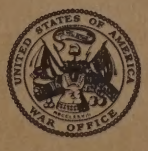
DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-2436

TO 31M1-2TMQ5-1

RADIOSONDE RECORDERS AN/TMQ-5 AND AN/TMQ-5A





DEPARTMENTS OF THE ARMY AND THE AIR FORCE

MARCH 1955

WARNING

HIGH VOLTAGE

is used in the operation
of this equipment

DEATH ON CONTACT

may result if operating
personnel fail to observe safety precautions

Be careful not to contact high voltage connections
or the power line voltage when testing
or servicing this equipment

TECHNICAL MANUAL
No. 11-2436
TECHNICAL ORDER
No. 31M1-2TMQ5-1

DEPARTMENTS OF THE ARMY AND
THE AIR FORCE

Washington 25, D. C., 9 March 1955

RADIOSONDE RECORDERS AN/TMQ-5 AND AN/TMQ-5A

		Paragraph	Page
CHAPTER 1.	INTRODUCTION		
Section I.	General	1, 2	3
II.	Description and data	3–11	3
CHAPTER 2.	OPERATION		
Section I.	Service upon receipt of equipment	12–21	18
II.	Controls and instruments	22, 23	29
III.	Operation under usual conditions	24–38	31
IV.	Operation under unusual conditions	39–42	39
CHAPTER 3.	ORGANIZATIONAL MAINTENANCE		
Section I.	Organizational tools and equipment	43, 44	40
II.	Preventive maintenance services	45–48	40
III.	Lubrication and weatherproofing	49, 50	45
IV.	Troubleshooting at organizational maintenance level	51–55	45
CHAPTER 4.	THEORY	56–74	50
5.	FIELD MAINTENANCE		
Section I.	Troubleshooting at field maintenance level	75–83	75
II.	Repairs	84–86	85
III.	Alinement and adjustment	87–94	91
IV.	Final testing	95–104	96
CHAPTER 6.	SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE.		
Section I.	Shipment and limited storage	105, 106	99
II.	Demolition of materiel to prevent enemy use	107, 108	99
INDEX		---	107

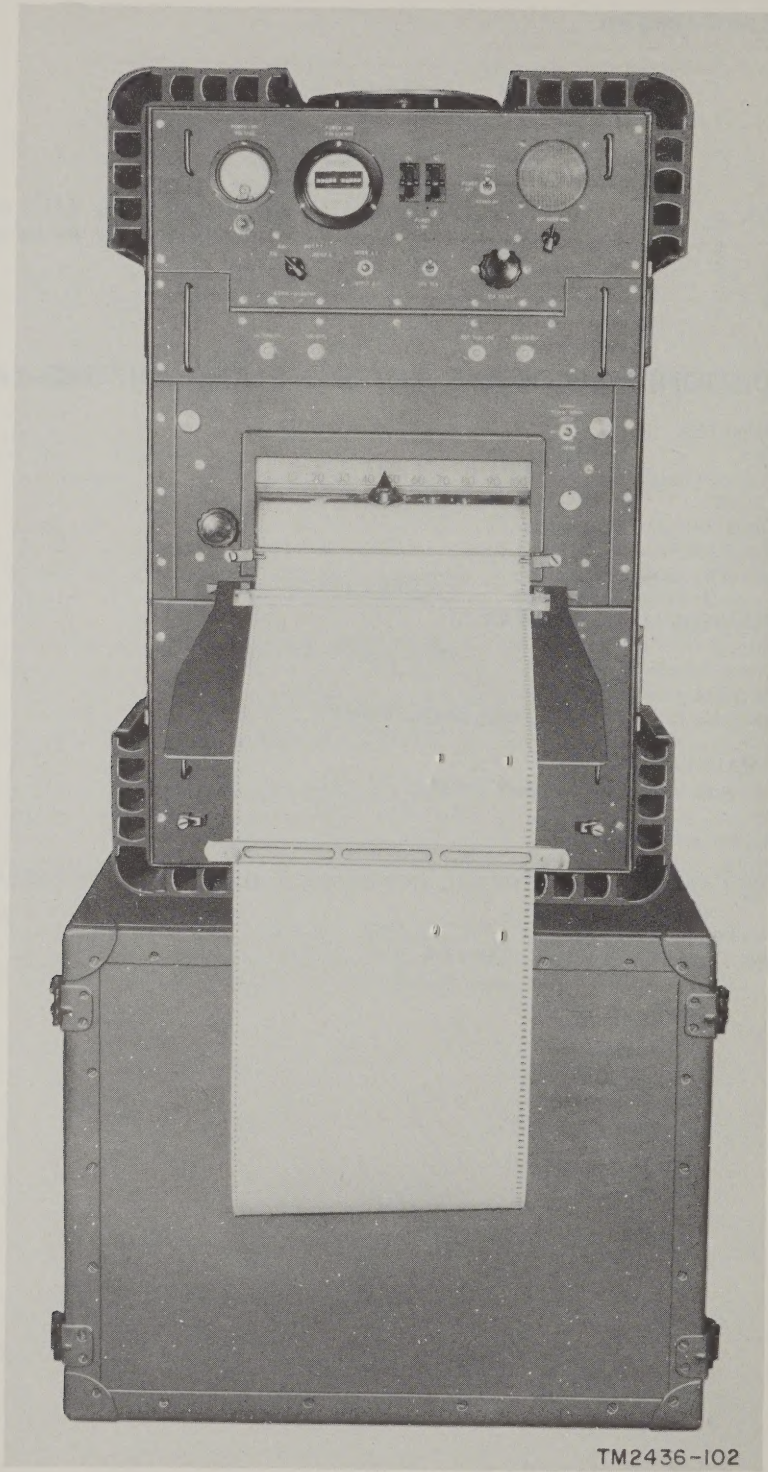


Figure 1. Radiosonde Recorder AN/TMQ–5A.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains instructions covering the installation, operation, maintenance (both organizational and field), alinement, and repair of Radiosonde Recorder AN/TMQ–5 and Radiosonde Recorder AN/TMQ–5A (fig. 1).

b. Official nomenclature followed by (*) indicates all models of the equipment item covered in this manual. Therefore, Radiosonde AN/AMT–2(*) represents Radiosondes AN/AMT–2 and AN/AMT–2A; Radiosonde AN/AMT–4(*) represents Radiosondes AN/AMT–4 and AN/AMT–4A; Rawin Set AN/GMD–1(*) represents Rawin Sets AN/GMD–1 and AN/GMD–1A; Radiosonde Recorder AN/TMQ–5(*) represents Radiosonde Recorders AN/TMQ–5 and AN/TMQ–5A.

c. Any comments on this manual will be forwarded directly to the Commanding Officer, Signal Corps Publications Agency, Fort Monmouth, New Jersey, ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army material and equipment, and in performing preventive maintenance:

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army), Navy Shipping Guide Article 1850–4 (Navy); and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer, as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded as prescribed in SR 700–45–5 and AF TD 00–35D–54.

d. DA Form 11–244, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radiosonde Receptor, Rawin) will be prepared in accordance with instructions on the back of the form (fig. 28).

e. DA Form 11–245, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radiosonde Receptor, Rawin), will be prepared in accordance with instructions on the back of the form (fig. 29).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. General. Radiosonde Recorder AN/TMQ–5(*) is an electronic meteorological instrument, which records on Graph Paper ML–432/TMQ–5 the weather information that is transmitted by a balloon-borne radiosonde. Application of the recorder in a radiosonde system is discussed in detail in paragraph 4. Radiosonde Recorder AN/TMQ–5A (fig. 2) is similar to Radiosonde Recorder AN/TMQ–5 (fig. 3) except for the differences described in paragraph 11. Units with serial numbers below 26 are Radiosonde Recorder AN/TMQ–5. Units with serial numbers 26 and above are Radiosonde Recorder AN/TMQ–5A. The discussion of system application (par. 4) applies to Radiosonde Recorders AN/TMQ–5 and AN/TMQ–5A.

b. Purpose. Radiosonde Recorder AN/TMQ–5(*) records, in printed form, weather information that is transmitted from a balloon-borne radiosonde.

c. Use. A signal is transmitted from a balloon-borne radiosonde, such as Radiosonde AN/AMT–4A (fig. 5). The transmitter of the radiosonde is modulated at an audio-frequency (af) rate, which

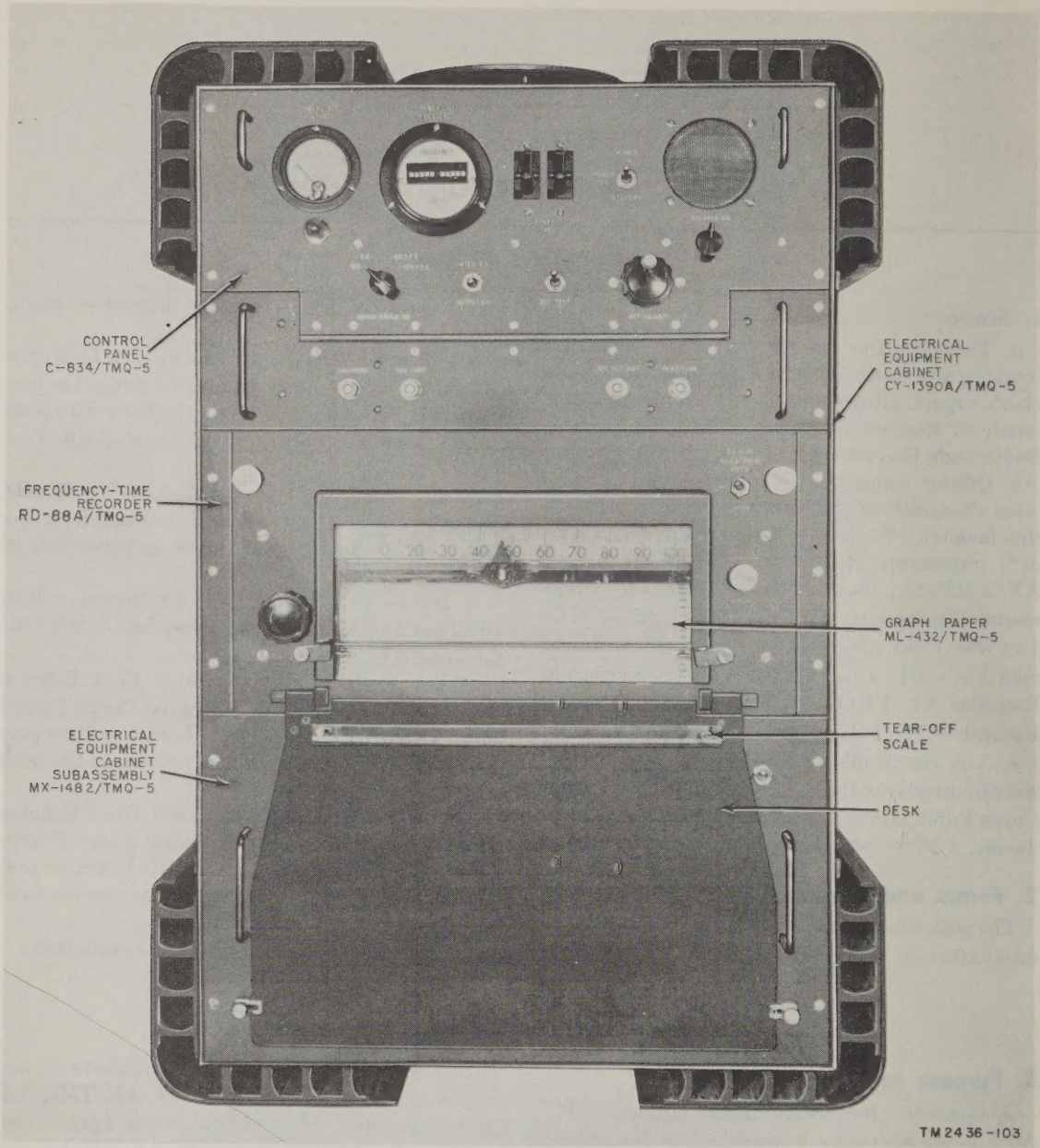


Figure 2. Radiosonde Recorder AN/TMQ–5A, front view operating components.

is determined by the meteorological factors of the atmosphere. The radiated signals are picked up by a radiosonde receiver, which amplifies and converts them to af signals of the proper wave shape. These af signals are then fed to Radiosonde Recorder AN/TMQ–5(*), which converts them to direct-current (dc) voltages; the value of the dc voltage at any instant is proportional to the af that creates it. This dc voltage excites a servo system that positions a pen in the recorder, and causes a graph to be drawn on calibrated paper. The record is then evaluated in terms of meteorological data, including temperature, pressure, and humidity. Radiosonde Recorder AN/TMQ–5A

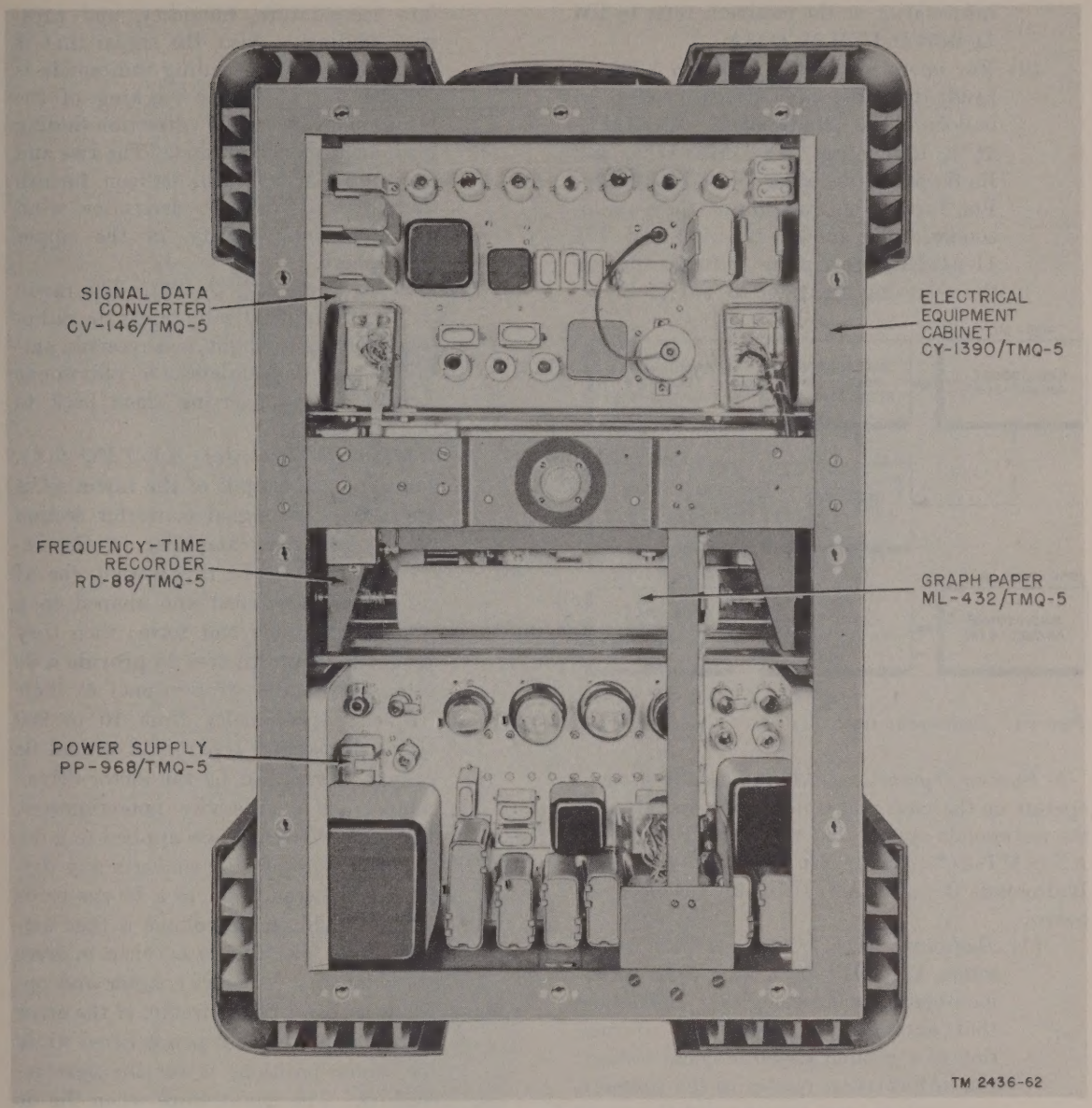


Figure 3. Radiosonde Recorder AN/TMQ–5, rear view operating components.

is adjusted to move at either of two speeds, ½ inch per minute, or 1 inch per minute. The higher chart speed is used when weather conditions cause the radiosonde balloon to rise relatively fast.

4. System Applications

a. Radiosonde Systems. Radiosonde Recorder AN/TMQ–5A may be used in any of the three radiosonde systems (fig. 4). They are described in the following:

(1) For operation on 403 megacycles (mc), use either of two radiosonde systems. One system consists of balloon-borne Radiosonde AN/AMT–2(*), Radiosonde Receiver R–228/FMQ–2, and Radiosonde Recorder AN/TMQ–5(*). The other system consists of balloon-borne Radiosonde AN/AMT–2(*), Radio Set SCR–658, and Radiosonde Recorder AN/TMQ–5(*). For more detailed information on these radiosondes, refer to TM 11–2430 and TM 11–2433. For further

information on the receivers, refer to TM 11–2434 and TM 11–1158A.

(2) For operation in the 1,660- to 1,700-mc band, the radiosonde system consists of balloon-borne Radiosonde AN/AMT–4(*), Rawin Set AN/GMD–1(*), and Radiosonde Recorder AN/TMQ–5(*). For further information on these radiosondes, refer to TM 11–2432 and TM 11–2432A. For more information on the receiving set, refer to TM 11–271.

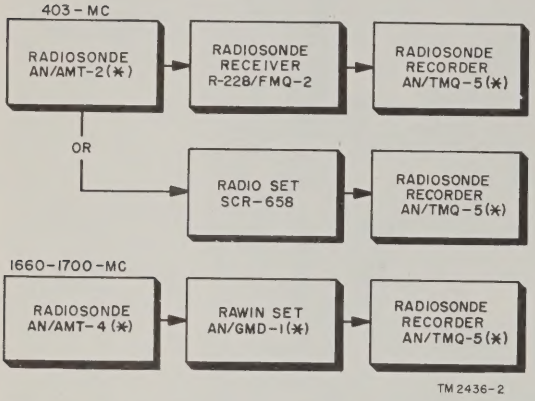


Figure 4. Radiosonde systems, simplified block diagram.

b. System Operation. All radiosonde systems operate on the same principles. The operation of the radiosonde system that comprises Radiosonde AN/AMT–4(*), Rawin Set AN/GMD–1(*), and Radiosonde Recorder AN/TMQ–5(*) is discussed below.

(1) *Radiosonde AN/AMT–4(*).* Radiosonde AN/AMT–4(*) (fig. 5) is a balloon-borne meteorological instrument that automatically transmits information to a ground meteorological station; this information relates to the pressure, temperature, and humidity of the upper air strata. The radiosonde transmits an amplitude-modulated (am.) signal at a carried frequency of 1,680 (nominal) mc. A radiosonde modulator unit, containing the pressure-sensitive element (aneroid), temperature element, humidity element, and a commutator, is a switching arrangement for a sequence of signals that are transmitted by the radiosonde. These signals are translated into temperature, humidity, and pressure readings. Also, the signal that is radiated by the ascending radiosonde is suitable for automatic tracking of the radiosonde by radio direction-finding equipment on the ground. The rise and horizontal drift of the balloon furnish the necessary data to determine wind direction and velocity in the upper atmosphere.

(2) *Rawin Set AN/GMD–1(*).* The rawin set (fig. 6) automatically tracks the radiosonde during its flight, and receives, amplifies, and demodulates the radiosonde signals, thus converting them back to their original af.

(3) *Radiosonde Recorder AN/TMQ–5(*).* The af signal output of the rawin set is applied to the signal converter section of the converter amplifier in the recorder (fig. 7). In this section, the af signals are amplified and shaped to a precise amplitude and form; then they are rectified and filtered to provide a dc voltage, which is proportional to their frequency (nominally from 10 to 200 cycles per second (cps)). A second dc voltage is supplied by the motor-driven contact of a slide-wire potentiometer. The two dc voltages are applied to a detection circuit, which converts any *difference* between them to a 60-cps error voltage. This error voltage is then amplified to a level that is sufficient to drive the balancing (or servo) motor and operate the pen-lifting circuit; if the error voltage is present, the pen is lifted while the motor positions it for the next recording. The motor stops when the dc voltage at the moving contact of the slide-wire potentiometer is equal to that delivered by the rectified signal; the pen is then lowered again to the moving paper and a trace is made. The entire operation takes place so that the pen always marks the chart at a point which corresponds to the meteorological information that is received from the radiosonde.

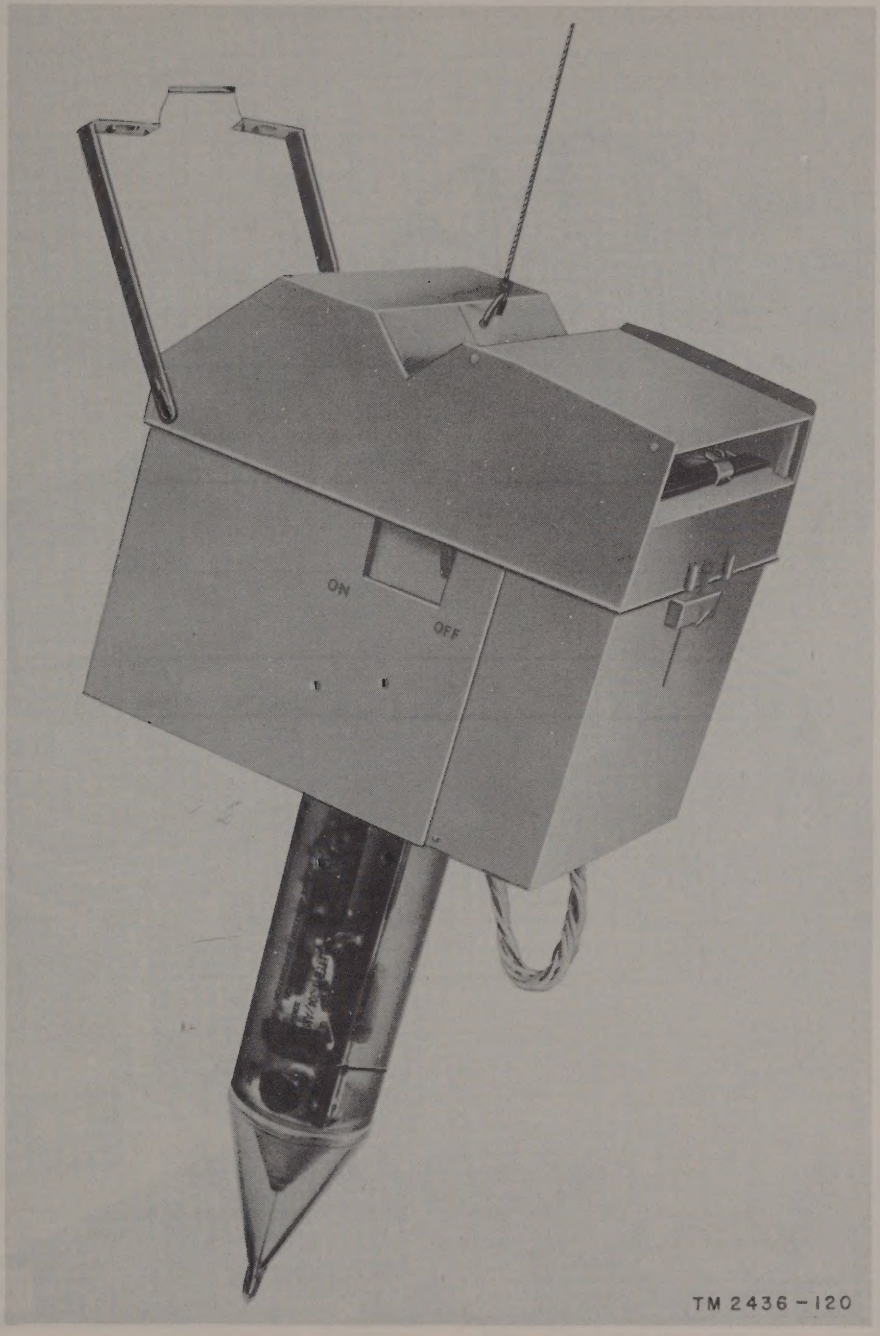


Figure 5. Radiosonde AN/AMT-4A.

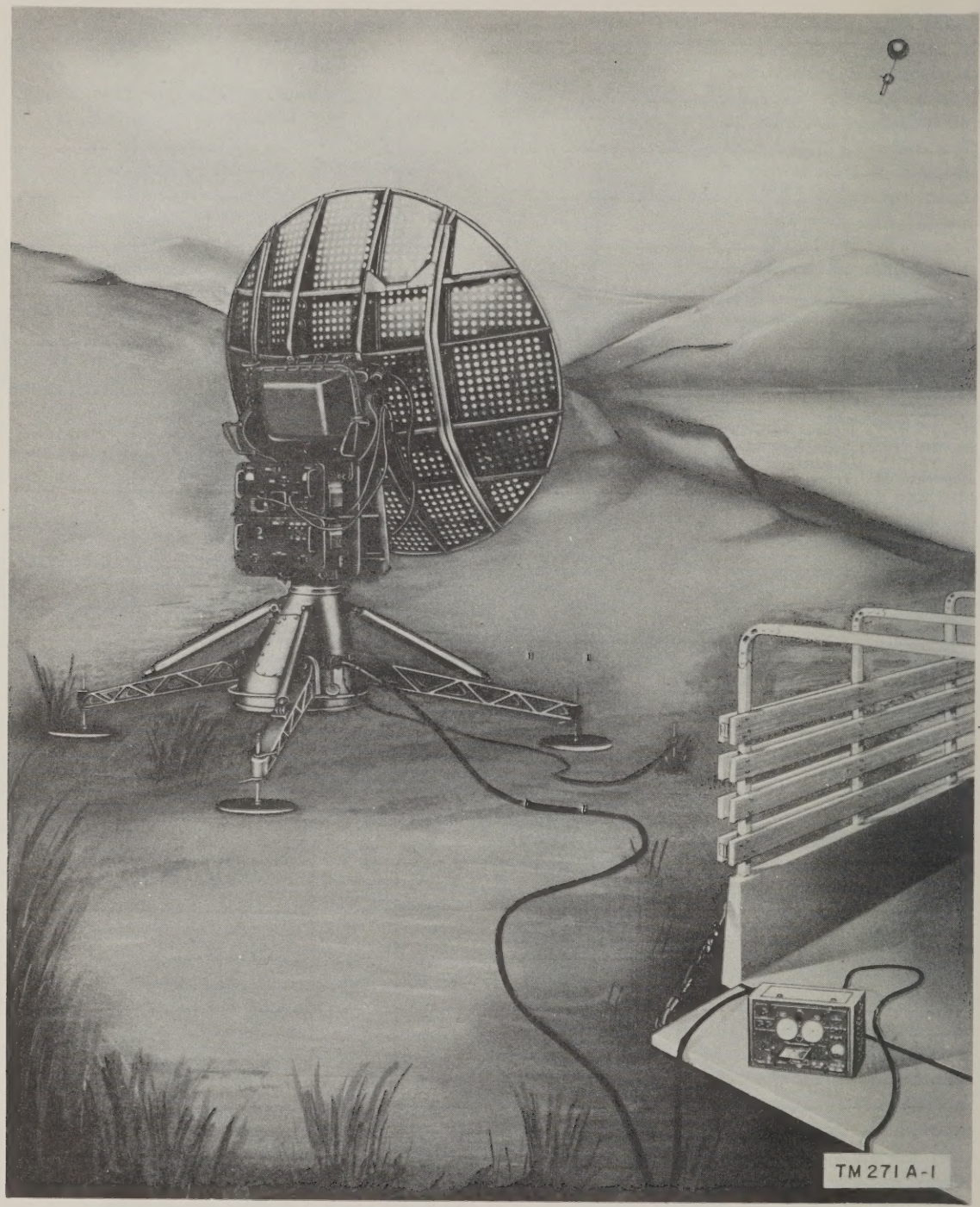


Figure 6. Rawin Set AN/GMD–1A.

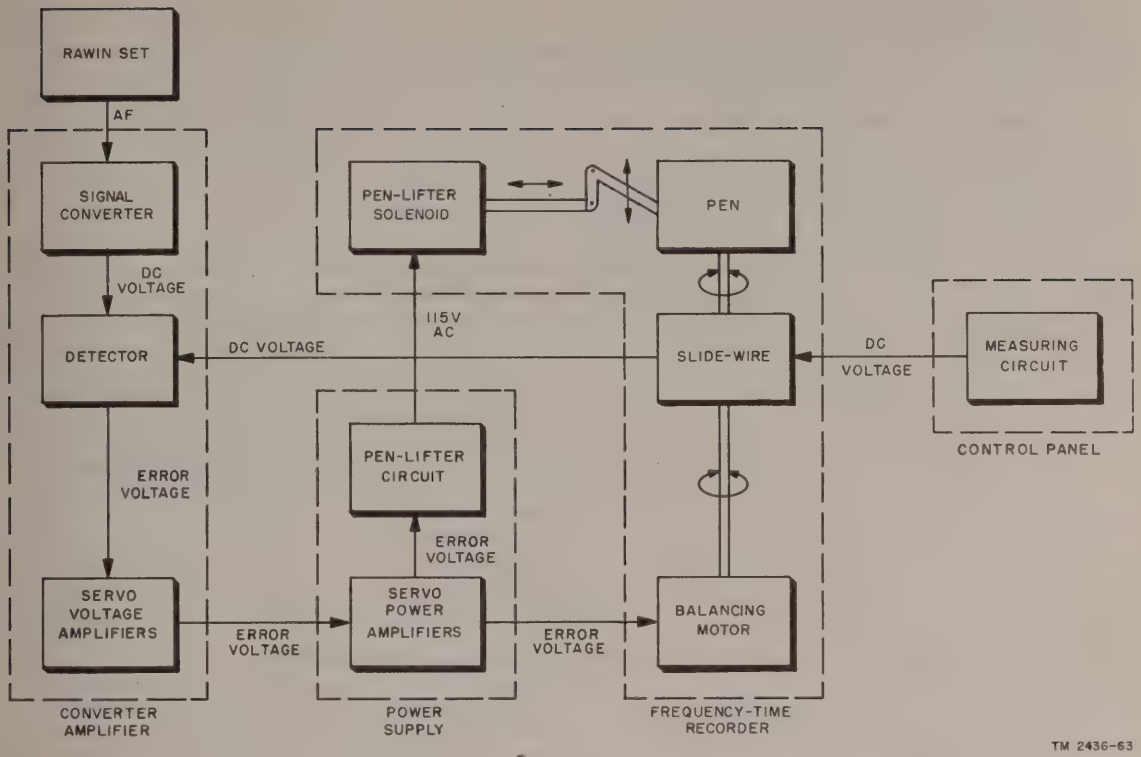


Figure 7. Radiosonde Recorder AN/TMQ–5, simplified block diagram.

5. Technical Characteristics

The general characteristics and performance data of Radiosonde Recorder AN/TMQ–5(*) are listed below.

Power requirements	105 to 125 volts, 50 to 65 cycles per second, single-phase, 225 to 275 watts.
Test signal:	
Sine wave	10 to 220 cycles per second, 10 volts peak-to-peak (minimum).
Input signal:	
Negative-going pulse or sawtooth	10 to 220 cycles per second, 10 to 100 volts peak-to-peak, 1,000 to 2,500 usec wide.
Power supply:	
Positive	Self-contained, full-wave, regulated, +300 volts.
Negative	Self-contained, full-wave, regulated, −175 volts.
Signal data converter output	Nominally 30 mv dc for full-scale deflection of pen.
REF. ADJUST frequency range	163 to 242 cycles per second.
Chart:	
Length	120 ft.
Width	$10\frac{11}{16}$ in. overall.
Vertical axis	½-in. intervals.
Horizontal axis	100 equal divisions.
Speed	½ in. per minute for Radiosonde Recorder AN/TMQ–5; ½ or 1 in. per minute (operator may choose) for Radiosonde Recorder AN/TMQ–5A.
Speed of response	2½ seconds maximum, including pen-lifting operation.
Weight	240 lb.
Dimensions	$33\frac{7}{8}$ in. high, $22\frac{7}{8}$ in. wide, and $17\frac{3}{8}$ in. deep.
Number of tubes	21.
Ambient temperature range	−40° to +125° F.

Note. Units that start with serial No. 26 will operate at either of two different chart speeds, ½ and 1 inch per minute, and operate in automatic or manual time-print synchronization with Control Recorder C–577(*)/GMD–1.

6. Packaging Data

Radiosonde Recorder AN/TMQ–5A and Radiosonde Recorder AN/TMQ–5A are shipped in two boxes as follows:

Note. Items may be packaged in a different manner from that shown below, depending on the supply channel.

Box No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu. ft.)	Unit weight (lb.)	Contents
1	46⅜	33⅞	30⅜	27. 4	490	Electrical Equipment Cabinet CY–1390/TMQ–5 or Electrical Equipment Cabinet CY–1390A/TMQ–5. The following components are mounted in the cabinets mentioned above: Control Panel C–834/TMQ–5. Signal Data Converter CV–146/TMQ–5, less vibrator inverter G301. Frequency-Time Recorder RD–88/TMQ–5 or Frequency-Time Recorder RD–88A/TMQ–5, less chart and ink. Power Supply PP–968/TMQ–5, less following tubes: V401 5R4WGY V402 6Y6GY V408 5R4WGY V409 6AS7G Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5.
2	24	30¼	21⅝	8	138	Accessories Case CY–930/TMQ–5. The following items are included in the accessories case: Running spares (par. 10). Accessories (par. 9*f*). Items removed from recorder for shipment (par. 9*f*).

7. Table of Components

The following table lists the nomenclature, dimensions, weight, and quantity of the components of Radiosonde Recorder AN/TMQ–5(*).

Nomenclature	Required No.	Length (in.)	Width (in.)	Height (in.)	Volume (cu. ft.)	Weight (lb.)
Control Panel C–834/TMQ–5	1	5	19	10½	0. 57	10
Signal Data Converter CV–146/TMQ–5	1	11⅝	19	9¾	1. 24	18
Power Supply PP–968/TMQ–5	1	11⅜	19	10	1. 3	39
Frequency-Time Recorder RD–88/TMQ–5 or Frequency-Time Recorder RD–88A/TMQ–5	1	10¾	19	8¾	1	34
Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5	1	3	19	10¼	. 34	5
Electrical Equipment Cabinet CY–1390/TMQ–5 or Electrical Equipment Cabinet CY–1390A/TMQ–5	1	17⅜	22⅞	33⅞	7. 6	130
Accessories Case CY–930/TMQ–5	1	19⅝	27¼	21	6. 4	66
Electrical Special Purpose Cable Assembly CX–2340/U	1	17				
Electrical Special Purpose Cable Assembly CX–2339/U	1	84				
Electrical Special Purpose Cable Assembly CX–2338/U	5	84				
Electrical Special Purpose Cable Assembly CX–2337/TMQ–5	1	96				
Power Cable Assembly CX–1492/U	1	15				
Graph Paper ML–432/TMQ–5	12	120 ft	$10\frac{11}{16}$			

8. Nomenclature Assignments

A list of the nomenclature assignments for the components of the Radiosonde Recorder AN/TMQ–5(*) is given below. A common name is indicated after each item.

Nomenclature	Common name
Control Panel C–834/TMQ–5	Control panel.
Signal Data Converter CV–146/TMQ–5.	Converter amplifier.
Power Supply PP–968/TMQ–5	Power supply.
Frequency-Time Recorder RD–88/TMQ–5 or Frequency-Time Recorder RD–88A/TMQ–5.	Frequency-time recorder.
Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5.	Fan panel.
Electrical Equipment Cabinet CY–1390/TMQ–5 or Electrical Equipment Cabinet CY–1390A/TMQ–5.	Cabinet.
Accessories Case CY–930/TMQ–5.	Accessories case.
Electrical Special Purpose Cable Assembly CX–2340/U.	Signal adapter cable.
Electrical Special Purpose Cable Assembly CX–2339/U.	Power-supply test cable.
Electrical Special Purpose Cable Assembly CX–2338/U.	Test cable.
Electrical Special Purpose Cable Assembly CX–2337/TMQ–5.	Signal and power cable.
Power Cable Assembly CX–1492/U.	Power adapter cable.
Graph Paper ML–432/TMQ–5	Chart.

9. Description of Radiosonde Recorder AN/TMQ–5(*)

The control panel, converter amplifier, frequency-time recorder, power supply, and fan panel are mounted in the cabinet (figs. 2 and 3). All chassis and panels are plug-in type and are easily removed from the cabinet (fig. 8) for preventive maintenance or servicing. Test cables operate any or all of the components when they are removed from the cabinet for test or repair purposes. A description of each of the individual components is given in *a* through *f* below.

a. Control Panel C–834/TMQ–5 (fig. 9). The control panel is in the upper front of the cabinet (fig. 2). The upper section of this panel is hinged and may be opened without interrupting operation to gain access to the converter-amplifier chassis. The speaker, meters, and majority of operating controls are mounted on the hinged section of the control panel. Four screwdriver adjustments are on the bottom unhinged section of the panel; they are SENSITIVITY, REC. ZERO, REC. TEST ADJ., and PEN LIFTER.

b. Signal Data Converter CV–146/TMQ–5 (fig. 10). The converter-amplifier chassis is mounted vertically in the upper rear of the cabinet, directly behind the control panel (fig. 3). It contains the converter, detector, and servo voltage-amplifier circuits. Test points facilitate servicing; they are accessible from the front after the control panel has been swung open (fig. 59). The noise suppression switch is mounted on the left-hand inner surface of the converter chassis and is accessible in the same way as the test points. All tubes in the converter circuit are replaced from the *rear* of the cabinet.

c. Frequency-Time Recorder RD–88(*)/TMQ–5 (fig. 11).

(1) The frequency-time recorder is in the middle of the cabinet (figs. 2 and 3). It contains the printing mechanism, balancing motor, chart motor, and slide-wire potentiometer. A knob on the left side of the panel is used to advance the chart manually to a desired position. The pen OPERATE-LOCK control knob is on the right-hand side of the panel. When this control is in the LOCK position, it will hold the pen above the chart. The desk (fig. 2) is attached to the front of the frequency-time recorder, so that the operator may make notations on the chart during operation. When the desk is not in use, it may be placed flush with the cabinet or removed. The recorder chassis is mounted on a slide-track assembly, and a short length of cable allows the unit to be drawn part way out of the cabinet without disturbing operation.

(2) In addition to the controls described above, Frequency-Time Recorder RD–88A/TMQ–5 (figs. 11 and 20) has two other controls. The CHART SPEED switch, on top of the chassis, behind the front panel, permits the selection of either of two chart speeds, ½ or 1 inch per minute. The RAWIN TIME PRINT switch, on the right-hand side of the front panel, is a three-position toggle

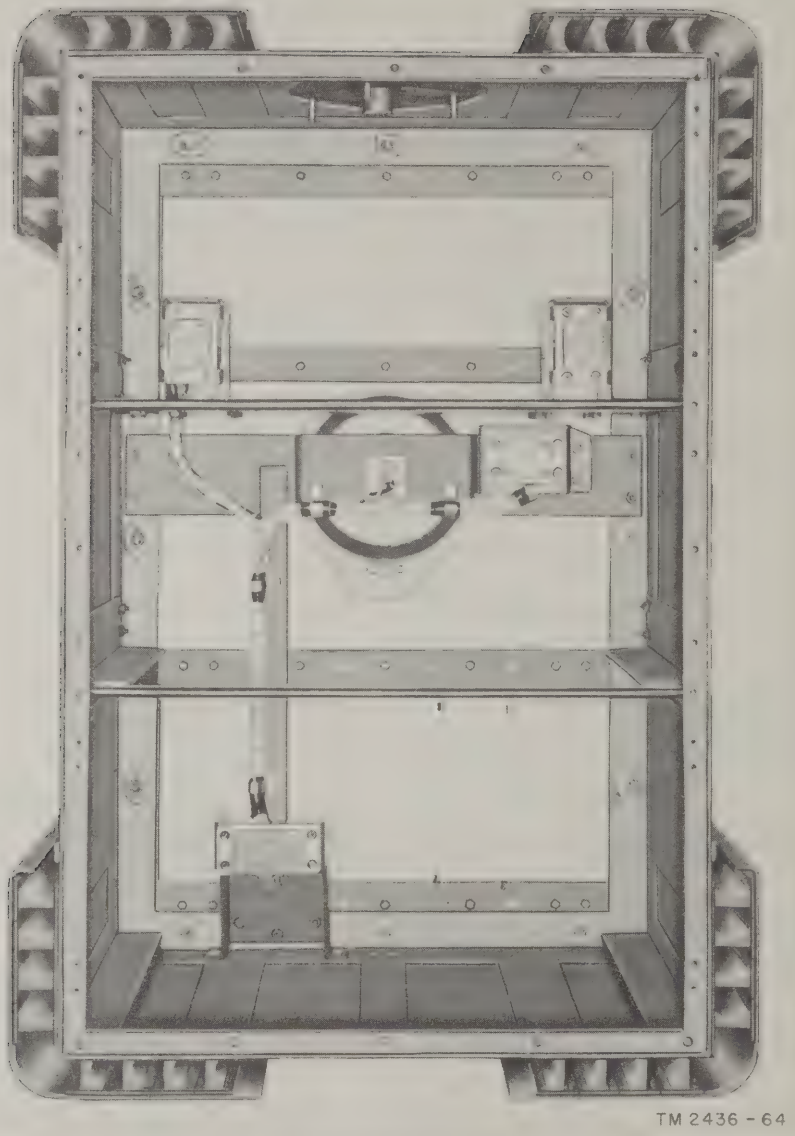
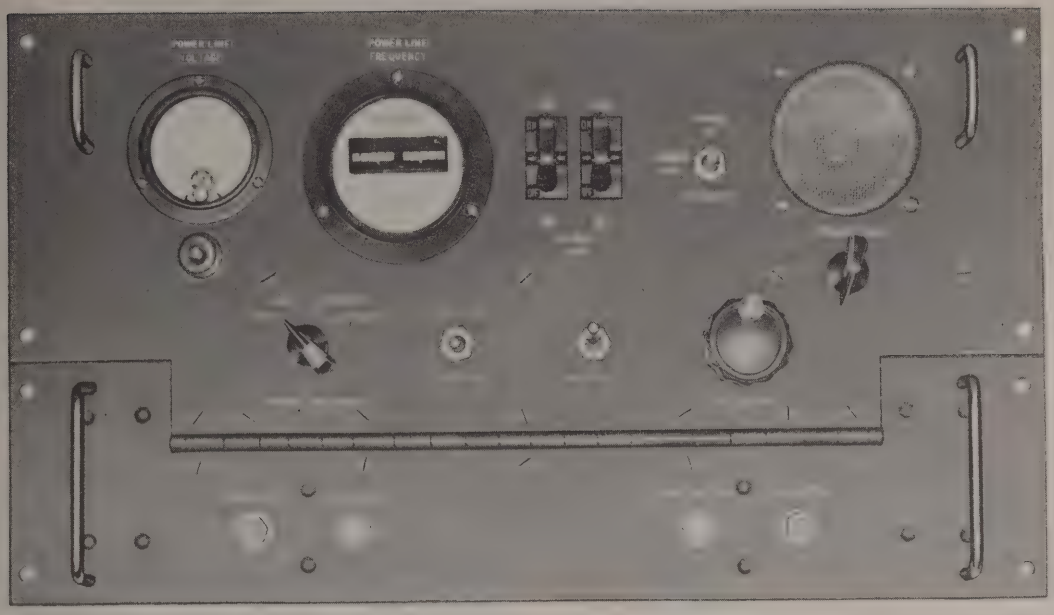


Figure 8. Electrical Equipment Cabinet CY–1390(*)/TMQ–5, components removed.

