TITLE
CIRCUIT BOARD TEST FOR PREAMPLIFIER FUNCTION BOARD WITH 2-SLOPE DIODE FUNCTION GENERATOR

FIRST MADE FOR

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MAR 25 1970

1.0 GENERAL DESCRIPTION

Fig. 1 shows a schematic circuit diagram of the PREAMPLIFIER FUNCTION BOARD with a 2-SLOPE DIODE FUNCTION GENERATOR which is called subsequently simply function board. The function board receives one input (E_L) from the load control unit and another one (E_F) from the SADI-board, (Servo Amplifier, Demodulator, Indicator). The signal E_L at the load control input represents load demand (or flow demand); and varies from 0v to +5v. The input from the SADI board is the feedback signal E_F representing actual valve position which also varies from +5 to 0 volt. There is a separate SADI board for each function board.

The voltage definition of the signals E_F and E_L with respect to valve position are as follows:

$E_L = E_{LMIN}$ corresponds during steady state to valve closed at cracking point.

$E_L = E_{LMAX}$ corresponds during steady state to valve wide open.

$E_F = +5v$ corresponds to valve closed at cracking point.

$E_F = 0v$ corresponds to valve wide open.

The feedback signal E_F feeds a resistor-diode network also known as diode function generator (DFG). (Fig. 1) which generates a 2-slope linear approximation to the valve characteristic (stem-lift versus flow).

As long as the inverting operational amplifier (op. amp.) operates in its linear range, it will try, due to its high gain (approx. 100 000 at 0cps) and negative feedback, to keep the summing junction SJ at a very

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273-12
273-71
273-15
273-314

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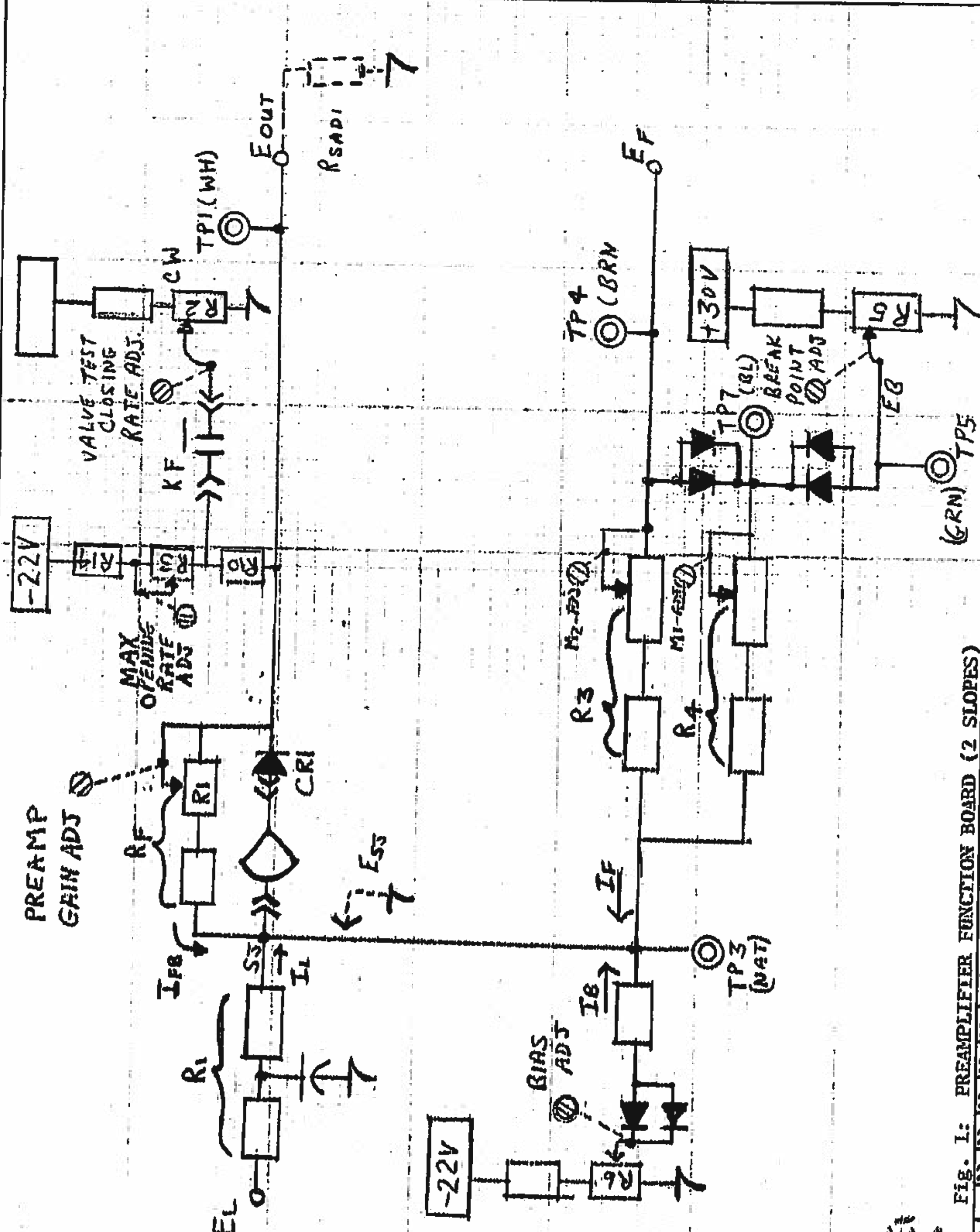

