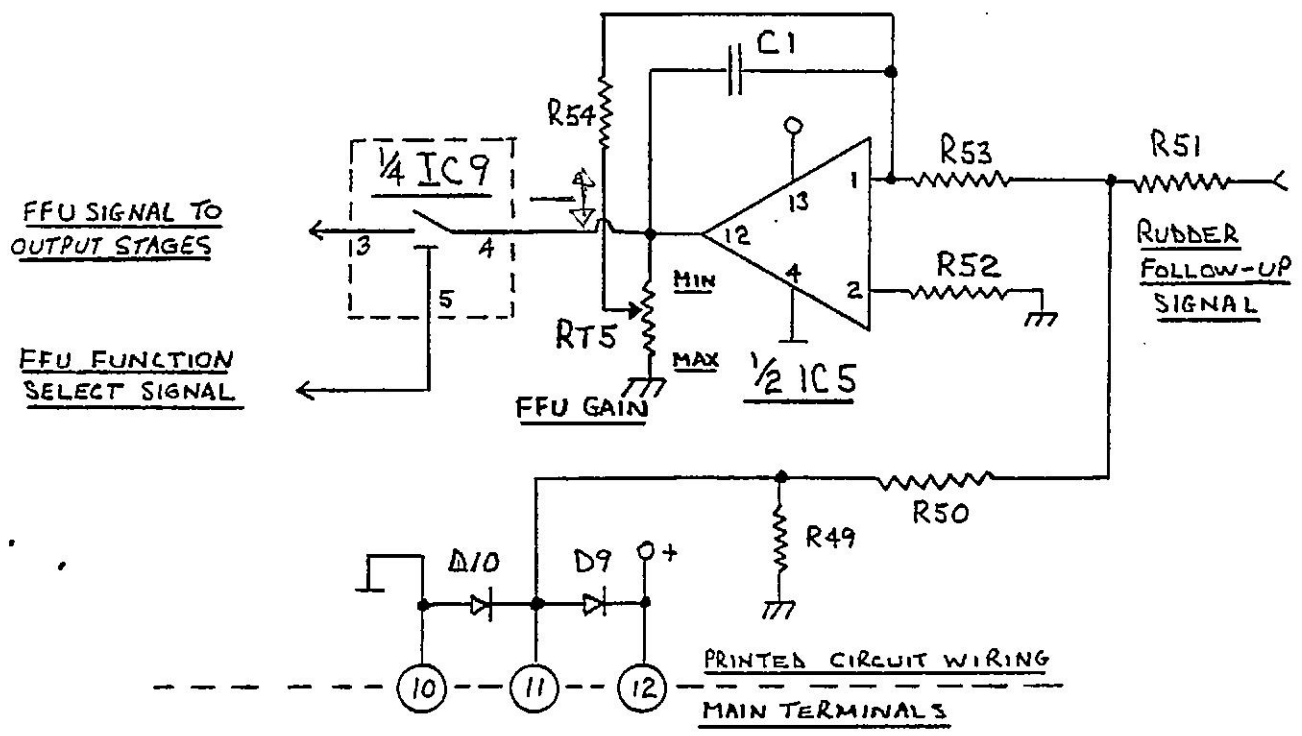
THE OPERATING PRINCIPLE OF MANUAL HYDRAULIC STEERING



1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	RE'
OCT. 2, 1973		
DRAWN		
B.A.S.	A-M007	01



- 1/2 IC5 FFU AMPLIFIER
- 1/4 IC9 FFU FUNCTION ELECT. SWITCH
- C1 DAMPING CAPACITOR
- D9,10 PROTECTION DIODES

MK-4 FFU AMPLIFIER SCHEMATIC

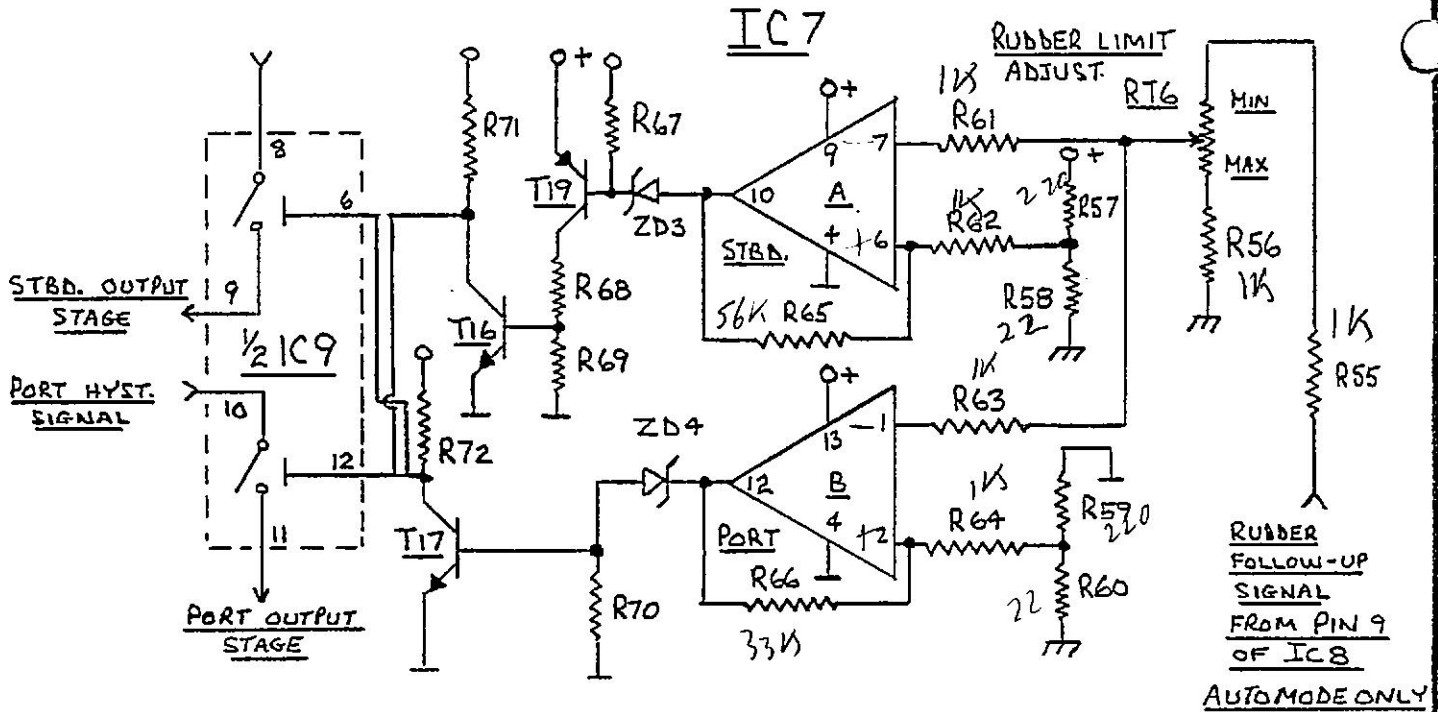


1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
10 9 75	A-2-233	0
DRAWN		
B. F. T.		

STBD. HYST. SIGNAL



- IC7 RUDDER LIMIT AMPLIFIER
- 1/2 IC9 RUDDER LIMIT ELECT. SWITCHES
- ZD3,4 LEVEL CHANGE ZENERS.
- T16,17,19 SIGNAL INVERT. TRANSISTORS