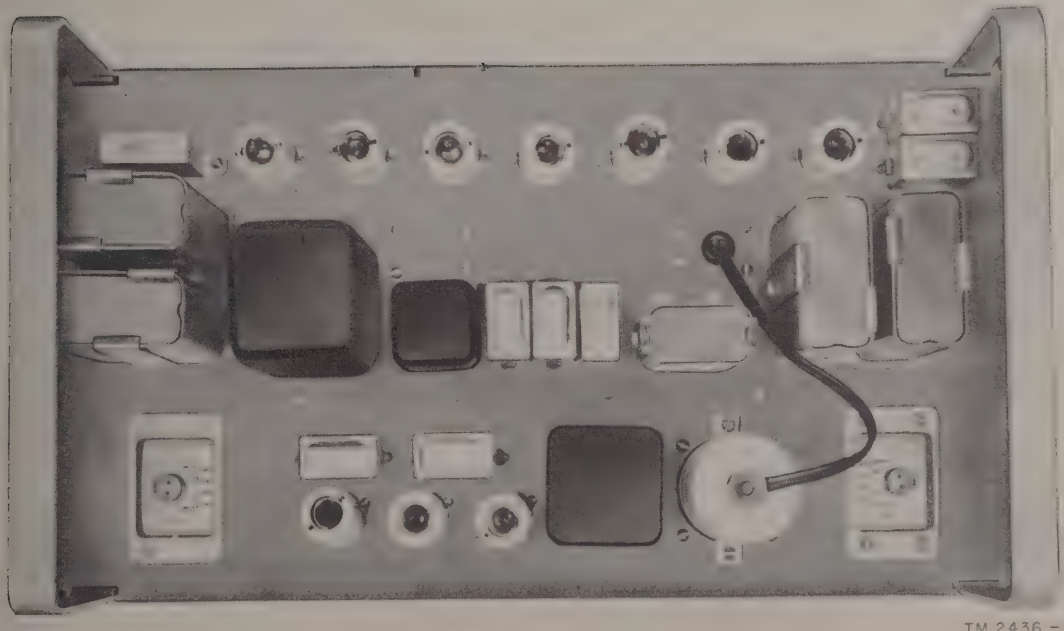
switch. When it is in the OFF position, the time-print mechanism of Control Recorder C–577(*)/GMD–1, in Rawin Set AN/GMD–1(*), is inoperative from Radiosonde Recorder AN/TMQ–5A. With the switch in the AUTO. position, a received reference signal from the radiosonde that causes the recorder pen to reach or exceed a position of 90 on the chart, closes a microswitch in the recorder. This microswitch causes the time-print mechanism of the control recorder to record the present time. When the RAWIN TIME PRINT switch is depressed momentarily to the MAN. position, the time-print mechanism is operated directly.

d. Power Supply PP–968/TMQ–5 (fig. 12).



TM 2436 – 65

Figure 9. Control Panel C–834/TMQ–5, front view.



TM 2436 – 66

Figure 10. Signal Data Converter CV–146/TMQ–5, top view.

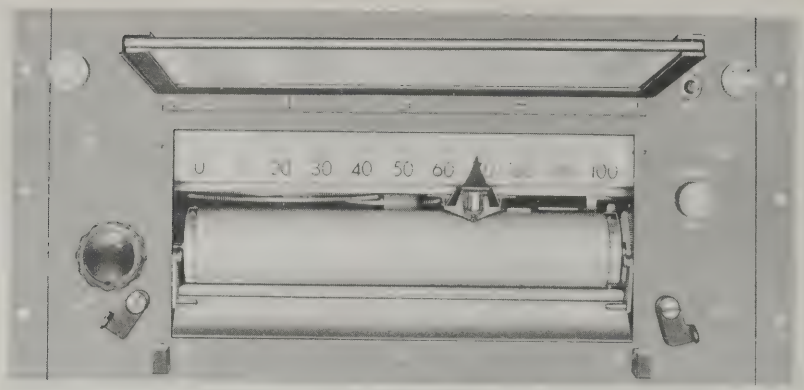


Figure 11. Frequency-Time Recorder RD–88A/TMQ–5, front view.

The power supply chassis is mounted vertically at the bottom rear of the cabinet (fig. 3). It contains one positive regulated supply, one negative regulated supply, the servo power amplifiers, and the pen-lifter circuit. All tubes are replaced from the rear of the cabinet. To gain access to the bottom of the power supply chassis, remove the fan panel on the lower front section of the cabinet.

e. Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5 (fig. 13). The fan panel is on the bottom front of the cabinet. It contains the fan and its associated FAN ON-OFF switch. When the vent on the top of the cabinet is open, the fan circulates air throughout the equipment.

f. Accessories Case CY–930/TMQ–5 (fig. 14). The accessories case is made of plywood and aluminum. It contains two drawers and two compartments, in which the accessories and running

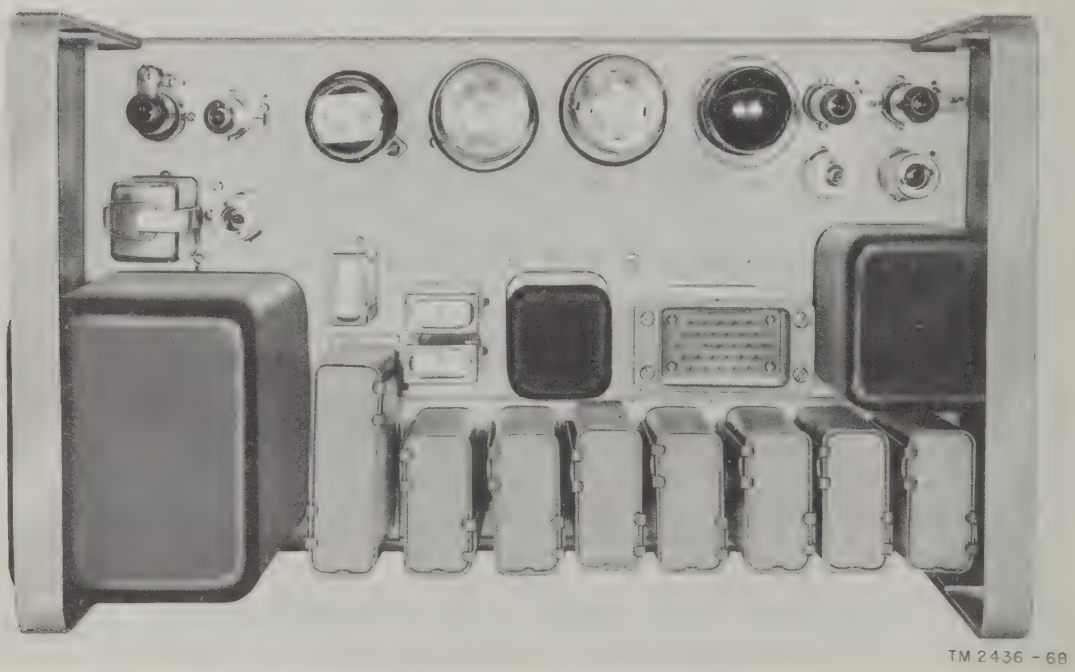


Figure 12. Power Supply PP–968/TMQ–5, top view.

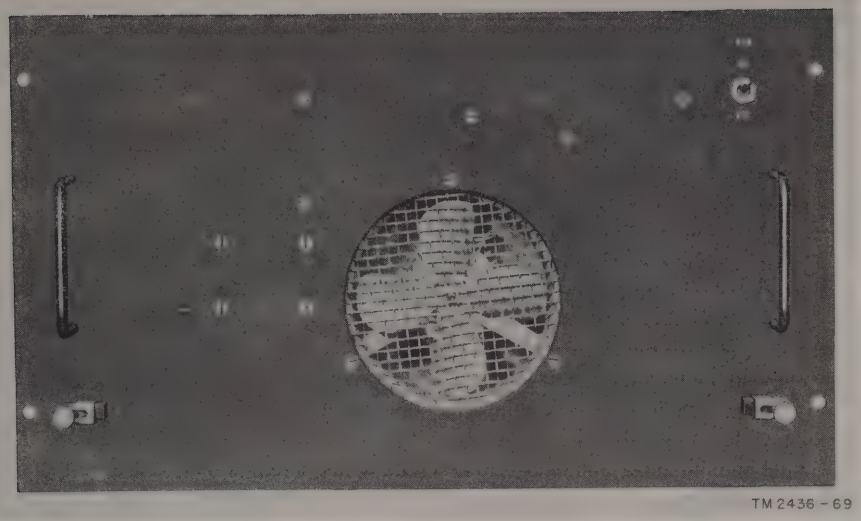


Figure 13. Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, front view.

spares are stored. The recorder is mounted on top of the accessories case during operation. All parts shipped in the accessories case are listed below.

(1) *Parts removed from recorder for shipment.*
- (*a*) Vibrator inverter G301.
- (*b*) Chart N601.
- (*c*) Tube type 5R4WGY, V401.
- (*d*) Tube type 6Y6GY, V402.
- (*e*) Tube type 5R4WGY, V408.
- (*f*) Tube type 6AS7, V409.
- (*g*) Recorder pen, O551.

(2) *Accessories.*
- (*a*) Two-inch screwdriver, H531, mounted in the frequency-time recorder chassis.
- (*b*) Double-end wrench H605 (¾ inch at one end, ⅞ inch at the other end) (two supplied).
- (*c*) Tube puller TL–201, H604.
- (*d*) Electrical Special Purpose Cable Assembly CX–2339/U, W606.
- (*e*) Electrical Special Purpose Cable Assembly CX–2338/U, W604 (five supplied).
- (*f*) Temperature - Humidity Evaluator ML–420A/AMT–4, N602 (two supplied).
- (*g*) Chart weight, O 518.
- (*h*) Electrical Special Purpose Cable Assembly CX–2337/TMQ–5, W601.
- (*i*) Electrical Special Purpose Cable Assembly CX–2340/U, W608.
- (*j*) Power Cable Assembly CX–1492/U, W609.

(3) *Running spares.* The running spares (par. 10) are shipped in the accessories case.

10. Running Spares

A group of running spares is supplied with each Radiosonde Recorder AN/TMQ–5(*) as follows:

12 chart rolls.
1 drive cable.
5 fuses, .125 ampere, type 3AG, slow-blow.
5 fuses, .3 ampere, type 3AG, slow-blow.
1 neon lamp (GE No. NE–51).
1 pilot lamp (Mazda No. 44).
1 pen.
1 tube type 5R4WGY.
1 tube type 6005/6AQ5W.
1 tube type 6AS7G.
1 tube type 6AU6.
1 tube type 6Y6G.
1 tube type 12AT7.
2 tubes type 12AU7.
2 tubes type 12AX7.
1 tube type 12AY7.
1 tube type 5651.
2 tubes of ink.
1 slide-wire contact and hardware.
1 vibrator inverter G301.

11. Differences in Models

a. The two models of the recorder are identical in size, shape and general appearance. The later model, however, has been modified to improve operational features. The differences between the two models discussed in this manual are given in



Figure 14. Accessories Case CY–930/TMQ–5, with some accessories.

the table below. Recorders with serial numbers 25 and below are Radiosonde Recorder AN/TMQ–5; those with serial numbers 26 and above are Radiosonde Recorder AN/TMQ–5A.

Item	Radiosonde Recorder AN/TMQ–5	Radiosonde Recorder AN/TMQ–5A
Frequency-time recorder.	Frequency-Time Recorder RD–88/TMQ–5 has a single chart speed of ½ inch per minute.	Frequency-Time Recorder RD–88A/TMQ–5 has selective chart speeds of ½ and 1 inch per minute. A CHART SPEED switch with two positions, ½ and 1 INS/MIN. is located on this model (fig. 20). The RAWIN TIME PRINT switch is on the front panel of the Frequency-Time Recorder RD–88A/TMQ–5 (fig. 17). This switch is used to control the operation of a cam-operated microswitch, added to this model. This microswitch (shown as the automatic time-print switch S504 (fig. 22)) controls the operation of the time-print circuit of Control Recorder C–577(*)/GMD–1 a part of Rawin Set AN/GMD–1(*).
Cabinet	Electrical Equipment Cabinet CY–1390/TMQ–5 mounts the panels, chassis, and interchassis wiring (fig. 83).	Electrical Equipment Cabinet CY–1390A/TMQ–5 mounts the panels, chassis, and interchassis wiring. There are connections between pins 11 and 12 of J105 and pins G and H of J101, respectively (fig. 84). This wiring connects the cam-operated microswitch, in the Frequency-Time Recorder RD–88A/TMQ–5, to the time-print circuit, in the Control Recorder C–577(*)/GMD–1.

b. Frequency-Time Recorder RD–88/TMQ–5 may be used with Electrical Equipment Cabinet CY–1390/TMQ–5 or CY–1390A/TMQ–5. In either case, the time-print circuit is inoperative and only one chart speed, ½ inch per minute, is available.

c. Frequency-Time Recorder RD–88A/TMQ–5 may also be used with either model of the cabinet. However, when Frequency-Time Recorder RD–88A/TMQ–5 is used with Electrical Equipment Cabinet CY–1390/TMQ–5, the time-print circuit is inoperative, although the dual chart speed feature is still available.

d. The capacitance value of capacitor C422, in the power supply of recorders with serial numbers above 40, is .05 microfarad (μf); in the lower numbered sets, the value is .01 μf.

CHAPTER 2

OPERATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

Note. When the cabinet, control panel, converter amplifier, frequency-time recorder, power supply, and fan panel are referred to as an integral unit, they will be called the recorder, for convenience and simplicity.

12. Siting.

Position the recorder as close as possible to the meteorological receiver with which it is used. Keep the signal and power cable lengths to a minimum. To facilitate maintenance, provide a minimum access space of approximately 3 feet on the front, and 1 foot on the sides and rear of the recorder. Locate the recorder where it will be subjected to as little vibration as possible; avoid locations near electrical machinery, high-tension lines, and other electrical noise-producing equipment. A reasonably quiet location is desirable to permit the monitoring loudspeaker to be heard. If the equipment is used out-of-doors, keep it well protected. The equipment should be mounted on the accessories case or in Shop Van M–109 (par. 21).

13. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 20.

a. General. When new equipment is received, select a location which is convenient to the permanent or semipermanent equipment installation, and where the equipment may be unpacked without exposure to the weather. The complete equipment is shipped in two boxes (par. 6). Be sure that both packing boxes are received and the equipment is undamaged.

Caution: Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul may be required, or the equipment may be rendered useless.

b. Uncrating and Unpacking Recorder (fig. 15).

(1) Place the packing box that contains the recorder as near the operating position as convenient.

(2) Cut and fold back the steel straps.

(3) Remove the nails with a nail puller. Remove the top and both sides of the wooden packing box. Do not attempt to pry off the sides and top; the equipment may become damaged.

(4) Remove the foam rubber and excelsior.

(5) Cut and fold back the steel straps around the V2S board carton.

(6) Open the top of the carton, and remove the sides by cutting along the edges; be careful not to cut too deeply.

(7) Remove the heat-sealed moisture-vaporproof barrier by cutting it carefully at the seams. Pull the barrier away from the sides.

(8) Open the inner carton and remove the sides.

(9) Remove the silica gel bags and corrugated packing.

(10) Remove the recorder, and carry it to its location by the two handles on each side.

c. Uncrating Accessories Case (fig. 16). The accessories case should be uncrated as follows:

(1) Cut and fold back the steel straps on the nailed wooden shipping box.

(2) Use a nail puller to remove the nails. Remove the top and one side of the box. Do not attempt to pry off the side and top; the accessories case may become damaged.

(3) Lift out and cut the moisture-vaporproof barrier along the heat-sealed seam; remove the barrier.

(4) Remove the V2S board carton. Remove the inner carton, and lift out the accessories case.

(5) Check the contents of the accessories case against the packing list to be sure that all parts are present.

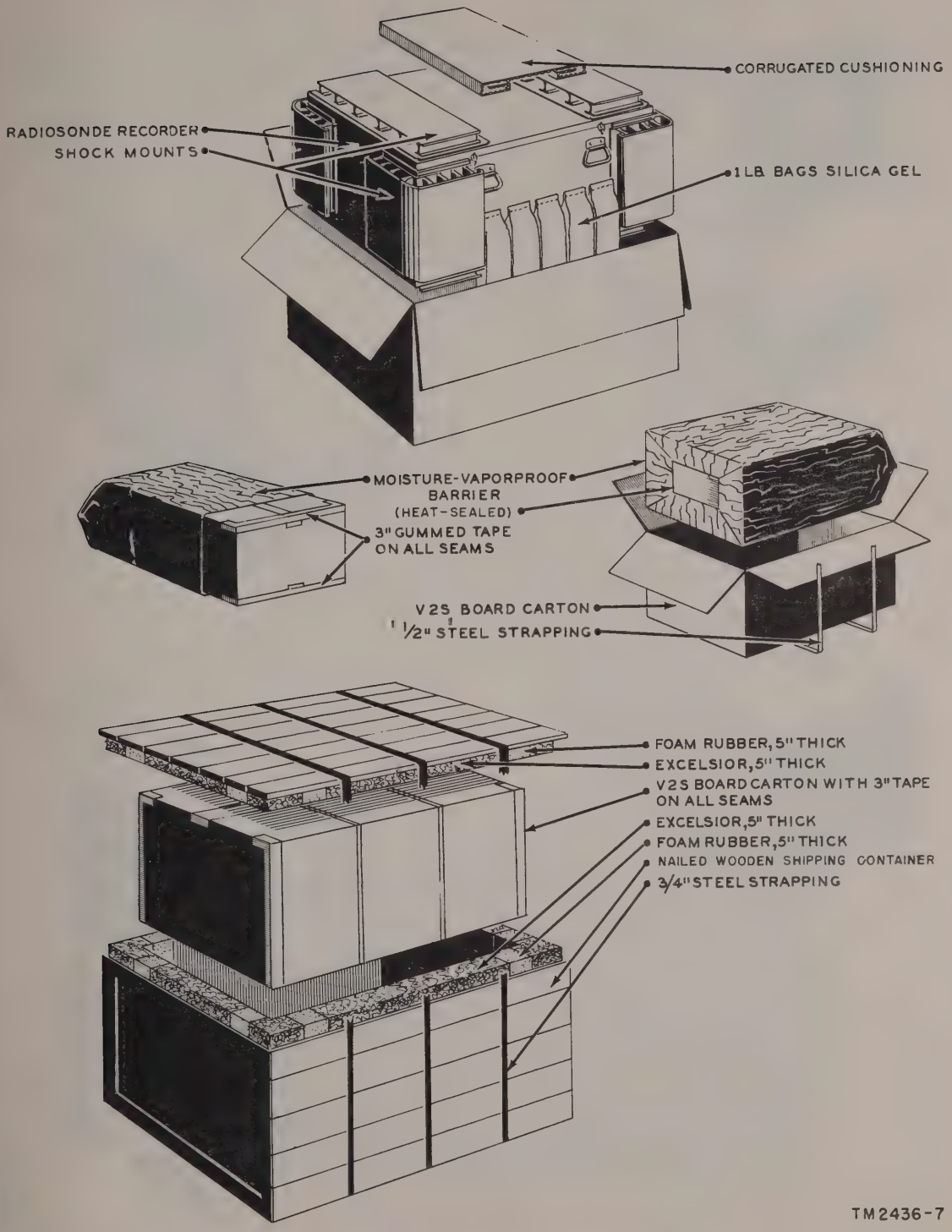


Figure 15. Packaging Radio Recorder AN/TMQ-5(*).

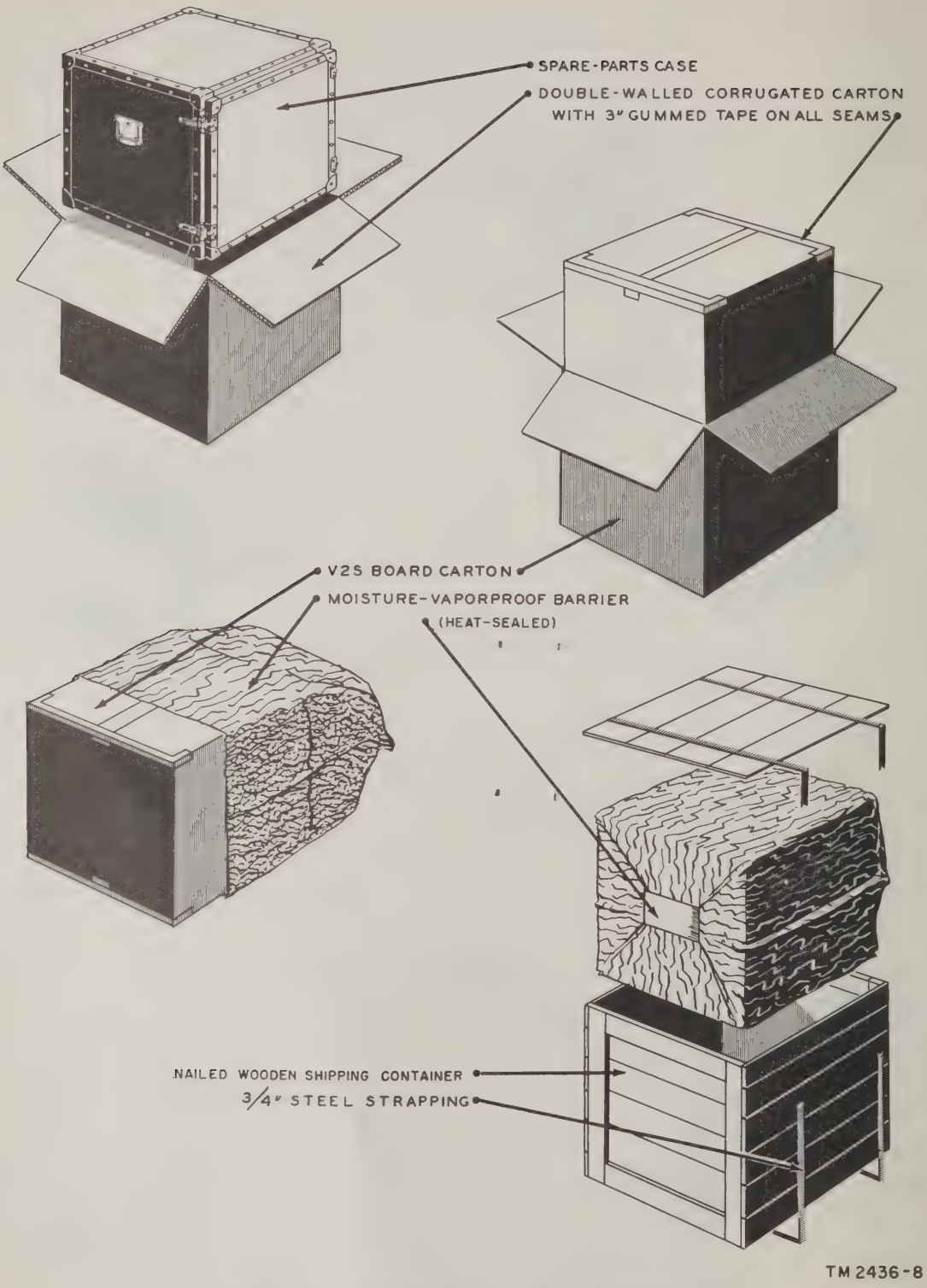


Figure 16. Packaging Accessories Case CY-930/TMQ-5.

14. Equipment Installation

a. After the equipment has been unpacked and a location selected, use the following procedure to install Radiosonde Recorder AN/TMQ–5(*).

(1) Place the accessories case in the location selected for the installation.

(2) Lift the recorder to the top rear of the accessories case, and slide the recorder forward so that the shock mounts will fit under the bracket on top of the accessories case (fig. 14).

(3) Remove the wooden bar that secures the window latches of the frequency-time recorder.

(4) Loosen the two desk latches that secure the desk to the fan panel.

(5) Open the frequency-time recorder drawer by turning the two panel latch knobs marked LOCKED (fig. 17) in a direction opposite to that of the arrows marked on the knobs.

(6) Remove the wooden bar from under the chart roller.

(7) Cut the lacing that holds the solenoid linkage and balancing motor gears on the underside of the frequency-time recorder.

(8) Remove the rear panel by unfastening the 12 Camloc fasteners.

(9) Remove the block of wood from under the power transformer (fig. 18) in the bottom of the cabinet.

b. Install the following items found in the accessories case:

(1) Place tubes V402 type 6Y6G, V409 type 6AS7G, V401 and V408 type 5R4WGY, in the power supply (fig. 18).

(2) Place vibrator inverter G301 in the converter-amplifier chassis (fig. 18). Connect cable W301 to the top of the vibrator inverter. Replace the rear panel of the cabinet.

15. Filling Pen

The following procedure should be used to fill the pen. (During shipment, the pen is in the accessories case.)

a. Open the frequency-time recorder drawer and remove screwdriver H531 (figs. 19 and 20) from the right-hand side of the chassis.

b. Open the recorder window to loosen the small setscrew in front of the pen carriage (fig. 17).

c. Carefully raise the pen from the pen carriage and unscrew the pen cap. Slide the pen heater from the pen barrel; be careful not to break the pen heater connecting wires.

d. While holding the pen in the left hand at approximately a 45° angle, insert the spout of the ink tube into the pen barrel until the spout touches the bottom. Squeeze the tube until the barrel is three-fourths full of ink. This method will force out air bubbles in the ink chamber.

e. Replace the pen heater and pen cap. Be sure the vent hole in the cap is not clogged.

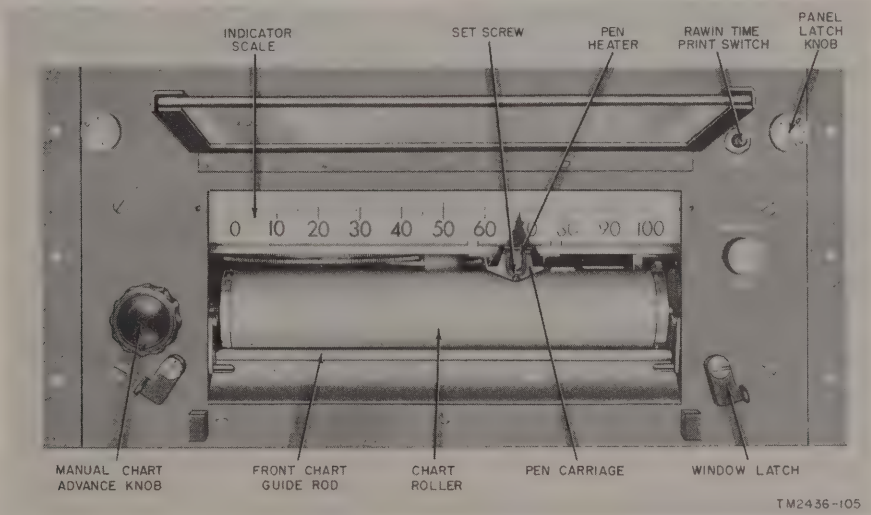


Figure 17. Frequency-Time Recorder RD–88A/TMQ–5, front view.

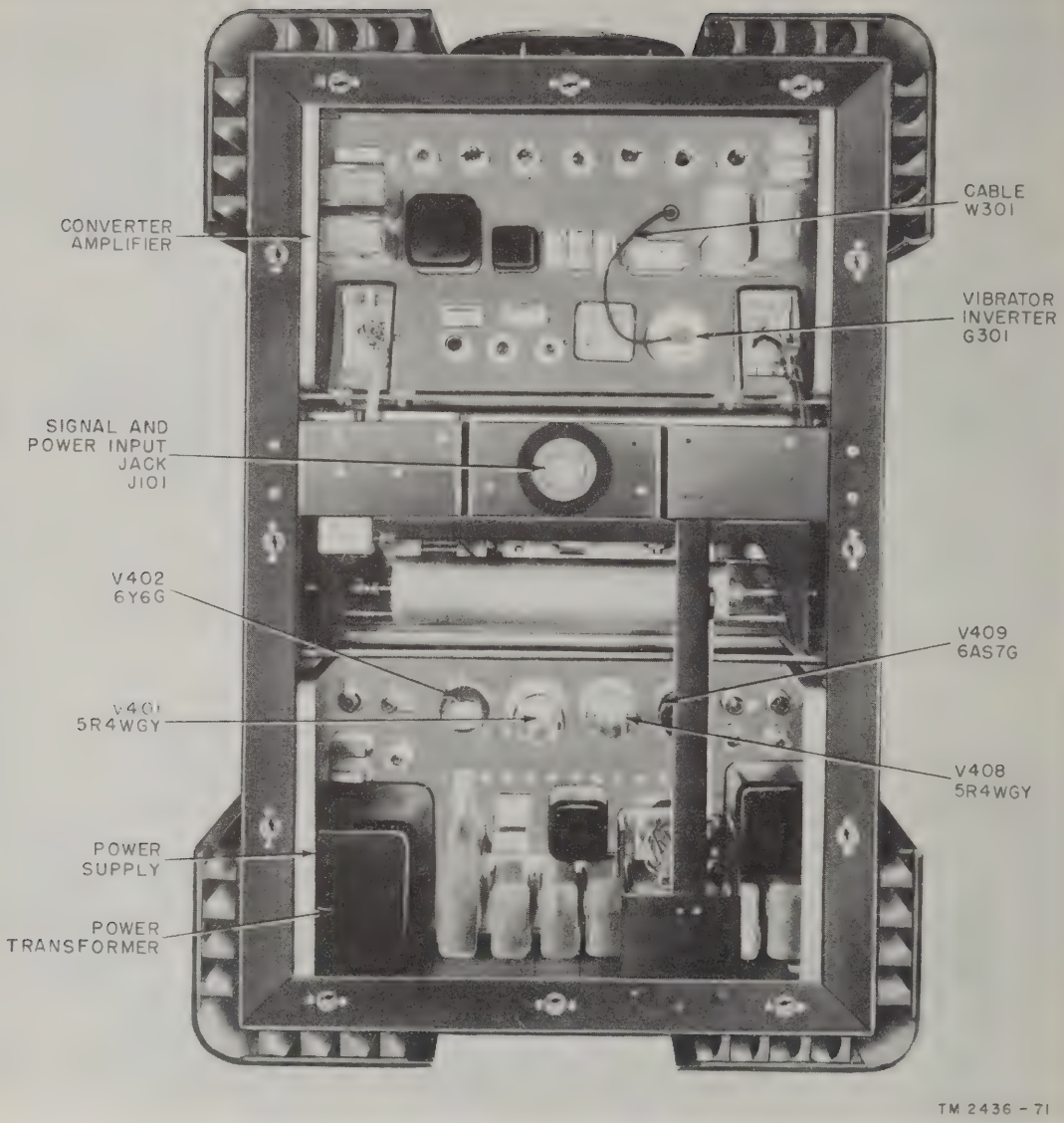


Figure 18. Recorder, rear view.

f. Replace the pen in the pen carriage; be sure the pen is seated firmly, and the barrel is in a vertical position.

g. Tighten the setscrew and dress the pen heater leads away from the carriage shaft and indicator scale. Close the recorder window.

16. Pen Heater

a. To prevent the ink from freezing, a heating wire element is wound around the pen barrel. This heater is turned on and off, as required, by a thermostat. Because the pen must cover too great a distance for flexible feed wires to be practical, a trolley system (pen-heater contact bar, fig. 19) is installed to supply electrical power to the heater element. Such a feature is unnecessary in warm weather. To allow the greatest freedom of movement to the pen motion throughout its excursion, the trolley system is lowered into position to make contact only when weather conditions demand.

The thermostat is located at the right-hand end of the pen-heater contact bar.

b. If the temperature drops to 40° F. or below, lower the contact bar to make contact with the moving contactors mounted on the pen carriage. The adjusting screws (fig. 19), on top of the bar are factory-adjusted, and should not be changed unless necessary. Loosen the two lock screws (fig. 19) on each end of the bar, and allow the bar to drop as far as the adjusting screws permit. Check the sliding contacts of the pen heater by sliding the pen carriage from one end of the scale to the other, first in the *up* position of the pen and then in the *down* position. While sliding the pen carriage, be sure that the sliding contacts make a good electrical contact throughout the excursion. Tighten the lock screws.

17. Chart Installation

a. Step 1.

(1) Release the panel latch knobs (fig. 17). Pull the frequency-time recorder chassis forward.

(2) Release the two window latches, and open the recorder window.

(3) Pull the *front* chart guide rod forward (away from the chart roller).

(4) Push back the spring-loaded intermediate chart guide rod (fig. 21). The right and left ends are accessible behind the lower portion of the front panel.

(5) Loosen the right-hand knurled screw that holds the tear-off scale (fig. 2) to the writing desk.

(6) Remove the writing desk by withdrawing the two spring-loaded knurled rods at the ends of the hinge axis.

b. Step 2

(1) Unwind about 2 feet of the new chart roll.

(2) With the printed side up, place the core of the chart roll over the right rear chart roll bearing O 571 (fig. 21). This bearing is spring-loaded and must be compressed to the right to follow the directions given in (3) below.

(3) Place the left end of the chart roll over the left rear chart roll bearing O 570. Be sure to engage the guide pin on the bearing with the core slot.

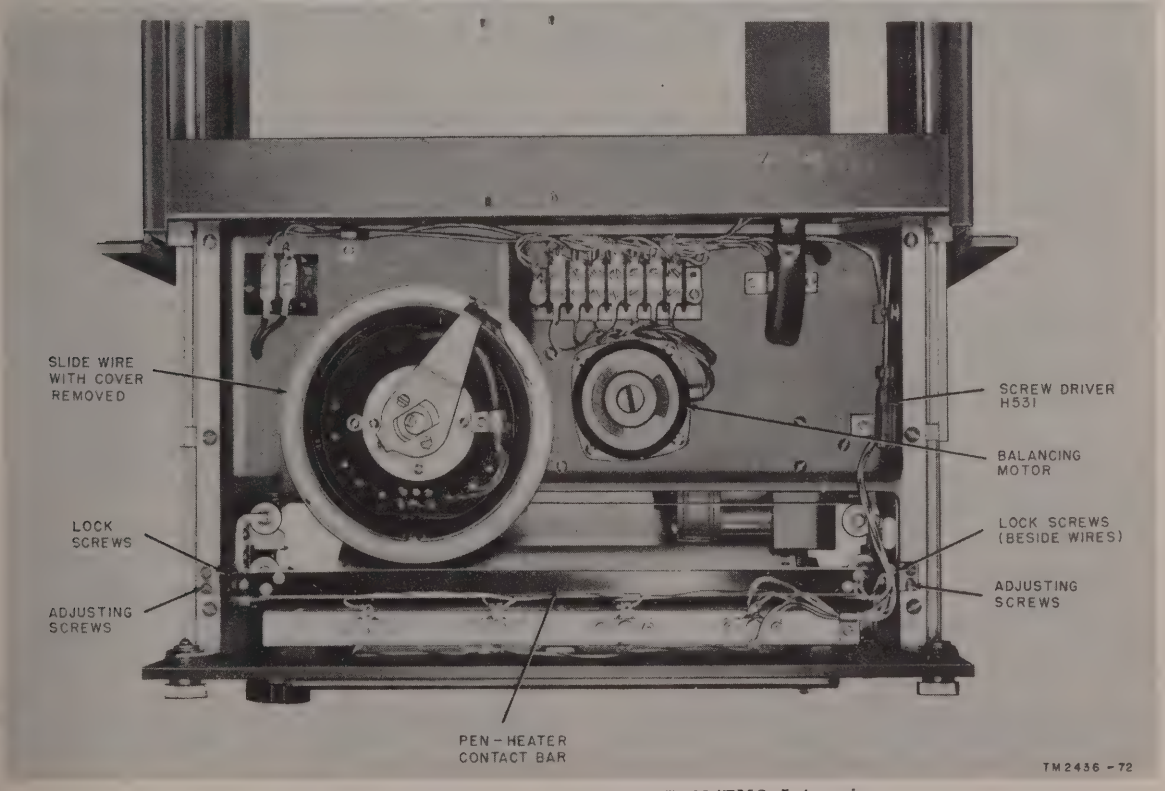


Figure 19. Frequency-Time Recorder RD–88/TMQ–5, top view.

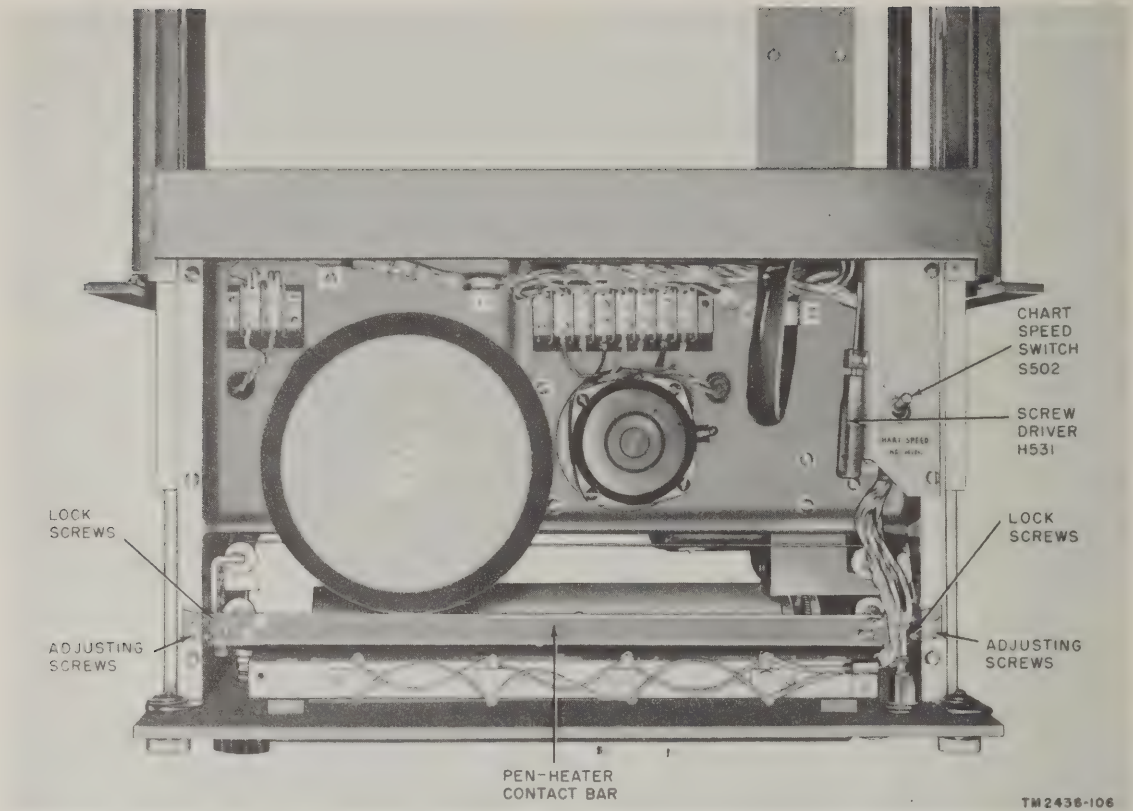


Figure 20. Frequency-Time Recorder RD–88A/TMQ–5, top view.

(4) Feed the chart under the rear and intermediate chart guide rods.

(5) Feed the chart over the chart roller and under the front chart guide rod (fig. 17). Engage the punched guide holes on the left side of the chart paper with the teeth on the roller.

(6) Check to see that the paper is against the chart guide collar located on the intermediate guide rod; then push this guide rod and the front guide rod into their respective operating positions.

(7) Replace the writing desk.

c. Step 3.

(1) Close the recorder window, and secure the window latches.

(2) Slide the recorder back into position, and lock the panel latch knobs.

(3) Slide the chart paper under the tear-off scale, and aline the scale graduations with the chart graduations by laterally positioning the tear-off scale. Then tighten the right-hand knurled screw that holds the tear-off scale to the desk.

(4) Place the chart weight (O 518, fig. 14) on the chart.

Note. As the chart advances, the chart weight will move toward the floor. Release the clamping pressure of the chart weight and slide it up toward the desk. If the weight tends to slip on the paper, use a small paper shim to increase the thickness between the clamping bars. *Do not* use pliers on the knurled nuts.

18. Chart Alinement

If, as the chart advances, it creeps to the right or left (as shown by increasing misalinement between the punched holes and the roller teeth on the left-hand end of the roller), make the following adjustments:

a. Loosen the nut on the threaded stud that supports the left-hand chart roll bearing O 570 (figs. 21 and 22).

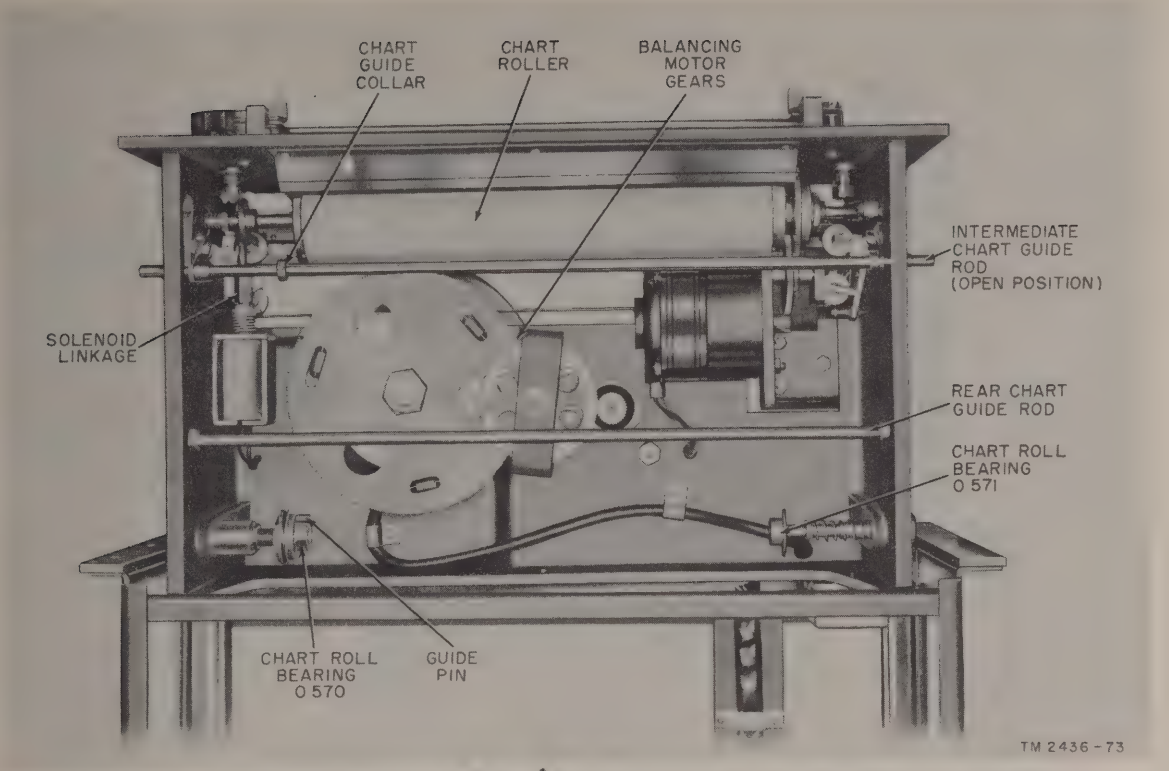


Figure 21. Frequency-Time Recorder RD–88/TMQ–5, bottom view showing main chart drive items.

b. Reposition this stud in a direction opposite to that of the chart misalinement; estimate the amount of shift required for a trial.

c. Tighten the nuts again; be sure that the stud does not turn and disturb the new alinement.

d. Aline the chart on the roller again, and reposition the guide collar on the intermediate guide rod, so that it just contacts the left edge of the chart.

e. Make another trial run of the chart, and repeat the preceding adjustments until the chart advances properly.

f. These adjustments may be necessary each time a new chart is installed.