Fig. 1: PREAMPLIFIER FUNCTION BOARD (2 SLOPES)

ET-273
273-71
273-2
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273-138
R2A

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MADE BY
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1.0 (Continued)

small voltage E_{SJ} (approx. 50 uv). Therefore, the current I_L is practically determined only by E_L. ($I_L = E_L/R_I$). Similar considerations hold for the other currents I_B, I_F, I_{FB} which feed the summing junction SJ. Since the voltage E_{SJ} is so small, the current I_{SJ} that flows into the op. amp., will also be very small (approx. 50 pa). Therefore, the op. amp. feedback current I_{FB} will be equal to the algebraic sum of all other currents contributing to the summing junction; i.e., $I_{FB} = I_L + I_F + I_B$. The output error voltage $E_{OUT} = R_F * I_{FB}$ will be proportional to the algebraic sum of the currents feeding the summing junction from outside (i.e., currents other than op. amp. feedback current) into the summing junction. Since there is a 5% mechanical bias in the servovalve in closing direction the voltage E_{OUT} will be -0.25v in the steady state; i.e., actual valve position is equal to desired valve position. An error voltage E_{OUT} (more positive)/than -0.25v actuates the valve in closing direction and a voltage E_{OUT} (less positive)/than -0.25v actuates the valve in opening direction. The bias current I_B (Fig. 1) is used to cancel the LVDT-off-set (Linear Variable Differential Transformer). Part of this bias is also used to produce the error voltage signal of E_{OUT} = -0.25v during steady-state at the board output E_{OUT}. When this board is used in a valve set where valves open sequentially, a part of this bias current is additionally used to allow sequential valve opening. This sequential bias current $I_{B\ SEQU}$ will keep the error voltage E_{OUT} positive (keeping the valve closed) until the load control voltage E_L reaches a certain value between 0v and +5v at which the sequential bias will be overcome. As an example

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* - word chgd

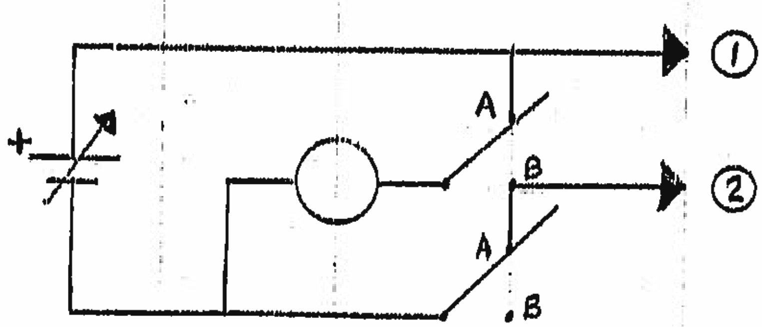
1.0 (Continued)

the number two control valve is to start opening when the load control input E_L reaches E_{LMIN} = +1.800 volt.