MK-4 RUDDER LIMIT SCHEMATIC

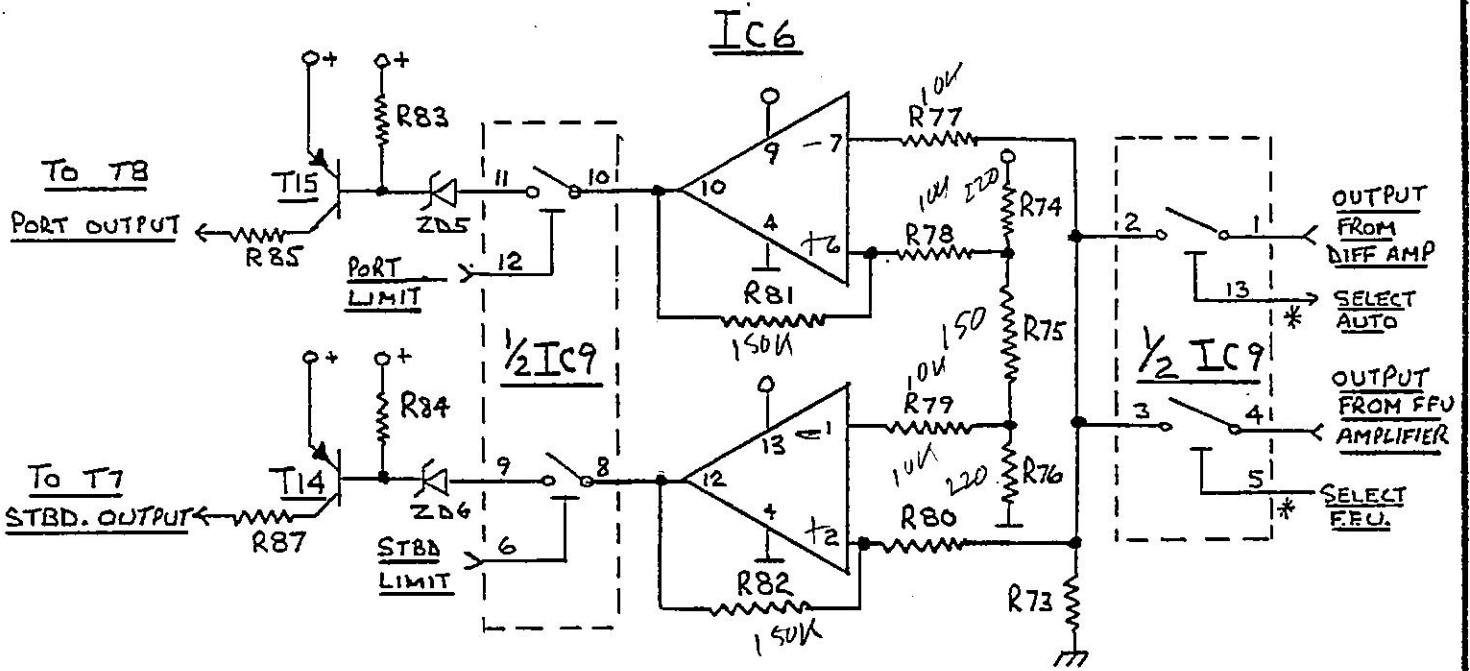


WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA
 Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	10 9 75
DRAWN	B.F.T.

DWG No.	REV
A-2-234	0



* NOTE + 8V = ON
 - = OFF

- IC 6 HYSTERESIS AMPLIFIER
- IC 7 ELECTRONIC SWITCH
- ZD5,6 LEVEL SHIFT ZENERS
- T14,15 OUTPUT DRIVER TRANSISTORS

MK4 HYSTERESIS STAGE SCHEMATIC

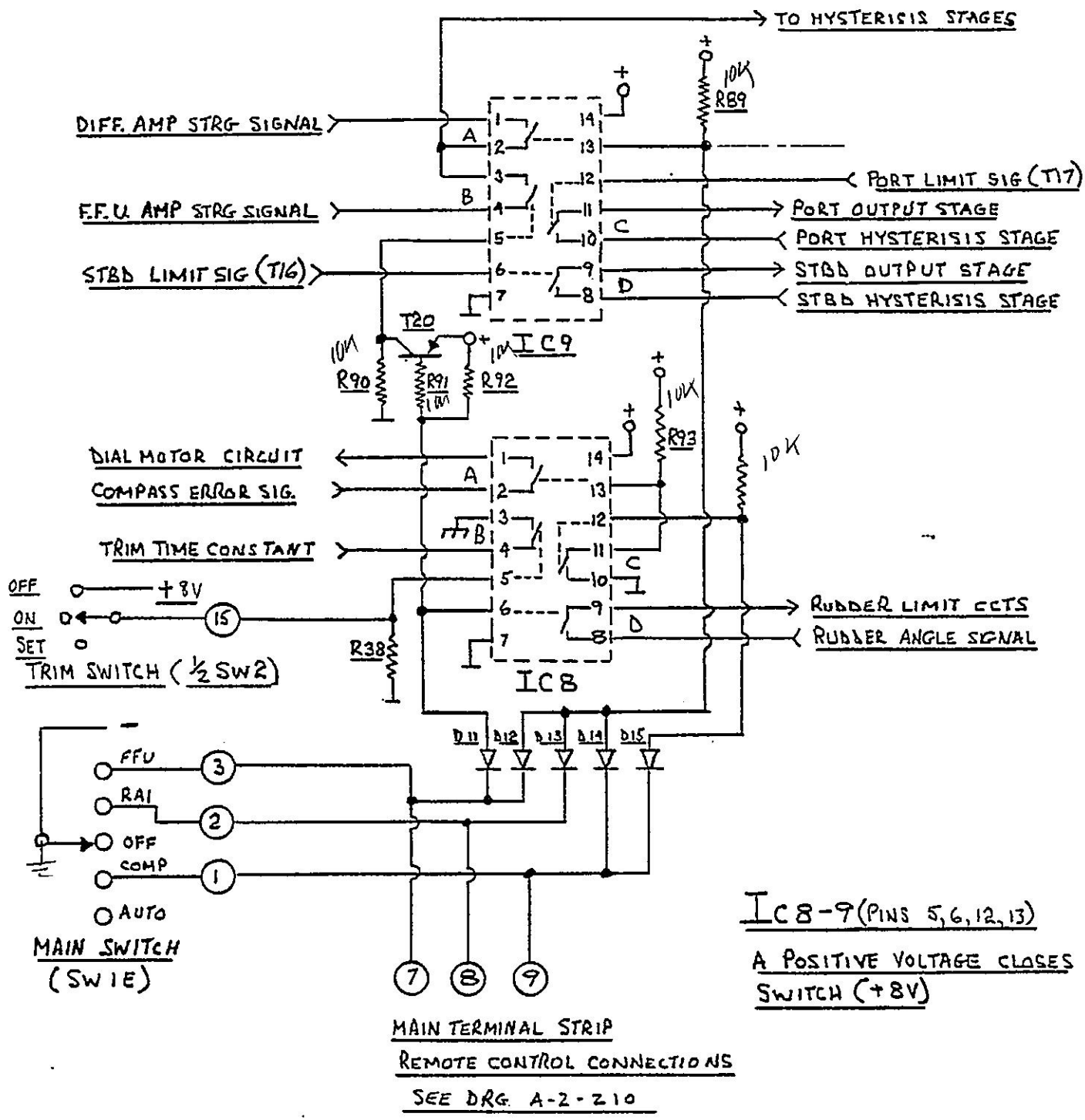


WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG.No.	REV.
10 9 75	A-2-235	0
DRAWN		
B.F.T.		



MK4 INTERNAL SWITCHING



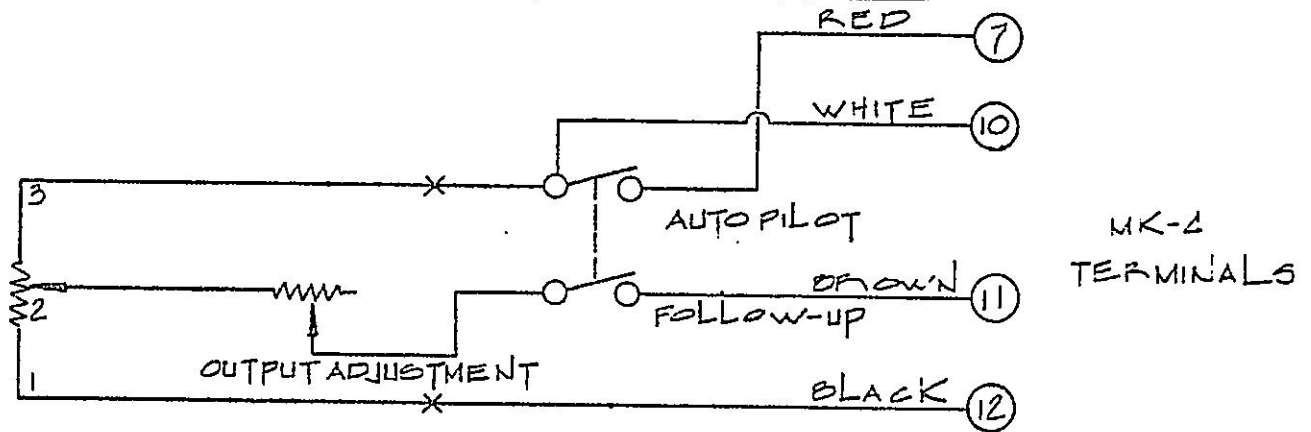
WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV
30 9 75		
DRAWN	A-2-237	0
B.F.T.		