19. System Connections

(fig. 23)

Radiosonde Recorder AN/TMQ–5(*) is used with any of the equipments listed below. *Installation instructions for each equipment also are given.*

a. Radiosonde Receiver R–228/FMQ–2 (fig. 23, Ⓐ). Connect signal and power cable W601 to J101 of the recorder. Connect the alternating-current (ac) power cable branch of cable W601 to 105- to 125-volt, 50- to 65-cycle power source. Connect the signal cable branch of cable W601 to signal adapter cable W608. Connect the black lead of signal adapter cable W608 to terminal G, and connect the white lead to the other terminal of terminal board TB101. Terminal board TB101 is located in the rear of Radiosonde Receiver R–228/FMQ–2. All cables mentioned above are located in Accessories Case CY–930/TMQ–5.

b. Rawin Set AN/GMD–1(*) (fig. 23 Ⓑ).

(1) *Location of cables.* Cable W921 or Special Purpose Cable Assembly CX–1217/U and the meteorological cable adapter, which consists of the switch box and a 5-foot length of coaxial cable, are located in the accessories case of the rawin set. Signal and power cable W601 is located in Accessories Case CY–930/TMQ–5.

(2) *Connections for Radiosonde Recorder AN/TMQ–5.* Connect one end of Spe-

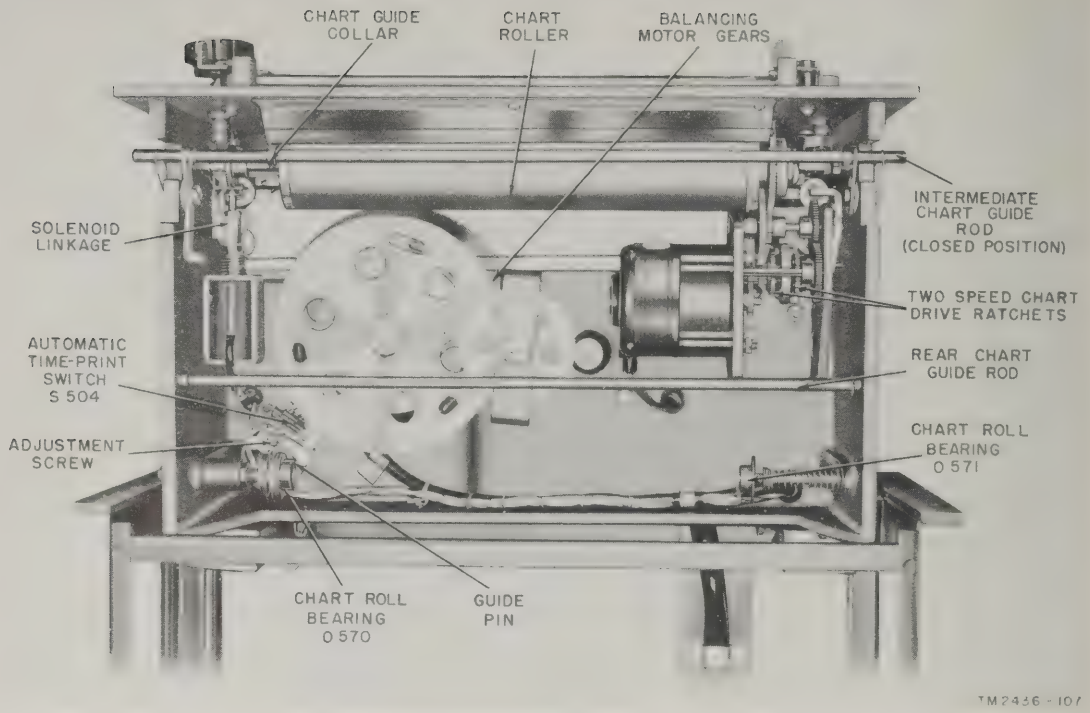


Figure 22. Frequency-Time Recorder RD–88A/TMQ–5, bottom view showing main chart drive items.

cial Purpose Cable Assembly CX–1217/U to socket J101 of the recorder, and connect the other end to J802 of Control Recorder C–577(*)/GMD–1 of the rawin set. In this installation, the primary power for the recorder is supplied through the rawin set. If the switch box that operates the time-print mechanism of the control recorder is required in this installation, proceed as follows.

(*a*) Connect signal and power cable W601 to J101 of the radiosonde recorder.

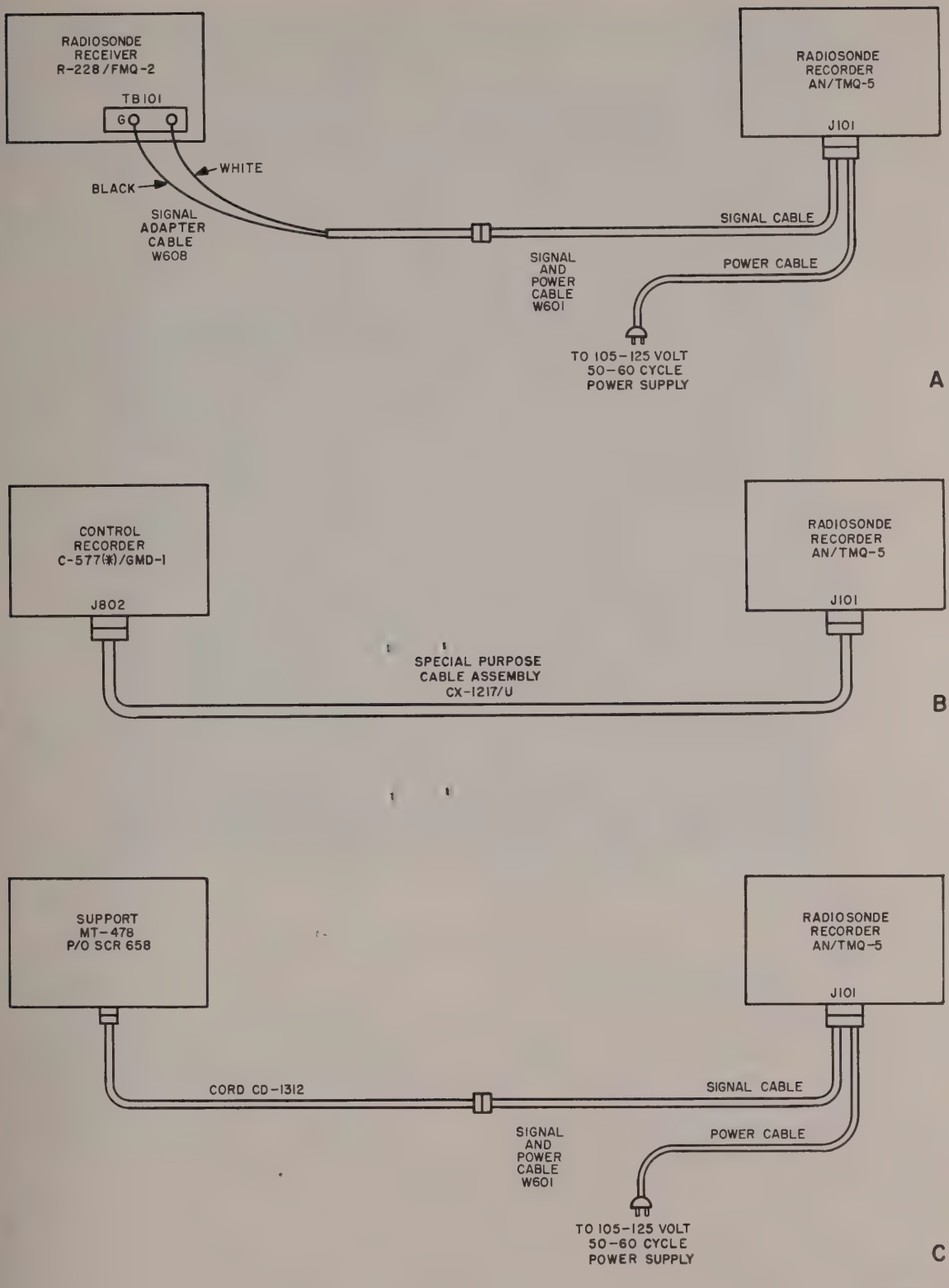
(*b*) Connect the power cable branch of cable W601 to the ac power source (105 to 125 volts, 50 to 65 cps).

(*c*) Connect the signal cable branch of cable W601 to the 5-foot length of coaxial cable from the switch box.

(*d*) Connect one end of Special Purpose Cable Assembly CX–1217/U into the switch box, and the other end into J802 of the control recorder.

(3) *Connections for Radiosonde Recorder AN/TMQ–5A.* Connect Special Purpose Cable Assembly CX–1217/U between J101 of the radiosonde recorder and J802 of the control recorder. In this installation, the primary power circuit, signal circuit, and time-print circuit are completed through the special purpose cable. The operation of the time-print circuit is controlled either automatically or manually from the front panel of Frequency-Time Recorder RD–88A/TMQ–5.

c. Radio Set SCR–658 (fig. 23, ©). Connect signal and power cable W601 to J101 of the recorder. Connect the power cable lead of cable W601 to 105- to 125-volt, 50- to 65-cycle power source. Connect the signal cable lead of cable W601 to Cord CD–1312, and connect the other end of Cord CD–1312 to the jack at the base of Support MT–478, which is part of Radio Set SCR–658. Signal and power cable W601 is located in Accessories Case CY–930/TMQ. Cord CD–1312 is located on Reel RL–39 in Chest CH–289, which is part of Radio Set SCR–658.



TM 2436-11

Figure 23. System connections.

20. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 13 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the change in this manual, preferably on the schematic diagram; include the serial number of the set in the notation.

c. Check the operating controls for ease of rotation.

d. Perform the installation procedures given in paragraphs 14 through 19.

21. Mounting Recorder in Shop Van M–109

Note. Before beginning the mounting procedures below, be sure to read the instructions thoroughly.

a. Mounting Radiosonde Recorder Support MT–1355/TMQ–5.

(1) Position the support between the second and third uprights on the forward right-hand side of the van. These uprights are in the wall between the first and second windows; their center lines coincide with the vertical rows of bolt heads that are visible behind the two upright members of the support shown in position in figure 24.

(2) Lift the support a few inches from the floor and rest the upper rear cross member (angle iron) of the support on the angle iron that is permanently attached to the wall of the van. Slide the support horizontally until it is symmetrically positioned with respect to the vertical rows of bolt heads. On the lower rear cross member of the support, locate and center punch the centers for two 9/16-inch holes to be drilled through the cross member and on through the outer wall. These hole centers will lie on the center lines of the rows of bolt heads.

(3) Locate and center punch the centers for four symmetrically spaced 11/16-inch holes in the upper cross member to match existing holes in the angle iron on the wall.

(4) Lower the support to a convenient position and drill the six holes whose centers have just been spotted. Use an 11/16-inch drill bit for the four holes on the upper cross member, and a 9/16-inch drill bit for the two holes in the lower cross member. (Pilot holes of 3/16-inch diameter will be found helpful.)

(5) Place the support in position again and bolt it to the angle iron on the wall. Four 5/8-inch diameter bolts are supplied for this purpose.

(6) Use the two holes in the lower cross member as guides and drill holes completely through the wall to the outer surface. Use the 9/16-inch drill bit for these holes.

(7) Bolt the lower cross member of the support to the van with the two 3 1/4-inch x 1/2-inch bolts supplied. Place the large square washer next to the bolt head and insert the bolt from the outside of the van. Place the lockwasher on the bolt and on the inside of the van.

(8) Tighten all nuts securely. Coat the external bolt heads and washers with any available material that will prevent rust.

b. Mounting Radiosonde Recorder on Support.

(1) Remove the clamp strips from the horizontal arms (fig. 24) and lay the strips aside. Mount the arms on the upright members but do not tighten the nuts completely.

(2) Remove the lower clamp strips from the support shelf and lay them aside.

(3) Place the recorder (rear side to wall) on the shelf. Slide it back until it is against the angle stops on the shelf.

(4) Slide the lower clamp strips through the bottom shock mounts and aline the bolt holes with those in the shelf. Insert the bolts and tighten the nuts securely.

(5) Slide the upper clamp strips through the side sections of the upper shock mounts and aline the bolt holes with those in the horizontal arms. Bolt the strips securely to the arms and tighten the nuts that hold the arms to the upright members.

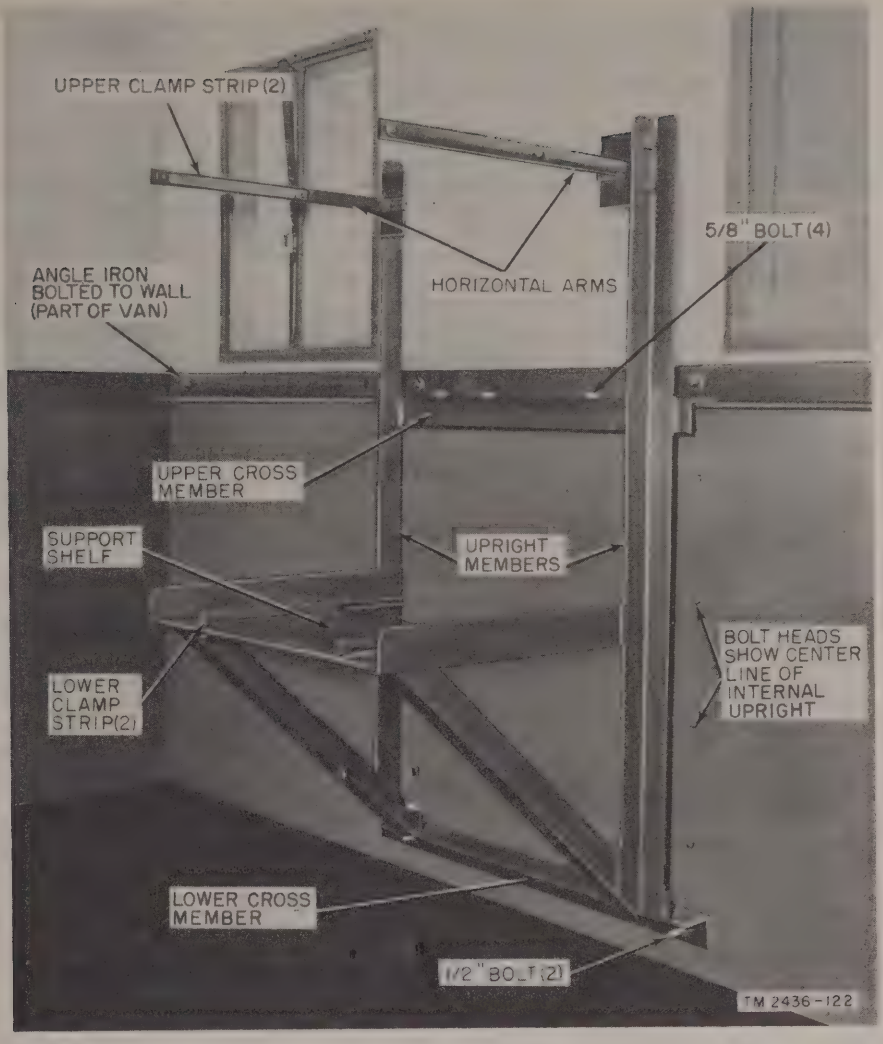


Figure 24. Radiosonde Recorder Support MT–1355/TMQ–5 mounted in Shop Van M–109.

Section II. CONTROLS AND INSTRUMENTS

22. General

Haphazard operation or improper setting of the controls may cause damage to the electronic equipment and record inaccurate data. Therefore, it is important to know the function of every control. The actual operation of the equipment is discussed in paragraphs 24 through 38 of this chapter.

23. Controls and Their Uses

The following table lists the controls and meters of the recorder and the function of each item. The majority of the controls and meters are mounted on the control panel (fig. 25).

Control	Function
POWER LINE VOLTAGE meter M202 (0–150 volts ac).	Indicates ac line voltage.
POWER LINE FREQUENCY meter M201 (vibrating-reed type).	Indicates ac line frequency between limits of 48 to 52 and 58 to 62 cps.
SIGNAL SELECTOR (S202)	In SIG. position, switch connects af signal from radiosonde receiving system to input circuit of signal converter. In S. C. position, a short circuit prevents any signal from entering signal converter amplifier. In 60 C. P. S. position, switch selects 60-cps voltage from T401 to be used as a signal for calibration and tests. In this position, pen marks chart at 30 (60 cps), if line frequency is 60 cps. In 120 C. P. S. position, switch selects 120-cps ripple voltage that is present at input to filter circuit of positive power supply; this signal is used for calibration and tests. In this position, pen marks chart at 60 (120 cps) if line frequency is 60 cps.
SPEAKER VOL. (R214)	Control is a potentiometer that adjusts audio level of monitoring speaker. Adjustment of this control has no effect on recorded signal. On some earlier units, control has switch that disconnects speaker, when control shaft is in its extreme counterclockwise position.
POWER LINE (K201 and K202)	Controls are circuit breakers, one in each side of power line, and are preset to open at 4 amperes.
POWER ON-POWER OFF-STAND BY (S201)	Switch is in series with circuit breakers K201 and K202. When they are on, S201 throws power on and off entire recorder system. In STAND BY position, power is applied to all circuits, except chart-drive motor and pen-lifting solenoid.
INTER S. C.-OUTPUT S. C. (S203)	Switch used for localization of trouble. INTER S. C. position shorts any incoming signal at input to univibrator. OUTPUT S. C. position shorts any dc output voltage that may exist across R203.
REC. TEST (S204)	Switch is momentary type, used to check operation of the frequency-time recorder. It disconnects signal from signal converter and substitutes test voltage.
REF. ADJUST (R202)	Vernier potentiometer that may be rotated through 10 revolutions. It is used to adjust the pen position for exact recording of the low reference signal during the ground check.
Speaker (LS201)	Permits audible monitoring of audio signal.
Power indicator lamp (I 201)	Lights when power switch is in ON or STAND BY position.
FAN ON-OFF (S1)	Switch, mounted on the fan panel, controls operation of fan.
Manual chart advance knob	This unmarked control, mounted at the left side of chart roller, advances chart manually.
CHART SPEED INS/MIN. ½–1 (S502)	Chart speed control switch that allows manual selection of chart speed, shown by panel marking. It is not included in first issue of recorder (RD–88/TMQ–5).
RAWIN TIME PRINT AUTO.-OFF-MAN. (S503).	In OFF position, switch causes printed time record from Control Recorder C–577(*)/GMD–1 to occur at regular predetermined rate, as selected by position of controls on control recorder. In MAN. position (momentary), an additional time print is recorded by control recorder. In AUTO. position, an additional time print is recorded by control recorder each time upward excursion of pen reaches 90 on the scale. These additional time prints of control recorder are distinguished by an asterisk, which is also printed when *time print only* circuit is energized. *Note.* To avoid improper actuation of control recorder time-print circuit, adjust radiosonde recorder reference control for recording reference signals in vicinity of 95 chart divisions.

Control	Function
SENSITIVITY (R213)	Screwdriver-adjusted potentiometer used to control gain of servo amplifier.
REC. ZERO (R208)	Screwdriver-adjusted potentiometer used to aline recorder pen on zero when SIGNAL SELECTOR switch is in S. C. position.
REC. TEST ADJ. (R211)	Screwdriver-adjusted potentiometer used to select amount of voltage that is necessary to make pen indicate 95 on scale, when REC. TEST switch is depressed.
PEN LIFTER (R215)	Screwdriver-adjusted potentiometer used to control amount of voltage that is fed by power amplifier tubes to pen-lifter circuit.
Noise suppression switch (S301)	Switch is accessible behind control panel, mounted on left-hand end of converter-amplifier chassis. When switch is in OUT position, noise suppression circuit is disabled.
OPERATE-LOCK knob	In LOCK position, this control clamps pen carriage rod, and prevents pen from touching paper or vibrating.

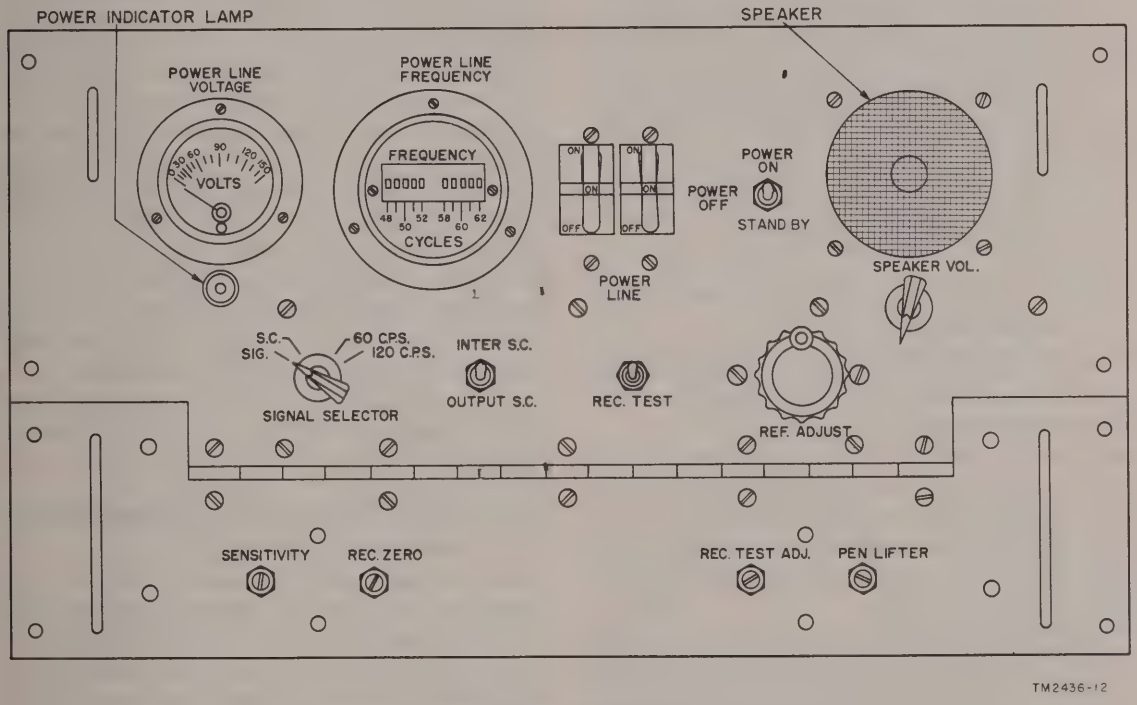


Figure 25. Control Panel C–834/TMQ–5, front view.

Section III. OPERATION UNDER USUAL CONDITIONS

24. Preparatory Procedure for Radiosonde System Operation

a. Procedure for Radiosonde Receiver R–228/FMQ–2.

(1) Make the necessary connections between units (par. 19).

(2) Inspect and prepare Radiosonde AN/AMT–2(*), following the procedure given in TM 11–2433.

(3) Inspect and prepare Radiosonde Receiver R–228/FMQ–2, following the procedure given in TM 11–2434.

(4) Follow the presetting, preliminary starting, and starting procedures for the recorder (pars. 25 through 27).

b. Procedure for Rawin Set AN/GMD–1(*).

(1) Make the necessary connections between units (par. 19).

(2) Inspect and prepare Rawin Set AN/GMD–1(*), following the procedure given in TM 11–271.

(3) Inspect and prepare Radiosonde AN/AMT–4(*), following the procedure given in TM 11–2432 or TM 11–2432A.

(4) Follow the presetting, preliminary starting, and starting procedures for the recorder (pars. 25 through 27).

c. Procedure for Radio Set SCR–658.

(1) Make the necessary connections between units (par. 19).

(2) Inspect and prepare Radiosonde AN/AMT–2(*), following the procedure given in TM 11–2433.

(3) Inspect and prepare Radio Set SCR–658, following the procedure given in TM 11–1158A.

(4) Follow the presetting, preliminary starting, and starting procedures for the recorder (pars. 25 through 27).

25. Presetting Procedures for Radiosonde Recorder AN/TMQ–5(*)

Before using the preliminary starting and starting procedures described in paragraphs 26 and 27, perform the following presetting procedures.

a. Open the vent on top of the cabinet by turning the knurled knob counterclockwise until it is loose. Spring action will open the cover.

b. Unfasten the two desk latches, and place the desk in the inclined position by pulling the bottom edge of the desk forward.

c. Check the chart feed mechanism for smooth movement and drift-free feed by turning the manual chart advance knob clockwise. Instructions to correct any drift are given in paragraph 18. Be sure there is enough chart paper left for a complete recording.

d. Throw the power switch to POWER OFF.

e. Rotate the SIGNAL SELECTOR switch to the S. C. position.

f. Rotate the REF. ADJUST to the middle of its range, that is, 5 revolutions from either end.

g. Throw the FAN ON-OFF switch to OFF.

h. Rotate the SPEAKER VOL. clockwise through three-fourths of its range.

i. If the frequency-time recorder is type RD–88A/TMQ–5, throw the chart speed switch to the desired position.

j. If the frequency-time recorder is type RD–88A/TMQ–5, throw the RAWIN TIME PRINT switch to the AUTO. or OFF position, as desired.

26. Preliminary Starting for Radiosonde Recorder AN/TMQ–5(*)

a. Throw the two POWER LINE circuit breakers ON.

b. Throw the power switch to STAND BY.

c. Read the POWER LINE FREQUENCY and POWER LINE VOLTAGE meters. If the frequency is not stable at a value between 50 and 65 cps, and the voltage is not between 105 and 125 volts, the performance of the equipment will be affected. If the voltage is normal, but the frequency is not, determine the line frequency from the POWER LINE FREQUENCY meter. When the frequency is some value other than 60 cps, the frequency of the test voltage that is available through the SIGNAL SELECTOR switch also will be different. The 60 C. P. S. position of the switch will deliver a frequency that is equal to the power line frequency, and the 120 C. P. S. position will deliver a frequency that is equal to twice the power line frequency. The chart readings for these frequencies will vary accordingly.

d. Throw the FAN ON-OFF switch to ON. Allow approximately 15 minutes for the recorder to warm up.

27. Starting Procedure for Radiosonde Recorder AN/TMQ–5(*)

Note. The values given in *a* through *e* below are for normal operation under normal power line conditions. If an abnormal result is obtained, refer to paragraph 55.

a. After the warm-up period, throw the power switch to POWER ON. The pen should record at zero on the chart (the SIGNAL SELECTOR switch still in S. C. position). If the pen does not record at zero, rotate the REC. ZERO control until the pen *does* record at zero.

b. Hold the REC. TEST switch in its down position; the pen should go to 95 and mark the chart. Release the switch, and the pen should return to zero and again mark the chart.

c. Rotate the SIGNAL SELECTOR switch to 60 C. P. S. The pen will go to 30 on the chart, or will be adjustable to 30 by rotating the REF. ADJUST. (This reading is one-half the line

frequency.) A 60-cps signal is heard in the speaker.

d. Rotate the SIGNAL SELECTOR switch to 120 C. P. S. The pen will go to 60 on the chart, or will be adjustable to 60 by rotating the REF. ADJUST knob; a 120-cps signal is heard in the speaker.

e. Rotate the SIGNAL SELECTOR switch to SIG. The recorder now is ready to receive and record signals.

Note. If calibration (par. 103) has not been accomplished within the past month, perform that calibration before proceeding with the ground check.

28. Ground Check

a. Procedure. Adjust the radiosonde to produce a low-reference signal. Adjust the REF. ADJUST until the low-reference frequency trace is exactly on the 95 line. Allow the recorder to print this trace for 30 seconds. Adjust the radiosonde, using the instructions in its technical manual, to produce 15-second traces for temperature, high reference, and humidity, in that order. Repeat this sequence until the recorder prints at least two successive identical traces for low reference, temperature, high reference, and humidity. Under extreme weather conditions, it is impossible to secure successive identical traces for humidity; traces that show only a slight change may be used.

b. Evaluation of Ground Check.

(1) Advance the chart manually to position the traces on the desk surface and draw straight lines (fig. 26) through the final temperature, humidity, and reference traces, respectively, to make them continuous plots. Draw a horizontal line across the chart at the top of the last humidity trace; this base line will show initial (ground) values of temperature and relative humidity.

(2) At the upper end of the last temperature trace, read the chart record to tenths of a chart division. This reading corresponds to the dry-bulb temperature, and the reading and temperature are entered on the chart along the base line (fig. 26). Use these data for the lock-in (par. 35*b*) of the temperature-humidity evaluator.

(3) At the intersection of the base line and the line that connects the humidity traces, read the humidity record to tenths of a chart division. This reading corresponds to the measured percentage of humidity at ground level, and the reading and percentage of humidity are entered next to the base line (fig. 26). Use these data for the temperature-humidity evaluator lock-in (par. 35*b*).

29. Final Preflight Procedure

a. Preparation. Prepare the radiosonde for launching according to the instructions in its technical manual. Lower the contact point of the radiosonde to the commutator. Record on the chart the barometric pressure and the segment number of the commutator on which the contact point is resting.

b. Procedure at Time of Launching Radiosonde. When a fast-rising balloon is used with Radiosonde Recorder AN/TMQ–5A, throw the chart speed switch to the 1 position (1 in. per min.). To identify the starting point of the flight record, a short zero trace may be made by throwing the SIGNAL SELECTOR switch to S. C. for about 5 seconds. Throw the switch back to SIG. and release the radiosonde. Record the time on the chart.

Note. For further details, refer to the applicable literature on Radiosondes AN/AMT–2(*) and AN/AMT–4(*).

30. Operating Instructions During Recording

a. As the low-reference signals are received, they indicate a more or less gradual drift, either upward or downward. Generally, the upward drift will not exceed 98 on the chart, in which case no readjustment will be made on the REF. ADJUST knob. This instruction also applies in case of a downward drift. If an upward drift should exceed 98 on the chart, the high-reference signal trace would be off the chart limit and would not print. This extreme condition is avoided by making an adjustment back to 95 whenever the drift indicates that it is going beyond 98. When the necessity for a readjustment has been established, be ready when the next low-reference signal is received. Make the adjustment quickly so that a suitable trace can be recorded before the low-reference signal terminates. If necessary, wait for the next low-reference signal to complete the adjustment.

b. Once the radiosonde is in flight, any drift will be considered as a drift for all signals and proportionate to the frequency being recorded. Corrections for this proportionate drifting will be ap-

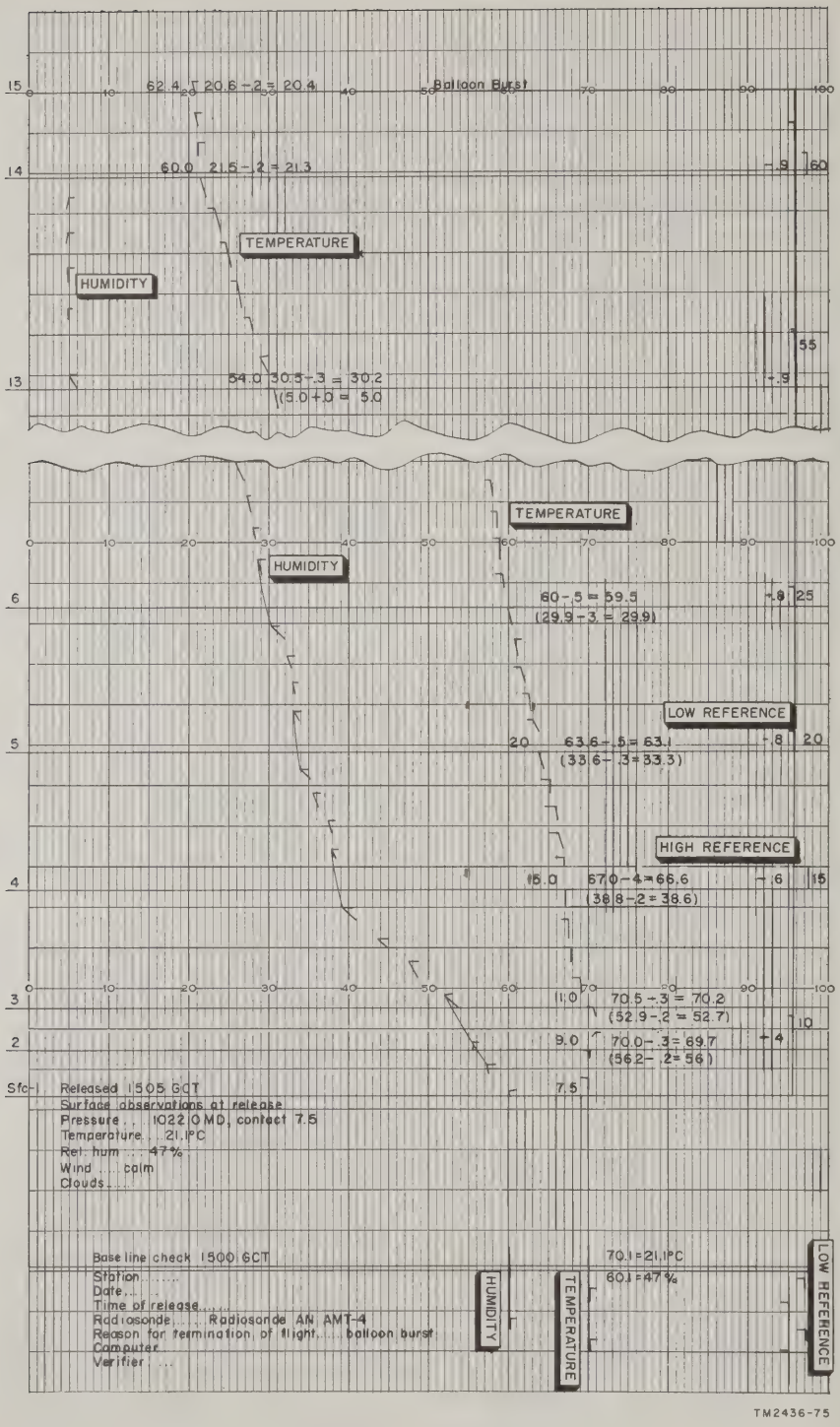


Figure 26. Flight record.

plied after the flight record is complete. *Do not* readjust the REF. ADJUST knob except under the condition stated in *a* above.

c. Because of the reflecting effect of nearby objects, a rapid drift may occur immediately after release of the radiosonde. The first low-reference signal in flight, therefore, may be expected to record *off* the 95 line. This rapid drift (or shift) is accounted for later in the application of corrections, the same as the more gradual drifts of the higher altitude traces.

d. The operator must determine whether the frequency variation of the low-reference signal occurs as a drift or a shift. Shifts occurring between low-reference signals may be spotted in the temperature and humidity traces. A sudden change in the audio note from the loudspeaker (not caused by a change-over in data recording) is indicative of a shift and informs the operator of the time of occurrence. Drifts are created by gradual changes within the radiosonde and show up as such on all traces. A shift either in the temperature or humidity trace, that does not show up in the other traces, indicates significant meteorological information. It is important that the operator give the equipment continuous attention during a recording.

e. If Radiosonde Recorder AN/TMQ–5A is used, and it is desired to have the control recorder print the time when the pen makes excursions to 90 or above, place the RAWIN TIME PRINT switch in the AUTO. position. If additional time readings are desired at intermediate points, place the RAWIN TIME PRINT switch in the MAN. position for each additional time print that is desired.

31. Descent Record

If a descent record is needed for confirmation or correction of various points on the ascent record, continue the recordings and observations. Instructions given in paragraph 30 involving REF. ADJUST will apply during the descent. The high-reference trace of the descent record often is needed to establish the actual contact number that corresponds to the highest altitude attained.

32. Chart Drift

To avoid inaccuracies caused by possible drift of the chart paper, check the zero line at the end of the descent record. With the SIGNAL SELECTOR switch on S. C., the trace still should lie exactly on the chart zero line. For accurate chart alinement and feed, refer to paragraph 18.

33. Record Evaluation

a. General. During the record evaluation described in this paragraph, have the correction data available that were obtained in the linearity test prescribed in paragraph 103. The final ordinate values for the temperature and humidity traces are affected by corrections for both linearity and low-reference drift. The levels at which evaluations are made (significant levels) are specified by the using service. Ground check observations (par. 28) are entered on the chart (fig. 26). The data include the station pressure, temperature, relative humidity, and pressure contact (commutator setting) at release, time of release, and any other information specified by the using service. Enter the actual pressure contact setting next to the release trace.

b. Data at Significant Levels. At the release trace and at each significant level, the pressure contact number (to the nearest tenth) is entered on the left side of the temperature record (fig. 26). (The top of the temperature trace, or bottom of the humidity trace, is considered the beginning of the pressure contact. The full contact will extend to the top of the next temperature trace.)

c. Preparation of Data.

(1) At each high- and low-reference trace on the chart, enter the contact number to the right of the reference trace. However, above the 105th contact, number only the high references.

(2) Connect each low-reference trace on the chart with a straight line (termed a drift line), drawn from the upper end of one low-reference trace to the lower end of the next trace. Normally this will be a straight line that coincides with the 95th abscissa line. This indicates a constant reference frequency of 190 cps. If a drift should occur in this reference frequency, recordings will be affected along the abscissa line, by an amount that is proportionate to the position of the recording between 0 and 95. Consider such drifts when evaluating the flight record.

(3) To correct for a drift in the low-reference frequency, the following example is typical. Assume that the low-reference trace

has shifted downward to 93.7, and the temperature trace for the same altitude level is 38.6. The decrease at the reference level is $95-93.7=1.3$. The decrease at 38.6 is $\frac{38.6}{93.7}\times 1.3=.54$; this value must be added to 38.6 to get the true temperature trace reading. (When a definite shift in the temperature and/or humidity traces occurs, without a corresponding shift in the low-reference trace, the recorded data above the level are questionable.)

34. Pressure Evaluation

Each radiosonde modulator is supplied with a pressure calibration chart, the serial number of which corresponds to the serial number of the radiosonde modulator. The calibration chart of one radiosonde modulator cannot be used to evaluate the flight of another.

a. The low-reference, high-reference, temperature, or humidity trace that occurs at any point of the chart corresponding to a particular contact on the commutator identifies the pressure at that point.

b. Observe the contact indication on the chart for the level desired. On the calibration chart, read vertically along the graph line that represents the contact to the calibration curve. Read the pressure from the horizontal line, at the intersection of the contact line and the calibration curve.

c. Check the release contact setting on the chart by counting back from the first complete reference after release. The fractional value of the contact at release can be estimated by comparing it with the length of the following contact.

(1) If the difference between the actual setting and the indicated setting is .5 contact or less, the pressure contact for significant levels should be corrected by the amount of the contact discrepancy.

Example: The record shows that the radiosonde was released with the contact point set at contact 8.4, but the calibration chart indicates that the setting should have been 8.2. The difference is .2 contact. Because the actual setting is higher than the correct setting (as obtained from the calibration chart), .2 should be subtracted from the contact value at the surface, and at all significant levels. If the actual setting is low, add the difference to the contact values at the surface and at all significant levels.

(2) If the difference between the actual setting and the indicated setting is greater than .5 contact, the correction method described in (1) above may be applied. However, because of the difference in the physical dimensions of the intermediate conducting segments, using this method may cause slight pressure errors.

Note. Contact discrepancies greater than .5 contact are caused by careless ground procedures.

35. Temperature-Humidity Evaluator ML–420A/AMT–4

(fig. 27)

This instrument is a circular slide rule that consists of three concentric plastic disks mounted together at their common center, so that each one is free to rotate. Also provided on the same center bearing is a transparent cursor arm, with a hairline engraved radially along its center. This hairline radially alines the graduations of one disk with those of another. The largest disk (base plate) contains two temperature scales (each scale to be used with different temperature elements) that are graduated in degrees centigrade. The middle disk is graduated in units that represent frequency in recorder divisions. The smallest disk has engraved on it a family of black curves that represent the percent of relative humidity, and another family of red curves that represent dew-point temperatures. The cursor also is graduated in degrees centigrade. Use the evaluator to evaluate the flight record, by translating the recorder frequencies into actual temperature and humidity readings. Use the ground true temperature and the ground true humidity data (base line data) as the reference data, when evaluating the chart traces. The base line data must be accurate.

a. Temperature Setting for Ground Check Data Lock-in.

(1) Set the hairline of the cursor at the ground check true temperature on the temperature plate (largest disk).

(2) Rotate the frequency (recorder divisions) plate (middle disk), until the frequency that corresponds to the ground check tem-

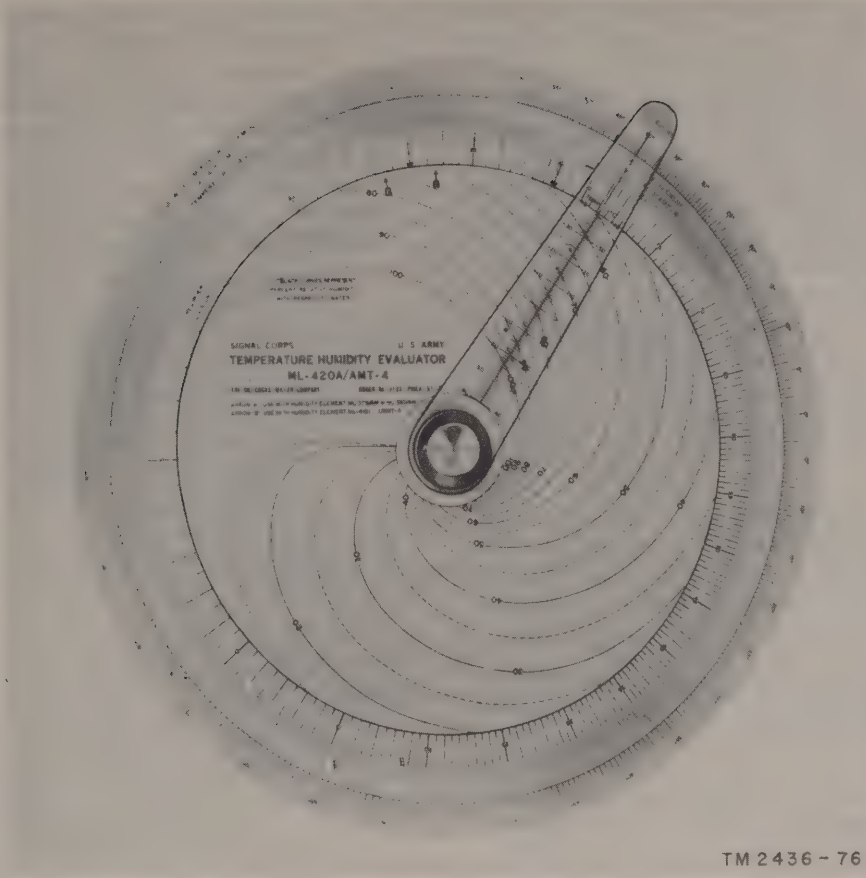


Figure 27. Temperature-Humidity Evaluator ML–420A/AMT–4.

perature trace (read on the chart) intersects the hairline of the cursor.

(3) Lock the two plates by turning the center (inside) knurled knob.

b. Humidity Setting for Ground Check Data Lock-in.

(1) Set the hairline of the cursor at the frequency reading on the frequency plate, that corresponds to the ground check humidity trace on the chart.

(2) Rotate the humidity (center) plate until the ground check true relative humidity intersects the hairline at the true temperature on the cursor.

(3) Lock the plates at the settings ((1) and (2) above), by turning the collar-type (outside) knurled knob.

Note. Replace the humidity element in the radiosonde if the appropriate arrow on the humidity plate does not fall between the arrows on the frequency plate (if surrounding conditions for both relative humidity and temperature were at least as high as 40 percent and 0° C., respectively).

36. Temperature Record Evaluation

a. Perform the procedure for locking in the ground check temperature data (par. 35*a*).

b. Move the cursor until its hairline is over the corrected temperature frequency that is determined for the temperature trace at the desired significant level (par. 33*b*).

c. Determine the value of the temperature on the temperature plate, as indicated by the cursor hairline. This is the actual temperature at the significant level on the chart.