The bias current I_B will be adjusted such that the error signal E_{OUT} is -0.25 volt when E_L = +1.8v. Further increases of E_L will cause the error voltage E_{OUT} to go more negative to open the number two control valve.

At the output of the op. amp. (Fig. 1) there is a diode which together with the -22v network on the right hand side of the op. amp. R3, R14, R10 and the "dashed" resistor R_{SADI} (since it is located on the SADI BOARD) determines the maximal opening rate. This circuit is sometimes called a <u>hard limit in opening direction</u>. During a valve test the NO contact KF is closed and makes the opening rate limit voltage level positive. Thus, the valve will close.

1.1 <u>TEST SET-UP FOR SLOPE - ADJ.</u>



NOTE: Make sure digital voltmeter (DVM) reads zero when input terminals are shorted. If not, adjust DVM.

<u>FIG. 1:</u> Test Set-up for variable resistance adjustment.

The test set-up as shown in Fig. 1 can be used for the adjustment of all * two slopes. During these adjustments the circuit board has to be disconnected. Notice that the PLUS-side of the variable power supply is connected to the 1 - terminal.

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1.2 M1 - SLOPE ADJ. (LOWER SLOPE)

1. Set switch SW to A - position.
2. Adj. variable voltage source until voltmeter reads voltage V_1.
3. Connect terminal 1 with TP7 (BLUE). (TP means Test Point).
4. Connect terminal 2 with TP3 (NAT).
5. Set switch SW to B - position.
6. Adj. M1 - potentiometer R7 until ammeter reads current I_1.

1.3 M2 - SLOPE ADJ. (UPPER SLOPE)

1. Set switch SW to A - position.
2. Adj. variable voltage source until voltmeter reads voltage V_2.
3. Connect terminal 1 with TP3.
4. Connect terminal 2 with TP4.
5. Set switch SW to B - position.
6. Adj. M2 - potentiometer R4 until ammeter reads current I_2.

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273-2
273-12
273-132
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2.0 ADJUSTMENT OF OP. AMP. FEEDBACK RESISTORS

With the same arrangement as shown in Fig. 1 and the VPU-board disconnected, set the variable resistors in the op. amp. feedback path as follows:

1. Set switch SW to A - position.
2. Adjust variable voltage source until voltmeter reads Voltage V_4.
3. Connect terminal 1 with TP1 (WH).
4. Connect terminal 2 with TP3 (NAT).
5. Set switch SW to B - position.
6. Adjust potentiometer R1 until ammeter reads current I_4.

3.0 GENERAL TEST SET-UP

Fig. 3 and Fig. 4 represent an analog simulation of the valve position control system. Fig. 3 shows on the left hand side below the ramp generator which is used for the X-Y plot. At the top of Fig. 4 there is a voltage divider (29.4 Kohm, 500 Ohm) (POT 3) which represents the servo-valve bias. The -5v bias circuit (POT 4) is used to simulate the LVDT offset. Various switches are used to supply the test voltages to the preamplifier function board.

Fig. 2 shows the E_L - E_F characteristic for steady state. The E_L and E_F axis are so arranged, that the curve looks like the valve characteristic (stemlift versus flow).

273-71
273-2
273-12
273-132
273-138
R2A
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OE... OPEN END
IP... INTERCEPT POINT
CP... CRACKING POINT

