TM 11-6660-204-25

TECHNICAL MANUAL

ORGANIZATIONAL, DS, GS, AND DEPOT MAINTENANCE MANUAL
INCLUDING DEPOT OVERHAUL STANDARDS

RADIOSONDE RECORDERS
AN/TMQ-5,
(NSN 6660-00-324-9426)
AN/TMQ-5A AN/TMQ-5B
(NSN 6660-00-393-2234)
AND AN/TMQ-5C
(NSN 6660-00-682-4500)

This copy is a reprint which includes current pages from Changes 1 through 4.

HEADQUARTERS, DEPARTMENT OF THE ARMY

19 NOVEMBER 1970

WARNING

HIGH VOLTAGE

is used in this equipment.

DEATH ON CONTACT

may result if operating personnel
fail to observe safety precautions.

CHANGE
No. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 12 August 1985

Organizational, Direct Support, General Support and Depot Maintenance Manual Including Depot Overhaul Standards

RADIOSONDE RECORDERS AN/TMQ-5 (NSN 6660-00-324-9426), AN/TMQ-5A, AN/TMQ-5B (NSN 6660-00-393-2234), AND AN/TMQ-5C (NSN 6660-00-682-4500)

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CHANGE No. 3

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DEPARTMENT OF THE ARMY
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Organizational, Direct Support, General Support and Depot Maintenance Manual Including Depot Overhaul Standards

RADIOSONDE RECORDERS AN/TMQ-5 (NSN 6660-00-324-9426), AN/TMQ-5A, AN/TMQ-5B (NSN 6660-00-393-2234), AND AN/TMQ-5C (NSN 6660-00-682-4500)

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3-11 through 3-23	3-11 through 3-28
4-1 through 4-4	4-1 through 4-4
4-7 and 4-8	4-7 and 4-8
4-15 through 4-25	4-15 through 4-22
5-3 through 5-9	5-3 through 5-7
6-3	6-3/(6-4 blank)
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FO-1	FO-1
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None	FO-35
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TECHNICAL MANUAL

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *19 November 1970*

ORGANIZATIONAL, DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL INCLUDING DEPOT OVERHAUL STANDARDS
RADIOSONDE RECORDERS AN/TMQ-5 (NSN 6660-00-324-9426), AN/TMQ-5A, AN/TMQ-5B (NSN 6660-00-393-2234), AND AN/TMQ-5C (NSN 6660-00-682-4500)

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monmouth, NJ 07703-5007.

A reply will be furnished to you.

ILLUSTRATIONS

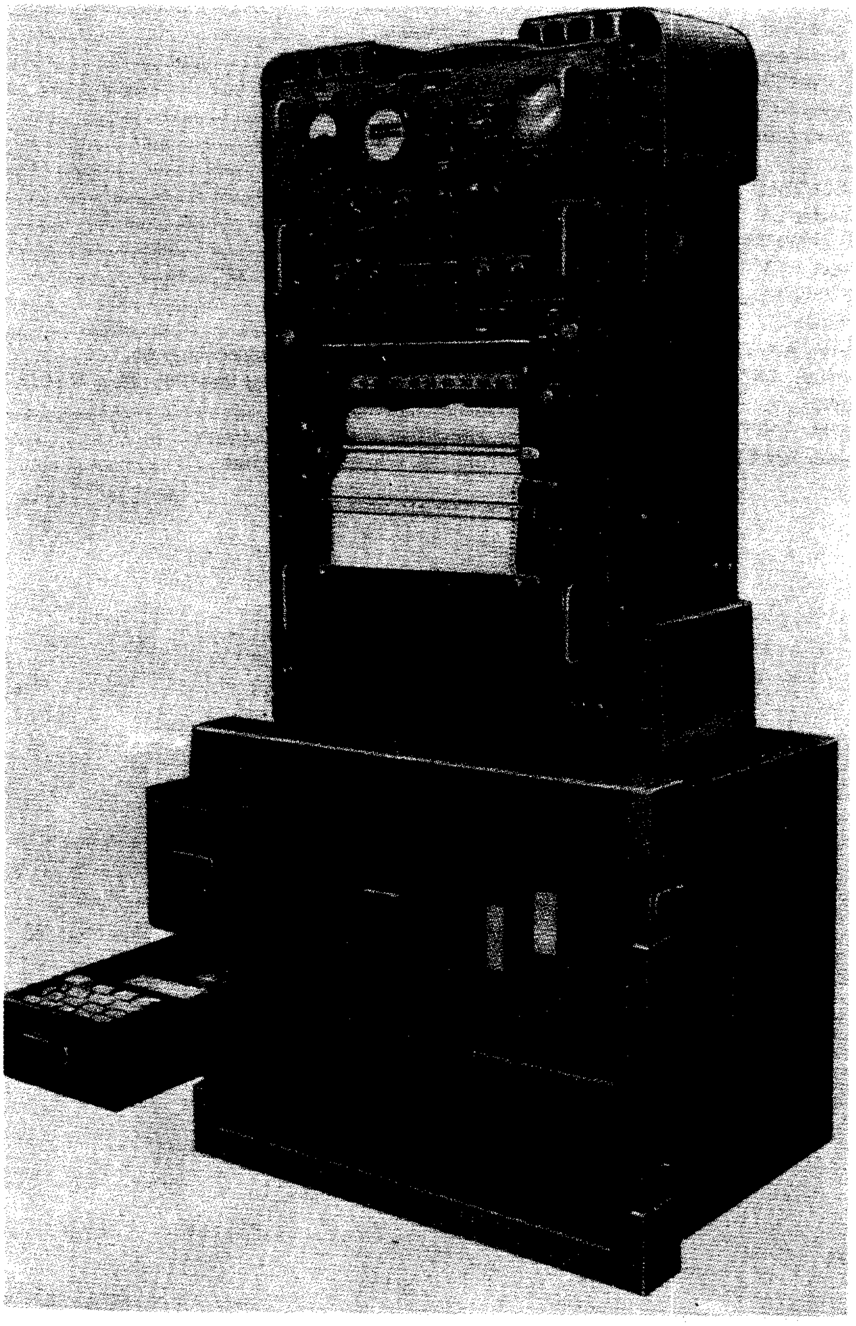


Figure 1-1. Radiosonde Recorder AN/TMQ-5(*).

CHAPTER 1

INTRODUCTION

1-1. Scope

a. This manual covers Radiosonde Recorders AN/TMQ-5, AN/TMQ-5A, AN/TMQ-5B, and AN/TMQ-5C (fig. 1-1). Included are instructions for troubleshooting, testing, repair and replacement of specified maintenance parts and calibration at organizational, direct support, general support, and depot maintenance levels and depot overhaul standards.

b. The use of an asterisk in parenthesis (*) is used to indicate models of an item or equipment that are sufficiently alike to be treated as a single model throughout the manual. Thus: Radiosonde Recorder AN/TMQ-5 (*) represents Radiosonde Recorders AN/TMQ-5, AN/TMQ-5A, AN/TMQ-5B, and AN/TMQ-5C. Rawin set AN/GMD-1 (*) represents AN/GMD-1A, and AN/GMD-1B; Computer, Humidity-Temperature CP-223 (*)/UM represents CP-223B/U M and CP-223C/UM; Control Panel C-834 (*)/TMQ-5 represents C-834/TMQ-5 and C-834A/TMQ-5; Signal Data Converter CV-146 (*)/TMQ-5 represents CV-146/TMQ-5 and CV-146A/TMQ-5; Frequency Time Recorder RD-88(*)/TMQ-5 represents RD-88A/TMQ-5, RD-88B/TMQ-5, and RD-88C/TMQ-5; Power Supply PP-968(*) represents PP-968/TMQ-5 and PP-968A/TMQ-5; Electrical Equipment Cabinet CY-1390 (*)/TMQ-5 represents CY-1390/TMQ-5 and CY-1390A/TMQ-5.

c. The maintenance allocation chart is in appendix B.

1-2. Consolidated Index of Army Publications and Blank Forms

Refer to the latest issue of DA Pam 310-1 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

1-3. Maintenance Forms, Records, and Reports

a. *Reports of Maintenance and Unsatisfactory Equipment.* Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750 as contained in the Maintenance Management Update.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF361) as prescribed in AR 55-38.

1-4. Reporting Equipment Improvement Recommendations (EIR)

If your AN/TMQ-5(*) needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monrnouth, New Jersey 07703-5007. We'll send you a reply.

1-5. Administrative Storage

Administrative storage of' equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the PMCS charts before storing. When removing the equipment from administrative storage, the PMCS should be performed to assure operational readiness. Disassembly and repacking of equipment for shipment or limited storage are covered in TM 740-90-1.

1-6. Destruction of Army Electronics Materiel

Destruction of Army electronics materiel to prevent enemy usc shall be in accordance with TM 750-244-2.

1-7. Differences in Models

Refer to TM 11-6660-204-10 for an explanation of the differences between the various models and a description of the equipment comprising these models.

CHAPTER 2
FUNCTIONING OF EQUIPMENT

Section I. BLOCK DIAGRAM EXPLANATION

2-1. Purpose and Use

*a. **General.*** Radiosonde Recorder AN/TMQ–5 (*) graphically records radiosonde data representing atmospheric pressure, temperature, and relative humidity received by Rawin Set AN/GMD–l (*). The latter equipment is a receiving-type direction finder which receives the signals transmitted by a balloon-borne radiosonde set with or without a hypsometer. The received intelligence from the rawin set is fed to the recorder in the form of audio frequency pulses that range nominally from 10 to 200 cps. A preflight calibration establishes the relationship between audio frequency and both temperature and relative humidity. The received data printed graphically is converted into actual temperature and relative humidity values by Computer, Humidity-Temperature CP–223 (*) /UM. Pressure information is obtained by reference to the pressure-calibration chart furnished with each individual radiososde set.

b. Block Diagram. A simplified block diagram of this recorder is covered in TM 11-6660–204-10, describing its function with respect to the complete radiosonde system. A more detailed block diagram analysis (fig. FO-1) is discussed below.

2-2. Electronic Circuit Functions Block Diagram Analysis (fig. FO-1)

a. General. Radiosonde Recorder AN/TMQ-5 (*) consists of six major components: Control Panel C-834(*) /TMQ–5, Signal Data Converter CV-146 (*) /TMQ-5, Frequency-Time Recorder RD-88 (*) /TMQ-5, Power Supply PP-968 (*) /TMQ–5, Equipment Cabinet Subassembly MX-1482/TMQ–5, and Electrical Equipment Cabinet CY–1390 (*) /TMQ–5. Functional circuits, however, are not always completely contained in a particular chassis but are distributed throughout two or more major components in some instances. The circuits are presented in the order of their signal functions and the components are referred to by functional common names. A list of components by nomenclature and common name is contained in TM 11-6660-204-10.

b. Converter-Amplifier Chassis. The converter-amplifier chassis contains Signal Data Converter CV-146 (*)/TMQ-5; this includes the signal conversion circuits (all circuits between the input and the detector), the detector, and a major portion of the servoamplifier system. Input signals that will properly excite the converter and deliver reliable output data must fall within the limits of the following specifications:

(1.) They must have an amplitude in the range of 10 to 100 volts, peak-to-peak.

(2) Their recurrence frequency must be below 250 cps.

(3) Their shape should be classified as sine, square, sawtooth with positive-going slope, or negative pulses. (Sine waves of higher amplitude than 100 volts peak-to-peak may be used.) The af signals are converted to a predetermined shape and amplitude, and are then rectified and filtered, The resultant dc signal to the detector is directly proportional to the recurrence frequency of the input signal which is suitable for application to the remainder of the recorder circuits (wave shape and amplitude are not factors). This linear result is explained in detail in paragraph 2-11. Provision is made for aural monitoring of the signal by means of a speaker located on Control Panel C-834/TMQ-5.

c. Detector. The detector, located in the converter-amplifier chassis, receives two dc voltages; one from output tube V307, and the other from the contact arm on slide-wire potentiometer R501B in the measuring circuit. When a difference exists between these two voltages, an ac error voltage is developed, the frequency of which is equal to that of the power line (nominally 60 cps). This error voltage is applied to the servoamplifier circuits to operate the recording portion of the equipment. The phase of the error voltage referred to the powerline phase is dependent on the polarity of the unbalance between the two dc voltages.

d. Measuring Circuit.. The measuring circuit contained in the control panel consists of an arrangement of resistors and potentiometers to develop and control the voltage across the slide-wire potentiometer which is mounted on the frequency-time recorder chassis. A test voltage is also developed in the measuring circuit and is used to check the operation of the recorder.

e. Servoamplifier. The servoamplifier system consists of five voltage amplifiers and a line voltage compensating tube in the converter-amplifier chassis, together with two power amplifier tubes located in the power supply. The 60-cycle error voltage from the detector is amplified in these stages, and is then used to drive the balancing motor in the frequency-time recorder chassis and to actuate the pen-lifting circuit in the power supply chassis. The pen-lifter circuit operates a solenoid which is mechanically coupled to the pen carriage of the recorder. When power is applied to the solenoid, the pen is lowered onto the chart. It is raised from the chart whenever an error voltage exists, so the chart is not marked while the pen is being moved to the proper position.

f. Balancing Motor B501. The balancing motor is a two-phase motor which is mechanically coupled to the moving arm of the slide-wire potentiometer asd to the recording pen. One winding of the motor is connected to a 60-cycle excitation voltage, and the other (control) winding is connected to the output of the servoamplifier circuit. When the balancing motor is actuated by the error voltage generated in the detector circuit, it drives the slide-wire potentiometer contact arm. The slide-wire contact arm voltage changes as the balancing motor continues to revolve. When this voltage becomes equal to the signal voltage applied to the detector, the error voltage is canceled by the balanced-bridge condition, and the balancing motor stops. While the balancing motor rotates the pen-lifter mechanism holds the pen above the chart, the pen moves across the chart; the pen makes no mark because it is in a lifted position. The sequence of operation is such that the pen always marks the chart at a point that corresponds to the meteorological information being received.

g. Frequency-Time Recorder. The frequency-time recorder is an electromechanical device which in effect makes a continuous printed record of the pulse recurrence frequency of the signals received from the radiosonde receiver. The chart motor continually advances the chart under the recorder pen at the rate of l/2-inch per minute (1/2 or 1 inch per minute in Frequency-Time Recorders RD–88A/TMQ–5 and RD-88B/TMQ–5, and ½, 1, or 2 inches per minute in Frequency-Time Recorders RD-88C/TMQ-5, so the received data are spaced along the chart from the beginning to the end of each radiosonde flight.

h. Power Supply. The power supply contains circuits that supply the voltages used to operate the recorder and its associated circuits. It comprises one common power transformer which furnishes an unregulated voltage for the balancing motor circuit, a positive supply voltage, and a negative supply voltage together with regulator circuits to maintain these dc voltages at a steady potential. Power supply also contains the servopower amplifier tubes, the pen-lifter circuit and tubes, and the solenoid relay.

i. Functional Operation. In considering the functioning of the recorder throughout the following detailed circuit analysis, bear in mind that basically the signal converter contains the wave shaping and pulse forming circuits for the detector. The servoarnplifier system contains the voltage amplifiers, power amplifiers, and pen-lifting and operating circuits, which are associated with the balancing motor circuit in the frequency-time recorder. The control panel supplies controls for the measuring circuits and the adjustments for proper operation, and the power supply furnishes the necessary operating potentials, The received radiosonde signals, regardless of their wave shape and amplitude at the recorder input, are converted into a dc voltage which is proportional to the low recurrence frequency of the input signal at any instant, This dc voltage is then applied to an electromechanical recorder which translates it and marks off the frequency variations corresponding to temperature and relative humidity readings as transmitted by the radiosonde. The chart can be read directly by a skilled operator or used at a later date for further evaluation of each radiosonde flight.

Section II. STAGE FUNCTIONING

2-3. Cathode Follower
(figs. 2-1 and 2-2)

Cathode follower V301A is one-half of a miniature twin-triode tube which functions as a buffer or isolating stage and offers a sufficiently high input impedance to prevent loading of the output circuit of the radiosonde receiver (which supplied signals to the recorder). The cathode follower presents a low output impedance to the noise-suppression circuit and the input signals can be in the form of sine waves, exponential waves, sawtooth waves, or pulses, depending on the type of equipment with which the recorder is used. For ease of presentation, all wave forms shown on the simplified diagrams in this chapter are taken with SIGNAL SELECTOR switch S202 in the 120 CPS position. The input test signal in this instance is the 120-cycle ripple voltage taken from the negative power supply ahead of the filter; the shape of the wave is between a sawtooth and sine. The 60 cps test voltage is a sine wave taken directly from the power transformer in the power supply.

a. The cathode follower circuit receives its input signal through. SIGNAL SELECTOR switch S202, which is mounted on the control panel. This switch has four positions and its rotor contact is connected to) the input (grid) of the cathode follower. One position, S.C. (short circuit), is used to ground the input, and effects a zero indication on the recorder. Two test-voltage positions, 60 CPS and 120 CPS, supply either a 60- or 120-CPS signal to the input circuit, which makes the recorder indicate a reference level of 30 or 60 chart divisions, respectively, when REF. ADJUST potentiometer R202 is correctly set. The fourth position, SIG., applies the radiosonde receiver output signal to the cathode follower input.

b. The input signal voltage is applied across resistor R301 and through de blocking capacitor C301 to the grid of tube V301A. The plate is connected directly to the low impedance 300-volt positive supply. Voltage-dividing resistors R304 and R305 reduce the positive potential to a nominal 140 volts for use as a "bias potential for the grid

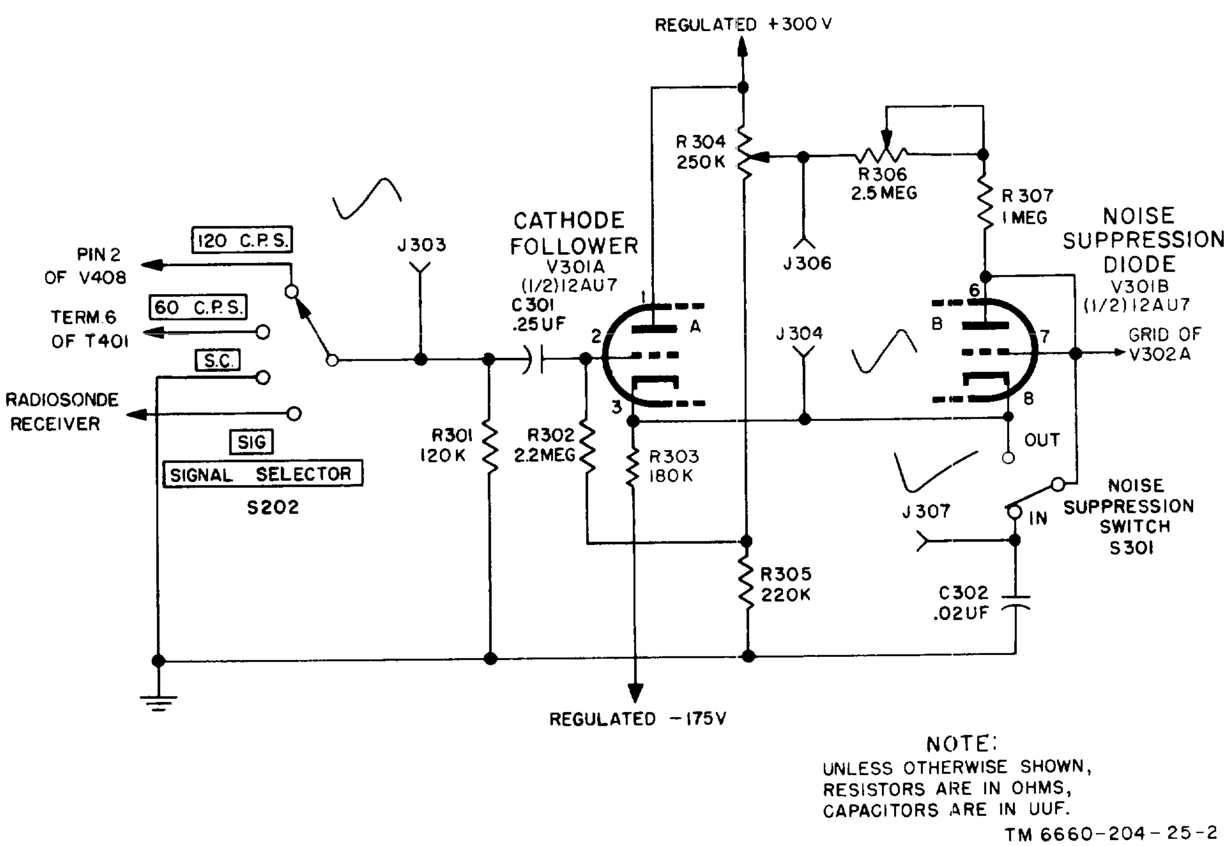


Figure 2–1. Cathode follower and noise-suppression diode, simplified schematic diagram.

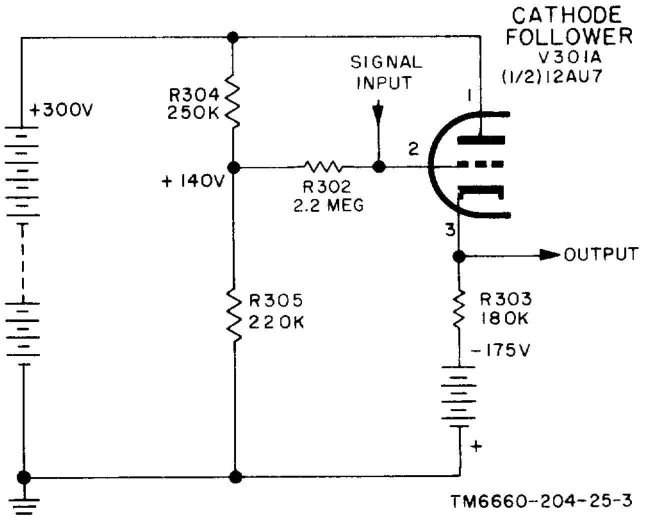


Figure 2-2. Bias circuit, simplified schematic diagram.

through R302. Cathode resistor R303 (180,000 ohms) is a return path to the negative 175-volt supply, so across the plate-cathode resistance and R303 (in series) there isa tota! potential of 475 volts. Cathode current in resistor R303 keeps the cathode above the 140-volt potential of the grid, so the tube actually has a negative bias. The advantage of this circuitry permits the injection of large signal voltages without overloading, and presents a high impedance to the signal source but a low impedance signal source to the load.

(1) The higher signal voltage is permitted because the cathode will follow closely any signal voltage applied to the grid, avoiding any appreciable change in grid-cathode potential. This action is probably best explained by an example: ('To simplify the figures, only approximate values are used).

(a) Assume the no-signal values of circuit conditions to be—

Plate-cathode potential - - - - - - +151 volts
Grid-cathode potential - - - - - - 8 volts
IR drop across R303 -------- 324 volts
Plate (or cathode) current - - 1.8 milliampere
Transconductance - - - - - - - 2,500 umho.

(b) This value of transconductance means a change in I_p of 2.5 microampere (Pa) for each millivolt change of grid-cathode potential. A positive grid signal swing of 50 volts would then create a positive cathode signal swing of 49.9 volts; the other tenth of a volt being a grid-cathode change, permitting the increase in I_p.

(2) The grid input circuit of a cathode-follower stage is high impedance because the small grid-ground capacity is the only one with any charge drain; the plate voltage remains constant, which eliminates the relatively high current required to charge the grid-plate capacity under ordinary amplification conditions. On the other hand, the output impedance is low because the plate, not having any external impedance to limit its current, will supply any reasonable current demands. (Output A = 1/Gm, nearly.)

2-4. Noise Suppression Diode
(fig. 2-1)

Noise suppression diode V301B is one-half of a miniature twin-triode tube which has had the plate and grid pins connected together to form an anode connection. The purpose of the diode is to reduce the high noise level in the signal to prevent false triggering of the univibrator giving false recordings, The diode may be switched in or out by means of the noise suppression switch (S301). When this switch is in the **OUT** position, the anode and cathode are shorted together and the signal is bypassed around the diode; the tube is inoperative. The explanation that follows (switch at the IN position) applies to actual noise suppression.

a. A small space current is present in the tube under no-signal conditions, because the anode is connected to --300 volts through resistors R307, R306, and R304; and the cathode is connected to —175 volts through resistor R303. Cathode resistor R303 is shared with tube **V301A** and is the coupling between the two tubes. The portion of the current in R303 that is delivered to tube V301B is about 30 μa or 1/60 of the total current in the resistor.

b. The signal at jack J304 is practically identical in amplitude and shape with that at jack J303 (para 2-3). This is the signal that appears on the cathode of the diode. When the signal raises the cathode potential above that of the anode, the tube will not conduct. When the signal lowers the cathode potential below that of the anode, the diode is able to conduct freely and can discharge any accumulated charge in capacitor C302, the hot terminal of which is connected to the anode through switch S301.

c. Under no-signal conditions the two cathodes of tube V301 will be about 150 volts potential above ground (para 2–3). Capacitor C302 will charge through resistors R307, R306, and R304; the voltage across C302 will rise exponentially toward that value determined by the setting of potentiometer R304. When this positive-going voltage becomes greater than that on the cathode, the diode conducts and allows current to be fed to the anode from R303. The upper limit of 155 volts on the capacitor (or anode), which is the condition of the circuit before application of the signal is controlled by a voltage divider string, consisting of resistor R303, the diode, resistors R307, R396 and the upper part of R304.

d. Assume that a strong signal wave, similar to that shown at J304 (fig. 2-1), is applied, The initial swing is negative, and capacitor C302 discharges through resistor R303 and the diode. At the frequencies involved, the voltage decline on capacitor C302 closely follows the signal voltage wave. After the completion of the downward swing of the signal voltage, the cathode signal potential starts rising. Immediately, conduction in the diode is cut off because the relatively long-time constant of capacitor C302, resistors R307, R306, and R304 prevents the voltage from rising on the capacitor (and anode) as the signal voltage rises on the cathode; the anode thus remains negative with respect to its cathode during this period. This results in an exponential rise of voltage on the capacitor as shown by the waveform (fig. 2-1) at J307; this voltage rises independently of the signal until such time in the next cycle when the signal voltage on the cathode again drops to a point where it is less than that on the anode, then the diode conducts starting a new cycle,

e. The output signal from the diode is free of noise voltage because the positive portion is not affected by the actual signal. It is this portion of the signal wave that triggers the univibrator; therefore, the noise that gets through the diode on the negative portion of the wave is of no consequence (within reasonable limits).

f. Jack J306 is a convenience terminal for checking the voltage applied to the noise-suppression circuit. This voltage is adjusted by potentiometer R304 which determines the signal amplitude. Potentiometer R306 is the main control of the time constant resistance-capacitance (RC) circuit, and is adjusted for linearity on the rising portion of the signal wave, (Only a small part of the exponential curve is used, and this appears to be linear on the test scope.) Because there is some interaction between these controls, the adjustment of one will affect the adjustment of the other; adjustments are alternated until the optimum position is found.

2-5. Cathode Follower (fig. 2–3)

Cathode follower V302 A is one-half of a miniature, hi-mμ, twin-triode tube. Its purpose is to prevent loading of the noise-suppression diode. Its operation is explained with switch S301 assumed to beat the IN position.

a. The signal from the plate of tube V301B is fed directly to the grid of cathode follower V302A. The plate of tube V302A is connected directly to the regulated +300 volts. The output signal is developed across cathode resistor R308 and is returned to the —175-volt regulated supply, which is the same as that of the input circuit, Although the cathode of tube V320A is connected to —175 volts and the grid connected to a positive voltage source, the currest through cathode resistor R308 produce a positive cathode potential, with respect to ground, that is greater than the grid potential, so the tube is biased negatively. The output signal from the cathode of tube V302A is fed to the clipper amplifier through coupling capacitor C303.

b. When the input signal goes negative, the plate current decreases and causes the voltage across cathode resistor R308 to decrease. As the signal swings positive, the plate current increases and causes the voltage to increase across resistor R308, which results in a waveshape across R308 (fig. 2-3) that is similar to the input signal of tube V302A. The amplitude of the output waveform is slightly smaller than the input, because the cathode-follower introduces a slight loss. Jack J308 is provided for test purposes where measurements can be made for both the output of V302A and the input to tube V302B.

2-6. Clipper Amplifier (fig. 2-3)

Clipper amplifier V302B is one-half of a miniature, hi-mμ, twin-triode tube. Its purpose is to distort the sawtooth waveform received from the preceding stage so its output is approximately a square wave.

a. The output signal of cathode follower V302AA is applied through coupling capacitor C303 across grid resistor R310. The signal is then applied to the grid of tube V302B, through grid-current limiting resistor R309, which clips the positive portions of the signal across resistor R310. The clipper output signal is developed across plate-load resistor R311, which is connected to the regulated +300 volt supply.

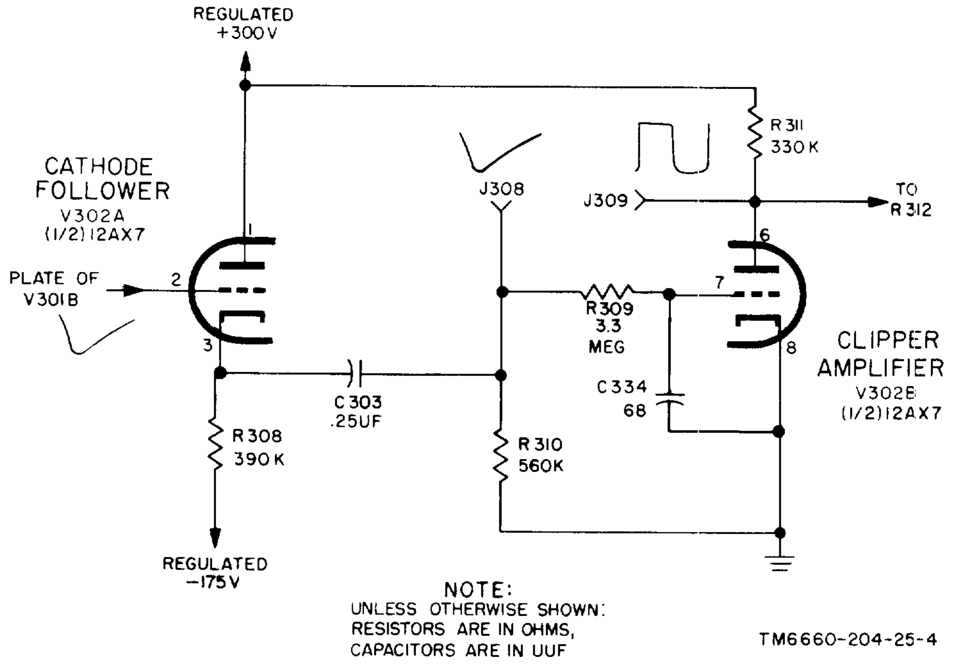


Figure 2–3. Cathode follower and clipper amplifier, simplified schematic diagram.

b. Coupling capacitor C303 isolates the grid of tube V302B from the dc component of the cathode voltage of the preceding stage. The waveform across resistor R310 is shown at J308 (fig. 2–3). The tube has no externally applied bias; high plate current is prevented by the large value of plate load resistor R311. High grid current on positive signal swings is prevented by the high value of resistor R309; this resistor limits the positive grid-cathode voltage to less than 1 volt, and the remainder of the signal voltage is taken up across the resistor. On a negative signal swing, plate current cutoff is reached at approximately —5 volts; any signal voltage in excess of this value has no effect on the output voltage from the stage.

c. To operate properly, the clipper amplifier tube must have a relatively large signal voltage applied from the preceding stage. As a result, the potential at the plate of the tube alternately rises to 300 volts during plate current cutoff, and drops to a few volts throughout the positive grid swing; the wave is approximately square (fig. 2–3), and can be checked at Jack J309.

d. The pulsating signal current in resistor R309 flows through R310 and, because capacitor C303 and resistor R310 form a self-rectified bias, is cut off, and exists only during signal reception. Under no-signal conditions, a slight bias is present because the high value of resistor R309 does not allow the space charge on the grid to leak off easily. The small value of capacitor C344 allows it to be effective as a bypass on the very high frequency components of the voltage wave without affecting the low frequency comp orients.

2–7. Voltage Discriminator (fig. 2-4)

a. The voltage discriminator is a miniature twin-triode tube, V303A and V303B. The clipped and partially shaped output signal of tube V202B triggers the voltage discriminator between two stable states to produce an output signal that is a square wave of constant amplitude and the frequency of which is the same as the original input signal. Potentiometers R314 and R317 set the dc operating levels of the cathode and grid. Resistor R312 is a grid-current limiting resistor, The output of this stage is taken from the resistor R318, which is the plate load resistor of V303B. Test jacks J310, J311, and J312 check respectively the cathode, grid, and plate waveforms.

b. Tube V303B conducts under a no-signal condition because the grid of the tube is connected to a positive voltage through a voltage-divider arrangement consisting of R315, R316, and R317 between +300 volts and ground.

Current flowing through common cathode resistors R313 and R314 produces a positive voltage at the cathode of tube V303A greater than the positive voltage applied to its grid through resistors R311 and R312. This effectively biases tube V303A at cutoff so normally, with no signal applied, tube V303A is at cutoff and tube V303B conducts. When a positive input signal is applied to the grid of tube V303A, the grid becomes positive with respect to the cathode. When the input signal reaches a value of approximately 150 volts, and tube V303A conducts decreasing the plate voltage and creating a negative swing which is applied, through capacitor C304, to the grid of tube V303B, This negative voltage, in turn, decreases the plate and cathode current of tube V303B. Because both cathodes are interconnected the decreased cathode voltage reduces the effective bias on tube V303A and aids the positive grid voltage of tube V303A. A regenerative action takes place, and leaves tube V303A conducting at maximum current and tube V303B at cutoff, Any increase of the grid-signal voltage of tube V303A past the triggering point has no effect on the output voltage of tube V303B. The two tubes remain in this steady state condition until the signal voltage at the grid of tube V303A drops below 120 volts. At this time, regenerative action again takes place, because the negative signal voltage produces a positive voltage across plate resistor R315, which is applied to the grid of tube V303B through capacitor C304. This positive voltage increases the drop across cathode resistors R313 and R314, and effectively returns the bias on tube V303A cathode to the cutoff condition that originally existed with no signal applied; tube V303A returns to a nonconducting condition and tube V303B conducts. The two tubes remain in a steady state until the signal voltage applied to the grid of tube V303A is raised to approximately 150 volts, at which time the circuit is triggered and the action is repeated. Thus when one tube is held at plate current cutoff and the other tube is conducting, a rectangular waveform of fixed amplitude is created at the recurrence frequency of the input signal, regardless of input waveform and amplitude. ‘The output of this stage is the signal voltage developed at the plate of tube V303B.

c. Capacitor C304 immediately applies the voltage developed across resistor R315 in the plate circuit of tube V303A directly to the grid of tube V303B rather than through resistor R316. Without this capacitor the steep voltage, rise and fall, developed across resistor R315 by operation of tube V303A would be delayed in application to the grid of tube V303B, and the corners of the square wave would be rounded instead of spiked. The positive spike is a desirable feature when this wave form is later applied to the univibrator.

2-8. **Positive Pulse-Selector Stretcher** (fig. 2-5)

a. The positive pulse-selector stretcher is one-half of a miniature twin-triode tube, V304A. Its purpose is to eliminate the negative portion of the applied input signal a:nd to develop a positive output pulse, at each of two output points, for each input pulse. One output is used as a trigger for univibrator V305, and the other to drive audio output tube V304B. The stretching is done on the time base to increase the audio component in the pulse applied to the audio tube.

b. The rectangular output wave from the plate of tube V303B is applied to an RC circuit consisting of resistor R319 and capacitor C305. The RC time constant of this circuit is very small compared to the width of the input wave and, as a result, this wave is differentiated. The differentiated wave is applied to the grid of tube V304A, whit h is set at the cutoff point by a fixed negative bias voltage applied between the grid and cathode. Negative pulse on the grid have no effect, because the tube is already biased to cutoff. However, a positive grid pulse produces a plate current pulse. This plate current pulse flows through resistor R322 (the cathode resistor of univibrator tube V305) to charge capacitor C306. Consequently a sharp positive pulse, produced by the capacitor-charging current, appears across resistor R322 and is used 10 trigger univibrator V305.

c. The waveform across cathode resistor R321 of tube V304A is shown at jack J313 (fig. 2–6). (The second spike is caused by the recovery of the univibrator.) The stretched pulse results from the exponential decay of voltage caused by the discharge of capacitor C306 through resistors R321 and R322. The stretched pulse is applied to the grid of audio output tube V304B. A momentary contact, INTER S.C. position of switch S203 on the (control panel, is connected across resistor R322 to short the univibrator trigger pulse for testing purposes. This switch can be used to help isolate trouble in the signal converter circuits and to determine whether the recorder circuits are functioning properly. (Recording at zero is obtained when the switch is depressed.) Tube V304A actually functions as a cathode follower to provide a signal for triggering the univibrator at a low impedance point.

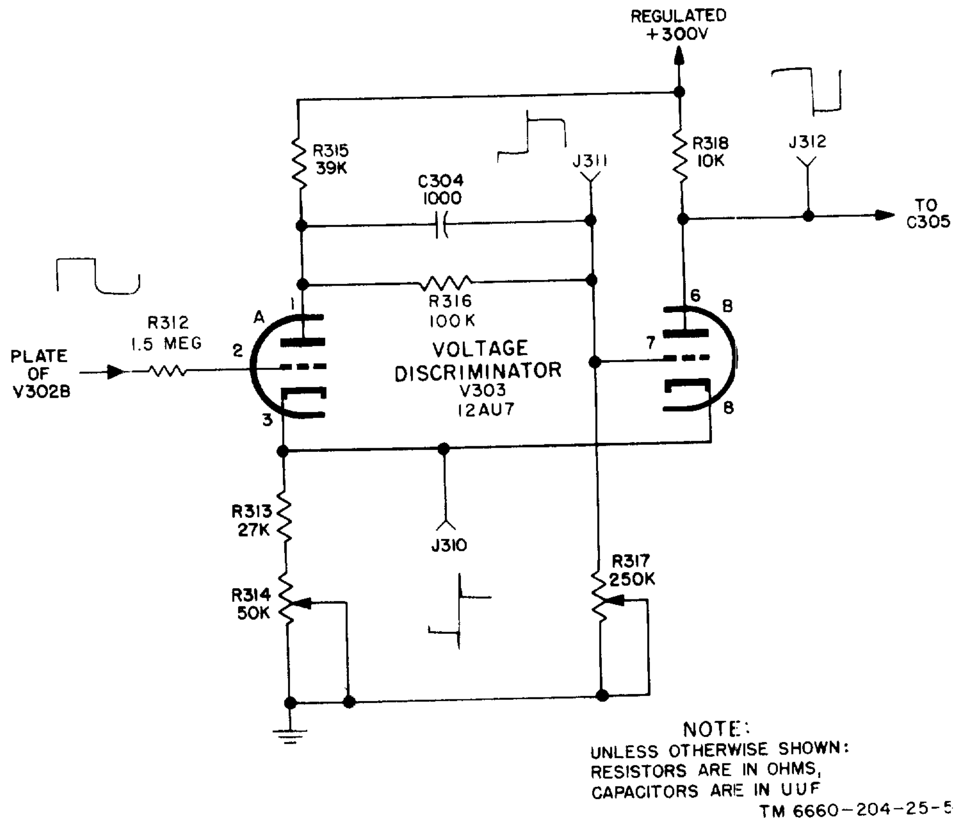


Figure 2-4. Voltage discriminator, simplified schematic diagram.

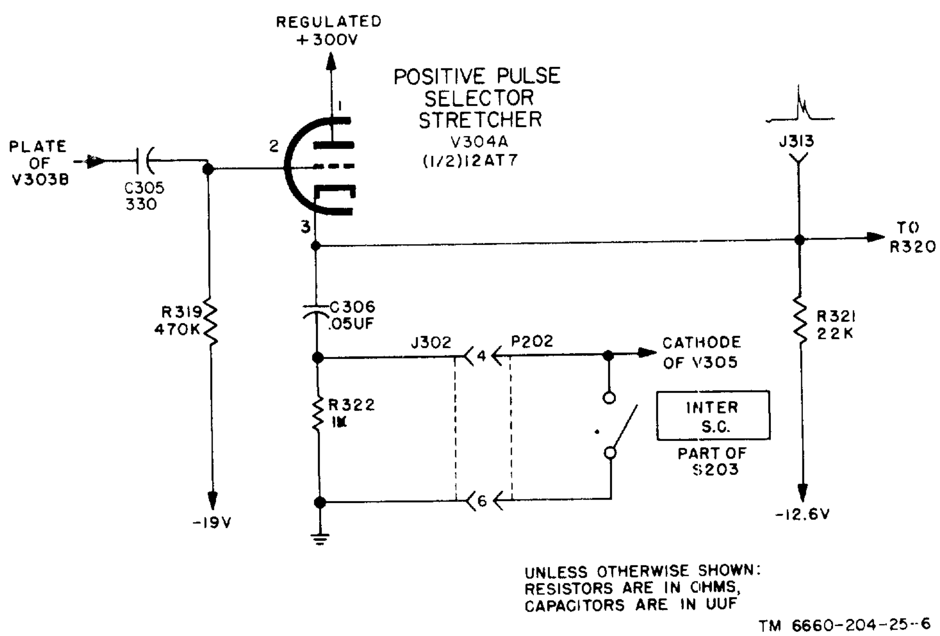


Figure 2-5. Positive *pulse selector stretcher,* simplified schematic diagram.

2-9. Audio Output
(fig. 2-6)

a. The audio output circuit uses one-half of a miniture twin-triode tube, V304B, to aurally monitor the signals as they are received from the radiosonde receiver. A volume control is mounted on the control panel to operate a speaker at the desired level. Switch S205 was included in early models but has been discontinued in later models.

b. The grid of tube V304B is directly connected through current-limiting resistor R320 to the cathode of tube V304A and is supplied with a fixed negative bias of 12.6 volts. When the positive streched pulse appears at the cathode of tube V304A, it is applied to the grid of tube V304B through grid-current limiting resistor R320. Because of the large signal amplitude swing, the tube draws a slight amount of grid current on the signal peaks through resistor R320 effectively clipping the spiked portion of the signal and producing a pleasing sound in the speaker. The signal is amplified and fed through audio output transformer T301 to the speaker mounted on the control panel. A simplified diagram is shown in figure 2-6. The cathode of tube V304B is returned to circuit ground through unbypassed potentiometer R214. This potentiometer has no shunt capacitor and effectively controls the amount of negative feedback, tube gain, and speaker volume,

2-10. Univibrator (fig. 2-7)

a. The univibrator uses both sections of a miniature twin-triode tube, V305 (fig. 2-7). The univibrator is essentially a one-shot multivibrator triggered by the output of the preceding pulse selector circuit. Its purpose is to generate a positive-going rectangular pulse of constant time width to operate voltage switch V306 (fig. 2-8).

b. Tube V305A has its grid connected to the +300-volt supply through resistor R328 so that it is normally in a conducting condition when no signal is applied. Biasing is accomplished by the flow of grid current through resistor R328, and develops a bias which is sufficient to produce a voltage drop across R328 almost equal to the voltage supply. Normally, with no signal applied, the grid rests at a potential of +4 or +5 volts. Because tube V305 is a high-gain triode, it requires only a small voltage for cutoff (approximately —5 volts at 300 plate volts). With a positive voltage on the grid, the tube conducts to produce a plate current flow of approximately 4 milliamperes (ma), and a cathode potential of approximately 4 volts. In operation the grid voltage is slightly higher than the developed cathode voltage, so the tube normally operates with a small positive bias. The grid of tube V305B is directly connected to the plate of tube V305A through resistor R324 and is biased beyond cutoff by a voltage divider arrangement which consists of resistors R324, and R325, and R326, between that + 50-volt plate of tube V305A and —175 volts, This bias is adjustable through variable resistor R326. Resistor R322 is the cathode resistor for tube V305A, and R329 is the cathode resistor for tube V305A. The input trigger voltage is applied to the cathode of tube V305A and the output signal is taken from the grid of tube V305A and applied to voltage switch tube

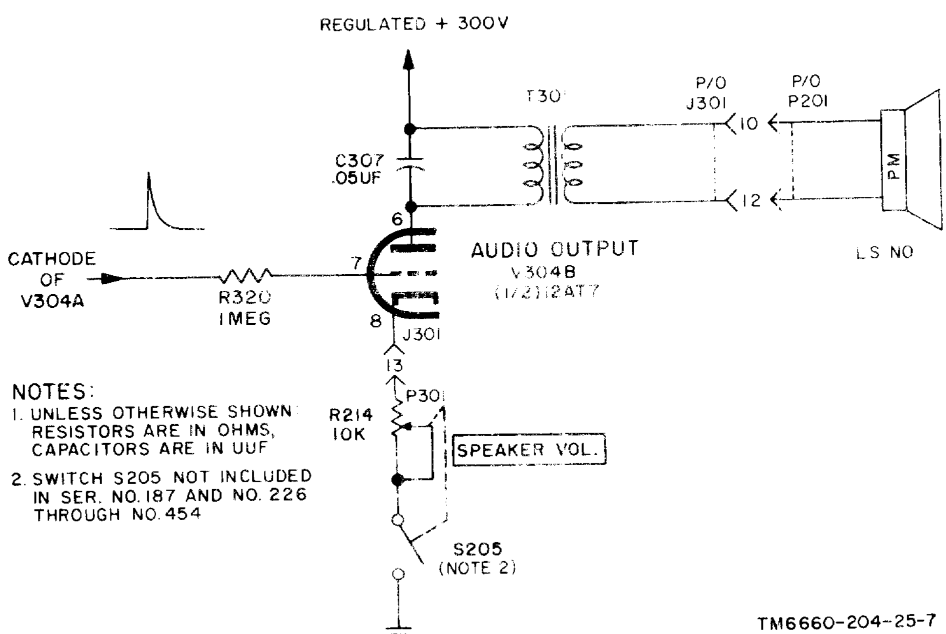


Figure 2-6. Audio output, simplified *schematic diagram.*

V306. Test jacks J315 and J316 (fig. 2–7) are provided to check the grid waveforms of tubes V305A and V305B, respectively. The cathode waveform is shown at jack 318 of tube V305B.

c. A positive pulse from the cathode of pulse selector tube V304A is impressed on the cathode of tube V305A through capacitor C306, to reduce the nearly zero bias to a high negative value which reduces plate current and produces a positive plate voltage swing because of the reduced voltage drop across resistor R323. This plate voltage swing is coupled to the grid of tube V305B through C308 producing a plate current flow which increases voltage drop across R327. Capacitor C308 permits the instantaneous signal swings to bypass resistor R324 so that this steep rise is not attenuated at the grid of tube V305B. This negaive plate voltage swing is, in turn, coupled to the grid of tube V305A by capacitor C309, causing regenerative action which rapidly increases the negative swing on tube V305A so the tube is immediately driven into cutoff. This new state of conduction exists until capacitor C309 is discharged sufficiently through resistor R328 to the point where the grid of tube V305A is brought above cutoff. Regenerative action then occurs in the reverse direction, and thus rapidly restores the circuit to its original stable state with tube V305A conducting and tube V305B at cutoff.

d. The grid of tube V305B is directly connected through resistor R330 to the grid of voltage switch tube V306; thus, the positive rectangular pulse created at this point (J316) is used to operate V306.

2-11. Voltage Switch and Output Gate (fig. 2-8)

a. Voltage switch V306 is a miniature, hi-rep, twin-triode tube. Both sections are connected in parallel, but they are shown as a single tube in the simplified diagram of figure 2–8 for ease of presentation. The output gate circuit utilizes both sections of miniature twin-triode tube V307 connected as twin diodes. The rectangular pulse output from the univibrator is utilized to develop an output pulse (one that is identical for each input pulse) by voltage switch tube V306 for application to the output gate circuit. The output gate functions to produce a 0- to approximately 30-millivolt output voltage that is proportional to the recurrence frequency of the input signal applied to the recorder.

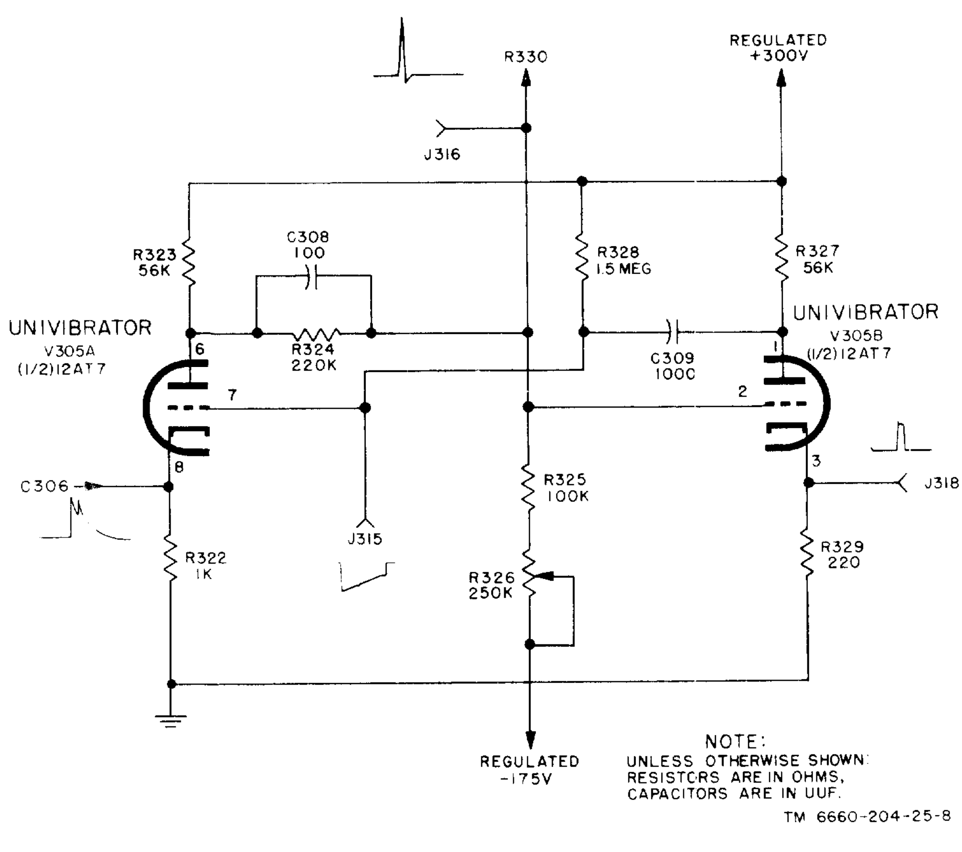


Figure 2–7. Univibrator, simplified schematic ***diagram.***

b. Voltage switch tube V306 is normally held beyond cutoff by the high grid bias applied to tube V305B through grid-current limiting resistor R330 (fig. 2-7). When a positive pulse is developed by the univibrator, the grid of tube V306 is driven rapidly from cutoff to zero or slightly positive, and the plate current of switch tube V306 rises steeply to a steady value. This value of plate current and its time of duration are essentially the same for each pulse. Plate-1oad resistor R331 is a precision wire-wound type and, therefore, because the plate current is essentially the same for each pulse, the voltage drop produced across resistor R331 is also essentially the same throughout each pulse.

c. Under static conditions of tube V306, capacitor C310 is charged to 300 volts. When a positive pulse is applied to the grid of tube V306, the resulting plate-cathode conductively serves as a closed circuit to permit a discharging current to occur. The low resistance of the tube drops the plate potential steeply to about 25 volts. The discharge path on the negative side of capacitor C310 may be traced through tube V307A and resistor R332. The time constant of this circuit is relatively low, so the discharge is completed long before the end of the controlling pulse; thus small variations in pulse duration cannot appreciably affect the extent of discharge. When the controlling pulse is over, voltage switching tube V306 is again cut off and capacitor C310 recharges through resistor R331, tube V307B, and the low impedance filter and load network between the cathode of tube V307B and ground. To assure an equal amount of energy per pulse being stored in filter capacitors C311, C313, and C314, the values of resistor R331 and capacitor C310 have been carefully designed to avoid the variations of resistance and capacitance that normally occur as a result of changes in temperature and/or humidity; *other resistors and capacitors will not be substituted* for these two particular items. The charging time for capacitor C310 is normally between one-fifth and one-tenth of the period of the highest pulse recurrence frequency that will be encountered, so there is always sufficient time for the capacitor to recover its full charge between pulses.

d. Because of the high value of capacity in the parallel combination of C311, C313, and C314 (75 μf total), only a few microvolt of charge are built up on each pulse. Choke L301 and its 5-μf shunt capacitor C312 resonate at approximately 10 CPS, which increases the series filtering effect at the low end of the af signal frequency scale. At the high end, further filtering is accomplished at

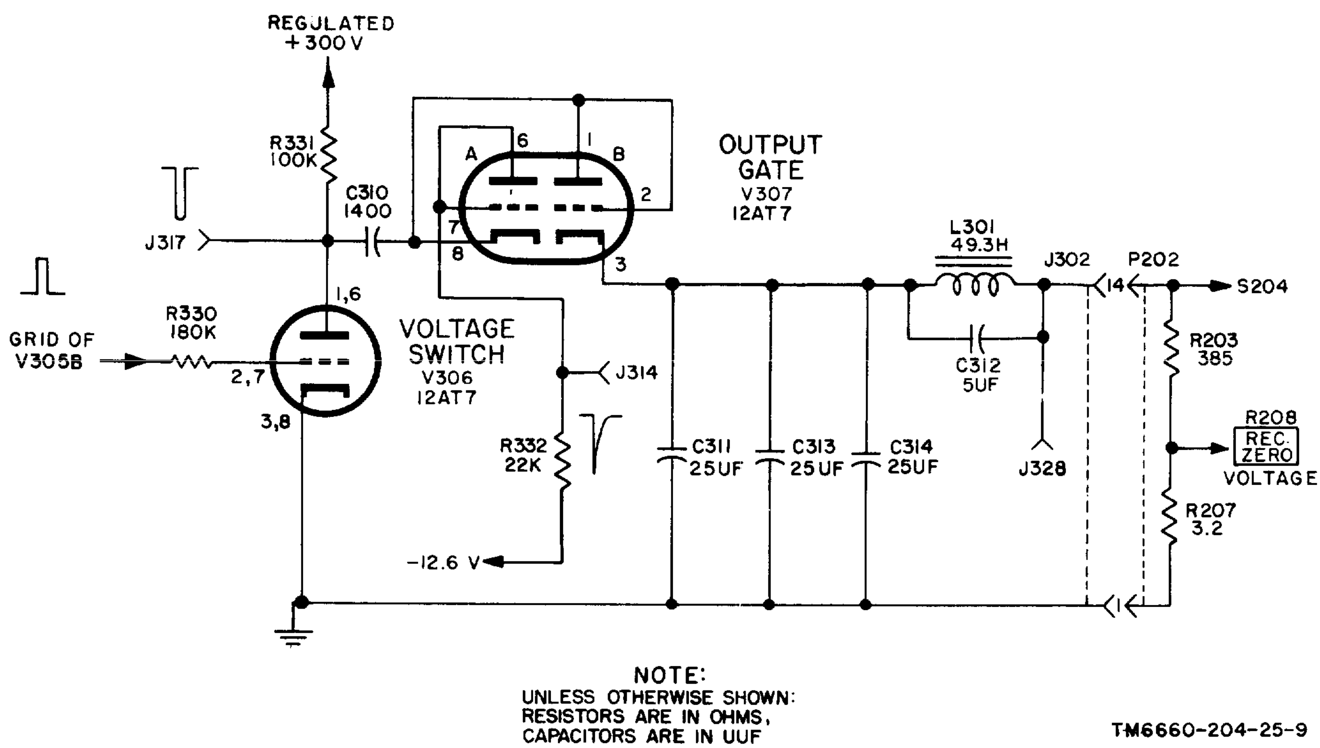


Figure 2-8. Voltage switch and output gate, simplified schematic diagram.

the input to the detector circuit (para 2–13d). Discharge current through load resistors R203 and R207 will be proportional to the voltage built up across the 75-μf capacitor combination.

e. The voltage across the 75-μf capacitor combination is directly proportional to the charge (in coulombs) stored there which, in turn, is directly proportional to the rate it receives pulses, because each pulse delivers a uniform charge. The discharge current at any instant is almost equal to the voltage across the capacity divided by 385 (the resistance of R203) ; this value would not be exact because of the slight effect of the calibrating voltage and current involved in resistor R207. These facts all indicate an output voltage that is a linear function of the audio frequency of the initial input signal to the converter, and can be calibrated on a suitable indicator.

f. The output voltage (that potential which exists mainly across resistor R207, because resistor R203 is comparatively very small) will range from near 0 to approximately 30 millivolts, which is again filtered before being applied to the vibrating reed of inverter G301 (para 2–13).