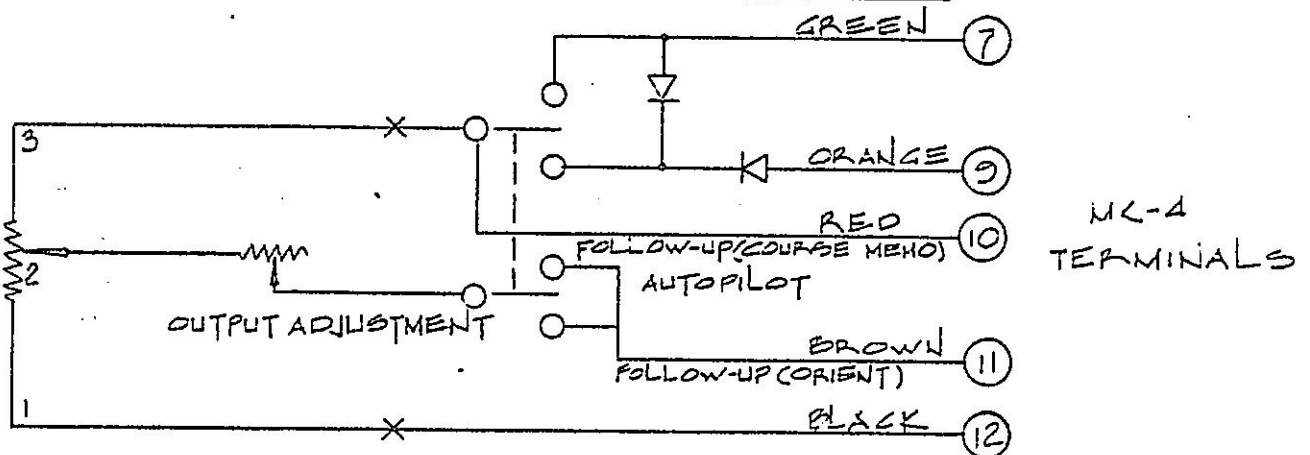
4 CONDUCTOR 750-103 CABLE



TS-2-S RC-5-S WIRING

- USE WHEN TILLER STATION IS COMBINED WITH OTHER REMOTE CONTROLS SWITCHES TILLER ON AND AUTOPILOT FUNCTION IS CHANGED TO FOLLOW-UP FUNCTION AT TILLER STATION.

9 CONDUCTOR 750-105 CABLE



TS-2-R - TILLER REMOTE CONTROL ALLOWS NORMAL AUTOPILOT OPERATION TO BE SWITCHED TO FOLLOW-UP WITH COURSE MEMORY OR FOLLOW-UP WITH COMPASS COURSE FOLLOWING SHIP'S HEAD

NOTE: X - IF TILLER (OR KNOB) CAUSES STEERING IN REVERSE DIRECTION REVERSE LEAD AT POTENTIOMETER INSIDE CONTROLLER UNIT

MK-4 TO RC-5-S TS-2-S AND TS-2-R WIRING



1742

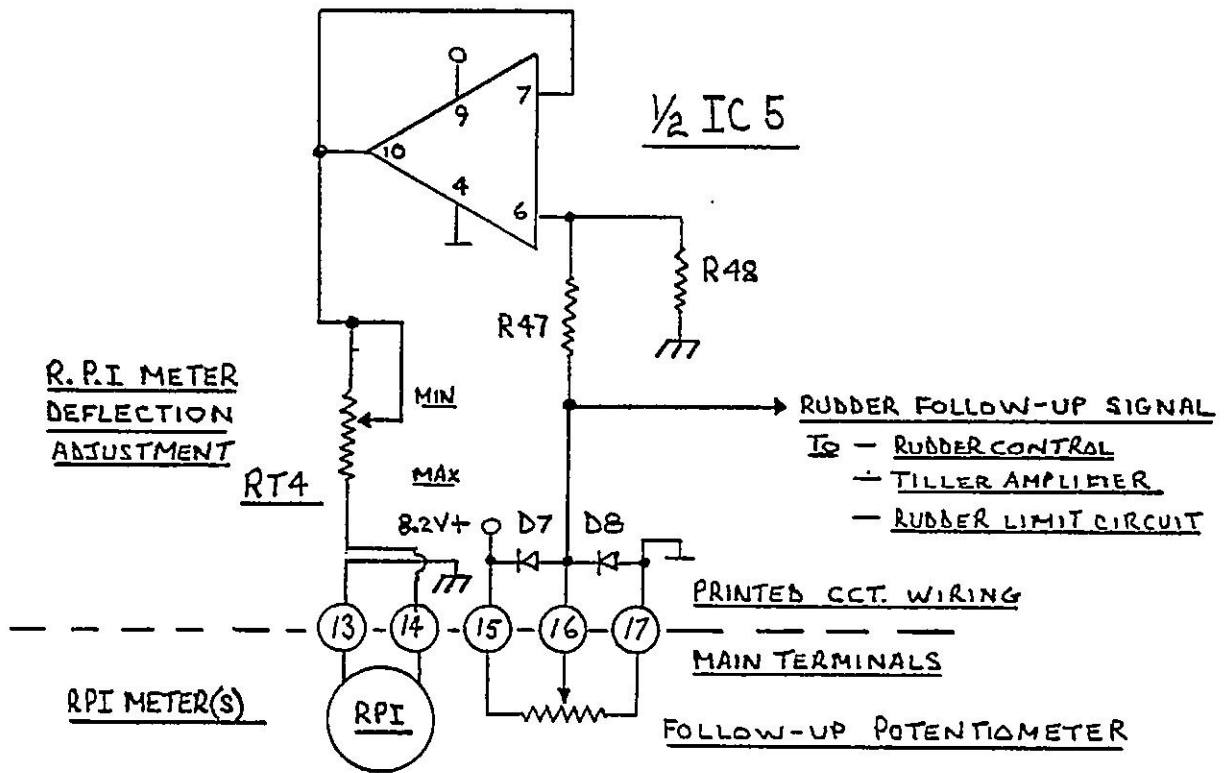
ENGINEERING LTD.

2nd AVENUE, VANCOUVER, B.C., CANADA
M/C STEERING GEARS and AUTOMATIC PILOTS

DATE
JAN. 19 1977
DRAWN

DWG No. REV.

A-2-249



1/2 IC 5 METER AMPLIFIER
D7,8 PROTECTION DIODES

MK-4 FOLLOW-UP CIRCUIT SCHEMATIC



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE

10 9 75

DRAWN

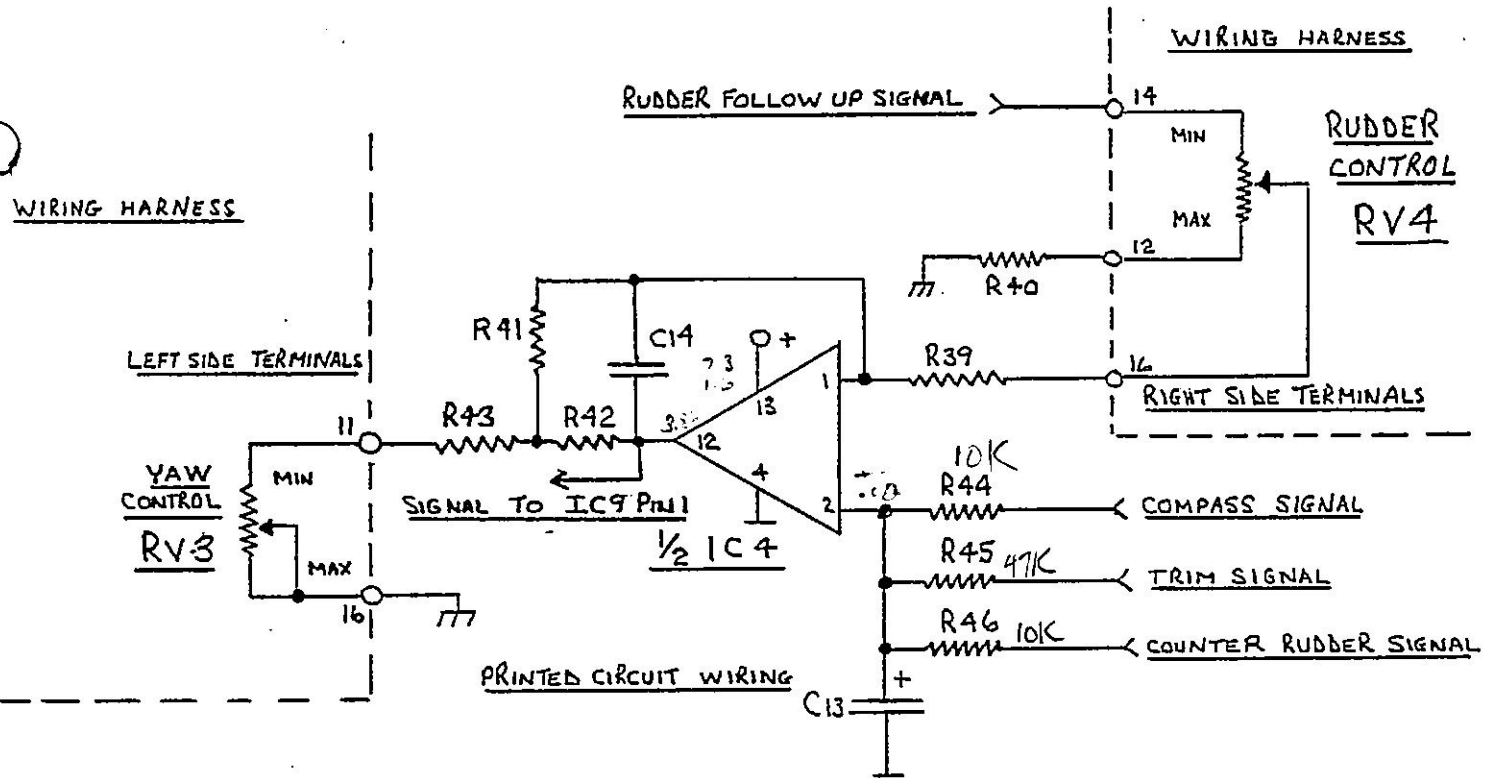
B.F.T.