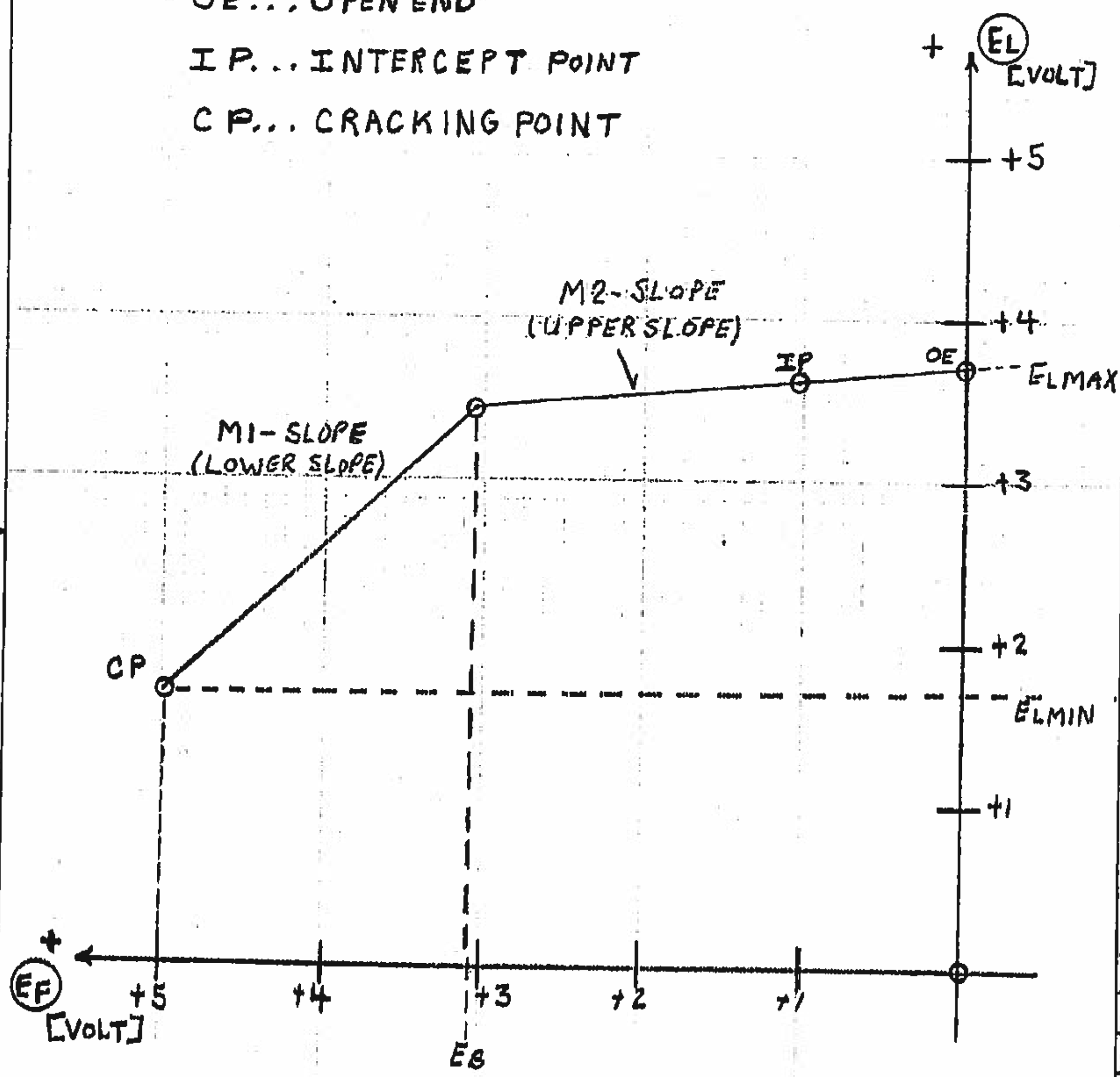

FIG. 2: The E_L - E_F STEADY-STATE CHARACTERISTIC

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273-12[2]