2-12. Measuring Circuit
(fig. 2-9)

The measuring circuit provides a dc voltage of approximately 30 millivolts across slide-wire potentiometer R501B. This is used as a comparison voltage for the dc signal voltage developed across load resistor R203. Slide-wire potentiometer R501B and trolley-wire resistor R501A are mounted on a common shaft in the frequency-time recorder chassis. The common shaft is mechanically coupled to balancing motor B501, recorder pen, and the indicator pointer. The remaining parts of the measuring circuit are mounted on the control panel. Zero adjust and recorder test circuits are also included in the measuring circuit,

a. Current from the regulated +300 volts is fed to the arm of REF. ADJUST potentiometer, R202, through R201. The current flowing through potentiometer R201 is divided into two main circuits (paths A and B, fig. 2-9). (A slight current which flows through path C is considered later.) Path A is through resistor R206 to ground. Path B is through resistor R205 and then divides into three parallel resistive paths to ground. One branch is through a series circuit which consists of resistors R210, R212, and REC. TEST ADJ. potentiometer R211; another branch is through resistor R209; and the third is through slide-wire potentiometer R501B.

b. Path B is replaced with potentiometer B (fig. 2-10), which represents the slide-wire circuit. The zero adjust circuit is eliminated. The resistance from the wiper arm of potentiometer R202, through either leg to circuit ground, depends on the position of the arm (fig. 2–10). The sum of the currents in path A and path B is practically constant, so the current in path B is proportional to the resistance in path A, and is adjusted by potentiometer R202. The voltage across the slide-wire can be changed by adjusting potentiometer R202, the position of the balance point can be changed with a corresponding change of the recorder pen position. This method is used to align the reference (calibration) signals with the correct frequency indication on the chart. The voltage from the slide-wire circuit is fed to the center tap of the primary of transformer T302 (fig. 2-9) through trolley-wire resistor R501A, where it is compared with the dc voltage developed by the input signal.

c. The recorder test circuit consists of two resistors, R210 and R212, in series with REC. TEST ADJ. potentiometer R211 and is in parallel with the slide-wire, The wiper arm of potentiometer R211, as determined by the resistance values, will control 91 to 97 percent of the voltage being applied to the slide-wire, through the contacts of REC TEST Switch S–204 to the vibrator, Potentiometer R211 is adjusted so the recorder pen will print at 95 chart divisions.

d. The zero adjust circuit (path C, fig. 2–9) is similar to the reference voltage circuit explained in *b* above. A voltage, determined by the position of the wiper arm of REC. ZERO potentiometer R208, is obtained across resistor R207. The voltage across resistor R207 is applied through load resistor R203 to detector circuit G301 and is used to balance out the slight voltage from the slide-wire circuit when the recorder pen is at zero and the slide-wire wiper arm contact is about one-half of one percent of full scale position from the ground end of the slide-wire resistance.

2-13. Detector and Balancing Circuit
(figs. 2-9,2-11, and FO-2)

The detector circuit detects any difference (or error) between the millivolts of potential created by the incoming signal and fed to the vibrating reed of G301, and the potential delivered by the wiper arm of the slide-wire potentiometer to the center tap of the primary of transformer T302.

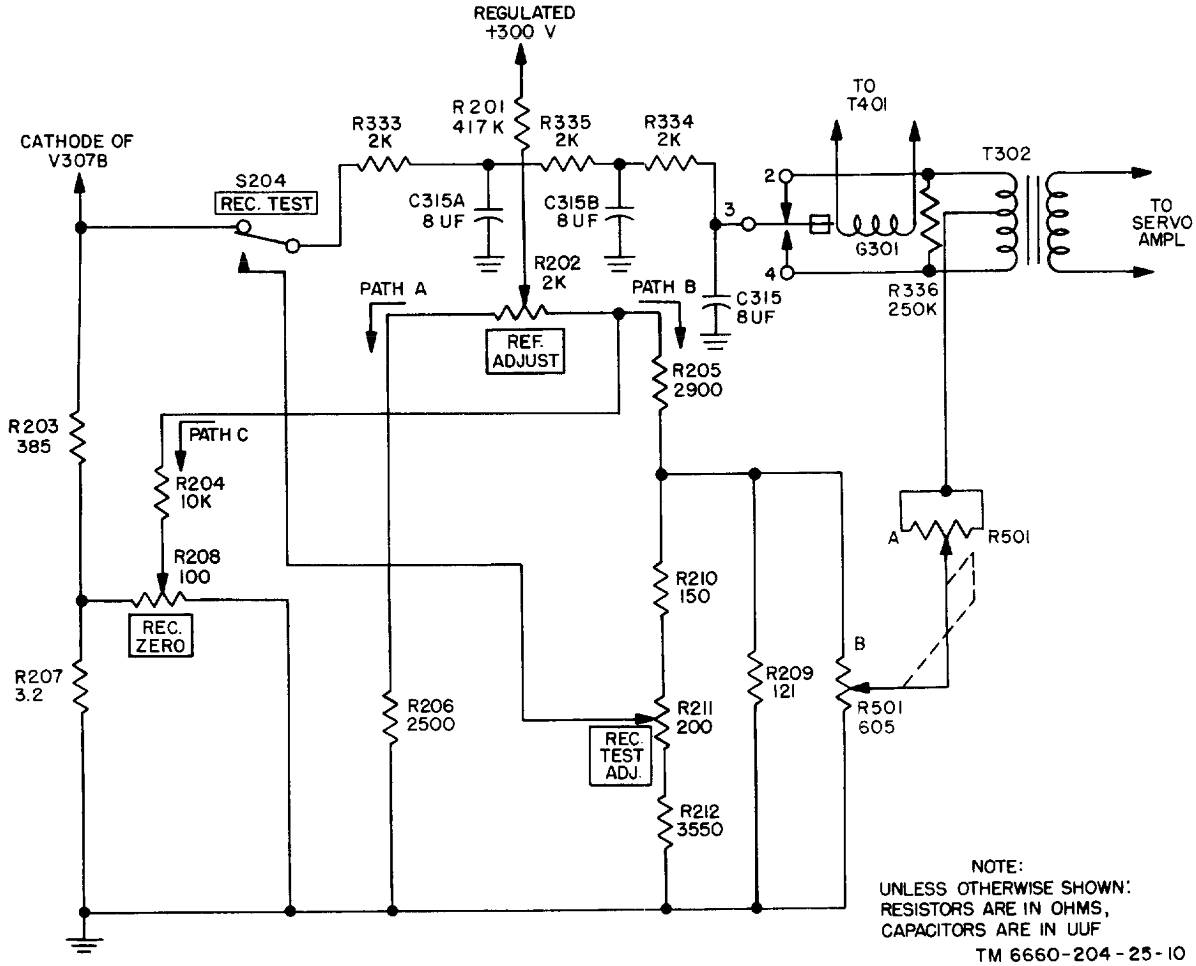


Figure 2-9. Measuring circuit, simplified schematic diagram.

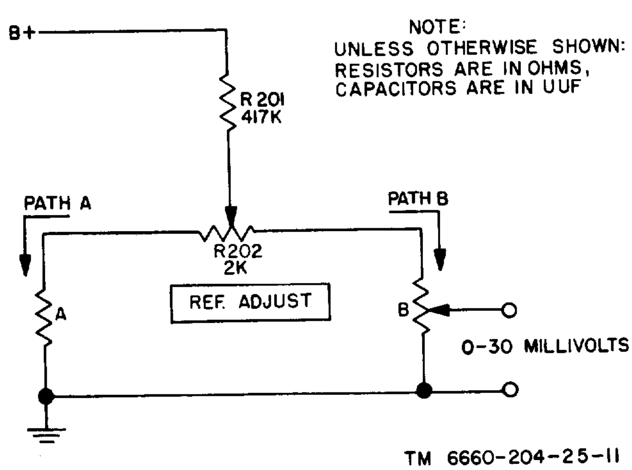


Figure 2-10. Reference adjust circuit, simplified schematic diagram.

The balancing circuit sets in motion the action necessary to rebalance these potentials once a difference has occurred, and thus cancel the error. The detector circuit converts the dc error voltage into an ac voltage which is amplified until it moves the balancing motor. The resulting motion is imparted by mechanical coupling to the wiper arm, which is another point of dc balance, At this point, there is no longer any driving power and the motor stops. This balance point is adjusted by the calibration controls to give a chart trace that may be translated into meteorological data.

a. The 0–30 millivolts of dc signal developed across resistors R203 and R207 is applied through the normally-closed contacts of REC. TEST switch S204, on the control panel, through the damping filter (which consists of R333, R334, and R335 and three-section capacitor C315) to the vibrating reed of inverter G301. This voltage is alternately applied to the two ends of the primary "windings of transformer T302, 60 times a second as the reed vibrates in synchronism with the ac applied to its operating coil. It is assumed that the signal voltage at this instant is slightly greater

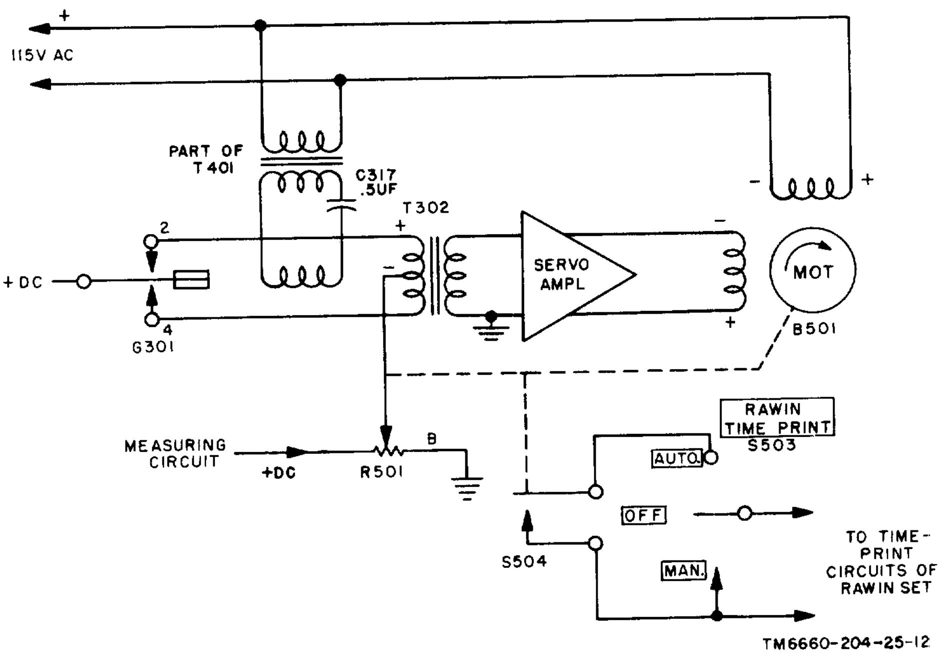


Figure *2-11. Detector and balancing circuit, simplified schematic diagram.*

(more positive) than the potential on the wiper arm of the slide-wire. The vibrating reed of G301 alternately switches this higher potential between the two ends of the transformer primary winding. Current flow will ocur during each contact and the resulting alternating magnetic field in the transformer core will induce an alternating secondary voltage and frequency which is still equal to the line frequency (nominally 60 CPS).

b. The vibrating reed is polarized in its motion and always hits contact No. 2 for a given polarity of voltage across its coil, and contact No, 4 for the other polarity. The polarity of the *hot* side of the secondary windings of transformer T302 depends on two things: which of the two contacts (No, 2 or No. 4) the reed has just hit, and whether the signal voltage on the reed is positive or negative with respect to the wiper arm. Therefore, the phase of the secondary voltage depends solely on the polarity of unbalance of the two dc voltages. This phase sensitiveness to the direction of unbalance turns the motor in whatever direction is necтssary to establish a dc balance.

c. The balancing motor is a low-power two-phase squirrel-cage induction type with two field windings. One field winding is powered by the ac power line as a fixed phase which cannot be changed except by a change in wiring; the other is the control field winding. Phase-shifting capacitor C317, in conjunction with some amplifier phase shifting, creates a phase difference of approximately 90° between the output of the servo-power amplifier and the fixed phase of the line power. This phase difference is either a lag or a lead, depending on the polarity of unbalance at the detector input. The direction of motor rotation depends on the lead or lag relationship between the two field windings; the motor leads must be connected properly so that the motor will rotate in the right direction to cancel an error voltage.

d. The damping filter in series with the dc signal applied to the vibrator consists of a three section RC filter network, R333, R334, R335, and C315. Resistor R336 is used to damp the primary winding of transformer T302 and reduce voltage transients. The damping filter performs two functions: First, it acts as a filter for the higher pulse recurrence frequencies so only the dc portion of the voltage developed in the output gate circuit is applied to the detector circuit. Secondly, it acts as a damping circuit to prevent overshooting of the recorder balance point (hunting.) This is an important feature included in the design of the equipment and when this equipment is repaired, or parts are replaced, the proper values of circuit components must be used to avoid lose of the damping action. Damping action is explained as follows: Assume that an unbalance exists between the dc voltage applied to the detector circuit from the output gate and the dc voltage developed by the slide-wire, and that the output gate voltage is greater than the slide-wire voltage. This causes an ac error voltage to appear at the detector, which acts to drive the slide-wire in a direction to balance out this voltage. As the slide-wire voltage rises toward the balanced condition, a charging current is produced in capacitor C315 (developed by the movement of the slide-wire arm, dependent on its speed) which is in a direction opposite to that of the current produced by the original dc error voltage. As the dc slide-wire voltage changes to equal the dc applied voltage at balance, the original current developed in capacitor C315 and the error voltage developed in the detector is reduced to zero. The opposing capacitor-charging current is developed as long as the slide-wire is moving; when the balance point is approached the opposing capacitor current will exceed the current that produces the error voltage. As this opposing current is developed in the detector, an effective ac balancing voltage is developed in opposition to the original ac error voltage; thus a reverse torque is applied to the balancing motor for braking action.

e. During any condition of unbalance, two opposing currents flow through the detector: one is determined by the amount and direction of unbalance, and the other by the speed and direction of balancing response. Two opposing voltages are developed in the detector circuit: one tends to drive the slide-wire arm in one direction, and the other tends to drive it in the opposite direction. This produces an effective braking action, and prevents overshooting the balance point.

2–14. Voltage Amplifiers
(figs. 2-12,2-13,2-14, and FO-3)

Five stages of voltage amplification are used to increase the ac error voltage from the detector to excite the power amplifiers, and drive the balancing motor. The first four stages are very stable, because all operating voltages, including the filaments, are obtained from regulated power supplies. The gain of the remainder of the servo system varies inversely with the line voltage. Line-compensating feedback is incorporated in the amplifier to compensate for line voltage variations to stabilize the overall gain of the servosystem. Figures 2–12, 2–13 and 2-14 show all cathode resistors are unbypassed. This produces a degenerative circuit action and is done to further stabilize the gain of the amplifier.

a. When an unbalance occurs in the detector, ac error voltage is developed in the secondary winding of transformer T302 and is applied to the grid of tube V308A, one-half of a twin-triode (fig. 2–12). This signal is amplified and appears across plate-load resistor R338. Self-bias is provided by cathode resistor R337, which is unbypassed to obtain negative feedback.

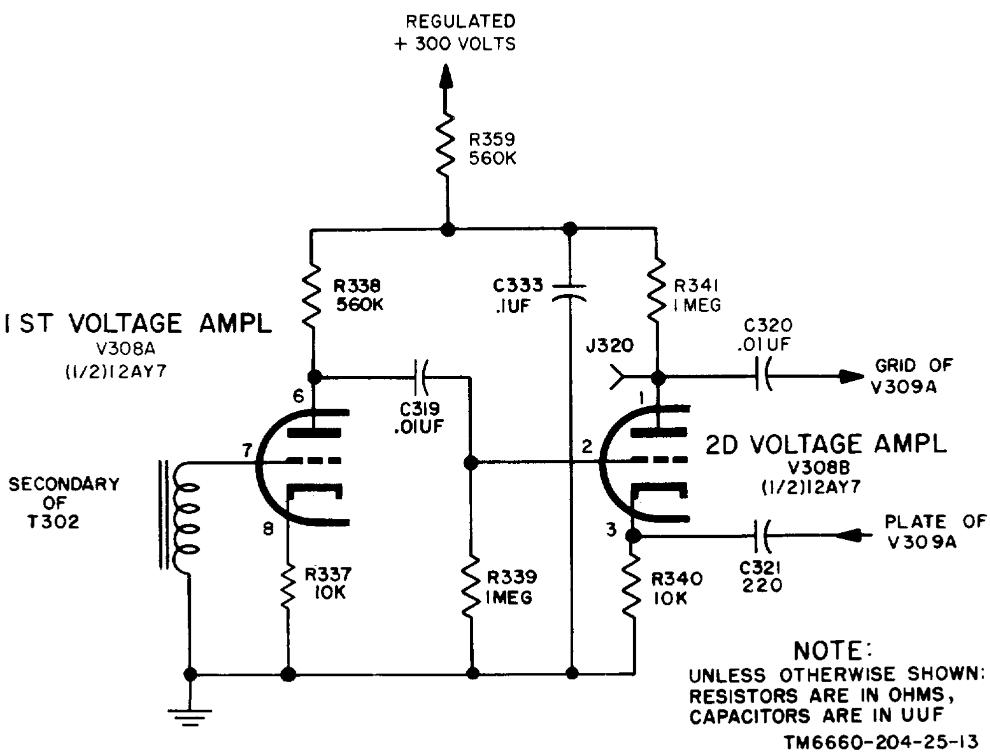


Figure 2-12. First and second voltage amplifiers, simplified schematic diagram.

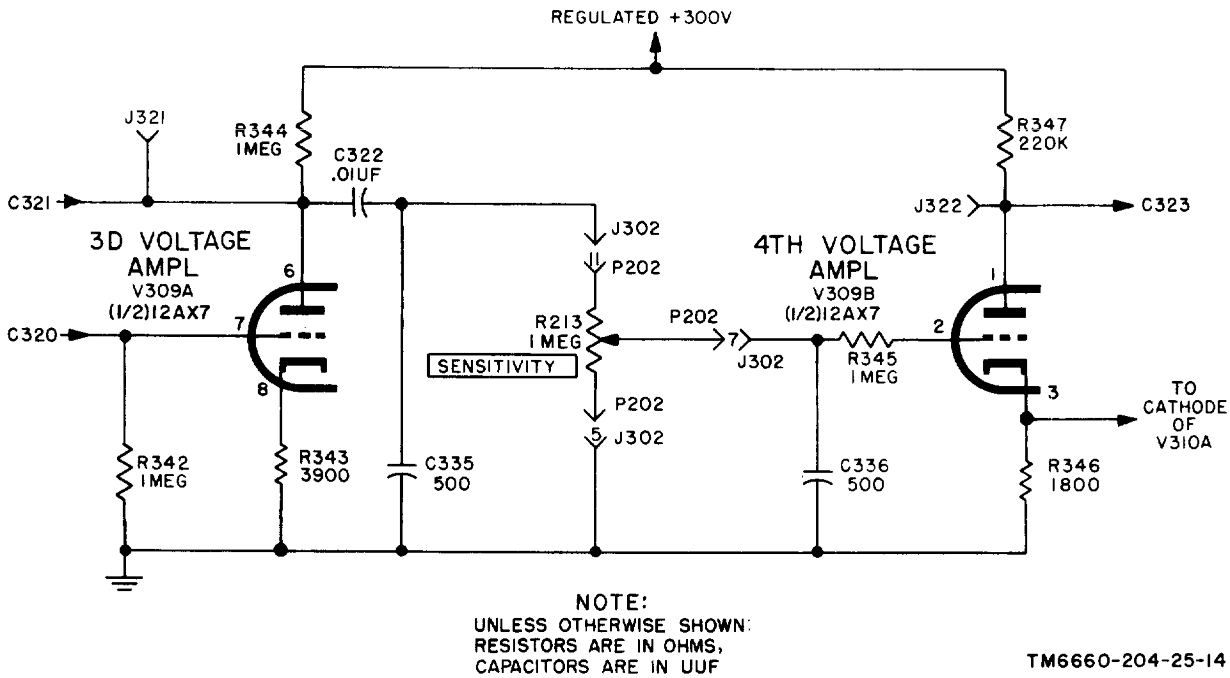


Figure 2–13. Third and fourth voltage amplifiers, simplified schematic diagram,

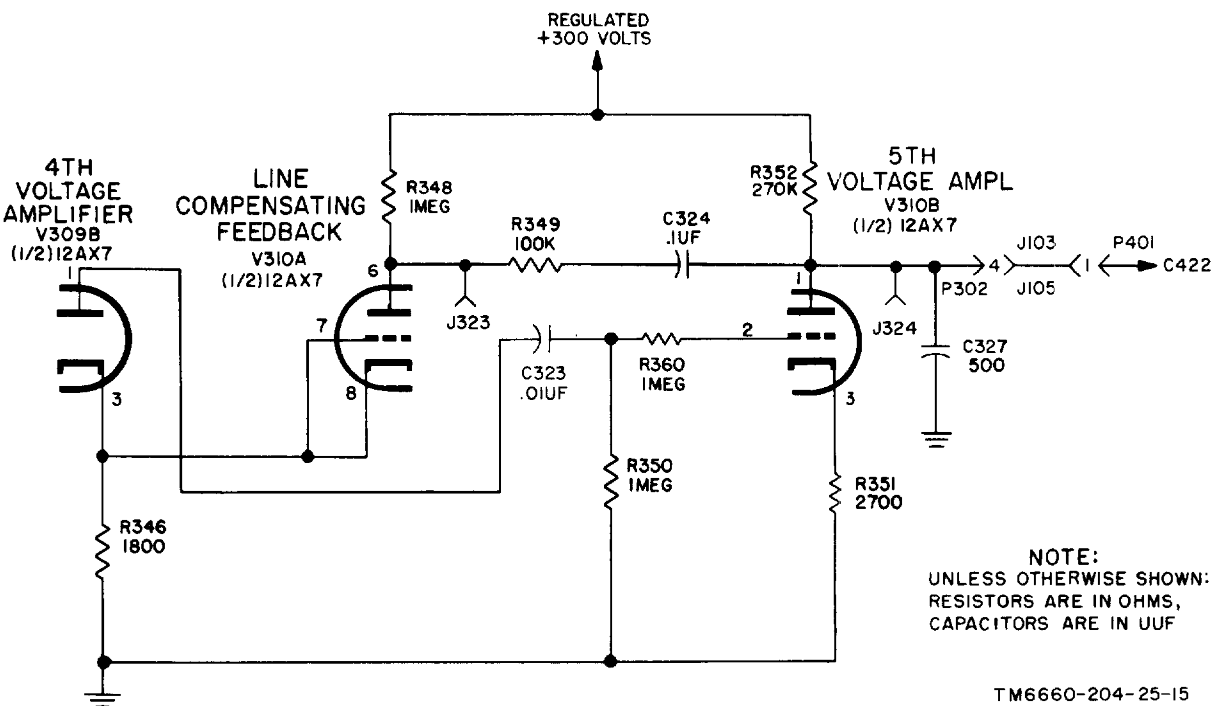


Figure 2–14. Line-compensating feedback and fifth voltage amplifier, simplified schematic diagram.

b. The signal from the plate of first amplifier tube V308A is fed through coupling capacitor C319 to grid resistor R339 and the grid of second amplifier tube V308B (fig. 2–12). The signal is amplified and appears across plate-load resistor R341. Self-bias is provided by cathode resistor R340, which is unbypassed to obtain negative feedback. The plate voltage of tubes V308A and

V308B is supplied through a decoupling circuit consisting of resistor R359 and capacitor C333. Capacitor C321 provides a feedback path, so the output voltage at the plate of tube V309A (fig. 2–13) is fed back to the cathode of tube V308B. This feedback circuit is degenerative and reduces the possibility of oscillations caused by stray positive feedback.

c. The third voltage amplifier (fig. 2-13) is one-half of a hi-mμ twin-triode tube V309A which receives the signal from the plate of tube V308B through coupling capacitor C320. The signal is developed across grid resistor R342 and applied to the grid of tube V309A where it is amplified and appears across plate-load resistor R344. Self-bias is provided by cathode resistor R343, which is unbypassed for negative feedback purposes.

d. The signal from the plate of third amplifier tube V309A is fed through coupling capacitor C322, and appears across SENSITIVITY potentiometer R213. The SENSITIVITY control is a screwdriver-adjusted potentiometer mounted on the front control panel. The wiper arm of this control is connected, through current-limiting resistor R345, to the grid of fourth amplifier tube V309B. This adjustment permits sufficient sensitivity for rapid servo action without jitter of the pen while tracing. The fourth voltage amplifier uses one-half of a hi-rep twin triode tube (V309) (fig. 2-13) where the signal is amplified and appears across plate-load resistor R347. Bias is obtained by the plate currents of amplifier tube V309B and line-compensating tube V310A (fig. 2–14) flowing through cathode resistor R346. The cathode resistor is unbypassed for degenerative purposes. Capacitors C335 and C336 (fig. 2–13) are bypass capacitors which provide a low-impedance path to ground for any voltages that are induced into the cabling between the control panel in the signal data unit.

e. The signal from the plate of fourth amplifier tube V309B is fed through coupling capcitor C323 (fig. 2-14) and developed across grid resistor R350. The signal is then applied to the grid of the fifth amplifier tube (V310B) which is one-half of a hi-P grid twin-triode, through current limiting resistor R360 where the amplified signal is applied across plate load resistor R312. Self-bias and some degenerations are provided by cathode resistor R351.

f. Line-compensating feedback tube V310A, which is one-half of a twin-triode tube, is connected as a diode and functions as a variable resistor, the resistance of which depends on its filament voltage to control feedback between the fourth and fifth voltage amplifiers. As the filament voltage increases, the plate resistance of tube V310A decreases and vice versa. When the line voltage is steady, this circuit provides a fixed value of negative feedback from the plate of tube V310B to the cathode of tube V309B. When the plate signal of tube V310B goes in a positive direction, more current flows through the feedback circuit (capacitor C324, resistor R349, and tube V310A) and causes a larger degenerative effect across cathode resistor R346 which reduces the gain of that stage. If the line voltage increases, the filament voltage in tube V310A will increase, thus decreasing the plate resistance and increasing the negative feedback to reduce the gain of tube V309B. The reduced gain of tube V309B, will compensate for the overall gain of the remainder of the servosystem. Conversely a de creased line voltage produces less gain but less negative feedback, which acts to keep the overall gain up to its normal level. Resistor R348 is the plate load resistor for tube V310A. Capacitor C327 is provided to bypass any extraneous high frequency (hf) voltages picked up by the cabling between the output of the fifth voltage amplifier and the power-amplifier circuits in the power supply chassis.

2–1 5. Power Amplifiers (figs. 2-15 and FO-6)

a. Two power amplifier tubes, V405 and V406, are mounted on the power supply chassis. The tubes are connected in parallel, but are shown as a single tube in figure 2–15 for simplicity of presentation. Tubes V405 and V406 supply excitation to the control winding of two-phase balancing motor B501 (para 2–13). The power amplifiers also supply a signal for operation of the pen-lifter circuit (para 2-16).

b. Plate voltage is obtained from the positive, unregulated, 500-volt supply through voltage dropping and plate decoupling resistors R417 and R418, and the parallel-tuned circuit which consists of capacitor C409 connected across the control winding of the balancing motor. Capacitor C408, together with resistor R417 and R418, forms an RC filter which presents a low impedance path to circuit ground for any hf voltage inducted by the line winding of B501 and reduces the 120-cycle ripple remaining in the 500-volt power supply circuit. Screen-grid voltage is obtained from the positive regulated 300-volt supply

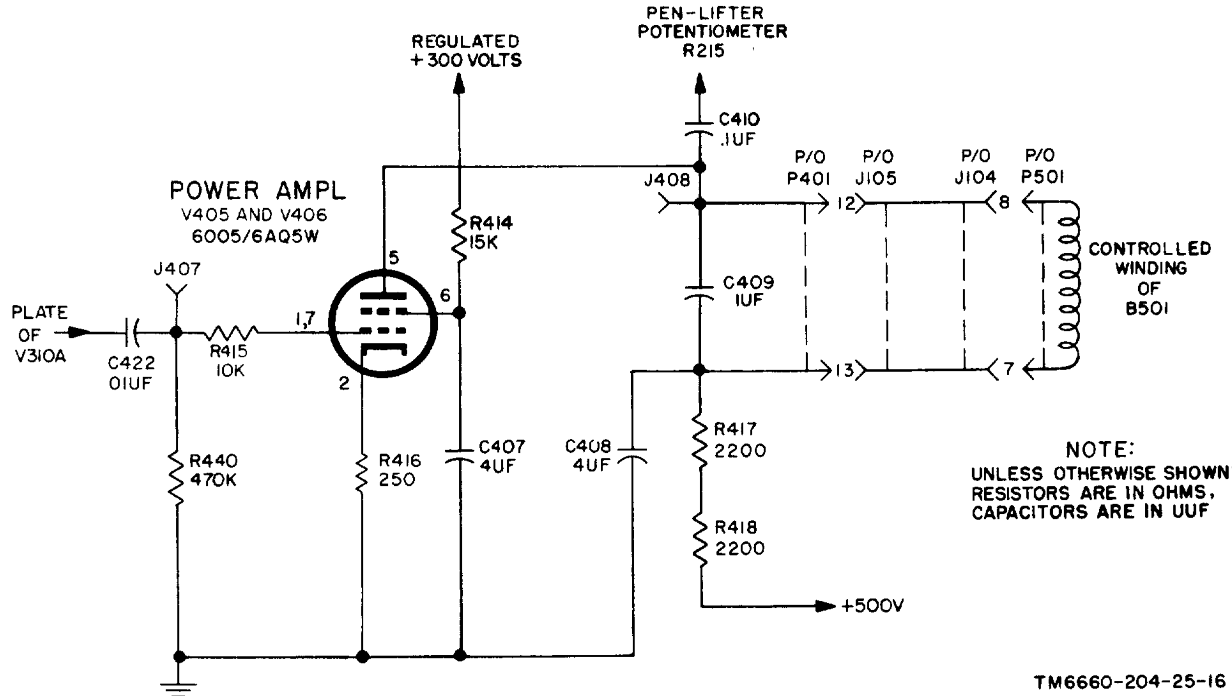


Figure 2-15. Power amplifier, simplified schematic diagram.

through dropping resistor R414. The screen-grid is bypassed to circuit ground by capacitor C407. Cathode bias is produced by the voltage drop across cathode resistor R416, which is unbypassed for degenerative purposes.

c. The ac error signal is applied from the plate of tube V310B, through coupling capacitor C422, across grid resistor R440, to the control grids of tubes V405 and V406 and through grid-current limiting resistor R415. The output power is applied to the control winding of balancing motor B501 and C409 which is a parallel-tuned circuit.

d. When a signal is applied to the grid of tubes V405 and V406, an amplified drop with the proper phase is developed across the tuned circuit of the motor winding (B501) to drive the motor. A portion of this plate signal voltage is also applied, through capacitor C410, to pen-lifter potentiometer R215 to operate the pen-lifter circuit. Jacks J407 and J309 can be used for checking grid and plate voltages.

2-16. **Pen-Lifter Circuit (figs. 2-16 and FO-6)**

a. The pen-lifter circuit uses both sections of miniature twin-triode tube V407. One half of the tube (V407A) is connected as a diode and used as a rectifier and the other half (V407B) functions as an amplifier control. In operation when a signal is received from the power amplifiers, the pen rises from the chart when it travels to its new position. The solenoid, however, does not lift the pen but merely releases a spring that performs the lifting. An energized solenoid compresses the spring and allows the pen to lower.

b. The amplified ac error signal from the plates of tubes V405 and V406 is fed through coupling capacitor C410 to pen-lifter potentiometer R215. A portion of this ac error voltage, determined by the position of the PEN LIFTER potentiometer arm, is rectified by tube V407A and dc voltage is developed across resistors R419 and R420. The voltage developed across resistor R420 and filtered by capacitor C403 is applied to the grid of control tube V407B. The entire rectifier circuit is returned to a negative 30-volt bias supply which is obtained from the junction of bleeder resistors R436 and R437, across the negative regulated 175-volt supply. The negative 30-volt bias holds pen-lifter control tube V407B at cutoff during no-signal conditions. Potentiometer R215 is used to adjust pen-lifter operation for various noise levels and is set low so the internal noise of the amplifier circuit does not overcome the fixed bias of tube V407B, but is set sufficiently high to obtain reliable operation for input signals.

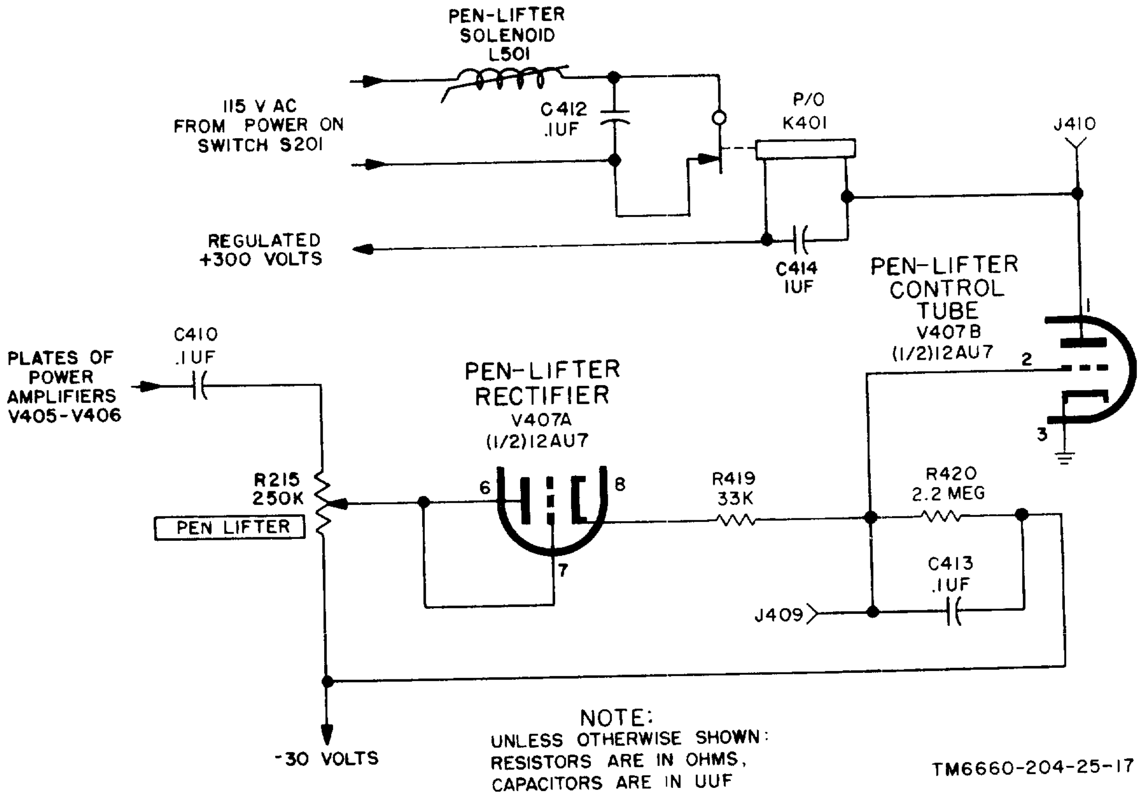


Figure 2–16. Pen-lifter circuit, simplified schematic diagram.

c. Pen-lifter solenoid L501, when not energized, is actuated by a spring to hold the recorder pen off the chart. When energized, through the normally closed contacts of relay K401, it keeps the recorder pen against the chart. When a signal is received, the dc voltage developed across resistor R420 overcomes the —30-volt bias. Tube V407B then conducts and operates relay K401 which, in turn, removes the 115 volts ac from pen-lifting solenoid L501. This permits the spring to pull the recorder pen to its up position, so the recorder chart is not marked while the balancing motor is moving the slide-wire to its balance point. When switch S201 on the control panel is in the STAND BY position, 115 volts ac is removed from the pen solenoid, and the pen rests in its up position until the switch is returned to POWER ON.

2-17. Power Supply
(figs. 2-17 and 2-18)

The power supply consists of one positive regulated supply, one negative regulated supply, and one unregulated supply, obtained from a single power transformer. The power supply furnishes filament voltages for all the tubes and all de operating voltages for the circuits in the radiosonde recorder.

a. Power transformer T401 is designed to operate from 105 to 125 volts at 50 to 65 CPS, with the capability of applying the following voltages from its secondaries:

(1) A voltage of 435 volts on each side of the center tap (terminals 3, 5, and 7) to supply the plate voltage to positive supply rectifier tube V401. Also 115 volts center tapped (terminals 4, 5, and 6 of that same secondary) are used to supply excitation to the vibrator inverter coil through capacitor C317. Terminal 6 also supplies a 57-volt test signal for S202 on the control panel.

(3) A voltage of 320 volts on each side of the center tap of the transformer terminals 8, 9, and 10 supply the plate voltage to negative supply rectifier tube V408.

(3) Two 5-volt windings (terminals 11 and 12; 13 and 14) form the filaments of positive supply V401 and negative supply V408 rectifier tubes, respectively. Terminal 13 of the transformer also has the unfiltered ripple voltage of the 175-volt negative supply which is applied direct to the 120 CPS terminal of switch S202 on the control panel.

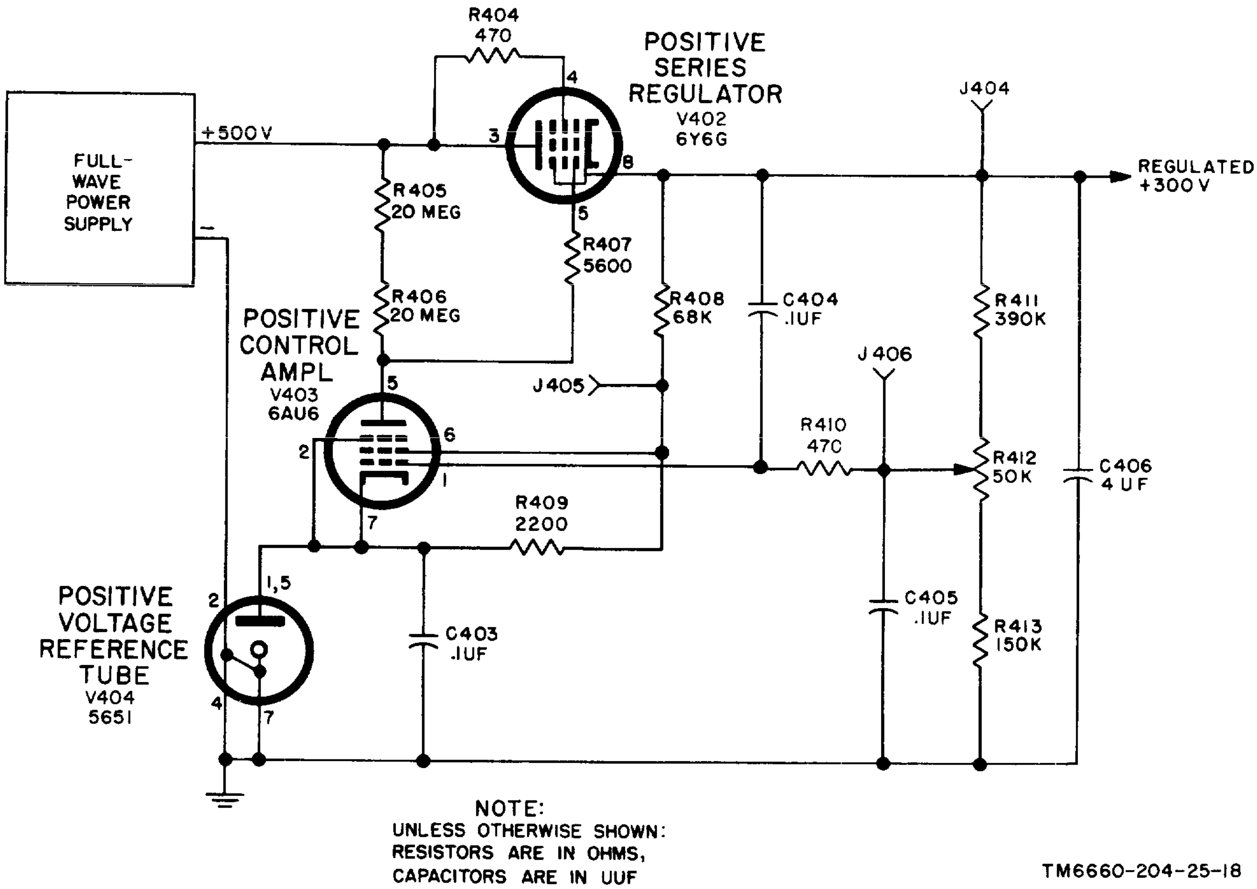


Figure 2-17. Positive regulated power supply, simplified schematic diagram.

(4) A 6.3-volt winding with one side of the filament connected to circuit ground (terminals 15, 16, and 17) supplies voltage to the pen heater, panel lamps, and to each of the filaments of tubes V303, V310, V405, V406, V409, and V410.

(5) A 6.3-volt winding with a center tap (terminals 18, 19, and 20 of the transformer) supplies filament voltage for tubes V301, V302, and V403. The center tap is connected to a positive 80-volt tap on the 300-volt supply so the filaments of these tubes will be near the potential of their cathodes to reduce the possibility of filament-cathode arc-over.

(6) A 6.3-volt winding with a center tap (terminals 21,22, and 23 of the transformer) supplies filament voltage for tube V402. The center tap is connected to the positive 300-volt supply so the filaments of tube V402 will be near the potential of its cathode to reduce the possibilitv of filament-cathode arc-over.

b. The positive regulated power supply (fig. 2-17) furnishes a constant positive 300-volts regardless of normal variations in the input voltage or load conditions,

(1) Rectifier tube V401 functions as a conventional full-wave rectifier. This circuit is shown as a block in figure 2–17; for individual components, refer to figure FO-6. Fuses F401 and F402 are connected in series with the plate leads of rectifier tub V401 for overload protection. Capacitor C401 and C402, with choke coil L401, comprise a one-section pi filter for the unregulated power supply. Bleeder resistor R401 discharges the filter capacitors when the equipment is turned off. The center tap of the plate winding is returned to circuit ground. The filtered but unregulated 500 volts is connected to the plate of series reglator tube V402. The screen-grid voltage is obtained from the unregulated supply through screen-grid voltage dropping resistor R404. Resistor R407 is a grid-current limiting resistor. The 300-volt regulated output is taken from the cathode of tube V402. A voltage divider, which adj usts the output voltage consisting of resistors R411 and R413 with potentiometer R412, is placed across the positive 300 volts and circuit

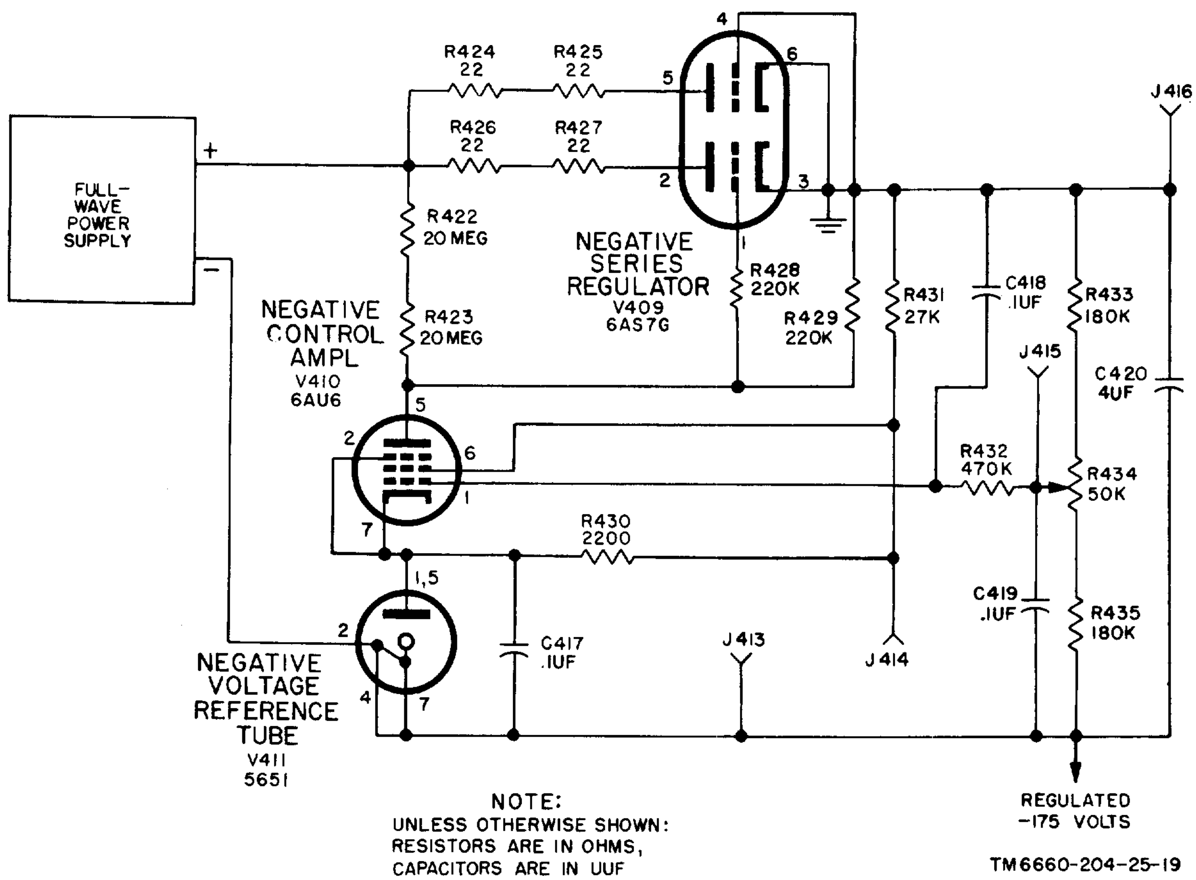


Figure 2-18. Negative regulated power supply, simplified schematic diagram.

ground. The voltage of potentiometer R412 is applied to the control grid of positive control amplifier tube V403. The screen-grid voltage for tube V403 is obtained from a voltage divider consisting of resistors R408 and R409 and positive voltage references tube V404 connected across the positive 300-volt output. The plate of tube V403 is directly connected to the grid of tube V402 through resistor R407, and determines the grid bias on this series regulator tube. Positive voltage reference tube V404 is a cold cathode-type gas voltage regulator tube, normally operating at 87 volts. This tube is connected to the cathode of tube V403 to provide a constant reference voltage for comparison with the grid voltage of control amplifier tube V403.

(2) Series regulator tube V402 functions as a variable resistor, the resistance is controlled by its grid voltage. A more positive grid voltage decreases resistance and a less positive voltage increases resistance. Control amplifier tube V403 controls the amount of voltage supplies to the grid of tube V402. The cathode of tube V403 is connected to a constant reference voltage, which is supplied from positive voltage reference tube V404. Because the cathode voltage is held constant, only the grid voltage affects operation of this circuit. The grid voltage is supplied from a bleeder network across the regulated positive 300-volt output determined by the position of the wiper arm of potentiometer R412. When an increase of voltage occurs at the cathode of tube V402 as a result of an increase in line voltage or a decrease in load current, the voltage across the bleeder increases. A portion of this voltage, determined by the setting of potentiometer R412, is amplified by tube V403 and applied as a negative swinging grid voltage to tube V402. This decrease in grid voltage causes an increase in the effective plate to cathode resistance and increases the voltage drop across tube V402. This increase in voltage drop, returns the grid of tube V403 almost to its original bias. The action of the regulator is very rapid and may be considered instantaneous. Capacitors C404 and C405 with resistor R410 form a series circuit across the output of the regulated positive 300-volt supply for any rapid changing voltage or for ripple voltage. The capac-

itors have a low reactance to ripple frequencies and practically the entire voltage change appears across resistor R410. This voltage change either adds to or subtracts from the grid voltage supplied by potentiometer R412, so this circuit reduces the 120-cycle ripple voltage as well as the changes due to line voltage or load conditions. Capacitor C406 is the output filter capacitor.

c. The negative regulated power supply (fig. 2–18) furnishes a constant negative 175 volts regardless of variations in the input voltage or load conditions.

(1) Rectifier tube V408 functions as a conventional full-wave rectifier. This circuit is shown as a block in figure 2–18; for individual components, refer to figure FO–6. Fuses F403 and F404 are connected in series with the plate leads of rectifier V408 for overload protection. Capacitors C415 and C416, with choke coil L402, comprise a pi one-section filter for the unregulated supply. Resistor R421 is a bleeder resistor which discharges the filter capacitors when the equipment is turned off. The negative series regulator tube is a twin-triode type which obatins its plate voltage from the unregulated supply, through parasitic suppressors R424 and R425 in one plate circuit, and parasitic suppressors R426 and R427 in the other plate circuit, The cathode is returned to circuit ground. The negative 175 volts is obtained from the center tap of the plate winding. Resistors R428 and R429 are grid-current limiting resistors, A voltage divider which consists of resistors R433 with potentiometer R434 is placed between the regulated negative 175-volt output and circuit ground. The voltage of potentiometer R434 is applied to the control grid of negative control amplifier tube V410. The screen-grid voltage” for this tube is obtained from a voltage divider consisting of resistors R430 and R431 and the negative voltage reference tube V411 to ground, connected across the regulated negative 175-volt supply. The plate of tube V410 is directly connected to the grids of tube V409 through grid-current limiting resistors R428 and R429, and controls the operation of this series regulator tube. Negative voltage reference tube V411 is a cold cathode-type gas voltage regulator tube, which normally operates at 87 volts and is connected to the cathode of tube V410 to provide a constant reference voltage for comparison with the grid voltage of negative control amplifier tube V410.

(2) Series regulator tube V409 functions as a variable series resistor, which is controlled by its grid bias voltage. A less negative grid voltage decreases resistance and a more negative voltage increases resistance. Control amplifier tube V410 controls the amount of voltage supplied to the grid of tube V409. The cathode of tube V410 is connected to a constant reference voltage, which is supplied from negative voltage reference tube V411. Because the cathode voltage is held constant, only the grid voltage affects operation of this circuit. The grid voltage is supplied from a bleeder network across the regulated negative 175 volts determined by the position of the arm of potentiometer R434. When the line voltage increases or the load current decreases, the voltage across the bleeder increases. A portion of this voltage change, determined by the setting of potentiometer R434, is amplified by tube V410 and applied as a negative swinging grid voltage to tube V409. This decrease of grid voltage causes an increase in the effective plate to cathode resistance and increases the voltage drop across tube V409, This increase in voltage drop, which is almost equal to the original voltage rise, returns the grid bias value of tube V410 to the original input. The action of the regulator is so rapid that it can be considered to be instantaneous. Capacitor C418 provides a low reactance path to the grid of tube V410 for any rapid changing voltage or ripple voltage. This voltage change either adds to or subtracts from the grid voltage supplied by potentiometer R434, so this circuit tends to minimize ripple voltage in addition to rapid changes in line voltage or load conditions, Capacitor C420 is the output filter capacitor and bypasses any hf voltage component.

d. A positive 500-volt unregulated voltage supply is obtained by taking the unfiltered and unregulated voltage from the filament of positive supply rectifier tube V401. This voltage is applied through resistors R417 and R418 to the control winding of balancing motor B501. Filtering is accomplished through capacitor C408 and the inherent inductance of the motor winding.

e. A filament burn-out neon indicator lamp (E401) is provided for pen-lifter control tube V407. This lamp is connected across the filament so it is normally short-circuited and does not indicate until the tube filament opens. A similar indication is provided for tubes V305, V304, V309, V308, V306, and V307 in the signal converter circuits by neon indicator lamps E301 through E306.

2-18. Frequency-Time Recorder

The purpose of the frequency-time recorder is to make a continuous record of the frequencies received from the radiosonde receiver in terms of a calibrated output voltage as indicated on a graph recorder. This is done by causing an inking pen to mark the moving recorder graph chart between positions fixed by preflight calibration adjustments and determined by the balancing motor rotation and the pen-lifting solenoid operation in accordance with the received radiosonde signal. The functions of the recorder areas follows:

a. ***Operation of Chart.***

(1) The chart consists of a paper roll 120 feet long by 10 $\frac{1}{16}$ inches wide. The vertical axis of the chart is graduated in l/2-inch intervals, and the horizontal axis into 100 equal divisions which represent the pulse frequency of the radiosonde signal (normally one division equals 2 CPS). The number of feet remaining on the roll is indicated by the number printed 1/2 inch to the right of the zero line.

(2) The chart is secured between two shaft-mounted chart roll bearings (fig. 2–19). The bearing on the right side is spring-loaded to ‘facilitate the replacement of the chart, and the one on the left side has a threaded shaft to permit adjustment of the chart so it can be aligned with the chart roller which is damped by a spring brass washer to prevent the chart from unwinding easily.

(3) The chart roller is driven by chart motor B502 through a reduction gear and a clutch assembly. The perforated edges of the chart coincide with the extrusions of the chart roller, and the chart is advanced at a constant selective speed.

(4) The clutch assembly consists of a black fiber washer, two spring retainers, and three springs mounted between the retainers. The retainer tabs fit into a slot of the roller shaft. The clutch assembly is held against a motor-driven gear which uses that roller shaft as its axis, but is not connected to the shaft. As the motor-driven gear is rotated, the pressure exerted by the three springs pressing the fiber washer against the flat surface of the gear causes the clutch assembly and the chart roller to rotate.