DWG No.

A-2-232 0

REV

0



- 1/2 IC4 DIFFERENTIAL AMPLIFIER
- C13 FILTER CAPACITOR
- C14 DAMPING CAPACITOR

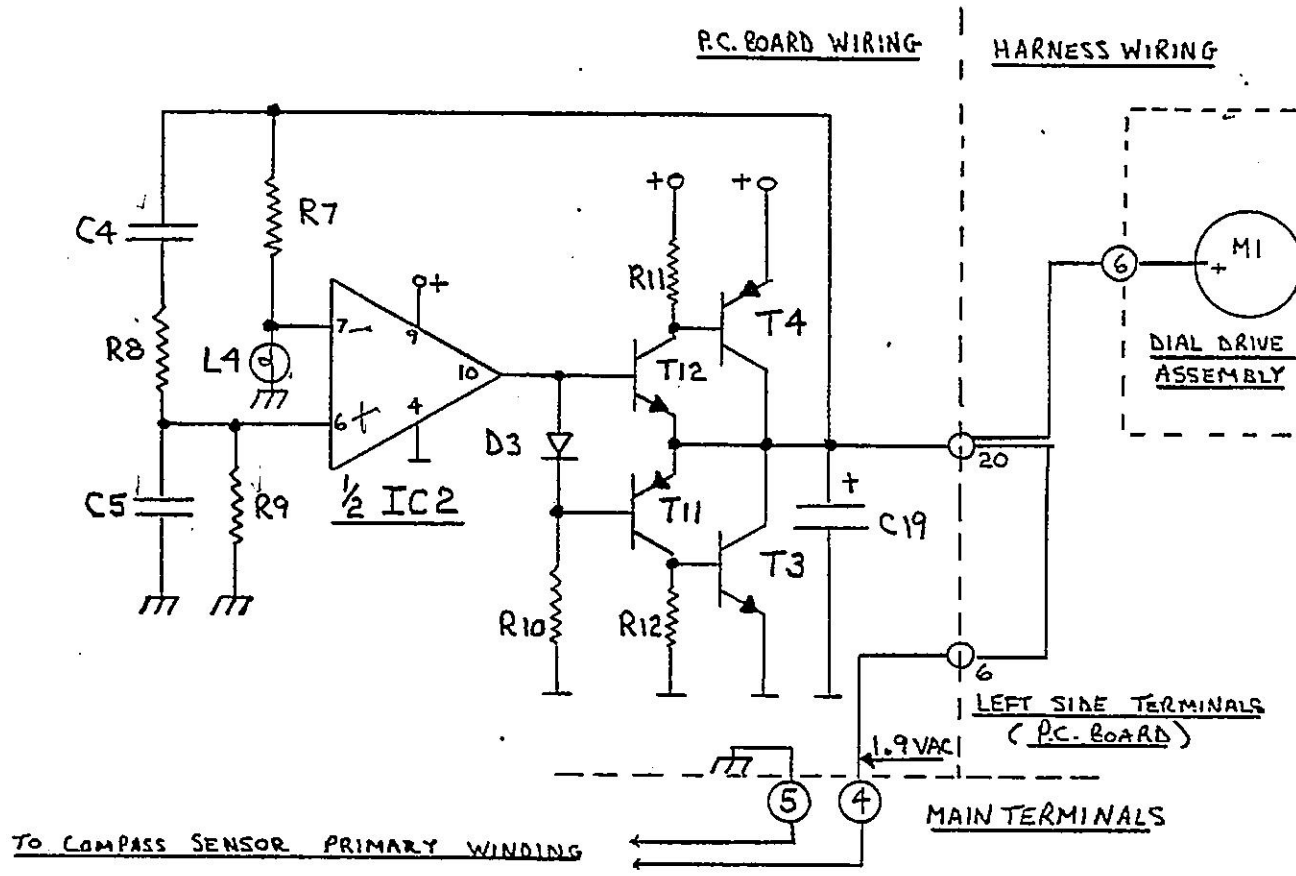
MK-4 DIFFERENTIAL AMPLIFIER SCHEMATIC



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA
 Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
10 9 75	A-2-231	0
DRAWN		
B.F.T.		



- 1/2 IC2 OSCILLATOR AMPLIFIER
- T11,12 OSCILLATOR OUTPUT DRIVERS
- T3,4 OSCILLATOR OUTPUT
- D3 . BIAS DIODE
- C4,5,R8,9-SET OSCILLATOR FREQUENCY
- L4 FEEDBACK STABILIZATION
- R7 FEEDBACK RESISTOR