273-132[2]
273-138
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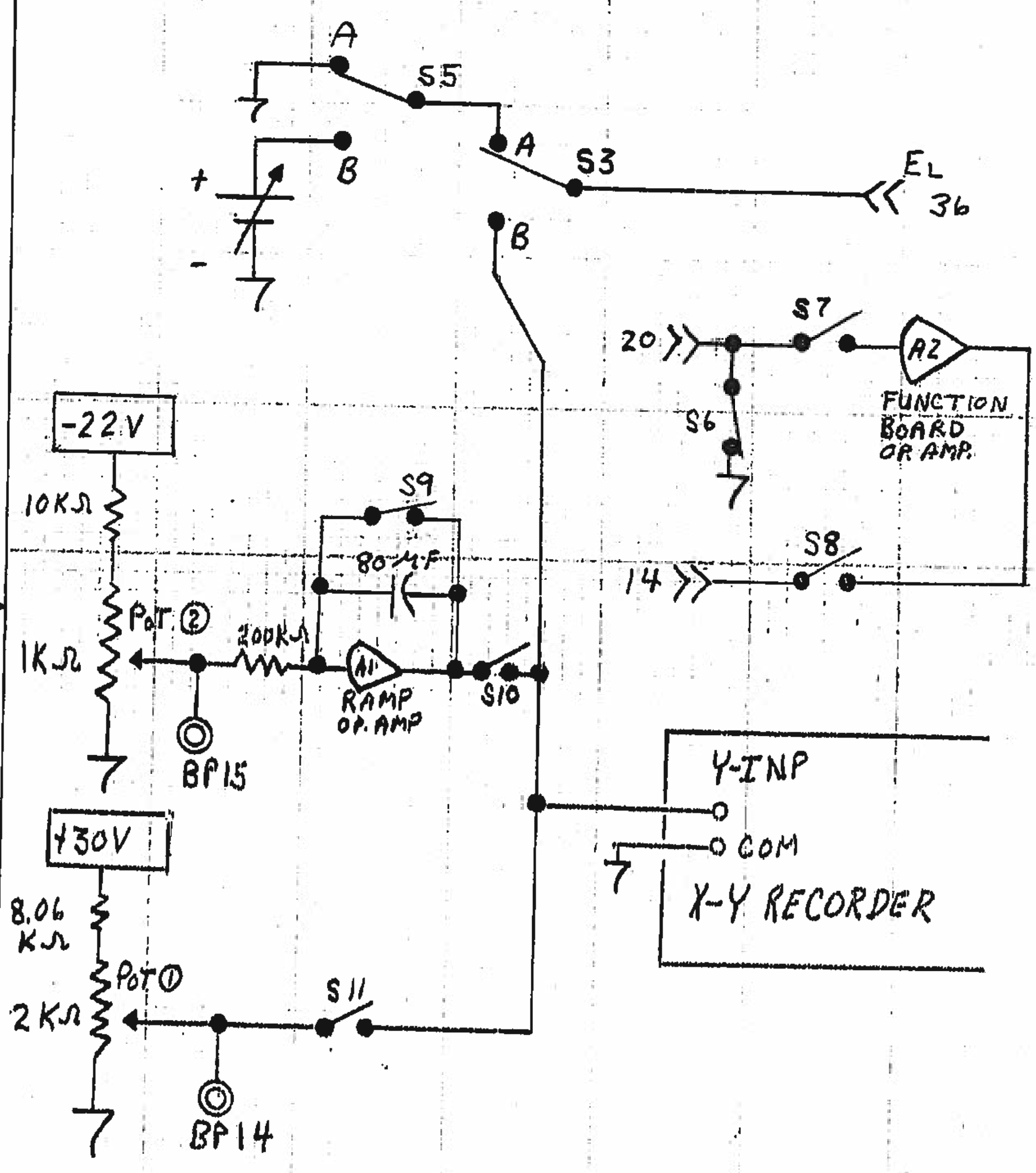

FIG. 3: GENERAL TEST SET-UP (PART 1)