(5) The chart can be advanced manually by turning the manual chart advance knob in a clock-

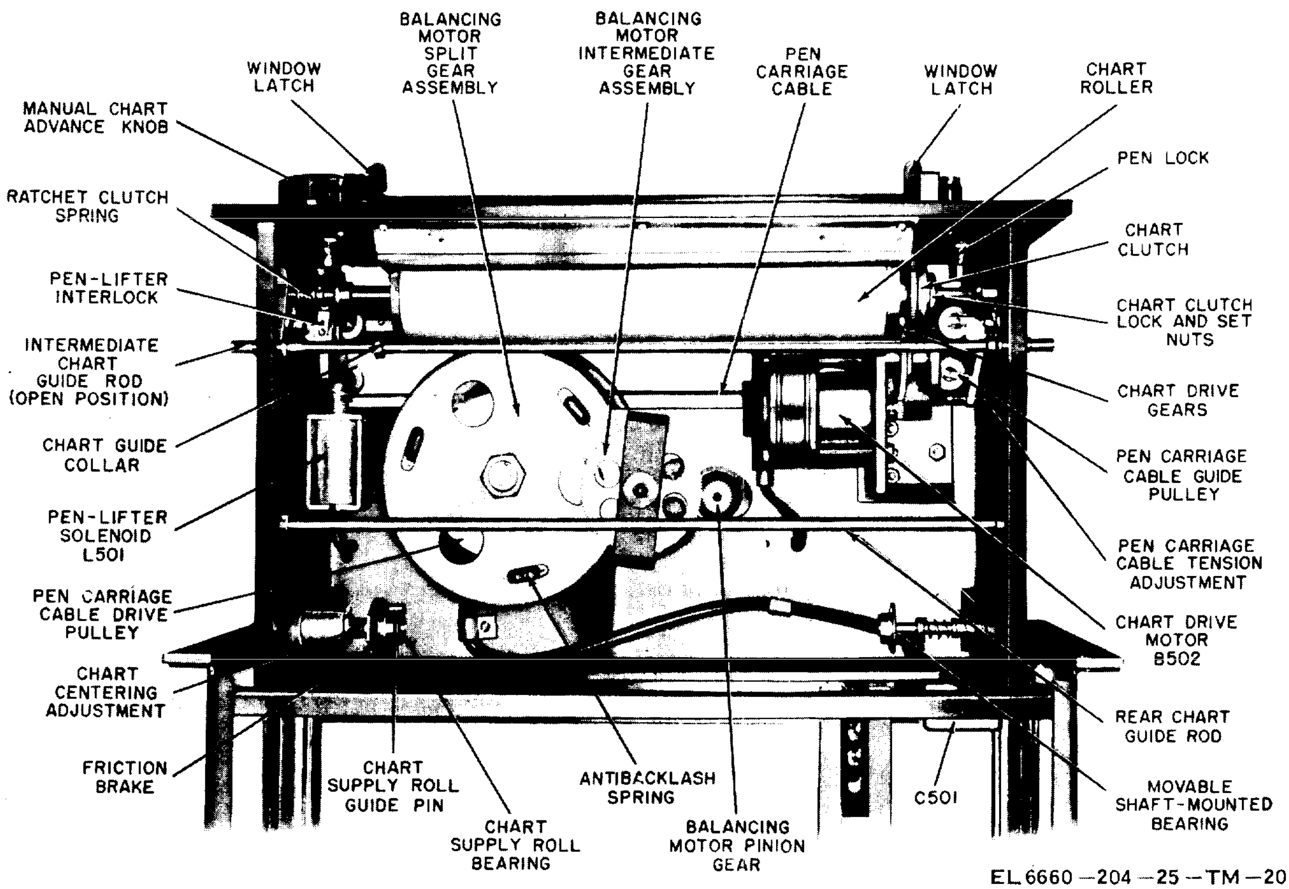


Figure 2–19. Frequency-time recorder, bottom view showing chart drive details.

wise direction. This knob is connected to the chart roller shaft by a set of beveled gears with a ratio of 2 to 1 (figs. 2–19 and 2–20).

(6) Three chart guide rods are used in the frequency-time recorder, but only two are movable. The movable intermediate guide rod on the underside of the frequency-time recorder (fig. 2-19) has a lever mounted on the left side of the rod. When the rod is in its open position (to the rear), the lever holds the pen-lifting linkage and does not permit the pen-lifting solenoid to lower the recorder pen. The front chart guide rod can be pulled out approximately 1 inch to insert the chart. The rear chart guide rod is located approximately halfway between the supply roll and the intermediate chart guide rod.

b. Operation of Recorder Pen,

(1) The recorder pen (fig. 2-20) is a ball-point pen which rides on its carriage above the chart roller, The carriage is moved along the pen-carriage shaft by the pen-carriage cable which is connected to a pen-carriage cable drive pulley through two sets of guide pulleys, one at each end of the frequency-time recorder casting, The pulley is attached to the split-gear assembly, which is driven by balancing motor B501 through a reduction gear assembly. The split-gear assembly consists of two identical gears (sometimes called scissor gears) that are spring-loaded. The double set of gears is used to prevent any backlash between the balancing motor and recorder pen.

(2) The plunger of pen-lifting solenoid L501 is connected to the pen-carriage shaft through mechanical parts as shown in figure 2-21. When the solenoid is deenergized, pressure exerted by spring O–576 pushes the double-ended bolt against the pen-lifter bracket which rotates the pen-carriage shaft slightly, and therby lifts the pen from the chart. When the solenoid is energized, the double-ended bolt is pulled toward the solenoid, The pen-pressure nuts then push against the pen-pressure spring which pushes the pen-lifter bracket, The pen-lifter bracket rotates the pen-carriage shaft and pushes the pen against the chart roller. The pressure with which the pen is held against the chart is adjusted by a pen-pressure set nut and held in place by a locknut.

(3) The pen heater is thermostatically controlled and mounted around the pen barrel (ink chamber), The heater is operated from 6.3-volt ac source which is supplied through thermostatic switch S501 and a set of contact bars that run parallel and above the carriage shaft. The voltage is applied from the contact bars to a set of sliding contacts which are connected” to pen heater HR501. The ‘thermostatic switch operates the heater at temperatures below approximately 0°C (32°F.) Panel lamps 1501 through 1504 are lighted by the same 6.3-volt source and provide illumination for the recorder scale and chart.

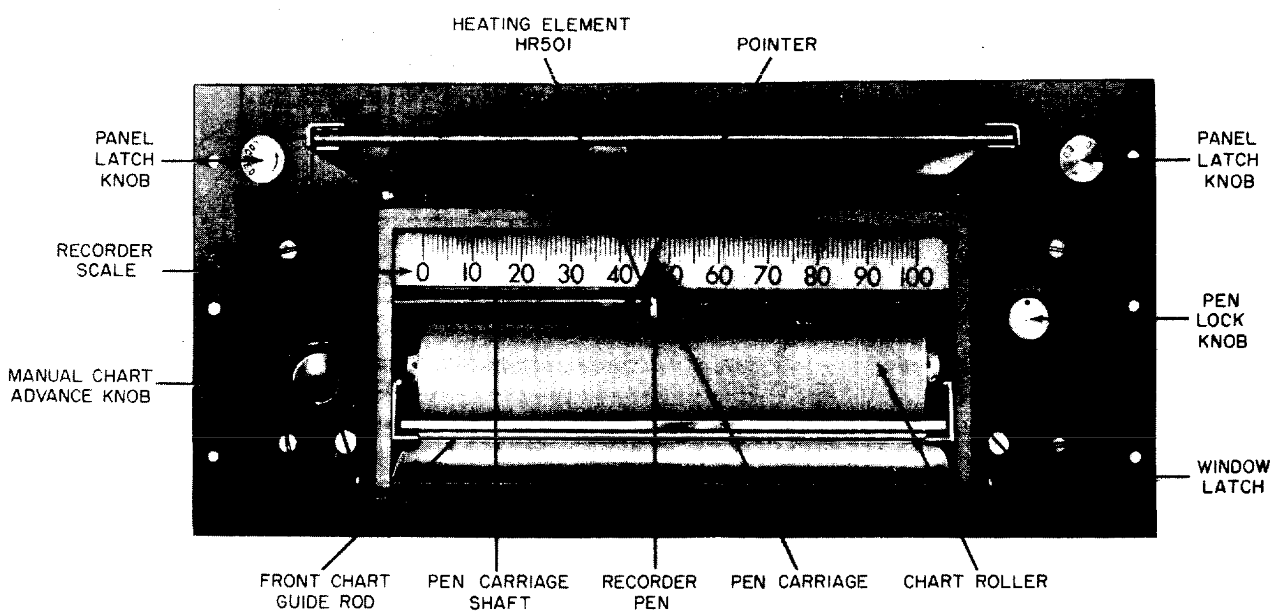


Figure 2-20. Frequency-time recorder, front view.

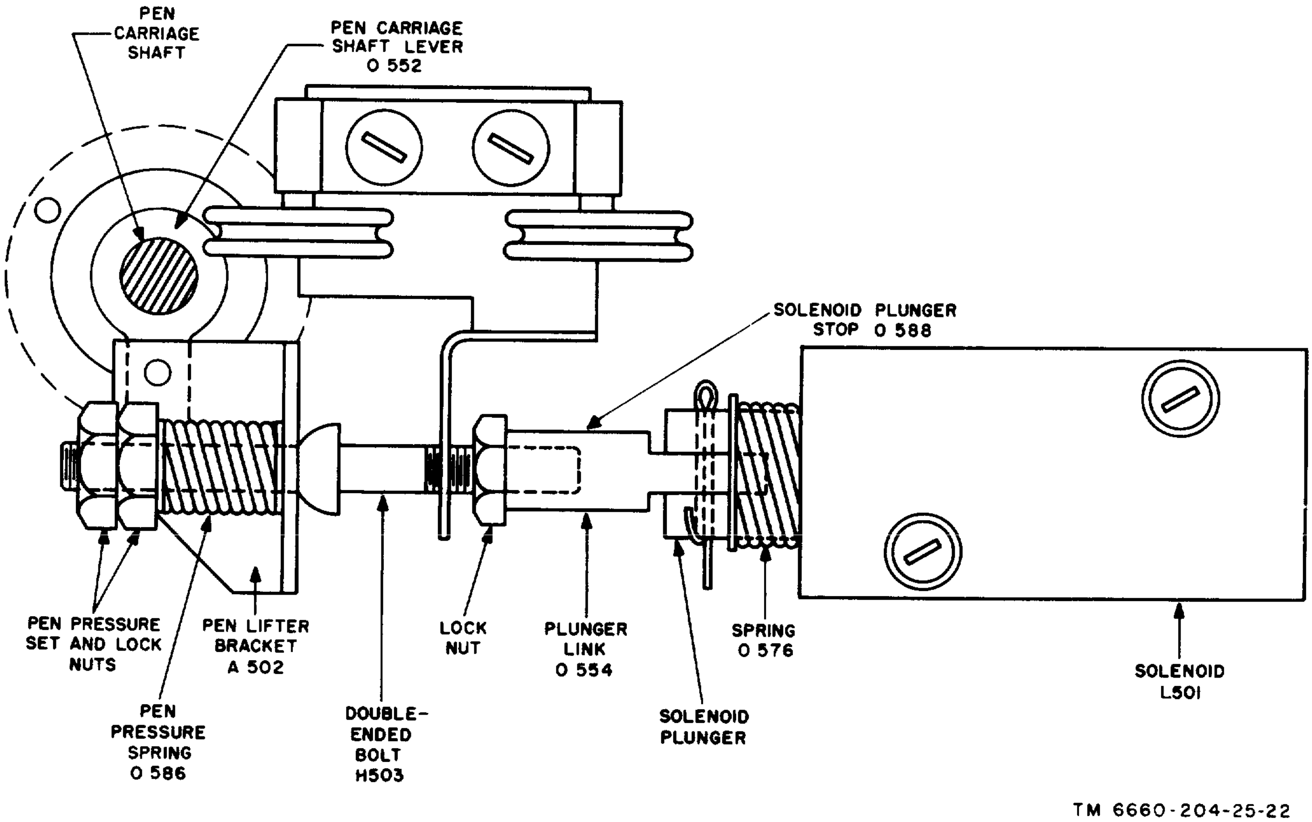


Figure 2-21. Pen-lifter mechanism.

2-19. Control Panel (figs. 4-5 and FO-2)

a. The control panel, in addition to the measuring circuit, contains control circuits for the application and checking of primary power to the power supply chassis, and the speaker used for monitoring the input signal.

b. Overload circuit breakers magnetic type, K201 and K202, rated at 4 amperes, are provided in series with each of the primary 110-volt ac leads. Application of power is controlled by a four-pole, double-throw switch S201. In the POWER OFF position no voltage is applied, and in the STANDBY position voltage is applied to all circuits except the chart drive motor and the pen-lifter solenoid; in the POWER ON position, voltage is applied to all circuits.

c. Neon indicator lamp 1201 indicates when switch S201 is in either STANDBY or POWER ON position. Meter M201 is a synchronous reed-type panel mounted frequency meter indicating the powerline frequency from 48 to 62 cycles when switch S201 is operated in either position. Meter M202 is an iron vane-type panel mounted ac voltmeter with a range of 0 to 150 volts to indicate line voltage.

CHAPTER 3
ORGANIZATIONAL MAINTENANCE

Section I. GENERAL

3-1. Scope

a. This chapter includes the instructions for organizational maintenance of Radiosonde Recorder AN/TMQ-5(*).

b. Organizational maintenance of the radiosonde recorder includes —

(1) Lubrication instructions (sec. II).

(2) Preventive Maintenance (sec. III).

(3) Organizational troubleshooting (sec. IV).

(4) Adjustments, repair, replacement, and testing (sec. V).

3-2. Tools, Test Equipment, and Materials Required

The tools, test equipment, and materials required are listed in the basic issue items list (TM 11-6660-204-10), repair parts and special tools list (TM 11-6660-204-25P and TM 11-6660-204-24P-1) and the Maintenance Allocation Chart (Appendix B). In addition to items listed above, a supply of lint free cloths and isopropyl alcohol are required.

Section II. LUBRICATION INSTRUCTIONS

3-3. Lubrication Requirements

All moving parts are lubricated by the manufacturer and require no further lubrication except for the multispeed chart drive mechanisms.

a. On Frequency-Time Recorder RD-88A/TMQ-5 and TD-88B/TMQ-5, once each month apply 1 drop of light low temperature machine oil to the oilhole in the hub on each of the two ratchet wheels, 0729 and 0830 (figs. 3-1 and 3-2).

b. On Frequency-Time Recorder RD-88C/TMQ-5 (fig. 3-3), once each month apply 1 drop of light low temperature machine oil to the oilholes in the hubs of each of the ratchet wheels in the three-speed chart drive mechanism.

CAUTION

Do not use any lubricant on the recorder mechanism except as stated above; lubricants collect dust that impairs the operation of the recorder.

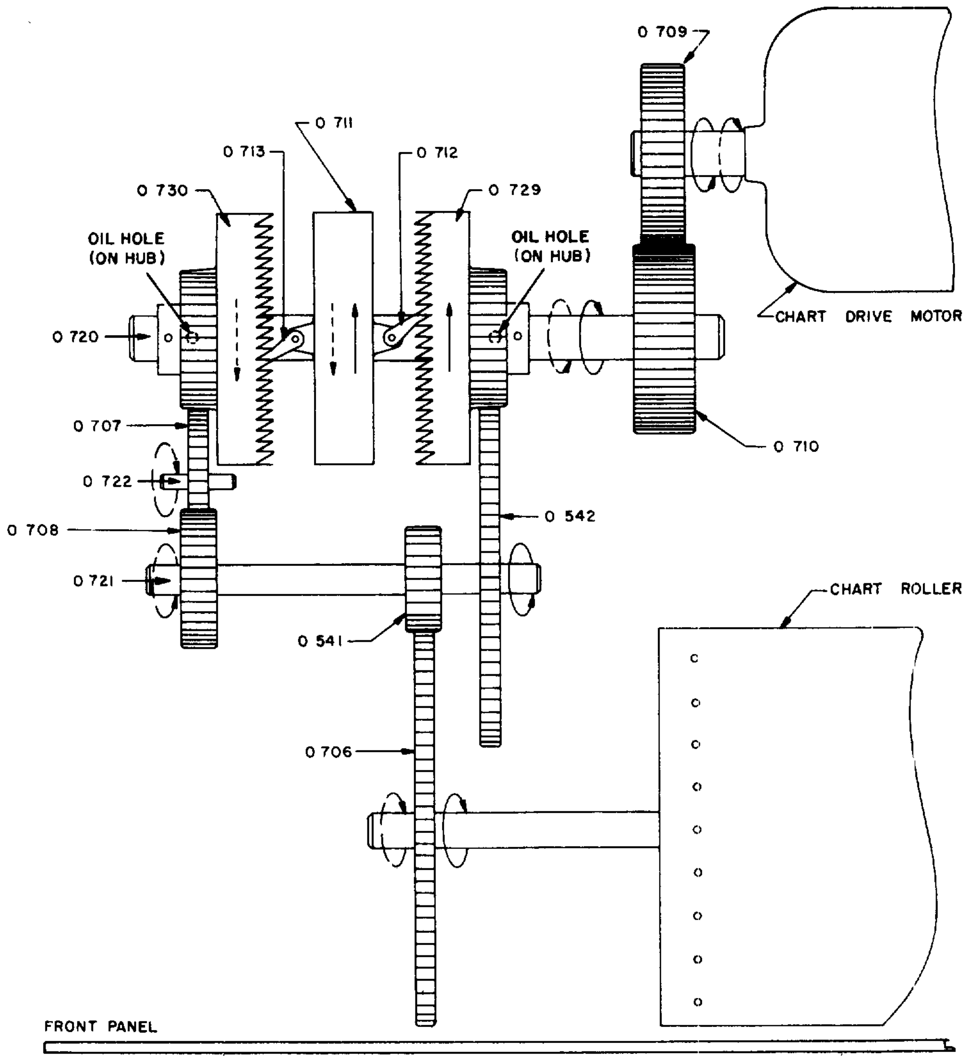


Figure 3-1. .Two-speed chart drive gear train.

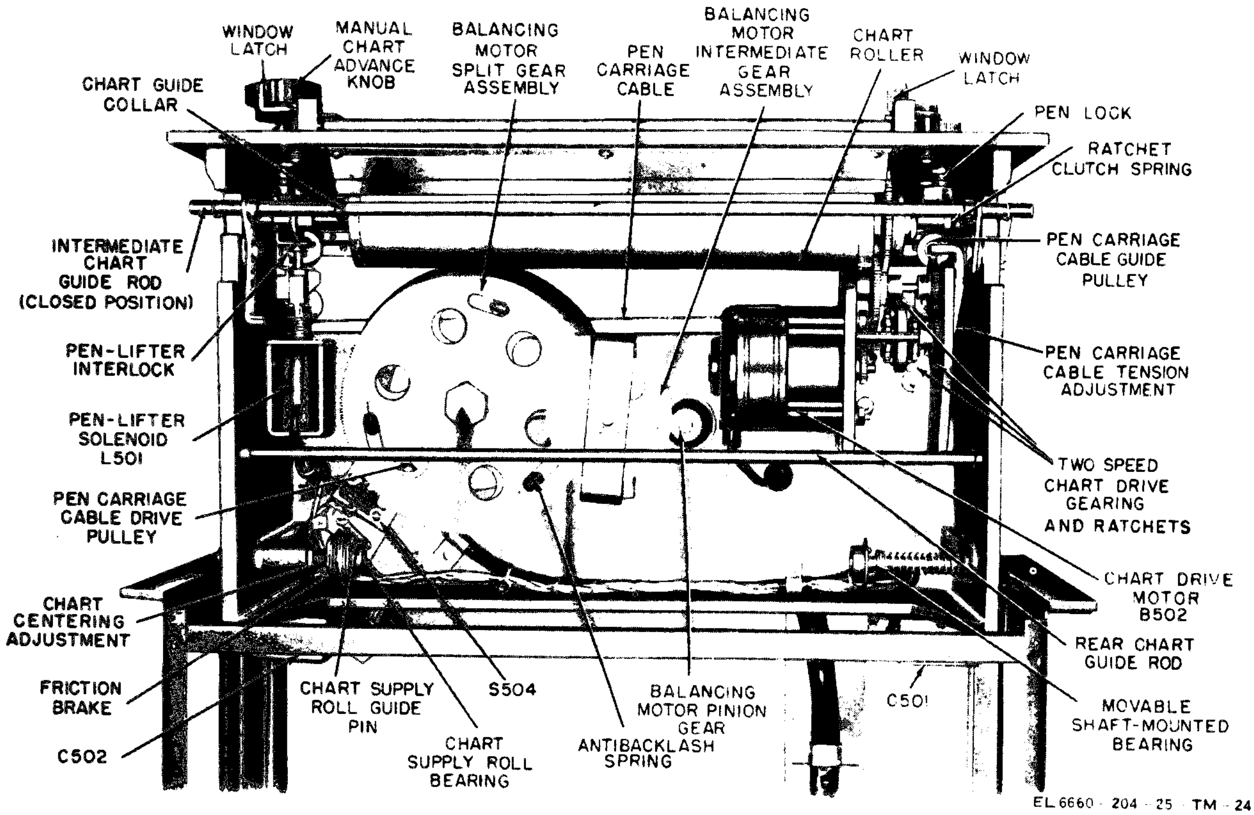


Figure 3-2. Frequency-time recorder RD-88A/TMQ–5, bottom view showing chart drive details.

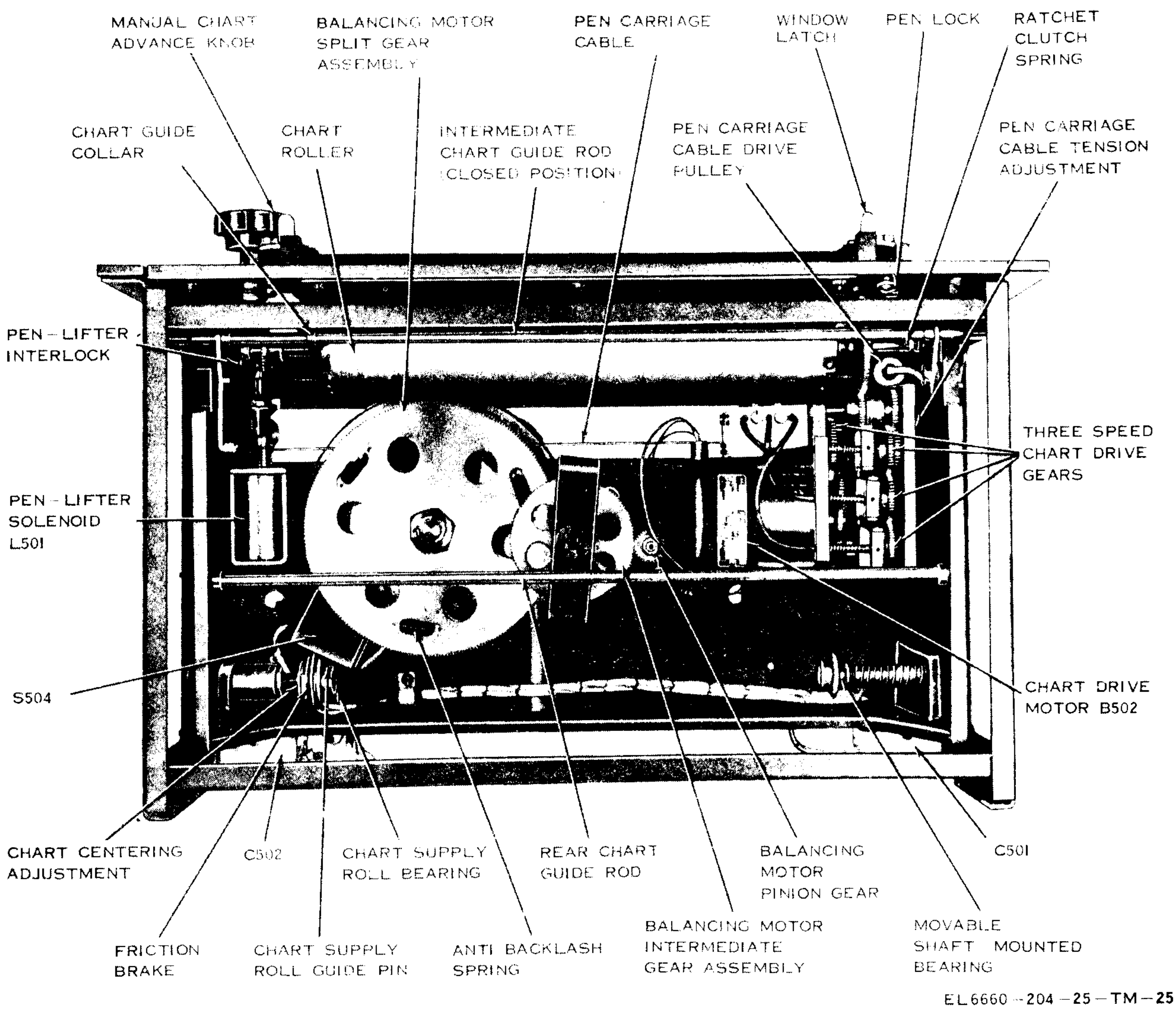


Figure 3-3. Frequency-time recorder RD-88C/TMQ-5. bottom view showing chart drive detail.

Section III. PREVENTIVE MAINTENANCE

3-4. General

a. Preventive maintenance is the systematic care, servicing, and inspection of the equipment to maintain it in servicable condition prevent breakdowns, and assure maximum operational capability. Preventive maintenance is the responsibility of all maintenance categories concerned with the equipment and includes the inspection, testing, and repair or replacement of parts, subassemblies, or units that inspection or tests indicate will probably fail before the next scheduled periodic service.

b. Preventive maintenance service and inspections of the radiosode recorder are made monthly unless otherwise directed by the commanding officer. On vehicular installations, the maintenance should be scheduled concurrently with the periodic service schedule of the carrying vehicle.

3-5. Organizational Preventive Maintenance Checks and Services

For equipment maintenance purposes, a month is defined as approximately 30 calendar days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly maintenance should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly maintenance performed on it. Equipment in limited storage (requires service before operation) does not require monthly maintenance. The monthly organizational preventive maintenance checks and services (PMCS) chart is contained in paragraph 3-6. Items in the Procedures column which reduce mission effectiveness must be subject to troubleshooting (Chapter 3, Section IV).

3-6. Organizational Preventive Maintenance Checks and Services Chart

NOTE
The checks in the "Interval" column are to be performed in the order listed.

M — Monthly

No. Item	Interval M	Item to be inspected	Procedures
1	*a*	Lubrication,	Ensure that equipment is properly lubricated as explained in paragraphs 3-3 and 3-11.
2	*a*	Linearity calibration.	Ensure that equipment linearity calibration is correct as explained in paragraph 3-38.
3	*a*	Frequency-Time Recorder Pen.	Ensure that pen is clear and filled wish ink as explained in paragraph 3-10.
4	*a*	Radiosonde Recorder AN/TMQ-5(*).	Ensure that equipment functions properly as explained by the operational test procedures in TM 11-6660-204-10.

***a.* As required by TM instructions.**

3-7. Quarterly Organizational Preventive Maintenance

(Paragraph 3-7 deleted.)

3-8. (Deleted)

3-9. Interior Cleaning

Inspect the interior of Radiosonde Recorder AN/TMQ–5 (*). The interior should be free of dust, dirt, grease, and fungus.

NOTE

Disconnect all power before performing the following operations, After completing the operations, reconnect the power and check the set for satisfactory operation (TM 11-6660-204-10).

a. Remove the desk and the mounting screws of the control panel and fan panels. Pull out these units by their handles and perform the following operations :

(1) Clean the exterior and interior of each panel and all parts.

(2) Clean the SIGNAL SELECTOR switch contacts and pins in plug P202 on the control panel (fig. 3-1) and plug P1 on the fan panel (fig. 3-5) with a cloth or stiff brush moistened with cleaning compound.

(3) C1ean the porcelain resistors (fig. 3-4) mounted near the lower edge of the control panel.

(4) Secure the desk control panel and fan panels.

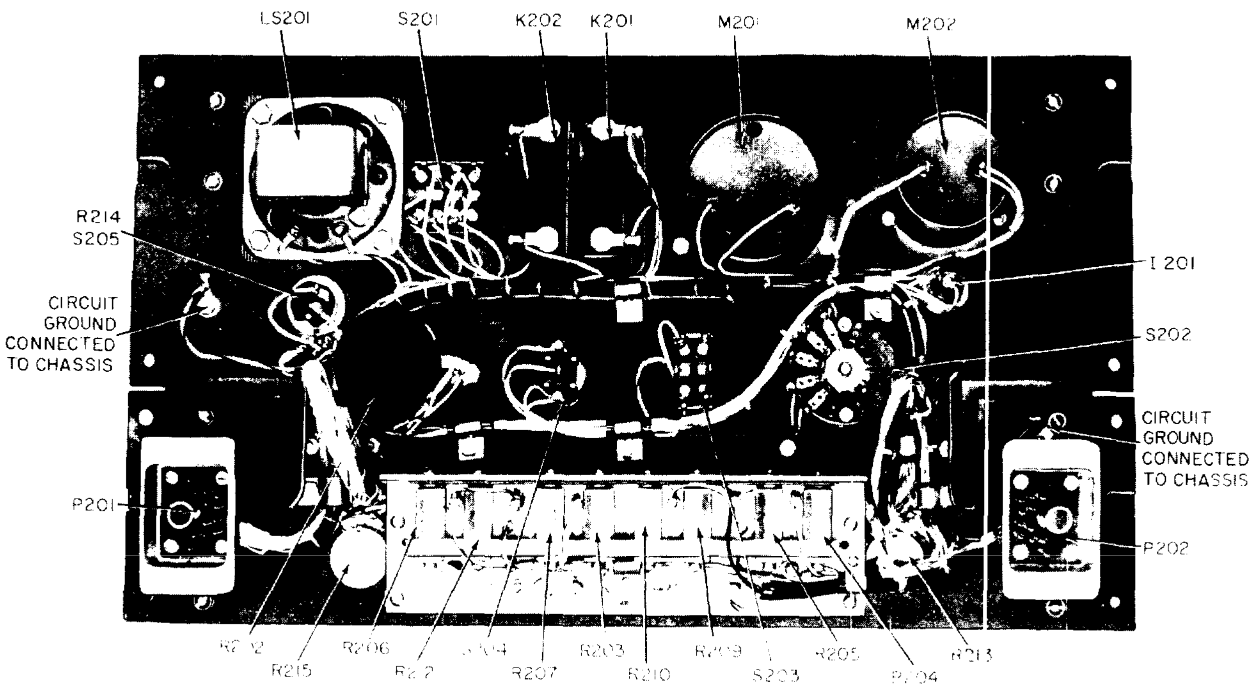


Figure 3-4. Control panel, rear view.

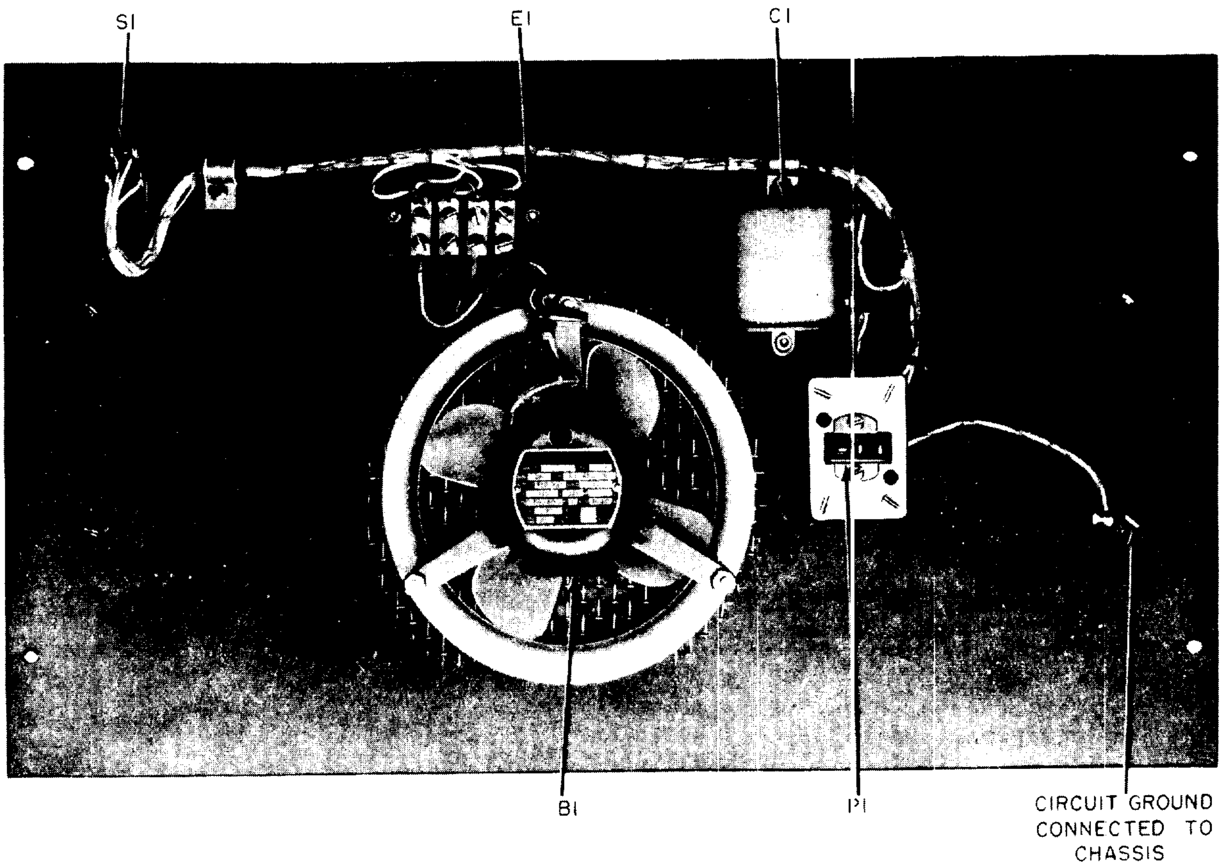


Figure 3-5. Fan panel, rear view.

b. Unlatch and pull out the frequency-time recorder. Open the recorder window and perform the following operations:

(1) Remove the chart.

(2) Remove dust and dirt from the top of the drawer, the lamps, the reflector, and the pen-heater contact bar (fig. 3-6).

(3) Remove the cover of the slide and trolley wires. Carefully clean these wires and their contacts with a cloth or brush moistened with cleaning compound.

(4) Clean the chart roller, pen (para 3-10), and pen carriage carefully. Be sure no lint is left around the penpoint,

(5) Secure the frequency-time recorder and close the recorder window.

c. Loosen the screws from the rear cabinet panel, then remove the rear panel of the cabinet and perform the following operations:

(1) Clean the tops of the converter amplifier and power supply chassis.

(2) Remove all dust and dirt from the bottom of the converter amplifier and power supply chassis. Do not move any wires or adjustments.

CAUTION

Do not attempt to remove dust and dirt from wire assemblies with a brush or rag; use a vacuum system to prevent broken wire connections.

(3) Inspect and clean fuses and fuse clips (fig. 3-7) .

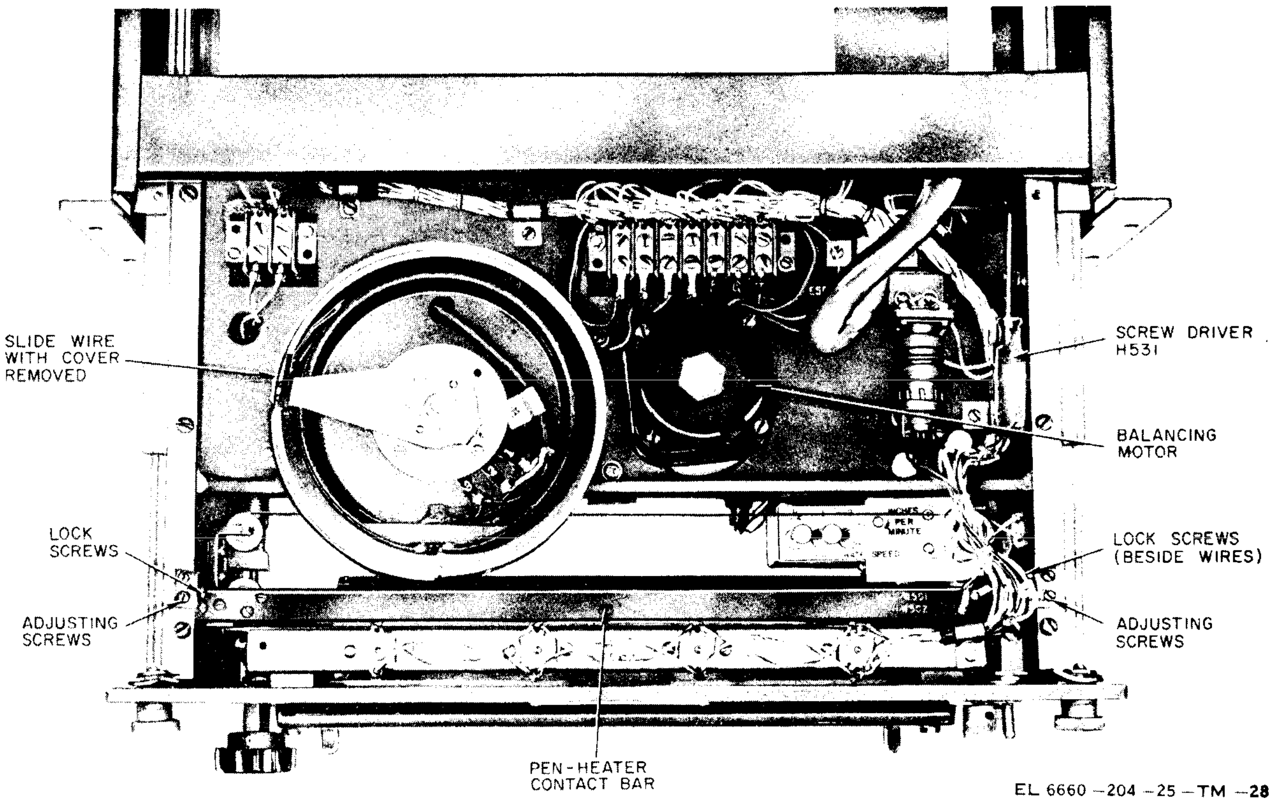


Figure 3-6. Recorder, top view.

(4) Replace the rear panel, control panel, fan panel, and desk. Tighten the mounting screws, reconnect the power, and check the recorder for normal operation.

3-10. Cleaning and Replacing Pen

Follow the procedure below to disassemble, clean, and reassemble the pen. Replace the nib (FSN 7510-537-7781) when necessary.

a. Removing Pen From Pen Carriage.

(1) Open the frequency-time recorder drawer and remove the screwdriver (fig. 4-7).

(2) Remove the panel lamp assembly from its mounting (fig. 4-7) by loosening the three mounting screws.

(3) Unscrew and remove the pen cap (fig. 3-8) from the ink barrel. The rubber washer will come off with the pen cap.

(4) Carefully lift the pen heater from the ink barrel by rotating the pen heater gently around the ink barrel. Lay the pen heater to one side. Be careful not to break the lead wires to the pen heater.

(5) Replace the pen cap on the ink barrel.

(6) Open the window of the frequency-time recorder by operating the window latches.

(7) Loosen the setscrew (fig. 3-9) on the front of the pen carriage.

(8) Grasp the ink barrel and gently lift it up until it is free of the pen carriage. (The barrel is reached from behind the panel.)

(9) Unscrew and remove the pen cap from the ink barrel; discard any excess ink. Separate the rubber washer from the pen cap.

b. Disassembling and Cleaning Pen (fig. 3-10).

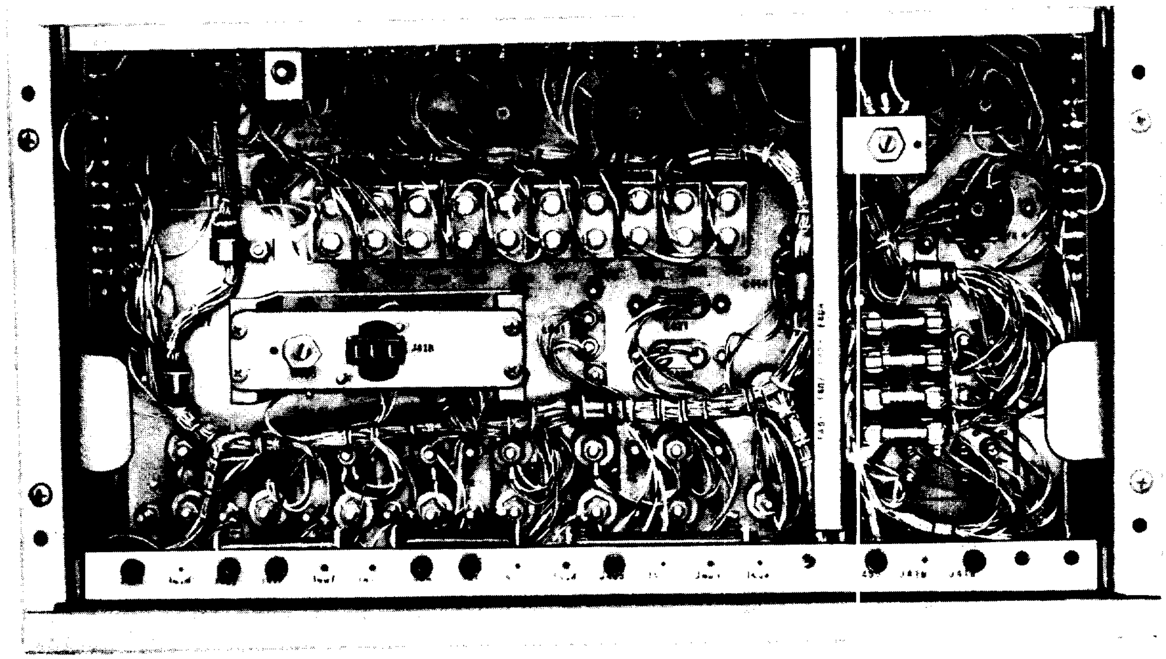
(1) Unscrew the penpoint assembly from the ink barrel.

(2) Unscrew the sleeve-holding screw from the nib.

(3) Hold the nib upside down and gently tap it until the sleeve assembly, with the attached jewel, slides out of the nib.

CAUTION

When the sleeve assembly is removed, the ball should come out. Check the nib



EL6660-204-25-TM-29

Figure 3-7. Power supply, rear view.

and sleeve assembly; be sure to locate the ball before proceeding.

(4) If the ball is still in the nib, continue tapping the nib until the ball comes out.

(5) Insert a thin piece of wire through the opening in the jewel to remove any paper fiber that may be lodged there.

(6) Place all parts of the pen into a small container that contains cleaning compound (isopropyl alcohol) and allow the parts to soak for 24 hours.

NOTE

If it is not possible to soak the parts for 24 hours, use several cleaning compound baths. Do not use the same bath more than once. Insert a cleaning wire ((5) above) through the jewel after each rinsing.

(7) Remove all parts, except the ball, from the cleaning compound bath.

(8) Hold each part securely and blow on it until it is dry. Use clean filtered air if available.

(9) Hold the sleeve assembly up to the light. If light can be seen through the opening in the jewel, the assembly is sufficiently clean, even though traces of ink still remain.

(10) If the sleeve assembly is not clean, repeat the cleaning compound bath. Check the sleeve assembly for cleanliness after each bath. Continue this procedure until the sleeve assembly is clean.

NOTE

If a cleaning compound is not available, pen cleaning can be accomplished by placing components in boiling water for 30 minutes. This is recommended as an emergency procedure only, if cleaning compounds or replacements parts are not available.

(11) Remove the ball from the bath with a pair of tweezers and place the ball on a piece of lint free paper.

(12) Dry tile ball by rotating it on the paper.

NOTE

As the ball dries, it will develop a small static charge. Therefore, be careful when approaching the ball with any charged

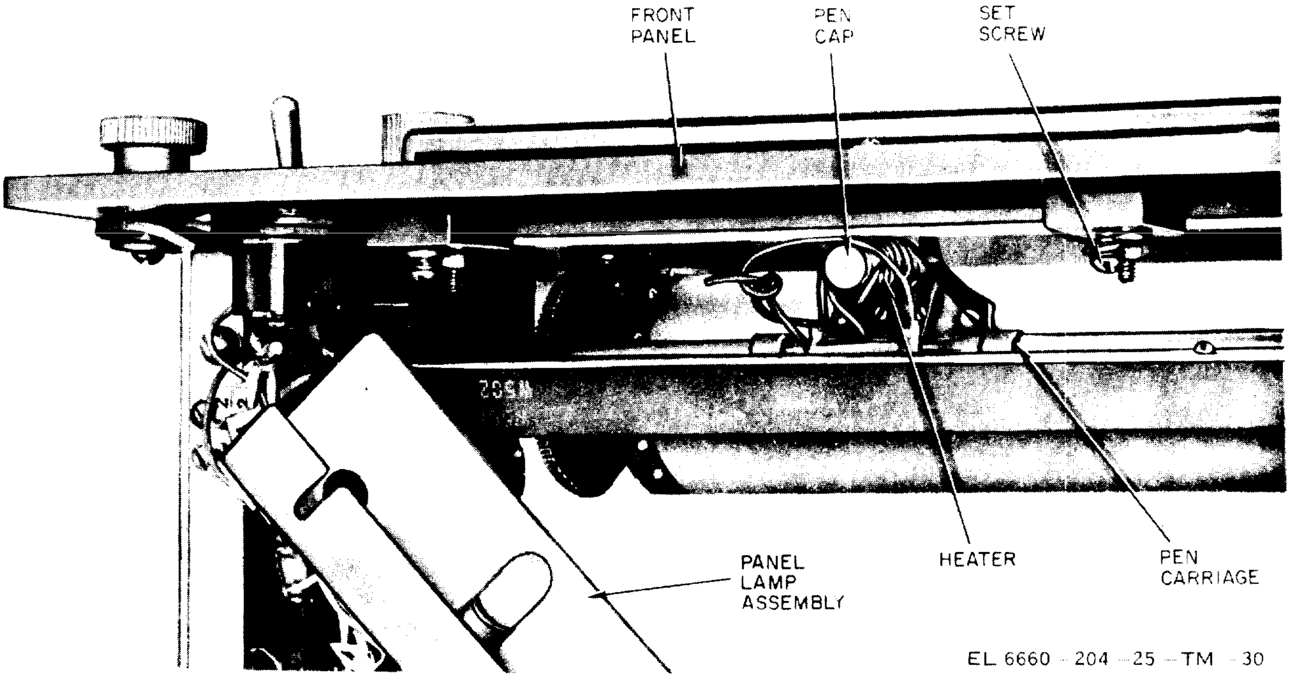


Figure 3–8. Pen assembly.

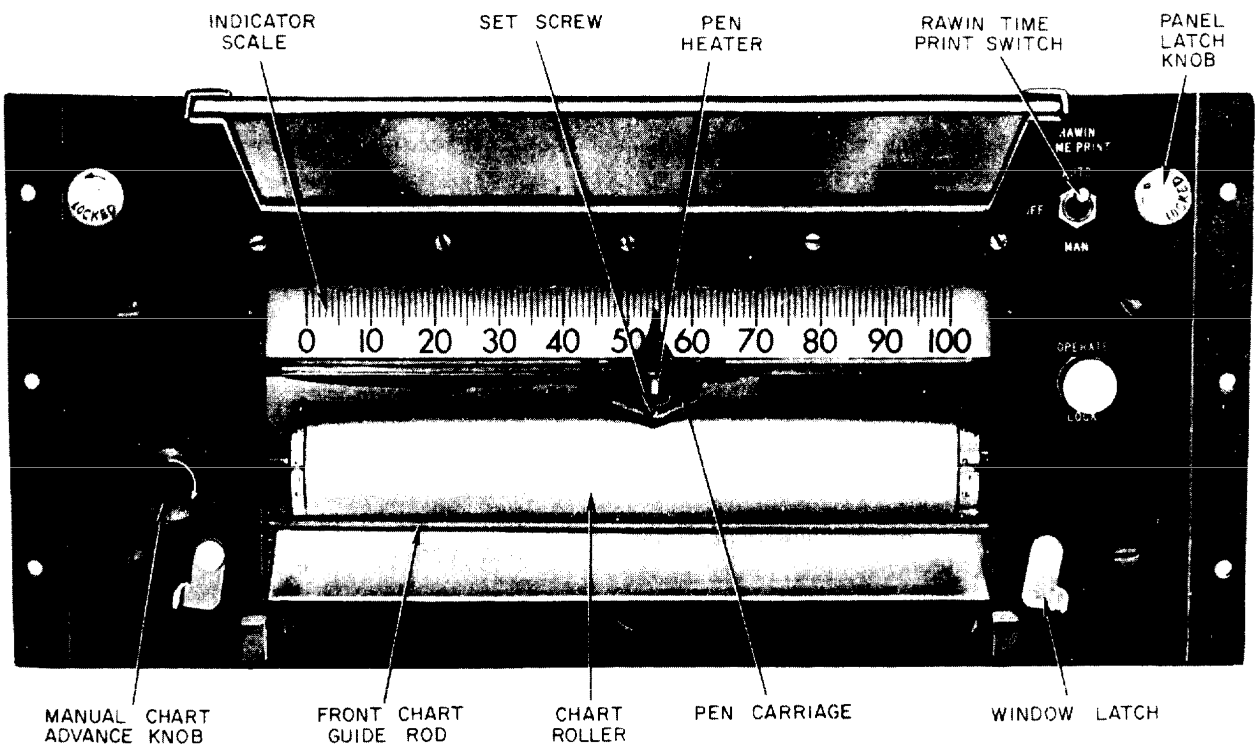


Figure 3–9. Recorder, front view.

object. The ball may move off the paper and get lost. Use brass tweezers to handle the ball.

c. ***Resembling Pen (fig. 3-10).***

(1) Be sure that all parts of the pen are thoroughly dry.

(2) Drop the ball into the nib.

(3) Insert the jeweled end of the sleeve as-***sembly*** into the nib and gently tighten the screw until the ball will not turn.

(4) Turn the sleeve-holding screw back one-eighth to one-quarter turn.

(5) Screw the penpoint assembly into the ink barrel.

(6) Fill the pen by holding it in the left hand at a 45° angle, insert the spout of the ink tube into the pen barrel until the spout touches bottom. Squeeze the tube until the barrel is three-fourths full of ink, Remove the spout.

(7) Place the rubber washer on the pen cap and screw the pen cap into the ink barrel.

(8) Place the pen on the pen carriage and tighten the setscrew (fig. 3–9). Be sure the ink barrel is in a vertical position.

(9) Remove the pen cap from the ink barrel.

(10) Place the pen heater (fig. 3-9) on the ink barrel.

(11) Screw the pen cap into the ink barrel.

(12) Replace the panel lamp assembly and tighten the setscrews to secure the panel lamp assembly.

3-11. Clean, Lubricate, and Tighten Internal Recorder Components

a. Unlatch the frequency time recorder and pull it out of its drawer.

b. Open the recorder window and remove the chart (figs. 3–2 and 3-11).

c. Remove the slide-wire cover.

d. Using a small soft brush, electric blower, or a vacuum cleaner, carefully clean the slide and trolley wires, the chart roller, pen and pen carriage, chart guide rods and the recorder scale. Use a lint free cloth and alcohol to remove any ink deposits on the pen, pen carriage, or pen carriage shaft. Operate the manual chart advance knob, as required, to gain access to all parts of the chart roller.

e. Using a pin or toothpick, apply one drop of light low temperature machine oil to the oilholes in the ratchet wheel hubs of the multiple speed recorders (figs. 3–1 and 3–3). Rotate the manual chart advance knob three turns to circulate the lubricating oil.

f. Tighten the chart guide collars (fig. 3-2), chart drive motor mounts, and all panel knobs.

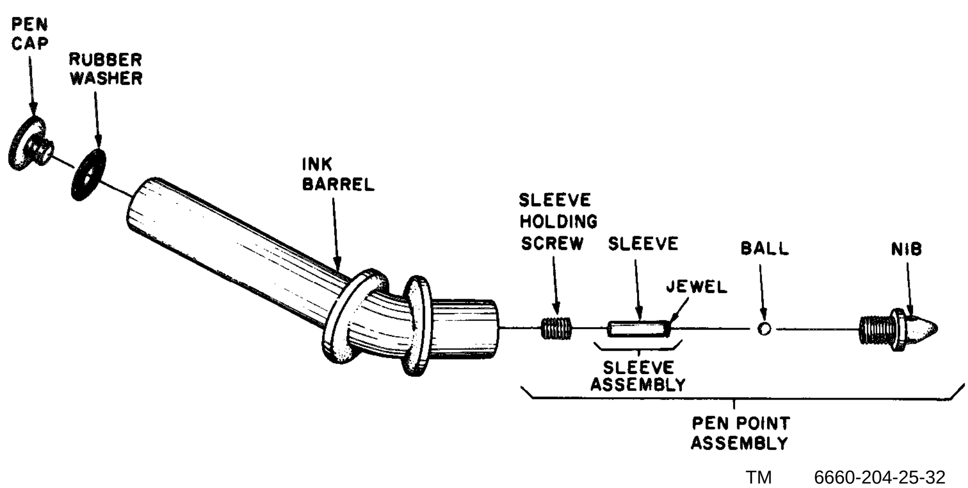


Figure 3-10. Pen, disassembled.

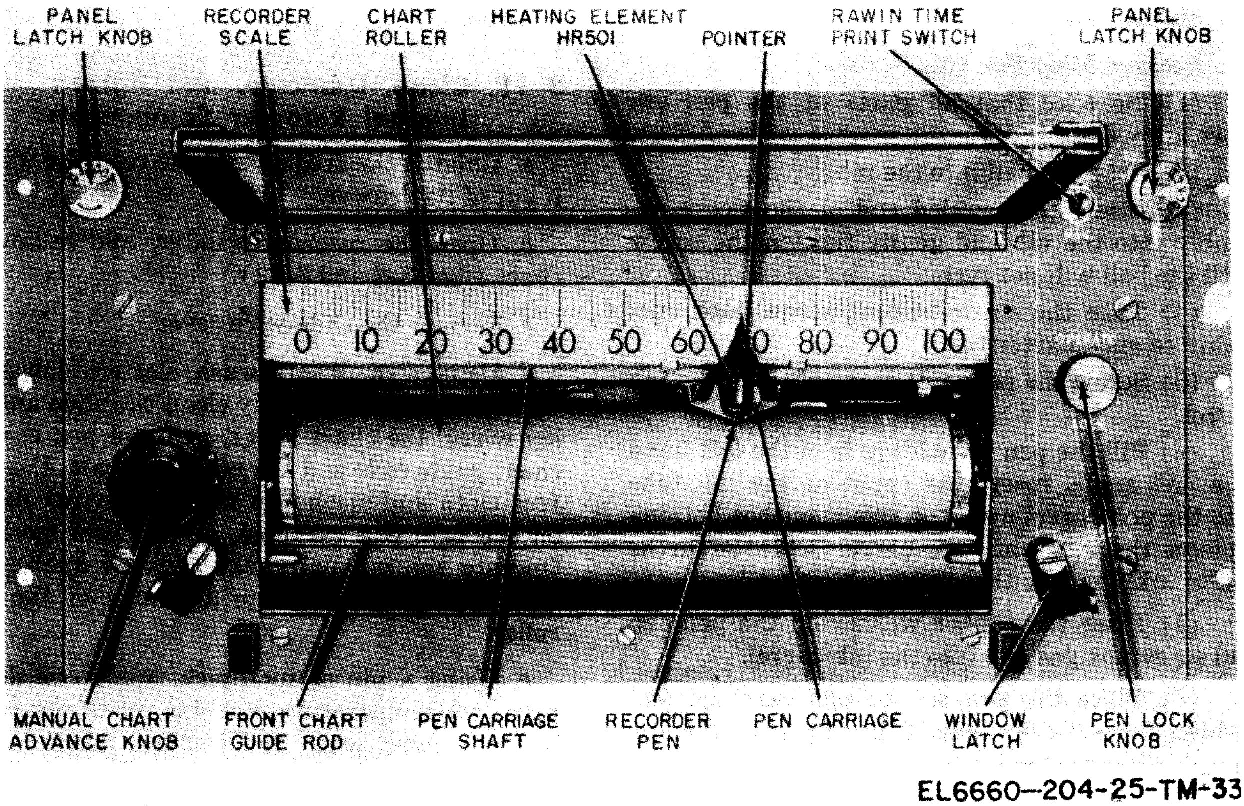


Figure 3-11. Frequency-Time RecorderRD-88A/TMQ-5, Front View of Operating Controls and Panel.

3-12. Check Chart Speed

Using the stopwatch and two measured marks on the chart insure that the chart will move exactly 71? inches in 15 minutes of a powerline frequency of 60 Hz. (Set multispeed recorders to ½ inch per minute.) If the chart speed varies more than 5 percent, send the unit to direct support maintenance for chart drive motor replacement (para 4-10).

3-13. Slide-Wire Contacts Check

Check the condition of the slide-wire contacts. If either is worn halfway through, replace and adjust (para 3-28c).

3-14. Clean and Inspect Interior of Cabinet
(fig. 4-13)

a. Unlatch all components and remove them from the cabinet.

b. Clean the interior of the cabinet with a vacuum cleaner.

c. Inspect all cables and connector for frayed wires, or signs of burning. Replace where required (para 3-40).