Example: At the time of release, the ground check temperature was 19.3° C. and the temperature trace, as read on the recorder chart, was 66.1. At the desired significant level, the temperature trace is 42.3. To obtain the correct temperature,

lock the ground check temperature at the ground temperature trace (par. 35). Rotate the cursor until the hairline is at 42.3 recorder divisions. The actual temperature is then read as −14.6° C.

Caution: Loosen the knurled knobs enough to permit the disks to be rotated easily. If the knobs are backed off too far, the disks may become uncentered. Check to see that −40 on the cursor is always on the innermost circle.

37. Humidity Data Evaluation

a. General. The humidity traces on the chart will, in general, show greater variations than the temperature traces. They usually are evaluated at a point where the significant levels intercept the tops of the traces, or where the levels intercept a straight line that connects the top ends of the humidity traces above and below the significant level. Therefore, draw a straight line that connects the top of each humidity trace to the top of the succeeding humidity trace. Connect all consecutive humidity traces for the entire flight.

Note. For exceptions to the following procedure, refer to WBAN Manual of Radiosonde Observations, with applicable amendments and addenda.

b. Data Record.

(1) Read the humidity frequency in tenths of a recorder division of the recorder chart.

(2) Read the corrected humidity frequency at the intersection of the humidity curve and the significant level. The procedure for correcting the humidity trace is given in paragraph 33*c*(3). Be sure to select the humidity trace, rather than the temperature trace, when finding the proportional drift of the humidity trace.

c. Humidity Evaluation With Temperature-Humidity Evaluator ML–420A/AMT–4.

(1) Lock-in the humidity setting for ground check humidity data (par. 35*b*).

(2) Move the cursor until the hairline lines up with the corrected humidity trace (par. 33c(3)) that is determined at the specific significant level under evaluation.

(3) Locate the point on the graduated cursor that identifies the value of the temperature at this same significant level.

(4) Read the value of the relative humidity for this level from that curve, in the family of black curves, that intersects the hairline of the cursor at this temperature. If no curve intersects the hairline, the humidity value can be determined by interpolation between humidity curves.

Note. Interpolation between humidity lines is made along the hairline of the cursor.

Example: At a given level, the humidity frequency is 69.5 recorder divisions. The temperature at the same level is −7° C. The humidity frequency at ground is 80.2 recorder divisions, corresponding to a ground humidity of 71 percent, and ground temperature of 19.3° C. Give the indicated relative humidity.

Solution: Rotate the cursor until its hairline is alined with the 80.2 recorder division mark. Move the center disk until the correct humidity curve, corresponding to the true relative humidity of 71 percent, intersects the hairline graduations of the ground temperature (19.3° C.). Lock the two plates by turning the outside knurled knob. Move the cursor until the hairline is at 69.5 recorder divisions. Read along the cursor hairline to −7.0° C.; the relative humidity is 72.5 percent.

38. Stopping Procedure

After the record has been completed, operate the recorder with the SIGNAL SELECTOR switch in the S. C. position to obtain a zero check. Stop the recorder by throwing the power switch to the POWER OFF position. Advance the chart, with the manual advance knob, until the zero trace is approximately halfway past the lower edge of the tear-off scale; leave enough of the zero trace to indicate correct calibration. Carefully rip the chart against the lower edge of the tear-off scale.

39. General

The operation of Radiosonde Recorder AN/TMQ–5(*) may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. Instructions for minimizing the effect of unusual operating conditions are given in the following paragraphs.

40. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. Check to see that the pen heater is operating properly. Leave the power switch at STAND BY when the set is not used, unless this overtaxes the ac power source.

c. Locate the equipment inside a heated inclosure, where there is no danger of a cold draft striking the glass tubes. A sudden draft of cold air may shatter the glass envelope of a heated tube. If the inclosure is so constructed that this precaution is impossible, place a blanket or some barrier between the source of the draft and the equipment.

d. When equipment that has been exposed to the cold is brought into a warm room, it will sweat until it reaches room temperature. Open the vent on top of the recorder and start the fan. The circulating air will dry the equipment.

41. Operation in Tropical Climates

a. For operation in tropical climates, the equipment may be installed in tents, huts, or, when necessary, in underground dugouts. In the tropics, when equipment is installed below ground, or when it is set up in swampy areas, moisture conditions are acute. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever its temperature becomes lower than that of the surrounding air. To minimize this condition, keep the fan in operation, and the vent open.

b. During periods of inactivity, the lowered viscosity of the ink (caused by high temperature) allows it to seep by the ball point and form a drop. If this drop becomes large enough to reach the chart, capillary (blotting) action starts. In sufficient time, this will drain the ink supply and necessitate a cleaning operation. This condition can be avoided by placing a piece of metal foil directly under the pen point. This foil should be from 1 to 2 inches square; it is usually available in protective coverings such as cigarette, gum, and candy wrappings.

42. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same protective measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand, dust, or dirt that enters the moving parts of the recorder, such as motors and linkage. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent their flapping in the wind.

c. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls, which may jerk the connections loose or break the lines.

d. Keep the equipment as free as possible from dust. Make frequent preventive maintenance checks.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

43. Tools and Materials Supplied With Radiosonde Recorder AN/TMQ–5(*)

Included with the operating cables and other equipment are the following tools and materials that are supplied for test and maintenance. They are packed in the accessories case furnished with each Radiosonde Recorder AN/TMQ–5(*); one of each is illustrated in figure 14.

a. One each 2-inch screwdriver.

b. Two each double open-ended wrenches (¾ inch one end, ⅞ inch other end).

c. One each Tube Puller TL–201.

d. Six each test cables (cables W604 and 1 cable W606).

44. Special Tools and Cables

a. The two double open-ended wrenches are used to adjust or to remove and replace the friction-clutch assembly and adjustable chart-roll mounting. The wrenches are also used to remove and replace the large driven gear of the frequency-time recorder.

b. The six test cables are used to operate any or all of the components when those components are removed from the cabinet (par. 79*a*). The 28-conductor cable is used to operate the power supply chassis; the five 14-conductor cables are used for the remaining components.

Section II. PREVENTIVE MAINTENANCE SERVICES

45. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service can be kept to a minimum. Preventive maintenance differs from troubleshooting and repair in that its object is to prevent certain troubles from occurring.

46. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, Dry Cleaning (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a cloth.

Caution: Repeated contact of carbon tetrachloride with the skin, or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, use dry compressed air at a line pressure not exceeding 60 pounds per square inch (psi) to remove the dust from inaccessible places; be careful, because mechanical damage from the air blast may result.

d. Even in temperate climates, tropical conditions sometimes exist, especially in the summer months. See paragraph 41 for preventive maintenance information under such conditions.

e. For further information on preventive maintenance techniques, refer to TB SIG 178.

47. Use of Preventive Maintenance Forms (figs. 28 and 29)

a. The decision as to which items on DA Forms 11–244 and 11–245 are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection.

Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 28 and 29 are partially or totally applicable to Radiosonde Recorder AN/TMQ–5(*). References in the item block refer to paragraphs in text which contain additional maintenance information.

48. Performing Preventive Maintenance

Perform the following preventive maintenance operations at the intervals indicated, unless these intervals are reduced by the local commander.

Caution: Screws, bolts, and nuts should be tightened carefully. Fittings tightened beyond the pressure for which they are designed will be weakened or broken.

a. Performing Exterior Preventive Maintenance.

(1) Check for completeness and satisfactory condition of the recorder.

(2) Inspect the frequency-time recorder for clean, well-defined printing and proper chart speed.

(3) Check the loaded line voltage and frequency readings for the proper operating values and stability. The proper procedure to be followed and the proper values to be indicated by the meters are listed in paragraph 26*c*.

(4) Check for normal operation. Perform the presetting, preliminary, and starting procedures (pars. 25, 26, and 27).

(5) Check to see that there is sufficient chart paper for a complete flight record.

(6) Clean and tighten connectors of the signal and power cable, signal adapter cable, and power adapter cable. Tighten all mounting screws in the front of the cabinet and all Camloc fasteners on the rear of the cabinet. Clean the exterior of the cabinet.

(7) Inspect the cabinet for rust, corrosion, and moisture.

(8) Inspect all external cabling and shock mounts for cuts, breaks, fraying, deterioration, kinks, and strain.

(9) Clean the meter windows.

(10) Inspect the meters for damaged glass and cases. Check the zero adjustment on the voltmeter.

b. Performing Interior Maintenance Operations. Disconnect all power before performing the following operations. After completing the operations, reconnect the power and check the set for satisfactory operation.

(1) Remove the desk and then remove the mounting screws of the control panel and the fan panel. Pull out these units by their handles and perform the following operations:

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

(*b*) Tighten switches and knobs that have become loose.

(*c*) Inspect controls for binding, scraping, excessive looseness, and positive action.

(*d*) Clean the SIGNAL SELECTOR switch contacts and pins in plugs P201 and P202 on the control panel (fig. 56), and plug P1 on the fan panel (fig. 65) with a cloth or stiff brush moistened with carbon tetrachloride.

(*e*) Clean the porcelain covered resistors that are mounted near the lower edge of the control panel.

(*f*) Inspect the fan motor for indications of overheating.

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

(*a*) Remove the chart.

(*b*) Remove dust and dirt from the top of the drawer, the lamps, the reflector, and the pen-heater contact bar.

(*c*) Remove the cover of the slide and trolley wires. Carefully clean these wires and their contacts with a cloth or brush moistened with carbon tetrachloride. Continued wear of the contacts against the slide and trolley wires produces a groove in the contacts. If this groove has progressed halfway through either contact, replace both contacts (par. 82*c* (3)).

(*d*) Check the ink supply in the pen (par. 15), the seating of the pen in the pen carriage, and the tension of the drive cable. This tension should be between 1 and 1.25 pounds (par. 92*c*).

(*e*) Clean the chart roller, pen, and pen carriage very carefully. Be sure there is no lint left around the pen point (par. 106*b*).

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIOSONDE RECEPTOR, RAWIN

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ⓧ Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(antenna assembly, receiver, frequency meter, recorder, amplifier, voltage regulator).* PAR. 48a (1)							
2	INSPECT FOR CLEAN IMPRESSION OF PRINTING; FOCUS OF RECORDER OPTICAL SYSTEM; PROPER ACTION OF RIBBON REVERSE ASSEMBLY; CORRECT PAPER ENGAGEMENT OF FRICTION FINGER ASSEMBLIES; PROPER RECORDER PAPER FEED. PAR. 48a (2)							
3	CHECK ANTENNA SWITCH FOR PROPER ANTENNA CONNECTION; INPUT VOLTAGE AND FREQUENCY READINGS FOR PROPER VALUES. PAR. 26c							
4	CHECK FOR NORMAL OPERATION. PARS. 25, 26, & 27							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
5	CLEAN AND TIGHTEN EXTERIOR COMPONENT, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, CABLE CONNECTIONS. PAR. 48a(6)		8	CLEAN BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 48a (9)	
6	INSPECT CASES, MOUNTINGS, ANTENNAS, EXPOSED METAL SURFACES FOR RUST, CORROSION AND MOISTURE. PAR. 48a (7)		9	INSPECT FOR TYPEWRITER RIBBON WEAR; CORRECT POLARITY MOUNTING OF PHOTOTUBE; GOOD GROUND CONNECTIONS.	
7	INSPECT WIRE, CABLE, CORD, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS AND STRAIN. PAR. 48a (8)		10	INSPECT METERS FOR CRACKED GLASSES, LOOSE TERMINALS, ZERO ADJUSTMENT. PAR. 48a (10)	

11 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-244 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

Figure 28. DA Form 11-244.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIOSONDE RECEPTORS, RAWIN

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE | EQUIPMENT SERIAL NUMBER

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(Antenna assembly, receiver, frequency meter, recorder, amplifier, voltage regulator)* PAR. 48a (1)	
2	INSPECT FOR CLEAN IMPRESSION OF PRINTING; FOCUS OF RECORDER OPTICAL SYSTEM; PROPER ACTION OF RIBBON REVERSE ASSEMBLY; CORRECT PAPER ENGAGEMENT OF FRICTION FINGER ASSEMBLIES; PROPER RECORDER PAPER FEED. PAR. 48a (2)	
3	CHECK ANTENNA SWITCH FOR PROPER ANTENNA CONNECTION; INPUT VOLTAGE AND FREQUENCY READINGS FOR PROPER VALUE. PAR. 26c	
4	CHECK FOR NORMAL OPERATION. PARS. 25, 26 & 27	
5	CLEAN AND TIGHTEN EXTERIOR COMPONENT, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, CABLE CONNECTIONS. PAR. 48a (6)	
6	INSPECT CASES, MOUNTINGS, ANTENNAS, EXPOSED METAL SURFACES FOR RUST, CORROSION AND MOISTURE. PAR. 48a(7)	
7	INSPECT WIRE, CABLES, CORD, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS AND STRAIN. PAR. 48a(8)	
8	CLEAN BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 48b	
9	INSPECT FOR TYPEWRITER RIBBON WEAR; CORRECT POLARITY MOUNTING OF PHOTO-TUBE; GOOD GROUND CONNECTIONS.	
10	INSPECT METERS FOR CRACKED GLASSES, LOOSE TERMINALS, ZERO ADJUSTMENTS. PAR. 48a (10)	
11	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS - TUBES, LAMPS, FUSES. PAR. 48b (3)	
12	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 48b (1)	
13	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS - SWITCHES, KNOBS, JACKS, ELECTRICAL CONNECTIONS, PILOT LIGHT ASSEMBLIES, LAMPS, TRANSFORMERS. PARS. 48b (1) (b) TO (e)	
14	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS, INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK DOUBTFUL TUBES BY SUBSTITUTION. PAR. 48b(3)(c)	
15	INSPECT FIXED CAPACITORS FOR DIELECTRIC LEAKAGE, BULGES, DISCOLORATION, DIRT, LOOSE CONTACTS. PAR. 48b(3)(d)	
16	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, LOOSE MOUNTINGS.	
17	INSPECT RESISTORS, BUSHINGS, AND INSULATORS FOR CRACKS, CHIPPING, BLISTERING, MOISTURE, DISCOLORATION, LOOSE CONTACTS AND CORROSION. PAR. 48b(3) (j)	
18	CLEAN AND TIGHTEN SWITCHES, TERMINAL STRIPS, RHEOSTATS AND POTENTIOMETERS, MULTIPLE CONNECTORS, INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 48b(1)(a) TO (e)	
19	INSPECT TERMINAL STRIPS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR. 48b(3)(i)	
20	INSPECT POWER AND AUDIO TRANSFORMERS, FILTER CHOKES FOR OVERHEATING, DIRT, DUST, MOISTURE, LEAKAGE. PAR. 48b(3)(e)	
21	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS - TRANSFORMERS, CHOKES, POTENTIOMETERS, RHEOSTATS, DRIVE MOTORS, VOLTAGE REGULATORS. PAR. 48b(3)	
22	INSPECT DRIVE MOTOR FOR OVERHEATING, BRUSH WEAR, BRUSH SPRING TENSION, ARCING OR PITTING OF COMMUTATOR. PAR. 48b(2)(f)	
23	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 49	
24	BEFORE SHIPPING OR STORING - REMOVE BATTERIES, PACK SILICA GEL BAGS. PAR. 107	
25	INSPECT FOR RECORDER DISK WARPAGE; ANTENNA CONTINUITY.	
26	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
27	INSPECT WEATHERPROOFING, DUSTPROOFING, TROPICALIZATION. PAR. 48b (4)	
28	MOISTURE AND FUNGIPROOF. PAR. 48b(4)	

29 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-245 *(Formerly DA AGO)* REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE

TM 2436-101

Figure 29. DA Form 11-245.

(*f*) Inspect the balancing motor and chart motor for any indications of overheating. Tighten their mounting screws.

(*g*) Inspect and tighten the chart motor and balancing motor gear trains. Inspect the chart clutch. Rotate the manual chart advance knob and inspect for binding of the chart roller. Clean and lubricate the chart mechanism as directed in paragraph 49.

(*h*) Inspect and tighten solenoid linkage and chart-roll bearings.

(*i*) When using Frequency-Time Recorder RD–88A/TMQ–5, manually rotate the balancing gears until the pen moves above 90 divisions on the scale. Check the action of cam-operated microswitch S504 for overtravel when actuated. The overtravel should not exceed one-thirty-second of an inch.

(*j*) Install the chart (par. 17); close and latch the frequency-time recorder.

(3) Remove the rear panel of the cabinet and perform the following operations:

(*a*) Clean the tops of the converter amplifier and power-supply chassis.

(*b*) Inspect vibrator inverter G301 to be sure it is seated properly and that its clamp is in place. Check tightness of cable W301 at the top of the vibrator inverter (fig. 57).

(*c*) Inspect the electron tubes on both chassis for loose envelopes, cracked sockets, and insufficient socket spring tension. Be sure tube shields are in place. Check doubtful tubes by substitution.

(*d*) Inspect fixed capacitors for bulges, discoloration, dirt, and loose contacts.

(*e*) Inspect power and audio transformers and filter chokes for overheating, dirt, loose contacts, moisture, and leakage.

(*f*) Remove all dust and dirt from the bottoms of the converter amplifier and power-supply chassis. Do not move any wires or adjustments.

(*g*) Inspect and clean fuses and fuse clips.

(*h*) Tighten the mounting nuts of the adjustment potentiometers.

(*i*) Inspect terminal strips for loose connections, cracks, and breaks.

(*j*) Inspect resistors, bushings, and insulators for cracks, chipping, blistering, moisture, discoloration, loose contacts, and corrosion.

(4) Inspect the recorder for tropicalization, moistureproofing, and fungiproofing.

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

(6) If the pen should become fouled by a partially or totally dried up ink supply, clean the barrel and pen thoroughly. The best cleaning agent is isopropyl alcohol; the next best is normal propyl alcohol. Carbon tetrachloride may be used in the absence of a better cleaning agent, but it is very slow in its action. Proceed as indicated below.

(*a*) Remove the pilot light assembly from its mounting and lay it to one side; to release it, loosen (do not remove) the three mounting screws that support it.

(*b*) Unscrew and remove the cap from the ink barrel.

(*c*) Carefully lift the pen-heating unit and lay it to one side; be careful not to break the lead wires.

(*d*) Loosen the set screw found in the front of the pen-supporting member.

(*e*) Remove the pen and ink barrel from the carriage assembly. Discard excess ink.

(*f*) Unscrew the ball point from the ink barrel.

(*g*) Immerse the parts (cap, barrel and point) in the cleaning agent and clean them thoroughly. Clear the vent hole in the cap with a small wire or broom splint.

(*h*) Reassemble the parts by reversing the above procedure.

Note. Isopropyl alcohol, in addition to being a good cleaning agent for this type of ink, also has the ability to neutralize the coloring matter; therefore, it serves as an excellent ink eradicator, when needed.

Section III. LUBRICATION AND WEATHERPROOFING

49. Lubrication

All moving parts of the recorder are lubricated by the manufacturer and do not require further lubrication except for the two-speed chart drive mechanism of Frequency-Time Recorder RD–88A/TMQ–5. Apply monthly 1 drop of light low-temperature machine oil to the oil hole in the hub on each of the two ratchet wheels, O 729 and O 730 (figs. 51 and 52).

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

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moisture-proofing treatment which provides a reasonable degree of protection has been applied to the recorder. This treatment is fully explained in TB SIG 13 and TB SIG 72.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are fully explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are fully explained in TB SIG 75.

50. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bare surfaces. Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright, smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used should be authorized and consistent with existing regulations.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

51. 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 (receiver-transmitter, 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 at a field maintenance level is indicated. If the fault cannot be determined through organizational procedures, reference is made to the necessary field maintenance instructions.

b. The techniques that are utilized for organizational troubleshooting include visual inspection, operational tests, tube tests, and simple continuity checks. The material is presented in the order that a repairman would normally employ when servicing a defective radio set. When the procedures indicated are not sufficient to determine the source of trouble, troubleshooting at a field maintenance level (ch. 5) will be required.

52. 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. 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.

53. System Sectionalization of Trouble to a Component

System sectionalization consists of determining whether the trouble is in the converter amplifier, frequency-time recorder, or power supply.

a. Operate the recorder and observe its performance. See the equipment performance check list (par. 55) for normal operating indications.

b. If the entire equipment is dead, the trouble is probably in the power source or circuit breakers. If circuit breakers continue to trip after they have been reset a few times, look elsewhere to determine the basic source of the trouble.

c. The overall operation can be checked by the short circuit and the two test voltages at 60 and 120 cycles obtained through SIGNAL SELECTOR switch S202. See the equipment performance check list (par. 55) for normal operating indications.

d. The operation of the servo voltage and servo power amplifiers and the frequency-time recorder can be checked by operating REC. TEST S204. The frequency-time recorder should indicate 95 on the scale if both are operating correctly.

e. Trouble in the converter amplifier can possibly be isolated to one of two sections by using INTER S.C.-OUTPUT S.C. switch S203 and SIGNAL SELECTOR switch S202. For normal indications, refer to the equipment performance check list (par. 55).

f. If dc voltage is not obtainable from either the positive or the negative power supply, the trouble is probably a burned-out fuse, F401, F402, F403, or F404. Do not continue to burn out fuses before looking elsewhere to determine the source of the trouble.

g. By the use of procedures similar to the simple checks given above, the trouble can be isolated to a particular component or part of a component.

54. Troubleshooting by Using Equipment Performance Check List

a. General. The equipment performance check list (par. 55) will help the operator to locate trouble in the equipment; the list gives the item to be checked, the conditions under which the item is checked, the normal indications of correct operation, and the corrective measures the operator can take. To use this list, follow the items in numerical sequence.

b. Action or Condition. For some items, the information given in this action or condition column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indications given in the normal indications column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should observe when the items are checked. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the operator can make without turning in the equipment for repairs. A reference in the table to a paragraph in chapter 5 indicates that the trouble cannot be corrected during operation and that troubleshooting by an experienced repairman is necessary. If the set is completely inoperative, or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the tactical situation requires that the set be kept in operation and the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

55. Equipment Performance Check List

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Signal and power cable	Signal cable connected to radiosonde receiver. Power cable connected to ac source.		
	2	Circuit breakers K201 and K202.	Set to ON.		
	3	Voltmeter M202 and frequency meter M201.	Indicate line voltage and frequency.	105 to 125 volts; 50 to 65 cps.	Consult manual on power equipment in use.
	4	SIGNAL SELECTOR switch S202.	Rotate to S. C.		
	5	REF. ADJUST R202	Rotate to middle of range.		
	6	SPEAKER VOL. control R214.	Rotate to middle of range.		
	7	Pen OPERATE-LOCK knob.	Turn to OPERATE.		
	8	Power switch S201	Set at STAND BY	Power jewel lights; meters indicate.	Check circuit breakers, power unit, cabling.
	9	Fan	Turn fan switch to ON	Fan motor starts	Check connector on fan panel; tighten mounting screws.
				Recorder pen goes to zero.	Adjust REC. ZERO. Check SENSITIVITY setting; check fuses F401 through F404. If ineffective, refer to item No. 15.
START	10	Power switch S201	Switch from STAND BY to POWER ON.	Chart motor starts and drives chart.	Check plug P501 for good contact; check chart clutch. Tighten mounting screws of frequency-time recorder frame.
EQUIPMENT PERFORMANCE	11	REC. TEST switch S204	Depress until check is finished; then release.	Recorder pen moves to 95 and marks chart. Pen returns to zero when switch is released.	If pen does not move, check fuses F401 and F402, setting of SENSITIVITY control, tubes in servo voltage amplifier (V308, V309, and V310), and tubes in servo power amplifier (V405 and V406). Check for burned-out filament in series circuit by checking neon indicator lamps E301 through E306, and E306 and E401. If indicator glows, replace associated tube. Check vibrator inverter G301. If pen comes to rest above or below 95, check setting of REC. TEST ADJ. R211.

Item No.	Item	Action or condition	Normal indications	Corrective measures
12	SENSITIVITY control	Turn control to clockwise limit.	Pen is unstable	If pen remains unstable, check the following: Tubes V308, V309, and V310 in servo voltage amplifier. Tubes V405 and V406 in servo power amplifier. Vibrator inverter G301. Mechanical balancing system movement.
13	Recorder pen	Pen not moving	Ink marks on chart	If pen does not ride against chart, check position of intermediate chart guide rod, OPERATE-LOCK control, relay K401, and solenoid linkage. Readjust PEN LIFTER control and check V407. If pen does ride against chart, check movement of chart; refill pen.
14	Pen-lifter circuit	When pen is moving in horizontal plane.	Pen lifts from chart	Remove relay K401. If pen does not lift, trouble is probably mechanical; check solenoid and linkage. If pen does lift with relay removed, check tube V407 and series filament circuit as in item No. 11. Check relay K401 and setting of pen-lifter potentiometer R215.
15	INTER S. C.-OUTPUT S. C. switch S203.	Depress INTER S. C.-OUTPUT S. C. switch to OUTPUT S. C.	Pen goes to zero	If pen does not go to zero after item No. 8 but returns to zero when INTER S. C.-OUTPUT S. C. switch is depressed, trouble is probably in converter amplifier. If pen remains at same position (other than zero) attained after item No. 8, trouble is probably in frequency-time recorder or servo system, and troubleshooting is necessary. Refer to paragraph 75.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE			Press INTER S. C.-OUTPUT S. C. switch to INTER S. C.; hold until pen stops.	Pen goes to zero	If trouble above is traced to converter-amplifier, and pen returns to zero in this test, check tubes V301 through V304. If depressing INTER S. C.-OUTPUT S. C. switch has no effect, check tubes V305 through V307.
	16	SIGNAL SELECTOR switch S202.	Rotate to 60 C. P. S	Pen goes to 30 and 60-cycle note is heard in speaker. (Speaker frequency is always twice chart frequency.)	If pen does not move and 60-cycle note is not heard in speaker, check switch S202 and tubes V301 through V304. If pen does not move, but 60-cycle note is heard in speaker, check tubes V305 through V307. In either case, check filament series circuit as described in item No. 11. Check vibrator inverter.
			Rotate to 120 C. P. S	Pen goes to 60 and 120-cycle note is heard in speaker.	Check same as above, but 120-cycle note should be heard in speaker.
			Rotate to SIG. If radiosonde and radiosonde receiver are not operating, leave switch at 120 C. P. S.	Recorder prints graphic marks when radiosonde and radiosonde receiver are operating.	Check signal cable and switch S202. Check operation of radiosonde receiver.
	17	Speaker	SPEAKER VOL. control to three-fourths of its range.	Signals or 120-cycle note should be heard, depending on position of SIGNAL SELECTOR.	Check tube V304, switch S205, and setting of volume control R214.
	18	CHART SPEED INS/MIN. switch S502.	Set at ½	Chart advances ½ inch per minute.	Check for rotation of chart drive motor pinion and action of pawls in gear mechanism.
			Set at 1	Chart advances 1 inch per minute.	Same as above.
	19	RAWIN TIME PRINT switch S503.	Set to OFF	Time print circuit open for all pen positions on scale.	Check associated circuit and S503.
			Set to AUTO	Time print circuit closed only when pen is at 90 or above on scale.	Check actuation of automatic time print switch S504 by cam on slide-wire shaft.
			Depress to MAN	Time print circuit closed for all pen positions on scale.	Same as above.
STOP	20	Power switch S201	Set at POWER OFF.	Meters return to zero; dial lights go out	Check switch S201.

CHAPTER 4

THEORY

56. General

Radiosonde Recorder AN/TMQ–5(*) measures and records radiosonde data (atmospheric pressure, temperature, and relative humidity) as received by a radiosonde receiving system such as Rawin Set AN/GMD–1(*). The latter equipment is a receiving-type direction finder which receives the signals transmitted by a balloon-borne radiosonde (Radiosonde AN/AMT–4(*)). The received intelligence from the radiosonde receiving equipment 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 are converted into actual temperature and relative humidity values by Temperature-Humidity Evaluator ML–420A/AMT–4. Pressure information is obtained by reference to the individual pressure-calibration chart furnished with each radiosonde system.

57. Block Diagram

A simplified diagram of this recorder (fig. 7) is discussed in paragraph 4*b*(3), describing its function with respect to the complete radiosonde system. A more detailed block diagram (fig. 30) is discussed below.

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. For ease of presentation, the circuits discussed in the order of their signal functions and the components are often referred to by functional common names. Paragraph 8 lists the components by nomenclature and common name.

b. Converter-Amplifier Chassis. The converter-amplifier chassis (figs. 10, 58, and 59) 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 servo amplifier system. Input signals that will properly excite the converter and deliver reliable output data must fall within the limits of the following specifications: they must have an amplitude in the range of 10 to 100 volts, peak-to-peak; their recurrence frequency must be below 250 cps; their shape should be classified as sine, square, sawtooth with positive-going slope, or negative video 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 then are rectified and filtered. The resultant dc signal to the detector is directly proportional to the recurrence frequency of the input signal and thus it 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 66. 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 is from output tube V307, and one is from the contact arm on slide-wire potentiometer R501B in the measuring circuit. When the 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 servo amplifier circuits to operate the recording portion of the equipment. The *phase* of the error voltage referred to the power line phase is dependent on the *polarity* of the unbalance between the two dc voltages.

d. Measuring Circuit. The measuring circuit contained in Control Panel C–834/TMQ–5 com-

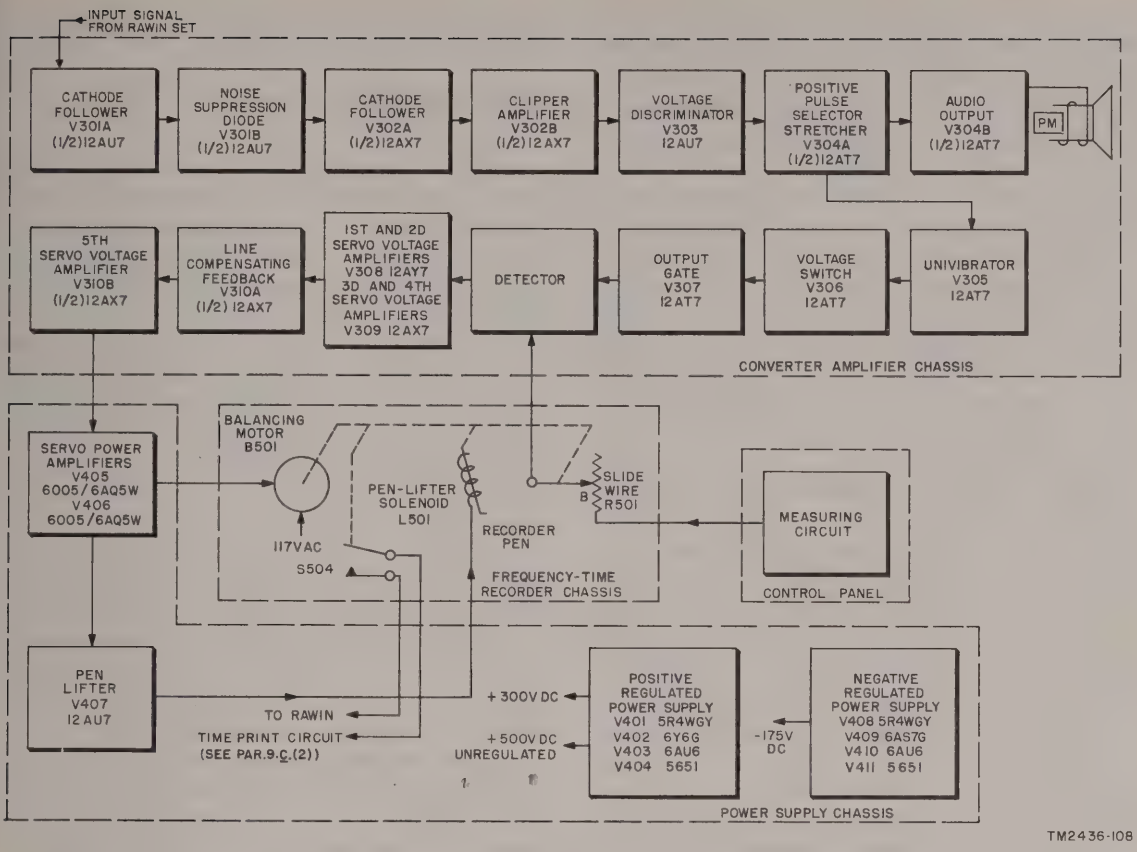


Figure 30. Radiosonde Recorder AN/TMQ–5(*), detailed block diagram.

prises an arrangement of resistors and potentiometers used to develop and control the voltage across the slide-wire potentiometer which is mounted on the Frequency-Time Recorder RD–88(*)/TMQ–5 chassis. A test voltage is also developed in the measuring circuit and is used to check the operation of the recorder.

e. Servo Amplifier. The servo amplifier 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 Power Supply PP–968/TMQ–5. 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 that the chart is not marked while the pen is being moved to the proper position.

f. Balancing Motor B501. Balancing Motor B501 is a two-phase motor which is mechanically coupled to the moving arm of the slide-wire potentiometer and to the recording pen. One winding of the motor is connected to a 60-cycle excitation voltage, and the other winding (the control winding) is connected to the output of the servo amplifier 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 cancelled 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 and, at the same

time, 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 meterological 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 one-half of an inch per minute (½ or 1 inch per minute in recorders serially numbered above 25), so that the received data are spaced along the chart from the beginning to the end of each radiosonde flight.

h. Power Supply. Power Supply PP–968/TMQ–5 contains the 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. It also contains the servo power 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 theory, bear in mind that basically the signal converter comprises the wave shaping and pulse forming circuits up to the dedector. The servo amplifier system comprises the voltage amplifiers, power amplifiers, and pen-lifting and operating circuits, which are necessarily associated with the balancing motor circuit in the frequency-time recorder. The control panel functions to supply controls for the measuring circuits and adjustments for proper operation, and the power supply furnishes the necessary operating potentials. Essentially 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.

58. Cathode Follower

(figs. 31 and 32)

Cathode follower V301A is one-half of a miniature twin-triode tube. It functions as a buffer or isolating stage which offers a sufficiently high input impedance to prevent loading of the output circuit of the radiosonde receiver (which supplies signals to the recorder). It also presents a low output impedance to the noise-suppression circuit. The input signal 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 discussion and presentation, all wave forms shown on the simplified diagrams in this chapter are taken with SIGNAL SELECTOR switch S202 in the 120 C. P. S. 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 C. P. S. and 120 C. P. S., supply either a 60- or 120-cps signal to the input circuit, which makes the recorder indicate a reference level of 30 or 60, respectively, if REF. ADJUST potentiometer R202 (fig. 25) 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 dc blocking capacitor C301 to the grid of 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 through R302. Cathode resistor R303, 180,000 ohms, returns to the negative 175-volt supply, so that across the plate-cathode resistance and R303 (in series) there is a total potential of 475 volts. Cathode current in R303 keeps the cathode above

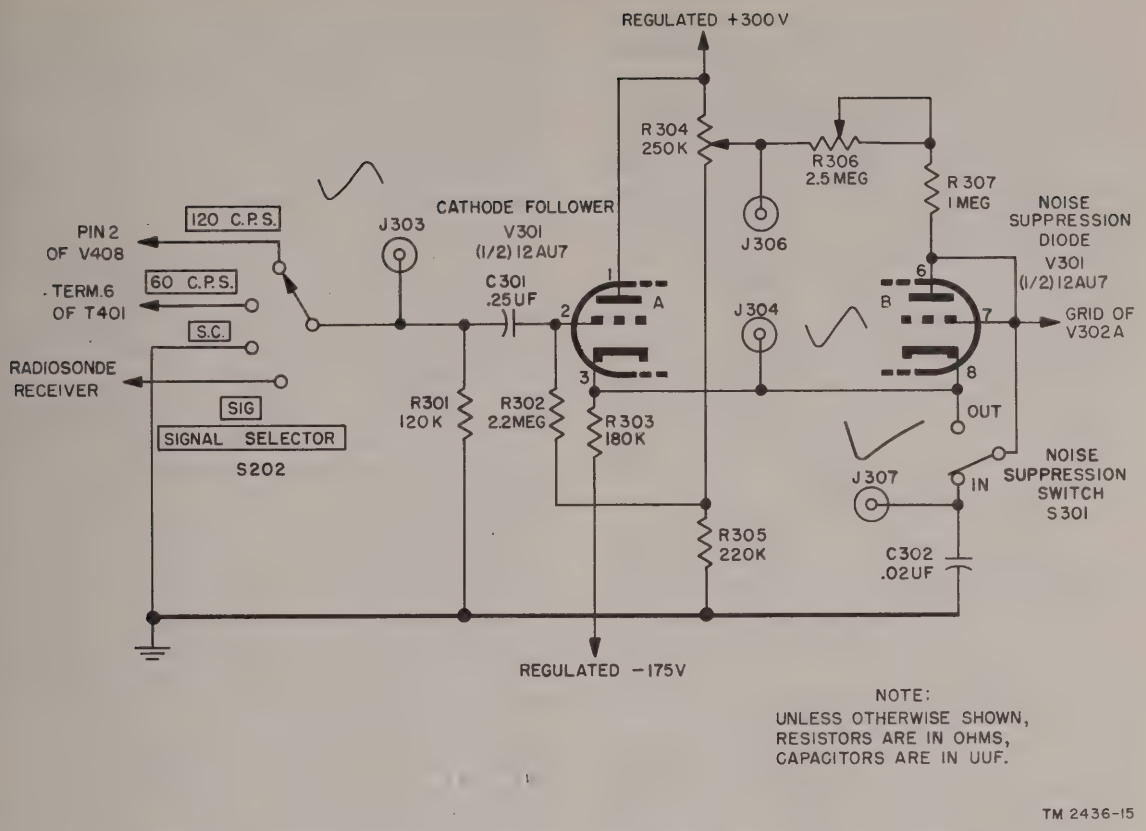


Figure 31. Cathode follower and noise-suppression diode, simplified schematic diagram.

the 140-volt potential of the grid, so that the tube actually has a negative bias. The advantage of this arrangement of circuity and values is two-fold: it permits the injection of large signal voltages without overloading, and it presents a high impedance to its signal source but is a low-impedance signal source for its load.

(1) The higher signal voltage is permitted because the cathode will follow very closely any signal voltage applied to the grid, and thus will avoid 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 (μa) 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 grid-ground capacity, which is very small, is the only one undergoing any appreciable change of charge; 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 $Z=1/G_m$, nearly.)

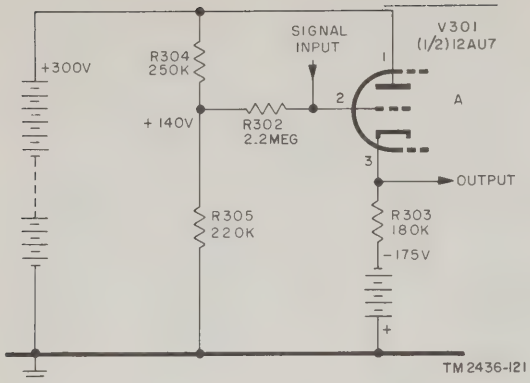


Figure 32. Bias circuit, simplified schematic diagram.

59. Noise Suppression Diode

(fig. 31)

Noise suppression diode V301B is one-half of a miniature twin-triode tube that has had the plate and grid pins connected together to form an anode connection. The purpose of the diode is to reduce the noise level in the signal when it becomes so high that it might cause false triggering of the univibrator and thus give false recordings. It may be switched in or out by means of 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 then performs no service. 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 R307, R306, and R304; and the cathode is connected to −175 volts through R303. Cathode resistor R303 is shared with V301A and is the coupling means between the two tubes. The portion of the current in R303 that is delivered to V301B is about 30 μa or 1/60 of the total current in the resistor.

b. The signal at J304 is practically identical in amplitude and shape with that at J303 (par. 58). 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 C302, the *hot* terminal of which is connected to the anode through switch S301.

c. Under no-signal conditions the two cathodes of V301 will be at about 150 volts potential above ground (par. 58). 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 R304. When this positive-going voltage becomes greater than that on the cathode, the diode becomes conductive and allows current to be supplied to the anode from R303. This introduces a voltage-divider string that is resistive, and the voltage will rise no higher; the string consists of R303, the diode, R307, R306, and the upper part of R304. The upper limit of voltage on the capacitor (or anode) is about 155 volts. This is the condition of circuit potentials before a signal is applied.

d. Assume that a strong signal wave, similar to that shown at J304, is now applied. The initial swing is negative-going, and C302 is permitted to discharge through R303 and the diode. At the frequencies involved, the voltage decline on C302 can follow the signal voltage wave quite closely. After the completion of the downward swing of the signal voltage, the cathode signal potential starts rising again. Immediately, diode conductivity has been cut off because the relatively long time constant of C302, R307, R306, and R304 does not permit the voltage to rise as fast 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 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 is conductive again and a new cycle is started.

e. Because the positive-going part of the output signal from the diode is unaffected by the actual signal, it is free of any noise voltage. As will be seen later, it is this portion of the signal wave that triggers the univibrator; therefore, the noise that gets through the diode on the negative-going portion of the wave is of no consequence (within reasonable limits).

f. Jack J306 is a convenience terminal to check the voltage applied to the noise-suppression circuit. This voltage is adjusted by R304 and mainly determines the signal amplitude. Potentiometer R306 is the main control of the time constant of the resistance-capacitance (RC) circuit, and is ad-

justed for linearity of the rising part 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 (par. 90).

60. Cathode Follower
(fig. 33)

Cathode follower V302A 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 S301 assumed to be at the IN position.

a. The signal from the plate of V301B is fed directly to the grid of cathode follower V302A. The plate of V302A is connected directly to regulated +300 volts. The output signal is developed across cathode resistor R308. This resistor is returned to the −175-volt regulated supply, which is the same as that of the input circuit (par. 58*b*). Although the cathode of V302A is connected to −175 volts and the grid connected to a positive voltage source, the current through cathode resistor R308 produces a positive cathode potential, with respect to ground, that is greater than the grid potential, so that the tube is biased negatively. The output signal from the cathode of V302A is fed to the clipper amplifier through coupling capacitor C303.

b. When the input signal goes in a negative direction, the plate current decreases and causes the voltage across cathode resistor R308 to decrease. As the signal swings in a positive direction, the plate current increases and causes the voltage to increase across R308, which results in a wave shape across R308 that is similar to that of the input signal of V302A. The amplitude of the output wave form is slightly smaller than the input, because the cathode follower introduces its usual slight loss. Jack J308 is provided for test purposes; it indicates both the output of V302A and the input to V302B.

61. Clipper Amplifier
(fig. 33)

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

a. The output signal of cathode follower V302A is applied through coupling capacitor C303 across grid resistor R310. The signal is then applied to the grid of V302B, through grid-current limiting resistor R309, which clips the positive portion of the signal across R310. The clipped output signal is developed across plate-load resistor R311, which is connected to the regulated +300 volt supply.