OSCILLATOR FREQUENCY 420 HZ ± 10%
SINEWAVE OUTPUT

MK-4 OSCILLATOR CIRCUIT SCHEMATIC

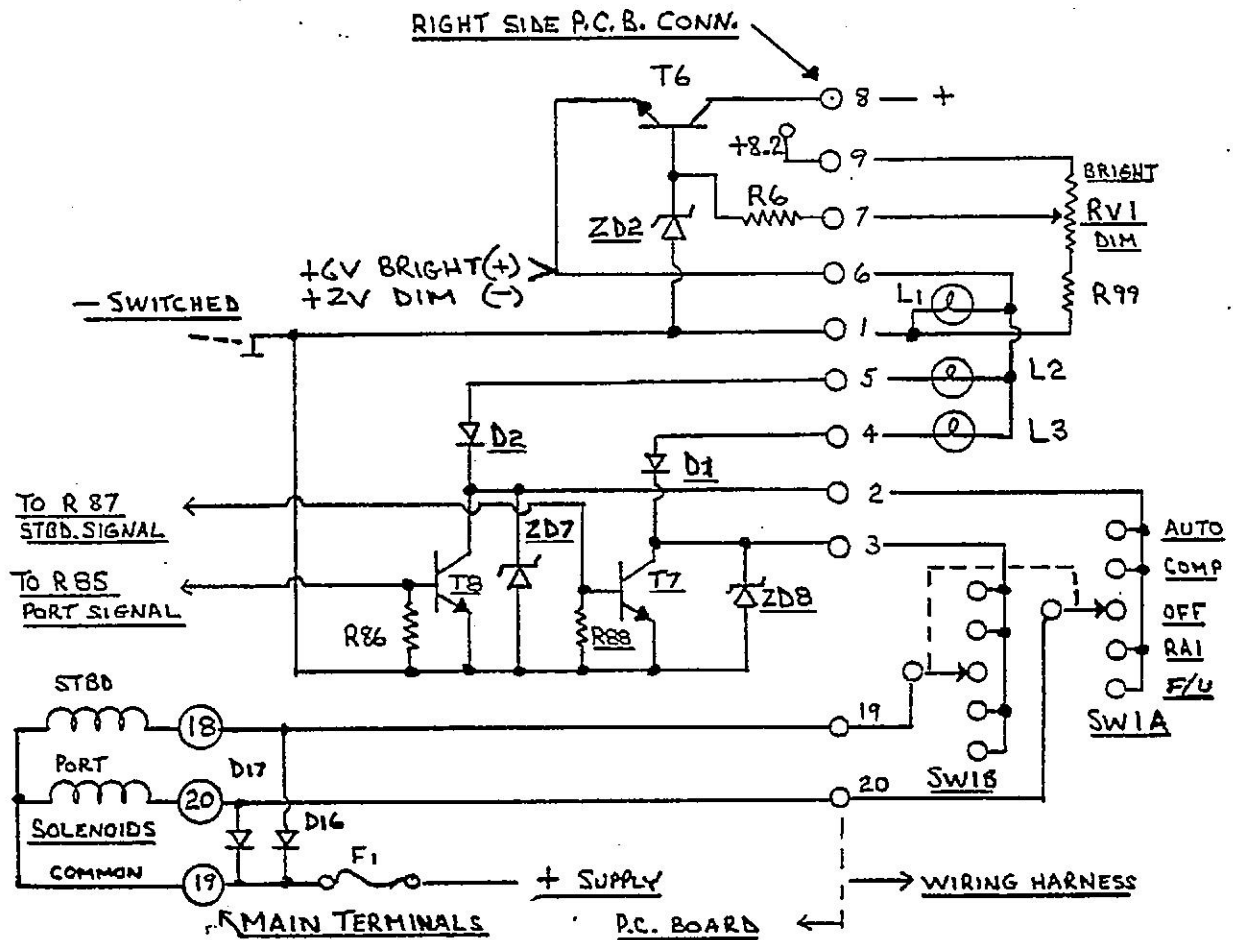


WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REVISION
10 9 75		
DRAWN		
BFT	A-2-226	0



- T6 LAMP DIMMER TRANSISTOR
ZD2 LAMP VOLTAGE LIMIT ZENER
RV1 DIMMER POTENTIOMETER
L1 DIAL LAMP
L2 PORT LAMP
L3 STBD. LAMP
D1, D2 LAMP ISOLATION DIODES
T7 STBD. OUTPUT TRANSISTOR
T8 PORT OUTPUT TRANSISTOR
ZD7, 8 OUTPUT PROTECTION ZENERS

MK-4 DIMMER AND OUTPUT CCT. SCHEMATIC



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE

10 9 75

DRAWN

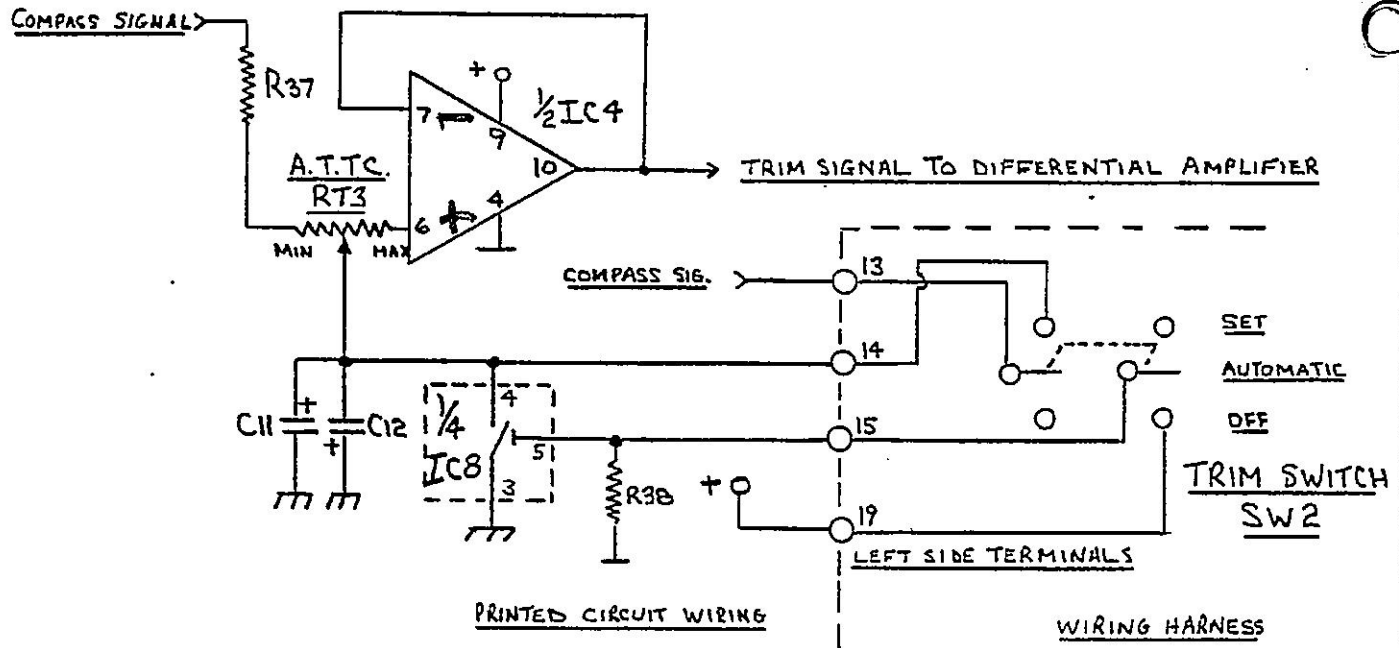
BET.

DWG No.

A-2-225

REV.

0



- 1/2 IC-4 TRIM BUFFER AMPLIFIER
- 1/4 IC 8 TRIM CANCEL ELECT. SWITCH
- RT 3 TIME CONSTANT POTENTIOMETER
- C11 12 TIME CONSTANT CAPACITORS

MK-4 TRIM CIRCUIT SCHEMATIC



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE

11 9 75

DRAWN

B.F.T.

DWG No.