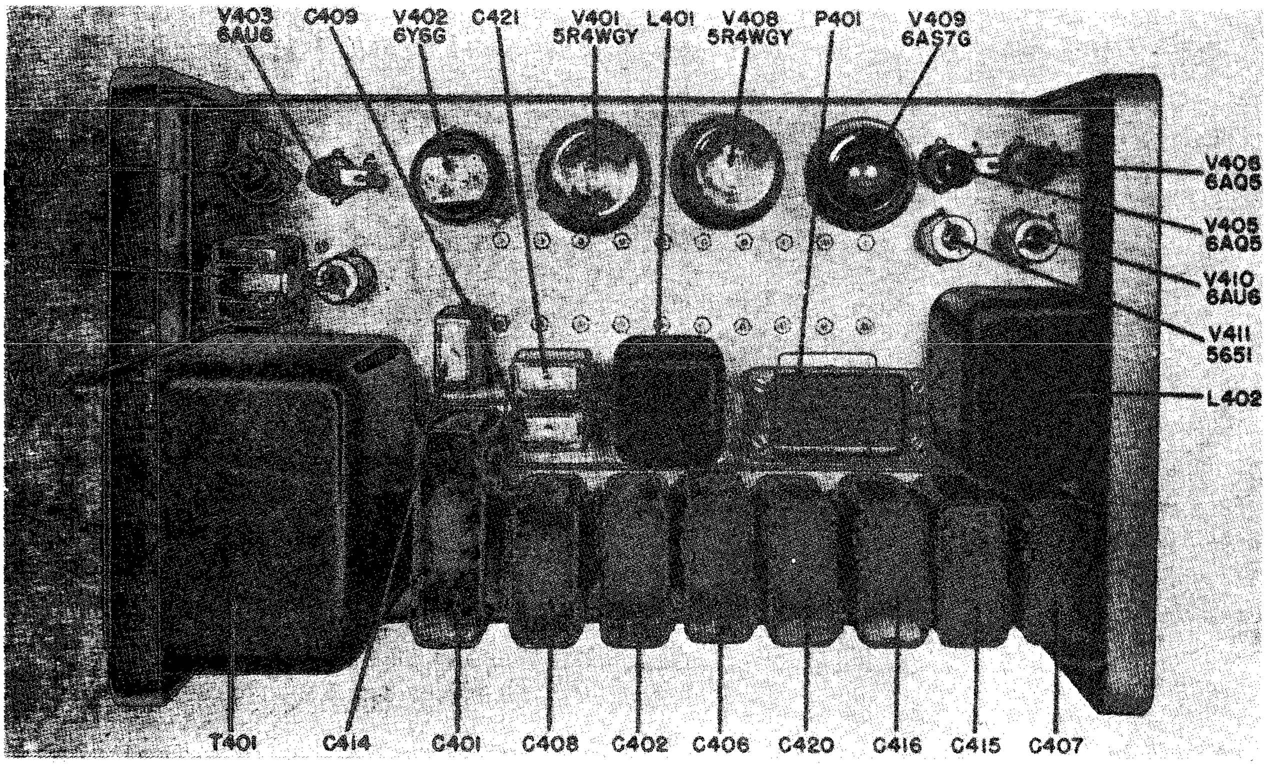
d. Check mechanical security of all connectors, connector brackets, and cable clamps. Tighten where required.

3-15. Clean Interior of Control Panel
(fig. 4-3)

Clean the control panel interior using a vacuum cleaner and a soft brush. Use the soft brush to loosen any foreign matter around the contacts of switch S202 and plugs P201 and P202; then remove the loosened material with the vacuum cleaner.

3-16. Clean and Inspect Signal Data Converter Interior
(fig. 3-15)

a. Clean the interior of the signal data converter using a vacuum cleaner. Remove any deposits using a lint free cloth and isopropyl alcohol.



EL6660-204-25-TM-34

Figure 3-12. Power Supply PP-968/TMQ-5, Top View.

b. Inspect all connections for frayed wires or defective solder joints. Check the leads to jacks J301 and J302 and plugs P301 and P302. Insure all tube shields are properly seated and that all components are securely mounted (ground connections).

3-17. Clean and Inspect Interior of Fan Panel

a. Clean the interior of the fan panel using a vacuum cleaner and a small brush. Thoroughly vacuum the motor, terminal block E1, and plug P1. Use the small brush to clean the screen over the fan.

b. Check all cables for frayed wires or loose connections. Insure that the leads near the fan blades do not have excess slack so that they can be accidentally pulled into the fan.

3-18. Clean and Inspect the Power Supply Interior

a. Clean the power supply top (fig. 3-12) and bottom (fig. 3-13) using a vacuum cleaner. Remove any dirt or corrosion with isopropyl alcohol and a lint free cloth.

b. Inspect for security of all tubes in their sockets and for burned or damaged components.

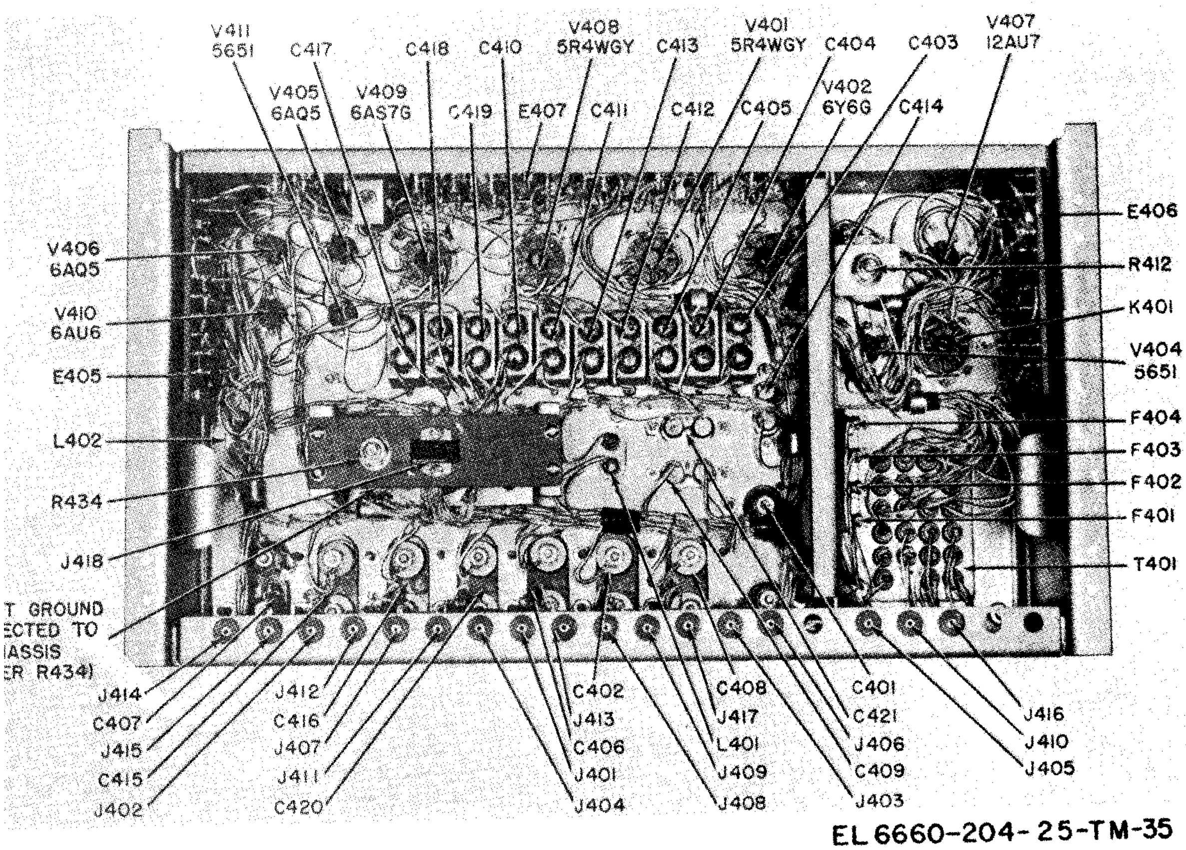


Figure 3-13. Power Supply PP-968/TMQ-5, Bottom View.

Section IV. ORGANIZATIONAL TROUBLESHOOTING

3-19. Extent of Instructions

a. Troubleshooting at an organizational level is limited to the localizing of defective parts that are readily replaceable at an organizational level (tube, fuses, etc), or to the sectionalizing of defective units that must be replaced as a unit (signal data converter), power supply, control unit, etc.). The procedures outlined are designed to determine first the defective unit and then the nature of the fault within the unit. If the fault can be determined through organizational procedures, corrective measures or the need for repair is indicated. If the fault cannot be determined through organizational procedures, reference is made to the direct support maintenance instructions.

b. The techniques that are utilized for organizational troubleshooting include visual inspection, operational tests, tube tests (para 3-24) and simple continuity checks. The material is presented in the order that a technician would normally use when servicing a defective radiosonde recorder. When the procedures indicated are not sufficient to determine the source of trouble, troubleshooting at a direct support maintenance level will be required.

3-20. Visual Inspection

a. Failure of this equipment to operate properly is usually caused by one or more of the following faults:

(1) Improper or improperly connected power source.

(2) Worn, broken, or disconnected cords or plugs.

(3) Burned-out fuses or tripped circuit breakers.

(4) Relay contacts burned because of overloads.

(5) Wires broken because of excessive vibration.

(6) Defective tubes or vibrator inverter.

b. When the cause of failure is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. Before performing the tube checks, refer to paragraph 3-24. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

c. Visually inspect the recorder for obvious abnormalities.

3-21. Operational Tests

a. General. Determination of operational capability is accomplished by means of the operational test chart (para 3-23). The chart gives the item to be tested, the action and conditions under which the item is tested, the normal indications of correct operation, and the corrective measures. To use the operational test procedures chart, follow the items in numerical sequence.

b. Corrective Measures. The corrective measures listed are those most commonly required to correct for abnormal indications. In most cases, the column indicates the area in which a malfunction must exist to cause the abnormal indications. Use conventional troubleshooting procedures to isolate the malfunction or trouble. A troubleshooting flowchart is provided in paragraph 3-22 and figure 3-13.1.

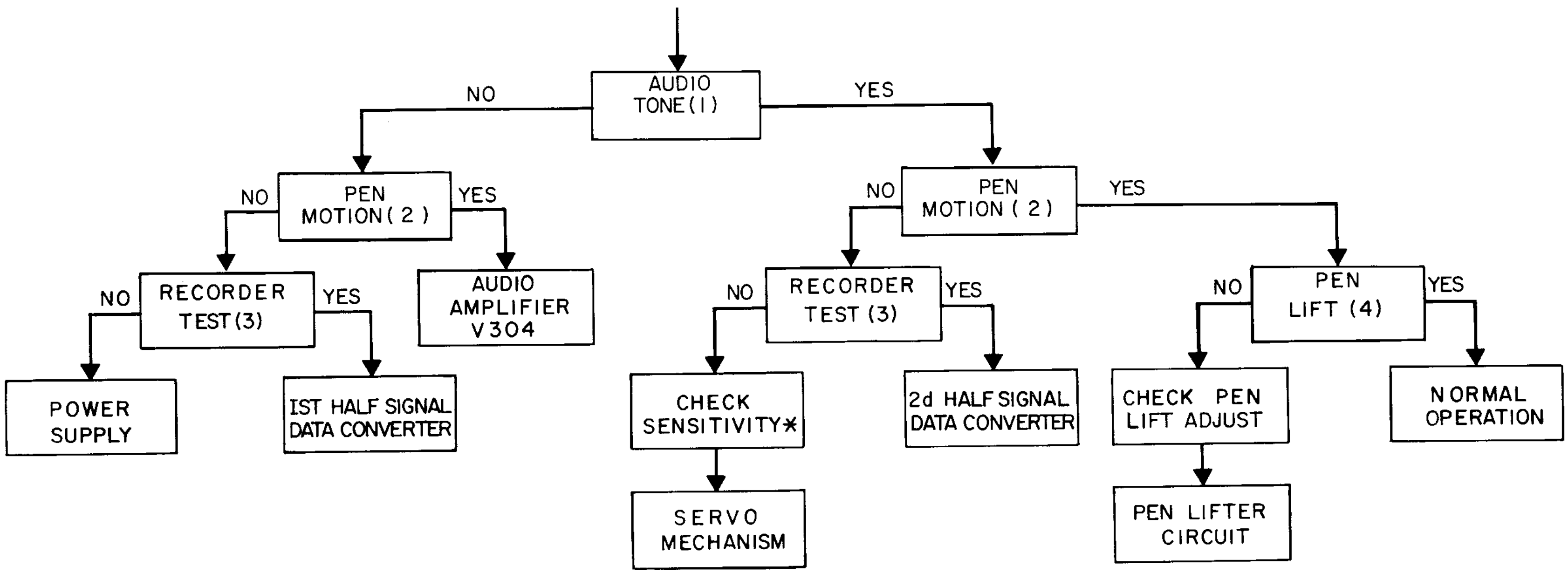
USE TROUBLE SHOOTING SHEET BELOW TO GENERALLY LOCATE TROUBLES IN THE Q-5
RESPONSES REFERRED TO BELOW ARE AS FOLLOWS:

1- AUDIO TONE FROM LOUDSPEAKER WITH SIGNAL SELECTOR SWITCH IN 60 OR 120 CPS POSITION.

2- PEN MOTION TO CORRESPOND WITH SETTING OF SIGNAL SELECTOR SWITCH, i.e., 60 CPS = 30 rec. div.

3- PEN MOVES TO APPROXIMATE 95 rec. div. WHEN RECORDER TEST SWITCH IS DEPRESSED.

4- PEN SHOULD LIFT CLEAR OF PAPER WHEN PEN MOVES ("POWER ON").



* ADJUST APPROXIMATE TO MIDPOINT

EL5UB007

Figure 3-13.1. Troubleshooting Flowchart.

3-22. System Sectionalization of Trouble

System sectionalization consists of determining whether the trouble is in the power supply, the first or second half of the signal data converter, the servo system, or the pen lifter circuit.

a. The first half of the signal data converter consists of stages V301 through V304.

b. The second half of the signal data converter consists of stages V305 through V307.

c. The servo system consists of stages V301, the measuring circuit, tube stages V308 through V310, and tube stages V405 and V406. Some of the servo system components are located in the signal data converter, on the control panel, the power supply, and in the frequency time recorder.

d. The pen lifter circuit consists of V407, K401, and L501.

e. The operational test procedures should be used to assure that the set will operate in conformance to standards. The troubleshooting flowchart (fig. 3-13.1) may be used to sectionalize a trouble.

f. After determining the section containing a malfunctioning component, use conventional trouble. shooting procedures to isolate the trouble within that section. To assist in isolation, simplified schematic diagrams of each section are provided in figure FO-31 through FO-35 at the end of the manual.

3-23. Operational Test Procedures

Item No.	Item	Action or Condition	Normal Indications	Corrective Measures
1	Signal and power cable(s).	Cable(s) connected in accordance with paragraph 2-8 in TM 11-6660-204-10.		
2	Circuit breakers.	Set to ON.		
3	SIG SEL switch.	Rotate to S.C.		
4	SPEAKER VOL. control.	Set to desired amount of volume.		
5	OPERATE-LOCK control.	Rotate OPERATE-LOCK control to OPERATE position.		
6	Vent.	Opened		
7	FAN switch.	Set to OFF.		
8	POWER switch.	Set to OFF.		
9	Chart feed.	Rotate manual chart advance knob clockwise.	Chart advances smoothly and without drift.	Check chart installation and alinement. Check chart feed adjustments (para 3-25).
10	POWER switch and FAN switch.	Change POWER switch from OFF to STANDBY and place the FAN switch to ON.	Voltmeter indicates between 105 and 125.	Check circuit breakers, cabling, and power source. Troubleshoot ac distribution circuits.
			Frequency meter indicates between 50 and 65 hertz.	
			Power jewel indicator illuminates.	Replace jewel indicator lamp.
			Fan motor starts and forces air from vent at top of recorder.	Check connections on fan panel.
			Recorder pen goes to zero (approximately) but remains lifted from the chart.	Troubleshoot servo system. If pen marks the chart, check pen adjustments (para 3-28).
		NOTE The accuracy of items 11 through 18 are determined by a satisfactory warmup time of 10 to 15 minutes depending on the ambient temperature.		
11	POWER switch.	Change from STANDBY to ON.	Chart motor starts and drives the chart. Pen sets down and marks the chart at zero.	Check charts drive circuits and mechanism in the frequency time recorder drawer. If pen does not ride against the chart, check the position of the intermediate chart guide rod, the OPERATE-LOCK control, SENSITIVITY, PEN LIFT control, and pen in-

Item No.	Item	Action or Condition	Normal Indications	Corrective Measures
11	Continued			stallation. If pen rides against the chart but does not print, clean and/or fill the pen.
12	REC ZERO control	Rotate REC ZERO control between limits. Adjust to cause the pen to print at zero.	Pen records below and above zero. Final setting produces a print at zero on the chart.	Check for noise in the signal data converter. Troubleshoot the measuring circuit.
13	REC TEST switch.	Press until check is finished, then release.	Pen lifts and moves to 95 and marks the chart. When switch is released, pen returns to previous setting.	If pen comes to rest above or below 95, check setting of REC TEST ADJ., drive cable tension, balancing motor, serve system, and measuring circuit.
14	60 C.P.S. check.	Rotate SIG SEL switch to 60 C.P.S. (Adjust SPEAKER VOL. as desired.)	Pen lifts from the chart and moves upscale, then sets down and marks the chart at 30 or to a position corresponding to one-half of the line frequency. A 60 hertz tone is heard from the speaker.	If pen comes to rest above of below 30, check setting of REF ADJ. control. If pen does not move, and no audio tone is produced, check the power supply. If an audio tone is produced, check stages V305, V306 and V307.
15	SPEAKER VOL.	Vary the setting of the SPEAKER VOL. control.	Loudness of tone from the loudspeaker changes. Control operate smoothly without producing noise in the tone.	Replace speaker volume control.
16	RFD ADJUST control.	Rotate the REF ADJ. handwheel fully clockwise. When check is completed readjust as for item 14.	Pen moves upscale and records 35 ordinated or higher.	Check power supply outputs. Troubleshoot measuring circuit. Replace R202.
17	120 C.P.S. check.	Rotate SOG SEL switch to 120 C.P.S.	Pen lifts from the chart and moves upscale and marks the chart at 60 or to a position corresponding to the line frequency. A 120 hertz tone is heard from the speaker.	If pen records at 30, replace F403 or F404. If pen does not move, check the circuit of S202.
18	SIG check. (If a signal source is not available from the rawin set or frequency standard, omit this step and leave the switch to either the 60 or 120 C.P.S. setting.)	Rotate SIG SEL switch to SIG.	Pen records at values equal to one-half the input frequency. The audio tone is heard from the speaker. Pen lifts each time the signal frequency is changed.	Check cable connections. Assure signal is provided from source (Rawin Set or Frequency Standard TS-65). Replace signal cable.
19	INTER S. C.-OUTPUT S.C. switch.	Set INTER S. C.-OUTPUT S.C. switch to OUTPUT S.C. Hold until pen stops.	Pen goes to zero.	Replace switch S203.
		Set switch to INTER S.C. Hold until pen stops.	Pen goes to zero.	Replace switch S203.
20	CHART SPEED INS/MIN. (Frequency-Time Recorders RD-88A/TMQ-5 and RD-88B/TMQ-5 have two-speed (1/2 and 1) chart drive mechanisms. RD-88C/TMQ-5 has three speed capabilities (1/2, 1, and 2).	Set at ½.	Chart advances ½–inch per minute.	If chart will not advance for any speed setting, check input to, or replace the chart drive motor.
		Set at 1.	Chart advances 1-inch per minute.	If the chart advances for only one speed for Recorder RD-88B, troubleshoot the circuit of S502 and C501.

Item No.	Item	Action or Condition	Normal Indications	Corrective Measures
20	Continued	Set at 2 (RD-88C) only).	Chart advances 2-inches per minute.	If one or two advance speed for the RD-88C are incorrect, inspect/repair the mechanical chart drive mechanism.
21	Rawin time-print (TPO). AUTO.-OFF-MAN switch (If the recorder is not connected to the rawin sat, omit this test.)	Set to OFF.	Control recorder TPO (Time Print-Only) does not operate for any pen position on the scale.	Replace S503 or C502.
		Set to AUTO.	Control recorder produces TPO when pen exceed 89 to 91 chart ordinates.	Check circuits of S503 and S504. Adjust setting of S504.
		Depress switch to MAN.	Control recorder produces TPO each time switch is depressed.	Replace S503.
22	POWER switch.	Set POWER switch.	Jewel power indicator lamp goes out and VOLTAGE and FREQUENCY meters indicate zero.	Replace POWER switch S201.

3-24. Tube Testing Techniques

When trouble occurs, check all cabling, connections, and the general condition of the equipment *before* attempting to remove the electron tubes. Isolate the trouble, if possible, to a particular unit or section of the equipment. Gain access to the suspected tubes and follow the procedures as outlined in *b* below. If tube failure is suspected, and a tube tester is not available, proceed as outlined in c below if this procedure fails to clear the trouble, follow the procedure outlined in *d* below.

CAUTION

Do not rock or rotate the top of a miniature tube when removing it from its socket; *pull it staight out.* Rocking or rotating the tube causes the pins to bend and may break the weld where the pin enters the glass. A high resistance or intermittent joint also may develop. If tube pins get bent, staighten them in the sockets provided for that purpose in the bottom of the cabinet.

a. *Access to Tubes.* To gain access to tubes for testing or replacement, proceed as follows:

(1) Operate the POWERLINE circuit breakers to the OFF position.

(2) Remove the rear panel retaining screws at the rear of the cabinet.

(3) Remove the rear panel to provide access to tubes.

(4) To remove rectifier tubes V401 and V408 and series regulator tubes V402 and V409 mounted on the power supply chassis, release the safety clamps around the base of the tube before pulling the tube from it's socket. Be sure that the safety clamp is tightened after the new tube has been placed in the socket.

b. Using Tube Tester.

(1) Remove and test one tube at a time. If it is necessary to remove more than one tube at a time, label each one so that it may be replaced, if satisfactory, in its original socket.

(2) Replace a tube only when there is an obvious defect, such as a broken glass envelope, open filament, broken lead, or connecting prong, or when a test in a tube tester or other equipment shows the tube to be defective.

(3) Do not discard a tube because it tests *on or near the minimum* test limit of the tube tester. Some new tubes test near the low end of the acceptability range of the tube specifications. These tubes provide satisfactory service over a long period of time, even though they remain at or near this low limit value.

(4) Do not discard a tube merely because it has been in use for a specific length of time. *Satisfactory operation in a circuit is the final proof of tube quality.*

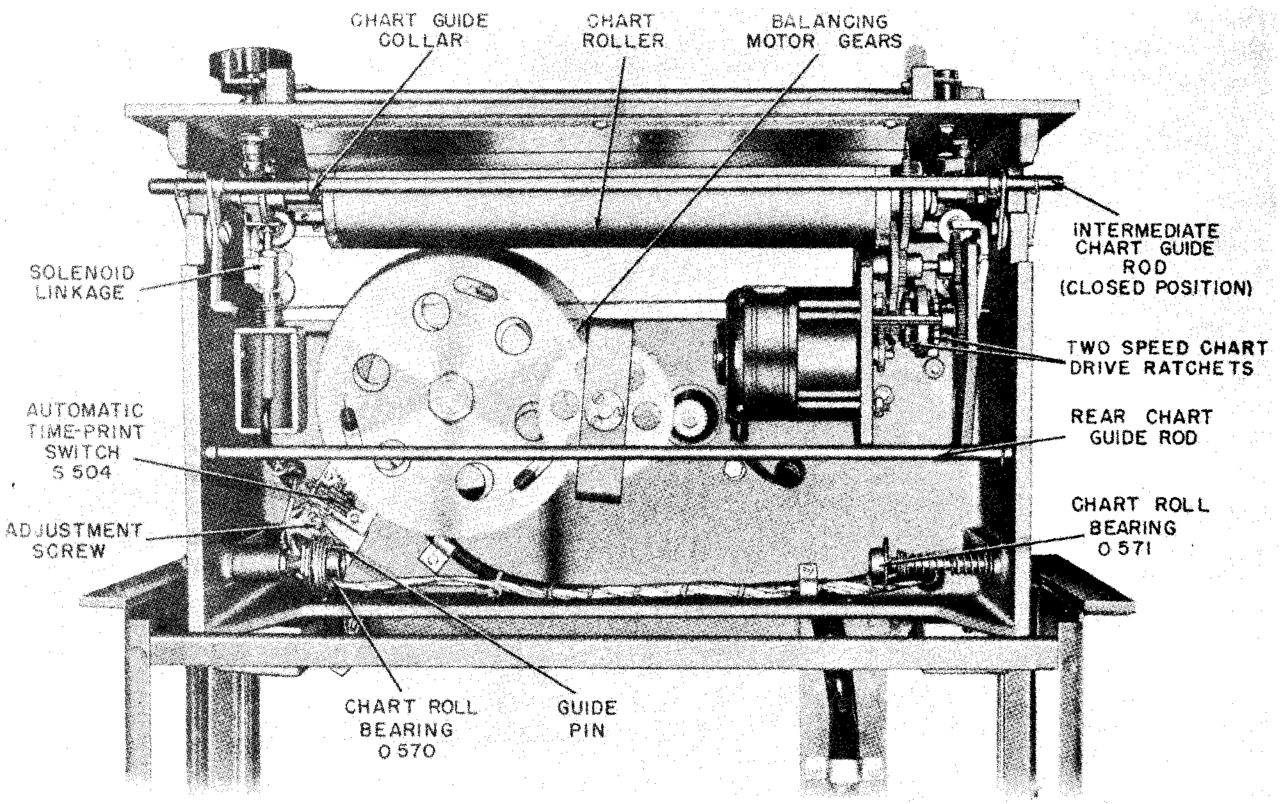


Figure 3-14. Frequency-Time Recorder RD-88A/TMQ-5, Bottom View Showing Main Chart Dive Items.

c. Single Tube Substitution Method.

(1) Substitute a new tube for one of the suspected original tubes. If the equipment continues to be inoperative, replace the new tube with the original. Similarly check each original tube suspected, one at a time, until the defective tube is located and the equipment becomes operative. Discard the last original tube removed from the equipment. *Do not leave a new tube in a socket if the equipment operates satisfactorily with the original tube.*

NOTE

The oscillator circuit of tube V304B in the receiver may function with one tube and not with another, even though both tubes are good. If practical, retain any removed tube until it is checked by suitable test equipment.

(2) If this method of tube substitution does not correct the trouble, try the method described in *d* below.

d. Multiple Substitution Method. Occasionally, two or more tubes are defective in a piece of equipment. In such cases, the procedure in *b* above will not locate the trouble. It is then necessary to install new tubes, one at a time, until the equipment becomes operative. This should be done as follows:

(1) Remove one of the suspected original tubes. Install a new tube. If the equipment is still inoperative, leave the new tube in place and remove the next suspected original tube. Install another new tube. Mark the original tubes with the socket numbers from which they were removed. Continue this procedure until the equipment becomes operative. The last original tube removed is defective and should be discarded.

(2) To determine whether another original tube is defective, return one of them to its original socket. If there is no noticeable difference in performance, leave the original tube in the equipment. In the same way, return the remaining tubes to their sockets, one at a time. If equipment failure occurs, or performance suffers, discard the last original tube installed. *Do not leave a new tube in a socket if the equipment operates satisfactorily with the original tube.*

e. Turn-In for Repair. If none of the procedures outlined above restore the equipment to normal operation, *return the original tubes to their sockets* before forwarding the defective item of equipment to a higher maintenance level for repair.

f. Interchangeability of Tubes. Unless specifically permitted by published instructions, different versions of the same tube type (ruggedized, nonruggedized, etc.) should not be substituted for the designated type. Signal Data Converter CV-146A/TMQ-5 uses several ruggedized tubes which should be replaced with the same type in each case. Do not substitute tube type 5184A for tube 12AU7 in the tube sockets for V301 and V303, and do not substitute tube type 5751 for tube 12AX7 in the tube sockets for V302 and V310; such substitutions could disable the set completely. The preferred type tube 5R4GWA may be substituted for the earlier type tube 5R4GWY in the tube sockets for rectifiers V401 and V408 in Power Supply PP-968-TMQ-5.

Section V. ADJUSTMENTS, REPAIRS, REPLACEMENT, AND TESTING

3-25. Chart Feed Adjustments

a. If the chart does not feed out straight during operation of the recorder the cause is probably misalignment of the chart supply roll. The left edge of the chart should be against the guide collar mounted on the intermediate guide rod, and the perforations on the edge of the chart should coincide with the extruded teeth around the left end of the chart roller. If the two positions do not align, loosen the two locknuts on the left side of the chart supply roll shaft, one on each side of the recorder casting (fig. 3-2). Shift the chart roll so that the chart will just rub against the guide collar and the perforations on the chart fit over the roller teeth. Tighten the locknuts. The fiction brake on the chart roll shaft should be only tight enough to prevent the chart from dropping below the bottom of the recorder. Excessive brake action may cause the chart to creep sidewise as it advances.

b. If the chart on the recorder feeds out intermittently there is too much dragon the supply roll which is caused by friction clutch slipping at times or there is a possibility of not enough clutch pressure. Check with the manual chart advance knob (fig. 2-20) for ease of operation. If there are no signs of mechanical binding, increase the clutch friction by tightening the set nut and locknut located on the right side of the chart roller shaft (fig. 2-19 or 3-2) until the proper chart advance rate is obtained. Another possible source of trouble is a loose pinion gear on the motor shaft, which may be easily tightened by the setscrew in the gear hub.

c. If the lubricating instructions given in paragraph 3-3 have not been followed, wear or binding may occur between the ratchet wheel hubs and shaft (figs. 3-1 and 3-2). Apply oil only as needed to correct the trouble, then lubricate as directed in paragraph 3-3.

3-26. Drive **Cable Tension Adjustment**

The tension on the drive cable should be between 1 and 1.25 pounds. This amount of tension is obtained by loosening the locknut and turning the setscrew on the drive cable guide pulley until the spring is fully compressed. Back off one full turn of the adjusting screw and tighten the locknut.

3-27. Adjustment of Split Gear Bias

The split gear bias adjustment is performed to eliminate gear backlash. The need for this adjustment is usually indicated by gear chatter, excessive error in hysteresis, or linearity calibration test errors.

a. Remove the nut below the pinion gear and pull the pinion gear from the motor shaft (fig. 2-19).

b. Expand the springs of the split gear by displacing the two halves of the gear by three teeth.

c. While holding the split gears in place, replace the pinion gear. Replace the nut on the motor shaft.

NOTE

If the nut securing the split gears is too tight, the gears cannot move independently, resulting in a split gear bias of zero. A clearance of approximately 1/32-inch should be provided between the nut and the gears.

3-28. Recorder Pen Adjustment

a. Mechanical Pen Lift Adjustment. If the pen does not lift 1/16 inch from the chart as it moves across the scale, check the position of the double-ended bolt connecting the solenoid plunger link to the pen-lifter bracket. To obtain the proper distance, throw the power switch to POWER OFF. Loosen the locknut (fig. 2-21) and turn the double-ended bolt until the pen is 1/ 16 inch from the chart. Tighten the locknut. If the pen carriage shaft rotates sufficiently but the pen does not rise, tighten the two screws in the pen clamp mounted on top of the pen carriage be sure to allow free movement of the carriage.

b. Pen Point Pressure Adjustment. If the pen does not mark the chart, check the condition of the pen for an adequate ink supply. If these are satisfactory, but the pen still makes either no mark or a very light one, check the pressure of the penpoint against the paper.

This pressure should be 2 ounces; it is varied by adjustment of the tension of the pen pressure spring (fig. 2-21).

c. Adjustment to Eliminate Erratic Pen Operation. Erratic operation of the pen may be caused by any one or a combination of the following conditions:

(1) *A loose connection between the drive cable and the pen carriage.* Check visually and/or check the alignment of the pen against the position of the arm of the slide and trolley wire (para 3-33).

(2) *Slackness in the drive cable.* If this condition exists, increase the tension by turning the setscrew on the drive cable guide pulley located on the right side of the recorder. Turn the setscrew until the spring is completely compressed, and then back it off 1 full turn.

(3) *A worn condition of the traveling trolley contacts.* If either one of these is worn half through, replace both of them. Pressure on the new contacts should be adjusted to between 1.75 and 2.5 ounces. To adjust the pressure, bend the contact spring as required for a course adjustment. To make the fine adjustment, loosen, the two screws that hold the contact arm and slide the arm toward or away from the contacts, as indicated. While performing these adjustments, turn the small backup screw on the side of the contact arm out of the way; after the adjustment is completed, turn the screw in as far as it will go and tighten the locknut. Check to see that there is a minimum of 1/16–inch clearance between any part of either contact spring and the slide. Also be sure that there is adequate clearance between the heads of the screws that hold the contact assembly to the contact arm and the bottom part of the slide-wire housing. Rotate the contact arm throughout its entire excursion in making this clearance check.

3-29. Adjustment of Regulated Power Supplies

a. Positive Regulated Power Supply. This unit is adjusted to give a constant output potential of 300 volts under normal loads. Connect the positive lead of a voltmeter (300-500 volt range) to J404 and the negative lead to chassis. Adjust R412 for a reading of 300 volts.

b. Negative Regulated Power Supply. This unit is adjusted to give a constant output potential of –175 volts under normal load. Connect the negative lead of a voltmeter (300-500 volt range) to J413 and the positive lead to chassis. Adjust R434 for a reading of 175.

3-30. Noise Suppression Diode Alignment

Noise suppression diode alignment is a direct support maintenance procedure and requires the use of an oscilloscope. However, if a replacement unit is not immediately available, or the situation is such that equipment cannot be removed from operation for direct support maintenance, the following procedure will temporarily provide noise suppression of a noisy radiosonde signal:

a. Set the noise suppression switch S301 fig. 3-15), to the IN position.

b. Use a pencil to mark the position of the slots of potentiometers R304 and R306.

c. Listen to the speaker and observe the pen. Adjust potentiometer R306 (fig. 3-15) to the maximum of ¼ turns in each direction and listen to the speaker for a reduction in noise while still maintaining a steady pen trace.

d. Adjust potentiometer R304 a maximum of ¼ turn in either direction for a reduction in noise while still maintaining a steady pen trace.

e. If noise cannot be adjusted out by this method return both potentiometers (R304 and R306) to their original (as marked) positions.

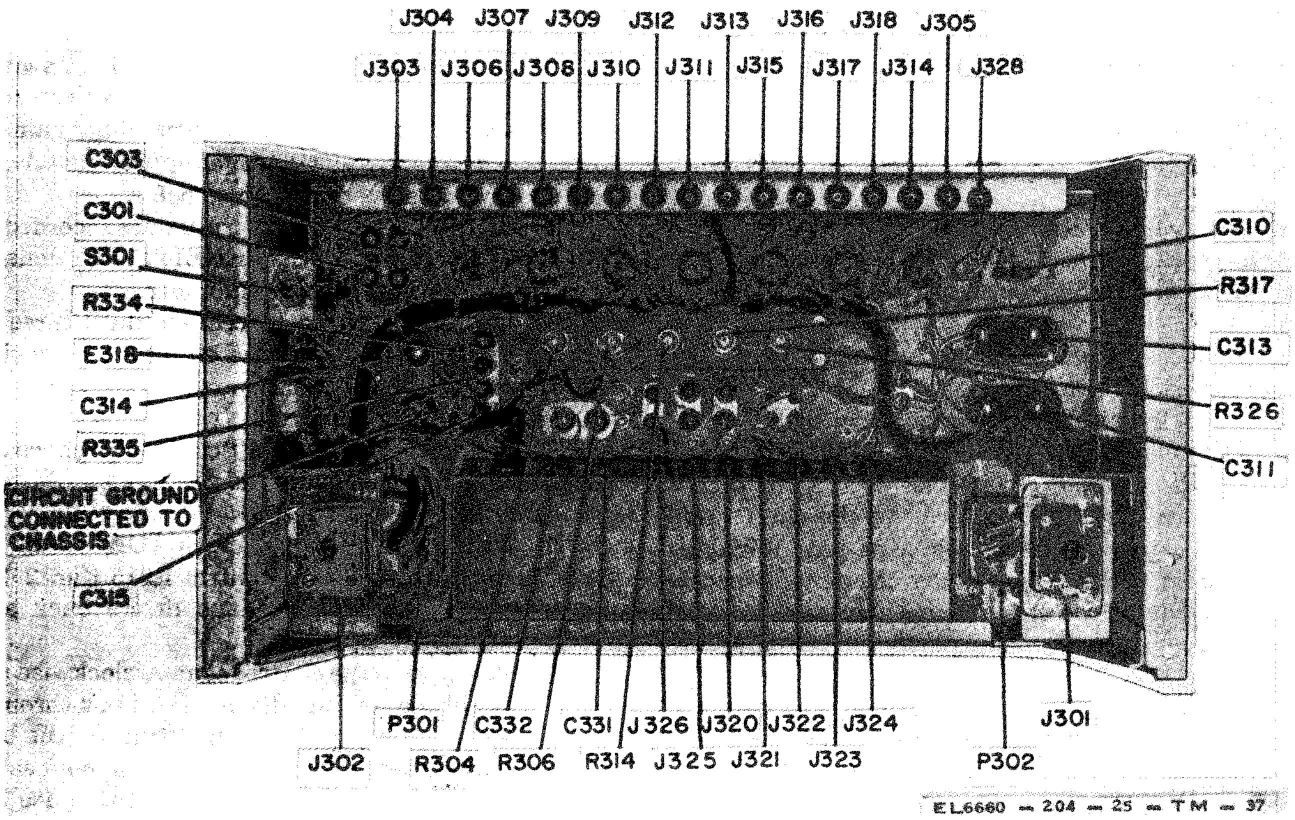


Figure 3-15. Signal Data Converter CV-146/TMQ-5, Bottom View Showing Socket Locations.

3-31. Voltage Discriminator Alinement

a. Rotate SIGNAL SELECTOR switch S202 to the S.C. position.

b. Rotate potentiometer R314 to it's clockwise limit, and potentiometer R317 to it's counterclockwise limit.

c. Place a jumper wire between J308 and J314.

d. Connect a voltmeter (200-300 volt scale) between J310 (positive) and chassis. Adjust R314 until the meter reads 120 volts. Remove the meter and jumper.

e. Connect a jumper between J304 and J308.

f. Connect the voltmeter between J310 (positive) and chassis. Adjust R317 until the meter indicates 160 volts. Remove the meter and jumper.

3-32. Univibrator Alinement

The univibrator potentiometer R326 should be set to the middle of the range in which stable operation of the univibrator is obtained.

a. Rotate the SIGNAL SELECTOR switch S202 to the 120 CPS position.

b. Advance R326 until the recorder pen indicates 60 on the chart. If the pen comes to rest at some other position, bring it to 60 by adjusting the REF ADJUST control.

c. Continue to advance R326 until the pen becomes unstable or until the mechanical limits of the potentiometer are reached. This procedure will establish one extreme of the range.

d. Turn the potentiometer counterclockwise until the pen again becomes unstable or until the mechanical limit of the potentiometer is reached. This procedure will establish the other extreme of the range.

e. The final setting of R326 should be halfway between the two extremes of the range.

3-33. Alinement of Recorder Pen and Slide-Wire

With no power applied to the radiosonde recorder and with the pen and indicator in the maximum counterclockwise position, the pen should record between one-third and one-half of a chart division to the left of the chart zero line. In the maximum clockwise position, the pen should record just left of the extrusions at the right-hand end of the chart drive roller. If it does not record in that position, perform the following alinement:

a. Loosen the two screws that secure the drive cable to the pen carriage.

b. Pull open the frequency time recorder and remove the slide-wire cover (fig. 3-6). Grasp the cover rim with the left hand; with the right hand, hold out the retainer spring that is found on the cover's rim. Turn the cover counterclockwise and lift it at the same time.

c. Rotate the contact arm of the slide-wire to its maximum counterclockwise position as viewed from above (fig. 3-6).

d. Manually position the pen carriage so that the pen is positioned at a point between one-third and me-half of a chart division to the left of the chart zero inc.

e. Tighten the left-hand screw that secures the drive cable to the pen carriage.

f. Manually rotate the contact arm of the slide-wire to its maximum clockwise limit.

g. The pen should record just to the left of the extrusions at the righthand end of the chart drive roller. If the pen contacts these extrusions, it may be damaged. If necessary, readjust the pen downscale slightly as described in *c, d,* and *e* above.

h. Tighten the right-hand screw that secures the drive cable to the pen carriage.

i. Turn on the equipment and allow it to warm up for 10 minutes.

j. Perform the sensitivity adjustment (para 3-34). Disregard any deviation in balance positions of the pen.

k. Turn the SIGNAL SELECTOR switch to the S.C. position.

l. Turn the REC ZERO control to its midpoint screwdriver slot vertical).

m. Loosen the two mounting screws on the slide-wire plastic molding. (One of these screws also secures a cable clamp.) Loosen the screw holding a second clamp near the cable clamp.

n. Carefully rotate the loosened slide-wire until the pen records at the chart zero line to within one-tenth of a chart division.

o. Tighten the mounting screws on the slide-wire molding.

p. Adjust the REC ZERO control to bring the recorder pen exactly on the chart zero line.

q. Replace the slide-wire cover.

3-34. **Sensitivity Adjustment**

a. Preferred Procedure.

(1) With the SIGNAL SELECTOR switch in the 60 C.P.S. position, turn the REF ADJUST control to cause the pen to be positioned to 40 recorder divisions. Allow the pen to record this value for approximately 10 seconds.

(2) Momentarily depress the INTER SC–OUTER SC switch to cause the pen to move down-scale 10 to 40 divisions and then move back upscale. Allow the pen to record this value for approximately 10 seconds and note the deviation from the 40 division ordinate.

(3) Momentarily depress the REC TEST switch to cause the pen to move upscale 10 to 40 recorder divisions and then move back downscale. Again allow the pen to record the value for approximately 10 seconds and note the deviation as before.

(4) Check the deviation of the values recorded in (2) and (3) above. Adjust the SENSITIVITY control to cause this deviation to be minimum.

(5) Repeat the above procedures until three or more traces on each side of the 40 recorder division ordinate are obtained with a maximum deviation of ± 0.2 recorder division.

(6) Turn the REF ADJUST control to reposition the pen to 30 recorder divisions.

b. Alternate Procedure.

(1) With the SIGNAL SELECTOR set at 60 CPS, turn SENSITIVITY control R213 (fig. 2-21) clockwise until the pen carriage jitters back and forth.

(2) Slowly turn the control counterclockwise until the jitter of the pen just disappears. Look through the window and observe the pinion gear on the balancing motor shaft; it will still have a noticeable small jitter. This point is the best compromise between the level of sensitivity that causes pen jitter and the level that makes the pen too sluggish in its response to error voltages.

(3) Try the servo response on the three fixed-signal positions of the SIGNAL SELECTOR switch (S. C., 60 CPS, and 120 CPS). If the pen movement is jerky the sensitivity may be backed off a little more

3-35. **Pen Lifter Adjustment**

Turn the PEN LIFTER potentiometer R215 to its counterclockwise limit. Then slowly advance it again, while alternating the SIGNAL SELECTOR switch between 60 C.P.S. and 120 C.P.S. positions Advancing this potentiometer will shorten the tail on the recorder signal; this tail should be between one and two chart divisions in length. Adjust the potentiometer to get that result.

NOTE

Occasionally a recorder may not provide proper pen lifter operation with the normal sensitivity setting. Increase, or decrease the sensitivity as needed for satisfactory pen lifter operation.

3-36. **Recorder Test Adjustment**

Depress REC TEST switch S204. The pen should record at 95 recorder divisions. If it does not, adjust REC TEST ADJ potentiometer R211 while holding the REC TEST switch depressed, until the pen does record at 95. Let the recorder trace a 1/4-inch line to insure proper setting of the control.

3-37. Adjustment of Automatic Time-Print Switch

When Radiosonde Recorder AN/TMQ-5A, -513, or -5C are used with Rawin Set AN/GMD-1(*), the action of automatic time-print switch S504 (fig. 3- **14)** should cause the control recorder to produce a time print each time the radiosonde recorder penis moved up-scale through the range of 89-91 recorder divisions. If automatic time printing occurs when the recorder pen is at any other position, perform the following adjustment procedures: (The automatic time-print switch is not included in earlier models of the radiosonde recorder.)

a. Turn the recorder power switch to the OFF position.

b. Manually turn the balancing motor split-gear assembly to position the pointer at the 90-division chart line on the scale.

c. Loosen the locking screw securing the bracket on which the time print only microswitch (S504) is mounted.

d. Move the bracket to a position that just causes microswitch S504 to close. This can be determined by an audible click when the switch closes.

e. Tighten the adjustment screw and replace the frequency-time recorder in the cabinet.

f. Recheck the action of S504.

3-38. Linearity Calibration

The printed record of the radiosonde recorder should have a nearly linear relation to the input frequency. Any deviation from the linearity should be plotted as a linearity correction graph to be used for corrections of recorded meterological data.

a. Preliminary Procedures.

(1) Connect the special purpose cable (split cable to J101 on the radiosonde recorder. Connect the spade lugs of the cable to the matching color-coded terminals of Frequency Standard TS-65(*)/FMQ-1. Connect the recorder and the frequency standard to a source of ac power and place their POWER switches to ON. Allow a warmup time of 10 minutes.

(2) Adjust the sensitivity (para 3-34a).

(3) Rotate the SIGNAL SELECTOR switch to SC and adjust REC ZERO to cause the pen to record at the zero chart ordinate.

(4) Rotate the SIGNAL SELECTOR to SIG. Set the OUTPUT LEVEL control of the frequency standard to its approximate midpoint. Check to assure that the recorder will properly respond to all frequency outputs from the TS-65( )/FMQ-1. Readjust the OUTPUT LEVEL control as necessary to provide operation at all frequencies. Do not change *the setting of the OUTPUT LEVEL control during the following procedures.*

b. Linearity Calibration Test.

(1) Set the frequency standard CYCLES control to 190. Adjust the radiosonde recorder REF. ADJUST control as necessary to cause the recorder to print at 95 recorder divisions. Allow sufficient time for the recorder to print a trace approximately 3/8-inch in length. (Do not make any additional changes in the REF. ADJUST setting for the remainder of this test).

(2) Change the output of the frequency standard to 180 hertz (cycles). Again allow the recorder to produce a 3/8-inch trace.

(3) Using all frequencies (including zero) available from the frequency standard, repeat step (2) in descending order and then in ascending order.

(4) Place the frequency standard POWER switch to OFF. Place the recorder POWER switch to OFF or STANDBY as desired.

c. *Construction of Linearity Correction Graph.*

(1) Use the manual chart advance knob to advance the portion of the chart containing the recordings and tear off the chart approximately 8-inches after the last trace. Place this portion of the chart on a smooth, flat surface in preparation for determining the deviation from linearity and for plotting the correction graph.

(2) Using a straight edge and a sharp pencil, draw a straight line vertically connecting the two traces obtained for each frequency value. Use the center of the width of the traces as starting and terminating points.

(3) Draw a baseline horizontally across the chart through the midpoints of the lines constructed in (2) above.

(4) Determine the recorder division where the 190 hertz line crosses the baseline. The deviation from linearity is the difference between this value and 90. The deviation is plus if this value is greater than 90, and is minus if it is less than 90 (fig. 3-16).

(5) Repeat step (4) for all other recorded frequencies (90, 70, 60, 50, 40, 30, 20, 10, and 5 recorder division). The maximum allowable deviation is 0.3 chart divisions. Should the deviation exceed this tolerance, corrective maintenance should be performed and a new linearity calibration test is performed.

(6) Draw the linearity correction as illustrated in figure 3-17. Note that the corrections have opposite signs as compared to the deviations.

(7) Date and retain the correction for future reference.

d. *Corrective Maintenance.* If any deviation exceeds 0.3 divisions, one or more of the following items may be the cause.

(1) Loose pen or pen carriage (fig. 3-9).

(2) Loose drive cable (tension adjustment) (para 3-26).

(3) Incorrect split-gear bias(para 3-27).

(4) Worn slide-wire contactor (para 3-28c).

(5) Maladjusted electrical or mechanical adjustments.

(6) Excessive tension setting on balancing motor (fig. 4– 16). Tension is adjusted by the means of the large screw at the top of the motor. Excessive tension may cause the recorded to respond slowly. Too little tension will cause the recorder pen to overshoot the desired position.

(7) Incorrect tube types (para *3-24f).*

(8) Insufficient warmup time. Normally, 10 min utes is sufficient. Occasionally, a longer warm up time is required depending on the ambient tempera ture.

(9) Tube conductance not balanced. The conductance of V304, V305, V306, and V307 should be as equally matched as possible. Check tube on a tube tester and replace any tube indicating a large variation from the other tube conductance.

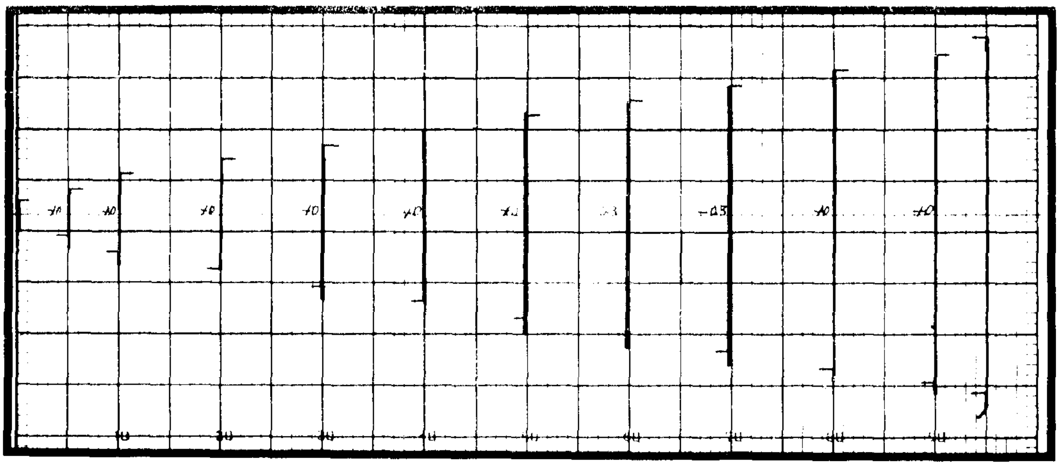


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Figure 3-16. Linearity *Calibration Test Chart,*

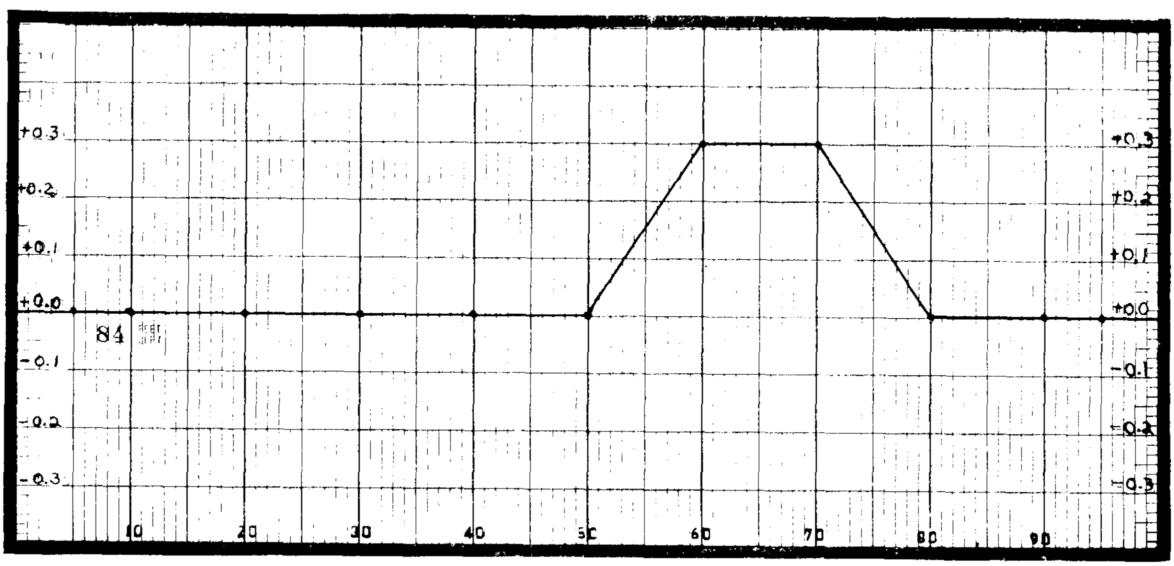


Figure 3-17. Linearity Correction Graph.

3-39. Connection Repair

Repair connections by resoldering the lead to the component. If a lead is shortened in the process of repairing a connection; insure that the lead is long enough so no tension exists. If not enough of the lead is left after shortening, remove the lead and replace with one of the same wire size, same insulation charactitistics, and of sufficient length.

3-40. Wiring Replacement

a. Loosen any clamps holding the wire(s) to be replaced.

b. Remove the clamps closest to the connectors in which the wire(s) terminate.

c. Remove the screws holding the connectors and remove the connectors from their mounting brackets. Remove the shells from the connectors.

CAUTION

To avoid equipment damage and erroneous data, be careful that small flakes of solder do not fall into the connector.

d. If the wire to be replace is connected to a terminal around the outside perimeter of the connector, unsolder the wire to be disconnected and solder the new wire in place.

e. If the wire to be replaced terminates near the center of the connector, it may be necessary to disconnect one or more wires in order to gain access to the wire to be replaced. Before unsoldering any wires, note their terminal numbers on a piece of tape and attach the tape to the wire about 5 inches back from the connector. Do this with each wire to be unsoldered, including the wire to be replaced. Unsolder the wires, replace the defective wire, and resolder all wires.

f. Repeat the previous step with the other connector.

g. Remove the tape, replace the connectors, and secure the clamps.

h. Use a multimeter to check continuity of the wire(s) replaced (see fig. FO-7 and FO-8). Also check for short circuits between all terminals of both connectors.

3-41. Systems Connecting Cables Replacement

To replace systems connections cables, refer to paragraph 2-8 (fig. 2-6) of TM 11-7770-204-10, paragraph 2-8 and figure 2-6 of this manual.

3-42. Circuit Breaker Installation

Install a circuit breaker on the control panel as follows:

a. Identify the top and bottom leads to the circuit breaker by noting their positions on masking tape attached to the wires.

b. Unsolder the top and bottom wires from the circuit breaker.

c. From the front side of the panel, remove the two circuit breaker mounting screws and remove the circuit breaker.

d. Install the circuit breaker in the panel and install and tighten the two mounting screws.

e. Solder the top and bottom wires to the circuit breaker terminals.

f. Remove the masking tape.

3-43. Indicator Meter Installation

Install the POWERLINE VOLTAGE or POWERLINE FREQUENCY indicator as follows:

a. Use masking tape to identify the position of each wire to be removed.

b. Unsolder the wires.

c. Remove the meter mounting screws from the front of the panel.

d. Remove the indicator, install the replacement indicator, and install the panel screws.

e. Solder the wires to the back of the indicator.

3-44. Knob Installation

The control panel knobs are held onto their shafts by means of a setscrew. Remove knobs by loosening the setscrew and pulling the knob from its shaft. Install knobs by pushing the knob on the shaft and tightening the setscrew. The signal selector knob should be installed so that at its extreme counterclockwise rotation, it points to SIG. The SPEAKER VOL. knob should be installed so that at the extreme counterclockwise position, it points to the 7 o'clock position.

3-45. Control Panel Light Assembly Replacement

Replace the control panel light assembly as follows:

a. Tag the leads with tape and unsolder the leads to the light.

b. Remove the mounting nut and lockwasher from the rear of the panel.

c. Install the new light assembly on the front of the control panel.

d. Install the mounting nut and lockwasher to the rear of the panel.

e. Solder the wires to the light assembly.

f. Remove the tape from the wires.

3-46. Loudspeaker Replacement

Replace the loudspeaker as follows:

a. Unsolder the wires to the loudspeaker.

b. Remove the four nuts, bolts, and lockwashers that retain the loudspeaker to the panel.

c. Install the new speaker to the panel by means of the four nuts, bolts, and lockwashers.

d. Solder the wires to the new speaker.