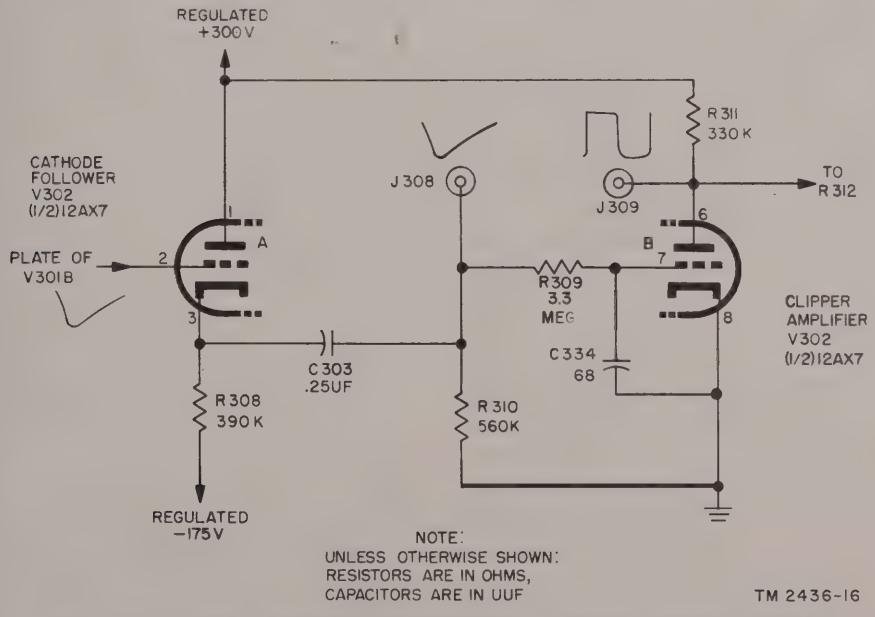


Figure 33. Cathode follower and clipper amplifier, simplified schematic diagram.

b. Coupling capacitor C303 isolates the grid of V302B from the dc component of the cathode voltage of the preceding stage. The wave form across resistor R310 is shown at J308 (fig. 33). The tube has no externally applied bias; high plate current is prevented by the large value of plate load resistor R311. Similarly, 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 about −5 volts; any signal voltage in excess of this value can, therefore, have no effect on the output voltage from the stage.

c. To operate properly, the tube must have a relatively large signal voltage applied from the preceding stage; this is normally the case. As a result, the potential at the plate 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. It may be checked at J309.

d. The pulsating signal current in R309 must also flow through R310. It is no longer a pulsating current at this point, however, because C303 and R310 form a filter circuit that smoothes out the ripples, and the voltage drop across R310 forms a self-rectified bias that exists only during signal reception. Under no-signal conditions, a slight bias is present because the high value of R309 does not allow the space charge on the grid to leak off easily. The small value of C344 allows it to be effective as a bypass on the very-high-frequency components of the voltage wave without affecting the low-frequency components.

62. Voltage Discriminator
(fig. 34)

a. The voltage discriminator is a miniature twin-triode tube, V303A and V303B. The clipped and partially shaped output signal of V202B triggers the voltage discriminator between two stable states. Its purpose is to produce an output signal that is a square wave of constant amplitude and the frequency of which is the same as that of the original input signal. Potentiometers R314 and R317 set the dc operating levels of the cathode and grid (par. 88). Resistor R312 is a grid-current limiting resistor. The output of this

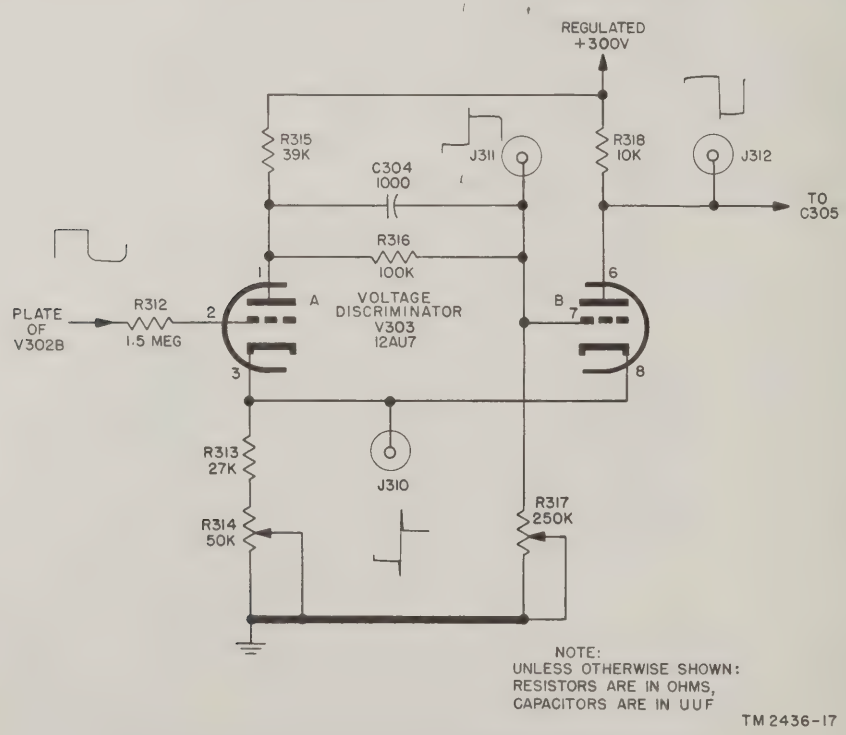


Figure 34. Voltage discriminator, simplified schematic diagram.

stage is taken from resistor R318, which is the plate load resistor of V303B. Test jacks J310, J311, and J312 permit checking the cathode, grid, and plate wave forms, respectively.

b. Because the grid of V303B is connected to a positive voltage through a voltage-divider arrangement which comprises R315, R316, and R317 between +300 volts to ground, this tube conducts under no-signal conditions. The cathode current flowing through common cathode resistors R313 and R314 produces a positive voltage at the cathode of V303A that is greater than the positive voltage applied to its grid through R311 and R312. This effectively biases V303A at cutoff so that normally, with no signal applied, tube V303A is a cutoff and V303B is conducting. When a positive-going input signal is applied to the grid of V303A, it makes the grid positive with respect to the cathode when the input signal reaches a value of approximately 150 volts, and permits conduction of V303A. As V303A starts to conduct, its plate voltage decreases and thus creates a negative swing which is applied, through capacitor C304, to the grid of V303B. This negative-going voltage, in turn, decreases the plate and cathode current of V303B. Because both cathodes are connected together, the decreased cathode voltage reduces the effective bias on V303A and aids the positive-going grid voltage of V303A, so that a regenerative action takes place, and quickly leaves V303A conducting maximum current and V303B at cutoff. Further increase of the grid-signal voltage of V303A past the triggering point has no effect on the output voltage of V303B. The two tubes remain in this steady state condition until the signal voltage at the grid of V303A drops below 120 volts. At this time, regenerative action again takes place, because the negative-going signal voltage produces a positive-going voltage across plate resistor R315, which is applied to the grid of V303B through C304. This positive-going voltage increases the drop across cathode resistors R313 and R314, and effectively returns the bias on V303A cathode to the cutoff condition that originally existed with no signal applied; this returns V303A to a nonconducting condition and causes V303B to conduct freely. The two tubes again remain in a steady state until the signal voltage applied to the grid of V303A is raised to approximately 150 volts, at which time the circuit is triggered and the action is repeated. Thus with one tube held at plate current cutoff while the other tube is conducting heavily, this stage creates a rectangular wave form of fixed amplitude at the recurrence frequency of the input signal, regardless of input wave form and amplitude. The output of this stage is the signal voltage developed at the plate of V303B.

c. Capacitor C304 is used to apply immediately the voltage developed across R315 in the plate circuit of V303A directly to the grid of V303B rather than through resistor R316. If this capacitor were not present, the steep voltage rise and fall developed across R315 by operation of V303A would be delayed in application at the grid of 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.

63. Positive Pulse-Selector Stretcher

(fig. 35)

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 and 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 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 V304A, which is set at the cutoff point by a fixed negative bias voltage applied between the grid and cathode. Negative pulses 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 R322 and is used to trigger univibrator V305.

c. The wave form across cathode resistor R321 of V304A is shown at J313 (fig. 35). (The second spike is caused by the recovery of the univibrator.)

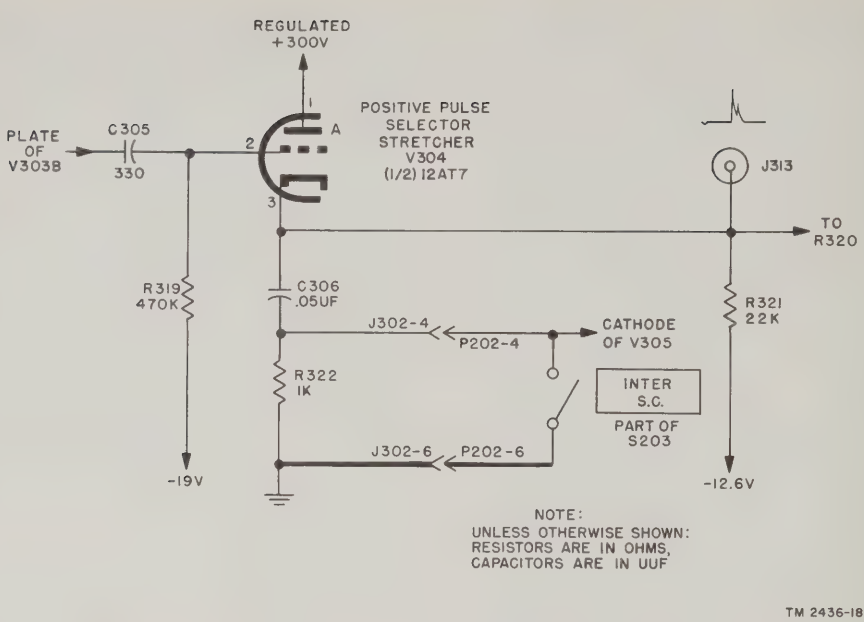


Figure 35. Positive pulse selector stretcher, simplified schematic diagram.

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 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.

64. Audio Output

(fig. 36)

a. The audio output circuit uses one-half of a miniature twin-triode tube, V304B. It is used 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 is discontinued in later models.

b. The grid of V304B is directly connected through current-limiting resistor R320 to the cathode of V304A and is supplied with a fixed negative bias of 12.6 volts. When the positive stretched pulse appears at the cathode of 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. This grid current through R320 effectively clips the spiked portion of the signal and produces a more pleasing sound to the ear. 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 36. The cathode of V304B is returned to circuit ground through unbypassed potentiometer R214. Potentiometer R214 has no shunt capacitor; it therefore controls the amount of negative feedback, the amount of tube gain, and it controls the speaker volume.

65. Univibrator

(fig. 37)

a. The univibrator uses both sections of a miniature twin-triode tube, V305 (fig. 34). 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.

b. Tube V305A has its grid connected to the +300-volt supply through resistor R328 so that

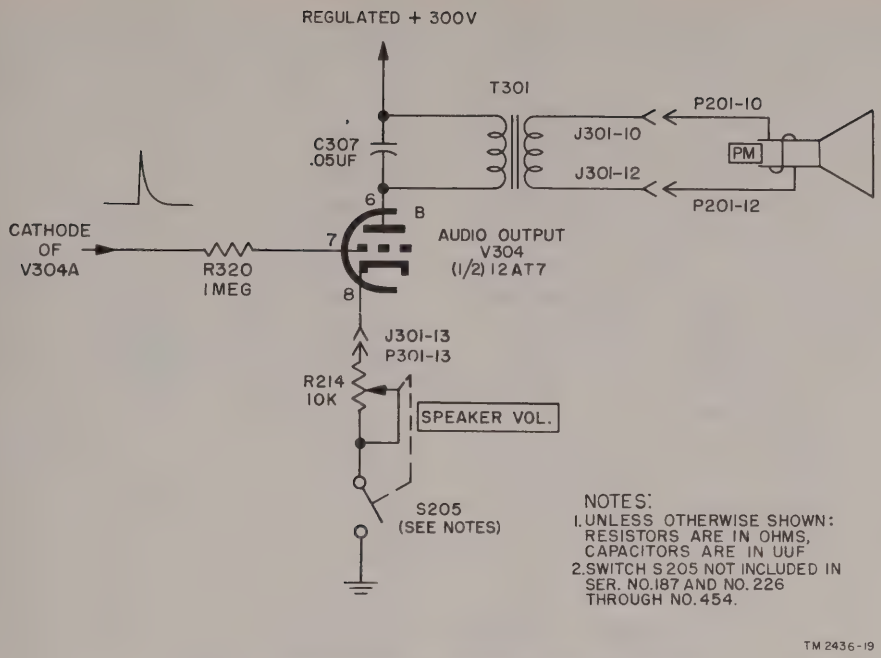


Figure 36. Audio output, simplified schematic diagram.

it is normally in a conducting condition when no signal is applied. Biasing is accomplished by the flow of grid current through R328, 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 V305 is a high-gain triode, it requires only a small voltage for cutoff (aprx −5 volts at 300 plate volts). With a positive voltage on the grid, the tube conducts sufficiently to produce a plate current flow of about 4 milliamperes (ma), which produces a cathode potential of about 4 volts. Operation is such that the grid voltage is slightly higher than the developed cathode voltage, so that the tube normally operates with a small positive bias. The grid of V305B is directly connected to the plate of V305A through R324 and is biased far beyond cutoff by a voltage divider arrangement which consist of resistors R324, R325, and R326, between the +50-volt plate of V305A and −175 volts. This bias is adjustable because R326 is connected as a variable resistor. Resistor R322 is the cathode resistor for V305A, and R329 is the cathode resistor for V305A. Input trigger voltage is applied to the cathode of V305A and the output signal is taken from the grid of V305B and applied to voltage switch tube V306. Test jacks J315 and J316 are provided to check the grid wave forms of V305A and V305B, respectively, and J318 indicates the cathode wave form of V305B.

c. When a positive pulse from the cathode of pulse selector tube V304A is impressed on the cathode of V305A through C306, it effectively reduces the nearly zero bias to a high negative value and causes a reduction of plate current which, in turn, produces a positive plate voltage swing because of the reduced voltage drop across R323. This plate voltage swing is coupled to the grid of V305B through C308 and plate current flows; this causes an increased voltage drop across R327. Capacitor C308 permits the instantaneous signal swings to bypass R324 so that this steep rise is not attenuated at the grid of V305B by R324. This negative plate voltage swing is, in turn, coupled to the grid of V305A by capacitor C309. This action is regenerative and rapidly increases the negative swing on V305A so that 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 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 V305A conducting and V305B at cutoff.

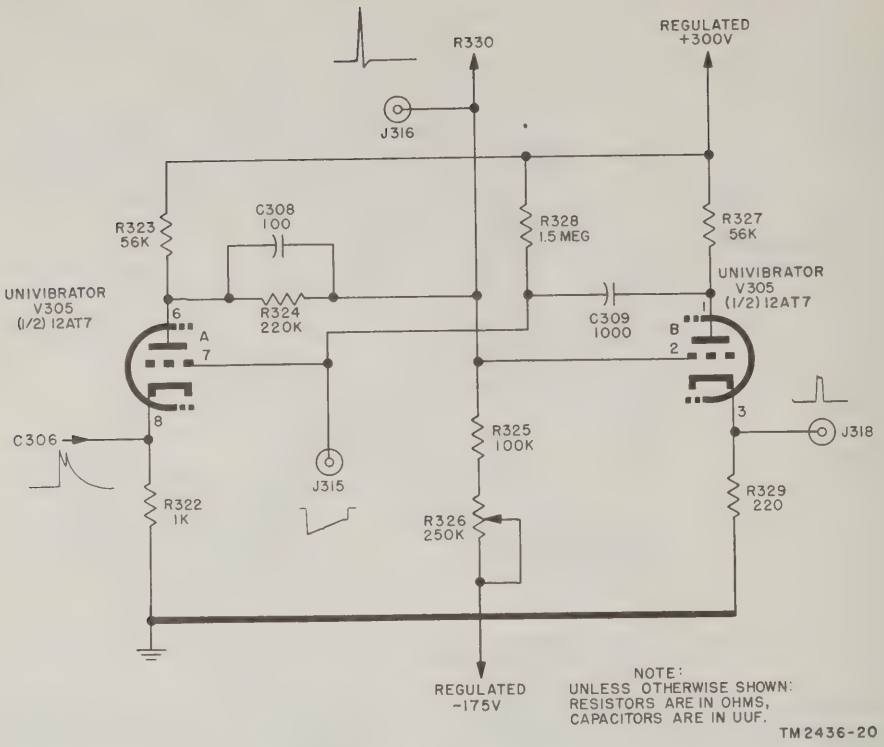


Figure 37. Univibrator, simplified schematic diagram.

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

66. Voltage Switch and Output Gate (fig. 38)

a. Voltage switch V306 is a miniature, hi-mμ, twin-triode tube. Both sections are connected in parallel, but they are shown as a single tube in the simplified diagram of figure 38 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 about 30-millivolt output voltage that is proportional to the recurrence frequency of the input signal applied to the recorder.

b. Voltage switch tube V306 is normally held well beyond cutoff by the high grid bias applied to V305B through grid-current limiting resistor R330 (fig. 37). When a positive-going pulse is developed by the univibrator, the grid of V306 is driven rapidly from cutoff to zero or slightly positive, and the plate current of 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-load 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 V306, capacitor C310 is charged to 300 volts. When a positive pulse is applied to the grid of V306, the resulting plate-cathode conductivity 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 V307A and R332. The time con-

stant 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, V306 is again cut off and capacitor C310 recharges through R331, V307B, and the low-impedance filter and load network between the cathode of V307B and ground. To assure an equal amount of energy per pulse being stored in filter capacitors C311, C313, and C314, the constancy of values of R331 and C310 becomes important. 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 may not be substituted for these two particular items. The charging time for 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.

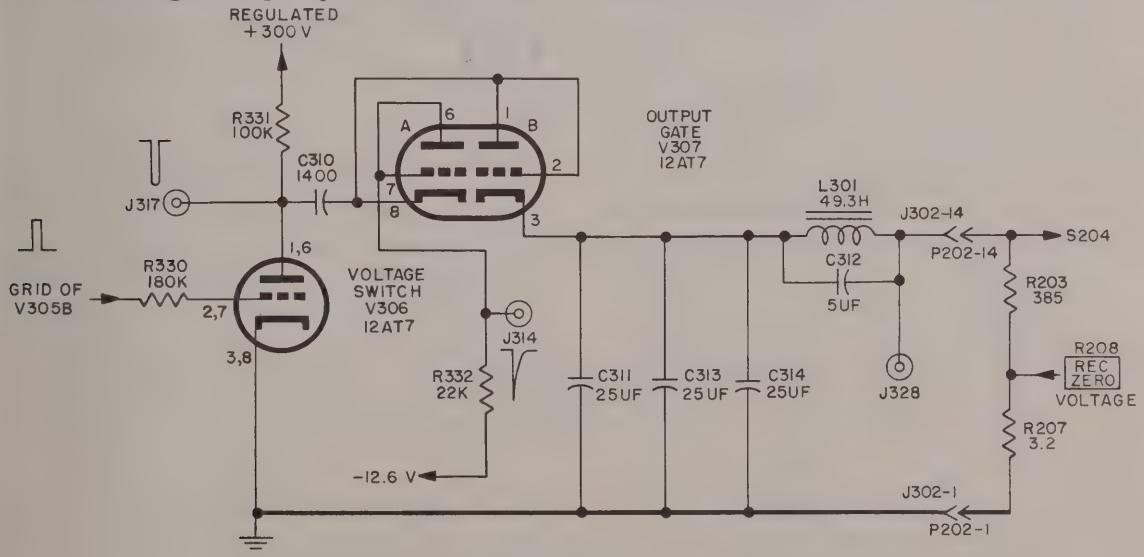
d. Because of the high value of capacity in the parallel combination of C311, C313, and C314 (75 μf total), only a few microvolts of charge are built up on each pulse. Choke L301 and its 5-μf shunt capacitor C312 resonate at approximately 10 cps; this increases the series filtering effect at the low end of the af signal frequency scale. At the high end, further filtering is accomplished at the input to the detector circuit (par. 68*d*). Discharge current through load resistors R203 and R207 will be proportional to the voltage built up across the 75 μf.

e. The voltage across the 75 μf is directly proportional to the charge (in coulombs) stored there; this charge, 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 R207. These facts all indicate an output voltage that, for all practical purposes, is a linear function of the audio frequency of the initial input signal to the converter, and may be so calibrated on a suitable indicator.

f. The output voltage (that potential which exists mainly across R207, because R203 is comparatively very small) will range from near 0 to about 30 millivolts. It is subjected to further filtering and then applied to the vibrating reed of inverter G301 (par. 68).

67. Measuring Circuit (fig. 39)

The measuring circuit provides a dc voltage of approximately 30 millivolts across slide-wire



NOTE:
UNLESS OTHERWISE SHOWN:
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UUF

Figure 38. Voltage switch and output gate, simplified schematic diagram.

TM2436-21

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 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 R201 is divided into two main circuits (paths A and B, fig. 39). (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 R209; and the third is through slide-wire potentiometer R501B.

b. In figure 40, path B is replaced with potentiometer B, 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. 40). Because the sum of the currents in path A and path B is practically constant regardless of the setting of R202, then the current in path B is proportional to the resistance in path A, and is adjusted by R202. Because the voltage across the slide-wire can be changed by adjusting potentiometer R202, the position of the balance point may be changed with a corresponding change of the recorder pen position. It is by this means that the reference (calibration) signals are alined with the correct

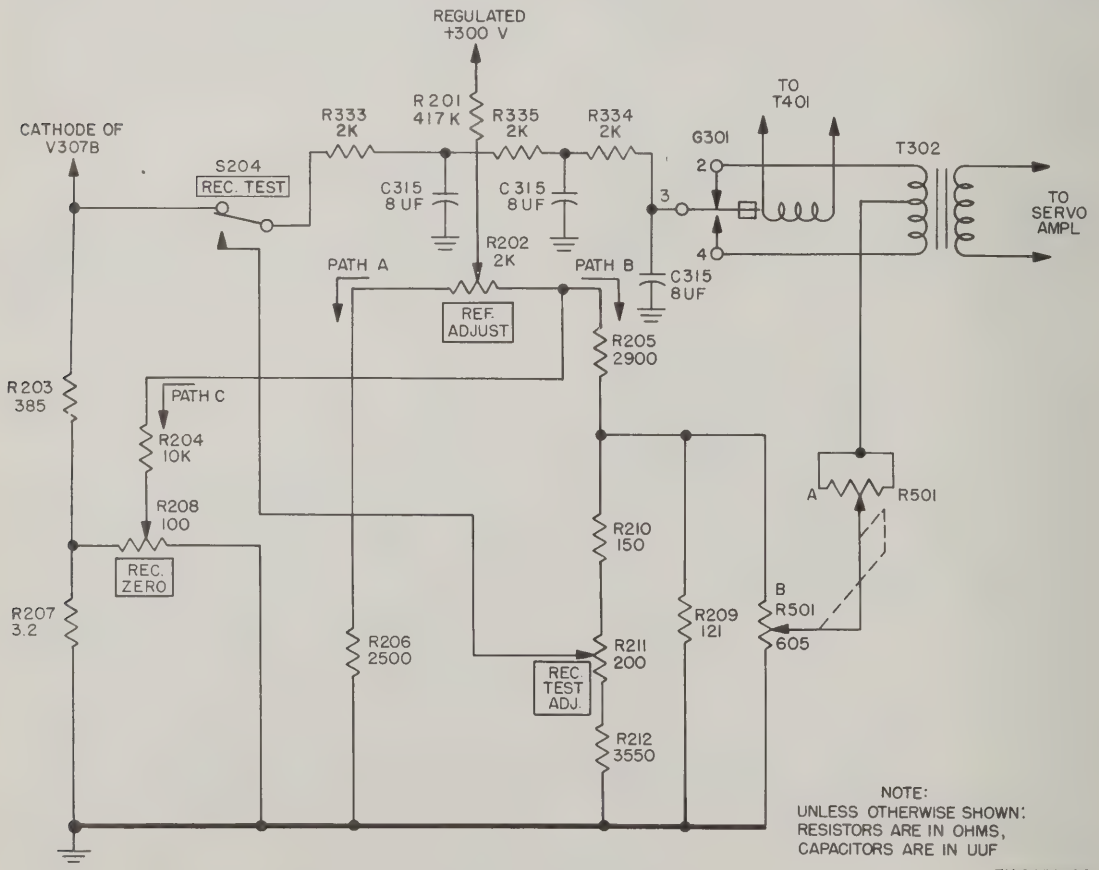


Figure 39. Measuring circuit, simplified schematic diagram.

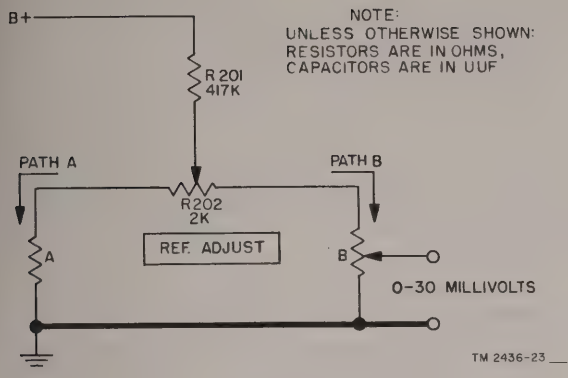


Figure 40. Reference adjust circuit, simplified schematic diagram.

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. 39) 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. This series circuit is in parallel with the slide-wire, and the resistance values are such that the wiper arm of R211 will deliver to REC. TEST switch S204, from 91 to 97 percent (approximately) of the voltage applied to the slide-wire. This voltage, when applied through the momentary contacts of REC. TEST switch S204 to the vibrator inverter, is adjusted by R211 to make the recorder pen indicate 95 on the chart.

d. The zero adjust circuit (path C, fig. 39) is similar to the reference voltage circuit previously explained in *b* above. A voltage, determined by the position of the wiper arm of REC. ZERO potentiometer R208, is obtained across R207. The voltage across 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.

68. Detector and Balancing Circuit (fig. 41)

The detector circuit is so named because it detects any *difference* (or *error*) between the millivolts of potential that exist at two separate points: the 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. The balancing circuit is so named because it sets in motion the action necessary to balance these potentials again, once a difference has occurred, and thus cancel the error. The detector circuit converts the dc error voltage into ac; this ac voltage is then amplified until it has sufficient power to move the balancing motor. The resulting motion is imparted by mechanical coupling to the wiper arm, and the new position of the arm is a new point of dc balance. At this point, there is no longer any driving power and the motor stops until the signal strength changes to a new value. 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 R203 and R207 are applied through the normally closed contacts of REC. TEST switch S204, on the control panel, through the damping filter (which consists of R333, R334, R335 and three-section capacitor C315 (fig. 77)) to the vibrating reed of inverter G301. This voltage is alternately applied to the two ends of the T302 primary 60 times a second as the reed vibrates in synchronism with the ac applied to its operating coil. It may be assumed that the signal voltage at this instant is slightly greater (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. Current will occur during each contact and the resulting alternating magnetic field in the transformer core will induce an alternating secondary voltage; the frequency is still equal to the line frequency (nominally 60 cps).

b. The vibrating reed is polarized in its motion; that is, it always hits contact No. 2 for a given polarity of voltage across its coil, and it hits contact No. 4 for the other polarity. The polarity of the *hot* side of the secondary of T302 depends on two things: which of the two contacts (No. 2 or 4) the reed has just hit, and whether the signal voltage on the reed is plus or minus with respect to the wiper arm. Therefore, the *phase* of the secondary voltage, referred to the power line voltage, depends solely on the *polarity of unbalance* of the two dc voltages. It is this *phase sensitiveness* to

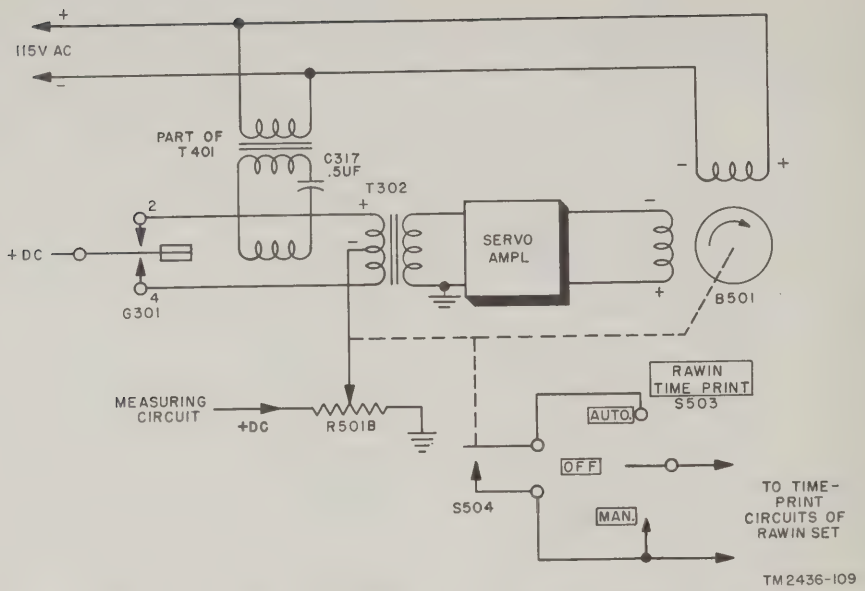


Figure 41. Detector and balancing circuit, simplified schematic diagram.

the direction of unbalance that makes the motor turn in the right direction to recreate a dc balance.

c. The balancing motor is a low-power two-phase squirrel-cage induction type, with one field winding continuously powered by the ac power line; this is a fixed phase and cannot be changed except by a change in wiring. The other field winding is called the control winding. Phase-shifting capacitor C317, plus some phase shifting that occurs in the amplifier, 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 turn in the right direction to cancel an error voltage.

d. The damping filter comprises a three section RC filter network of R333, R334, R335, and C315 (fig. 77) in series with the dc signal applied to the vibrator. Resistor R336 is used to damp the primary of T302 and reduce voltage transients. The damping filter performs two functions: First, it acts as a filter for the higher pulse recurrence frequencies so that essentially 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, and if these parts are replaced, the proper values of circuit components must be used to avoid loss 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, it produces a charging current in capacitor C315 (developed by the movement of the slide-wire arm, and 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 C315 and the error voltage developed in the detector reduce to zero. The opposing capacitor-charging current is developed as long as the slide-wire is moving; as the balance point is approached, the opposing capacitor cur-

rent exceeds the current that produces the error voltage. As this opposing current is developed in the detector, it produces an effective ac balancing voltage 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.

69. Voltage Amplifiers

(figs. 42, 43, and 44)

Five stages of voltage amplification are used to increase the small ac error voltage from the detector to an amplitude sufficient to excite the power amplifiers, which in turn 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 as the line voltage. Line-compensating feedback is incorporated in the amplifier to compensate for line-voltage variations. This stabilizes the overall gain of the servo system. As shown in figures 42, 43, and 44, all cathode resistors are left 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 of transformer T302 and is applied to the grid of V308A, one-half of a twin-triode tube (fig. 42). 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.

b. The signal from the plate of first amplifier tube V308A is fed through coupling capacitor C319 and appears across grid resistor R339 of the second amplifier. This signal is fed to the grid of V308B (fig. 42). 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 V308A and V308B is supplied through a decoupling circuit consisting of resistor R359 and capacitor C333. Capacitor C321 provides a feedback path, so that the output voltage at the plate of V309A (fig. 43) is fed back to the cathode of V308B. This feedback circuit is degenerative and reduces the possibility of oscillations caused by stray positive feedback.

c. The third voltage amplifier (fig. 43) is one-

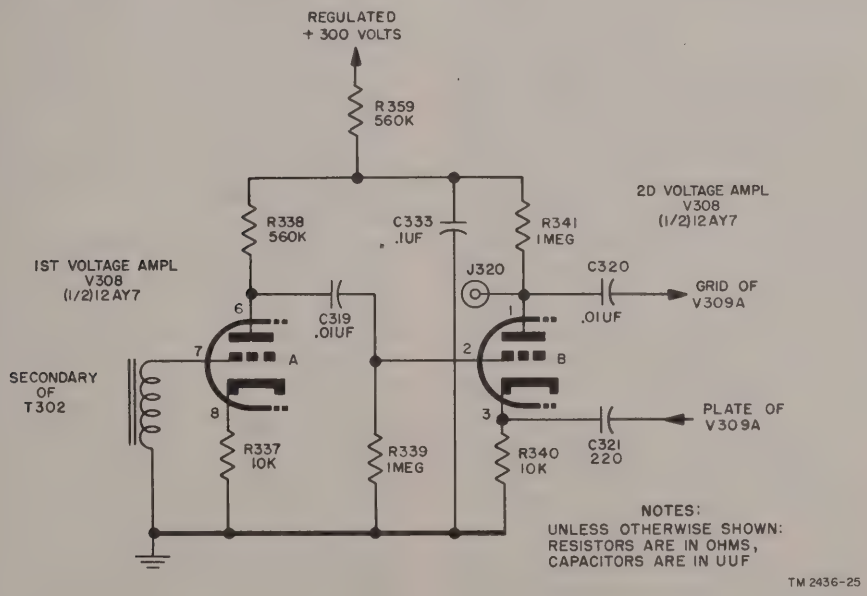


Figure 42. First and second voltage amplifiers, simplified schematic diagram.

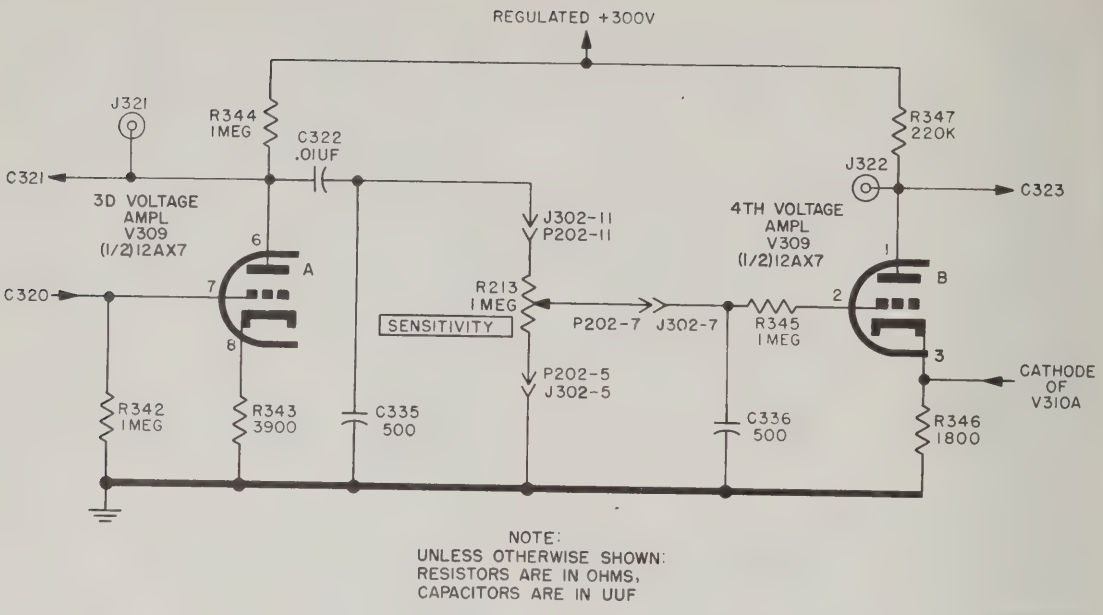


Figure 43. Third and fourth voltage amplifiers, simplified schematic diagram.

half (V309A) of a hi-mμ twin-triode tube; it receives the signal from the plate of V308B through coupling capacitor C320. The signal is developed across grid resistor R342 and fed to the grid. The signal 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 V309A is fed through coupling capacitor C322, and appears across SENSITIVITY potentiometer R213. The SENSITIVITY control is a screwdriver-adjusted potentiometer mounted on the control panel. The wiper arm of this control is connected, through current-limiting resistor R345, to the grid of fourth amplifier V309B. This control is adjusted according to instructions given in paragraph 93. 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-μ twin-triode tube (fig. 43). 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. 44) flowing through cathode resistor R346. The cathode resistor is unbypassed for degenerative purposes, as in the other stages. Capacitors C335 and C336 (fig. 43) 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 capacitor C323 (fig. 44) and appears across grid resistor R350 of a fifth amplifier tube V310B. The signal is fed to the grid of V310B through grid-current limiting resistor R360. The tube is one-half of a hi-μ twin-triode. The signal is amplified and appears across plate-load resistor R352. Self-bias and some degeneration 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. It may be considered a variable resistor, the resistance of which depends on its filament voltage and controls feedback between the fourth and fifth voltage amplifiers. As the filament voltage increases, the plate resistance of V310A decreases and vice versa. When the line voltage is steady, this circuit provides essentially a fixed value of negative feedback from the plate of V310B to the cathode of V309B. When the plate signal of V310B goes in a positive direction, more current flows through the feedback circuit (capacitor C324, resistor R349, and tube V310A)

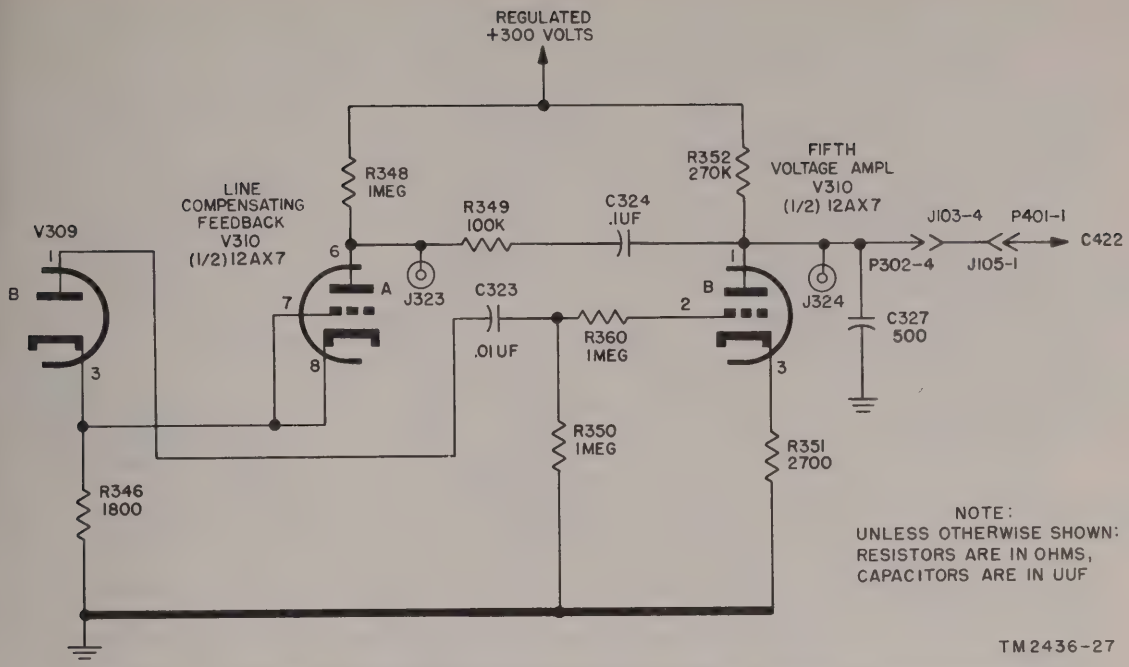


Figure 44. Line-compensating feedback and fifth voltage amplifier, simplified schematic diagram.

and causes a larger degenerative effect across cathode resistor R346. This, in effect, reduces the gain of that stage. If the line voltage increases, the overall gain of the servo voltage amplifiers and the filament voltage of V310 increases. Increasing the filament voltage of V310 decreases its plate resistance and increases the negative feedback which further reduces the gain of V309B. The reduced gain of V309B, therefore, compensates for the overall gain of the remainder of the servo system. Conversely a decreased 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 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.

70. Power Amplifiers

(fig. 45)

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 45, for simplicity of presentation. Tubes V405 and V406 supply excitation to the control winding of two-phase balancing motor B501 (par. 68*c*). The power amplifiers also supply a signal for operation of the pen-lifter circuit (par. 71).

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 resistors R417 and R418, forms an RC filter which presents a low-impedance path to circuit ground for any hf voltage induced by the line winding of B501 and reduces 120-cycle ripple remaining in the 500-volt power supply circuit. Screen-grid voltage is obtained from the positive regulated 300-volt supply 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 V310B, through coupling capacitor C422, across grid resistor R440, to the control grids of V405 and V406 through grid-current limiting resistor R415. The output power is delivered to the parallel-tuned circuit consisting of the control winding of balancing motor B501 and C409.

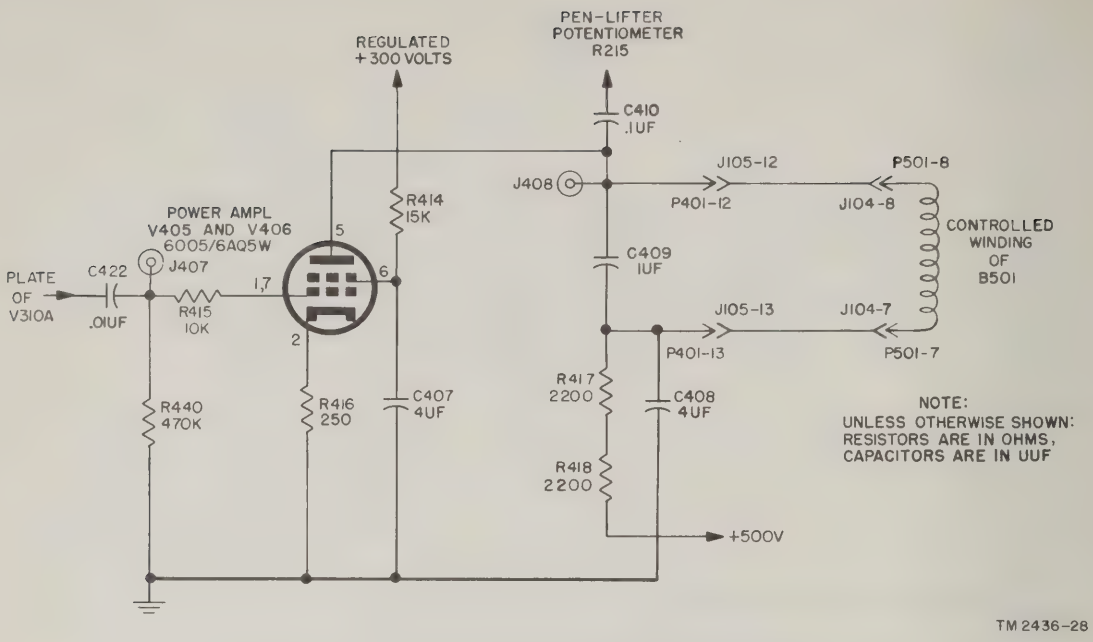


Figure 45. Power amplifier, simplified schematic diagram.

When a signal is applied to the grid of V405 and V406, a voltage drop of sufficient amplitude and proper phase to drive motor B501 is developed across the tuned circuit of the motor winding. 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 J409 are provided for checking grid and plate voltages, respectively.

71. Pen-Lifter Circuit

(fig. 46)

a. The pen-lifter circuit uses both sections of miniature twin-triode tube V407. Tube V407A is connected as a diode and is used as a rectifier tube, and V407B is an amplifier control tube (fig. 46). The operation is such that when a signal is received from the power amplifiers, the pen rises from the chart as it travels to its new position. The solenoid, however, does not lift the pen; it 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 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 V407A and dc voltage is developed across resistors R419 and R420. The voltage developed across resistor R420 and filtered by capacitor C413 is applied to the grid of control tube V407B. The entire rectifier circuit is returned to a −30-volt bias supply which is obtained from the junction of bleeder resistors R436 and R437, across the negative regulated 175-volt supply. The −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. It is set low enough so that the internal noise of the amplifier circuit does not overcome the fixed bias of V407B, but is set sufficiently high to obtain reliable operation for input signals (par. 92).