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273-12 2
273-132 2
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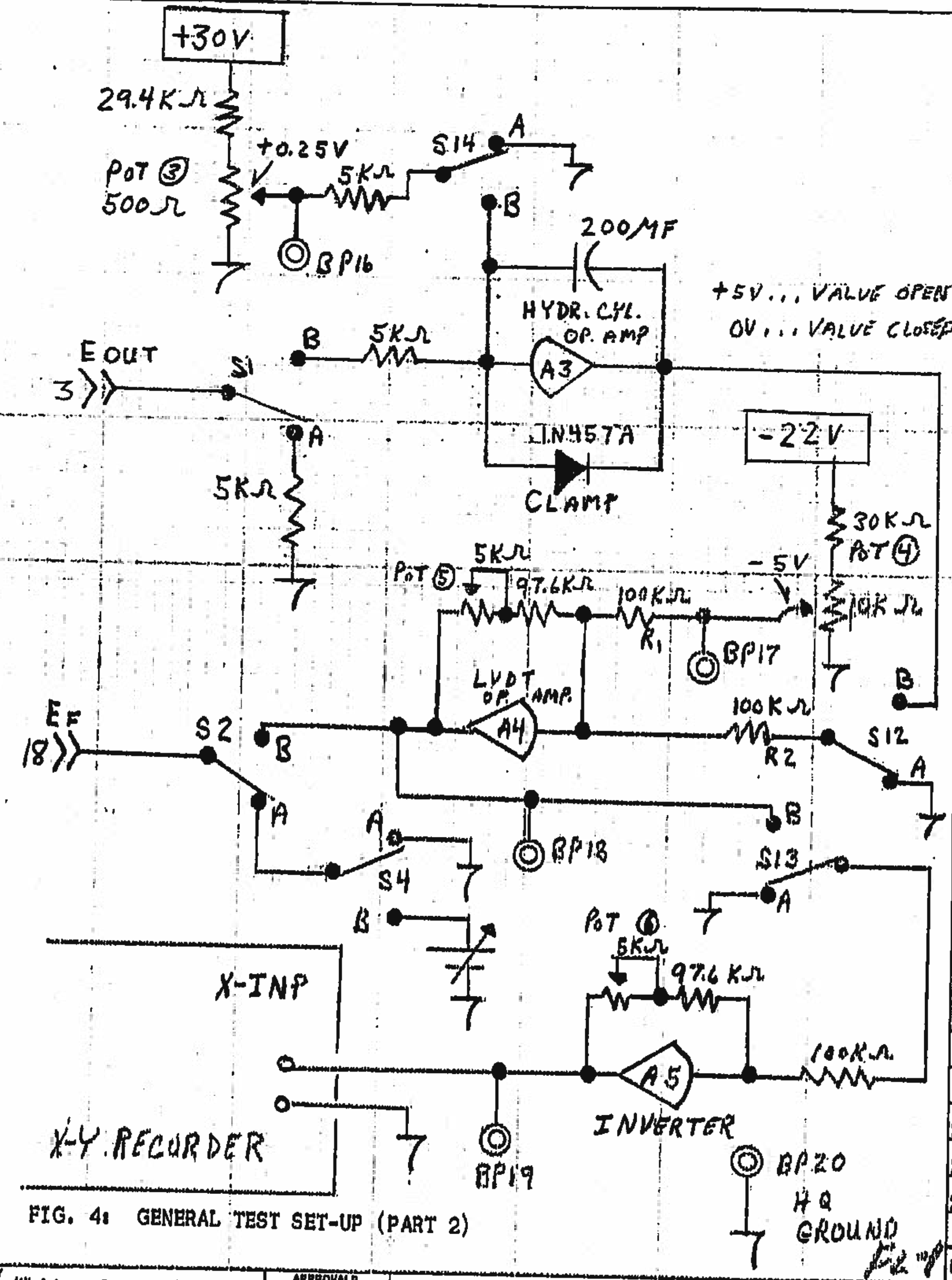

FIG. 4: GENERAL TEST SET-UP (PART 2)

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273-12 2
273-132 2
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R2A

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The valve position control system is made up of a function board, a SADI board, a servo-valve, a hydraulic cylinder, and an LVDT. This control system is also known as valve position unit (VPU).

3.1 PRELIMINARY SETTINGS

1. Hook up board as per test set-up (Fig. 3 and 4). The recorder will not be used in the first part of the test. Insert board into connector.
2. Set S1, S2, S3, S4 and S5, S12, S13, S14 to the "A" position. Open S7, S8, S10 and S11. Close S6 and S9. These settings represent the "RESET" state, from which all other settings will be defined.
3. Adjust POT 2 for -1.0v at BP15. (BP means Binding Post).
4. Adjust POT 3 for +0.25v at BP16.
5. Adjust POT 4 for -5 v at BP17.

3.2 ADJ. OF OPENING RATE LIMIT

1. Verify that -22 volts are applied to pin 21 of function board and that pin 19 is grounded; e.g., connected to the PLUS terminal of 22v power supply.
2. Adjust variable resistor R8 until voltage at TP1 (WH) reads $V_{OP\ LIMIT}$.