3-47. Toggle Switch Cable Assembly Replacement

Replace the signal data converter noise suppression switch (S301) cable assembly as follows (fig. FO-3 and FO-11):

a. Remove the nut holding the switch and remove the switch from its bracket to provide access to its terminals.

b. Mark the position of the yellow wire on the switch and remove all three leads to the switch.

c. Unsolder the yellow wire and two green wires from the terminal board.

d. Connect one end of the new yellow wire to the (previously marked yellow wire terminal) switch. Connect the other end of the yellow wire to the terminal to which resistor R303 and a yellow wire are connected.

e. Attach one end of one green wire to the center of the switch. Attach the other end of this green wire to the terminal to which resistor R307 and a green wire are connected.

f. Attach one end of the other green wire to the remaining terminal on the switch. Attach the other end of this green wire to the terminal to which capacitor C302 and a green wire are attached.

g. Use a Multimeter to check the continuity of the connections just made.

h. Carefully position the wires so that they do not contact any components.

i. Remount the switch (with the yellow wire up) and tighten the retaining nut.

3-48. **Replace Relay in Power Supply** (fig. 3-12 and FO-6)

To replace relay K401, snap back the retainer clip and remove the relay. Install the new relay in the socket after insuring that the key on the relay aligns with the key on the relay socket. Reinstall the retainer clip.

3-49. **Fan Motor and Blade Replacement** (fig. 3-5 and FO-9)

Replace the fan motor and blade assembly by first tagging, then electrically disconnecting the fan leads from terminal strip E 1, then removing the three nuts holding the motor to the bracket. The fan may be detached from the motor by loosening the setscrew and removing the blade. To install, slide the fan blade on the new motor shaft and tighten the setscrew. Mount the motor to the panel and install the three mounting nuts. Electrically connect the motor leads terminal block E 1. (Refer to fig. FO-9 for connection data.)

CHAPTER 4

DIRECT SUPPORT MAINTENANCE

Section I. GENERAL

4-1. Scope of Maintenance

a. This chapter contains instructions covering direct support maintenance for Radiosonde Recorder AN/TMQ-5(*). It includes instructions for replacement of specified direct support maintenance parts and intructions for troubleshooting and repair procedures to be accomplished by direct support mainte nance personnel. This section supplements those instructions in previous chapters of this manual where direct support maintenance is referenced. This section provides replacement procedures which must be perfomed at direct support category. Maintenance procedures for all categories of maintenance are listed in appendix B.

b. Direct support maintenance of Radiosonde Recorder AN/TMQ-5(*) includes—

(1) General troubleshooting (para 4-3 to 4-7).

(2) Operational testing (para 3-21).

(3) Troubleshooting (para 4-3 through 4-9).

(4) Adjustments and alinements (para 3-25 through 3-37,4-12 and 4-13).

(5) Replacement of authorized parts (para 4-10 and 4-11).

(6) Dynamic testing (chapter 5).

4-2. Tools, Test Equipment, and Materials Required

For tools, test equipment, and materials required for direct support maintenance of Radiosonde Recorder AN/TMQ-5(*), refer to TM 11-6660-204-25P and TM 11-6660-204-24P-1.

Section II. TROUBLESHOOTING

4-3. General

a. Procedure. The first step in servicing a defective equipment is to sectionalize the fault. Sectionalization means tracing the fault to the major component. The second step is to localize the fault. Localization means tracing the fault to the defective section of a particular component. The third step is isolating the fault to the defective part. Some faults such as meter indications or binding of mechanical components can be isolated by sight or hearing. The majority of faults must be isolated by detailed mechanical checks.

b. *Sectionalization Check.* When an operational test (Para 3-21) indicates a fault, the cause may be immediately self-evident. If not, proceed to the troubleshooting chart (para 4-9) in further localize the trouble.

c. General Precautions. Whenever the equipment is serviced, observe the following precautions very carefully:

(1) Be careful when panels are opened; dangerous voltages are exposed.

(2) Careless replacement of parts causes new faults. Note the following points:

(a) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads.

(b) Be careful not to damage other leads by pulling or pushing them out of the way.

(c) Do not allow drops of solder to fall into the equipment, since they may cause short circuits.

(d) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the faults most difficult to find.

(e) When a part is replaced, it must be placed exactly as the original was placed. Give particular attention to proper grounding when replacing a part. Use the same ground or circuit-ground wire as in the original wiring. Failure to observe these precautions may result in decreased gain or possibly in oscillation of the circuit.

d. Test Cables.

(1) All chassis and panels are of the plug-in type and may be removed from the cabinet for testing. Test cable W604 and power supply test cable W606 permit the operation of the components when they are removed from the cabinet. Test cables should be used only between those receptacles shown in figure 4-1. If test cables are connected in any other way, equipment may become damaged.

(2) Power supply test cable W606 is connected between P401 mounted on the power supply chassis (fig. 3-14) and jack J105 located at the rear of the recorder. The power supply test cable is used for this connection only as indicated in figure 4-1. Test cable W604 is connected between the components as indicated by figure 4-1. Five of these cables are needed to maintain the components in operation when all are removed from the cabinet at the same time.

4-4. Voltage Measurements

Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from, or produce, abnormal voltages. Voltage measurements can be measured between two points in a circuit, without circuit interruption. Complete information on normal operating voltages is given in figures FO-13 and FO-14.

a. Unless otherwise specified, voltages are measured between the indicated point and ground.

b. Always begin the measurements by setting the voltmeter on the highest range so that the voltmeter will not be overloaded. Then, if necessary, set the voltmeter on a lower range.

c. When checking cathode voltage, remember that a reading can be obtained when the cathode resistor is actually open; the resistance of the meter may act as a cathode resistor. Thus the cathode voltage may be approximately normal only as long as the voltmeter is connected between the cathode and ground. An abnormally high plate voltage may indicate an open cathode resistor.

4-5. Resistance Measurements

After a trouble has been localized to a specific stage or circuit, resistance measurements will often isolate the specific defective component. Normal resistances are specified in figures FO-13 and FO-14. Resistance of coils, transformers and motors are given below. Insure that one side of the component under measurement is disconnected from the circuit to eliminate error due to shunt resistances.

4-6. Waveforms

Checking waveforms is another method of localizing troubles. Waveforms may be observed on an oscilloscope at the various test points shown along with actual reference waveforms on figure FO-15.

Transformer motor or coil	Terminals	Ohm ±5%
T401	1-2	.82
	3-4	31
	4-5	5
	5-6	5
	6-7	33
	8-9	18
	9-10	19
	11-12	.07
	13-14	.07
	15-17	.02
	18-20	.15
	21-23	.15
L401	1-2	168
L402	1-2	149
K401	1-8	7,320
G301	1-2 top of can	482
T301	Pri	660
	Sec	.92
T302	1-2	258
	2-3	258
	4-5	7,340
B501	Grn-yel	652
	Blk-wht	391
B502	Red-gray	600
	Gray-blk	738
L501	1-2 of E502	368
B1	Yel/wht-blu/wht	830
	Red/wht-red/yel	830

a. All waveforms are obtained by connecting the oscilloscope between the test point specified on figure FO-15 and the chassis.

b. Set the oscilloscope horizontal sweep selector to display the horizontal frequency shown on the waveform of figure FO-15. Set the vertical amplifier control so that the vertical component of the waveform falls within the value specified.

c. In some cases it maybe necessary to unbalance the detector to create a signal in the servo amplifier. To unbalance the detector, place the SIGNAL SELECTOR switch in the 60 CPS position and adjust the REF. ADJUST control until the pen indicates 30 chart divisions. Operate the power switch (S201) to the POWER OFF position. Disconnect the black and white wires of balancing motor B501 from terminals 3 and 4 of terminal board E501. Operate the power switch (S201) to the POWER ON position. Manually rotate the slide and trolley wire arm until the pen travels a distance corresponding to the percentage of unbalance desired. (The number of chart divisions that the pen travels from 30 chart divisions is equal to the percentage of unbalance in the detector.) Therefore, to obtain a 2-percent unbalance, rotate the slide and trolley wire arm so that the pen will

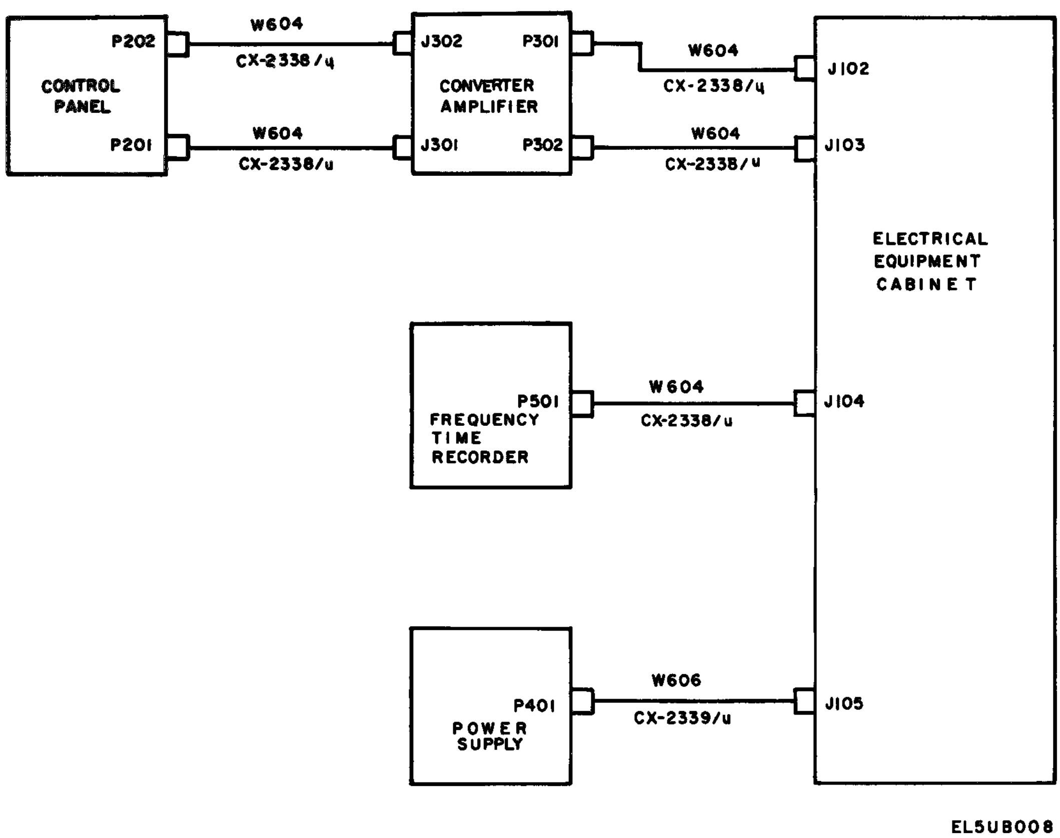


Figure 4-1. Radiosonde Recorder AN/TMQ-5(*), Cable Connections.

When the test, is completed, throw power switch (S201) to the POWER OFF position and replace the motor wires; be sure that the black wire is replaced on terminal 3 and that the white wire is replaced on terminal 4 of terminal board E501 (fig. FO-4).

4-7. Illustrations

As an aid to troubleshooting, illustrations of various assemblies are listed as follows:

a. Converter Amplifier.

Fig. No.	Description
4-2	Signal Data Converter CV 146(*)/TMQ-5, top view.
4-3	Signal Data Converter CV-146(*)TMQ-5, socket shield removed, bottom view,
3-15	Signal Data Converter CV – 146(*)/TMQ- 5, bottom view.
4-4	Signal Data Converter CV- 146(*)/TMQ- 5, terminal boards.
FO-15	Signal Data Converter CV-146(*)/TMQ-5,typical wave forms,
FO-13	Signal Data Converter CV- 146(*)/TMQ-5, voltage and resistance diagram.
FO-11	Signal Data Converter CV 146(*)/TMQ -5, wiring diagram.
FO-3	Signal Data Converter CV 146(*)/TMQ-5, schematic diagram

b. Control Panel.

Fig.No.	*Description*
4-5	Control Panel C–834(*)/TMQ–5, front view.
3-4	Control Panel C–834(*)/TMQ–5, rear view.
4-6	Control Panel C–834(*)/TMQ–5, rear view.
FO-10	Control Panel C–834(*)/TMQ–5, wiring diagram.
FO-2	Control Panel C–834(*)/TMQ–5, schematic diagram.

c. Frequency-Time Recorder.

Fig.No.	*Description*
3-6	Frequency-Time Recorder RD–88/TMQ–5, top view.
4-7	Frequency-Time Recorder RD–88A/TMQ–5, top view.
4-8	Frequency-Time Recorder RD–88B/TMQ–5, top view.
4-9	Frequency-Time Recorder RD–88C/TMQ–5, top view.
4-10	Frequency-Time Recorder RD-88/TMQ-5, bottom view, showing main chart drive items.
3-10	Frequency-Time Recorder RD-88A/TMQ-5, bottom view, showing main chart drive items.
2-19	Frequency-Time Recorder RD-88/TMQ-5, bottom view, showing chart drive details.
3-2	Frequency-Time Recorder RD-88A/TMQ-5, bottom view, showing chart drive details.
3-3	Frequency-Time Recorder RD-88C/TMQ-5, bottom view showing chart drive details.
2-20	Frequency-Time Recorder RD-88/TMQ-5, front view.
3-11	Frequency-Time Recorder RD-88A/TMQ-5, front view of operating controls and panels.
FO-4	Frequency-Time Recorder RD-88/TMQ-5, schematic diagram.
FO-5	Frequency-Time Recorder RD-88A, B, C/TMQ-5, schematic diagram.

d. Power Supply.

Fig. No.	*Description*
3-12	Power Supply PP-968/TMQ-5, top view.
3-13	Power Supply PP-968/TMQ-5, bottom view.
4-11	Power Supply PP-968/TMQ-5, terminal boards.
FO-14	Power Supply PP-968/TMQ-5, voltage and resistance diagram.
FO-12	Power Supply PP-968/TMQ-5, wiring diagram.
FO-6	Power Supply PP-968/TMQ-5, schematic diagram.

e. Fan Panel.

Fig. No.	*Description*
4-12	Electrical Equipment Cabinet Subassembly MX-1482/TMQ-5, front view,
3-5	Electrical Equipment Cabinet Subassembly MX-1482/TMQ-5, rear view.
4-12-1	Electrical Equipment Cabinet Subassembly MX-1482/TMQ-5, schematic diagram.
4-13	Electrical Equipment Cabinet CY-1390(*)/TMQ-5, front view.
4-14	Electrical Equipment Cabinet CY-1390(*)/TMQ-5, rear view.
FO-7	Electrical Equipment Cabinet CY-1390/TMQ-5, schematic diagram.
FO-8	Electrical Equipment Cabinet CY-1390A/TMQ-5, schematic diagram.

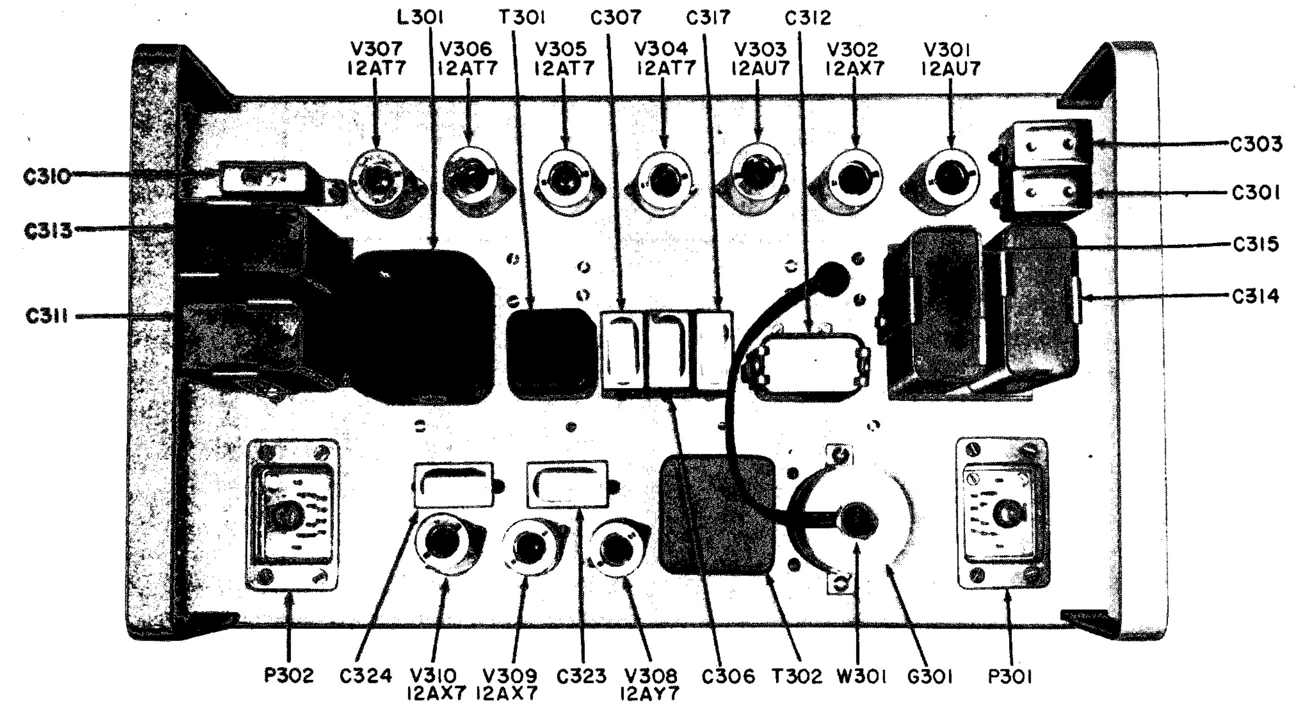


*Figure 4-2. Signal Data Converter CV-146 (*) /TMQ-5, top view.*

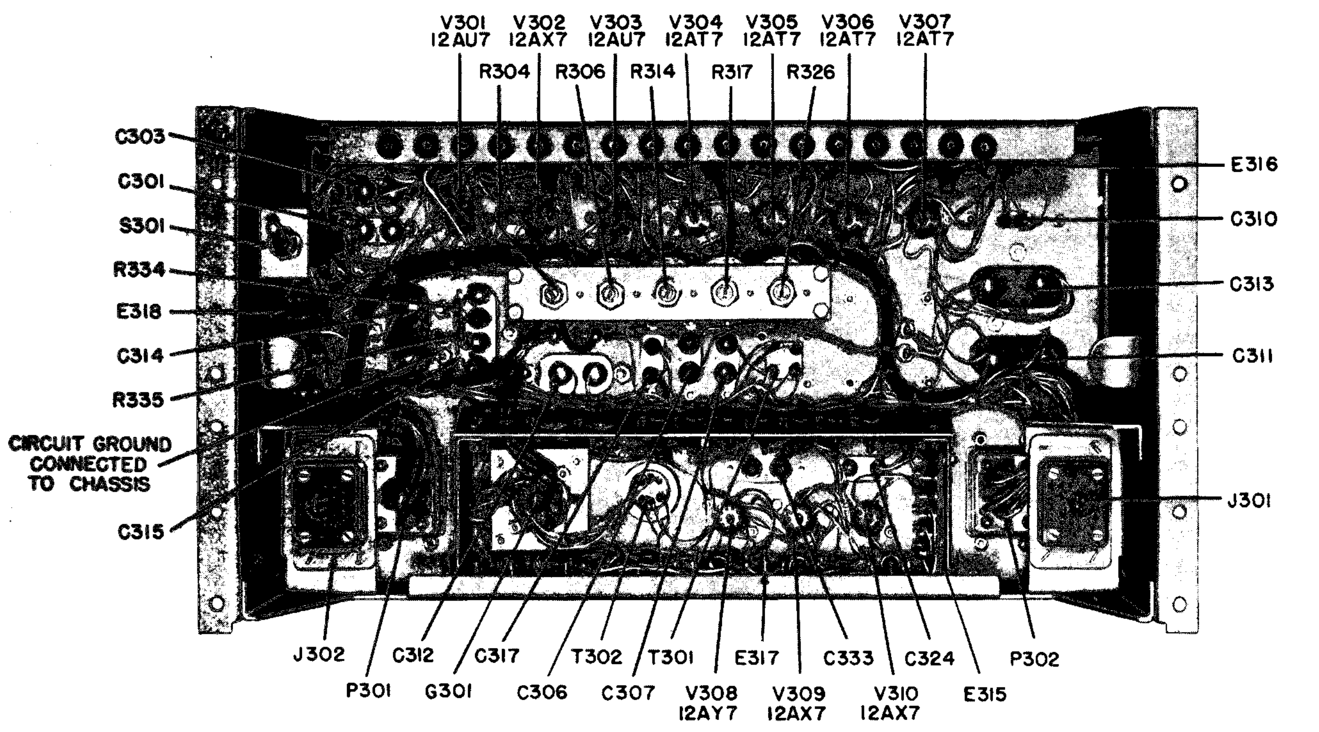
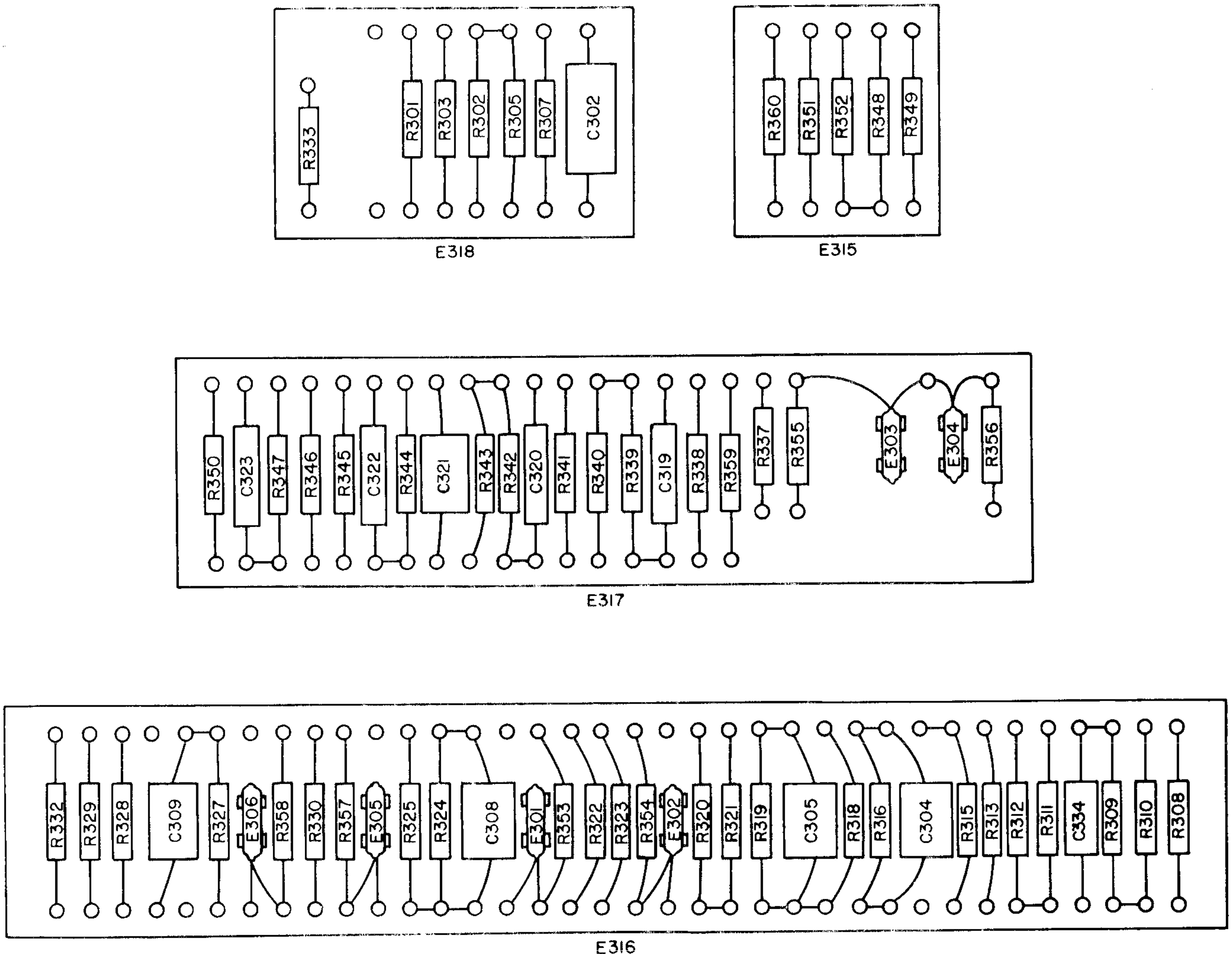
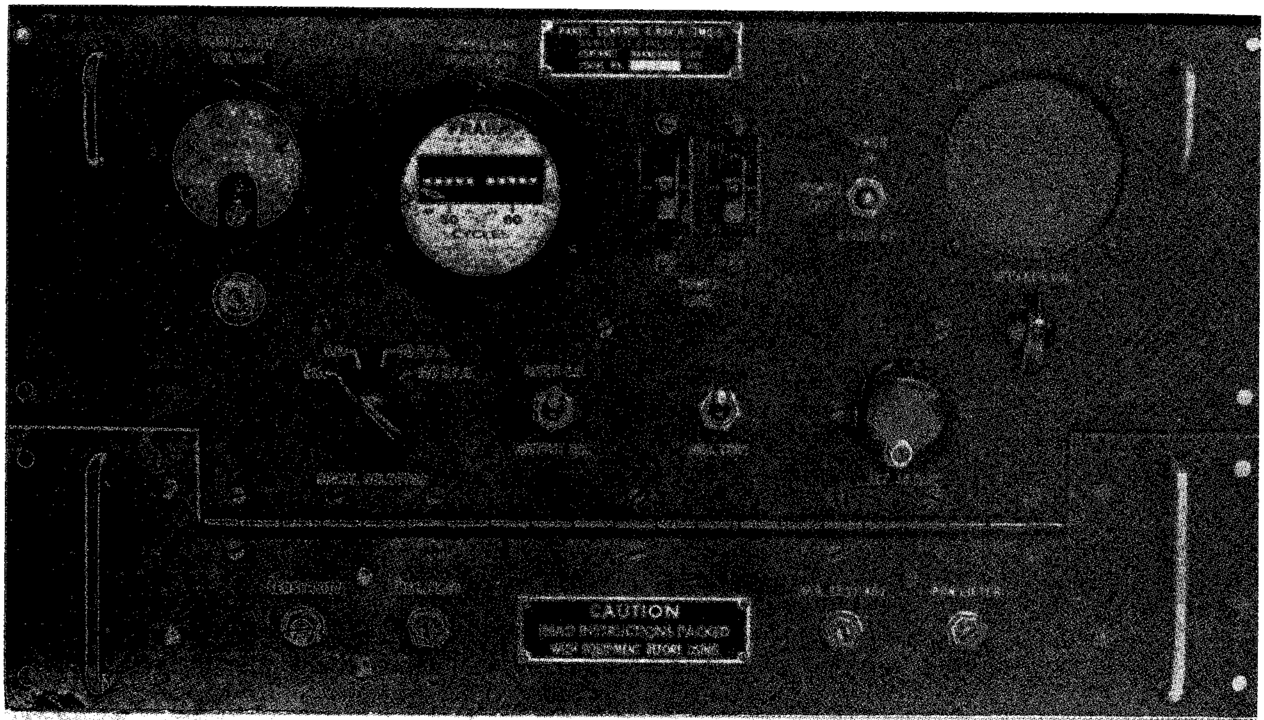


*Figure 4-3. Signal Data Converter CV-146 (*) / TMQ-5, socket shield removed, bottom view.*



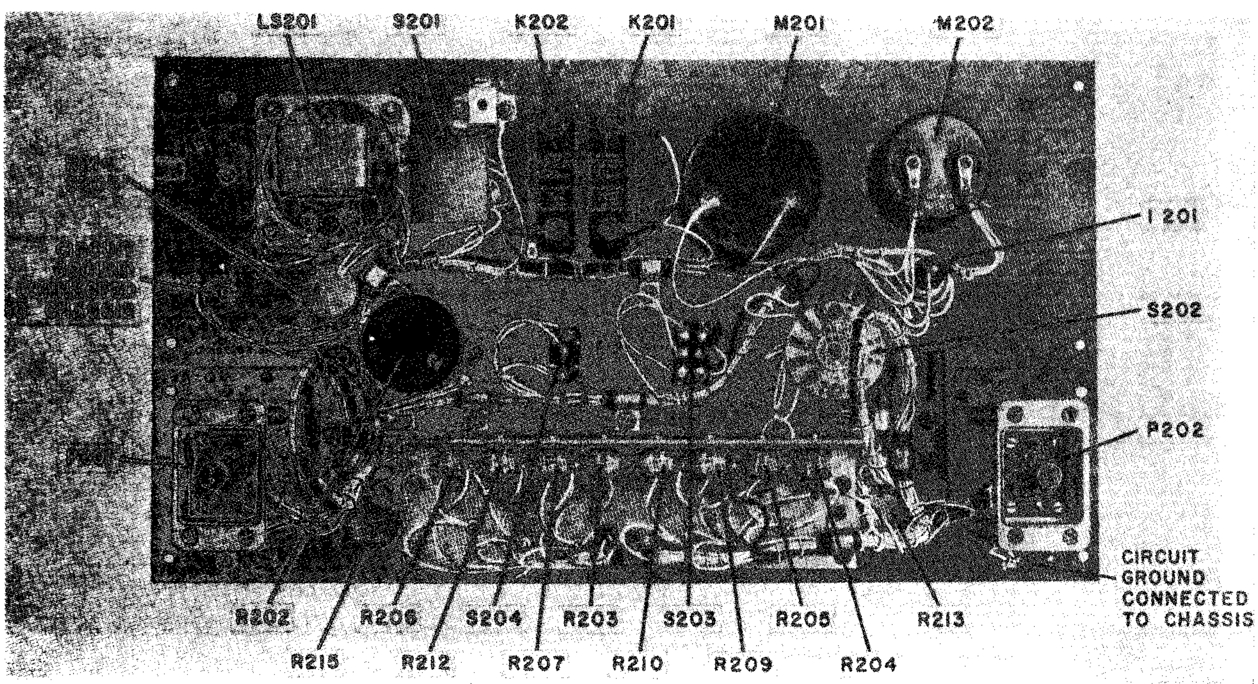
TM 6660-204-25-41

Figure 4-4. *Signal Data Converter CV–146(*)/TMQ-5, terminal boards.*



EL 6660-204-25-TM-42

Figure 4-5. Control Panel C-834(*)/TMQ-5, Front View.



EL 6660-204-25-TM-43

Figure 4-6. Control Panel C-834A/TMQ-5, Rear View.

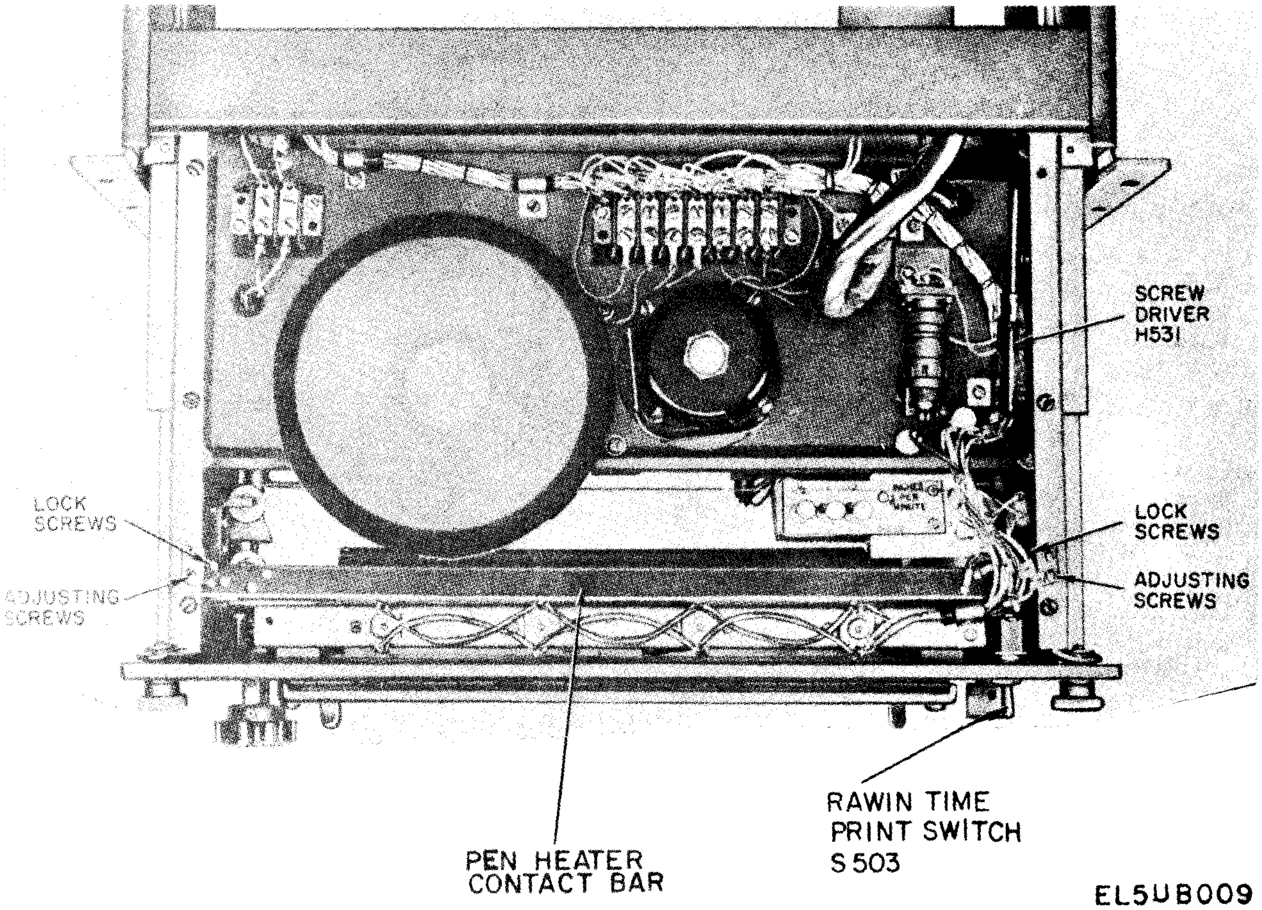


Figure 4-7. Frequency -Time Recorder RD-88A/TMQ-5, Top View.

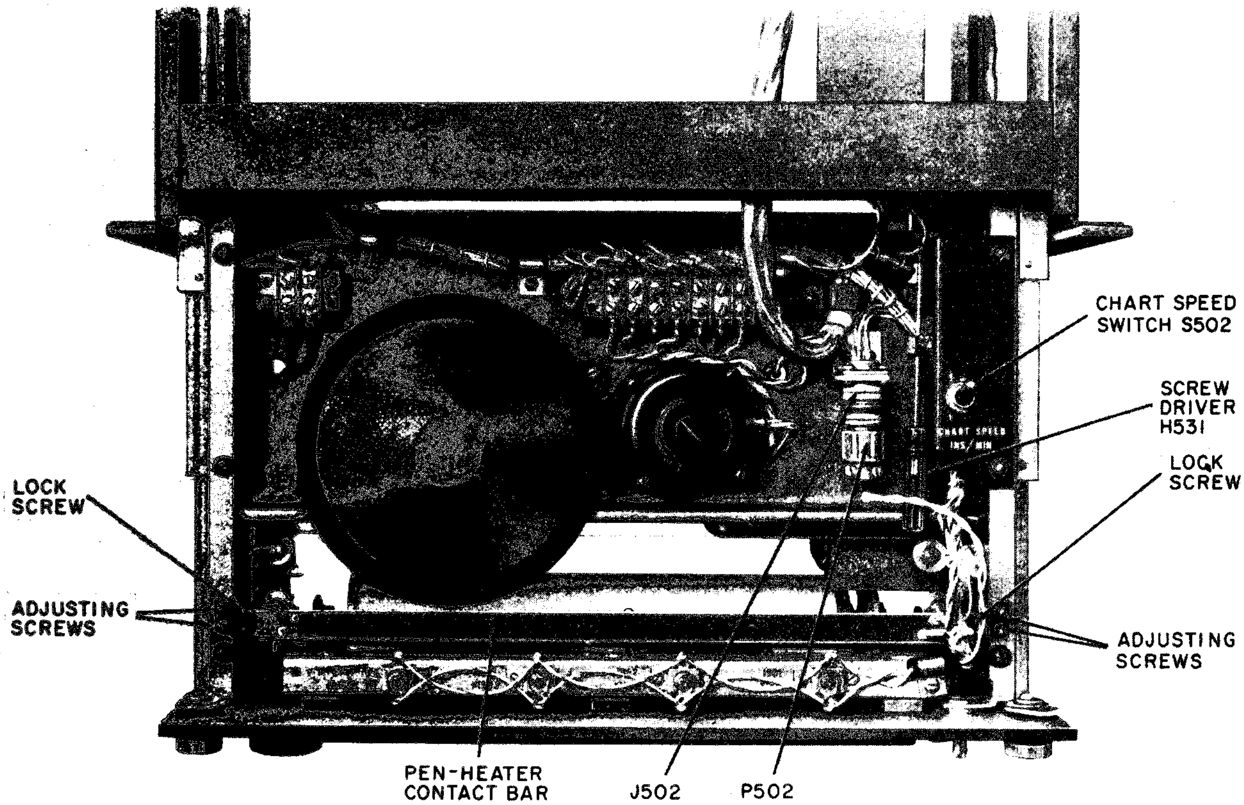


Figure 4-8. Frequency-Time Recorder RD-88B/TMQ-5, only, top view.

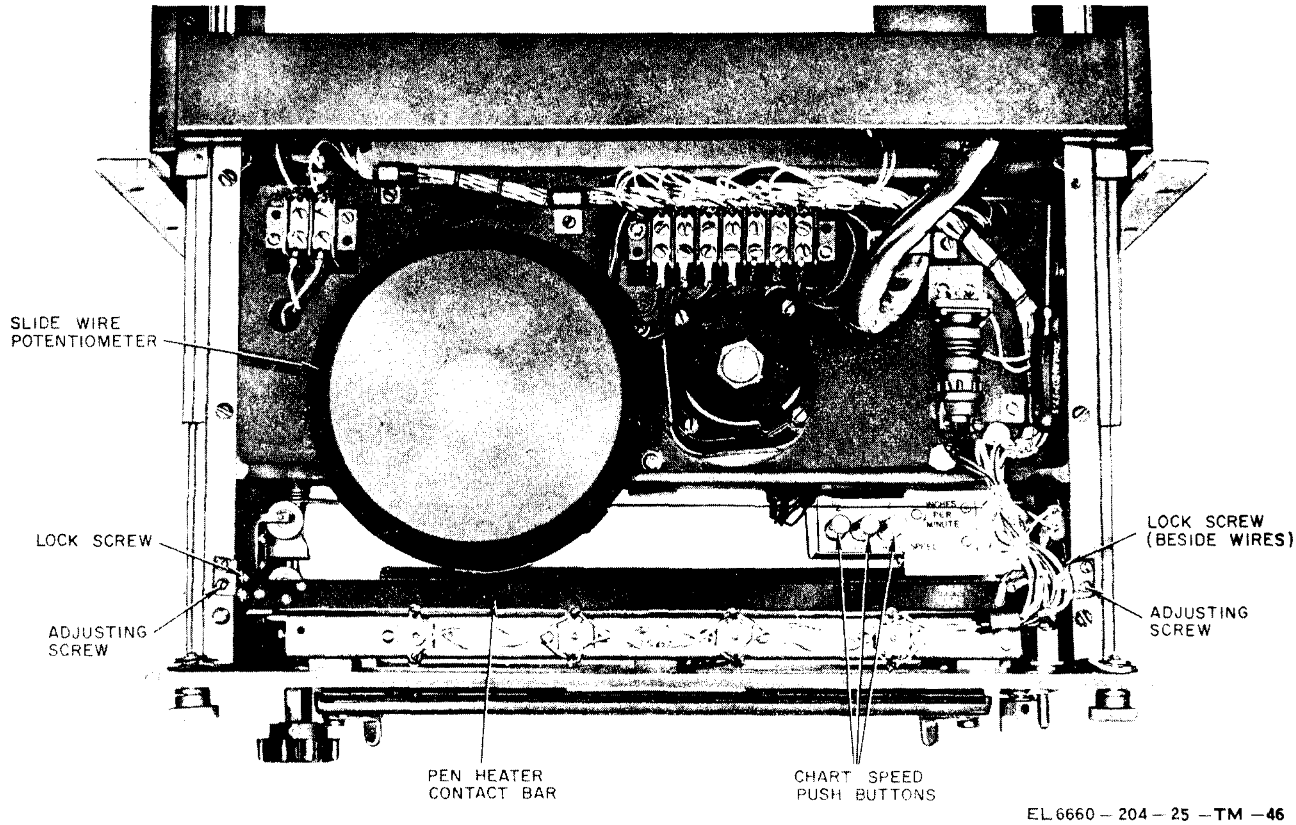


Figure 4-9. Frequency-Time Recorder RD-88C/TMQ-5, top view.

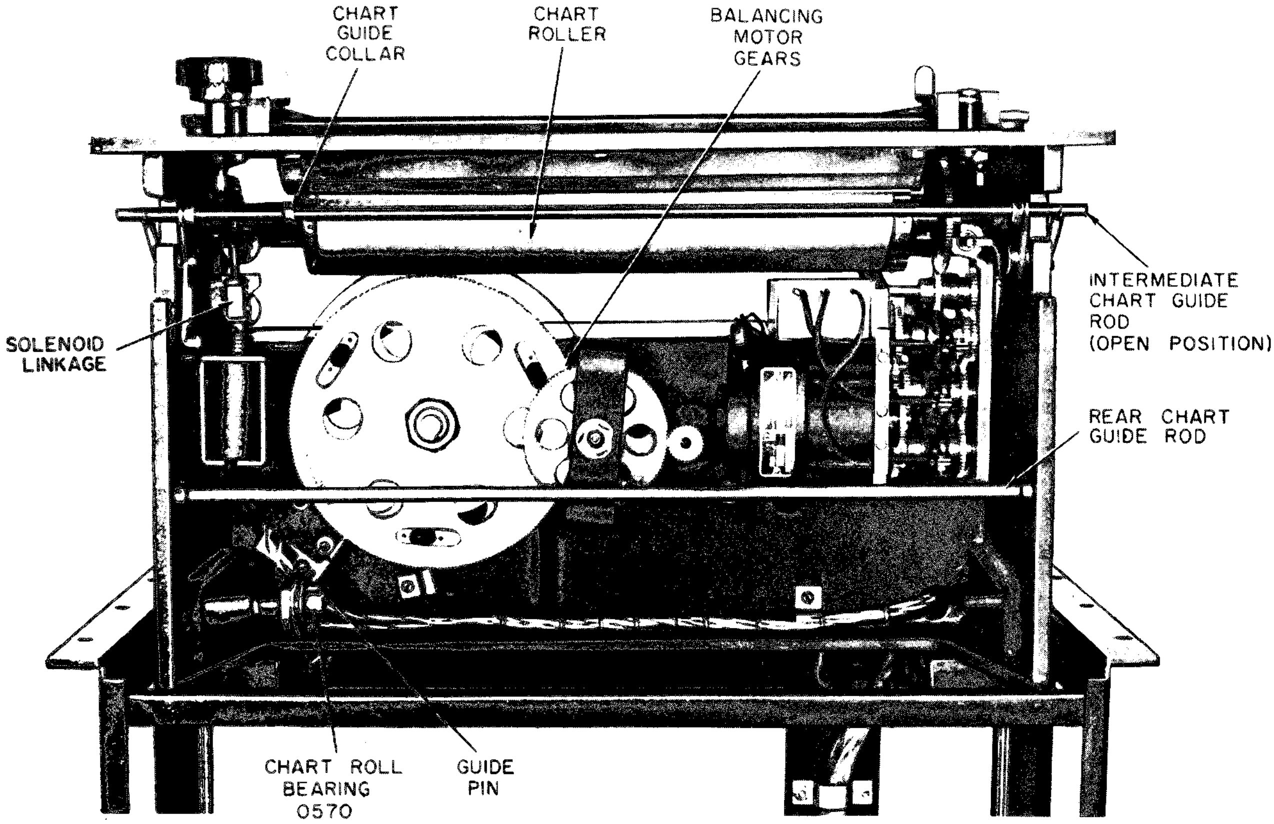


Figure 4-10. Frequency-Time Recorder RD-88/TMQ-5, bottom view, showing main chart drive items.

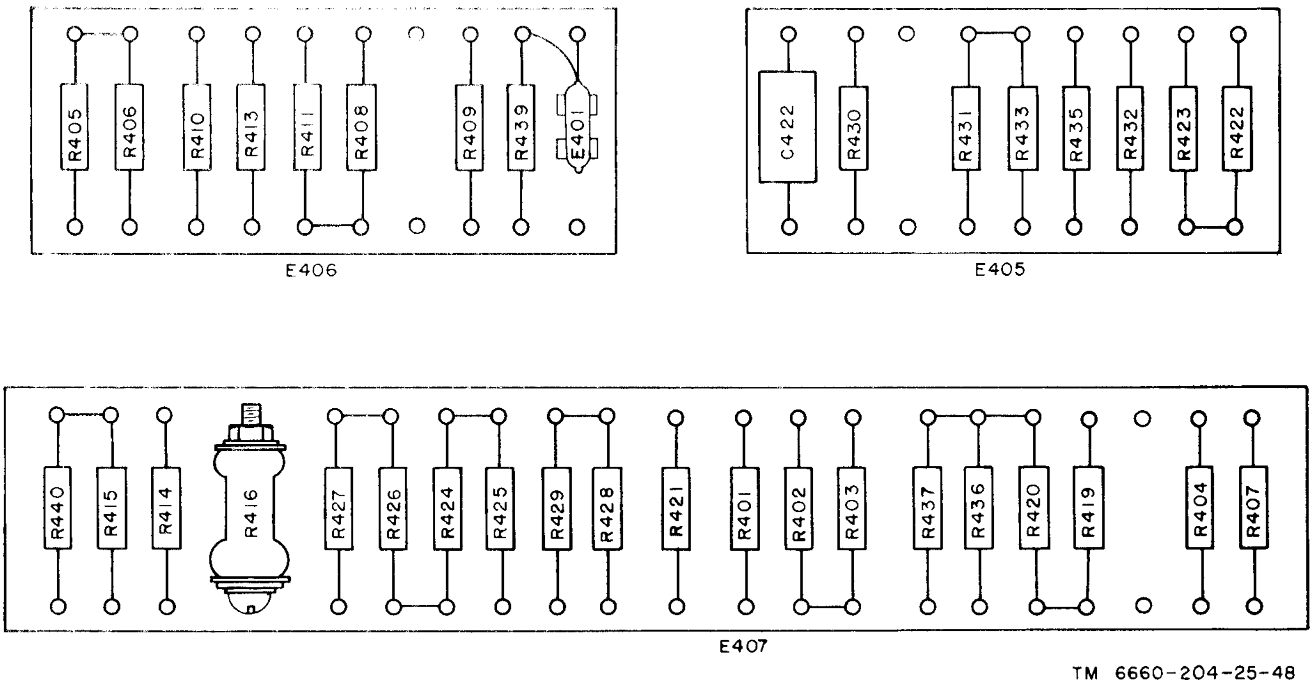


Figure 4-11. Power Supply PP-968/TMQ-5, terminal boards.

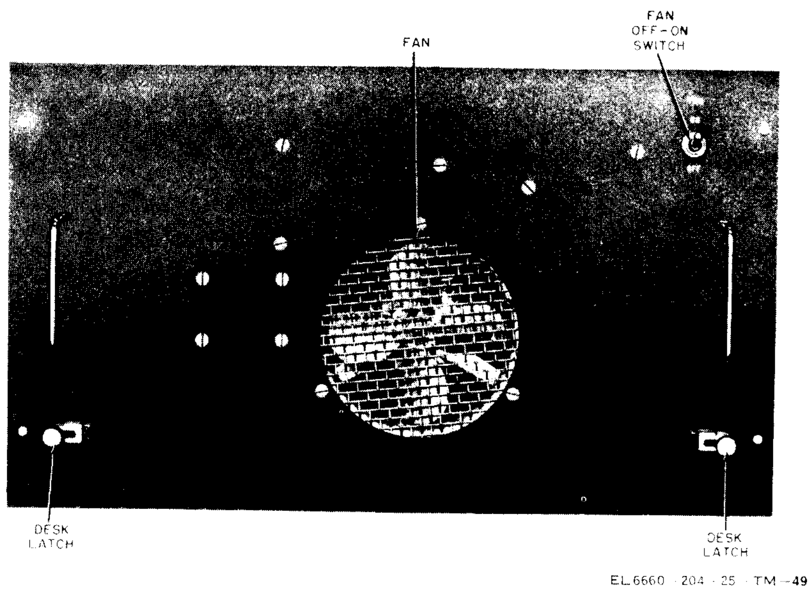


Figure 4-12. Electrical Equipment Cabinet Subassembly MX-1482/TMQ–5, front view.

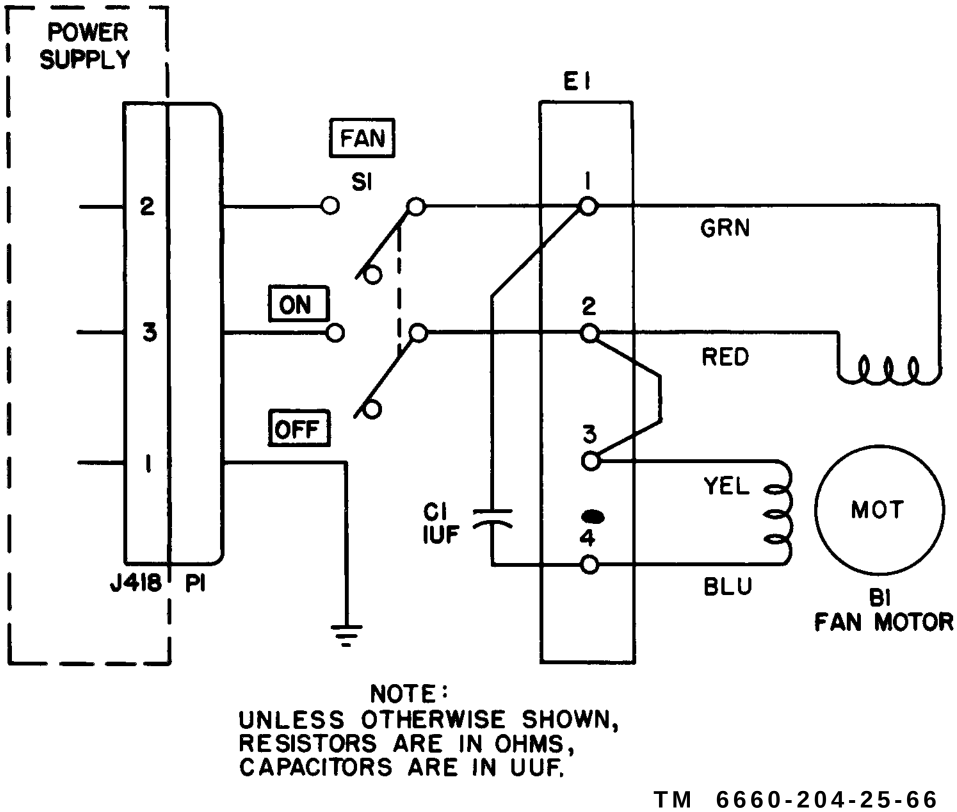


Figure 4-12-1. Electrical equipment cabinet subassembly MX-1482/TMQ-5, sckematic diagram.

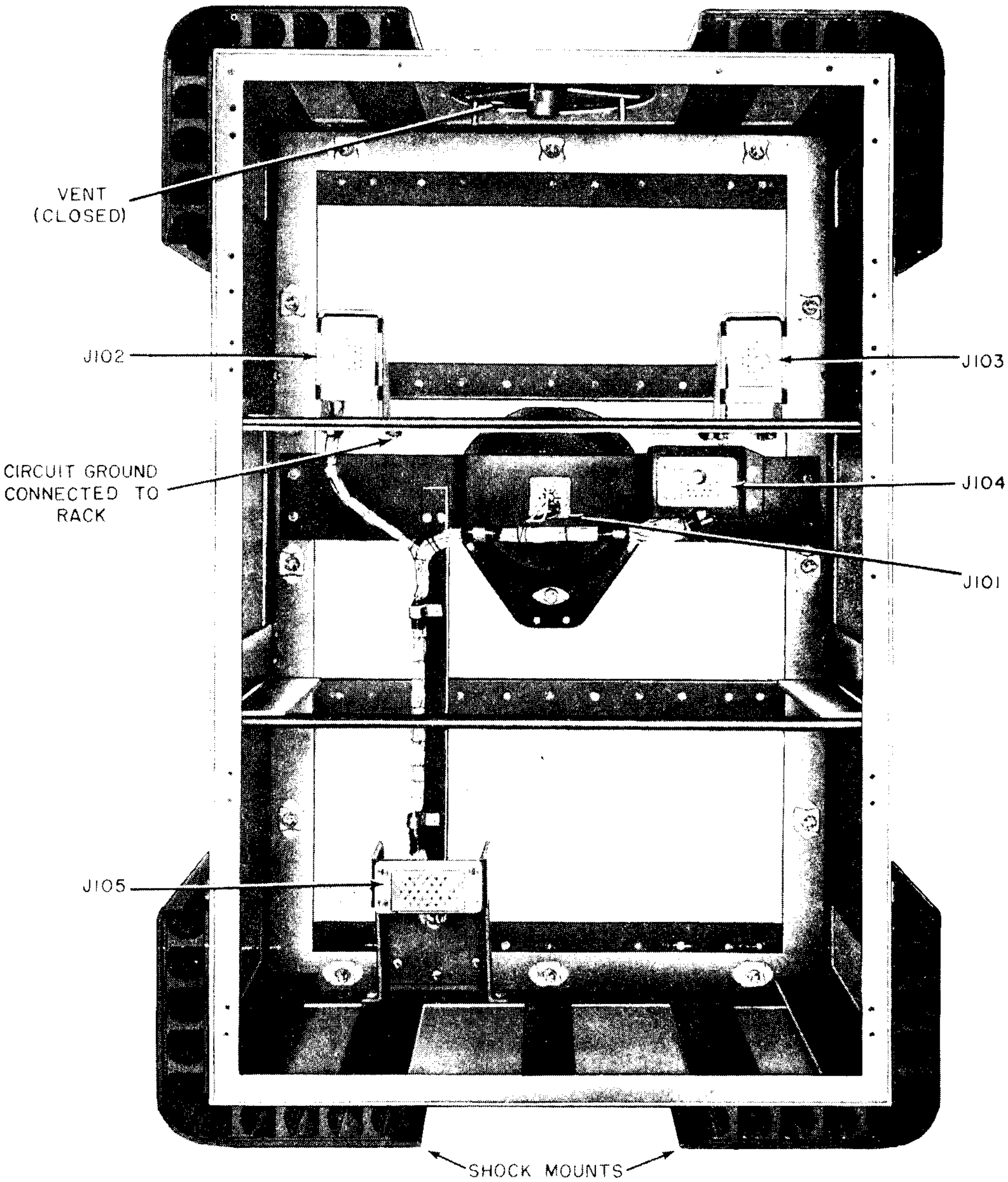


Figure 4-13. Electrical Equipment Cabinet CY–1390(*)/TMQ-5,front view.