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 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 that the recorder chart is not marked while the balancing

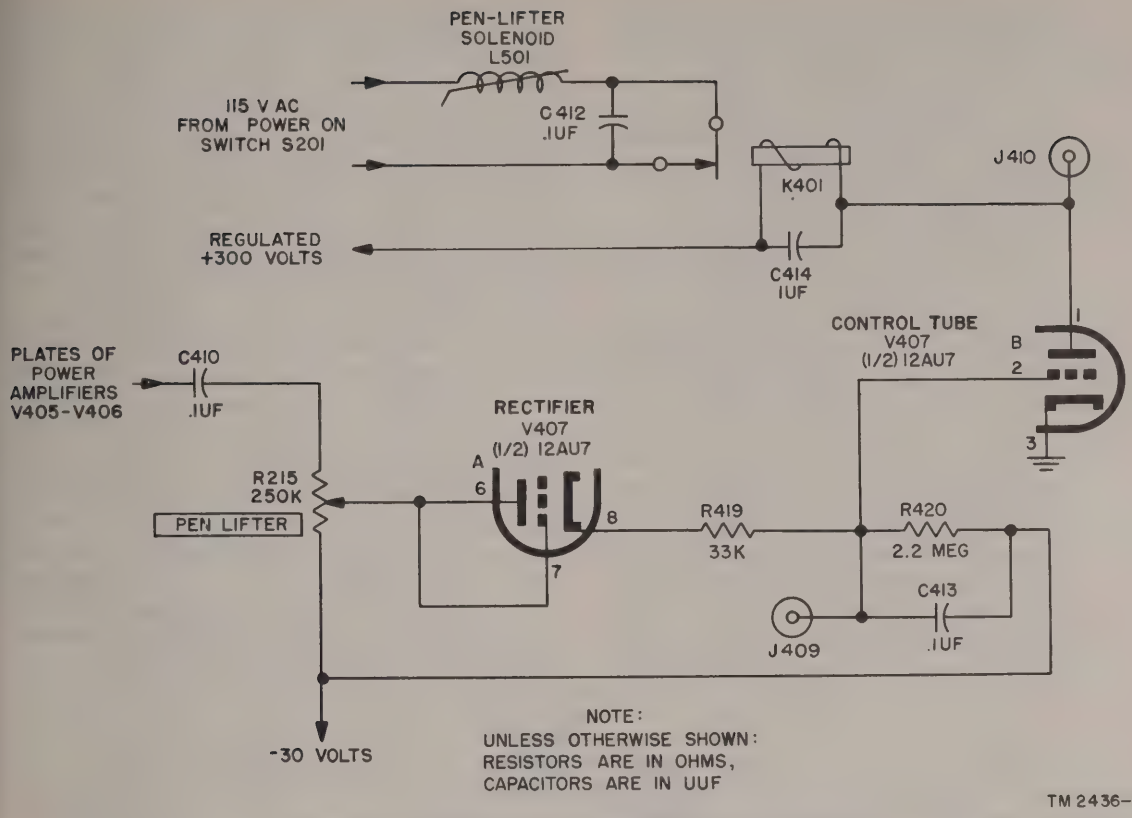


Figure 46. Pen-lifter circuit, simplified schematic diagram.

motor is moving the slide-wire to its balance point. When S201 on the control panel is in the STAND BY position, 115 volts ac are again removed from the pen solenoid, and the pen rests in its *up* position until the switch is returned to POWER ON position.

72. Power Supply

(figs. 47 and 48)

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 dc 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, and it delivers the following voltages from its secondaries (fig. 81):

(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.

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

(3) Two 5-volt windings (terminals 11 and 12; 13 and 14) for the filaments of positive supply V401 and negative supply V408 rectifier tubes, respectively. Terminal 13 also has the unfiltered ripple voltage of the 175-volt negative supply; it is taken directly to the 120 C. P. S. terminal of S202 on the control panel.

(4) A 6.3-volt winding with one side of the filament connected to circuit ground (terminals 15, 16, and 17) to supply voltage to the pen heater; to the fila-

ments of V303, V310, V405, V406, V409, and V410; and to the panel lamps.

(5) A 6.3-volt winding with a center tap (terminals 18, 19, and 20) to supply filament voltage for V301, V302, and V403. The center tap is connected to a +80-volt tap on the 300-volt supply.

(6) A 6.3-volt winding with a center tap connected to the +300-volt supply (terminals 21, 22, and 23) to supply the filament voltage of V402.

b. The positive regulated power supply (fig. 47) furnishes a constant +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 47; for components, refer to figure 81. Fuses F401 and F402 are connected in series with the plate leads of rectifier V401 for overload protection. Capacitors C401 and C402, with choke coil L401, comprise a one-section Pi filter for the unregulated 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 regulator 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 this tube. A voltage divider, which adjusts the output voltage and consists of resistors R411 and R413 with potentiometer R412, is placed across +300 volts and circuit ground. The voltage of potentiometer R412 is applied to the control grid of positive control amplifier V403. The screen-grid voltage for this tube is obtained from a voltage divider which comprises resistors R408 and R409 and positive voltage refer-

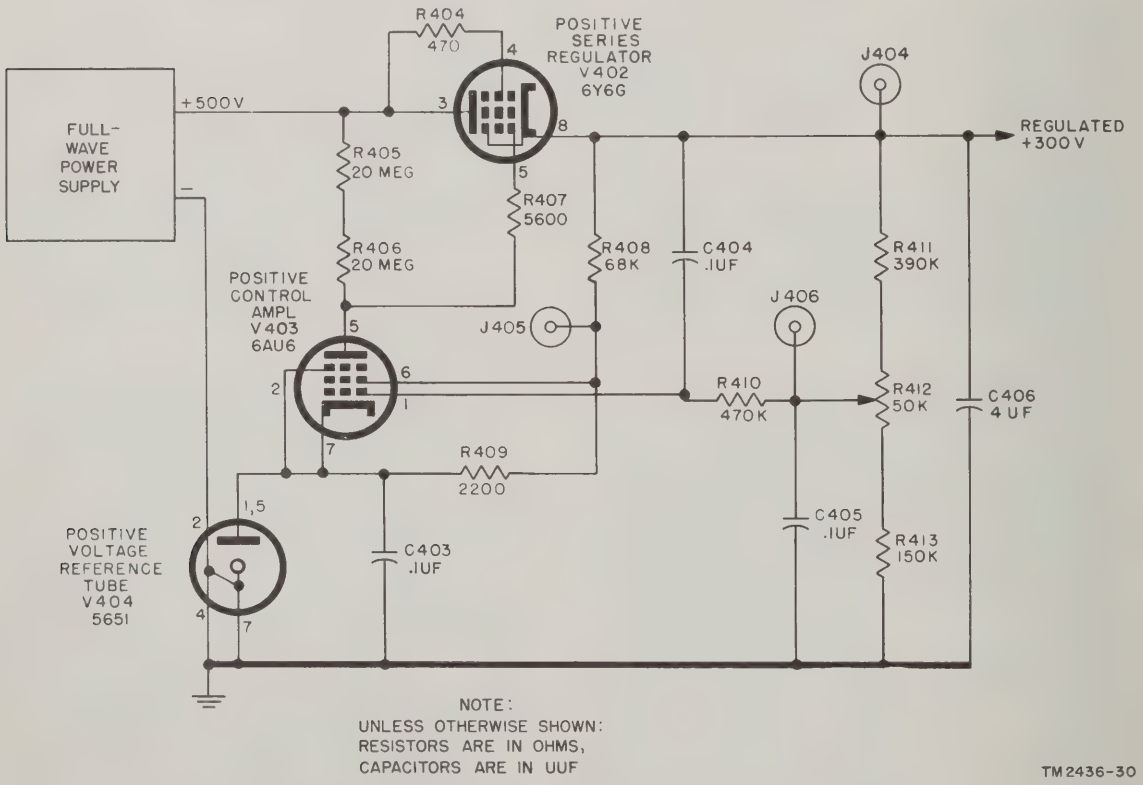


Figure 47. Positive regulated power supply, simplified schematic diagram.

ence tube V404 connected across the +300-volt output. The plate of V403 is directly connected to the grid of 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 V403 to provide a constant reference voltage for comparison with the grid voltage of control amplifier tube V403.

(2) Series regulator tube V402 may be considered a variable resistor, the resistance of which is controlled by its grid voltage. A more positive grid voltage decreases its resistance and a less positive voltage increases its resistance. Control amplifier tube V403 controls the amount of voltage supplied to the grid of V402. The cathode of 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 +300 output determined by the position of the wiper arm of potentiometer R412. When an increase of voltage occurs at the cathode of 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 R412, is amplified by V403 and applied as a negative swinging grid voltage to V402. This decrease in grid voltage causes an increase in the effective plate to cathode resistance and increases the voltage drop across V402. This increase in voltage drop, almost equal to the original rise, returns the grid of V403 almost to its original bias. The action of the regulator is very rapid and for all practical purposes may be considered instantaneous. Capacitors C404 and C405 with resistor R410 form a series circuit across the output of the regulated +300 volt supply for any rapid changing voltage or for ripple voltage. The capacitors 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 that 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. 48) furnishes a constant −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 48; for components, refer to figure 81. 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. It obtains 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 −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 and R435 with potentiometer R434 is placed between the regulated −175-volt output and circuit ground. The voltage of potentiometer R434 is applied to the control grid of negative control amplifier V410. The screen-grid voltage for this tube is obtained from a voltage divider which comprises resistors R430 and R431 and the negative voltage reference tube V411 to ground, connected across the regulated −175-volt supply. The plate of V410 is directly connected to the grids of V409 through grid-current limiting resistors R428 and R429, and controls the operation of this series regulator tube. Negative voltage reference tube

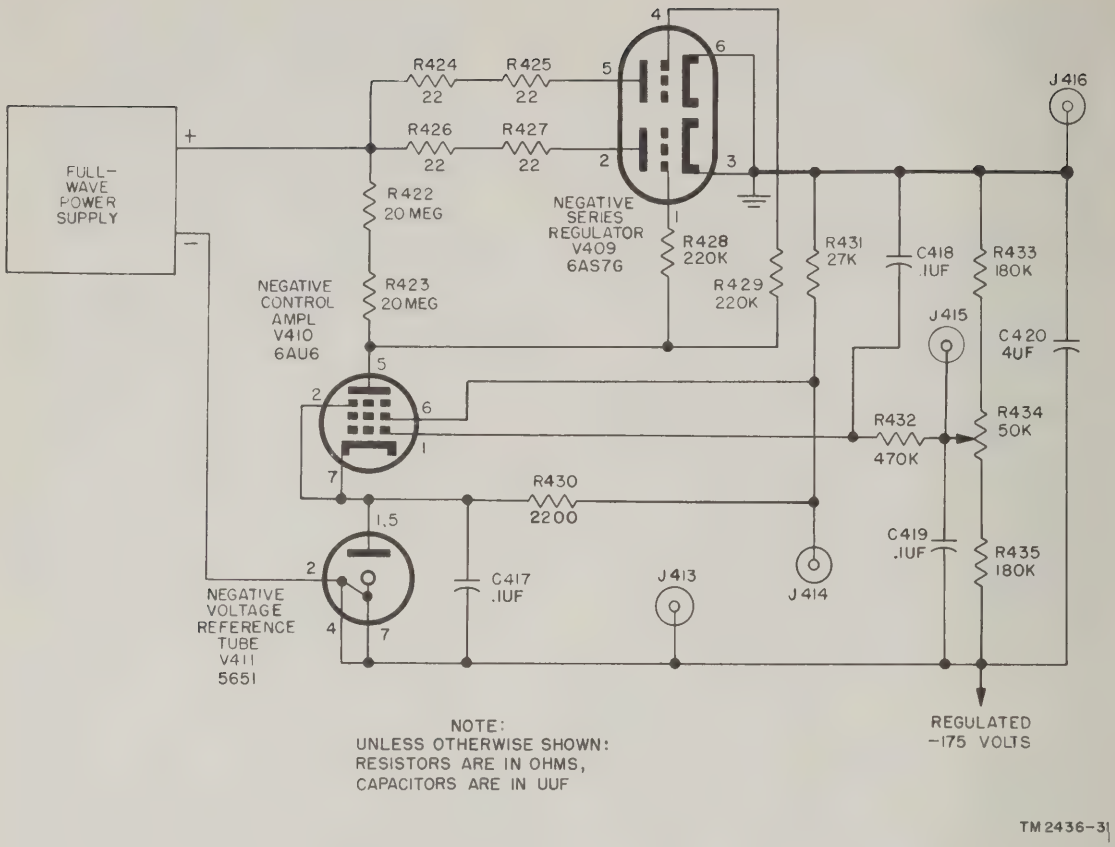


Figure 48. Negative regulated power supply, simplified schematic diagram.

V411 is a cold cathode-type gas voltage regulator tube, which normally operates at 87 volts and is connected to the cathode of V410 to provide a constant reference voltage for comparison with the grid voltage of negative control amplifier V410.

(2) Series regulator tube V409 may be considered as a variable series resistor, the resistance of which is controlled by its grid bias voltage. A less negative grid voltage decreases its resistance and a more negative voltage increases its resistance. Control amplifier tube V410 controls the amount of voltage supplied to the grid of V409. The cathode of 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 −175-volt output 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 R434, is amplified by V410 and applied as a negative swinging grid voltage to V409. This decrease of grid voltage causes an increase in the effective plate to cathode resistance and increases the voltage drop across V409. This increase in voltage drop, which is almost equal to the original voltage rise, returns the grid to V410 to almost its original bias value. The action of the regulator is so rapid that for all practical purposes it may be considered to be instantaneous. Capacitor C418 provides a low reactance path to the grid of

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 that 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; it bypasses any hf voltage component.

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

e. A filament burn-out indicator is provided for pen-lifter control tube V407 by neon indicator lamp E401. This lamp is connected across the filament so that 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.

73. 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 are as follows:

a. Operation of Chart.

(1) The chart consists of a paper roll 120 feet long by 10$^{11}/_{16}$ inches wide. The vertical axis of the chart is graduated in ½-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 one-half of an inch to the right of the zero line.

(2) The chart is secured between two shaft-mounted chart roll bearings (fig. 50). 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 alined with the chart roller. It 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 on the roller shaft. The clutch assembly is held against a motor-driven gear which uses the 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 at any time by turning the manual chart advance knob in a clockwise direction. This knob is connected to the chart-roller shaft by a set of beveled gears with a ratio of 2 to 1 (figs. 50 and 53).

(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. 50) 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. 53) 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 the mechanical parts illustrated in figure 55. When the solenoid is de-energized, pressure exerted by spring O 576 pushes the double-ended bolt against the pen-lifter bracket which rotates the pen-carriage shaft slightly, and thereby lifts the pen from the chart. When the solenoid is energized, the double-ended bolt is pulled towards the solenoid. The pen-pressure nuts then push against the pen-pressure spring which in turn pushes the pen-lifter bracket. The pen-lifter bracket in turn 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 its associated lock nut.

(3) The pen heater is thermostatically controlled and mounted around the pen barrel (ink chamber). The heater is operated from 6.3-volt ac, 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 I 501 through I 504 are lighted by the same 6.3-volt source and provide illumination for the recorder scale and chart.

74. Control Panel

a. The control panel (fig. 78), 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 K201 and K202, of the magnetic type and rated at 4 amperes, are provided in series with each of the primary 110-volt ac leads. Application of power is controlled by S201, a four pole double throw switch. In POWER OFF position no voltage is applied, and in STAND BY position voltage is applied to all circuits except the chart drive motor and the pen lifter solenoid; in POWER ON position, voltage is applied to all circuits.

c. Neon indicator lamp I 201 indicates when S201 is in either STAND BY or POWER ON position. Meter M201 likewise indicates the power line frequency in either position of S201. It is a synchronous-reed type panel-mounted frequency meter indicating from 48 to 62 cycles. Meter M202 is an iron vane type panel mounted ac voltmeter with a range of 0 to 150 volts to indicate line voltage.

CHAPTER 5

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing the equipment, be extremely careful; high voltage is present. Keep one hand in your pocket when measuring socket voltages. After voltage is turned off, short-circuit the part to circuit ground before touching any part of the equipment with your hands.

75. Troubleshooting Procedures

The first step in servicing electronic equipment is sectionalization, which means tracing the fault to the *major component or circuit* responsible for the abnormal operation of the equipment. The second step is localization, which means tracing the fault to the defective *part* responsible for the abnormal condition. Some faults, such as burned-out resistors and short-circuited transformers, can often be located by sight, smell, or hearing. The majority of faults, however, must be localized by *checking voltage and resistance.*

a. System Sectionalization. System sectionalization is discussed in paragraph 53.

b. Component Sectionalization and Localization. The tests listed below aid in isolating the source of trouble. First, trouble should be localized to a single stage or circuit. Then the trouble may be isolated within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

(1) *Visual Inspection.* The purpose of visual inspection (par. 52) is to locate any visible trouble. Through this inspection alone, the repairman may frequently discover the trouble or determine the stage in which the trouble exists.

(2) *Operational tests.* The operational tests (par. 52 through 55) are important because they frequently indicate the general location of trouble. In many instances, the information gained will indicate the exact nature of the fault. For this information to be fully used, all symptoms must be interpreted in relation to one another.

(3) *Troubleshooting chart.* The trouble symptoms listed in this chart (par. 80) will aid greatly in localizing trouble.

(4) *Intermittents.* In all these tests, the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. Look for loose connections; it is possible that the trouble is not in the equipment itself, but in the installation, such as cord connections, etc.

c. Wave Forms. Checking wave forms is of great value in locating troubles. By the use of an oscilloscope, wave forms at various test points in the equipment may be obtained. By comparing the observed wave form with the actual reference wave form shown in figure 71, faults can be localized rapidly.

(1) All wave forms are obtained by connecting the oscilloscope between a specified point and chassis. In some cases, it is necessary to unbalance the detector to create a signal in the servo amplifier.

(2) To unbalance the detector, place the SIGNAL SELECTOR switch to the 60 C. P. S. position and adjust the REF. ADJUST control until the pen indicates 30. Throw 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. Throw 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 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 indicate 28 or 32. When the test is completed, throw power switch S201 to 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. 79).

d. Voltage Measurements. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from, or produce, abnormal voltages. Voltage measurements are always made between two points in a circuit, and the circuit need not be interrupted. Complete information on normal operating voltages is given in this section.

(1) Unless otherwise specified, voltages are measured between the indicated point and ground.

(2) 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.

(3) 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.

e. Dc Resistance of Transformers and Coils. After a trouble has been localized to a stage or circuit, a check of the transformer and coil dc resistances in that stage will often help to isolate the trouble (par. 83).

76. Troubleshooting Data

Take advantage of the material supplied in this technical manual. It will help in the rapid location of faults. Consult the following troubleshooting data.

a. Converter Amplifier.

Fig. No.	Description
57	Signal Data Converter CV–146/TMQ–5, top view.
58	Signal Data Converter CV–146/TMQ–5, socket shield removed, bottom view.
59	Signal Data Converter CV–146/TMQ–5, bottom view.
60	Signal Data Converter CV–146/TMQ–5, terminal boards.
71	Signal Data Converter CV–146/TMQ–5, typical wave forms.
72	Signal Data Converter CV–146/TMQ–5, voltage and resistance diagram.
74	Signal Data Converter CV–146/TMQ–5, wiring diagram.
77	Signal Data Converter CV–146/TMQ–5, schematic diagram.

b. Control Panel.

Fig. No.	Description
9	Control Panel C–834/TMQ–5, front view.
56	Control Panel C–834/TMQ–5, rear view.
76	Control Panel C–834/TMQ–5, wiring diagram.
78	Control Panel C–834/TMQ–5, schematic diagram.

c. Frequency-Time Recorder.

Fig. No.	Description
19	Frequency-Time Recorder RD–88/TMQ–5, top view.
20	Frequency-Time Recorder RD–88A/TMQ–5, top view.
21	Frequency-Time Recorder RD–88/TMQ–5, bottom view, showing main chart drive items.
22	Frequency-Time Recorder RD–88A/TMQ–5, bottom view, showing main chart drive items.
50	Frequency-Time Recorder RD–88/TMQ–5, bottom view, showing chart drive details.
52	Frequency-Time Recorder RD–88A/TMQ–5, bottom view, showing chart drive details.
53	Frequency-Time Recorder RD–88/TMQ–5, front view.
54	Frequency-Time Recorder RD–88A/TMQ–5, front view of operating controls and panel.
79	Frequency-Time Recorder RD–88/TMQ–5, schematic diagram.
80	Frequency-Time Recorder RD–88A/TMQ–5, schematic diagram.

d. Power Supply.

Fig. No.	Description
61	Power Supply PP–968/TMQ–5, top view.
62	Power Supply PP–968/TMQ–5, bottom view.
63	Power Supply pp–968/TMQ–5, terminal boards.
73	Power Supply PP–968/TMQ–5, voltage and resistance diagram.
75	Power Supply PP–968/TMQ–5, wiring diagram.
81	Power Supply PP–968/TMQ–5, schematic diagram.

e. Fan Panel.

Fig. No.	Description
64	Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, front view.
65	Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, rear view.
82	Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, schematic diagram.

f. Cabinet.

Fig. No.	Description
66	Electrical Equipment Cabinet CY–1390(*)/TMQ–5, front view.
67	Electrical Equipment Cabinet CY–1390(*)/TMQ–5, rear view.
83	Electrical Equipment Cabinet CY–1390/TMQ–5, schematic diagram.
84	Electrical Equipment Cabinet CY–1390A/TMQ–5, schematic diagram.

77. Test Equipment Required for Troubleshooting

The test equipment required for troubleshooting Radiosonde Recorder AN/TMQ–5(*) is listed below. The technical manuals associated with the test equipment are also listed.

Test equipment	Technical manual
Multimeter TS–352/U	TM 11–5527
Frequency Standard TS–65C/FMQ–1	TM 11–2602B

78. General Precautions

Whenever the equipment is serviced, observe the following precautions very carefully.

a. Be careful when panels are opened; dangerous voltages are exposed.

b. Careless replacement of parts causes new faults.

Note the following points:

(1) 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.

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

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

(4) 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.

(5) 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.

79. Test Cables

a. 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 connected by arrows in figure 49. If test cables are connected in any other way, the equipment may become damaged.

b. Power-supply test cable W606 is connected between P401 mounted on the power-supply chassis (fig. 61) and J105 located at the rear of the recorder (fig. 66). The power-supply test cable is used for this connection only as indicated by arrow No. 1 in figure 49. Test cable W604 is connected between the components as indicated by arrows Nos. 2 through 6. Five of these cables are needed to maintain the components in operation when all are removed from the cabinet at the same time. The following table of test connections will help in locating the various cable terminations:

Test cable W604 connections

Designated by arrow No.	Connected between	Location
2	P501 and J104	P501: Rear of frequency-time recorder. J104: Mounted in cabinet (fig. 66).
3	P302 and J103	P302: Top of converter-amplifier (fig. 57). J103: Mounted in cabinet (fig. 66).
4	P301 and J102	P301: Top of converter-amplifier (fig. 57). J102: Mounted in cabinet (fig. 66).
5	P201 and J301	P201: Rear of control panel (fig. 56). J301: Bottom of converter amplifier (fig. 59).
6	P202 and J302	P202: Rear of control panel (fig. 56). J302: Bottom of converter amplifier (fig. 59).

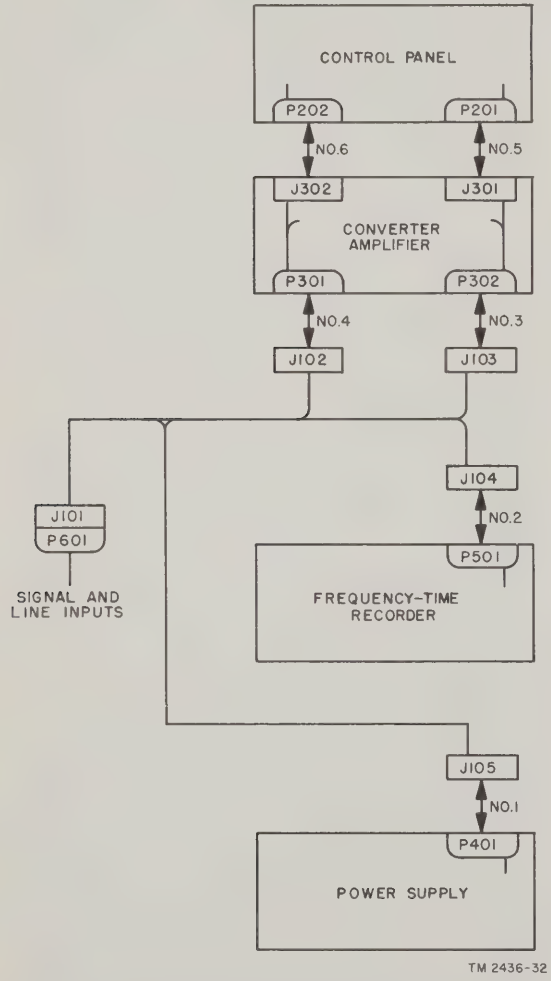


Figure 49. Radiosonde Recorder AN/TMQ–5(*), block installation diagram.

80. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble in the radiosonde recorder. The chart lists the symptoms that the repairman observes, either aurally or visually, while making a few simple tests. Once the trouble has been localized to a stage or circuit, a tube check and voltage and resistance measurements of this stage or circuit should be sufficient to isolate the defective part. Normal voltage and resistance measurements are shown in figures 72 and 73. Wave forms obtained at various test points throughout the equipment are shown in figure 71. Location of parts of major components of the recorder are shown in figures 50 through 67 and the wiring diagrams of the converter amplifier, power supply, and control panel are shown in figures 74 through 76. Figures 77 through 82 are the schematic diagrams of the converter amplifier, control panel, frequency-time recorder (both models), power supply, and fan panel. Figures 83 and 84 are the schematic diagrams of the cabinets. The resistor and capacitor color codes are shown in figures 69 and 70 respectively.

Symptom	Probable trouble	Correction
1. Power line voltage and power line frequency meters indicating correctly. Equipment inoperative.	Regulated positive power supply not operating (figs. 62, 75, and 81).	Troubleshoot power supply.
2. Voltages measured between pins 4 and 6 of V401 and chassis are zero or subnormal (figs. 73 and 81).	Open fuse F401 or F402.	Replace defective fuse. It it blows again, check filter capacitors C401 and C402.
	Faulty socket connection or open jumper in V404.	Replace V404 or clean contacts.
	Defective transformer T401.	Replace transformer T401.
3. Voltage measured between J403 and chassis is abnormal (figs. 62, 73, and 81).	Check tube V401 and capacitors C401 and C402.	Replace defective part.
4. Voltage measured between J404 and chassis is abnormal (figs. 62, 73, and 81).	Defective tube V402, V403 or V404.	Replace defective tube. If voltage is close, but not exactly 300 volts, adjust potentiometer R412 (par. 87).
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.
	Broken drive cable.	Replace cable.
	Defective or loose gears.	Tighten set screws; if necessary, replace gear.
	Defective line winding of balancing motor.	Replace balancing motor B501.
6. 60-cycle error signal does not appear at J320 when REC. TEST and INTER S. C.-OUTPUT S. C. switches are alternately depressed.	No voltage from measuring circuit.	Check resistors of measuring circuit.
	Defective vibrator inverter circuit.	Check voltage across vibrator inverter coil. If correct, replace vibrator inverter G301.
	Defective first or second servo voltage amplifier stage.	Test V308 and then, if necessary, make voltage and resistance measurements of both stages (fig. 72).
7. 60-cycle error signal does not appear at 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 (fig. 72).
8. 60-cycle error signal does not appear at 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. 73).
	Open controlled winding of balancing motor.	Replace balancing motor B501.
9. Pen will not rise from chart as it travels from one position to another.	Defective pen-lifter circuit.	Troubleshoot pen-lifter circuit.
	Binding of mechanical linkage.	Repair or replace defective part.
	PEN LIFTER control set too low.	Adjust PEN LIFTER control R215 (par. 93*c*).
10. The pen rises from the chart when a jumper is placed between J409 and ground.	Insufficient signal from power amplifiers.	Adjust PEN LIFTER control potentiometer R215 (par. 92*b*).
	Defective tube V407.	Replace V407.
	Defective capacitor C410, C411, or C413.	Replace defective capacitor.
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 V407.

Symptom	Probable trouble	Correction
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 (par. 92*b*)
	Contacts of relay K401 not making.	Replace relay.
	Defect in regulated negative power supply.	Troubleshoot regulated negative power supply.
13. Voltage measured between pins 4 and 6 of 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 V411.	Replace V411 or clean contacts.
14. Voltage measured between J412 and J413 is less than 260 volts. The positive meter lead is placed in J412.	Check tube V408 and capacitors C415 and C416.	Replace defective part.
15. Voltage measured between J413 and chassis is not −175 volts.	Defective tube V409, V410, or V411.	Replace defective tube. If voltage is near −175 volts, adjust potentiometer R434 (par. 87).
16. No speaker output, and the pen does not move when SIGNAL SELECTOR switch S202 is rotated to 60 C. P. S. and then to 120 C. P. S.	Defective stage between V301 and V304.	Using an oscilloscope, compare the wave forms obtained from J303 through J313 with those of figure 71. Check the tube of the defective stage and then, if necessary, make voltage and resistance measurements (fig. 72) to determine the defective part.
17. Correct speaker output is obtained, but the pen does not move when SIGNAL SELECTOR switch S202 is rotated to the 60 C. P. S. position and then to the 120 C. P. S. position.	Defective stage between V305 and V307.	Using an oscilloscope, compare the wave forms obtained from J313 through J318 with those of figure 71. Check the tube of the defiective stage and then, if necessary, make voltage and resistance measurements (fig. 72) to determine the defective part.
18. Pen jitters or oscillates.	Input filter faulty (includes R333 through R336 and C315).	Replace defective part or parts.
	SENSIVITITY control set too high.	Adjust SENSITIVITY control.
	Split gear bias not set properly.	Adjust split gear bias as described in paragraph 84*b*.
19. Poor linearity.	Faulty V305, V306, or V307.	Replace faulty tubes.
	R326 improperly adjusted.	Adjust R362 (par. 89).
	Worn or defective slide-wire assembly.	Replace contacts or defective part of slide-wire assembly.

81. Chart Feed Difficulties

a. If the chart does not feed out straight during operation of the recorder the cause is probably misalinement 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 aline, loosen the two locknuts on the left side of the chart supply roll shaft, one on each side of the recorder casting (figs. 50 or 52). 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 friction brake on the chart roll shaft should be only tight enough to prevent the chart from drooping below the bottom of the recorder. Excessive brake action may cause the chart to creep sidewise as it advances.

b. On Recorder RD–88A/TMQ–5, if the chart feeds out intermittently, this indicates there is too much drag on the supply roll, causing the friction clutch to slip at times, or that there is not enough clutch pressure. Check with the manual chart advance knob (fig. 53) for ease of operation. If

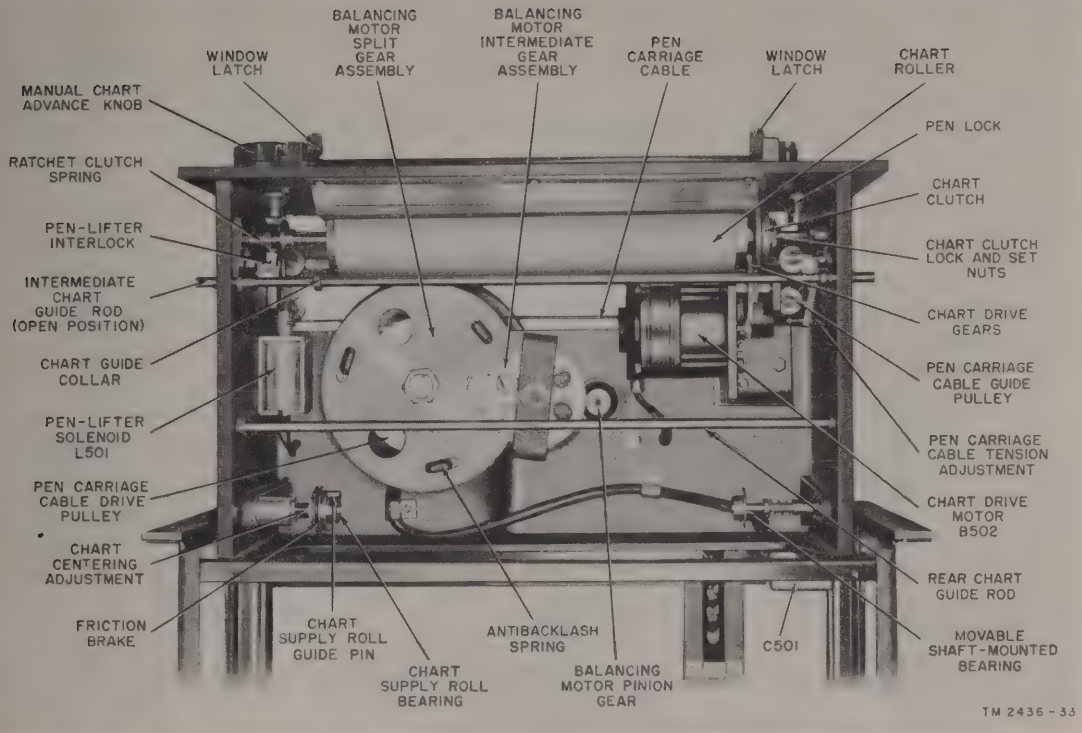


Figure 50. Frequency-Time Recorder RD–88/TMQ–5, bottom view showing chart drive details.

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 (figs. 50 or 52) 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 49 have not been followed, wear or binding may occur between the ratchet wheel hubs and shaft (figs. 51 and 52). Apply oil only as needed to correct the trouble, then lubricate as directed in paragraph 49.

82. Recorder Pen Difficulties

a. If the pen does not lift one-sixteenth of an 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. 55) and turn the double-ended bolt until the pen is one-sixteenth of an 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. 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 pen point against the paper. This pressure should be 2 ounces; it is varied by adjustment of the tension of the pen pressure spring (fig. 55).

c. 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 alinement of the pen against the position of the arm of the slide and trolley wire (par. 91).

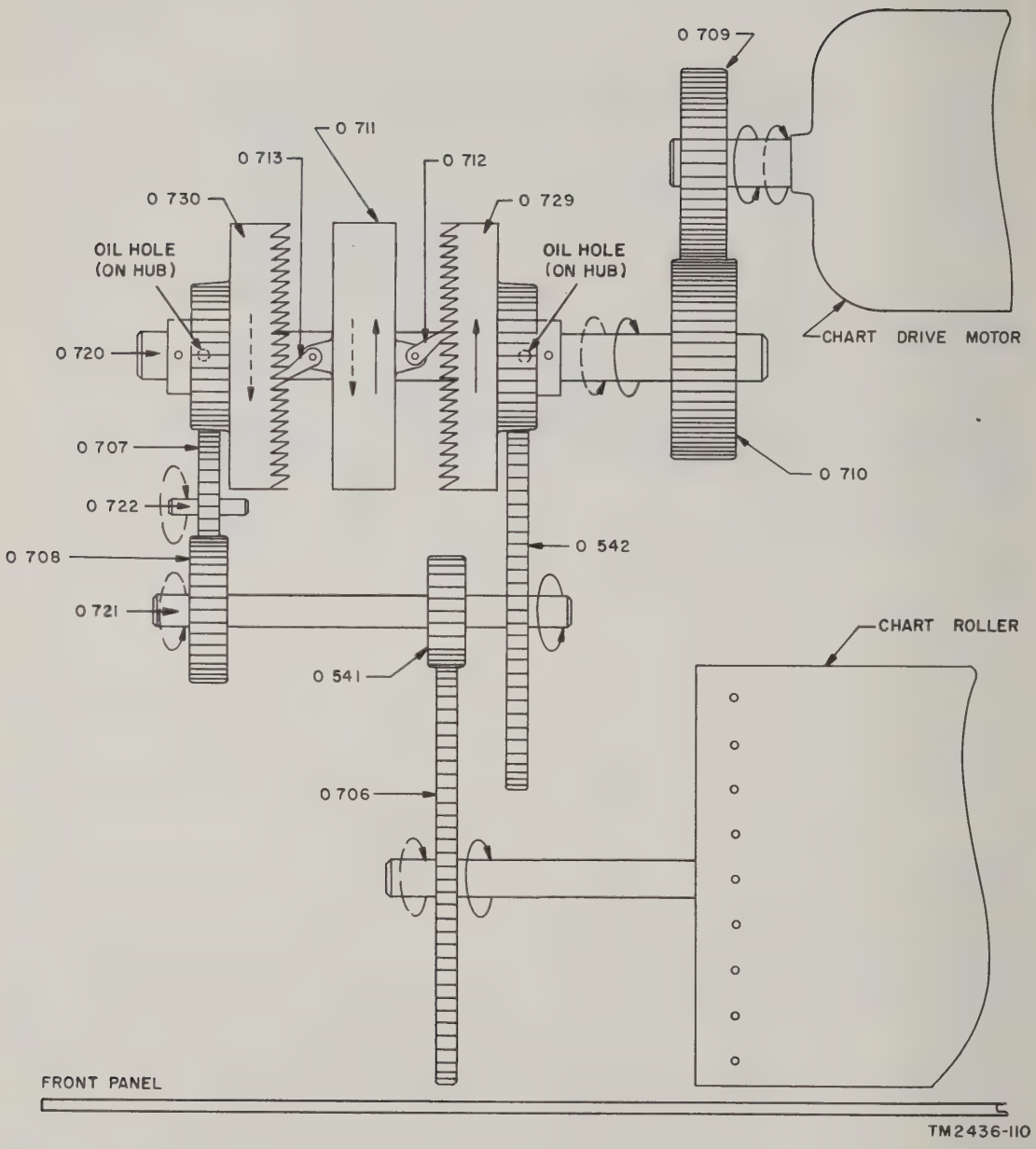


Figure 51. Two-speed chart drive gear train.

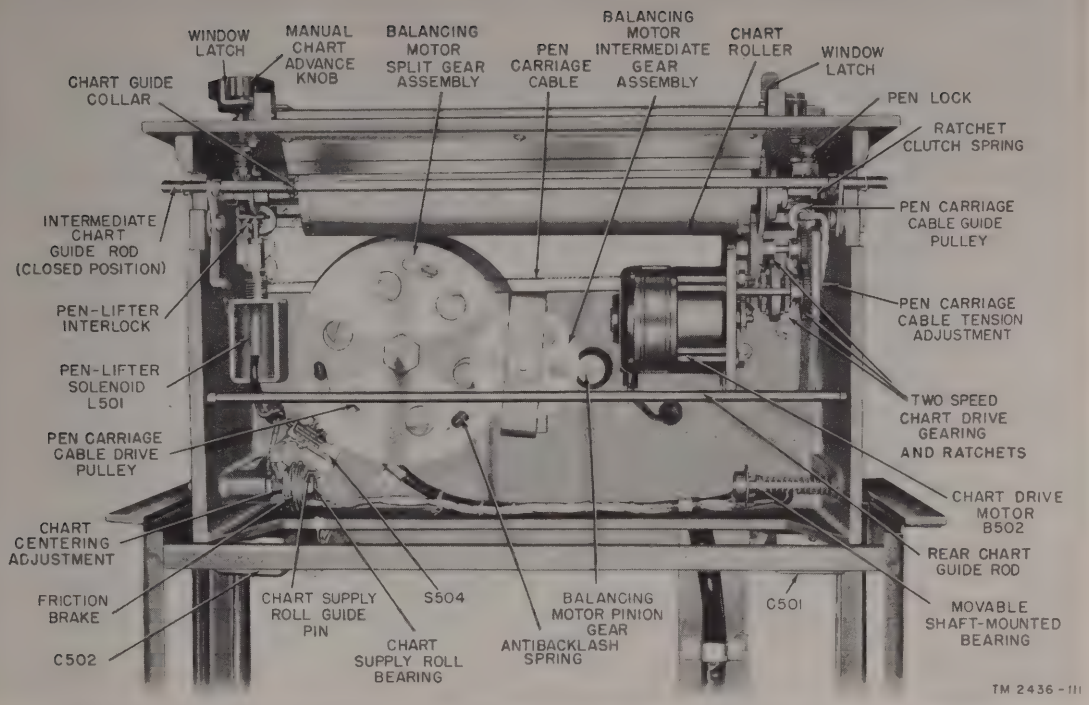


Figure 52. Frequency-Time Recorder RD–88A/TMQ–5, bottom view showing chart drive details.

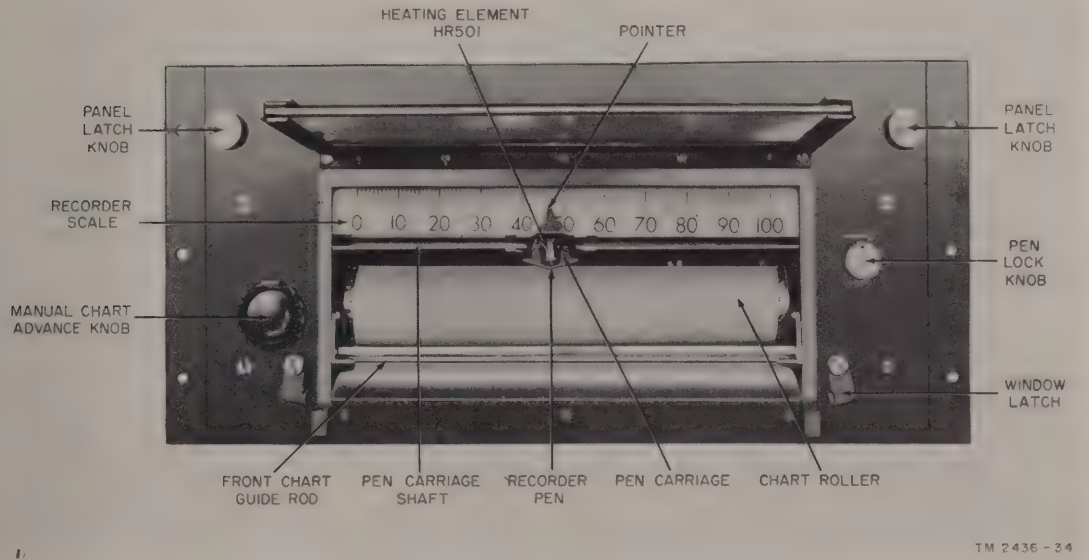


Figure 53. Frequency-Time Recorder RD–88/TMQ–5, front view.

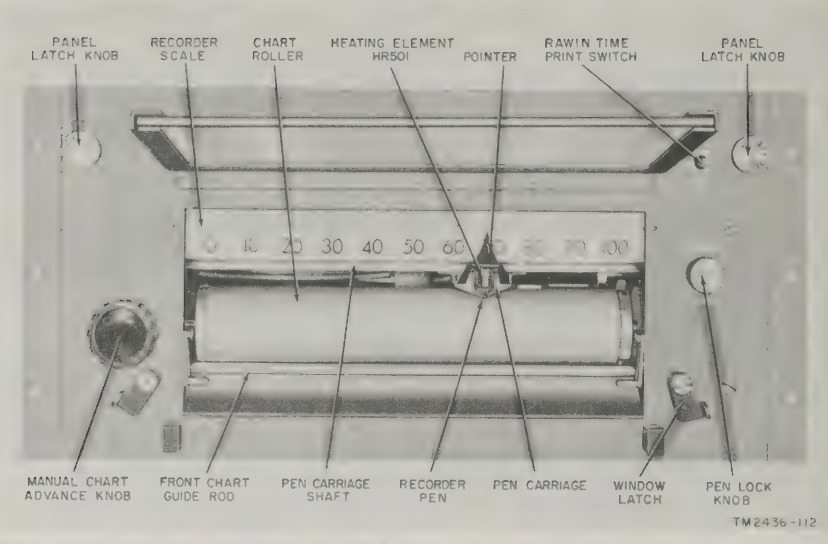


Figure 54. Frequency-Time Recorder RD–88A/TMQ–5, front view of operating controls and panel.