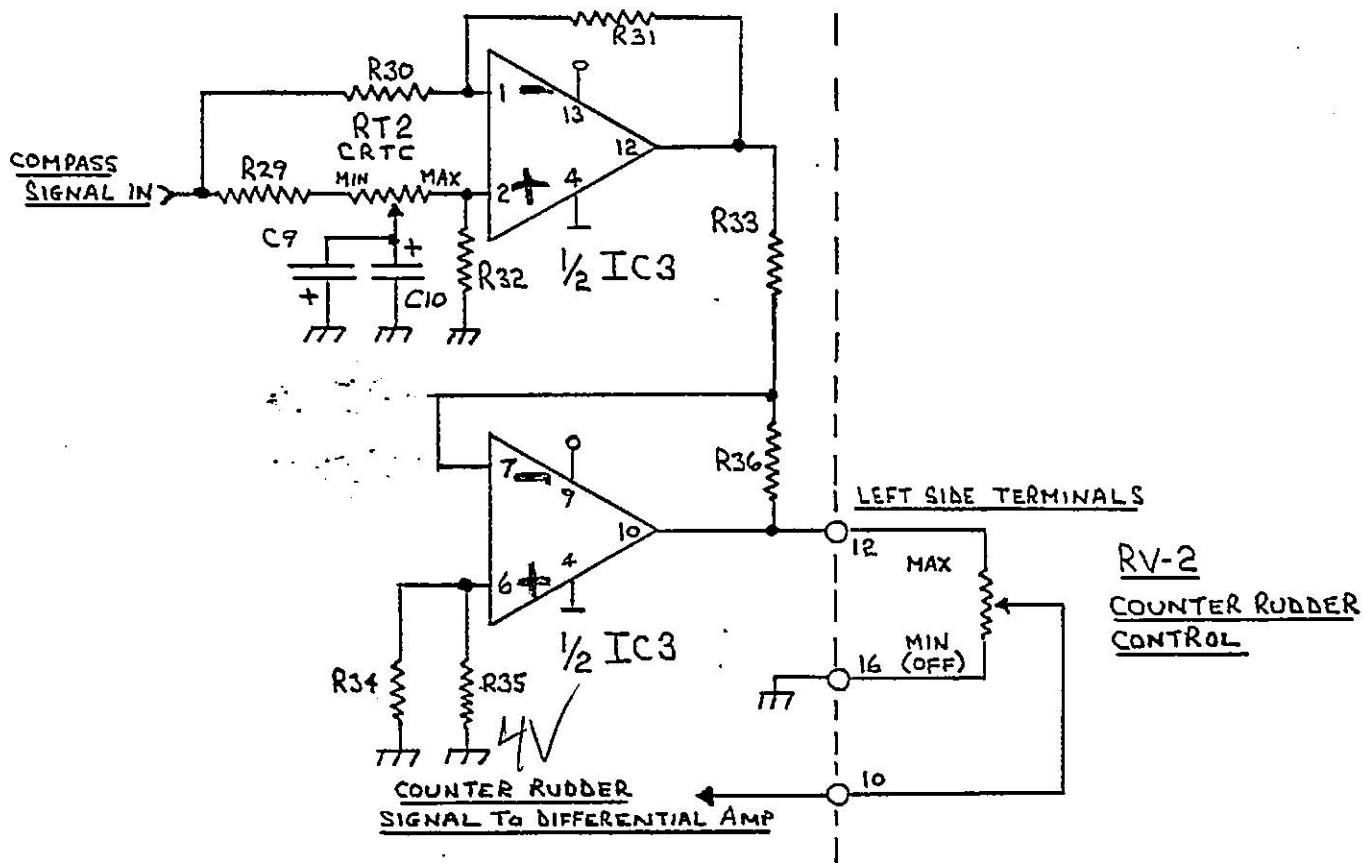
A-2-230

REV

0

PRINTED CIRCUIT WIRING

WIRING HARNESS



IC 3 COUNTER RUDDER AMPLIFIER
RT 2 TIME CONSTANT POTENTIOMETER
C9,10 TIME CONSTANT CAPACITORS

MK-4 COUNTER RUDDER SCHEMATIC



WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

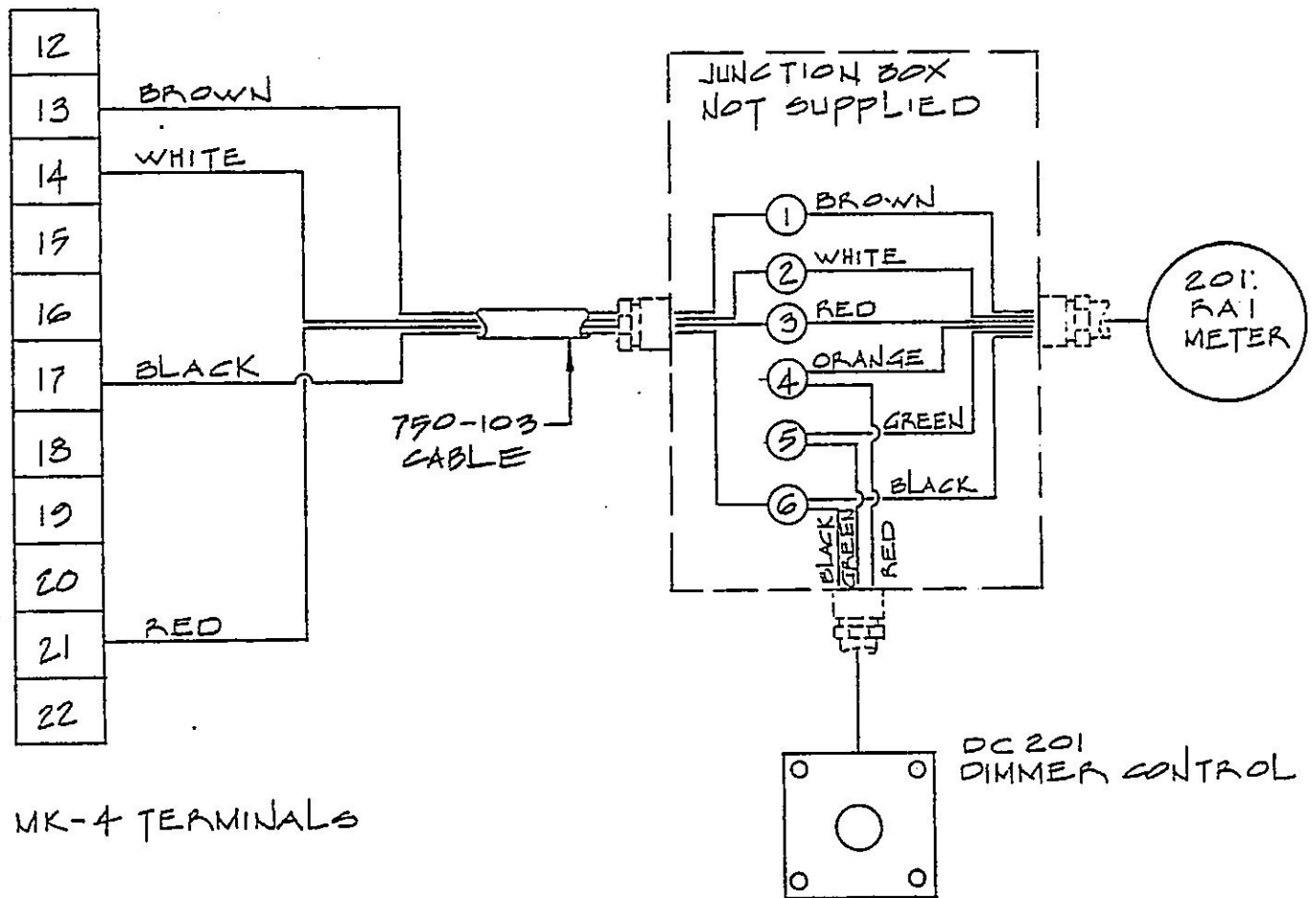
DATE	DWG No.	REV.
10 9 75	A-2-229	0
DRAWN		
B.F.T.		

SECTION III TESTS AND ADJUSTMENTS

A DOCKSIDE TESTS (If difficulties arise, refer to Service and Repair Section)

These tests should be completed in the following order:

- 1) Visually check all wiring and component mounting very carefully for possible causes of damage from vibration, chafing, strain, over heating and short circuits from loose wires.
- 2) Power Source Checks.
Use a voltmeter or trace the power leads for correct polarity and voltage applied to control unit (and optional power supply, if fitted.)
- 3) Initial Test-set all controls to MINUS (-) or minimum position, set TRIM to OFF, set all remote controls to AUTO position, and all steering controllers to midships position.
Set control unit main switch to COMPASS REPEATER position. The course dial should rotate to within 2° (degrees) of the autopilot compass heading (errors greater than this should be corrected later). Observe illumination lamp inside housing. At minus (-) (minimum) it should be glowing dimly and at plus (+) or maximum it should be bright.
- 4) Rudder follow-up reversal correction.
 - (a) Manually set rudder to approximately midships position.
 - (b) Switch control unit to AUTOPILOT position (steering pump off at this time).
 - (c) Move rudder manually to PORT. The STARBOARD lamp should light.
 - (d) Move rudder manually to STARBOARD. The PORT lamp should light.
 - (e) If lamps are reversed then reverse the follow-up wires at terminals 15 and 17 of the control unit, then repeat steps (a) to (d).

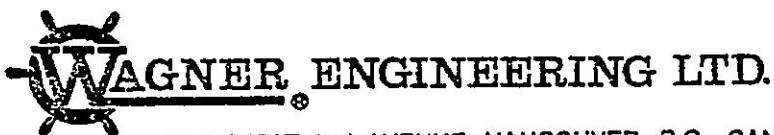


MK-4 TERMINALS

WAGNER PART No.

MODEL 201 R.A.I. METER 510-018
 10 FT. OF 750-103 CABLE SUPPLIED
 DC 201 DIMMER CONTROL 510-082
 5 FT. OF 750-101 CABLE SUPPLIED