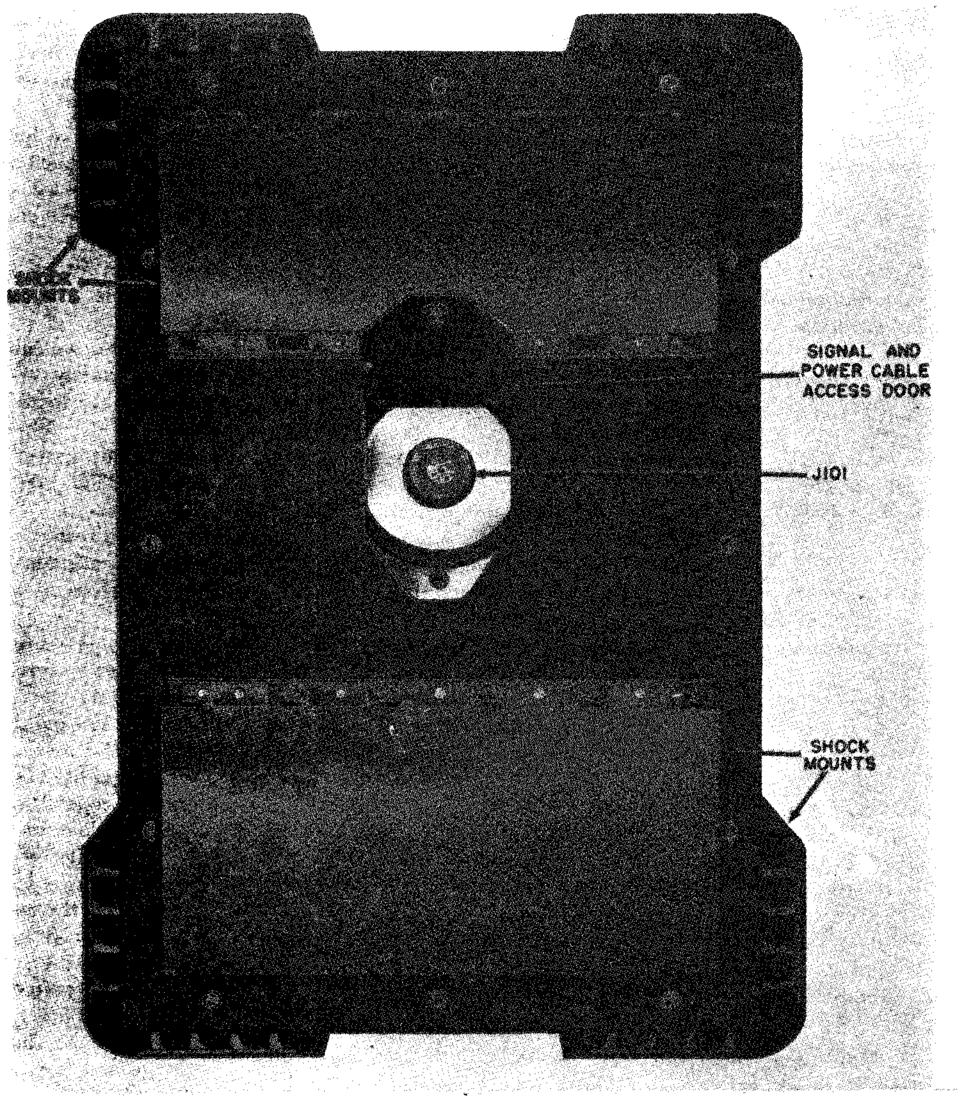


Figure 4-14. Electrical Equipment Cabinet CY-1390(*)TMQ-5, Rear View.

4-8. Operational Tests

Operational tests including the most likely area of a trouble are shown in paragraphs 3-21 through 3-23.

4-9. Troubleshooting Chart

	Symptom	Probable trouble	Correction
1	Powerline voltage and powerline frequency meters not indicating correctly.	Circuit brakers K201 and K202.	Check circuit breakers K201 and K202. Troubleshoot ac power distribution circuits. Check cabling.
2	Voltages measured between pins 4 and 6 of tube V401 and chassis read zero or subnormal.	Open fuse F401 or F402	Replace defective fuse. If it blows again, check filter capacitors C401 and C402 (figs. FO-6 and FO-14).
		Fault socket connection or open jumper in tube V404.	Replace tube V404 or clean contacts.
		Defective transformer T401	Replace transformer T401.
3	Voltage measurement reading between J403 and chassis is abnormal.	Check tube V401 and capacitors C401 and C402.	Replace defective parts (figs. FO-6 and FO-14).
4	Voltage measurement reading between jack J404 and chassis is abnormal.	Defective tube V402, V403 or V404	Replace defective tube. If voltage is close, but not exactly 300 volts, adjust potentiometer R412 (para 3-29) and figs. FO-6 and FO-14).
5	Pen does not move when REC. TEST S204 or INTER S.C.-OUTPUT S. C. S203 switches are depressed.	Defect exists in servo system	Troubleshoot servo system (figs. FO-4, FO-5 and FO-14).
		Broken drive cable	Replace cable.
		Defective or loose gears	Tighten setscrews; if necessary, replace gear.
		Defective line winding of balancing motor.	Replace balancing motor B501 (para 4-11).
6	60-cycle error signal does not appear at jack J320 when REC. TEST and INTER switches are alternately depressed.	No voltage from measuring circuit	Check resistors of measuring circuit (fig. FO-5).
		Defective vibrator inverter circuit	Check voltage readings across vibrator inverter coil. If correct, replace vibrator inverter G301.
		Defective first or second servo voltage amplifier stage.	Test tube V308 and then, if necessary, make voltage and resistance measurements of both stages fig. FO-13).
7	60-cycle error signal does not appear at jack J407 when REC. TEST and INTER S.C.-OUTPUT S. C. switches are alternately depressed.	Defect exists between third voltage amplifier and grid circuit of power amplifier of servo system.	Use oscilloscope to determine the presence of the 60-cycle error signal across grid and plate circuits of successive voltage-amplifier stages to localize the defective stage. Since the 60-cycle error signal appears only when the pen is supposed to be moving, INTER S. C.-OUTPUT S. C. and REC. TEST switches must be alternately depressed for every test. Test tube in defective stage and then, if necessary, make voltage and resistance measurements of the defective stage (figs. FO-13 and FO-15).
8	60-cycle error signal does not appear at jack J408 when REC. TEST and INTER S.C.-OUTPUT S.C. switches are alternately depressed.	Defective power amplifier stage	Check tubes V405 and V406. Make voltage and resistance measurements (fig. FO-14).
		Open controlled winding of balancing motor.	Replacement balancing motor B501 (para 4-11).
9	Pen will not rise from chart as it travels from one position to another.	Defective pen-lifter circuit	Troubleshoot pen-lifter circuit (fig. 2-21).
		Binding of mechanical linkage	Repair or replace defective part.
		PEN LIFTER control set too low	Adjust PEN LIFTER control R215 (para 3-35).
10	The pen rises from the chart when a jumper is placed between jack J409 and ground.	Insufficient signal from power amplifiers.	Adjust PEN LIFTER control potentiometer R215 (para 3-35 and fig. 4-15).
		Defective tube V407	Replace tube V407.
		Defective capacitor C410, C411, or C413.	Replace defective capacitor (fig. FO-6).
11	The pen does not rise when performing procedure given in step 10 above.	Pen-lifter solenoid is energized	Check relay K401 for open coil or shorted contacts. Check capacitor C412 for a short.
		Defective tube V407	Replace tube V407 (fig. FO-6).
12	Pen will not make contact with chart.	Intermediate chart guide rod in open position.	Return the bar to its closed or forward position.
		PEN LIFTER potentiometer set too high.	Adjust PEN LIFTER R215 (para 3-35).
		Contact of relay K401 not making	Replace relay.
		Defect in regulated negative power supply.	Troubleshoot regulated negative power supply (fig. FO-6).

	Symptom	Probable trouble	Correction
13	Voltage measurements between pins 4 and 6, of tube V408 and chassis are abnormal.	Open fuse F403 or F404	Replace defective fuse. If it blows again, check filter capacitors C415 and C416.
		Faulty socket connection or open jumper in tube V411.	Replace tube V411 or clean contacts. (fig. FO-6).
14	Measured voltage reading between jack J412 and jack J413 is less than 260 volts. The positive meter lead is placed in jack 412.	Check tube V408 and capacitors C415 and C416.	Replace defective part.
15	Measured voltage reading between jack J413 and chassis is not a negative 175 volts.	Defective tube V409, V410, or V411	Replace defective tube. If voltage is near a negative 175 volts, adjust potentiometer R434 (para 3-29 and fig. 5-5).
16	No speaker output, and the pen does not move when SIGNAL SELECTOR switch S202 is rotated to 60 CPS and then to 120 CPS.	Defective stage between tubes V301 and V304.	Using an oscilloscope compare the waveforms obtained from jacks J303 through J313 with those of fig. FO-15. Check the tube of the defective stage and then, if necessary, make voltage and resistance measurements (fig. FO-13) to determine the defect part.
17	Correct speaker output is obtained, but the pen does not move when SIGNAL SELECTOR switch S202 is rotated to the 60 CPS position and then to the 120 CPS position.	Defective stage between tubes V305 and V307.	Using an oscilloscope, compare the waveforms obtained from jacks J313 through J318 with those of figure FO-15. Check the tube of the defective stage and then, if necessary, make voltage and resistance measurements (fig. FO-13) to determine the defective part.
18	Pen jitters or oscillates	Input filter faulty (includes R333 through R336 and C315).	Replace defective part or parts (fig. FO-3).
		SENSITIVITY control set too high	Adjust SENSITIVITY control (fig. 4-15)
		Split gear bias not set properly	Adjust split gear bias as described in paragraph 3-27.
19	Poor linearity	Faulty tube V305, 306, or V307	Replace faulty tubes. R326 (para 4-32).
		R326 improperly adjusted	Adjust potentiometer.
		Worn or defective slide-wire assembly	Replace contacts or defective part of slide-wire assembly.

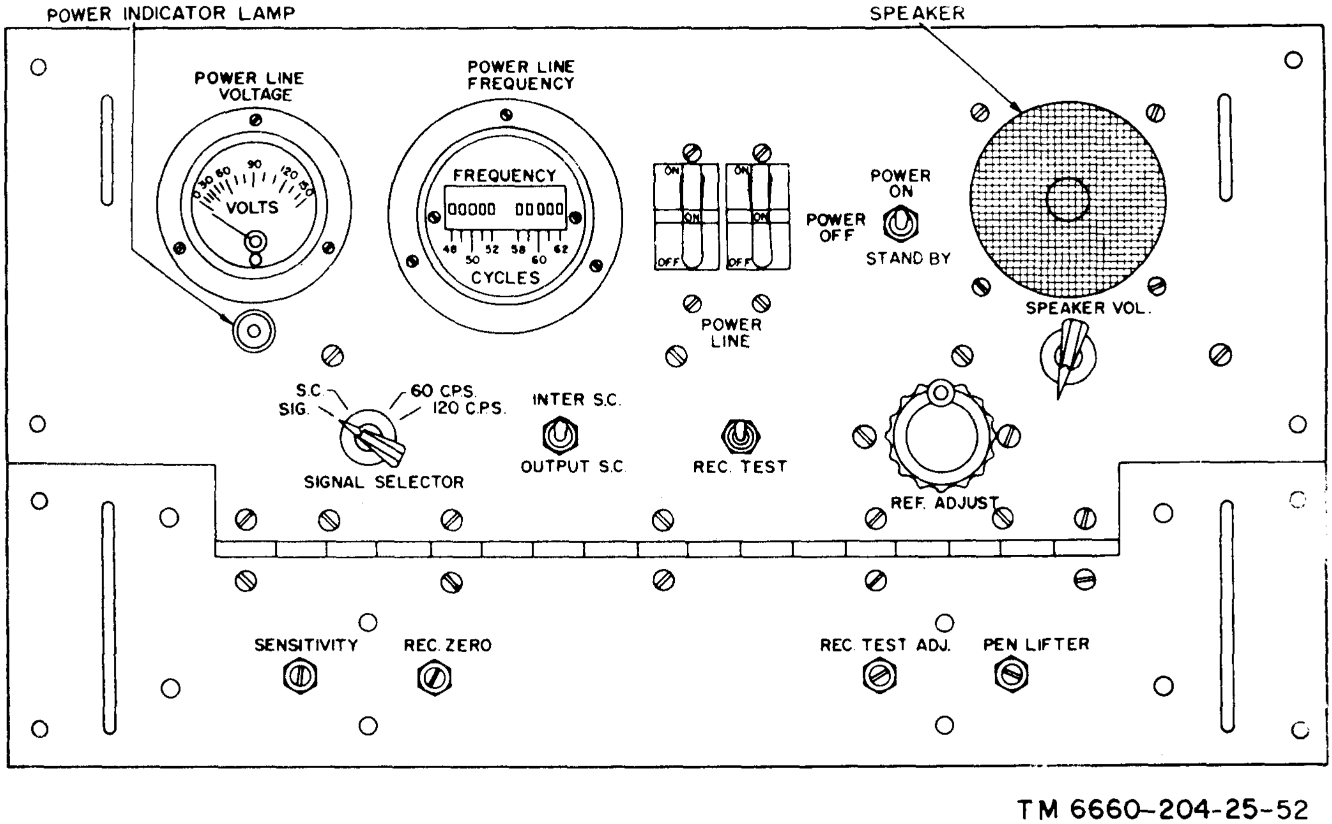


Figure 4-15. Control Panel C-834/TMQ-5, Front View.

Section III. ADJUSTMENTS, ALIGNMENT, REPAIR, REMOVAL, AND REPLACEMENT

4-10. Removal and Replacement of Chart Drive Motor

a. Removal.

(1) Remove the frequency-time recorder chassis from the cabinet.

(2) Remove the chart drive motor connecting leads from the terminal board (fig. 4-16).

(3) Secure the chart drive mechanism gears with masking tape to prevent the gears from separating (fig. 4-17).

(4) Remove the three nuts and washers (fig. 4-17) that hold the chart drive motor to the mounting plate.

NOTE

Remove only the three accessible nuts. Do not attempt to remove the inaccessible nut as it is the only thing holding the motor together when the other nuts are removed.

(5) Remove the chart drive motor studs.

(6) Loosen the two Allenhead setscrews (fig. 4-17) from the chart drive motor pinion gear and pull the pinion gear free of the motor shaft.

(7) Remove the chart drive motor from the frequency-time recorder chassis.

b. Replacement. Install a new chart drive motor as follows:

(1) Install the chart drive motor in its brackets in the frequency-time recorder chassis. Be sure that the pinion gear meshes properly with the other chart drive mechanism gears.

(2) Install the motor studs. Secure the motor with the three nuts and lockwashers.

(3) Tighten the two Allenhead setscrews on the pinion gear.

(4) Remove the masking tape. Remove any residue from the masking tape from around the gear assembly.

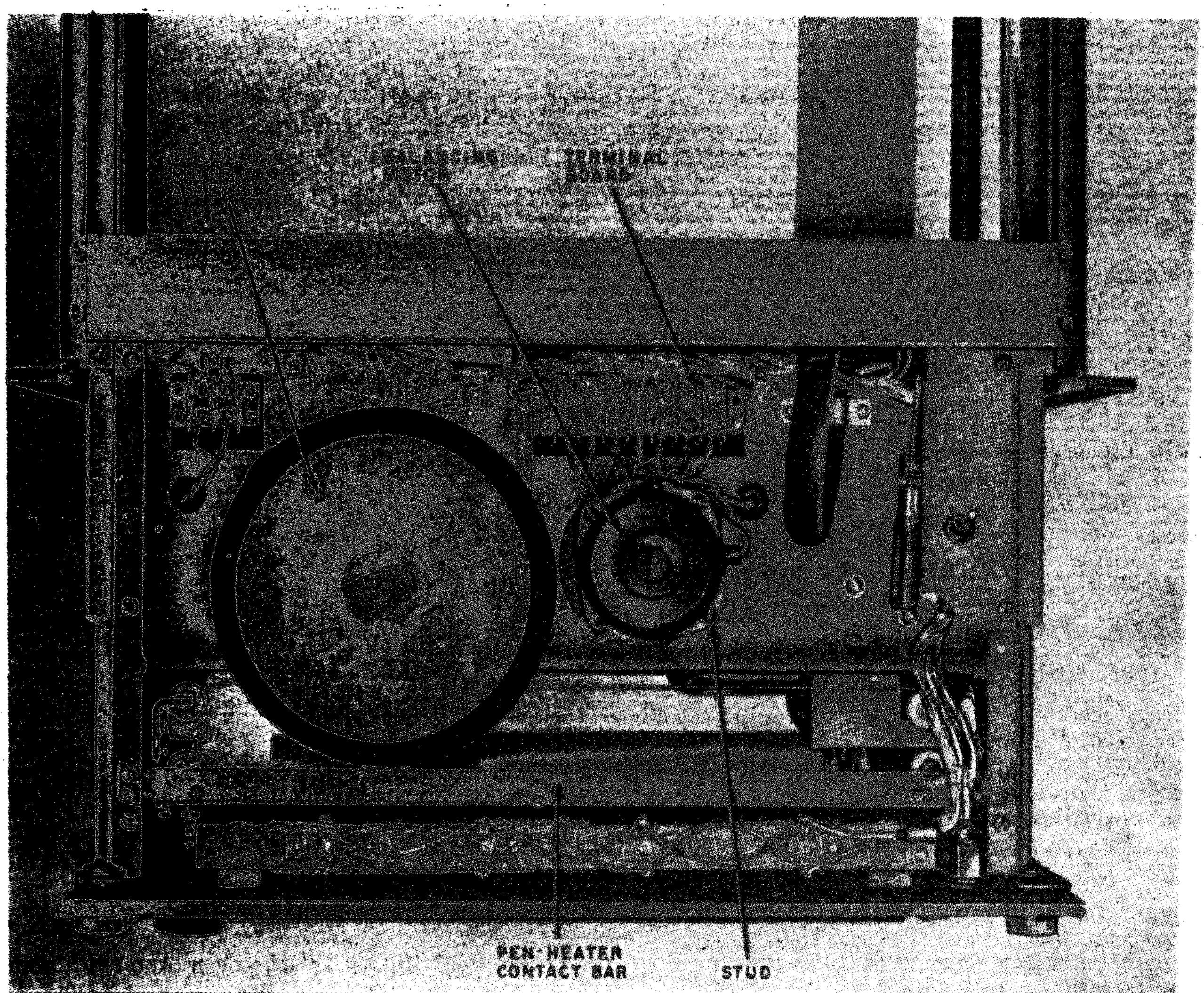


Figure 4-16. Chart Drive Motor Mounting.

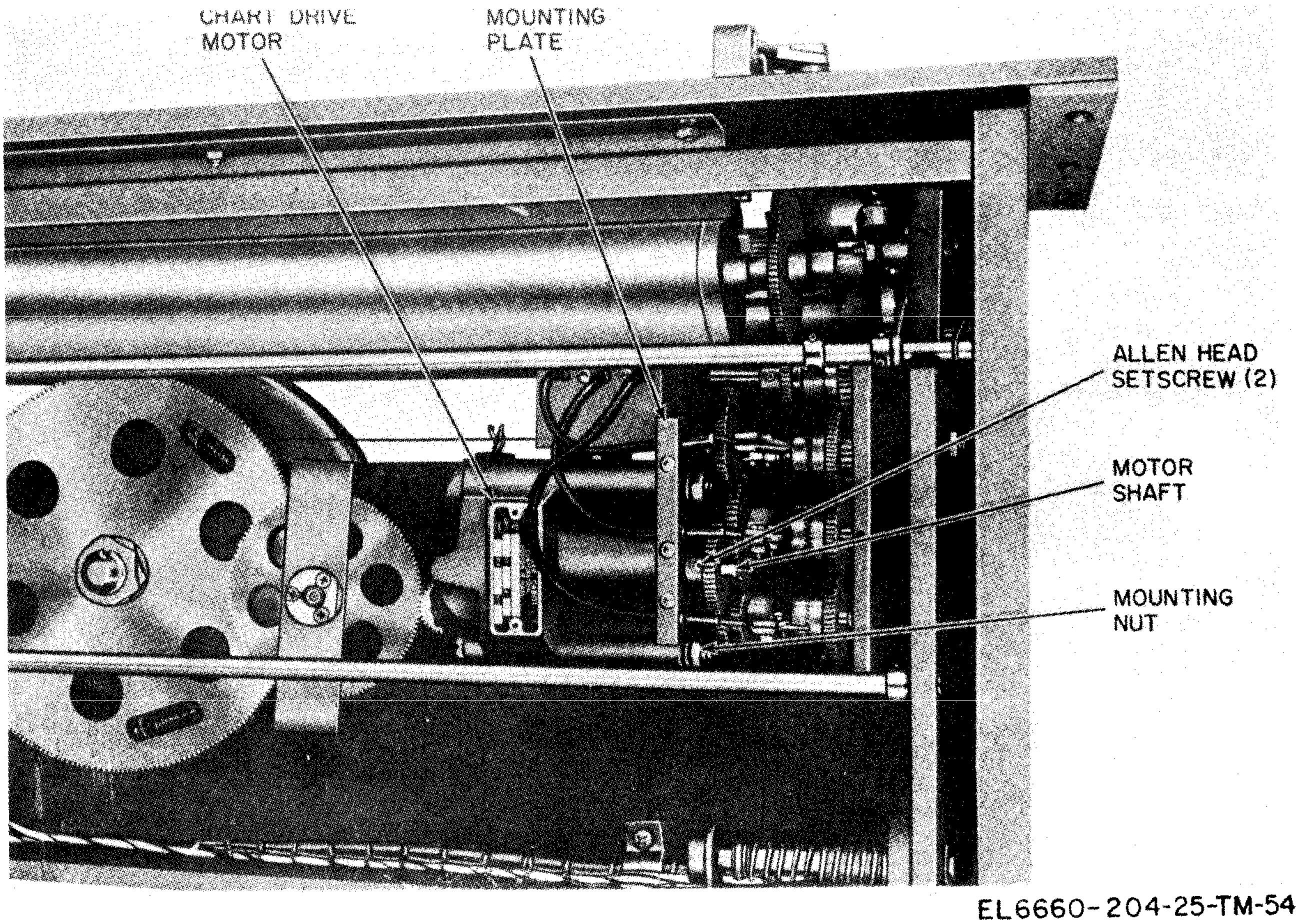


Figure 4-17. Balancing Motor Mounting.

4-11. Removal and Replacement of Balancing Motor and Gear Assembly

a. Removal.

(1) Remove the frequency-time recorder chassis from the cabinet.

(2) Insert a piece of wood between the intermediate gear assembly (fig. 4-18) and the split gear assembly. Make sure that the piece of wood fits snugly between the gear assemblies.

(3) Secure the gear assembly with masking tape to prevent movement.

CAUTION

The balancing motor gear assemblies must remain in a fixed position during the replacement of the balancing motor. Be sure that the gears will not turn before proceeding with the removal of the motor.

(4) Tag and remove the balancing motor connecting leads from the terminal board (fig. 4-16).

(5) Remove the balancing motor studs from the top of the balancing motor (fig. 4-16).

(6) Remove the nut that holds the balancing motor pinion gear (fig. 4-18) to the motor shaft and remove the pinion gear from the motor shaft.

(7) Remove the balancing motor from the frequency-time recorder chassis.

(8) Replace any gear mechanism components if required, in the exact same position as the components removed.

b. Replacement. Install a new balancing motor as follows. Make sure that the gear assemblies mesh properly and are in the same relative position they were in before the motor was replaced.

(1) Install the balancing motor in the frequency-time recorder chassis.

(2) Install the pinion gear on the motor shaft and install the retaining nut.

(3) Install the studs and secure the motor to the chassis.

(4) Connect the tagged motor leads.

(5) Remove the masking tape and thoroughly remove any residue.

(6) Remove the wood from the gear assemblies.

(7) Reinstall the frequency-time recorder in the cabinet.

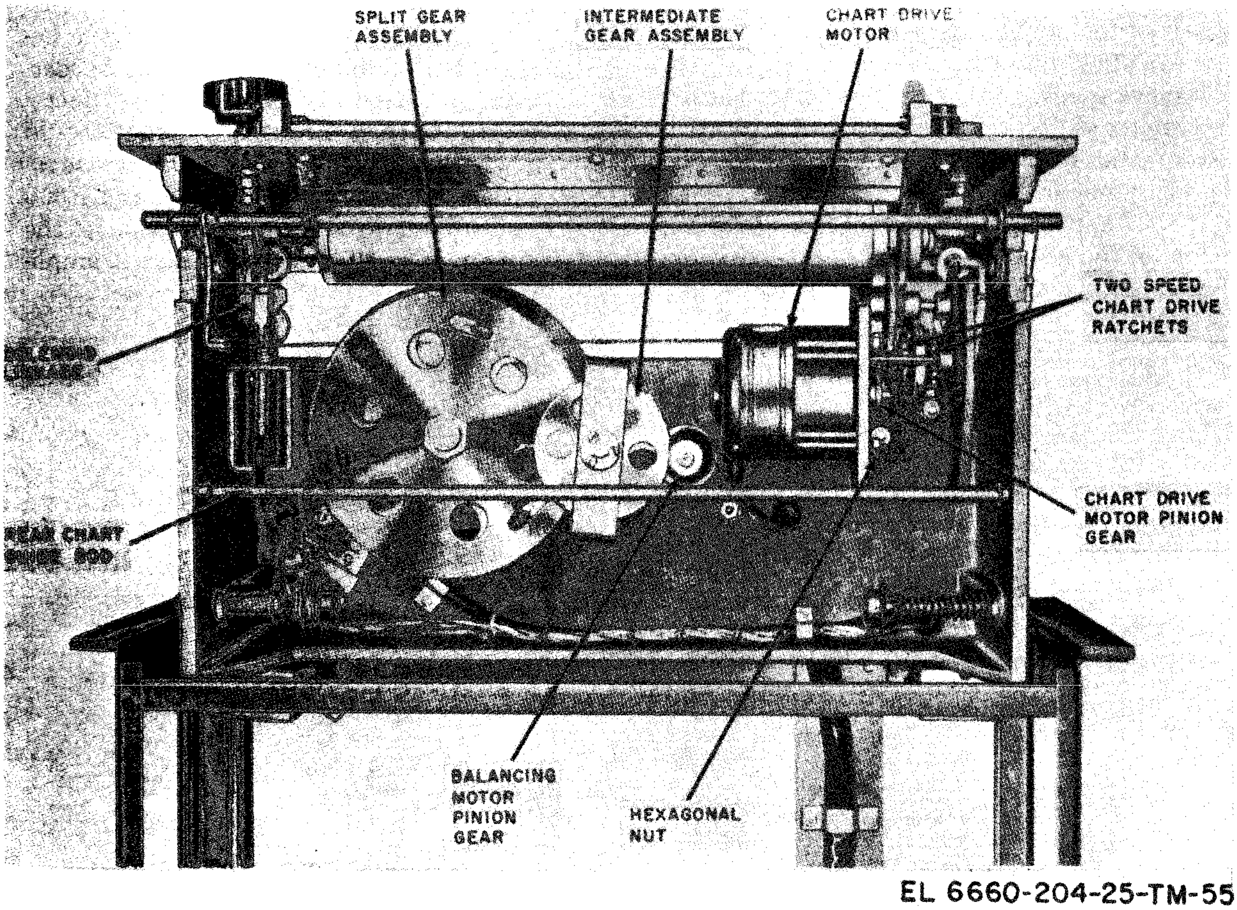


Figure 4-18. Frequency-Time Recorder, Bottom View Showing Main Chart Drive Components.

4-12. Elimination of Hysteresis Error

a. Operate the circuit breakers and power switch to the ON position.

b. Operate the SIGNAL SELECTOR switch to S.C. and let the recorder warm up for 15 minutes.

c. Unlock the control panel and draw the recorder forward sufficiently to reach the split gear assembly on the bottom side (fig. 4-18). Apply finger pressure to the rim of the split gears and force the pen slightly to the right; then remove the force slowly, so that the pen carriage will not *jump* back into its former position. Let the pen record in its percent position for 10 or 15 seconds. Next, force the pen a little to the left. Release slowly, and again allow a short chart recording. If there is any difference between the two recordings (hysteresis error), this difference should be centered on the chart zero line by adjusting the REC.

4-13. Noise Suppression Diode Alignment

Since the types of noise on the received radiosonde signals vary with atmospheric conditions and radiosonde systems, the noise-suppression diode should be aligned only when the radiosonde signals are being received. An oscilloscope will be required to align the noise suppression diode properly.

a. Observe the signal at Jack J303 (fig. 3-15). If the signal is not noisy, set noise suppression switch S301 (fig. 3-15 to the OUT position. If the signal is noisy, set noise suppression switch S301 to the IN position.

b. Rotate potentiometers R304 and R306 (fig. 3-15) to their maximum clockwise position.

c. Connect the oscilloscope between jack J307 and ground.

d. If noise appears on the oscilloscope at jack J307, adjust potentiometers R304 and R306 as follows:

(1) If noise appears on the oscilloscope at the bottom of the waveform (1, fig. 4-19), try counter-clockwise rotation of potentiometer R306 and clockwise rotation of potentiometer R304.

(2) If noise appears on the oscilloscope at the top of the waveform (2, fig. 4-19), try clockwise rotation of potentiometer R306 and counterclockwise rotation of potentiometer R304.

(3) If noise appears on the oscilloscope at the top and bottom of the waveform (3, fig. 4-19), try counterclockwise rotation of potentiometer R304 and R306.

NOTE

Do not turn either potentiometer, especially R306, too far counterclockwise because high frequency signals may be lost. Changes should be made in small increments and the effect of each change should be checked carefully. Counterclockwise rotation of potentiometers R304 and R306 tends to increase the response time of the circuit to sudden drops in signal amplitude.

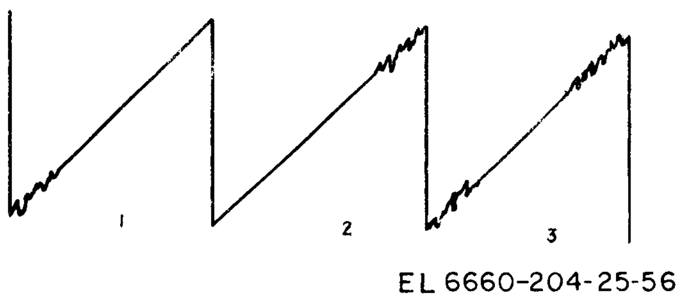


Figure 4-19. Signal Wave Form, Showing Noise Superimposed.

CHAPTER 5

DIRECT SUPPORT TESTING PROCEDURES

5-1. General

a. Scope. This chapter contains testing procedures to be used by direct support maintenance personnel to determine whether repaired equipment is performing satisfactorily for return to users.

b. Test and Procedures. Tests are limited to those that can be performed with the tools, test equipments, and materials allocated to direct support maintenance. Tests and procedures are on charts preceded by a list of test equipment and material required, and by instructions for setting up and interconnecting the test equipment.

c. Performances Standards. Performance standards are included in each chart to provide a direct go-no-go basis on which the tester can reject or pass the repaired equipment.

5-2. Standard Test Conditions

a. Test Equipment. Test equipment ordinarily consists of Frequency Standard TS-65C/FMQ-1 (as a signal source), Oscilloscope AN/USM-140 (as an indicating device), and a stopwatch. Also used is a radiosonde unit having a regulated output to simulate specific temperature, humidity, and pressure conditions for dynamically checking the accuracy of the Radiosonde Recorder AN/TMQ-5(*) data print.

b. Alternate Test Equipment. If Oscilloscope AN/USM-140 is not available, any test scope capable of accepting, without overloading, input voltages of 40 volts (root mean square) or higher can be used. If the test scope has no vertical calibrator, then it must be calibrated by a reasonably accurate voltmeter and an adjustable source of 60-Hz voltage. This calibration should be continuous between zero and 115 volts peak-to-peak, or 40 volts rms. (For sine wave shapes, the peak-to-peak value equals 2.83 times the voltmeter value; conversely, the voltmeter value equals 0.353 times the peak-to-peak value.) When an oscilloscope is not available, an electronic voltmeter may be substituted if allowance is made for the difference in indications (rms versus peak-to-peak) as described above.

c. Equipment Warmup and Connections.

(1) Before taking any measurements, allow the equipment to warm up for at least 30 minutes with the power switch at STAND BY.

(2) Adjust the operating controls to permit optimum operation of the equipment.

(3) With the signal and power cable assembly (Special Purpose Cable Assembly W601), interconnect jack J101 on the recorder, Frequency Standard TS-65C/FMQ-1, and a convenient 60-Hz power outlet. When making the connections to the frequency standard, the black lead is connected to the ground (lower) terminal and the white lead to the signal terminal.

(4) Room temperature and humidity conditions must be normal and reasonably constant.

(5) Line voltage and frequency must be normal and constant (115 volts (approximately) and 60 Hz).

5-3. Chart Feed Test

The chart feed test measures the number of graph line spaces that the chart travels in 5 minutes.

a. Test Equipment and Materials. A stopwatch is required for this test.

b. Test Connections and Conditions. No special connections are required. The prime power source should supply 110 to 125 volts at exactly 60 Hz as indicated on the control panel meters. Check the number of speeds in the following procedure as applicable to the unit being tested.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	Stopwatch	CHART RATE SPEED ½ INCH PER MINUTE pushbutton* depressed.	Allow the chart to travel for 5 minutes.	Five line spaces should be traversed.
2	Stopwatch	CHART RATE SPEED 1 INCH PER MINUTE pushbutton* depressed.	Allow the chart to travel for 5 minutes.	Ten line spaces should be traversed.
3	Stopwatch	CHART RATE SPEED 2 INCHES PER MINUTE pushbutton depressed.	Allow the chart to travel for 5 minutes.	Twenty line spaces should be traversed.

*Pushbutton or switch on multispeed recorders. No multispeed selection capability on single speed recorders.

5-4. Speaker Output Test

a. Test Equipment and Materials. Frequency Standard TS-65C/FMQ-1 is required for this test.

b. Test Connections and Conditions. Connect the frequency standard (with its output at zero) to test jack J303 on the signal data converter. The prime power source should supply 110 to 125 volts at 58 to 62 cycles as indicated on the control panel meters.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	Frequency standard set to 190 Hz at 10 volts peak-to-peak.	SPEAKER VOL. control at halfway point.	Listen to audio output	Signal should not be raspy or distorted.

5-5. Pen Performance Test

a. Test Equipment and Material.

(1) Scale (weighing), 8 ounces.

(2) Scale (measuring), calibrated in 1/16-inch increments.

(3) Frequency Standard TS-65C/FMQ-1.

(4) Stopwatch.

b. Test Connections and Conditions. No special test connections or test conditions are required.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	N/A	Control panel power switch to STANDBY.	Measure distance between penpoint and chart.	1/16 inch.
2		Control panel power switch to POWER ON.	Measure the pen pressure against the chart.	2 ounces.
3	N/A	Control panel SIGNAL SELECTOR switch to S. C. Adjust REC. ZERO adjustment, if necessary, to position the penpoint exactly at zero chart divisions. Set SIGNAL SELECTOR switch to SIG.	N/A	N/A.
4	Adjust frequency standard for an output of 20 volts peak-to-peak at 190 Hz.	If necessary, adjust control panel REF. ADJUST to position the pen at exactly 95 chart divisions.	Alternate the SIGNAL SELECTOR switch between SIG and S.C. and note the time required for the pen to travel between zero and 95, and 95 and zero chart divisions.	The time required to travel in either direction, including pen lifting and lowering, should not exceed 2 ½ seconds.

5-6. Pen-Lifter Test

a. Test Equipment and Materials. Frequency Standard TS-65C/FMQ-1 is required for this test.

b. Test Connections and Conditions. Connect the frequency standard output to test jack J303 on the signal data converter. The frequency standard output should be at zero. On multispeed recorders, select ½ inch per second chart speed.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	Raise the output of the frequency standard to 50 volts at 190 Hz.	N/A	N/A	N/A.
2	While maintaining a 50 volt level, change the frequency to 25 Hz.	N/A	Observe the trace for 30 seconds.	Tails (caused by lateral pen motion occuring before the pen point has cleared the chart) do not exceed two recorder chart divisions.
3	While maintaining a 50 volt level, change the frequency to 150 Hz.	N/A	Observe the trace for 30 seconds.	Tails do not exceed two recorder chart divisions.
4	While maintaining a 50 volt level, change the frequency to 60 Hz.		Observe the trace for 30 seconds.	Tails do not exceed two recorder chart divisions.

5-7. Hysteresis Test

The recorded input signal to the radiosonde recorder at any frequency between 10 and 190 Hz should not deviate from the recording of the same signed by more than 0.1 of one chart division when approached by a higher or lower frequency. This deviation is called hysteresis. Excessive hysteresis is eliminated as explained in paragraph 4-12.

a. Test Equipment and Materials. Frequency Standard TS-65C/FMQ-1 is required for this test.

b. Test Connection and Conditions. Connect the frequency standard output to test jack J303 on the signal data converter. Adjust sensitivity of the recorder as described in paragraph 3-34.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	Adjust the frequency standard for a 20-Hz signal at 15 volts peak-to-peak.	Depress the INTER S. C.–OUTPUT S. C. switch until the pen goes to zero chart divisions.	Release the switch and observe that the pen approaches the 10 division mark on the chart from the lower value. Record for 30 seconds.	N/A.
2	N/A	Depress the REC. TEST switch until the pen goes to 95 chart divisions.	Release the REC TEST switch and observe that the pen approaches the 10 division mark on the chart from the higher value.	The horizontal distance between the two traces is the hysteresis at 20 Hz and should not exceed 0.1 of one chart division.
3	Adjust the frequency standard for a 60-Hz signal at 15 volts peak-to-peak.	Depress the INTER S. C.–OUTPUT S. C. switch until the pen goes to zero chart divisions.	Release the switch and observe that the pen approaches the 30 division mark on the chart from the lower value. Record for 30 seconds.	N/A.
4	N/A	Depress the REC TEST switch until the pen goes to 95 chart divisions.	Release the REC TEST switch and observe that the pen approaches the 30 division mark on the chart	The horizontal distance between the two traces is the hysteresis at 60 Hz and should not ex-

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
			from the higher value. Record for 30 seconds.	ceed 0.1 of one chart division.
5	Adjust the frequency standard for a 100 Hz signal at 15 volts peak-to-peak.	Depress the INTER S. C.-OUTPUT S. C. switch until the pen goes to zero chart divisions.	Release the switch and observe that the pen approaches the 50 division mark on the chart from the lower value. Record for 30 seconds.	N/A.
6	N/A	Depress the REC TEST switch until the pen goes to 95 chart divisions.	Release the REC TEST switch and observe that the pen approaches the 50 division mark on the chart from the higher value. Record for 30 seconds.	The horizontal distance between the two traces is the hysteresis at 100 Hz and should not exceed 0.1 of one chart division.
7	Adjust the frequency standard for a 140 Hz signal at 15 volts peak-to-peak.	Depress the INTER S. C.-OUTPUT S. C. switch until the pen goes to zero chart divisions.	Release the switch and ob-observe that the pen approaches the 70 division mark on the chart from the lower value. Record for 30 seconds.	N/A.
8	N/A	Depress the REC TEST switch until the pen goes to 95 chart divisions.	Release the REC TEST switch and observe that the pen approaches the 70 division mark on the chart from the higher value. Record for 30 seconds.	The horizontal distance between the two traces is the hysteresis at 140 Hz and should not exceed 0.1 of one chart division.
9	Adjust the frequency standard for a 180 Hz signal at 15 volts peak-to-peak.	Depress the INTER S. C.-OUTPUT S. C. switch until the pen goes to zero chart divisions.	Release the switch and observe that the pen approaches the 90 division mark on the chart from the lower value. Record for 30 seconds.	N/A.
10	N/A	Depress the REC TEST switch until the pen goes to 95 chart divisions.	Release the REC TEST switch and observe that the pen approaches the 90 division mark on the chart from the higher value. Record for 30 seconds.	The horizontal distance between the two traces is the hysteresis at 180 Hz and should not exceed 0.1 of one chart division.

5-8. Signal Sensitivity Test

a. Test Equipment and Materials. Frequency Standard TS-65C/FMQ-1 is required for this test.

b. Test Connections and Conditions. Connect the frequency standard output to test jack J303 on the signal data converter.

c. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1		Operate the noise suppression switch to IN. (The noise suppression switch is on the upper left side of the signal-data converter chassis. It is accessible by folding down the front of the control panel.	Adjust the frequency standard for 10 Hz; reduce frequency standard output to zero.	The recording should be along the zero chart line.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
2	N/A	N/A	Advance the frequency standard output voltage slowly until the recorder makes a straight line at 5 chart divisions.	Peak-to-peak output of the frequency standard should be less than 10 volts.
3			Increase the frequency standard to maximum.	The pen should continue to record steadily in a straight line.
4	N/A	N/A	Adjust the frequency standard for 190 Hz; reduce frequency standard output to zero.	The recording should be along the zero chart line.
5	N/A	N/A	Advance the frequency standard output voltage slowly until the recorder makes a straight line at 85 chart divisions.	Peak-to-peak output of the frequency standard should be less than 10 volts.
6	N/A	N/A	Increase the frequency standard output to maximum.	The pen should continue to record steadily in a straight line.
7	Adjust the frequency standard output to zero at 10 Hz.	Operate the noise suppression switch to OUT.	Repeat steps 2 through 6	Performance should be the same.

5-9. Automatic Time-Print Test

This test applies only to Frequency-Time Recorders RD-88A/TMQ-5 and RD-88B/TMQ-5; it is performed without any power applied to the set.

a. Unlock the two panel fasteners on the recorder panel and draw the recorder forward far enough to allow acess to the split gear assembly on the bottom side.

b. Manually turn the split gear assembly so the pen will move to the right. Listen carefully as the indicator point passes 90 chart divisions on the scale; there should be an audible click as the microswitch throws.

5-10. Voltage Tests

a. Test Equipment and Materials.

(1) Multimeter TS-352/U.

(2) Test cables W604 (4) and W606 (1).

b. Test Connections and Conditions.

(1) With the POWER LINE circuit breakers off, remove the fan panel to expose the power supply test points.

(2) Fold down the front control panel to expose the signal data converter test points.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	Circuit breakers and power switch on; SELECTOR switch to S.C.	Measure voltages between ground and the following power supply test point jacks:	Voltages are ±20% unless otherwise noted:
			J401	+500 volts
			J402	+115 volts
			J403	+470 volts
			J404	+300 volts ±2%)
			J405	+88 volts (±2%) (varies with setting of potentiometer R412).
			J406	+85 volts
			J407	0 volts (dc)
			J408	+240 volts
			J409	−9.5 volts
			J410	+300 volts
			J411	0 volts (ac)
			J412	+92 volts

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
			J413	−175 volts (±2%)
			J414	−85 volts
			J415	−90 volts
			J416	0
			J417	−30 volts
2	N/A..	Circuit breakers and power switch on; SELECTOR switch to S.C.	Measure voltages between ground and the following signal data converter test points:	Voltages are ±20% unless otherwise noted:
			J303	0 volts (dc)
			J304	+150 volts (plain, A & B models) or +45 volts (C model).
			J305	
			J306	+150 to +300 volts depending on the setting of potentiometer R304.
			J307	+150 volts (plain, A & B models) or +45 volts (C model) with noise suppression switch in operation and depending on the setting of potentiometer R304.
			J308	0 volts (dc)
			J309	+90 volts
			J310	+160 volts (±5%)
			J311	+150 volts
			J312	+260 volts
			J313	−9 volts
			J314	+12.6 volts
			J315	+4 volts
			J316	±30 to −60 volts
			J317	+300 volts (±2%)
			J318	0 volts (dc)
			J320	+30 volts
			J321	+70 volts
			J322	+170 volts
			J323	+2 to +5 volts
			J324	+170 volts
			J325	+300 volts depending on setting of potentiometer R317.
			J326	0 volts (dc)
			J328	0 volts (dc)

5-11. Waveshape Tests

a. Test Equipment and Materials.

(1) Oscilloscope AN/USM-140.

(2) Frequency Standard TS-65C/FMQ-1.

b. Test Connections and Conditions.

(1) Connect the frequency standard output to test point jack J303.

(2) Connect the oscilloscope vertical input to the test point jack specified and adjust the oscilloscope control as specified in the following procedure.

c. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performances standard
1	Frequency standard at 180 Hz, 50 volts peak-to-peak output.	Circuit breaker and power switch on; SELECTOR switch at 60 cps.	N/A...	N/A.
2	Oscilloscope horizontal, sweep and vertical amplitude as specified on figure FO-15.	Equipment settings and detector unbalance as specified on figure FO-15. Unbalance the detector, as required, as described in paragraph 4-6*c*.	Connect the oscilloscope to the test point jacks as specified on figure FO-15.	Waveforms and waveform parameters as specified on figure FO-15 for each test point jack.

5-12. Dynamics Test Using Radiosonde AN/AMT-4(*) or AN/AMT-12(*)

a. Test Equipment and Materials. A test radiosonde unit having a regulated output to simulate specific temperature, humidity, and pressure conditions is required for this test.

b. Test Connections and Conditions. Connect the radiosonde recorder under test to a Rawin set as described in TM-11-6660-204-10, paragraph 2-8.

c. Procedure. Dynamically test the radiosonde recorder by means of the steps described in TM-11-6660-204-10 (paras 3-6 through 3-19). Note the readings obtained and using the linearity deviation curve (para 3-38) compare temperature, humidity, and pressure readings with the known output of the radiosonde.

CHAPTER 6
GENERAL SUPPORT MAINTENANCE

6-1. Scope

a. This chapter contains instructions covering general support maintenance of Radiosonde Recorder AN/TMQ-5(*). The instructions cover overhaul procedures to be accomplished by general support maintenance personnel. Operating instructions are in TM 11-6660-204-10.

b. General support maintenance of Radiosonde Recorder AN/TMQ-5(*) includes the following:

(1) Overhaul electrical equipment cabinet (para 6-3).

(2) Overhaul cable assemblies (para 6-4).

(3) Overhaul control panel (para 6-5).

(4) Overhaul signal data converter (para 6-6).

(5) Overhaul fan panel (para 6-7).

(6) Overhaul power supply (para 6-8).

(7) Overhaul frequency-time recorder, paragraph 6-9.

6-2. Tools, Materials, and Test Equipment

Required for general support maintenance-

a. Tools. All tools required for general support maintenance are contained in Toolkit TK-100 and Toolkit TK-105.

b. Materials.

(1) Clean, lint free cloths.

(2) Cleaning compound (FSN 7930-395-9542).

(3) Cleaning brush.

(4) Vacuum cleaner.

c. Test Equipment.

(1) Frequency Standard TS-65C/FMQ-1.

(2) Multimetir TS-352/U.

(3) Oscilloscope, AN/USM-40/U.

(4) Scale, weighing, 8 ounces.

(5) Test Set, Electron Tube, TV-7,

(6) Toolkit, TK-100.

(7) Toolkit, TK-105.

(8) Stopwatch.

6-3. Electrical Equipment Cabinet

a. Remove all equipment from Electrical Equipment Cabinet CY-1390(*)/TMQ-5.

b. Thoroughly vacuum the interior of the cabinet.

c. Inspect interior and exterior for rust or corrosion. If rust or corrosion exists, clean it off with emery cloth or fine sandpaper and repaint.

d. Tighten all panel and jack mounting hardware within the cabinet.

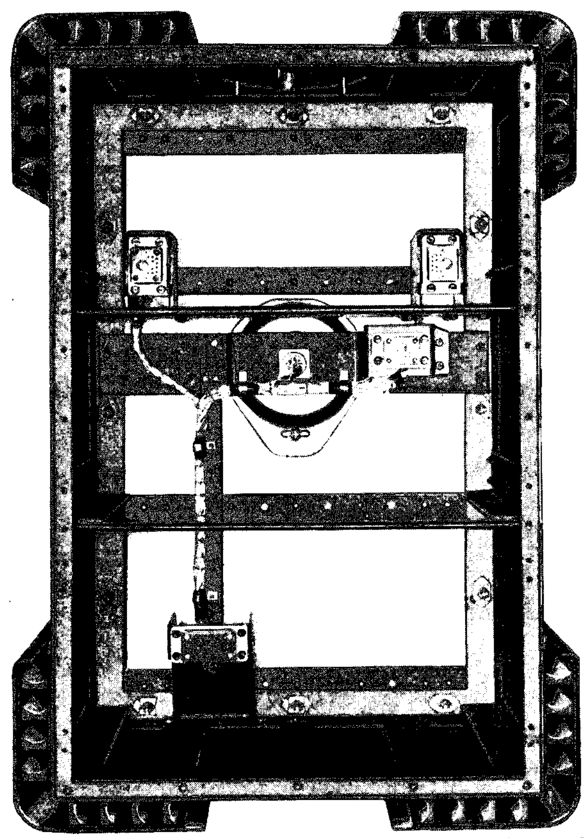


Figure 6-1. Electrical equipment cabinet CY-1390( )/TMQ-5, components removed.*

6-4. Cable Assemblies

a. Visually inspect cable assemblies for the following:

(1) All cable clamps installed and tight (fig. 6-1).

(2) No insulation or sleeves chafed at cable clamps.

(3) No insulation or sleeves chafed where cables enter plugs.

b. Electrically check continuity of cables using Multimeter TS-352 and figure FO-7. Check all connections-

(1) J101 and J102.

(2) J101 and J103.

(3) J102 and J104.

(4) J102 and J105.

(5) J104 and J105.

6-5. Control Panel

a. Check mechanical security of all front panel control knobs and tighten if required.

b. Check controls and circuit breakers for loose attachment to the panel and tighten if required.

c. From the inside of the panel, apply a few drops of light oil to the panel hinge. After allowing 1 minute to soak in, thoroughly wipe dry with a clean cloth.

d. From the rear of the panel, check the security of the hardware that mounts the meters, speaker, and plugs to the panel; tighten if required.

e. Check for signs of corrosion; repaint if required.

f. Check lacing of cables and replace if required.

g. Check action of switch S202; if the detent appears worn, tag and unsolder wires, remove and replace the switch, and resolder the wires.

h. Check the mechanical security of the resistor mounting assembly; tighten if required.

i. Using first a vacuum cleaner, then a lint free cloth, thoroughly clean the front and rear of the panel.

6-6. Signal Data Converter

a. Remove all tube shields.

b. Using a vacuum cleaner, thoroughly clean the top and bottom (figs. 42 and 4-3) of the chassis (including plugs and jacks).

c. Using the tube tester, check all vacuum tubes one at a time, being sure to replace tubes in the same socket from which they were removed; replace any defective tubes with the same type or a currently approved substitute.

d. Check the mechanical security of all components; tighten if required.

e. Replace all tube shields.

6-7. Fan Panel

a. Using a vacuum cleaner and a clean cloth, thoroughly clean the fan panel interior and exterior.

b. Check the mechanical security of all components; tighten if required.

c. Check the routing of the interior cable to insure that it will not contact the moving fan; reroute the cable if necessary.

d. Turning the fan by hand, check that the blade is not bent, out of line, or hitting the screen or brackets.

e. Check capacitor C1 for any sign of leaking or swelling; replace if necessary.

f. Check for rust or corrosion. Repaint if required.

6-8. Power Supply

a. Remove all tube shields.

b. Using a vacuum cleaner, thoroughly clean the top and bottom (figs. 3-14 and 3-15) of the chassis including plugs and jacks.

c. Using the tube tester, check all vacuum tubes. Replace defective tubes with the same type or a currently approved substitute.

d. Check the mechanical security of all components; tighten if required.

e. Replace all tube shields.

6-9. Frequency-Time Recorder

a. Using a vacuum cleaner and lint free cloth thoroughly clean the exterior and the interior of the recorder.

b. Check the security of all panel hardware; tighten if necessary.

c. Check all interior mounting brackets; tighten if required.

d. Perform the following tests and adjustments:

(1) Alignment of recorder pen and slide-wire (para 3-33).

(2) Adjustments of recorder pen (para 3-28).

(3) Adjustment of automatic time print switch (para 3-37).

(4) Hysteresis adjustment (para 4-12).

(5) Pen-lifter test (para 5-6).

CHAPTER 7
DEPOT MAINTENANCE

7-1. Scope of Depot Maintenance

This chapter contains instructions for depot maintenance of Radiosonde Recorder AN/TMQ-5(*). These instructions supplement those appearing in the preceding chapters of this publication. Operating instructions are in TM 11-6660-204-10.

7-2. Tools, Materials, and Test Equipment Required

a. Tools.

(1) Tool Kit, Electronic Equipment TK-100/G.

(2) Tool Kit, Electronic Equipment TK-105/G.

b. Materials.

(1) Lint free cloths.

(2) Cleaning compound (FSN 7930-395-9452).

(3) Lubricating oil.

c. Test Equipment.

(1) Multimeter TS-352.*

(2) Oscilloscope AN/USM-140.*

(3) Scale, weighing, 8 ounces.

(4) Test Set, Electron Tube TV-2.

(5) Stopwatch.

*Or equivalent. Refer to APP. B.

7-3. Depot Maintenance Standards

a. Depot maintenance, including the rebuilding of the Frequency-Time Recorder RD-88(*)/TMQ-5, will be made after a technical inspection of Equipment turned in for repair. The technical inspection determines the extent of repairs required and provides the basis for the requisitioning of parts, assemblies, or supplies necessary to accomplish the repairs.

b. Inspection will determine the classification of the equipment as follows:

(1) *Serviceable.* Serviceable material consists of all new or used supplies which are in condition for issue for the purpose intended and all supplies which can be placed in such condition through preissue tests or inspection, in-storage deprocessing, installation of accessories, correction of minor deficiencies which have developed since the item was last classified as serviceable, and application of modification work orders for which parts are available or assembly of available components.

(2) *Unserviceable.* Unserviceable material consists of all supplies which are not serviceable. The definition of unserviceable material is further broken down into the following subclassifications:

(a) Material which is unserviceable but economically repairable.

(b) Material which is unserviceable but uneconomically repairable.

7-4. Depot Maintenance of Radiosonde Recorder AN/TMQ-5(*)

a. Check to see that the radiosonde recorder is free from defects as determined in chapter 5. Refer to paragraphs 3-25 through 3-49 and 4-10 through 4-14 for repair of defects by adjustment, alignment, repair, or replacement.

b. Repair and rebuild procedure consists of replacing any part which has been determined to be unserviceable. No procedures are recommended for restoring any unserviceable parts to good condition, only total replacement of defective parts is recommended.

c. Disassembly for part replacement will be made in accordance with one of the illustrations in chapter 8.

d. All equipment repaired at depot maintenance level must meet the requirements set forth in chapter 8.

CHAPTER 8
DEPOT OVERHAUL STANDARDS

Section I. GENERAL

8-1. Applicability of Depot Overhaul Standards

The tests outlined in this chapter are designed to measure the performance of repaired or overhauled equipment. The tests will be made on all repaired or overhauled equipment to insure that it meets the required performance standards prior to return to stock.

8-2. Applicable References

a. Repair Standards. Applicable procedures for the depots performing these tests and the general standards required for repaired equipment form a part of the requirements for testing this equipment.

b. Technical Publications. The following additional technical publications are applicable to this equipment:

(1) TM 11-6660-204-10.
(2) TM 11-6660-204-ESC.
(8) TM 11-6660-204-25P.
(4) TM 11-6660-204-24P-1.

c. Modification Work Orders. Perform all applicable modification work orders pertaining to this equipment before making the specified tests. DA Pam 310-7 lists all current modification work orders.

8-3. Tools, Test Equipment, and Materials Required

The following tools, test equipment, and materials are required. When the specific item is not available, an equivalent item maybe substituted.

Nomenclature	Manufacturer and model or Federal stock number
Toolkit TK-100	5180-605-0079
Toolkit TK-105	5180-610-8177
Watch, stop	5310-719-3950
Test Set, Electron Tube, TV-2	6625-699-0263
Scale, Weighing, 8 oz	6670-599-5296
Scale, Measuring, calibrated to 1/64-inch increments.	
Oscilloscope AN/USM-140*	6625-987-6603
Frequency Standard TS-65C/FMQ-1	6625-649-4279
Test Cable CX-2337/TMQ-5	6660-306-2126
Test Cable CX-2340/U	6660-503-0670

*Or equivalent. Refer to Appendix B.

Section II. EQUIPMENT TEST PROCEDURES

8-4. Equipment Warmup and Mechanical Checks

a. Standard Test Conditions.