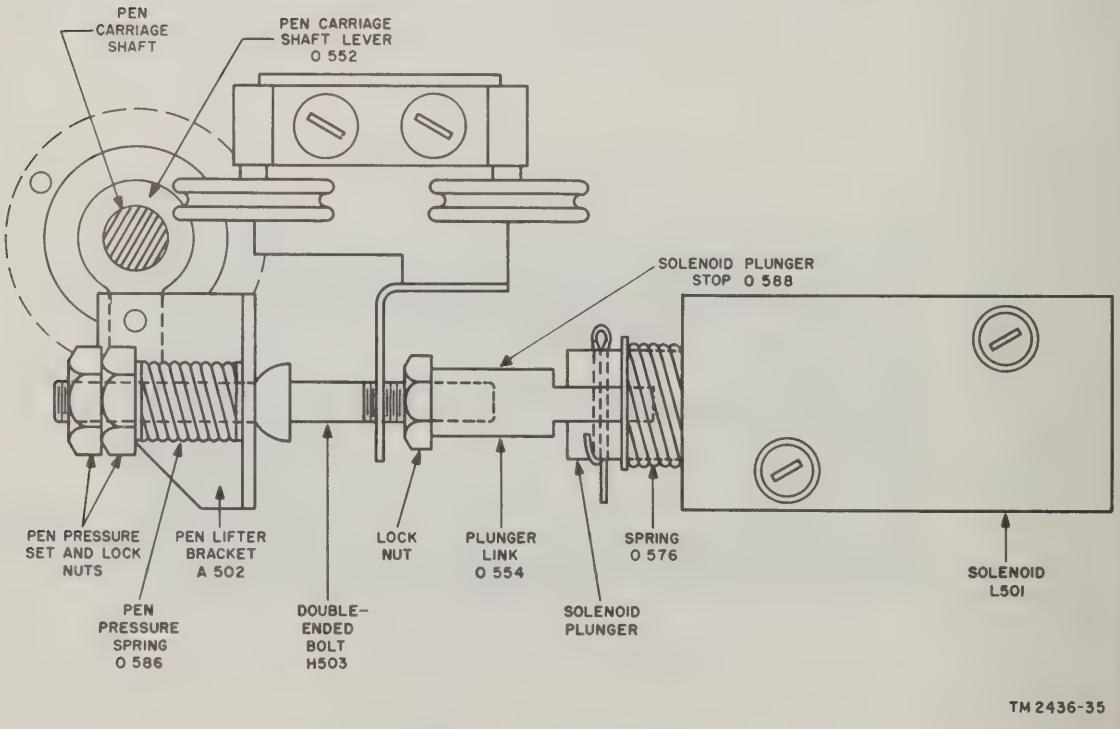


Figure 55. Pen-lifter mechanism.

(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 travelling 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 coarse 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 back-up 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 $\frac{1}{16}$-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 slidewire housing. Rotate the contact arm throughout its entire excursion in making this clearance check.

83. Dc Resistances of Coils, Transformers, and Motors

The measured resistance values of the coils, transformers, and motors are listed below. Some of these will appear as a short circuit on the average voltohmmeter.

Transformer motor or coil	Terminals	Ohms ±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
K501	1–2 of E502 (fig. 79)	368
B1	Yel/wht-blu/wht	830
	Red/wht-red/yel	830

Section II. REPAIRS

84. Replacement of Parts

a. Most of the parts in Radiosonde Recorder AN/TMQ–5(*) are readily accessible and may be replaced if faulty. In all cases, mark or tag the wires connected to the faulty part before making the replacement. When replacing a part that is connected to circuit ground, be sure the replacement part is connected to the same circuit ground as was the original part.

b. To replace the pinion, idler, or split gears, remove the nut below the pinion gear and pull the pinion gear from the motor shaft (fig. 50). If the pinion gear is faulty, set the bias of the split gear and replace the pinion gear with a new one. To set the bias, expand the springs of the split gear by displacing the two halves of the gear by three teeth. Hold the split gear while the pinion gear is replaced. If the idler gear is faulty, remove the pinion gear and the idler gear. Replace the idler gear with a new one, set the bias of the split gear, and replace the pinion gear. If the split gear is faulty, remove the three gears. Install the new split gear. (Be sure to locate the groove pins and to stake the screwheads.) Install the idler gear, set the bias of the split gear, and replace the pinion gear.

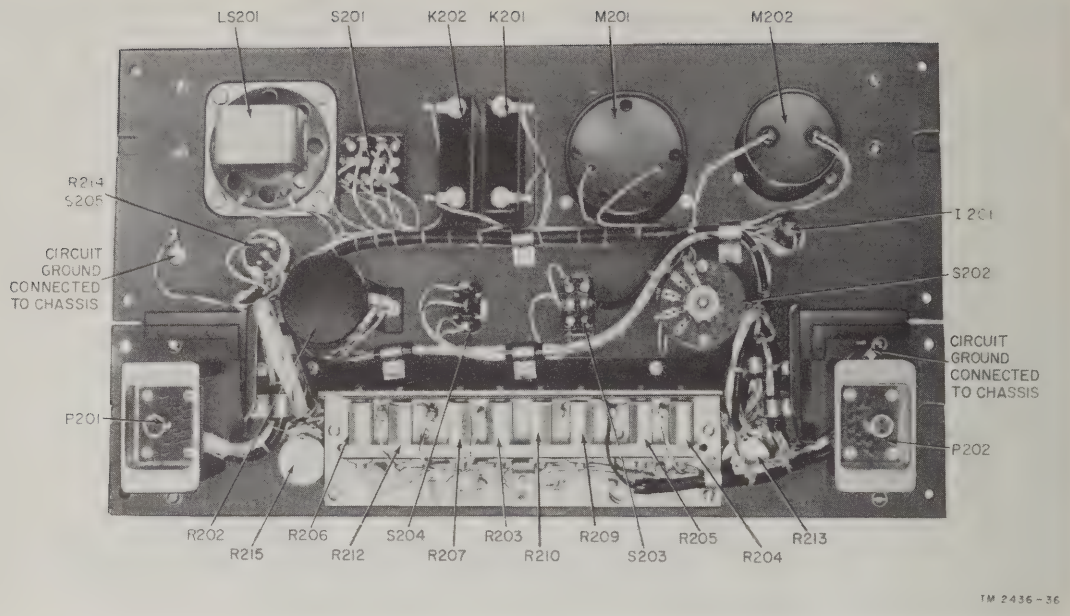


Figure 56. Control Panel C-834/TMQ-5, rear view.

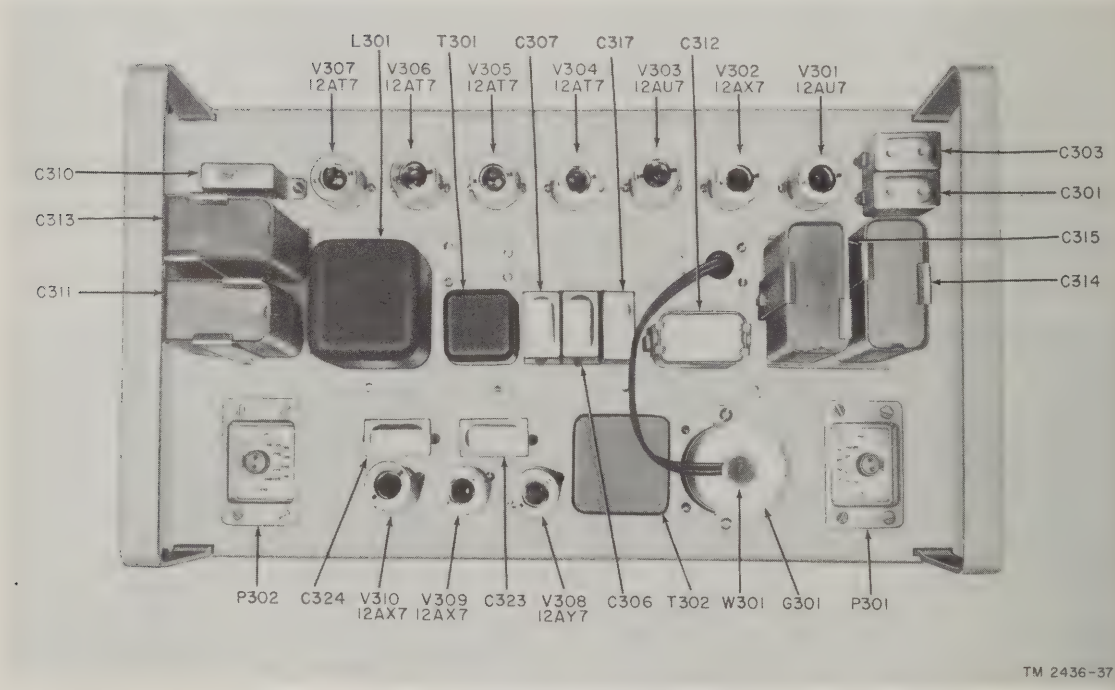


Figure 57. Signal Data Converter CV-146/TMQ-5, top view.

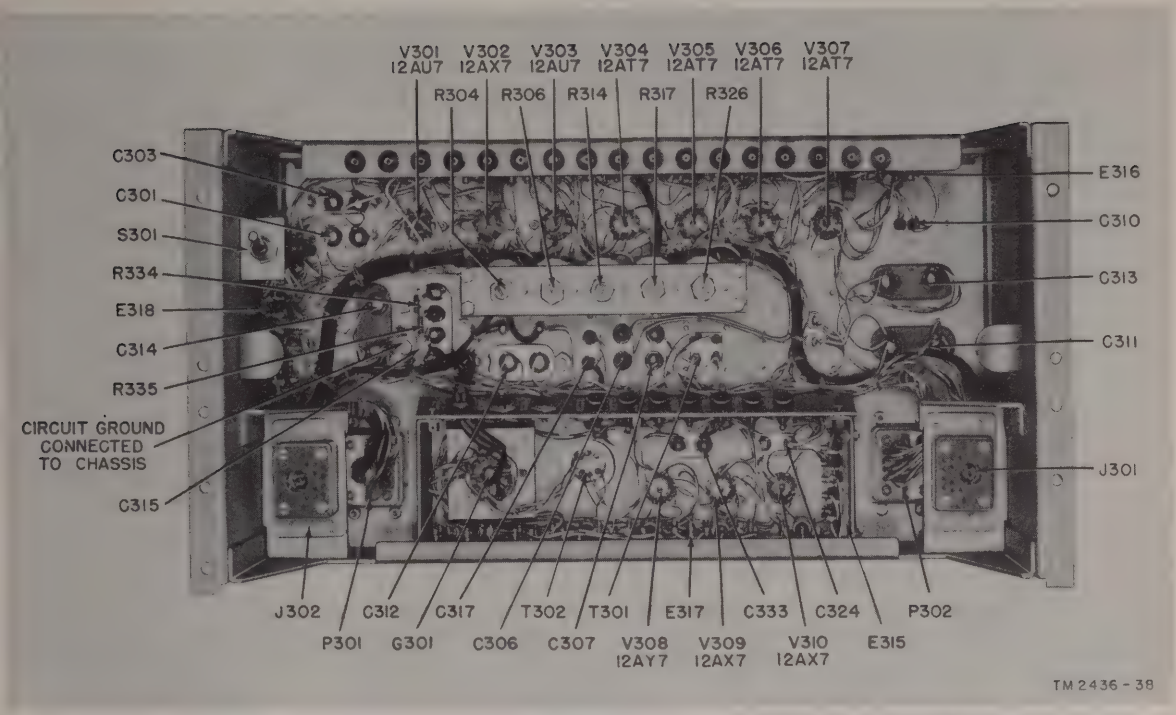


Figure 58. Signal Data Converter CV–146/TMQ–5, bottom view showing socket locations.

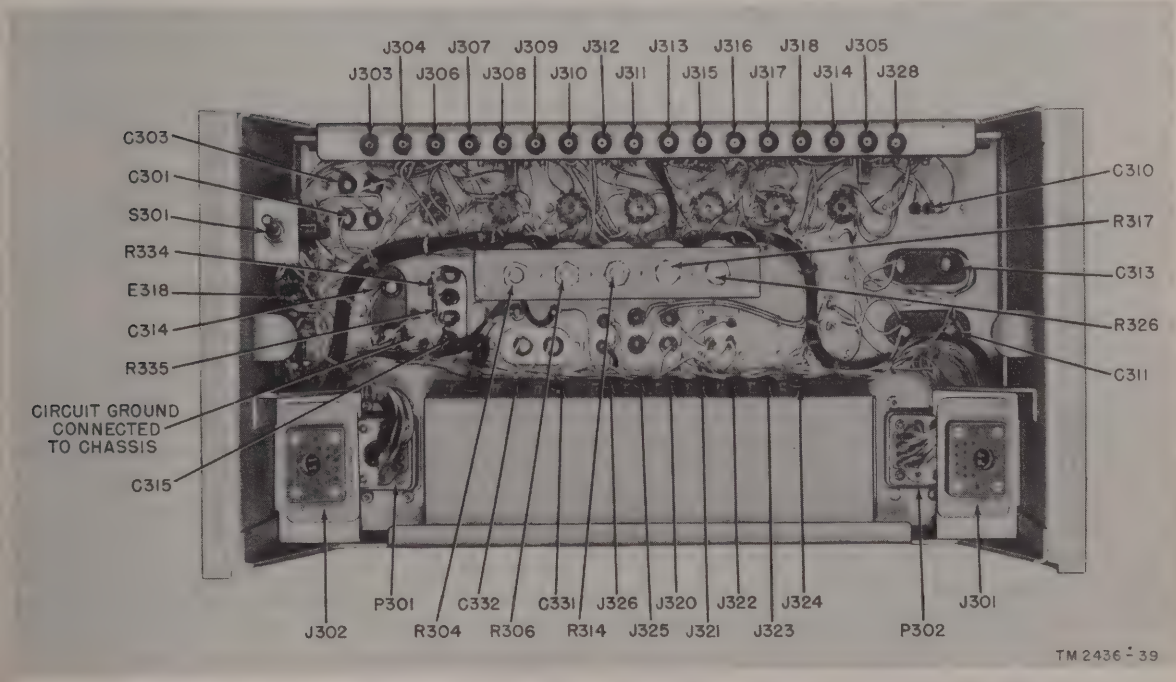
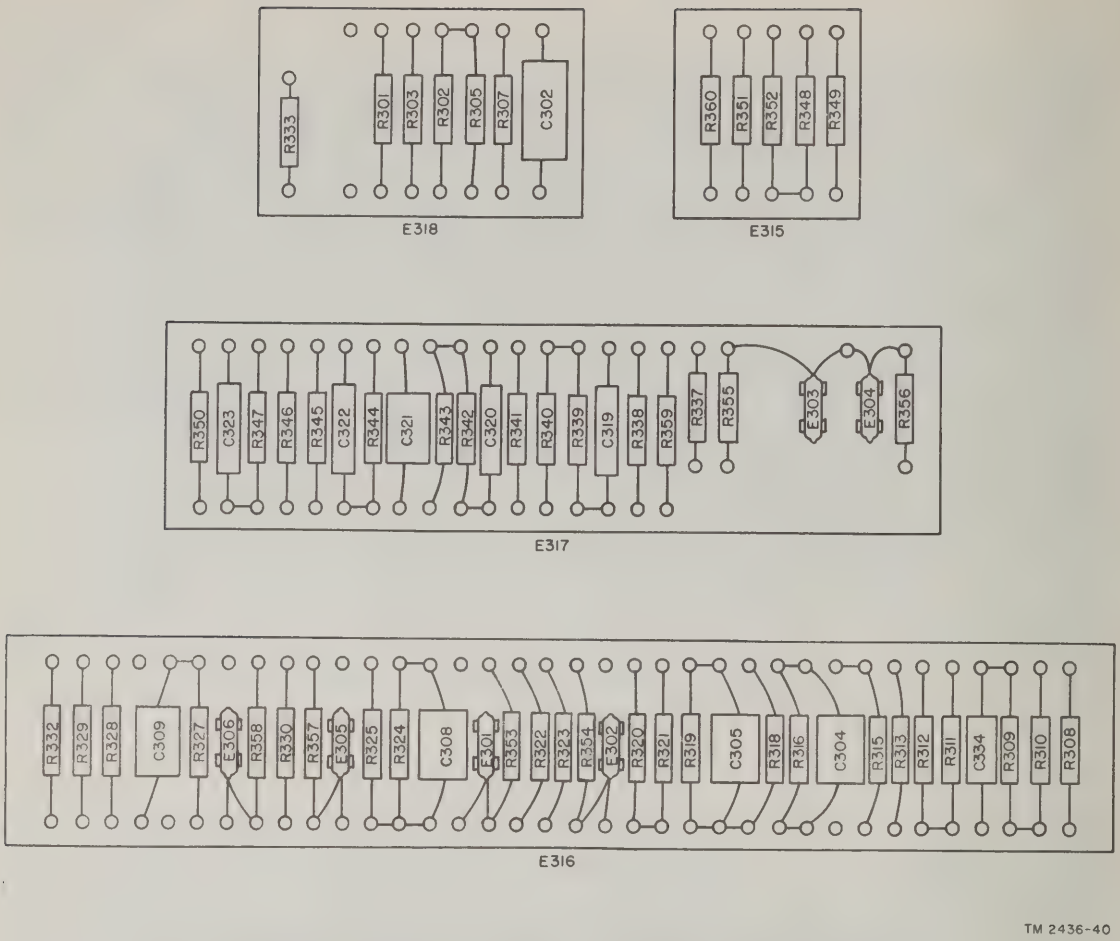


Figure 59. Signal Data Converter CV–146/TMQ–5, bottom view showing test terminal locations.



TM 2436-40

Figure 60. Signal Data Converter CV-146/TMQ-5, terminal boards.

85. Fuse Replacement

To replace either the positive or the negative regulated power-supply fuses, remove the four screws that secure the fan panel. Pull the fan panel straight out (fig. 64). Four fuses are located on a terminal board on the right-hand side of the power-supply chassis (fig. 62). Remove the defective fuse from the clips and replace it with one of the same value. Fuses F401 and F402, in the positive supply-power line, are ⅛-ampere, type 3AG, slow-blow fuses; and F403 and F404 in the negative supply-power line are .3-ampere, type 3AG, slow-blow fuses (fig. 81). Replace the fan panel; be careful to insure proper connection of the receptacles.

Caution: Be careful to replace the defective fuse with one having the current rating given in figure 81. One having a larger current rating could damage the equipment.

86. Tube Replacement

a. To remove the miniature-type tubes found in Radiosonde Recorder AN/TMQ-5(*), a special tube puller (H604), packed in the accessories case (fig. 14), is used. Be very careful when replacing miniature tubes so that the tube pins do not bend.

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

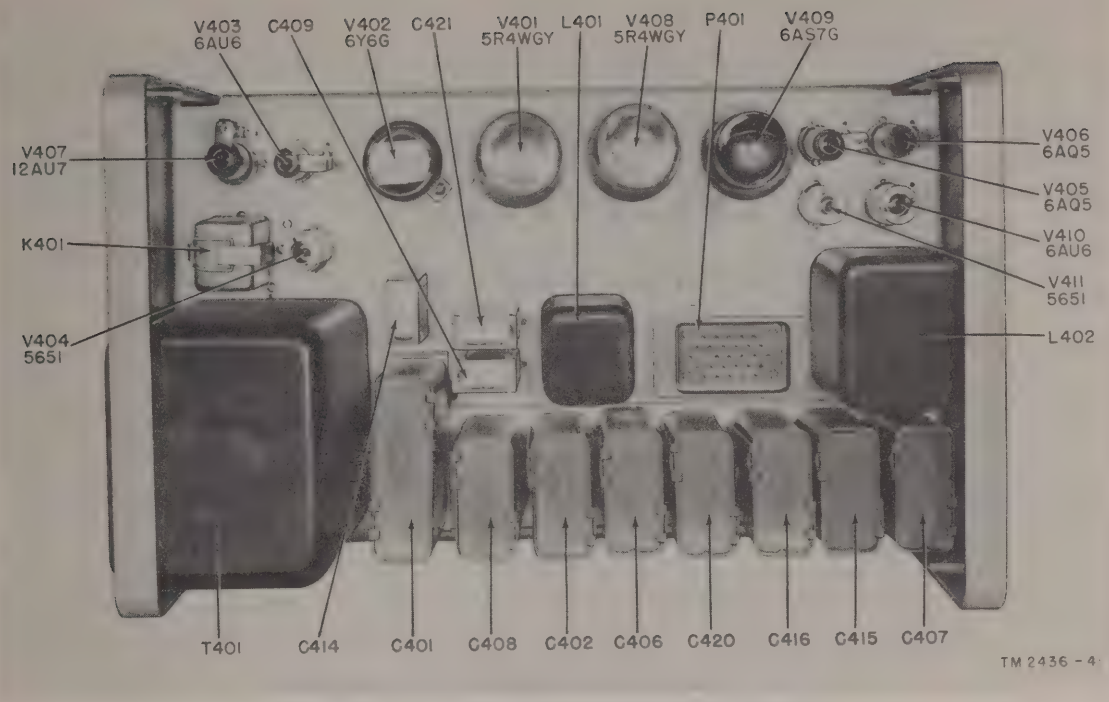


Figure 61. Power Supply PP–968/TMQ–5, top view.

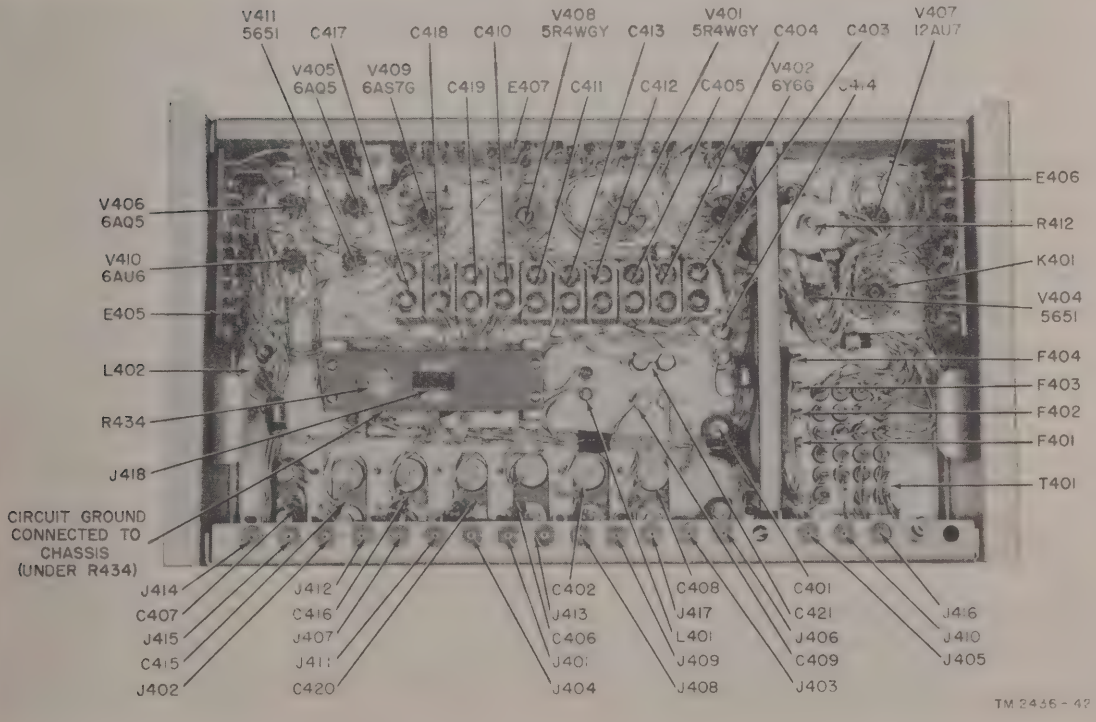


Figure 62. Power Supply PP–968/TMQ–5, bottom view.

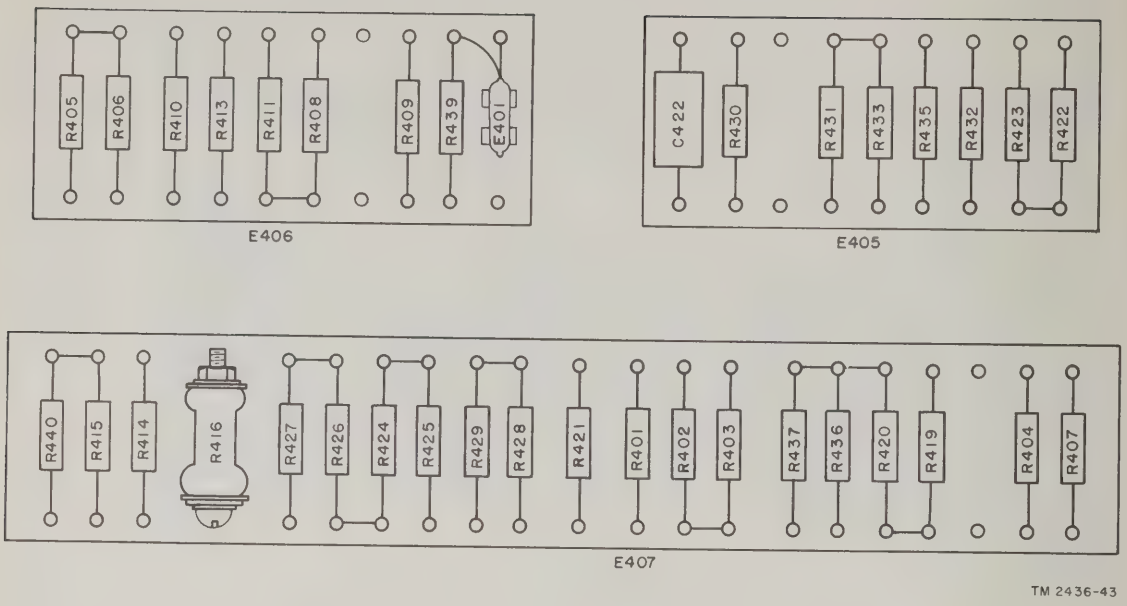


Figure 63. Power Supply PP–968/TMQ–5, terminal boards.

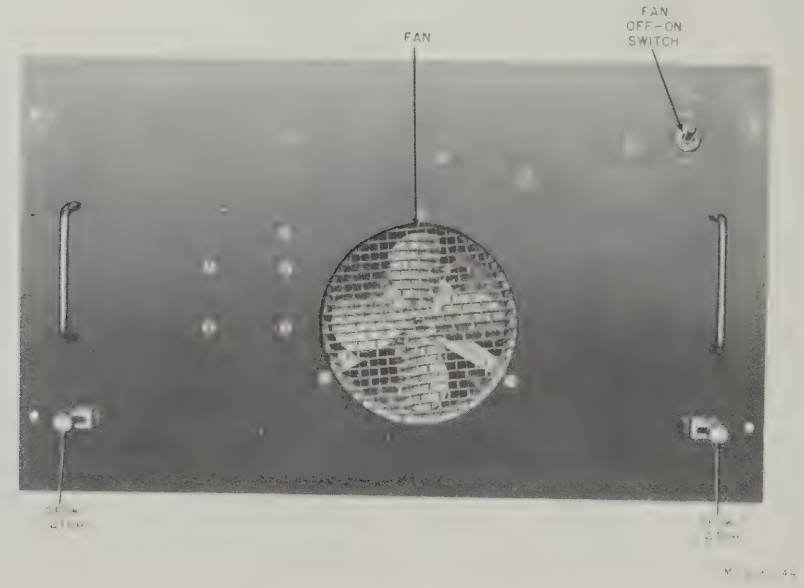


Figure 64. Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, front view.

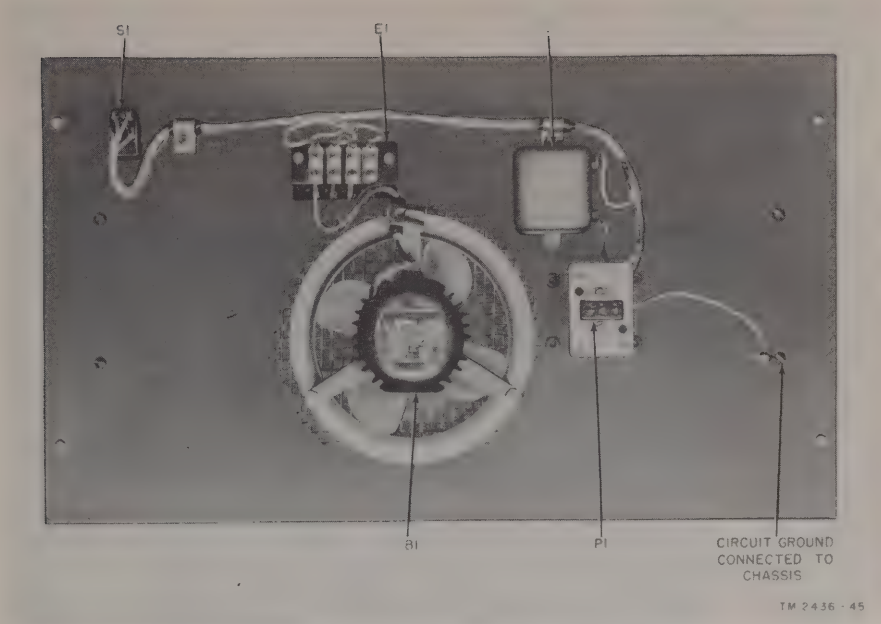


Figure 65. Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, rear view.

Section III. ALINEMENT AND ADJUSTMENT

87. Adjustment of Regulated Power Supplies

a. Positive Regulated Power Supply (figs. 61 and 62). This unit is adjusted to give a constant output potential of 300 volts under normal loads. The adjusting potentiometer is R412. Connect the positive lead of a 20,000-ohms-per-volt meter to J404 and the negative lead to the chassis; adjust R412 for the correct reading.

b. Negative Regulated Power Supply (figs. 61 and 62). This unit is adjusted to give a constant output potential of 175 volts under normal conditions. The adjusting potentiometer is R434. Connect the negative lead of 20,000-ohms-per-volt meter to J413 and the positive lead to the chassis; adjust R434 for the correct reading.

88. Alinement Procedure for Voltage Discriminator

Note. This circuit is in the converter amplifier; refer to figures 58 and 59.

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

b. Rotate potentiometer R314 to its clockwise limit, and potentiometers R317 and R326 to their counterclockwise limits.

c. Place a jumper wire between J308 and J314; this biases the clipper-amplifier tube heavily and thereby raises the voltage on the grid (pin 2) of V303A to assure plate conduction. Check the voltage at J309; it should be between 230 and 280 volts dc.

d. Connect the voltmeter (200- to 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; this applies a small positive bias on the clipper-amplifier tube and thereby drives V303A to plate current cutoff. Check the voltage between J309 and ground. This voltage should be between 20 and 50 volts.

f. Connect the voltmeter between J310 and ground. Adjust R317 until the meter indicates 160 volts. Remove the jumper.

89. Alinement Procedure for Univibrator (figs. 58 and 59)

Set univibrator potentiometer R326 to the middle of the range in which stable operation of the univibrator is obtained, as follows:

a. Rotate SIGNAL SELECTOR switch S202 to the 120 C. P. S. position.

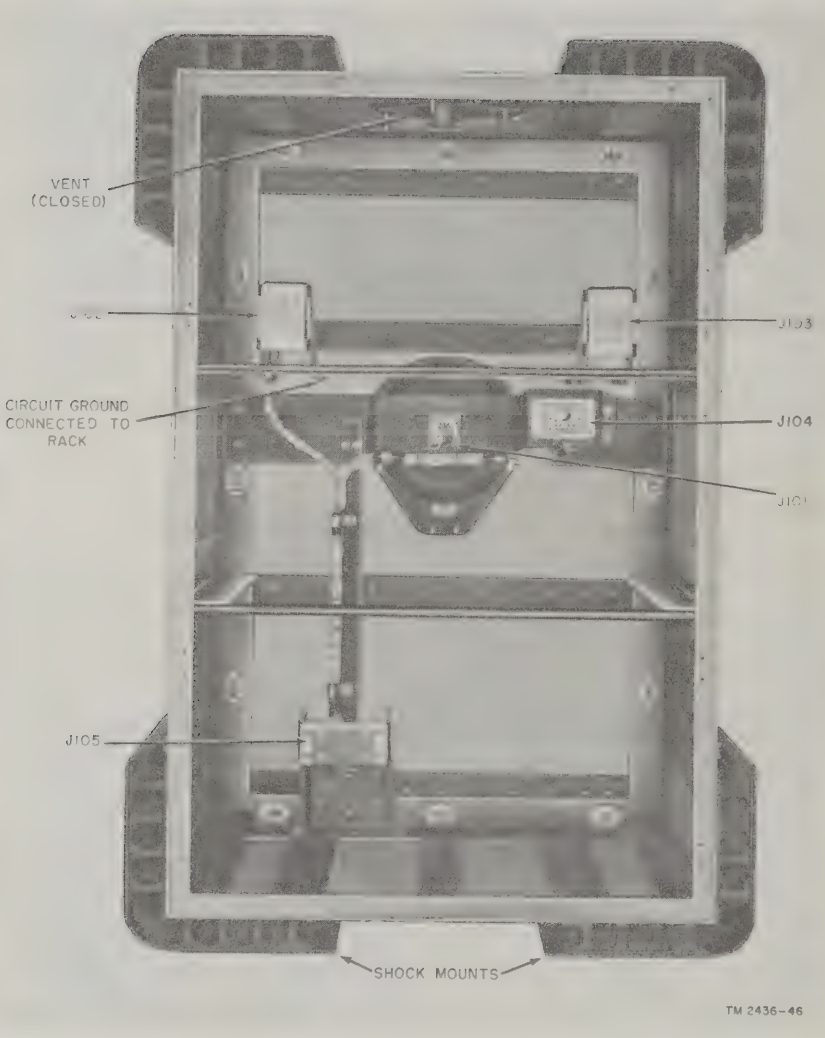


Figure 66. Electrical Equipment Cabinet CY-1390(*)/TMQ-5, front view.

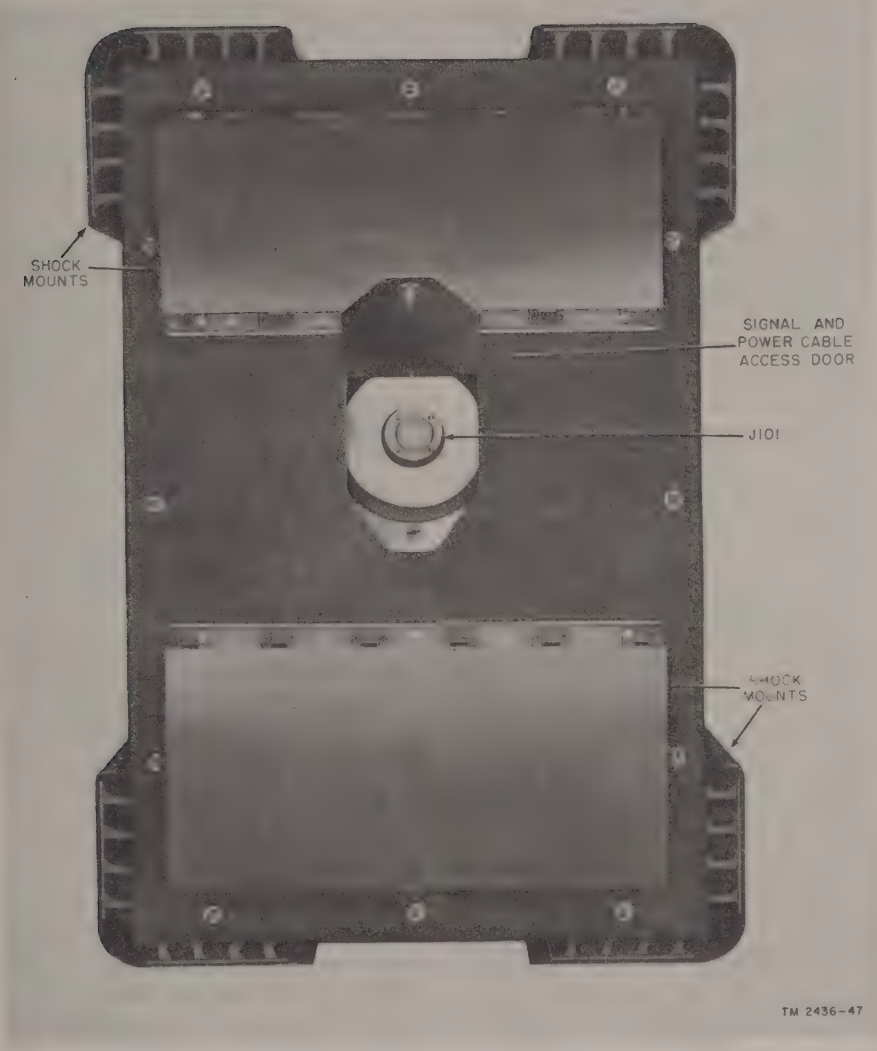


Figure 67. Electrical Equipment Cabinet CY-1390(*)/TMQ-5, rear view.

b. Advance R326 slowly until the recorder pen rests at 60 on the chart. If the pen comes to rest at some other position, bring it to 60 by adjusting REF. ADJUST. This will establish one extreme of the range.

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

d. The final setting of R326 will be halfway between the two extremes of the range.

90. Alinement Procedure for Noise-Suppression Diode

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

a. Observe the signal at J303 (fig. 59). If the signal is not noisy, set noise-suppression switch S301 (fig. 59) to the OUT position. If the signal is noisy, set noise-suppression switch S301 to the IN position.

b. Rotate potentiometers R304 and R306 to their maximum clockwise position.

c. Connect the oscilloscope between J307 and ground.

d. If noise appears at J307 (fig. 72), adjust potentiometers R304 and R306 as follows:

(1) If noise appears at the bottom of the wave form (1, fig. 68), try counterclockwise rotation of R306 and clockwise rotation of R304.

(2) If noise appears at the top of the wave form (2, fig. 68), try clockwise rotation of R306 and counterclockwise rotation of R304.



Figure 68. Signal wave form, showing noise superimposed.

(3) If noise appears at the top and bottom of the wave form (3, fig. 68), try counterclockwise rotation of 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 R304 and R306 tends to increase the response time of the circuit to sudden drops in signal amplitude.

91. Alinement of Recorder Pen and Slide-Wire

a. Turn on the equipment and allow it to warm up for 15 minutes.

b. Turn the SENSITIVITY control (fig. 25) to its counterclockwise limit.

c. Remove the slide-wire cover; to do this, pull out the control panel (fig. 19). 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.

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

e. Rotate the contact (wiper arm) of the slide-wire to its counterclockwise limit, as viewed from above (fig. 19).

f. Manually position the pen carriage until the pen alines with a point between ⅓- and ½-chart division above the chart zero line.

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

h. Manually rotate the wiper arm to its clockwise limit.

i. Advance the SENSITIVITY control until the servo system positions the pen and comes to rest; then turn sensitivity back to zero. The pen should aline on the chart immediately to the left of the teeth on the right-hand end of the chart roller. If the pen goes too far and contacts these teeth, damage to the pen will result. If this extent of travel is encountered, readjust the pen slightly farther to the left by repeating the instructions given in *e*, *f*, and *g*, above.

j. If the pen positions properly on the right-hand end, tighten the right-hand screw that secures the drive cable to the pen carriage. The carriage now is alined properly on the drive cable.

k. Turn the SIGNAL SELECTOR switch to the 120 C.P.S. position (fig. 25).

l. Make the sensitivity adjustment given in paragraph 93; disregard any deviation in balance positions of the pen from those given.

m. Turn the SIGNAL SELECTOR switch to its S.C. position.

n. Turn the REC. ZERO control (fig. 25) to its midpoint; the screwdriver slot will be vertical.

o. Loosen the two mounting screws of the slide-wire plastic molding. One of these screws also secures a cable clamp. Close by this clamp is another clamp that must be loosened.

p. Carefully rotate the loosened slide-wire assembly until the pen records at the chart zero line (±.1 division).

q. Retighten the three screws that support the slide-wire assembly.

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

s. Replace the slide-wire cover.

92. Adjustments of Recorder Pen

After the pen has been alined with the drive cable and the slide-wire (par. 91), proceed as follows:

a. Recorder Test Adjustment. Depress REC. TEST switch S204 (fig. 25). The pen should record at 95. If it does not, adjust REC. TEST ADJ. potentiometer R211 (fig. 25), while holding the REC. TEST switch depressed, until the pen does record at 95. Let the recorder trace a ¼ inch of line to insure proper setting of the control.

b. Pen-Lifter Adjustment. Turn PEN LIFTER potentiometer R215 (fig. 25) to its counterclockwise limit. Then slowly advance it again, while alternating the position of the SIGNAL SELECTOR switch between 60 C.P.S. and 120 C.P.S. Advancing this potentiometer will shorten the "tail" on the recorded signal; this "tail" should be between one and two chart divisions in length. Adjust the potentiometer to get that result.

c. 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 increasing the tension to maximum (figs. 50 and 52), as shown by the closing of the space between turns on the spring, and then backing off 1 full turn of the adjusting screw. Tighten the locknut on this screw.

93. Sensitivity Adjustment

a. With the SIGNAL SELECTOR set at 60 C.P.S., turn SENSITIVITY control R213 (fig. 25) clockwise until the pen carriage jitters back and forth.

b. 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.

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

94. Adjustment of Automatic Time-Print Switch

When Radiosonde Recorder AN/TMQ–5A is used with Rawin Set AN/GMD–1(*), the action of automatic time-print switch S504 (fig. 22) should be checked as instructed below.

Note. This switch is not included in the early models.

a. With the rawin set operating, turn the recorder power switch to the POWER OFF position.

b. Throw RAWIN TIME PRINT switch S503 (fig. 21) to the AUTO. position.

c. Release the knurled panel latches on either side of the front panel of Recorder RD–88A/TMQ–5 and partially withdraw the unit.

d. Manually rotate the balancing motor split-gear assembly in the direction that causes the pen carriage to move upscale through 90 on the chart.

e. Reverse the direction of rotation until the pen is at 85 or less.

f. Repeat the procedure given in *d* above. Rawin Set AN/GMD–1(*) should time-print each time the pen is moving upscale through the range of 89 to 91. If the printing occurs at any other time, the apparatus needs the following alinement:

(1) Manually turn the split-gear assembly to position the pen at 90 on the chart. (The indicator scale may be used if it is alined with the chart accurately.)

(2) Loosen the locking screw that secures the bracket on which automatic time-print microswitch S504 (fig. 52) is mounted.

(3) Move the bracket to a position that just causes the microswitch to close. (When the switch closes, an audible click can be heard.)

(4) Retighten the locking screw.

g. Replace the recorder in the cabinet.

h. Recheck the action of the time-print mechanism after power has been applied to the recorder.

Section IV. FINAL TESTING

95. General

This section is intended as a guide to be used in determining the quality of a repaired Radiosonde Recorder AN/TMQ–5(*). The minimum test requirements outlined in paragraphs 96 through 104 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation. The tests given below must be made in the order shown, since the accuracy and effectiveness of the tests of any specific section of the equipment are based on the fact that all previous sections have been checked and found to be functioning properly.

96. Standard Test Conditions

Test equipment ordinarily consists of Frequency Standard TS–65C/FMQ–1, as a signal source, and any available well-functioning test scope capable of accepting, without overloading, input voltages of 40 volts (root mean square) or higher. If the test scope has no vertical calibrator, then it must be calibrated by a reasonably accurate voltmeter and an adjustable source of 60-cps 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 .353 times the peak-to-peak value.) Except where otherwise specified, perform the tests under the following standard test conditions:

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

b. Adjust the operating controls to permit optimum operation of the equipment.

c. With the signal and power cable assembly (Special Purpose Cable Assembly W601), interconnect J101 on the recorder, Frequency Standard TS–65C/FMQ–1, and a convenient 60-cps power outlet. When making the connections to the frequency standard, the black lead goes to the ground (lower) terminal and the white one to the *hot* terminal.

d. Room temperature and humidity conditions must be normal and reasonably constant.

e. Line voltage and frequency must be normal and constant (115 volts, approximately, and 60 cps).

f. A calibrated scope will be used for peak-to-peak voltage measurements, when available. A vacuum tube voltmeter may be substituted; make due allowance (as mentioned above) for the difference in reading values. In either case, the input signal voltage is the potential to be measured.

97. Chart Feed Test

The time required to draw a pen trace over a given number of horizontal line spaces (½ in. per line) is measured by a watch.

a. If the set under test is Radiosonde Recorder AN/TMQ–5, then five line spaces should be traversed by the trace in 5 minutes.

b. If the set is a Radiosonde Recorder AN/TMQ–5A, with the CHART SPEED switch in the 1/2 INS/MIN position, the trace length should be five line spaces in 5 minutes. At 1 INS/MIN position, the trace length should be 10 line spaces in 5 minutes.