3.3 ADJ. OF CLOSING RATE BIAS

1. Verify that +30v is applied to pin 17 of function board and -22v applied to pin 21 and ground pin 19 is connected with the common potential of +30v and -22v power supplies.
2. Connect pin 5 with pin 12.

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3. Adjust valve test closing into potentiometer R2 until voltage at TP1 (WH) reads $V_{CL\ LIMIT}$.
4. Remove lead that connects pin 5 with pin 12.

3.4 EB BREAK POINT ADJUSTMENT

1. Set S4 to B - position.
2. Apply E_F = +6v at pin 18 (E_F).
3. Adjust EB - potentiometer R5 until voltage at TP5 (GRN) reads E_P.
4. Reset S4 to A - position.

3.5 BIAS ADJUSTMENT

1. Set S4 to B - position.
2. If E_{LMIN} = 0v, leave S5 in A - position.

   If E_{LMIN} ≠ 0v, set S5 to B - position.
3. Apply E_F = +5v at pin 18 (E_F).
4. Apply E_L = E_{LMIN} at pin 36 (E_L).
5. Open S6. Close S7 and S8.
6. Adjust bias pot R6 until voltage at pin 3 (E_{OUT}) reads -0.25v.
7. Reset S4 and S5 to A - position.
8. Reclose S6. Reopen S7 and S8.

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273-2
273-12 2
273-132 2
273-138
R2A

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3.6 CALIBRATION OF AUXILIARY AMPLIFIERS

(If several boards are tested in sequence, this procedure has to be done only for the first board test).

1. Turn POT 4 down to bottom. Check voltage BP17 for 0 volts ± 5 mv.
2. Check voltage at BP18 for 0 volts ± 5 mv. If outside this range, adjust op.amp. A4 at zero adjustment.
3. Adjust POT 4 until it reads -5v at BP17 within ± 5 mv.
4. Abserve voltage at BP18. Adjust POT 5 until voltage at BP18 reads +5v within instrument accuracy.
5. Observe voltage at BP19. It should be 0v ± 5 mv. If outside this range, adjust op. amp. A5 at zero adjustment.
6. Set switch S13 to B - position.
7. Voltage at BP19 should read -5v within ± 5 mv. If not, adjust POT 6 until correct reading is obtained.
8. Reset switch S13 to A - position.

3.7 RECORDING OF STATIC DFG-CURVE

1. Turn on recorder. Set function selector switch at STANDBY. Set sensitivity switch at 1 volt/inch on the X and Y inputs.
2. Turn POT 1 to bottom position and make sure voltage at BP14 is 0v ± 5 mv.
3. Insert curve sheet from engineering into X-Y PLOTTER.
4. Set zero adjustments on X and Y channel such that pen coincides with (0v/0v) position marked on the lower right hand side of the sheet.
5. Set switch S13 to B - position. This should cause the pen to drive 5

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5. inches to the left. If not, adjust gain of X-channel until this is the case.

6. Close switch S11. Turn POT 1 upwards until BP14 reads +5v within ± 5 mv. This should cause the pen to drive 5 inches upwards. If not, adjust gain of Y-channel until this is the case. Turn POT 1 downwards to the bottom.

7. Reset switch S13 to A - position.

8. Reopen switch S11. The pen should be now again at the (0v/0v) position.

9. Set S1, S2, S3 and S12, S13, S14 to B - position.

10. Close S7, S8 and S10. Open S6.

11. Open S9. The plotter starts now plotting the curve. When it reaches the upper right corner the pen should be lifted first and then S9 should be closed.

12. If curve deviates too much, the DFG has to be readjusted.

13. If this is necessary: Open S10 and close S11.

14. The pen can be moved manually along the curve by turning the knob of POT 1. Slope pots break point pots, and bias pot can be adjusted until plotted curve coincides with the curve supplied by engineering.

15. Send final recorded trace up to EHC engineering (Bldg. 285, Rm. 241).

16. Apply red paint on slope pot - and break pot adjustment screws.

NOTE: Write board serial number, signature and date on each XY trace.

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PREPARED BY: T.B. White DATE 10/7/69
T. B. White
Turbine Control Design Engineering

APPROVED BY: P C Callan DATE 10/7/69
P. C. Callan, Manager
Turbine Control Design Engineering

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