(1) Line voltage ---- 115 volts ac
(2) Line frequency -- 60 Hz
(3) Temperature ---- Ambient room temperature
(4) Signal input ---- Frequency Standard TS-65C/FMQ-1
(5) Test configuration Refer to figure 8-1

b. Epuipment Turn-On. Turn the POWER LINE switch to ON, the POWER switch to STAND BY, open the vent on top of cabinet, turn the FAN switch to ON, the RAWIN TIME PRINT switch to OFF, the OPERATE LOCK switch to OPERATE, and the INTER S.C.-OUTPUT S.C. switch to its center position. After the equipment has stabilized for approximately 30 minutes, turn the POWER switch to ON and optimize operation by adjusting the following controls.

(1) With the SIGNAL SELECTOR switch in the S.C. position, adjust the REC. ZERO control so the recorder pen marks at 0 divisions on the chart.

(2) Turn the signal selector switch to 60 CPS; the recorder pen should print at approximately 30 chart divisions. Turn the SIGNAL SELECTOR switch to 120 CPS; the recorder pen should print at approximately 60 chart divisions.

(3) Depress the REC. TEST toggle switch and adjust REC. TEST ADJ. control so the recorder pen prints at 96 chart divisions.

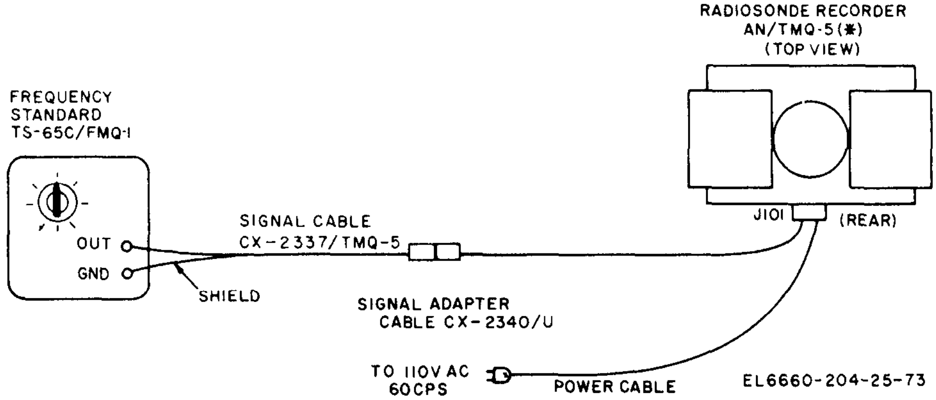


Figure 8-1. External test configuration.

(4) Repeat steps (1), (2), and (3) above to insure that one adjustment has not altered another.

(5) Turn the SIGNAL SELECTOR switch to SIG. position.

c. Mechanical Checks. Perform the following visual checks prior to equipment warmup:

(1) All mechanical components including panel locks and rack slides should operate smoothly.

(2) The frequency-time recorder chart drive gear train shall have no worn gears or broken gear teeth. All chart drive gear train mechanism mounting components shall be secure.

d. Powerline Frequency and Voltage Meters. The powerline frequency meter should indicate 60 Hz. The powerline voltage meter should indicate within ±5% of the input line voltage from the power source.

8-5. Fan Operation

a. Place a piece of tissue paper over the fan opening. The fan will have sufficient air moving capabilities if the paper remains in place while the fan is in operation.

b. Remove the tissue paper from the fan opening.

8-6. Speaker Output

The speaker output test will be conducted simultaneously with the pen tests at various frequencies. During these tests, listen to the speaker output and signal quality; it should be free of audible distortion and be capable of being heard in a reasonably quiet room at a distance of 25 feet.

8-7. Pen-Lift Test
(fig. 8-2)

a. Adjust the output of the Frequency Standard Test Set TS-65C/FMQ-1 to 190 Hz at a peak-to-peak voltage of 10 volts. Remove the screws from the converter panel and pull down the panel door to obtain access to the test jacks. Connect Oscilloscope AN/USM-140A to the output of Test Set TS-65C. Connect the signal lead of the test cable from the output of the test set to jack J303 and the shield of the cable to ground at jack J326.

b. Operate the SIGNAL SELECTOR switch to the SIG. position and adjust the test set so the recorder pen will print successively at approximately 0, 30, 60, 95, 60, 30, and 0 chart divisions.

c. The beginning and ending tails of the recording shall not exceed two chart recorder divisions.

d. Replace the screws and secure the control panel unless other tests are to be made.

8-8. Chatter

a. Place SIGNAL SELECTOR switch in S.C. position, allow pen to print at 0 chart divisions for a few seconds, depress REC. TEST switch and hold until the pen comes to rest, then release and allow the pen to return to 0 chart divisions.

b. There should be no chatter of the pen holder assembly when moving either up or down scale.

8-9. Pen Pressure

a. Place the control panel power switch in the

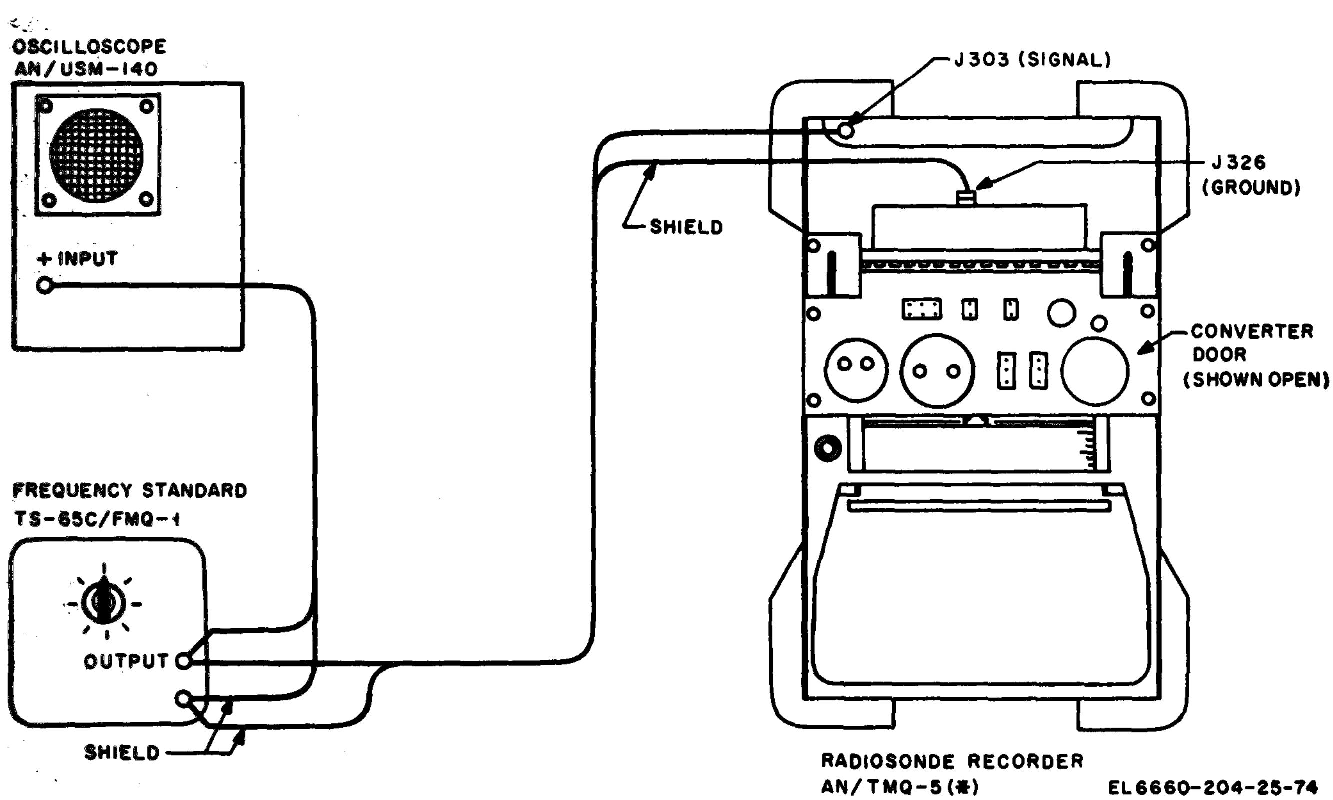


Figure 8-2. Standard test configuration.

STANDBY position and measure the distance between the pen point and the chart, which should be 1/16 inch.

b. Operate the control panel power switch to the ON position and use the weighing scale to check pen pressure against the chart at the ball of the pen, which should be 2 ounces.

8-10. Chart Feed

a. The prime power source should be 60 Hz when the chart feed test is checked. If the power source is interrupted during the time check, repeat the test.

b. Operate the chart rate speed set at ½ inch per minute. The chart should feed 15 ± 1/64 inches (30 line spaces) in 30 minutes.

c. Operate the chart rate speed at 1 inch per minute (two and three-speed recorders only). The chart should feed 15 ± 1/64 inches (30 line spaces) in 15 minutes.

d. Operate the chart rate speed set at 2 inches per minute (three-speed recorders only). The chart should feed 30 ± 1/32 inches (60 line spaces) in 15 minutes.

8-11. Zero Adjust

a. Operate the SIGNAL SELECTOR switch to S.C. position.

b. Operate the REC. ZERO adjustment to the extreme clockwise position which should position the pen within ½ chart division above zero. Then operate the REC. ZERO adjustment to the extreme counterclockwise position, which should position the pen within ½ chart division below zero.

c. Operate the REC. ZERO adjustment to position the pen at zero chart divisions.

8-12. Reference Adjust Voltage

a. Connect the frequency standard to the radiosonde recorder as shown in figure 8-2.

b. The recorder must be capable of being adjusted to 80 chart divisions when an input signal frequency of 140 Hz to 190 Hz is applied.

(1) Adjust the frequency standard for a 190 Hz, 25-volt peak-to-peak signal.

(2) Adjust the REF. ADJUST control until the pen indicates 80 chart divisions.

(3) Adjust the frequency standard for a 140 Hz, 25-volt peak-to-peak signal.

(4) Adjust the REF. ADJUST control until the pen indicates 80 chart divisions.

(5) Adjust the frequency standard for a 190 Hz, 25-volt peak-to-peak signal.

(6) Adjust the REF. ADJUST control until the pen indicates 95 chart divisions.

8-13. Signal Voltage Variation Test for Converter and Recorder

a. General. Turn on the equipment and allow the equipment to warm up for 30 minutes. Connect the radiosonde recorder with the associated test equipment as shown in figure 8-2.

b. Procedure.

(1) Adjust the TS-65C/FMQ-1 Frequency Standard for a 10-volt peak-to-peak intput signal.

(2) Place the SIGNAL SELECTOR switch in the SIG position.

(3) Adjust the signal input frequency to 10 Hz.

(4) Allow the pen to trace for 5 seconds to obtain a stable line.

(5) Repeat steps (3) and (4) above, adjusting the signal frequency to each frequency given in the table below.

(6) Adjust the frequency standard for a 20-volt peak-to-peak signal voltage and repeat steps (3) through (5) above.

(7) Adjust the frequency standard for a 30-volt peak-to-peak signal voltage and repeat steps (3) through (5) above.

(8) Use the 20-volt signal recordings as a reference. The 10-volt and 30-volt recordings should not vary more than ±.1 division from the 20-volt recording for each of the corresponding frequency inputs.

Step	*Frequency (Hz)*	*Chart Recording*
1	10	5
2	40	20
3	80	40
4	120	60
5	160	80
6	190	95

8-14. Linearity and Hysteresis Measurements

a. General.

(1) Connect the recorder with the associated test equipment as shown in figure 8-2.

(2) With the SIGNAL SELECTOR switch in SIG. position, signal (approximately 25v peak-to-peak) shall be applied in the sequence of 0, 10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 190, 180, 160, 140, 120, 100, 80, 60, 40, 20, 10, and 0 Hz. Allow the recorder to print at each frequency setting for at least 10 seconds.

b. Linearity Measurements (Converter and Recorder Combined). Compare the chart recording obtained in *a* above versus the frequency input for both the ascending and descending plot of frequencies. The correct chart recording should be a value equal to ½ the input frequency. The difference (spread) between the largest positive deviation from the correct reading and the largest negative deviation from the correct reading shall not exceed 0.2 division (approximately .020 inch). This linearity measurement includes the effects of hysteresis.

c. Hysteresis Measurements (Converter and Recorder Combined).

(1) With the test configuration shown in figure 8-2, apply a 10-HZ, 15-volt peak-to-peak signal to the recorder.

(2) Depress the INTER S.C. -OUTPUT S.C. switch until the pen goes to zero. Release the switch and observe the pen. approach 5 on the chart from the lower value. Allow the pen to record for 30 seconds.

(3) Depress the REC. TEST switch until the pen goes to 95. Release the REC. TEST switch and observe the pen approach 5 on the chart from the higher value. Allow the pen to record for 30 seconds.

(4) The horizontal distance between the two traces (hysteresis) should not exceed 0.1 of one chart division,

(5) Repeat the above procedure for 20, 40, 60, 80, 100, 120, 140, 160, 180, and 190 Hz.

8-15. Speed of Response

a. With the radiosonde recorder and test equipment in a room temperature environment and warmed up for 20 minutes, connect as shown in figure 8-1.

b. Rotate the SIGNAL SELECTOR switch to the S.C. position. Adjust for a zero chart recording. Set the TS-65C/FMQ-1 for a 190 Hz input signal. Rotate the SIGNAL SELECTOR switch to SIG. Adjust the pen to indicate 95.

c. When the pen is properly adjusted, operate the SIGNAL SELECTOR switch back and forth between the SIG. and S.C. positions. Record the time for the pen to travel between zero and the 95 division mark using a stopwatch. This time should not exceed 2½ seconds.

APPENDIX A

REFERENCES

The following publications contain information applicable to the operation and maintenance of Radiosonde recorder AN/TMQ-5(*).

DA Pam 310-1	**Consolidated Index of Army Publications and Blank Forms.**
DA Pam 738-750	**The Maintenance Management System (TAMMS).**
TM 11-6660-204-ESC	**Equipment Serviceability Criteria for Radiosonde Recorder AN/TMQ-5(*).**
TM 11-6660-204-10	**Operator's Manual, Radiosonde Recorders AN/TMQ-5 (NSN 6660-00-324-9426), AN/TMQ-5A (NSN 6660-00-393-2234), AN/TMQ-5B (NSN 6660-00-393-2234) and AN/TMQ-5C (NSN 6660-00-682-4500).**
TM 11-6660-204-24P-1	**Organizational, Direct Support, General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Recording Set, Weather Data AN/TMQ-5C (NSN 6660-00-682-4500).**
TM 11-6660-204-25P	**Organizational, Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools Lists, Radiosonde Recorders AN/TMQ-5, AN/TMQ-5A, AN/TMQ-5B, and AN/TMQ-5C.**
TM 11-6660-206-12	**Operator's and Organizational Maintenance Manual, Rawin Sets AN/GMD-1A (NSN 6660-00-224-6317, AN/GMD-1B (NSN 6660-00-599-8252), AN/GMD-1C (NSN 6660-01-007-7797) and AN/GMD-1D (NSN 6660-01-072-9995).**
TM 11-6660-219-12	**Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tools Lists: Radiosonde Baseline Check Set AN/GMM-1 and AN/GMM-1A (NSN 6660-00-527-8392).**
TM 11-6660-220-10	**Operator's Manual Radiosonde Sets AN/AMT-12 and AN AMT-12A.**
TM 11-6660-228-10	**Operator's Manual, Radiosonde Set AN/AMT-4D.**
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

APPENDIX A

REFERENCES

The following publications contain information applicable to the operation and maintenance of Radiosonde recorder AN/TMQ-5(*).

DA Pam 310-1	Consolidated Index of Army Publications and Blank Forms.
DA Pam 738-750	The Army Maintenance Management System (TAMMS).
TM 11-6660-204-ESC	Equipment Serviceability Criteria for Radiosonde Recorder AN/TMQ-5(*).
TM 11-6660-204-10	Operator's Manual, Radiosonde Recorders AN/TMQ-5 (NSN 6660-00-324-9426), AN/TMQ-5A (NSN 6660-00-393-2234), AN/TMQ-5B (NSN 6660-00-393-2234) and AN/TMQ-5C (NSN 6660-00-682-4500).
TM 11-6660-204-24P-1	Organizational, Direct Support, General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Recording Set, Weather Data AN/TMQ-5C (NSN 6660-00-682-4500).
TM 11-6660-204-25P	Organizational, Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools Lists, Radiosonde Recorders AN/TMQ-5, AN/TMQ-5A, AN/TMQ-5B, and AN/TMQ-5C.
TM 11-6660-206-12	Operator's and Organizational Maintenance Manual, Rawin Sets AN/GMD-1A (NSN 6660-00-224-6317, AN/GMD-1B (NSN 6660-00-599-8252), AN/GMD-1C (NSN 6660-01-007-7797) and AN/GMD-1D (NSN 6660-01-072-9995).
TM 11-6660-219-12	Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tools Lists: Radiosonde Baseline Check Set AN/GMM-1 and AN/GMM-1A (NSN 6660-00-527-8392).
TM 11-6660-220-10	Operator's Manual Radiosonde Sets AN/AMT-12 and AN AMT-12A.
TM 11-6660-228-10	Operator's Manual, Radiosonde Set AN/AMT-4D.

APPENDIX B
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

B-1. General

This appendix provides a summary of the maintenance operations for AN/TMQ-5(*). It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix maybe used as an aid in planning maintenance operations.

B-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or eletrical charactitistics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an itim to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

B-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a “work time” figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate “work time” figures will be shown for each category. The number of task-hours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C - Operator/Crew
O - Organizational
F - Direct Support
H - General Support
D - Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in section IV, Remarks, which is pertinent to the item opposite the particular code.

B-4. Tool and Test Equipment Requirements (Sec. III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance caterogy allocated the tool or test equipment.

c. *Nomenclature.* This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

B-5. Remarks (Sec. IV)

a Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
00	RADIOSONDE RECORDER AN/TMQ-5(*)	Inspect		0.3					A
		Test		0.5				1, 5, 7	B
		Test			2.5			1-3, 5, 6, 8-10	C
		Service		0.2				7	D
		Service				3.0		1-3, 5, 6, 8-10	E
		Adjust		0.5				7	F
		Align		0.5				7	G
		Adjust			1.0			6, 8	H
		Align			1.0			6, 8	G
		Install		0.7				7	I
		Replace			1.0			6, 8	
		Repair		0.5				7	J
		Repair			1.5			6, 8	K
		Repair				2.0		6, 8	K
		Repair					2.5	6, 8	K
		Overhaul					30	1-10	
01	CABINET, ELECTRICAL EQUIPMENT CY-1390(*)/TMQ-5	Repair		0.5				7	J
		Repair			1.0			6, 8	K
		Repair					1.5	6, 8	K
02	PANEL, CONTROL C-834(*)/TMQ-5	Repair		1.5				7	J
		Repair			2.0			6, 8	K
03	CONVERTER, SIGNAL DATA CV-146(*)/TMQ-5	Repair			1.5			6, 8	K
		Adjust		0.5				1	
		Replace		0.8				5	
04	CABINET SUBASSEMBLY, ELECTRICAL EQUIPMENT MX-1482/TMQ-5	Repair			1.0			6, 8	K
05	POWER SUPPLY PP-968(*)/TMQ-5	Repair			1.5			6, 8	K
06	RECORDER, FREQUENCY TIME RO-88(*)/TMQ-5	Repair		1.0				7	J
		Repair			2.0			6, 8	K
07	CASE, ACCESSORIES CY-930/TMQ-5	Repair		0.5				7	J
08	COMPUTER, HUMIDITY - TEMPERATURE CP-223C/U	Repair		0.3				7	J
09	CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-2338/U (5 ea)	Replace		0.2					L
		Repair				1.0		6, 8	K
10	CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-2339/U	Replace		0.2					L
		Repair				1.0		6, 8	K
11	CABLE ASSEMBLY, POWER ELECTRICAL CX-1492/U	Replace		0.2					M
		Repair				1.0		6, 8	K
12	CABLE ASSEMBLY CX-3711/TMQ-5	Replace		0.2					N
		Repair				1.0		6, 8	K
13	CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-2337/TMQ-5	Replace		0.2					M
		Repair				1.0		6, 8	K
14	CABLE ASSEMBLY CX-3712/U	Replace		0.2					N
		Repair				1.0		6, 8	K

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR
RADIOSONDE RECORDERS AN/TMQ-5(*)

OOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	IATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	O, F, H, D	MULTIMETER, AN/USM-223 *	625-00-999-7465	
2	F, H, D	OSCILLOSCOPE, AN/USM-281 A *	625-00-228-2201	
3	F, H, D	SCALE, WEIGHING	670-00-599-5296	
4	D	TEST SET, ELECTRON TUBE TV-2/U	625-00-699-0263	
5	O, F, H	TEST SET, ELECTRON TUBE TV-7D/U	625-00-820-0064	
6	F, H, D	TOOL KIT, TK-100/G	180-00-605-0079	
7	O	TOOL KIT, TK-101 /G	180-00-064-5178	
8	F, H, D	TOOL KIT, TK-105/G	180-00-610-8177	
9	F, H, D	WATCH, STOP	645-00-126-0286	
10	F, H, D	FREQUENCY STANDARD TS-65C/FMQ-1	625-00-649-4279	
		* Or equivalent test equipment		

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A.	VISUAL INSPECTION
B.	ELECTION TUBES, CONTINUITY TESTs.
C.	OPERATIONAL TESTS INCLUDES CHART FEED, SPEAKER OUTPUT, PEN PERFORMANCE, PEN LIFTER, HYSTERESIS, SIGNAL SENSITIVITY, LINEARITY CALIBRATION, AUTOMATIC TIME PRINT, VOLTAGES AND RESISTANCES, WAVESHAPES, AND DYNAMIC TESTING.
D.	PREVENTIVE MAINTENANCE INCLUDING INTERIOR CLEANING AND LUBRICATION OF MULTISPEED CHART DRIVE MECHANISMS.
E.	PREVENTIVE MAINTENANCE AND QVERHAUL OF ELECTRICAL EQUIPMENT CABINET, CABLE ASSEMBLIES, CONTROL PANEL SIGNAL DATA CONVERTER, FAN PANEL, POWER SUPPLY, AND FREQUENCY-TIME RECORDER.
F.	ADJUSTMENTS OF RECORDER PEN, AUTOMATIC TIME PRINT SWITCH, AND REGULATED POWER SUPPLIES.
G.	ALIGNMENT OF RECORDER PEN AND SLIDE WIRE.
H.	ADJUSTMENT OF RECORDER PEN, AND SENSITIVITY CONTROL, CHART FEED ADMUSTMENTS.
I.	SYSTEMS APPLICATIONS AND SITING.
J.	BY REPLACEMENT OF KNOBS, LAMPS, FUSES, CABLES, TUBES, AND ITEMS WHICH DO NOT REQUIRED SPECIAL TOOLS AND EQUIPMENT.
K.	BY REPLACEMENT OF AUTHORIZED PIECE PARTS
L.	USED ON AN/TMQ-5B AND AN/TMQ-5C.
M.	USED ON AN/TMQ-5 AND AN/TMQ-5A.
N.	USED ON AN/TMQ-5B.

INDEX

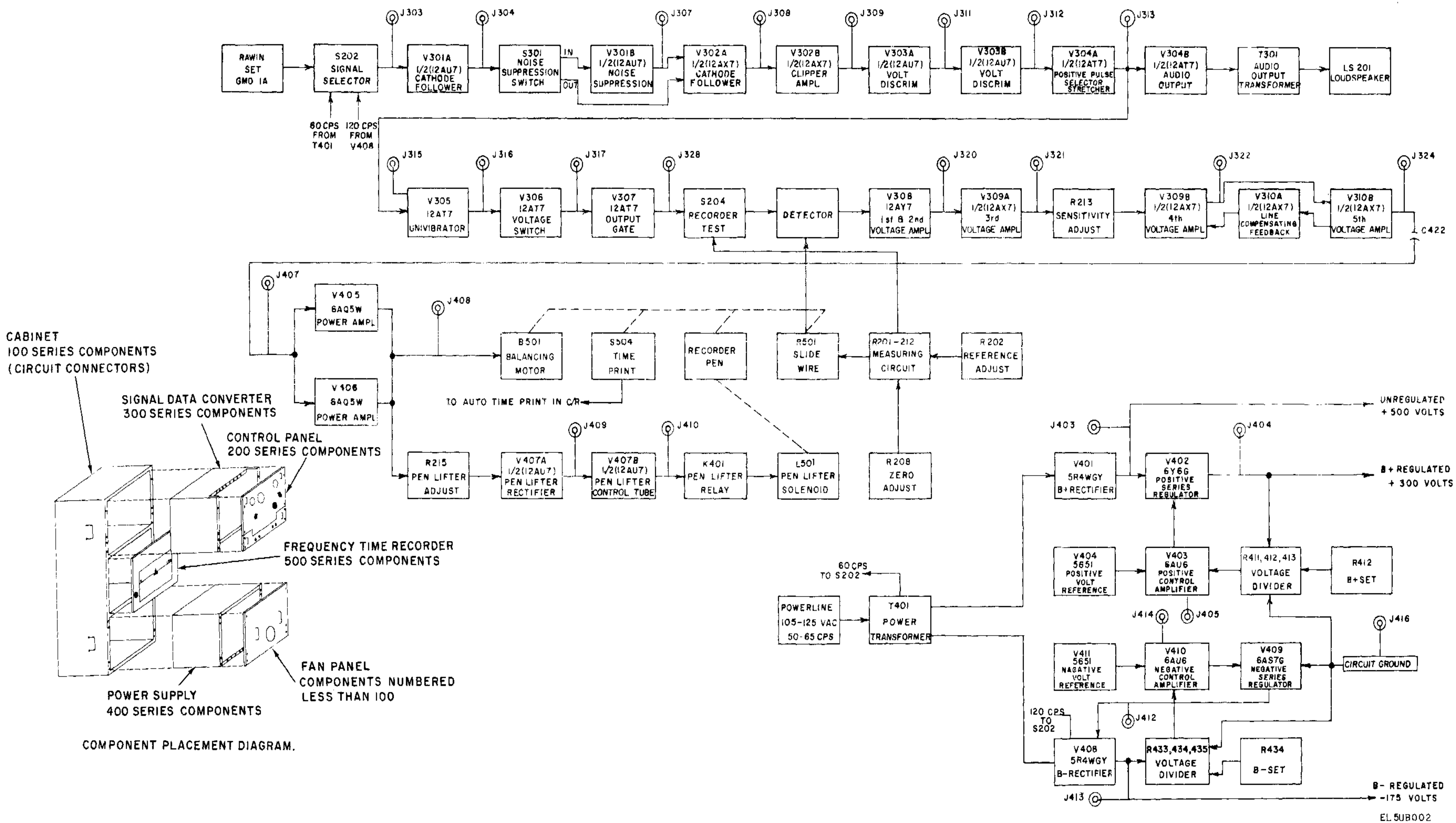
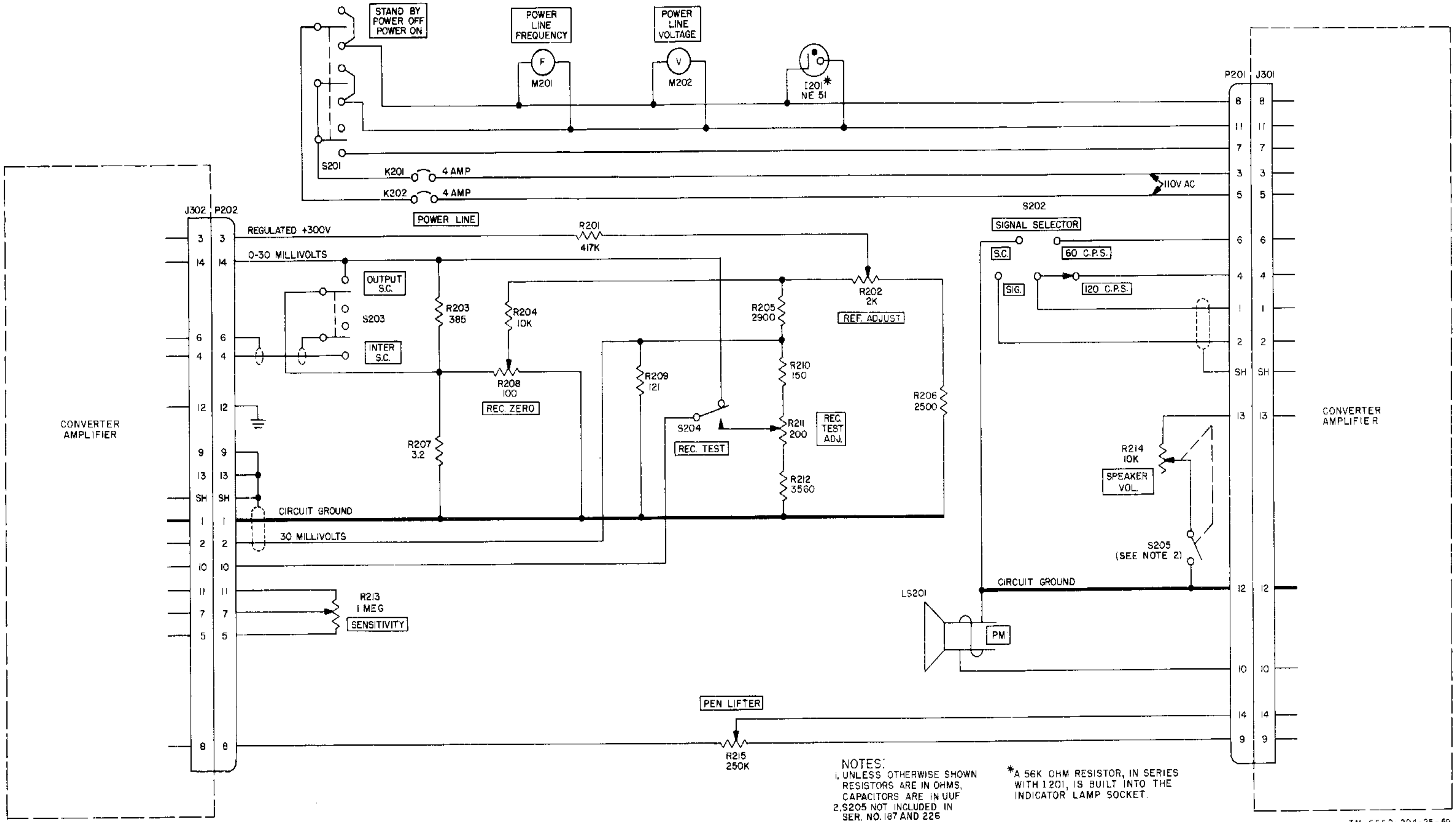


Figure FO-1. Radiosonde Recorder AN/TMQ-5(*), Detailed Block Diagram.



NOTES:
1. UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF
2. S205 NOT INCLUDED IN SER. NO. 187 AND 226 THROUGH 454

*A 56K OHM RESISTOR, IN SERIES WITH I201, IS BUILT INTO THE INDICATOR LAMP SOCKET.

TM-6660-204-25-59

Figure FO-2. Control Panel C-834/TMQ-5, schematic diagram.

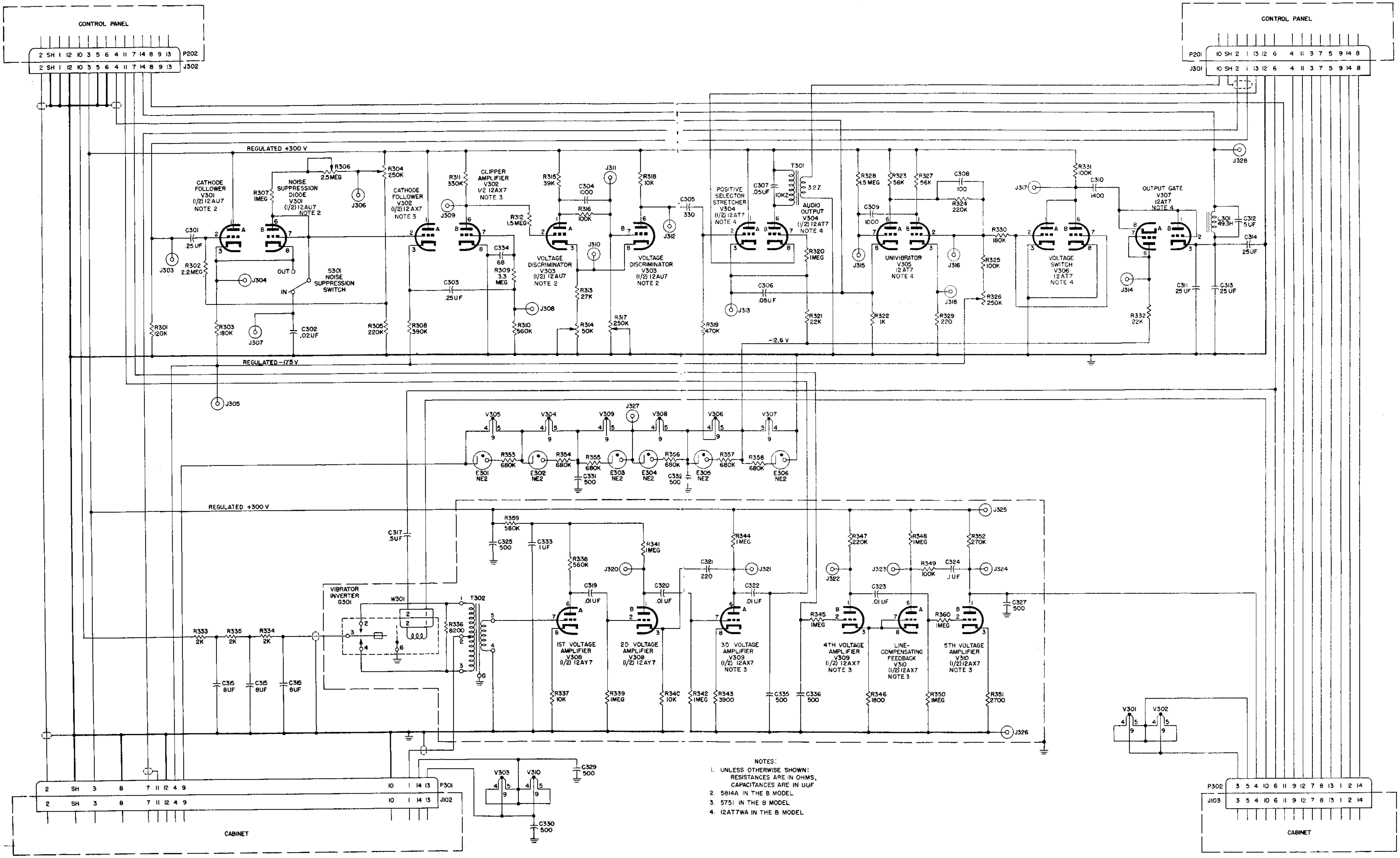


Figure FO-5. Signal Data Converter CV-146/TMQ-5, schematic diagram.

TM 6660-204-25-60

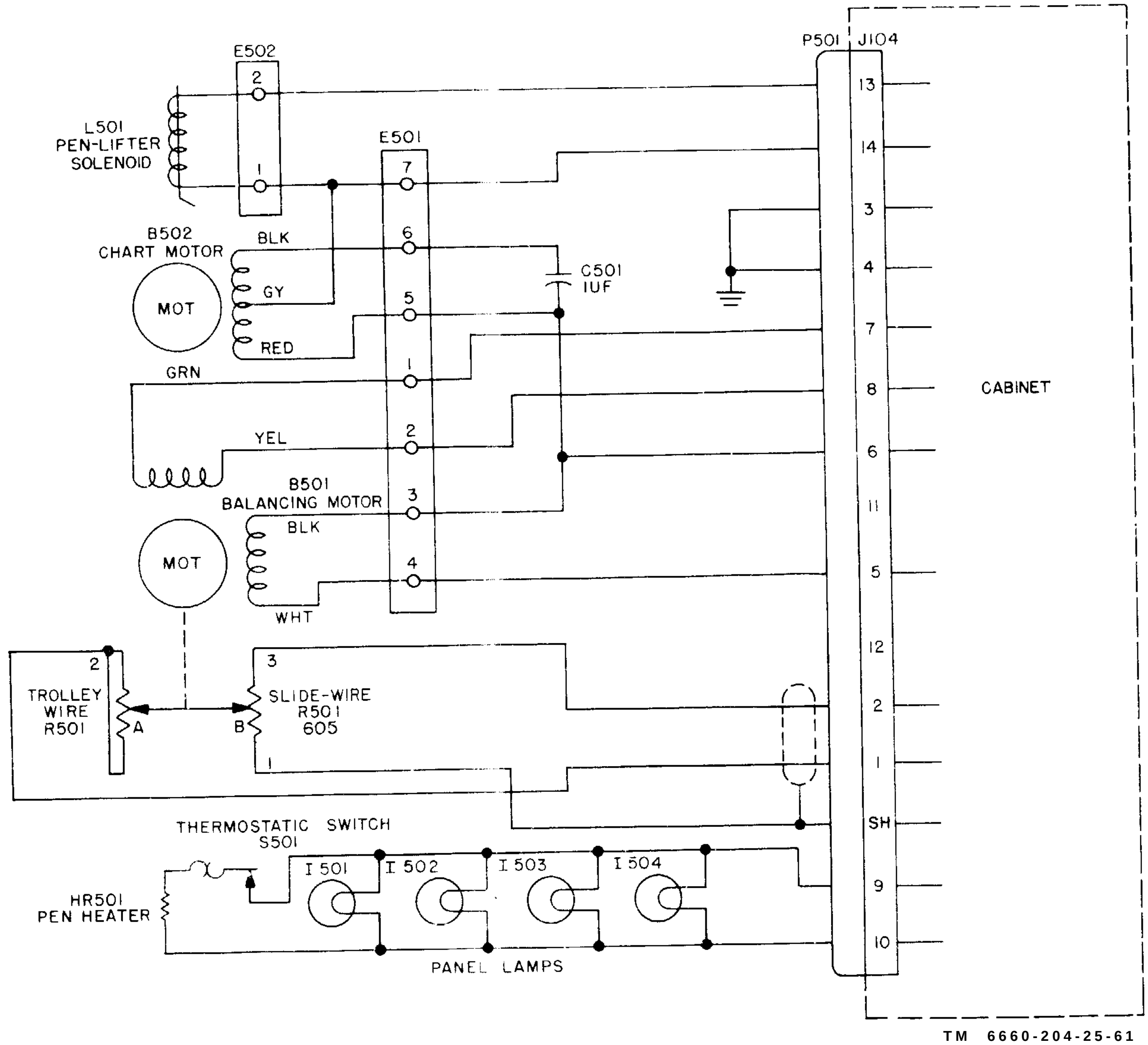
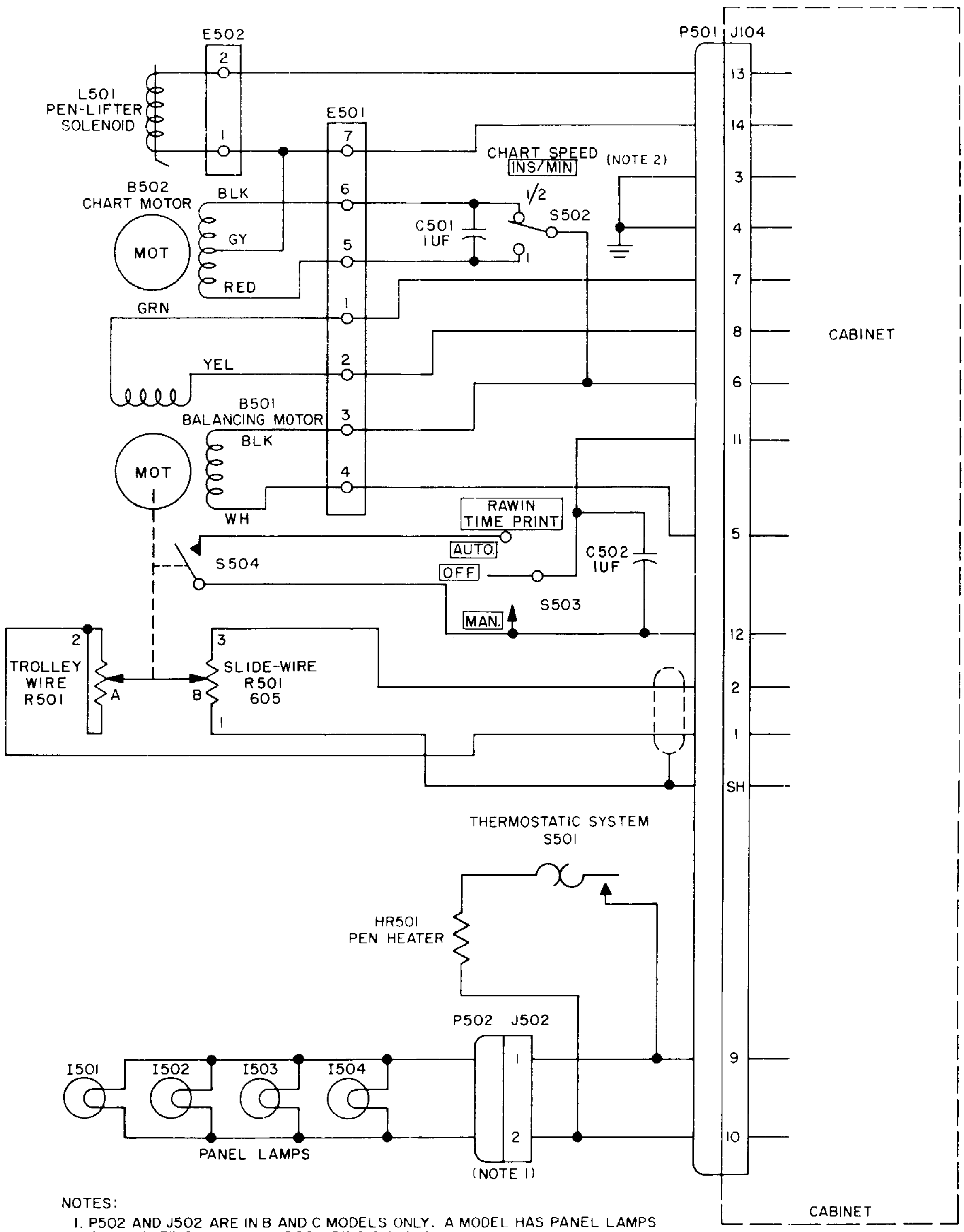


Figure FO-4 Frequency-Time Recorder RD-88/TMQ-5, schematic diagram.



NOTES:

1. P502 AND J502 ARE IN B AND C MODELS ONLY. A MODEL HAS PANEL LAMPS CONNECTED DIRECTLY TO P501, PINS 9 AND 10.

2. IN C MODEL, S502 AND JUMPER FROM TERMINAL 6 OF P501 TO S502 ARE NOT USED. A JUMPER IS ADDED BETWEEN TERMINALS 3 AND 5 OF E501. CHART SPEED IS CHANGED MECHANICALLY (GEAR CHANGES CONTROLLED BY PUSH BUTTONS).

TM 6660-204-25-62

Figure FO-5. Frequency-Time Recorder RD-88A/TMQ-5, schematic diagram.

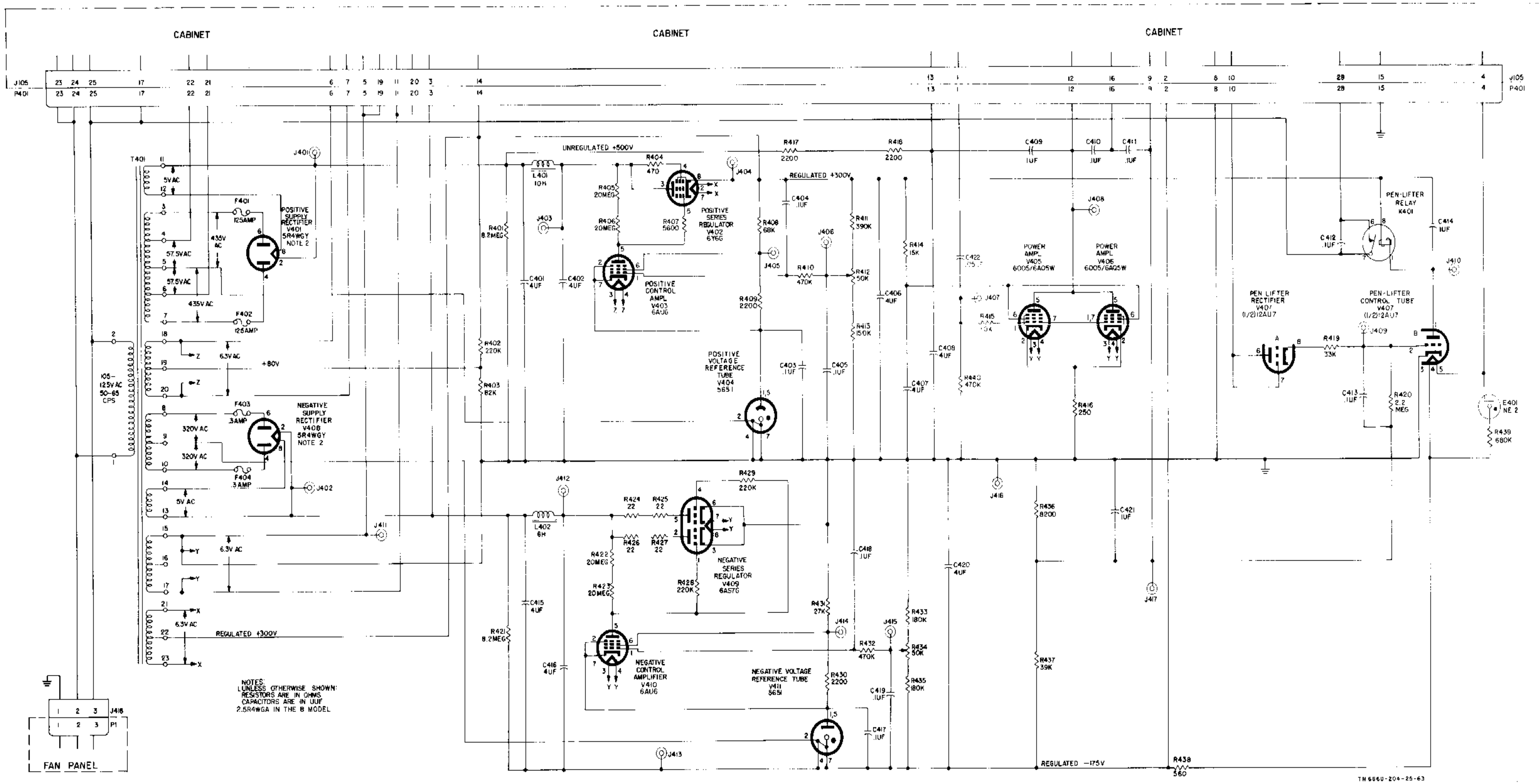


Figure FO-6. Power Supply PP-968/TMQ-5, schematic diagram.

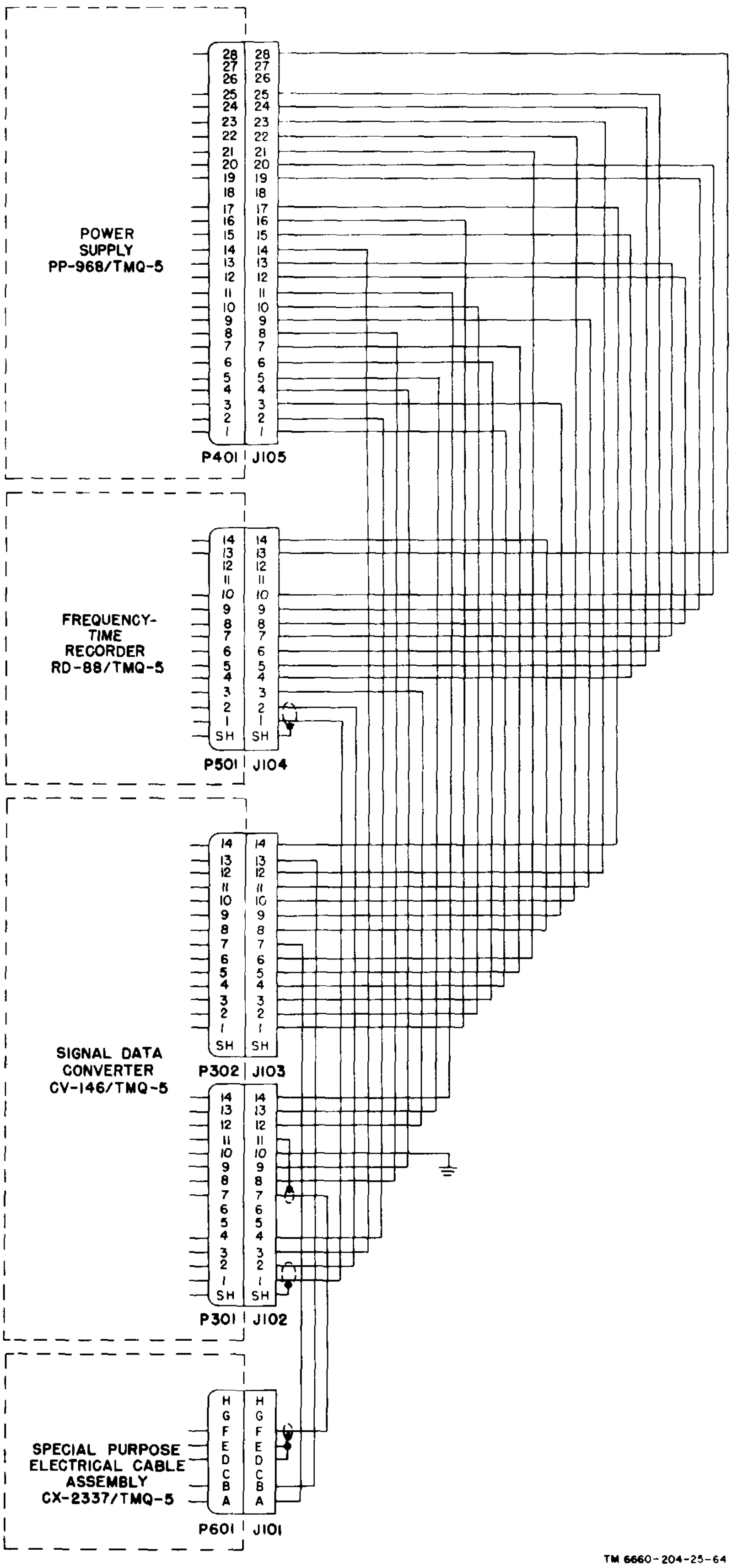


Figure FO–7. Electrical Equipment Cabinet CY–1390/TMQ-5, schematic diagram.

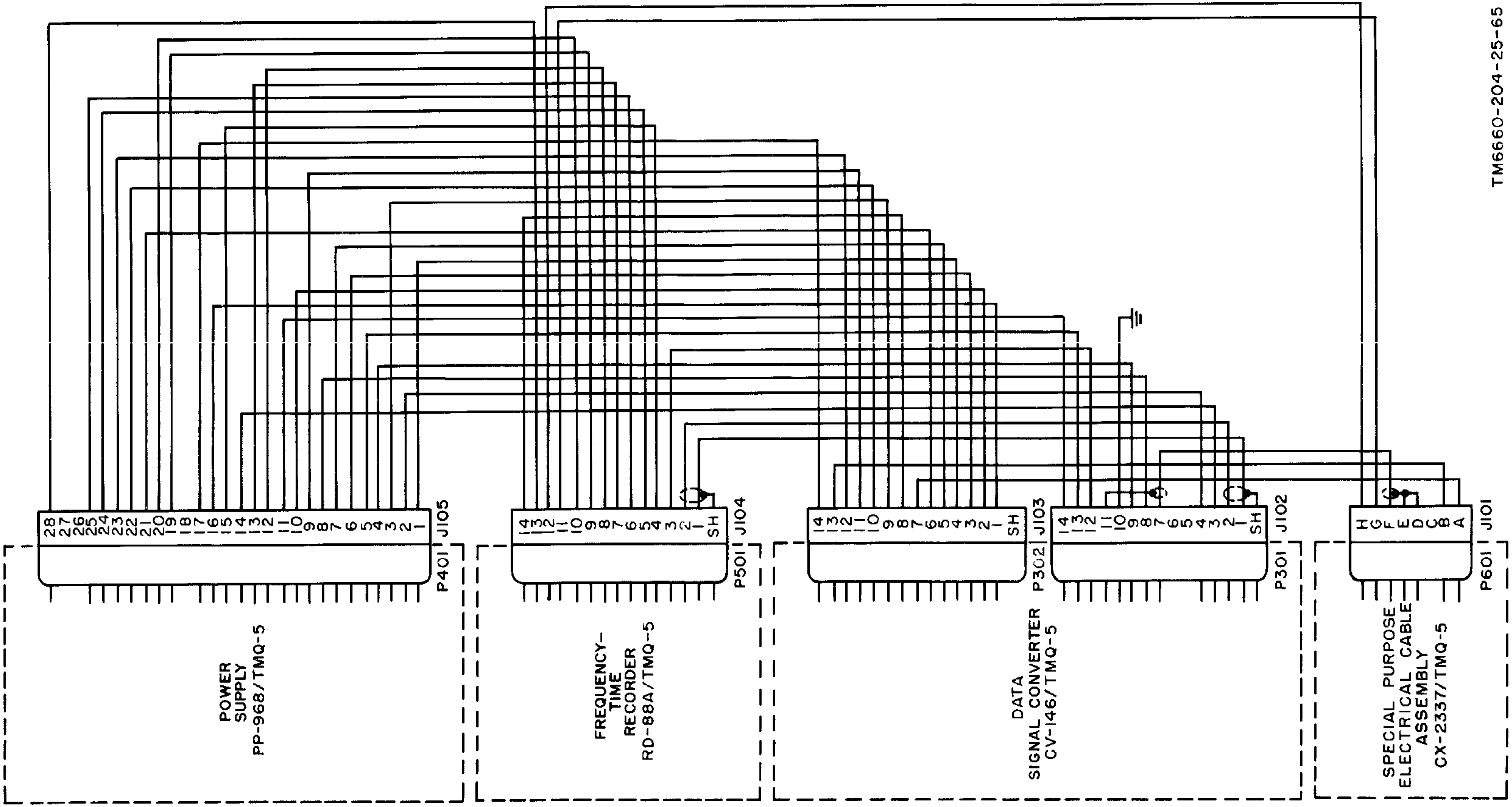


Figure FO-8. Electrical Equipment Cabinet CY-1390/TMQ-5, schematic diagram.