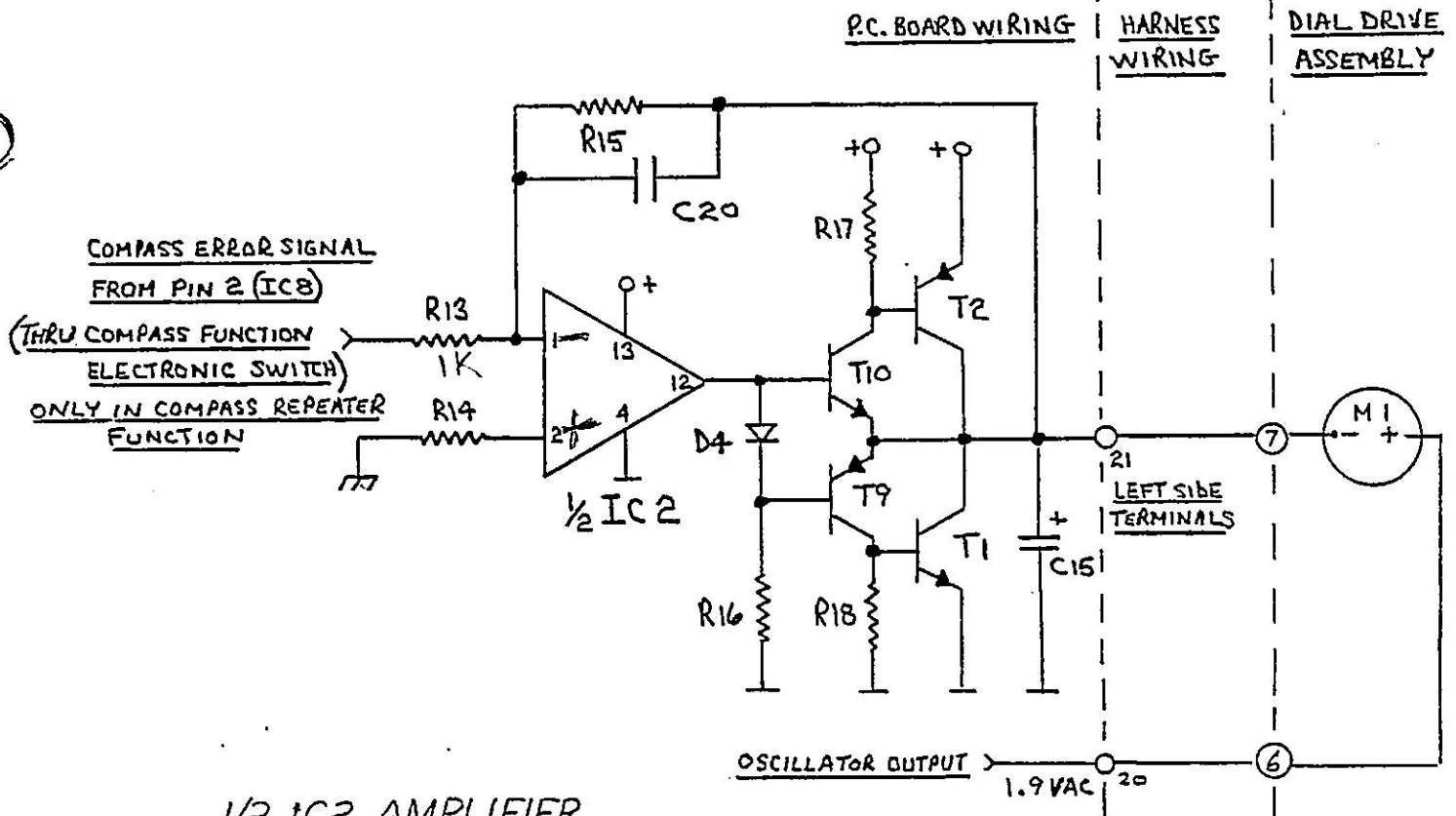
MODEL 201 R.A.I. METER TO MK-4 CONTROL UNIT CONNECTIONS



1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV.
JAN. 21 / 77	A-2-216	
DRAWN		



1/2 IC2 AMPLIFIER

T9,10 DRIVER TRANSISTORS

T1,2 OUTPUT TRANSISTORS

D4 BIAS DIODE

THIS CIRCUIT ONLY OPERATES WHEN THE
COMPASS FUNCTION IS REQUIRED

I.E. MAIN SWITCH TO COMPASS

REMOTE CONTROL TO ORIENT, OR COURSE CHANGE'S

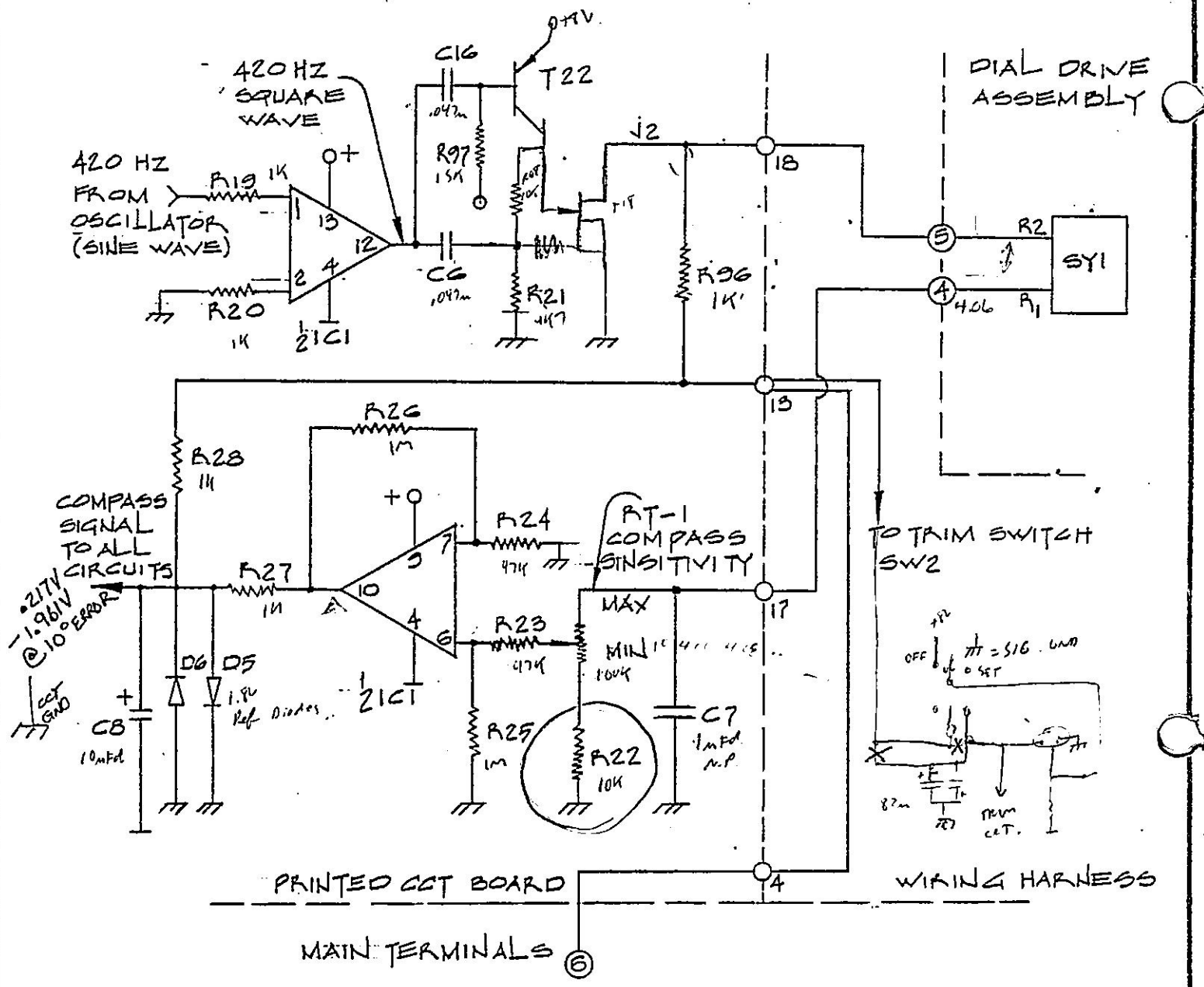
MK-4 MOTOR AMPLIFIER SCHEMATIC

WAGNER ENGINEERING LTD.
1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	10 9 75
DRAWN	B.F.T.

DWG No.	REV.
A-2-227	0



- IC1 AMPLIFIER (GATE AND COMPASS SIGNALS)
- T18 GATE SWITCH
- C7, C8 COMPASS SIGNAL FILTERS
- D5, D6 COMPASS SIGNAL LIMITING DIODES

MK-4 COMPASS SIGNAL DETECTOR SCHEMATIC

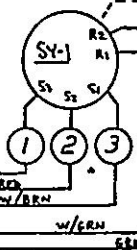
WAGNER ENGINEERING LTD.