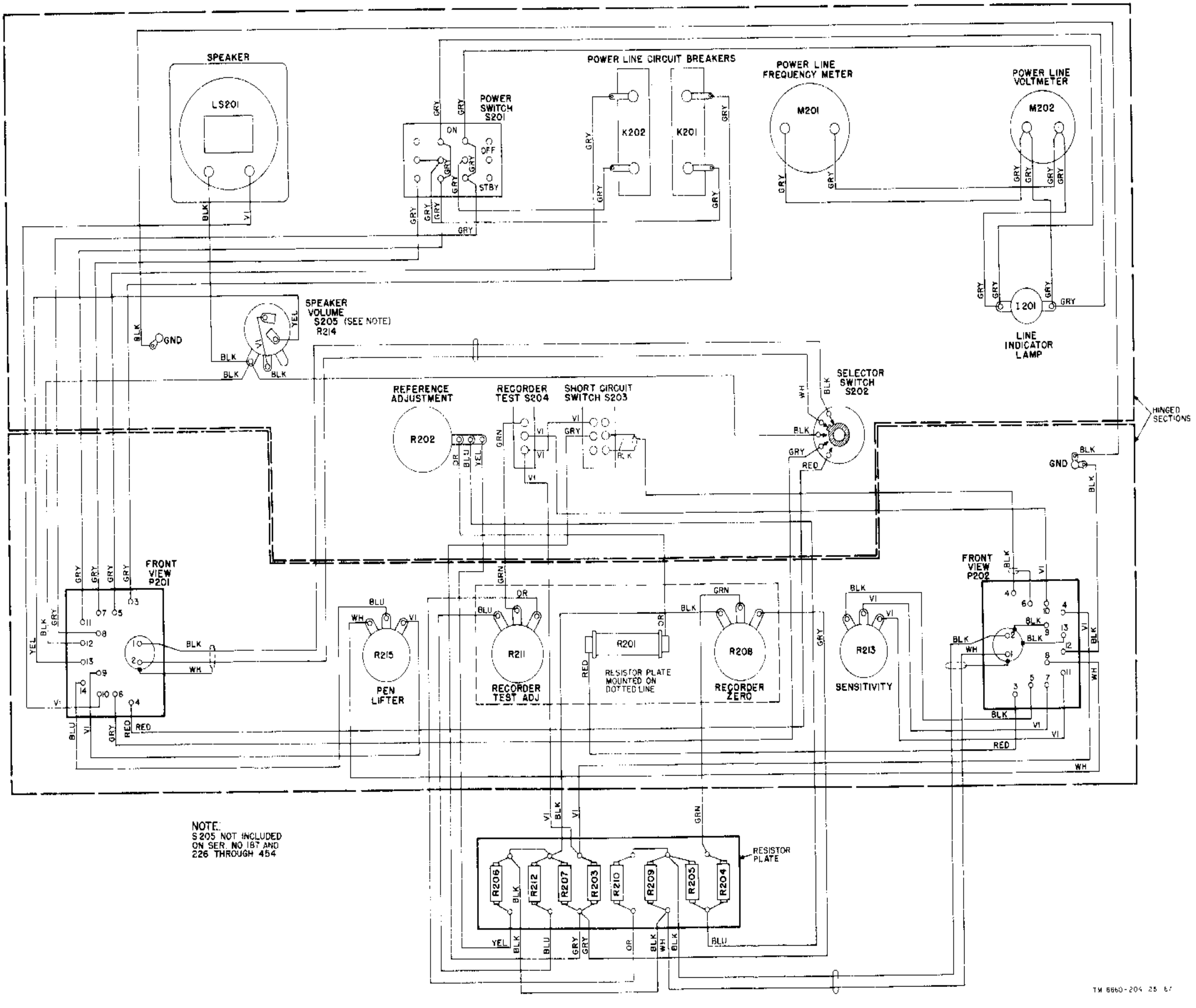


Figure FO-10. Control Panel C-334/TMQ-5, wiring diagram.

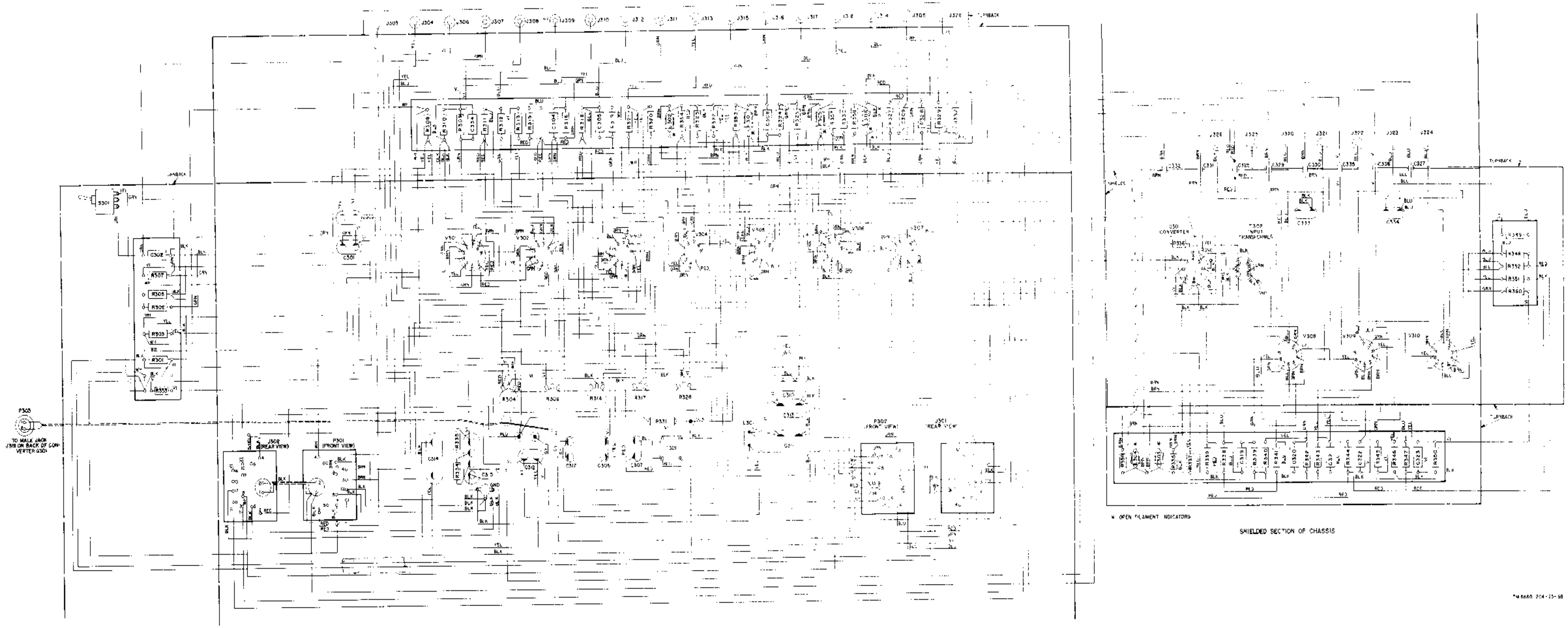


Figure FO-11. Signal Data Converter CV-146/TMQ-5, wiring diagram.

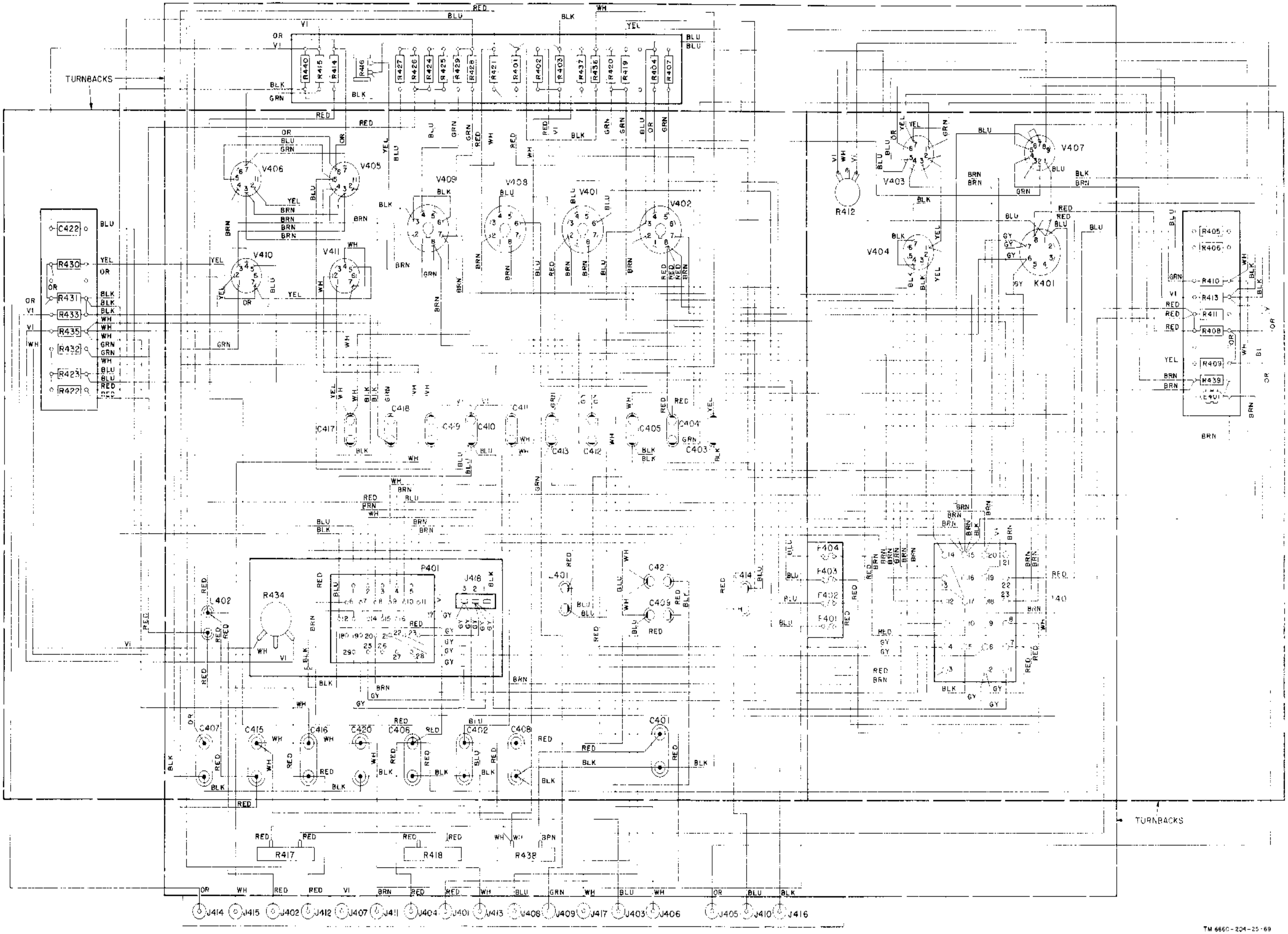
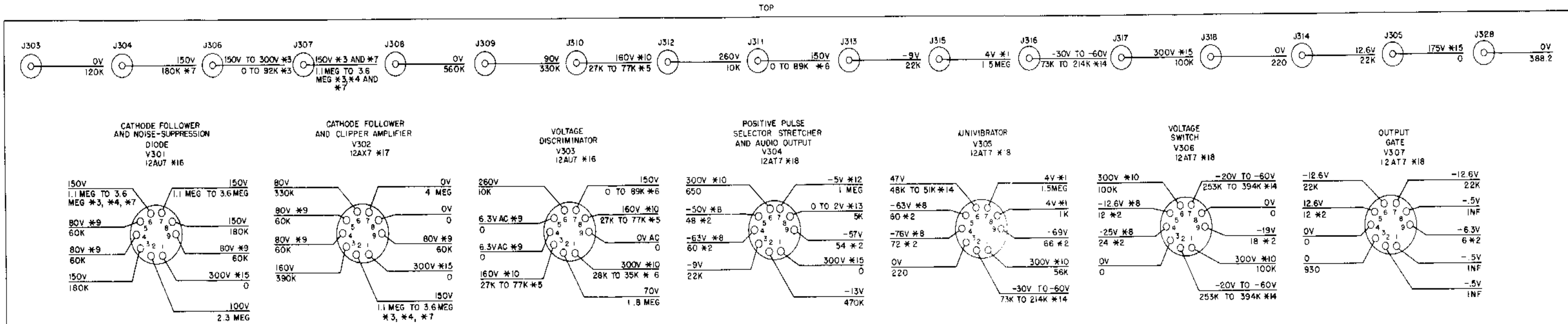


Figure FO-12. Power Supply PP-968/TMQ-5, wiring diagram.

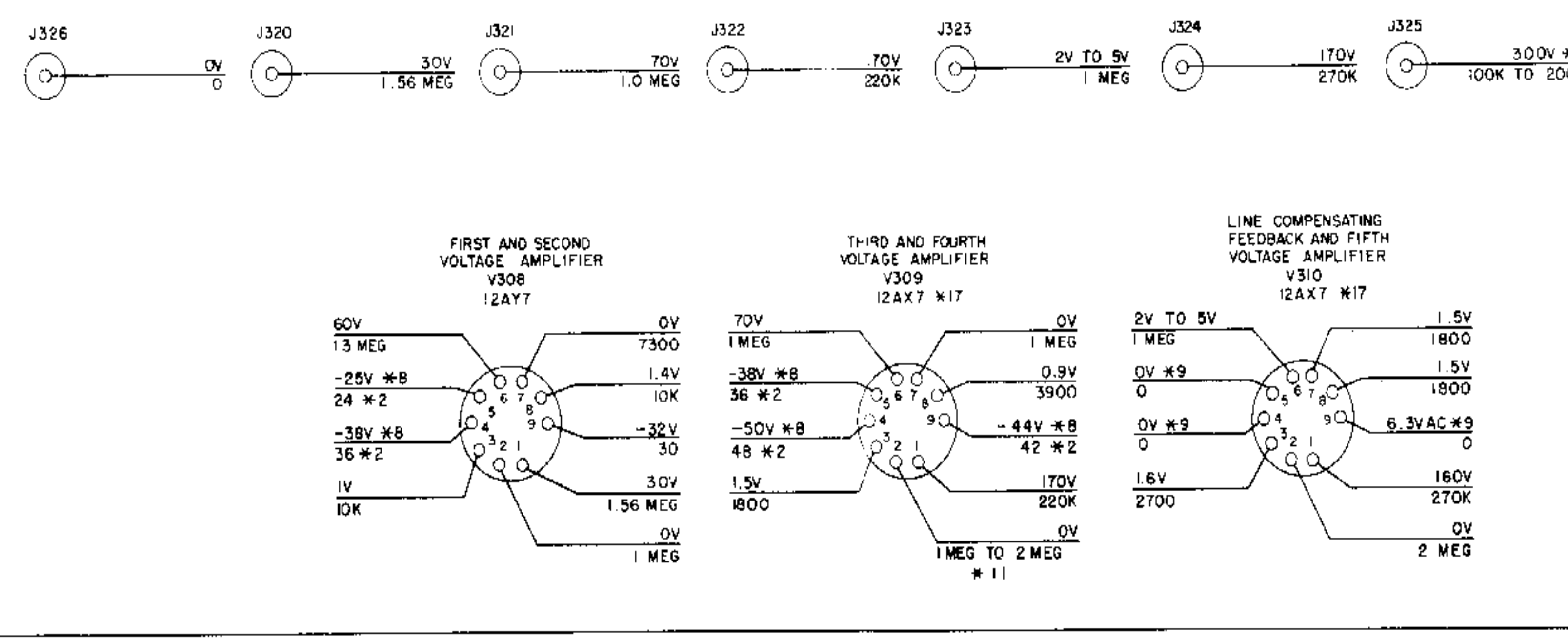


NOTES:

1. LINE VOLTAGE 115V AC 60 CYCLES.
2. SIGNAL SELECTOR SWITCH TO S.C.
3. VOLTAGE MEASURED TO CHASSIS, EXCEPT AS NOTED, WITH A 20,000 OHMS-PER-VOLT METER.
4. ALL VOLTAGES ARE POSITIVE, DC, ±20%, UNLESS OTHERWISE NOTED, AND WITH R314, R317, AND R326 PROPERLY ADJUSTED, AND NOISE SUPPRESSION SWITCH IN OUT POSITION UNLESS OTHERWISE NOTED.
5. RESISTANCE MEASUREMENTS ARE ±20%, UNLESS OTHERWISE NOTED, AND ARE MADE TO CIRCUIT GROUND WITH THE CHASSIS IN THE RACK, THE POWER SWITCH IN POWER OFF POSITION, AND THE POWER LINE SWITCH IN OFF POSITION, WITH J328 (B+) AND J305 (B–) CONNECTED TO CIRCUIT GROUND J326, AND WITH THE SPEAKER VOL. AT CENTER POSITION, AND NOISE SUPPRESSION SWITCH IN OUT POSITION, UNLESS OTHERWISE NOTED.
6. THE FOLLOWING CODE COLORS ARE USED FOR TEST TERMINALS IN CV-146A/TMQ-5:

J303 VIOLET	J308 VIOLET	J311 GREEN	J317 BLUE	J328 VIOLET	J321 BLUE
J304 YELLOW	J309 BLUE	J313 YELLOW	J318 YELLOW	J326 BLACK	J322 BLUE
J306 VIOLET	J310 YELLOW	J315 GREEN	J314 BLUE	J325 RED	J323 BLUE
J307 GREEN	J312 BLUE	J316 GREEN	J305 WHITE	J320 BLUE	J324 BLUE

*1 VOLTAGE IS ZERO WHEN SIGNAL SELECTOR SWITCH IS DEPRESSED TO INTER S.C. POSITION.
*2. RESISTANCE INCREASES WITH TIME, AS A RESULT OF HEATING OF FILAMENTS BY OHMMETER CURRENT
*3. DEPENDS ON SETTING OF R304.
*4. DEPENDS ON SETTING OF R306.
*5. DEPENDS ON SETTING OF R314.
*6. DEPENDS ON SETTING OF R317.
*7. NOISE SUPPRESSION SWITCH IN.
*8. 12.6V DC ACROSS FILAMENTS ±15%.
*9. 6.3V AC MEASURED BETWEEN PINS 9 AND 4 OR 5 ±8%.
*10. TOLERANCE IS ± 5%.
*11. DEPENDS ON SETTING OF SENSITIVITY, R213.
*12. MEASURED WITH ONE MEGOHM VOLTMETER.
*13. MEASURED WITH 200K VOLTMETER.
*14. DEPENDS ON SETTING OF R326
*15. TOLERANCE IS ±2%.
*16. 5814A IN THE B MODEL
*17. 5751 IN THE B MODEL
*18. 12AT7WA IN THE B MODEL



TM 6660-204-25-70

Figure FO-13. Signal Data Converter CV-146/TMQ-5, voltage and resistance diagram.

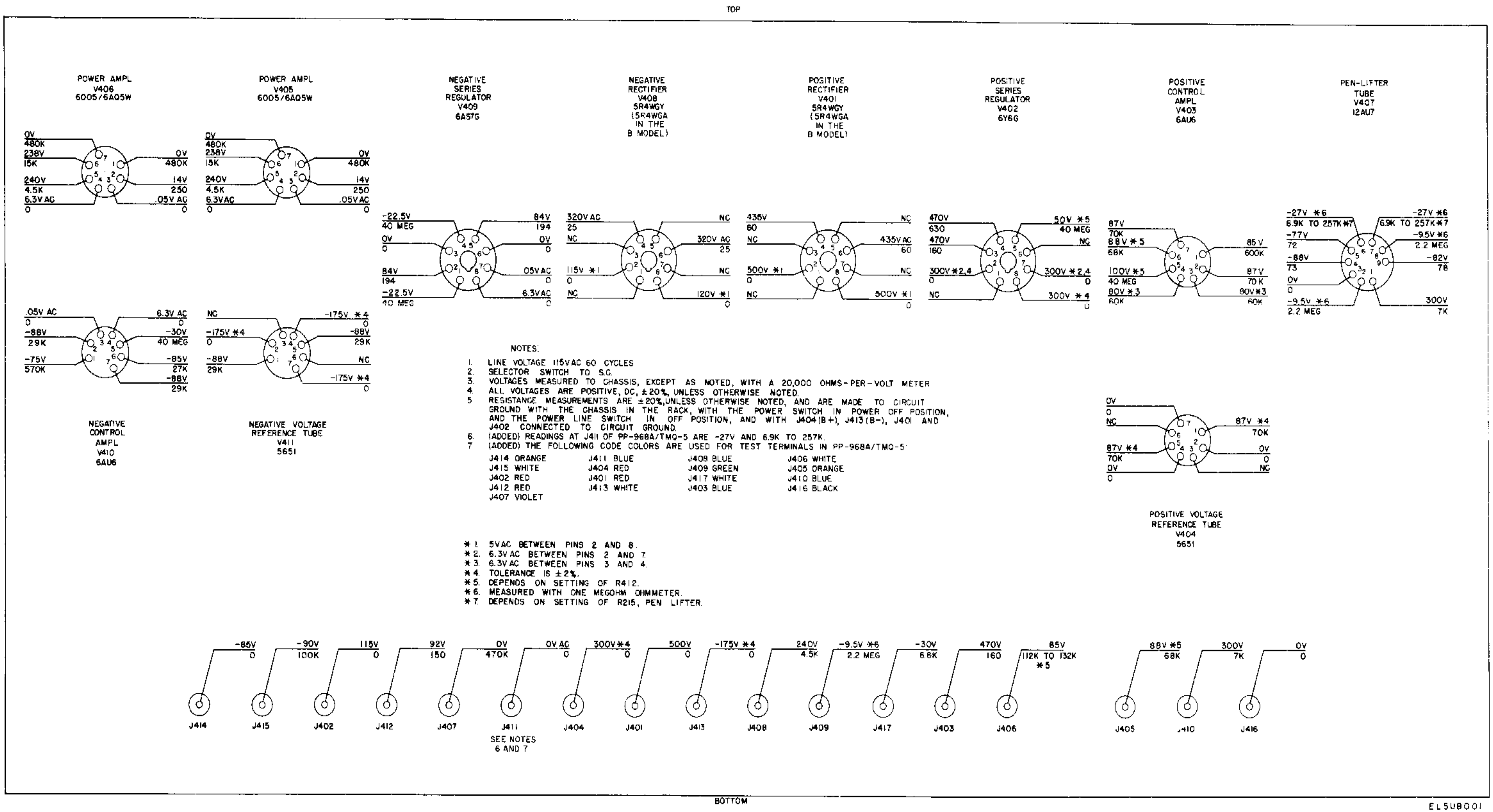
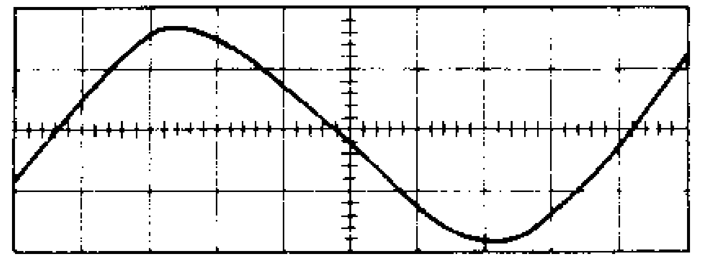
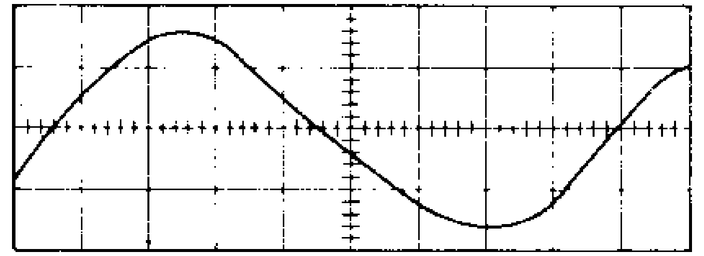


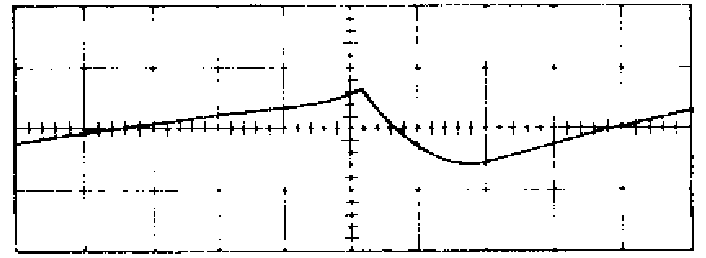
Figure FO-14. Power Supply PP-968/TMQ-5, voltage and resistance diagram.



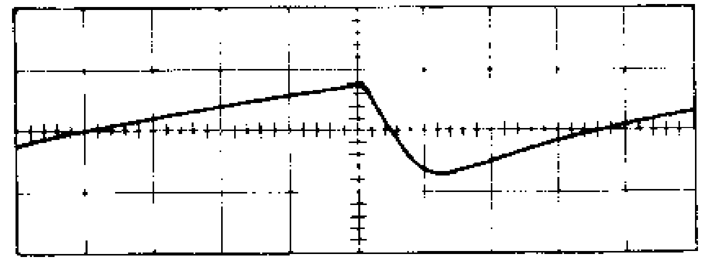
TEST POINT: J303 PROBE 10/1
VERTICAL: 5 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



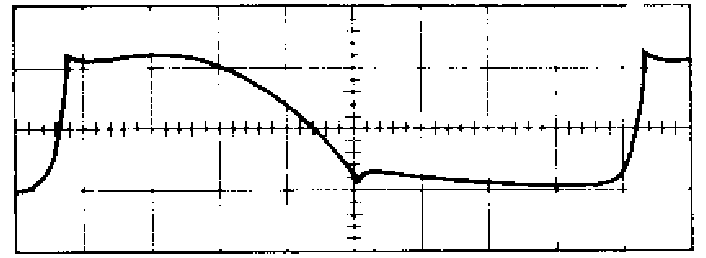
TEST POINT: J304 PROBE 10/1
VERTICAL: 5 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



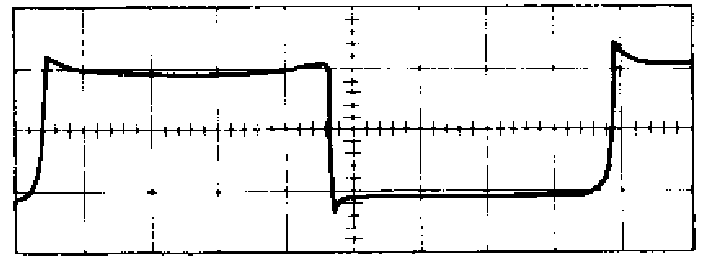
TEST POINT: J307 PROBE DIRECT
VERTICAL: [illegible] VOLTS/CENTIMETER
HORIZONTAL: [illegible] MILLISECONDS/CENTIMETER
(NOISE SUPPRESSION SWITCH IN)



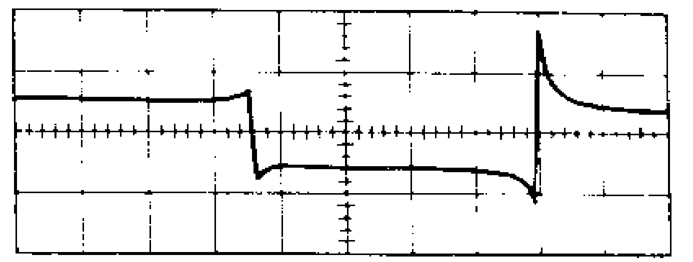
TEST POINT: J308 PROBE DIRECT
VERTICAL: 20 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(NOISE SUPPRESSION SWITCH IN)



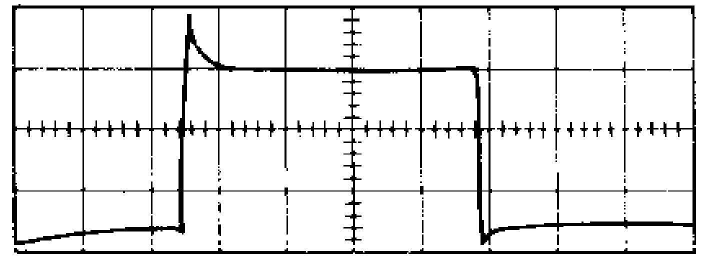
TEST POINT: J309 PROBE 10/1
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(NOISE SUPPRESSION SWITCH IN)



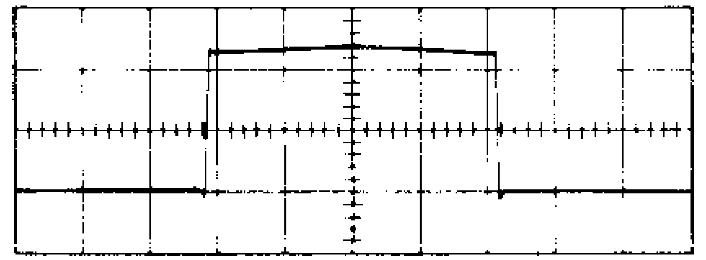
TEST POINT: J309 PROBE 10/1
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(NOISE SUPPRESSION SWITCH OUT)



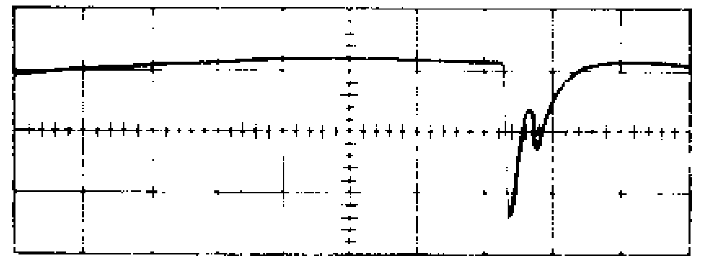
TEST POINT: J310 PROBE DIRECT
VERTICAL: 20 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(NOISE SUPPRESSION SWITCH OUT)



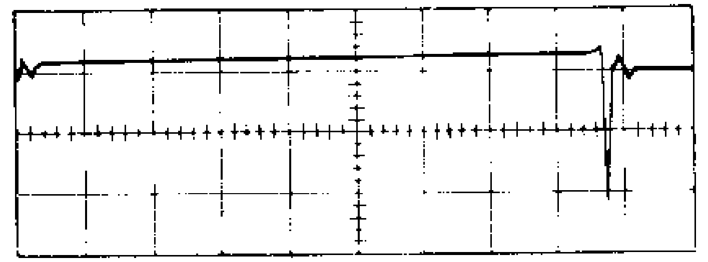
TEST POINT: J311 PROBE DIRECT
VERTICAL: 20 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



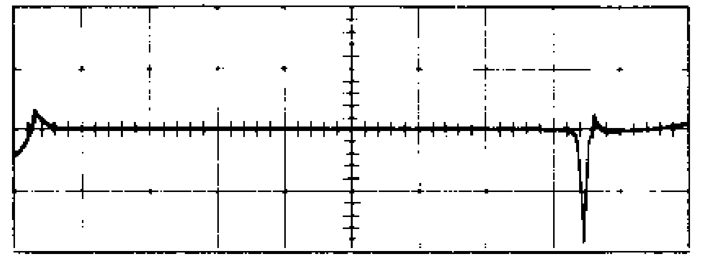
TEST POINT: J312 PROBE DIRECT
VERTICAL: 20 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



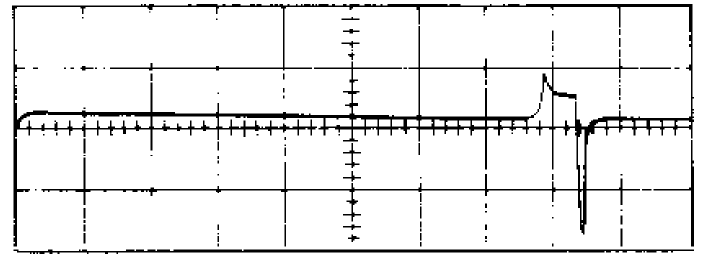
TEST POINT: J313 PROBE DIRECT
VERTICAL: [illegible] VOLTS/CENTIMETER
HORIZONTAL: [illegible] MILLISECONDS/CENTIMETER



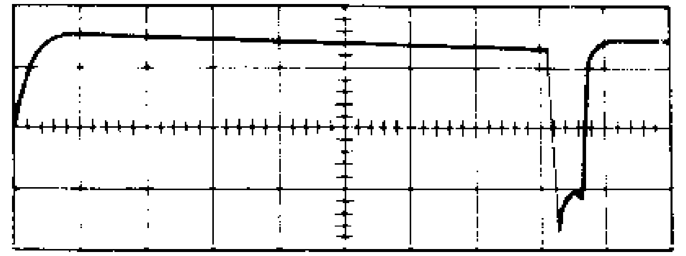
TEST POINT: J314 PROBE 10/1
VERTICAL: 5 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



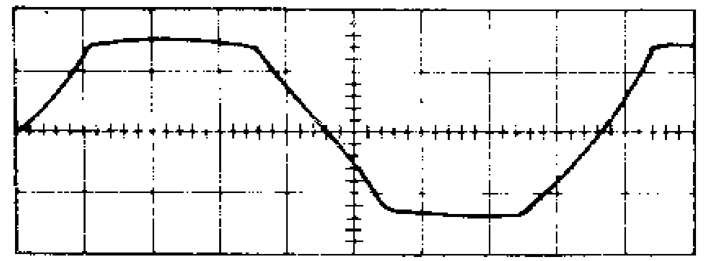
TEST POINT: J315 PROBE 10/1
VERTICAL: 20 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



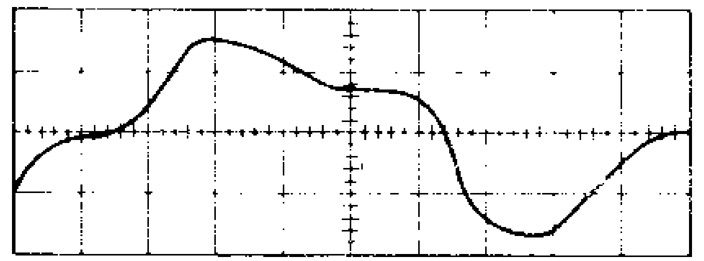
TEST POINT: J316 PROBE 10/1
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER



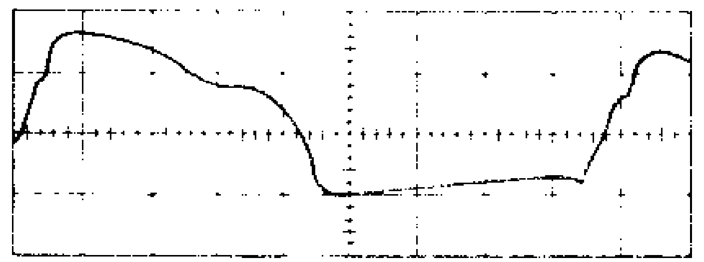
TEST POINT: J317 PROBE 10/1
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 5 MILLISECONDS/CENTIMETER



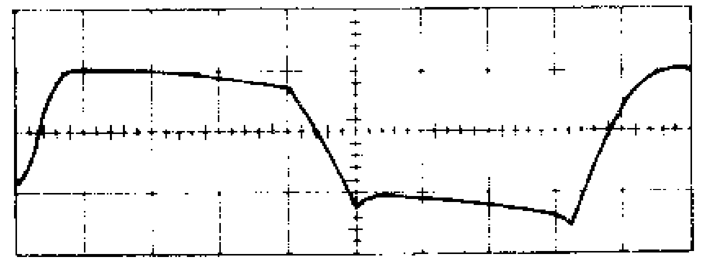
TEST POINT: J321 PROBE DIRECT
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(2% UNBALANCE IN DETECTOR)



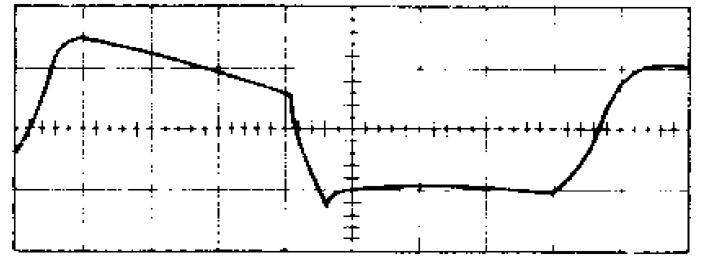
TEST POINT: J322 PROBE DIRECT
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(2% UNBALANCE IN DETECTOR)



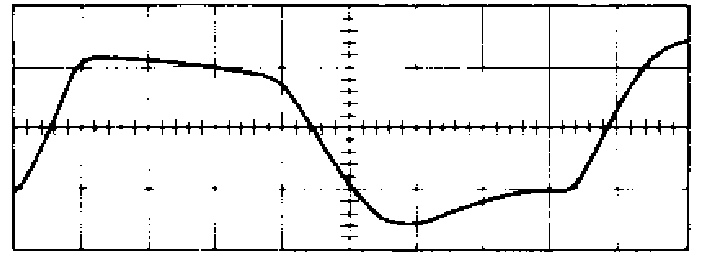
TEST POINT: J323 PROBE DIRECT
VERTICAL: [illegible] VOLTS/CENTIMETER
HORIZONTAL: [illegible] MILLISECONDS/CENTIMETER
(2% UNBALANCE IN DETECTOR)



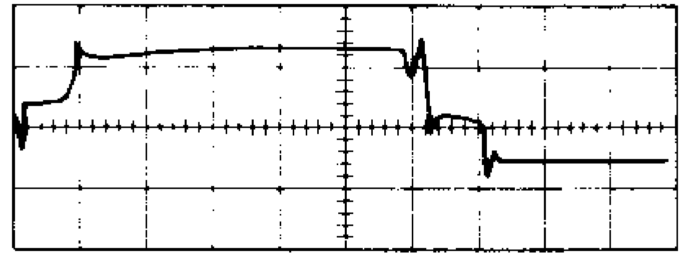
TEST POINT: J324 PROBE 10/1
VERTICAL: 5 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(2% UNBALANCE IN DETECTOR)



TEST POINT: J407 PROBE 10/1
VERTICAL: 5 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(2% UNBALANCED IN DETECTOR)



TEST POINT: J408 PROBE 10/1
VERTICAL: 10 VOLTS/CENTIMETER
HORIZONTAL: 2 MILLISECONDS/CENTIMETER
(2% UNBALANCE IN DETECTOR)

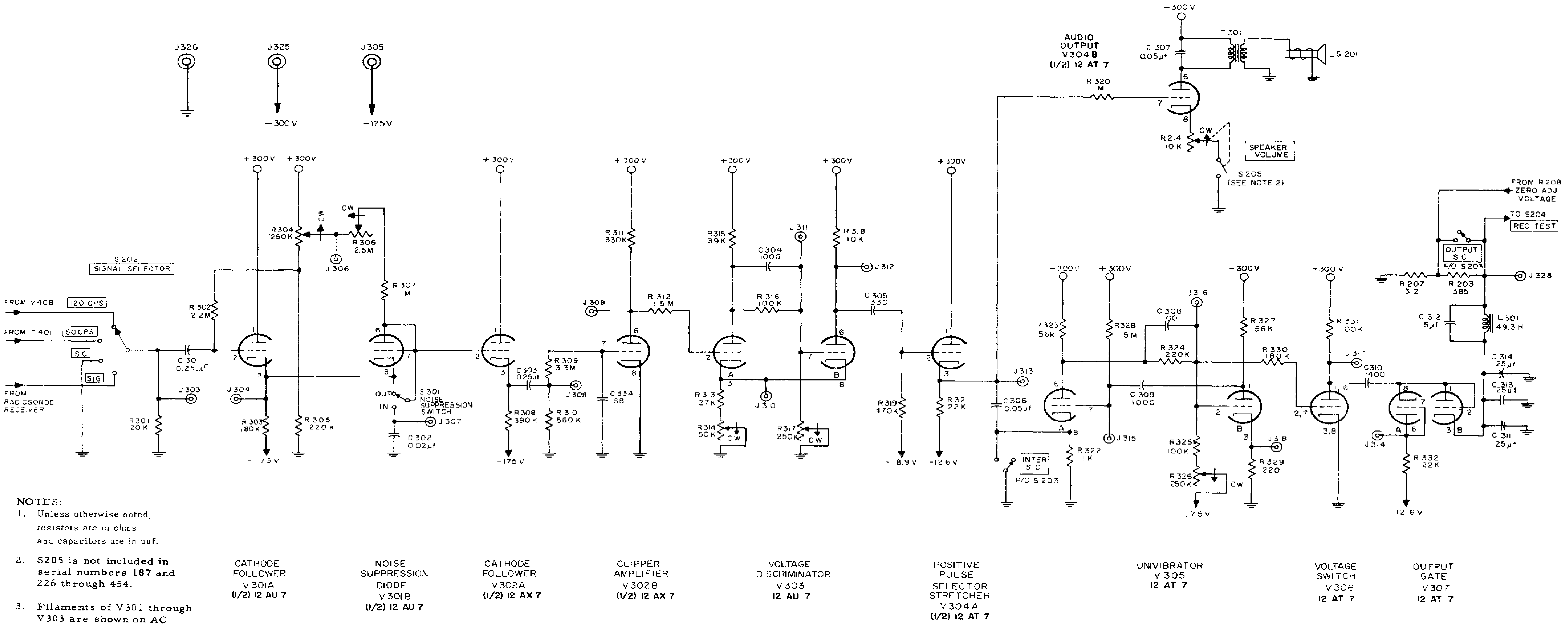


TEST POINT: PIN 6, V308 PROBE DIRECT
VERTICAL: .1 VOLTS/CENTIMETER
HORIZONTAL: .1 MILLISECONDS/CENTIMETER
(10% UNBALANCE IN DETECTOR)
(SET HORIZONTAL VERNIER TO DISPLAY ONE PULSE)

NOTES: 1. SIGNAL SELECTOR AT 60 CPS
2. POWER SWITCH IN STANDBY
3. AMPLITUDES MAY VARY 20%

EL 6660-204-25-TM-72

Figure FO-15. Signal Data Converter CV-146/TMQ-5, typical waveforms.



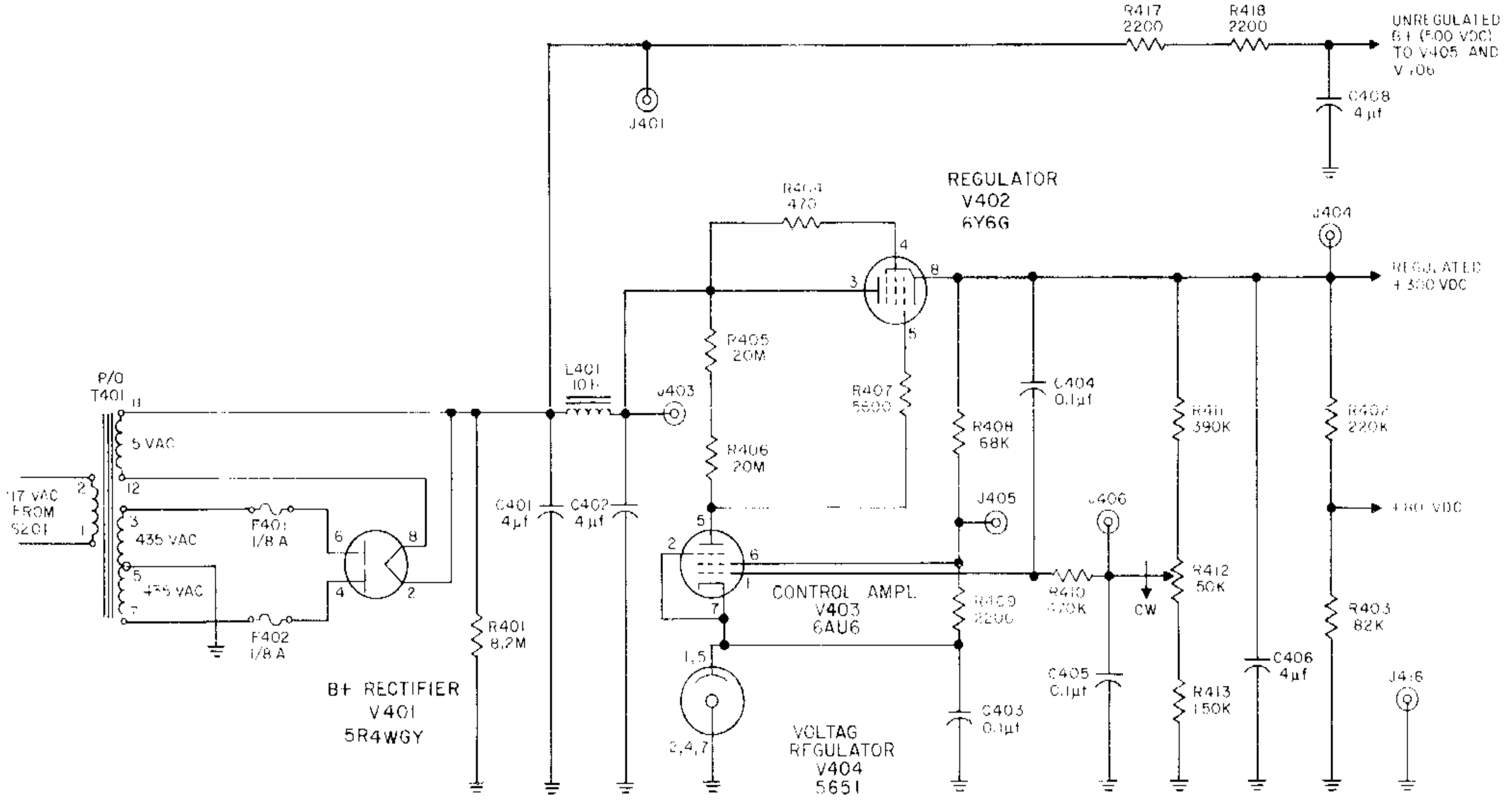
NOTES:

1. Unless otherwise noted, resistors are in ohms and capacitors are in uuf.
2. S205 is not included in serial numbers 187 and 226 through 454.
3. Filaments of V301 through V303 are shown on AC power distribution schematic. Filaments of V304 through V307 are shown on DC power distribution schematic.

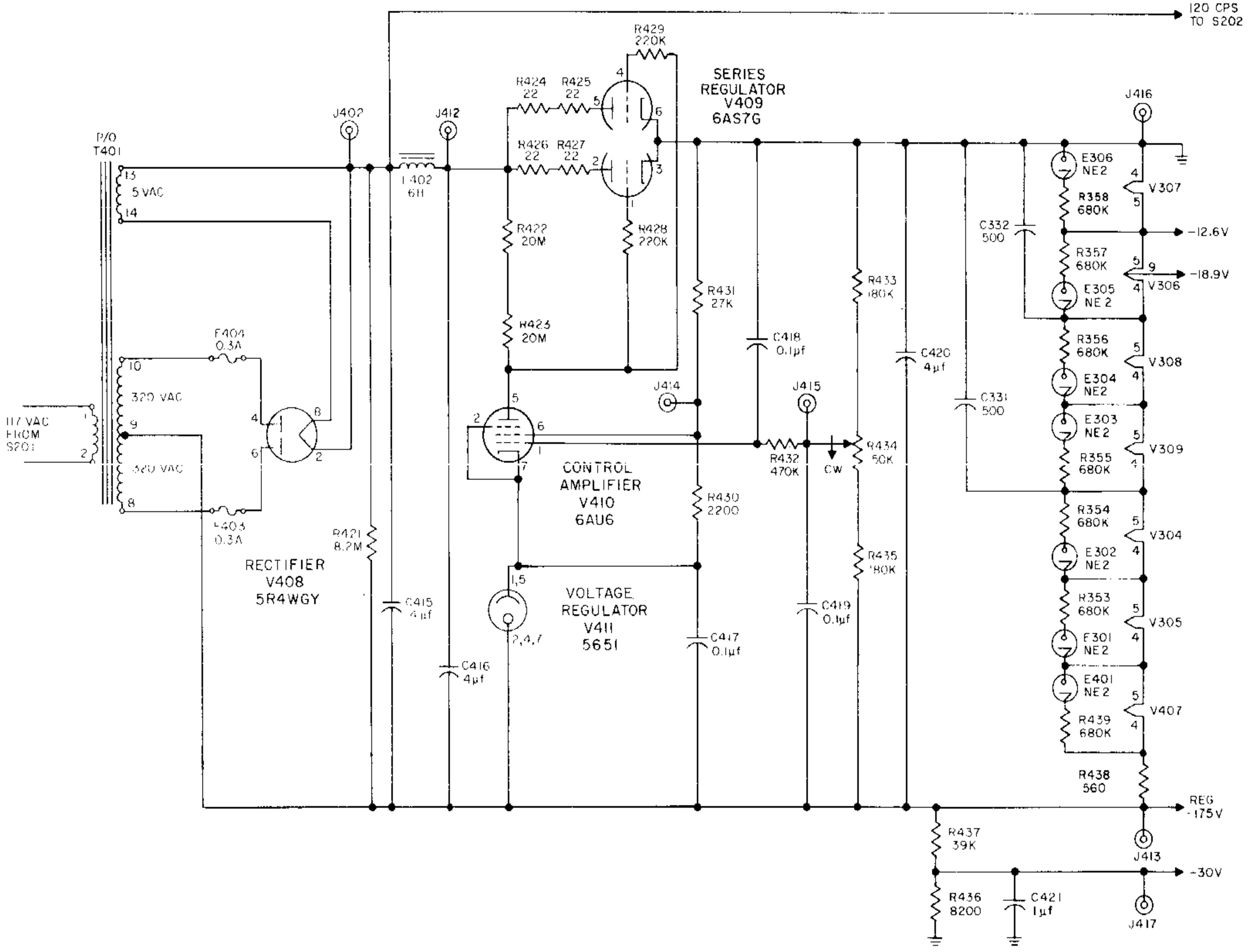
Figure FO-16. Radiosonde AN/TMQ-5( ) Signal Data Converter, Simplified Schematic Diagram.

NOTES:
1. Unless otherwise noted, resistors are in ohms, capacitors are in uuf.
2. Filaments of V308, V309 and V407 are shown on the DC power distribution schematic, filament of V310 is shown on the AC power distribution schematic.
3. The automatic time print feature is not included on service numbers 1 through 25.
4. In the AN/TMQ-5A, J411 is connected to pins 6 and 7 of V407.

FO-17. Radiosonde Recorder AN/TMQ-5( ) Servo Mechanism Circuit, Measuring and Pen Lifter Circuit, Simplified Schematic Diagram.



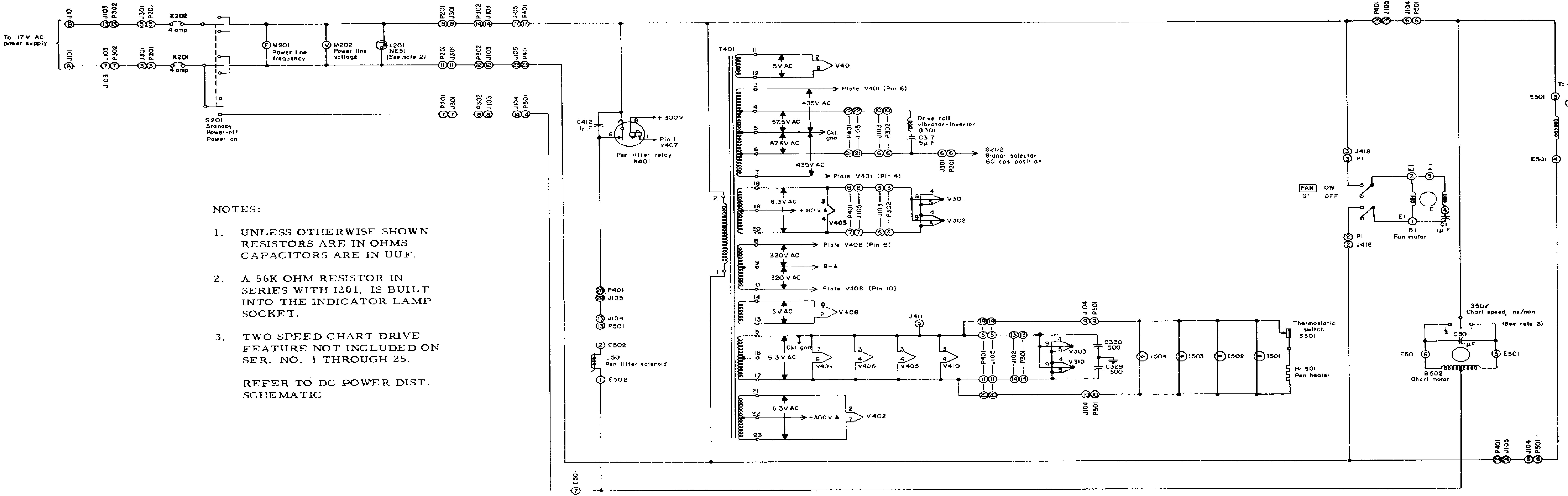
Positive power supply.



Negative regulated power supply.

EL5UB005

Figure FO-18. Radiosonde Recorder AN/TMQ-5( ) Power Supplies, Simplified Schematic Diagram.



NOTES:

1. UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS CAPACITORS ARE IN UUF.

2. A 56K OHM RESISTOR IN SERIES WITH I201, IS BUILT INTO THE INDICATOR LAMP SOCKET.

3. TWO SPEED CHART DRIVE FEATURE NOT INCLUDED ON SER. NO. 1 THROUGH 25.

REFER TO DC POWER DIST. SCHEMATIC

EL5UB006

Figure FO-19. Radiosonde Recorder AN/TMQ-5( ) AC Power Distribution, Schematic Diagram.

By Order of the Secretary of the Army:

W.C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:
KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

ribution:

Active Army:

USASA (2)
CNGB (1)
ACSC-E (2)
Dir of Trans (1)
CofEngrs (1)
TSG (1)
CofSptS (1)
USAARENBD (2)
USAMB (10)
USACDC (2)
USACDC Agcy (1)
USAMC (1)
CONARC (5)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (4)
USAREUR (10)
USARYIS (10)
LOGCOMD (5)
USAMICOM (4)
USATECOM (2)
USASTRATCOM (4)
USAESC (70)
MDW (1)
Armies (2)
Corps (2)
1st Cav Div (3)
Svc Colleges (2)
USASCS (10)
USASESS (20)
USAADS (20)
USAFAS (20)
USAARMS (10)
USAIS (10)
USAES (2)
USAINTS (3)
WRAMC (1)
USACDCEC (10)
Instl (2) except
- Fort Gordon (10)
- Fort Huachuca (10)
- WSMR (3)
- Fort Carson (25)

Army Dep (2) except
- LBAD (14)
- SAAD (30)
- TOAD (14)
- LEAD (7)
- NAAD (5)
- SVAD (5)

GENDEPS (2)
Sig Sec GENDEP (5)
Sig Dep (10)
Sig FLDMS (2)
ATS (1)
USAERDAA (2)
USAERDAW (5)
USACRREL (2)
MAAG (1)
USARMIS (1)
DPG (5)
JPG (5)
USAFABD (2)
Units org under fol TOE:
(2 cys each)
6-100
6-185
6-200
6-201
6-300
6-302
6-385
6-386
6-525
6-526
6-565
6-575
6-576
6-700
6-701
7
7-100
11-15
11-35
11-36
11-95
11-158
11-215
11-237
11-500(AA-AC)
17
17-100
29-134
29-136
37
37-100
39-51
57
67

NG: **State AG (3); Units—same as active army except allowance is one (1) copy to each unit.**

USAR: None.

For explanation of abbreviations used, see AR 810-50.

*U.S. GOVERNMENT PRINTING OFFICE: 1988-206-997/33470

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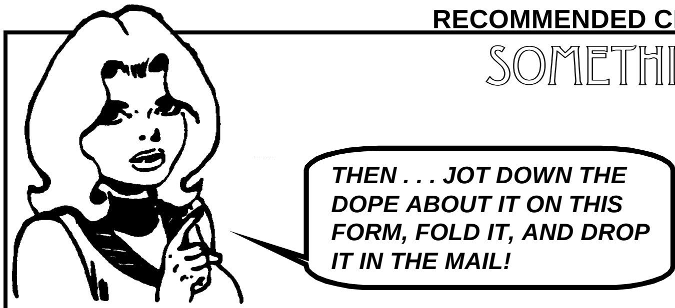

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THE METRIC SYSTEM AND EQUIVALENTS

NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

EIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

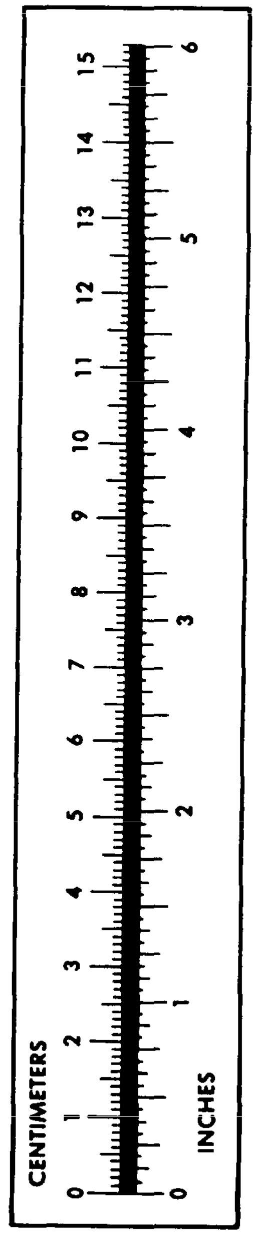
1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F



APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
nts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
ometers per Liter	Miles per Gallon	2.354
meters per Hour	Miles per Hour	0.621

PIN: 016172-004