1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA

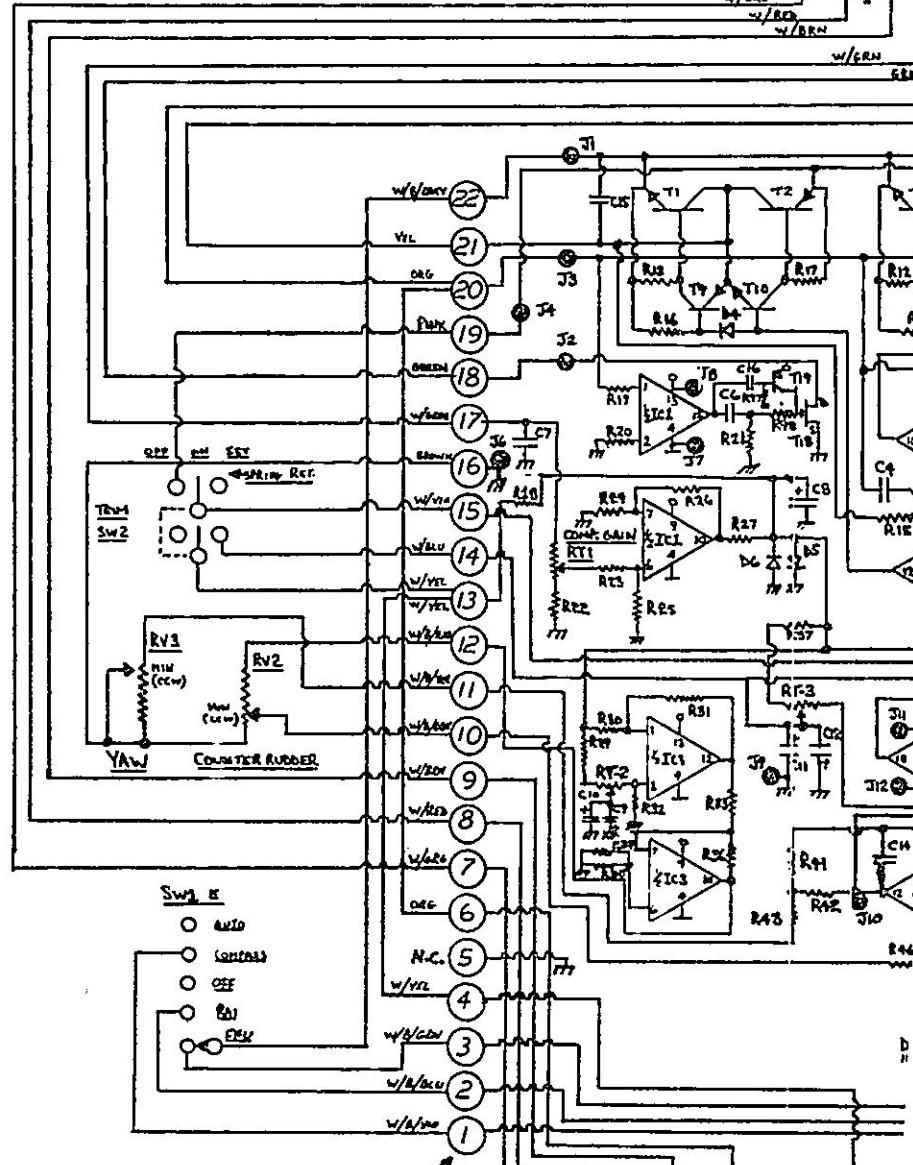
Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS

DATE	DWG No.	REV
FEB. 4 / 77	A-2-228	
DRAWN		

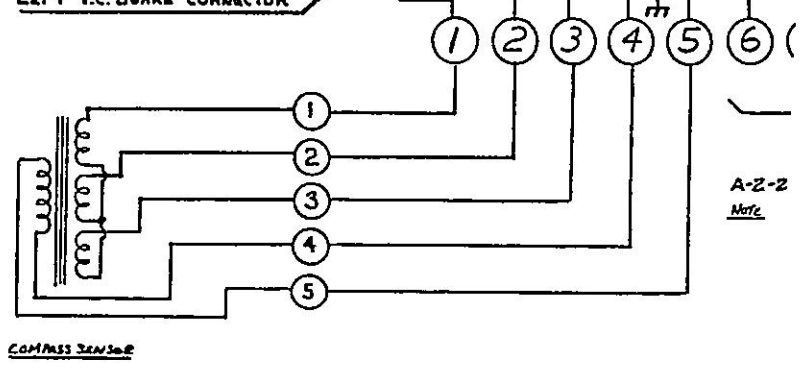
DIAL DRIVE ASSEMBLY

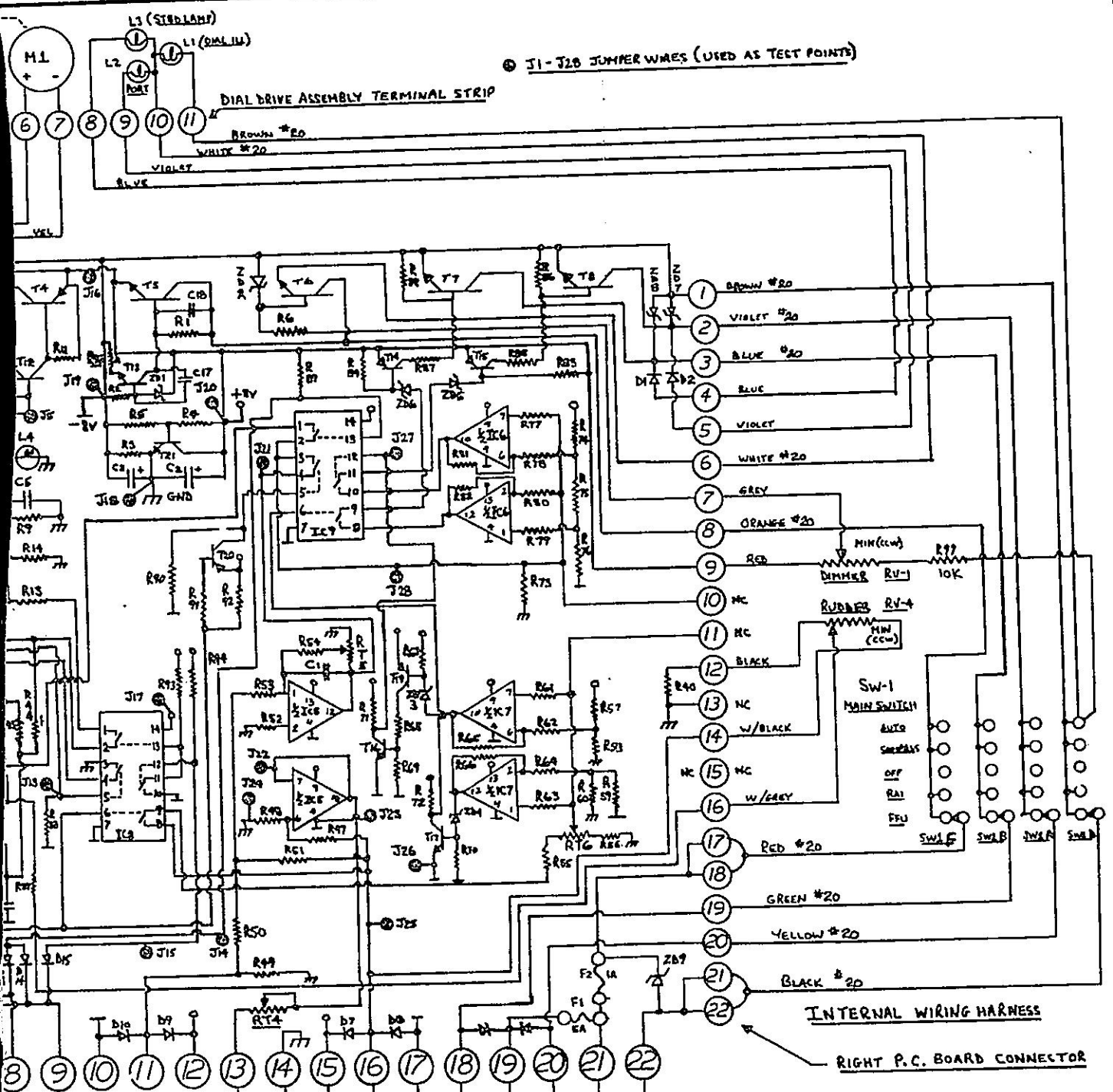


217V-12961W
 © 10/2/64W



- SW1 E
- AUTO
 - CONTACT
 - OFF
 - ON
 - ESW






E CONTROL TERMINALS
SEE DRAWINGS
-213, A-2-214, A-2-249
UNCONNECTED WHEN REMOTES
NOT FITTED

OPTIONAL
RUBBER WIRE
RUBBER FOLLOW-UP
STEER PORT
SOLENOIDS

SUPPLY VOLTAGE
11-10VAC

DETAIL	QUANTITY	DESCRIPTION	MATERIAL
 WAGNER ENGINEERING LTD. 1742 WEST 2nd AVENUE, VANCOUVER, B.C., CANADA Manufacturers of MARINE HYDRAULIC STEERING GEARS and AUTOMATIC PILOTS			
TITLE			
MK 4 AUTOPILOT COMPLETE SCHEMATIC			
DRAWN	DATE	SCALE	QUOTE NO
B.F.T.	8 & 75	N.T.S	
REVISION NOTES			DRAWING NO
			REV.
			C-2-202 1