98. Speaker Output Test

Adjust the frequency standard to deliver a signal of 190 cps at 10 volts peak-to-peak. Listen and note the quality of the signal from the speaker. The signal should not sound raspy or distorted.

99. Pen Performance Test

a. Set the power switch on the control panel at STAND BY. The distance between the pen point and the chart should be $\frac{1}{16}$ inch.

b. Throw the power switch to POWER ON. The pressure of the pen against the chart should be 2 ounces. (In the absence of any measuring device, this pressure will have to be estimated.)

c. Rotate the SIGNAL SELECTOR switch on the control panel to S. C. Adjust REC. ZERO on the control panel, if necessary, to position the

pen point exactly on zero. Switch SIGNAL SELECTOR back to SIG. Adjust the frequency standard to deliver a signal of 190 cps at 20 volts peak-to-peak. If necessary, adjust REF. ADJUST on the control panel to position the pen exactly on 95. Next, alternate the SIGNAL SELECTOR switch between SIG. and S. C. and note the time required, as closely as possible, for the pen to travel between 0 and 95, first in one direction and then in the other; the time of travel in either direction should not exceed 2½ seconds, including the pen lifting and lowering operations.

100. Pen-Lifter Test

a. This test is designed primarily to determine the time relationship between pen lifting and pen travel, as shown by the undesirable horizontal "tails" caused by lateral pen motion occurring before the point has cleared the chart.

b. Raise the input signal voltage to 50 volts peak-to-peak; then switch to several frequencies of input signal, successively; allow each frequency to be traced for about 30 seconds. The "tails" of the recordings should not exceed two recorder divisions.

101. Hysteresis Test

The recording of an input signal to the radiosonde recorder at any frequency between 10 and 190 cps, when approached from a higher frequency (from the right), should not deviate from the recording of the same signal, when approached from a lower frequency (from the left), by more than .1 of one chart division. This deviation is called hysteresis; to check its extent on recordings, proceed as follows:

a. Adjust the frequency standard to deliver 20-cps signal of a potential somewhat greater than 10 volts peak-to-peak (actual value unimportant).

b. Adjust the sensitivity of the recorder as instructed in paragraph 93.

c. Depress the INTER S. C.-OUTLET S. C. switch until the pen goes to zero, then release the switch. This causes the pen to approach the desired setting (in this case, 10 on the chart) from a lower value. Allow a 30-second recording.

d. Depress the REC. TEST switch until the pen goes to 95 and then release it. This causes the pen to approach the desired setting from a higher value. Again allow a 30-second recording.

e. Note the horizontal distance between the two traces just made. This distance is the amount of hysteresis at 20 cps and should not exceed .1 of one chart division.

f. Repeat the check at 60, 100, 140, and 180 cps. Different values of hysteresis may be found at different frequencies. Excessive hysteresis is eliminated as explained in paragraph 103*b*.

102. Signal Sensitivity Test

The radiosonde recorder should properly record input signals over its designed frequency range, provided the signal amplitude lies between 10 and 100 volts peak-to-peak. (These are the practical limits to be expected from the usual signal sources. They may be exceeded by certain wave forms for test purposes.) To check the signal sensitivity of the recorder, proceed as follows:

a. Throw the noise suppression switch on the control panel to IN.

b. Adjust the frequency standard to deliver 10 cps; reduce the output voltage to zero, with the attenuator on its panel. The recording should now be along the zero line.

c. By advancing the attenuator on the frequency standard panel, bring up the signal voltage slowly until the recorder pen makes a steady straight line. Note the peak-to-peak input voltage required for this result; it should not exceed 10 volts.

d. Increase the signal voltage to 100 volts peak-to-peak. The pen should continue to record steadily on the same straight line as initially started in *c* above.

e. Select 190 cps as the next test frequency and repeat the test just performed with 10 cps. The results should be the same as those previously required.

f. Throw the noise suppression switch to OUT.

g. Repeat the procedure given in *b*, *c*, and *d* above; the same results should be obtained.

h. Repeat the procedure given in *e* above; the same results should be obtained.

103. Linearity Calibration Test

The radiosonde recordings should be nearly linear with the frequency of the input signal voltage to the converter, in the relationship: Recorder reading=½ frequency. To check the amount of deviation from linearity, and hence the amount by which recorder readings must be corrected, proceed as follows:

a. Rotate the SIGNAL SELECTOR switch to

331892 O—55——7

S. C.; the recorder should record along the zero line.

b. The effect of hysteresis, if any exists, should now be eliminated. Unlock the control panel and draw the recorder forward sufficiently to reach the split gear assembly on the bottom side. 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 its present position for 10 or 15 seconds. Next, force the pen a little to the left, release slowly, and again allow a short recording. If there is any difference between the two recordings, this difference should be centered on the chart zero line by adjusting the REC. ZERO control.

c. Rotate the SIGNAL SELECTOR switch to SIG.

d. Set the frequency standard to deliver a 50-volt peak-to-peak signal at 190 cps. The recording should be at 95; adjust the REF. ADJUST, if necessary.

e. Change the input frequency to 180 cps and allow a 30-second recording. Repeat, in succession, this procedure for all the frequencies available from the frequency standard, in *descending* order. Then repeat them in *ascending* order.

f. Remove these recordings to a flat surface. With a sharp pencil and straight edge draw a straight line between the ends of the two recordings obtained for 180 cps. Use the *center* of the width of the pen traces for terminating points. Determine the center (in length) of this pencil line and determine its horizontal position on the chart; this will be the average of the two 180-cps recordings. The deviation in linearity is the difference between this value and 90; the deviation is plus if this value is greater than 90, and minus if it is less than 90.

g. Repeat this determination of deviation for each pair of recordings made; that is, a value of deviation for each frequency available from the frequency standard.

h. No deviation should exceed a fourth of a chart division.

i. These values of deviation would be applied for correcting any future flight recordings. For example, if a recorder flight reading is 60 and the deviation from linearity at 120 cps is $-.1$ chart division, then a correction of $+.1$ should be applied to the reading for a corrected final reading of 60.1.

j. If a recording lies within a range where corrections are required (determined by the calibration procedure above) but does not fall at any of the chart positions for which deviation figures were obtained, then the amount of correction that should be applied must be interpolated from the deviations obtained for chart positions on each side of the reading to be corrected. For this purpose, it is recommended that the linearity deviations obtained be plotted in terms of corrections versus chart readings. Connect the plotted points by straight lines. Date and retain this curve for future use.

104. Automatic Time-Print Test

This test applies only to Frequency-Time Recorder RD–88A/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 access to the split gear assembly on the bottom side.

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

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

105. General

The circumstances involved in shipment and storage vary; therefore, a definite procedure that applies in all situations cannot be given. The following instructions are intended as a guide for preparing the radiosonde recorder for shipment and storage.

106. Repacking for Shipment or Limited Storage

a. The procedure in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Reverse the instructions given in paragraph 13.

b. To prevent possible fouling of the pen by dried ink, remove and discard any ink remaining in the barrel, prior to packaging for any purpose. Perform the cleaning and reassembly procedure given in paragraph 48*b*(6).

c. Whenever practicable, place a dehydrating agent such as silica gel inside the packing. Protect the equipment with a waterproof paper barrier. Seal the seams of the paper barrier with a waterproof sealing compound or tape. Pack the protected equipment in a padded wooden case; provide at least 3 inches of excelsior padding or similar material between the paper barrier and the outer packing case.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

107. General

The demolition procedures outlined in paragraph 108 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

108. Methods of Destruction

a. Smash. Smash the controls, tubes, coils, switches, capacitors, transformers, loudspeaker, and printing mechanism; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut cords and wiring; use axes, handaxes, or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades. When time is very limited, incendiary grenades are most effective.

d. Bend. Bend panels, cabinets, and chassis.

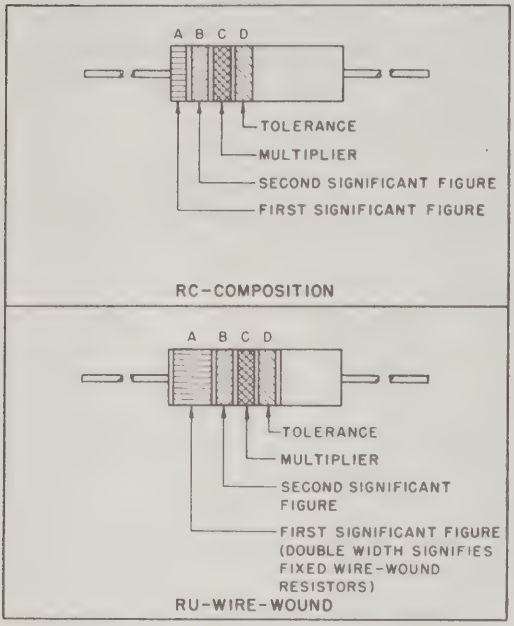
e. Explode. If explosives are necessary, use firearms, grenades, or TNT.

f. Dispose. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

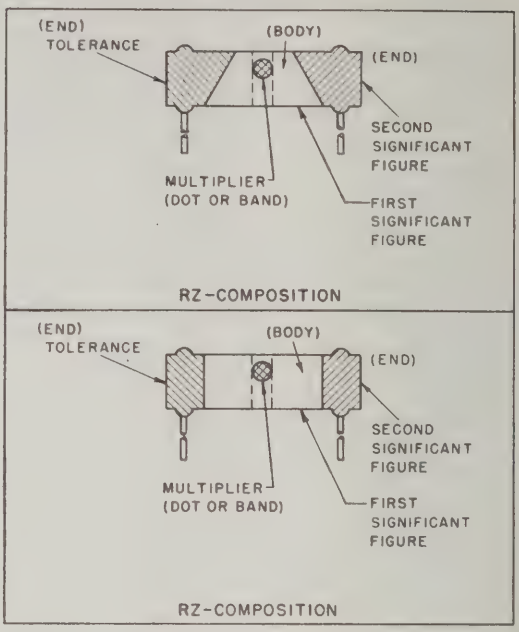
g. Destroy. Destroy everything.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)



RADIAL-LEAD RESISTORS (UNINSULATED)



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

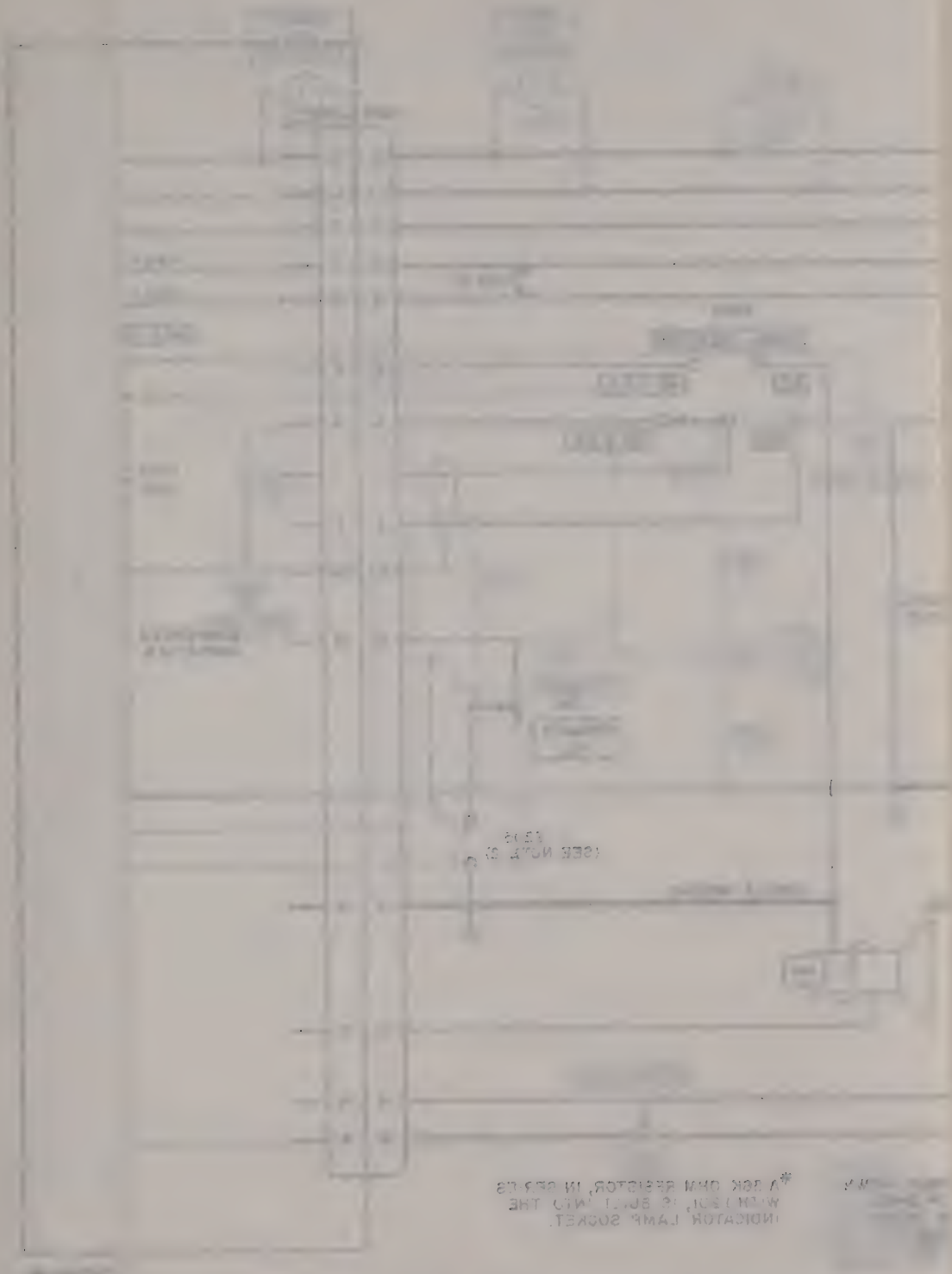
*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT. YELLOW BAND A, PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT. ORANGE BODY; BLACK END, RED DOT OR BAND; SILVER END.

STD-R1

Figure 69. Resistor color codes.



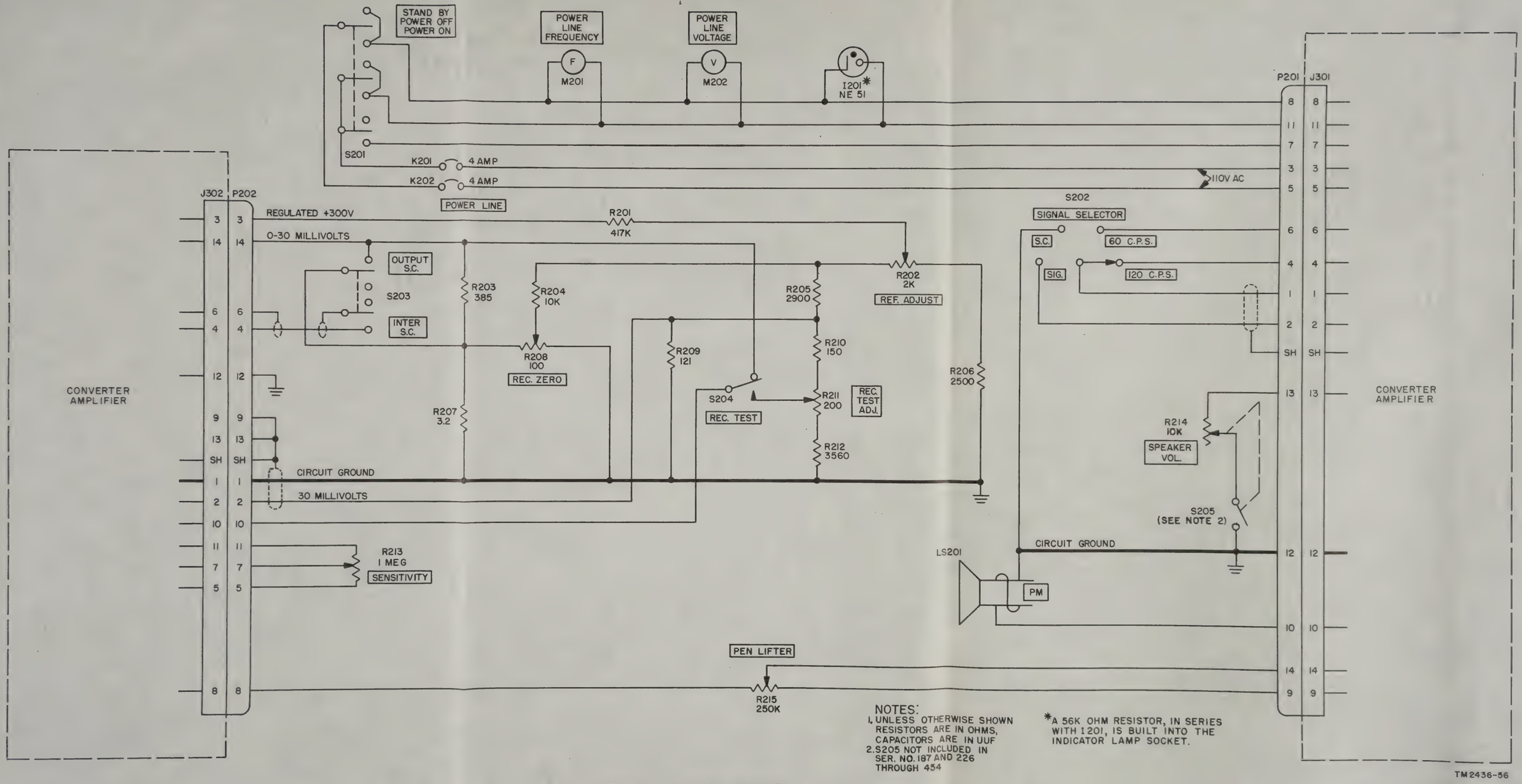


Figure 78. Control Panel C–834/TMQ–5, schematic diagram.



CONTROL PANEL

2 SH 1 12 10 3 5 6 4 11 7 14 8 9 13 P202

2 SH 1 12 10 3 5 6 4 11 7 14 8 9 13 J302

CONTROL PANEL

P201 10 SH 2 1 13 12 6 4 11 3 7 5 9 14 8

J301 10 SH 2 1 13 12 6 4 11 3 7 5 9 14 8

REGULATED +300 V

J328

CATHODE FOLLOWER V301 (1/2) 12AU7

R306 2.5MEG

NOISE SUPPRESSION DIODE V301 (1/2) 12AU7

R307 1MEG

J306

R304 250K

CATHODE FOLLOWER V302 (1/2) 12AX7

R311 330K

CLIPPER AMPLIFIER V302 1/2 12AX7

J309

R312 1.5MEG

R315 39K

C304 1000

J311

R316 100K

R318 10K

C305 330

J312

C301 .25 UF

J303

R302 2.2MEG

J304

OUT

IN

S301 NOISE SUPPRESSION SWITCH

C303 .25UF

C334 68

R309 3.3 MEG

J308

VOLTAGE DISCRIMINATOR V303 (1/2) 12AU7

J310

VOLTAGE DISCRIMINATOR V303 (1/2) 12AU7

R313 27K

R314 50K

R317 250K

R301 120K

R303 180K

J307

C302 .02UF

R305 220K

R308 390K

R310 560K

POSITIVE SELECTOR STRETCHER V304 (1/2) 12AT7

C307 .05UF

T301 10KΩ 3.2Z

AUDIO OUTPUT V304 (1/2) 12AT7

R319 470K

C306 .05UF

J313

R320 1MEG

R321 22K

R328 1.5 MEG

R323 56K

R327 56K

C308 100

R324 220K

C309 1000

J315

UNIVIBRATOR V305 12AT7

J316

R330 180K

R325 100K

J318

R326 250K

R322 1K

R329 220

J317

R331 100K

C310 1400

OUTPUT GATE V307 12AT7

L301 49.3H

C312 5 UF

C314 25UF

VOLTAGE SWITCH V306 12AT7

J314

C311 25 UF

C313 25 UF

R332 22K

-12.6 V

REGULATED -175 V

J305

V305 V304 V309 J327 V308 V306 V307

R353 680K R354 680K R355 680K R356 680K R357 680K R358 680K

E301 NE2 E302 NE2 E303 NE2 E304 NE2 E305 NE2 E306 NE2

C331 500 C332 500

REGULATED +300 V

C317 .5UF

R359 560K

C325 500

C333 1UF

R338 560K

J320

R341 1MEG

R344 1MEG

C321 220

J321

C319 .01UF

C320 .01 UF

C322 .01 UF

J322

J323

J325

R347 220K

R348 1MEG

R352 270K

R349 100K

C324 .1UF

J324

C323 .01 UF

C327 500

VIBRATOR INVERTER G301

W301

T302

R336 8200

R333 2K

R335 2K

R334 2K

C315 8UF

C315 8UF

C315 8UF

1ST VOLTAGE AMPLIFIER V308 (1/2) 12AY7

2D VOLTAGE AMPLIFIER V308 (1/2) 12AY7

3D VOLTAGE AMPLIFIER V309 (1/2) 12AX7

4TH VOLTAGE AMPLIFIER V309 (1/2) 12AX7

LINE-COMPENSATING FEEDBACK V310 (1/2) 12AX7

5TH VOLTAGE AMPLIFIER V310 (1/2) 12AX7

R345 1MEG

R360 1MEG

R337 10K

R339 1MEG

R340 10K

R342 1MEG

R343 3900

C335 500

C336 500

R346 1800

R350 1MEG

R351 2700

J326

V301 V302

V303 V310

C329 500

C330 500

NOTE:
UNLESS OTHERWISE SHOWN:
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UUF

2 SH 3 8 7 11 12 4 9

2 SH 3 8 7 11 12 4 9

P301 10 1 14 13

J102 10 1 14 13

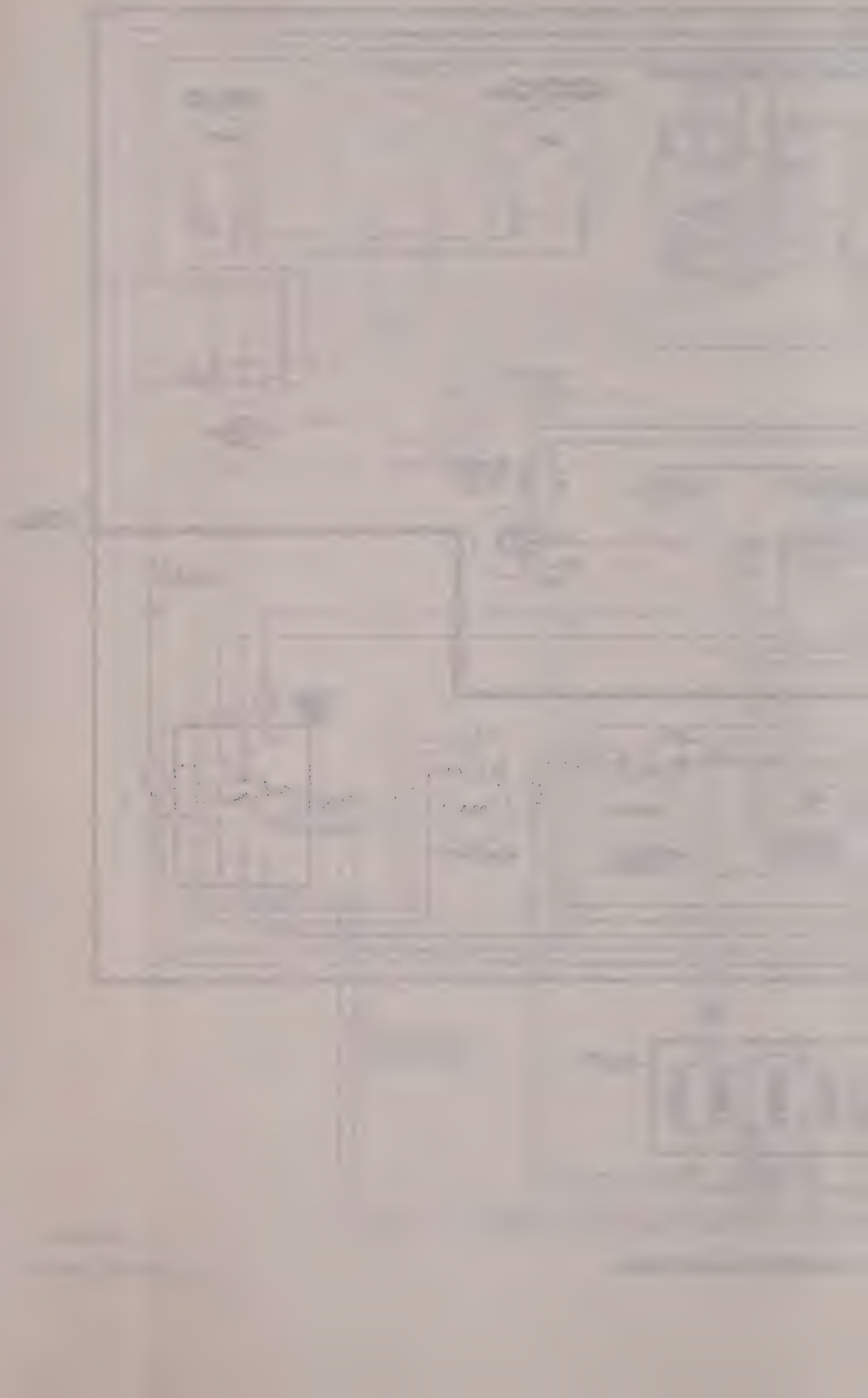
CABINET

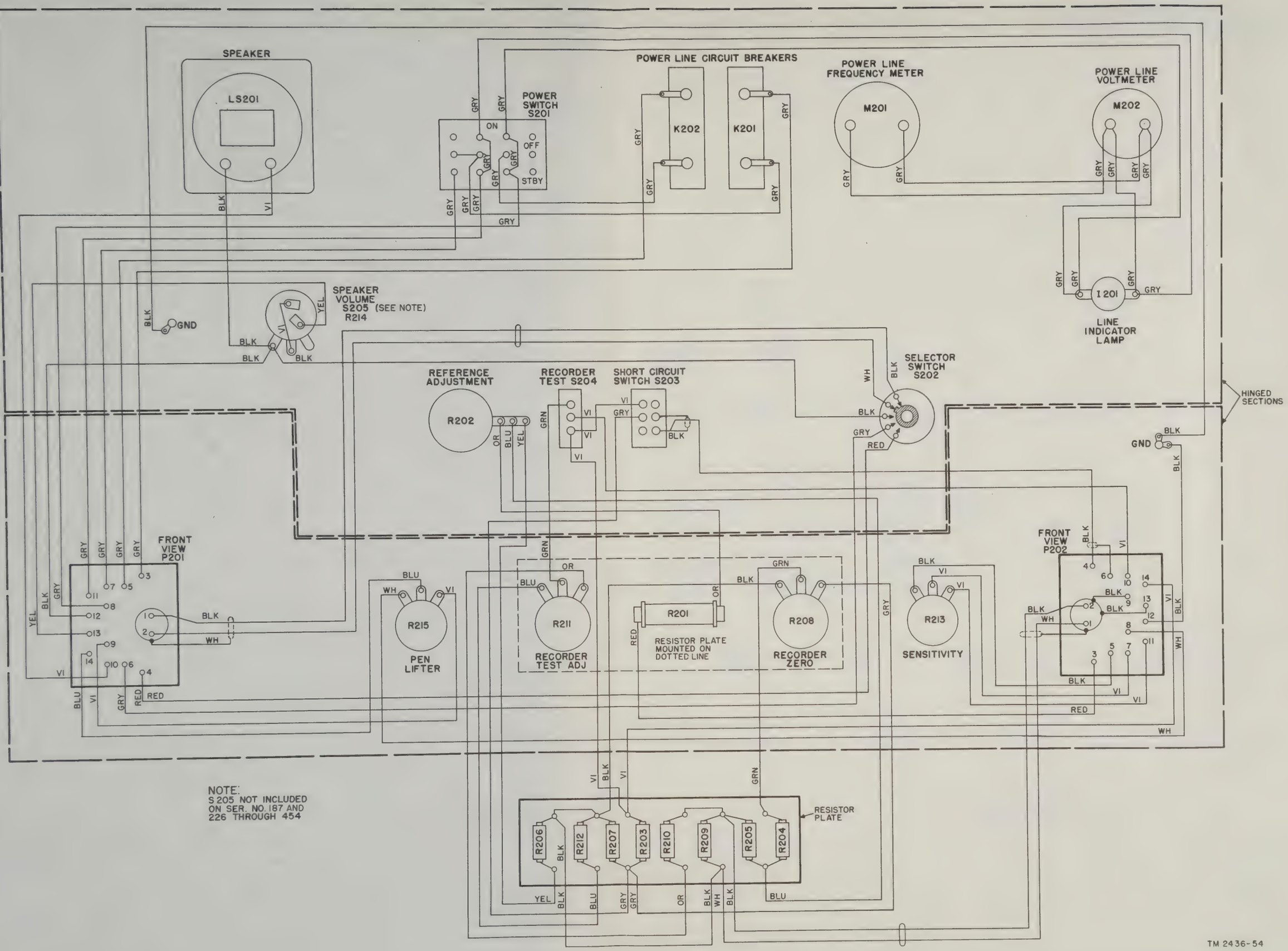
P302 3 5 4 10 6 11 9 12 7 8 13 1 2 14

J103 3 5 4 10 6 11 9 12 7 8 13 1 2 14

CABINET

Figure 77. Signal Data Converter CV-146/TMQ-5, schematic diagram.





NOTE:
S 205 NOT INCLUDED ON SER. NO. 187 AND 226 THROUGH 454

TM 2436-54

Figure 76. Control Panel C–834/TMQ–5, wiring diagram.

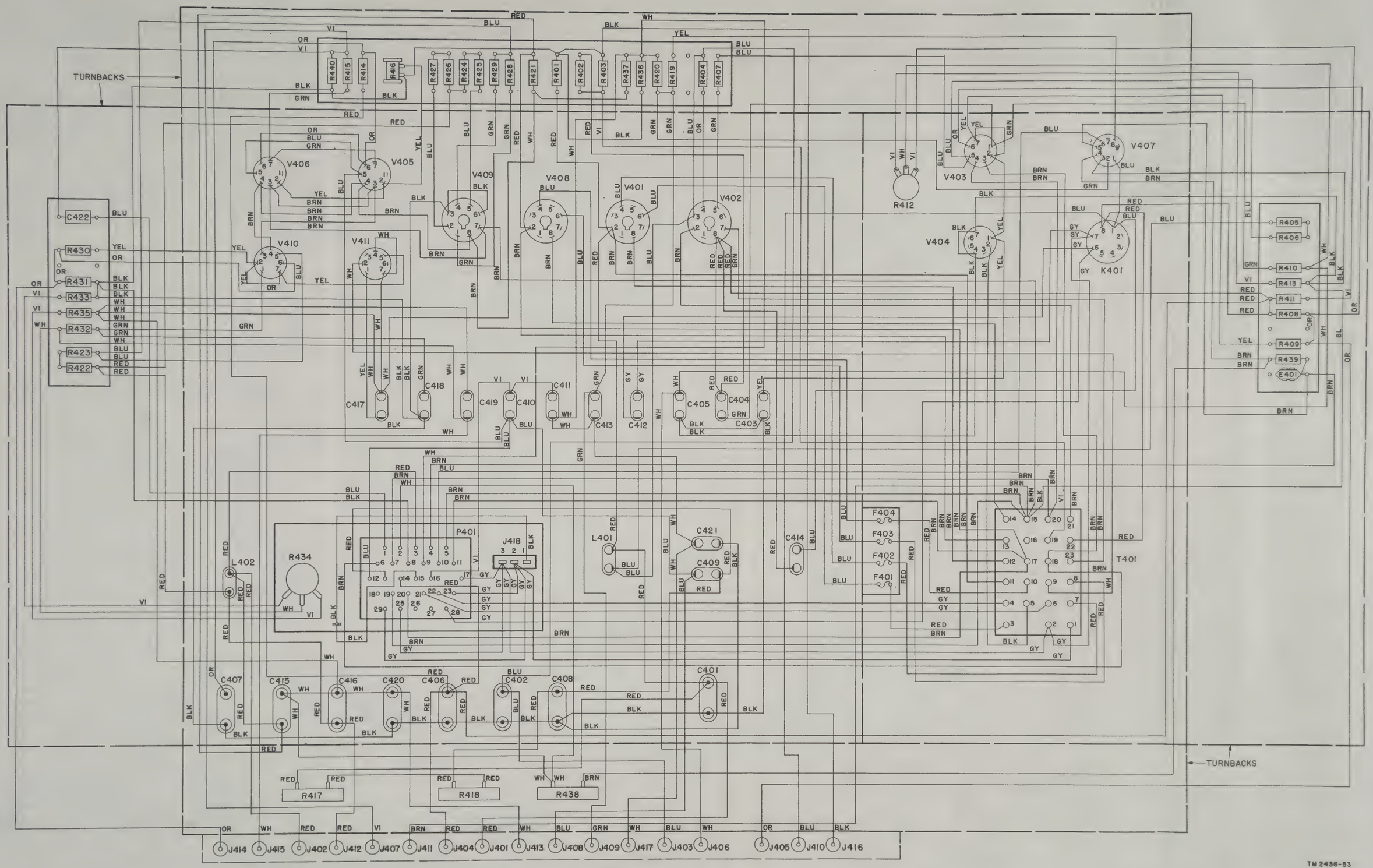


Figure 75. Power Supply PP-968/TMQ-5, wiring diagram.



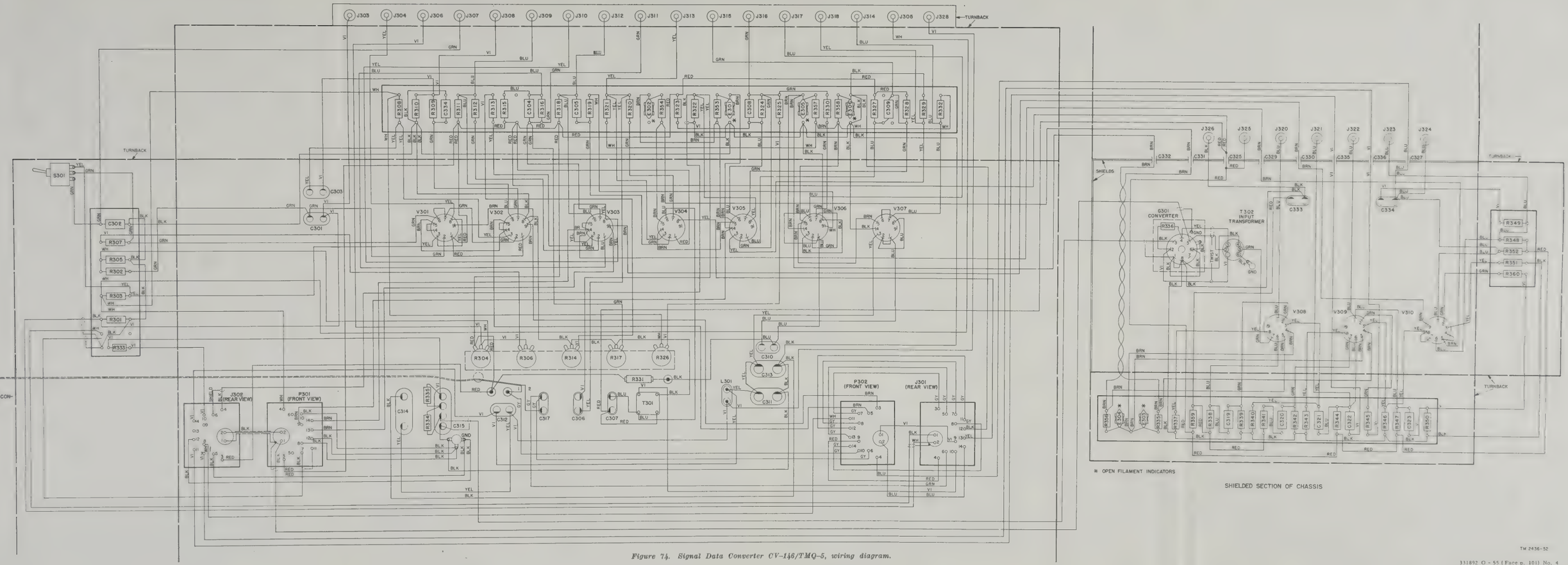
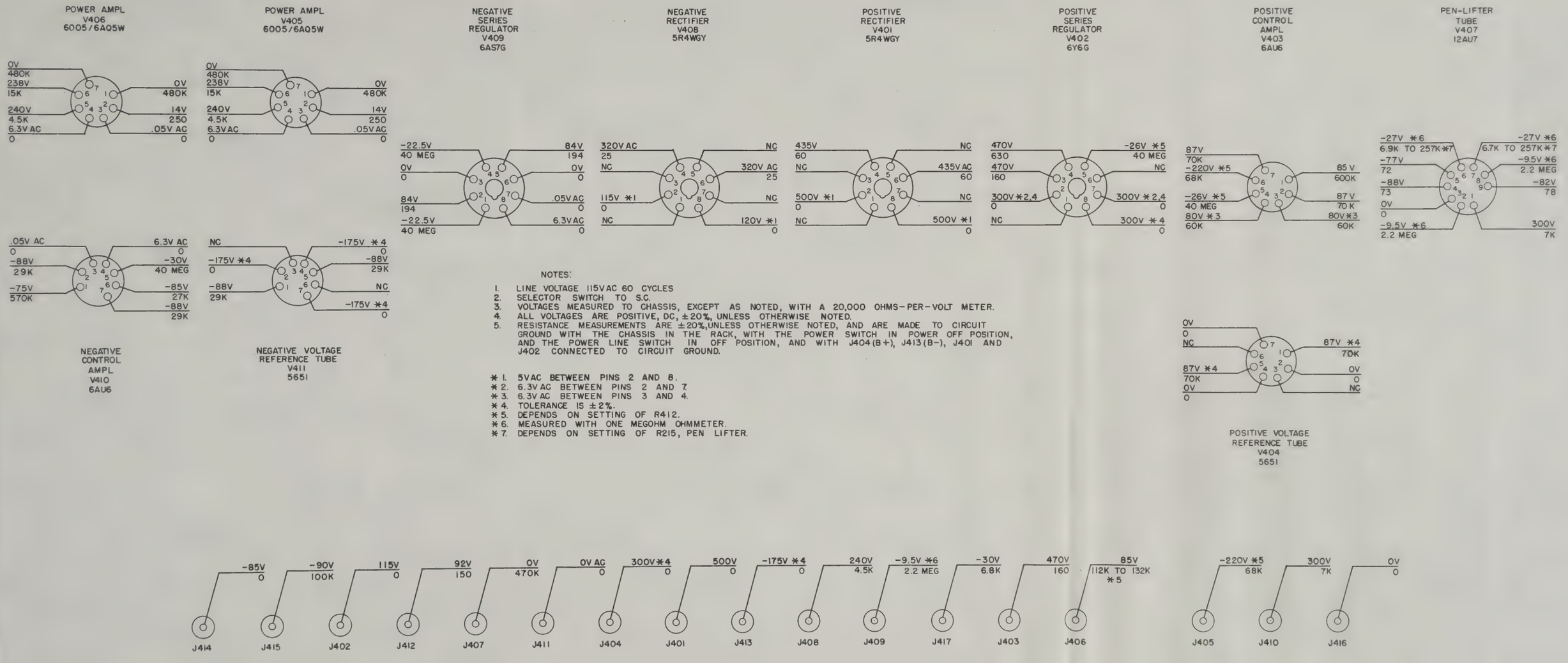


Figure 74. Signal Data Converter CV-146/TMQ-5, wiring diagram.

TOP



NOTES:

1. LINE VOLTAGE 115VAC 60 CYCLES
2. SELECTOR SWITCH TO S.C.
3. VOLTAGES MEASURED TO CHASSIS, EXCEPT AS NOTED, WITH A 20,000 OHMS-PER-VOLT METER.
4. ALL VOLTAGES ARE POSITIVE, DC, ±20%, UNLESS OTHERWISE NOTED.
5. RESISTANCE MEASUREMENTS ARE ±20%, UNLESS OTHERWISE NOTED, AND ARE MADE TO CIRCUIT GROUND WITH THE CHASSIS IN THE RACK, WITH THE POWER SWITCH IN POWER OFF POSITION, AND THE POWER LINE SWITCH IN OFF POSITION, AND WITH J404(B+), J413(B-), J401 AND J402 CONNECTED TO CIRCUIT GROUND.

*1. 5VAC BETWEEN PINS 2 AND 8.
*2. 6.3V AC BETWEEN PINS 2 AND 7.
*3. 6.3V AC BETWEEN PINS 3 AND 4.
*4. TOLERANCE IS ±2%.
*5. DEPENDS ON SETTING OF R412.
*6. MEASURED WITH ONE MEGOHM OHMMETER.
*7. DEPENDS ON SETTING OF R215, PEN LIFTER.

BOTTOM

TM 2436-51

Figure 73. Power Supply PP-968/TMQ-5, voltage and resistance diagram.

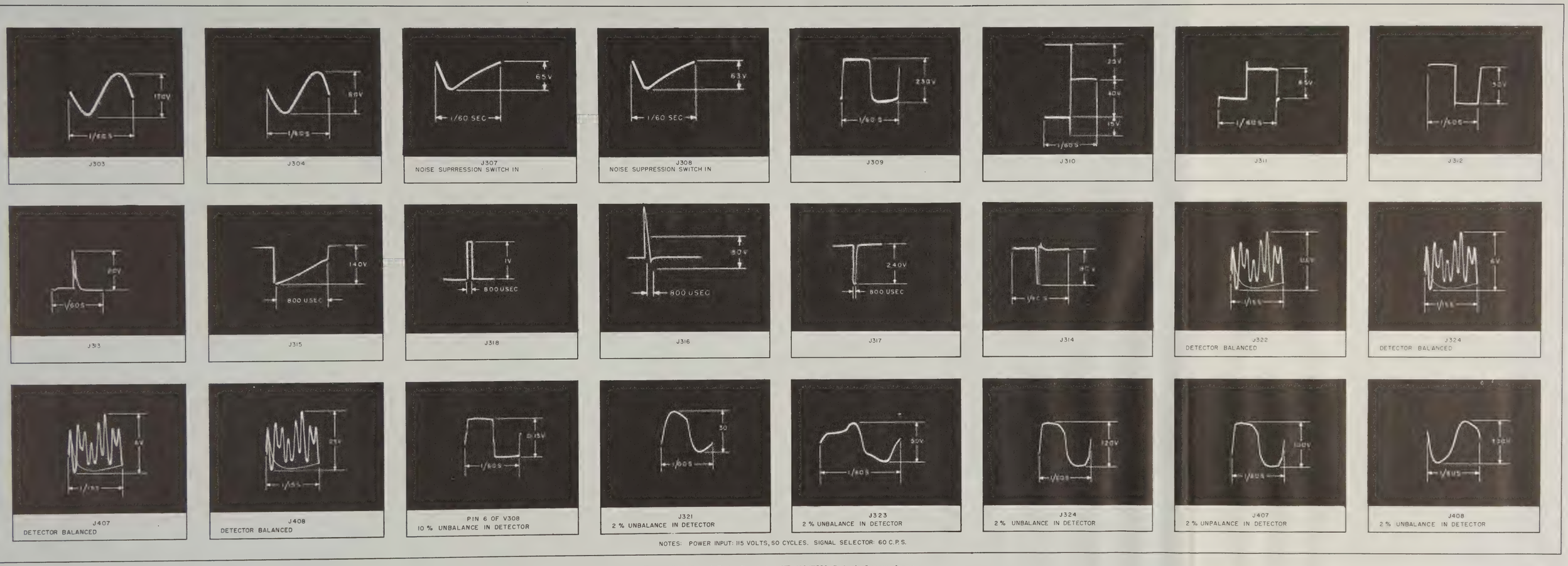


Figure 71. Signal Data Converter CV–146/TMQ–5, typical wave forms.

331892 O - 55 (Face p. 10.) No. 1



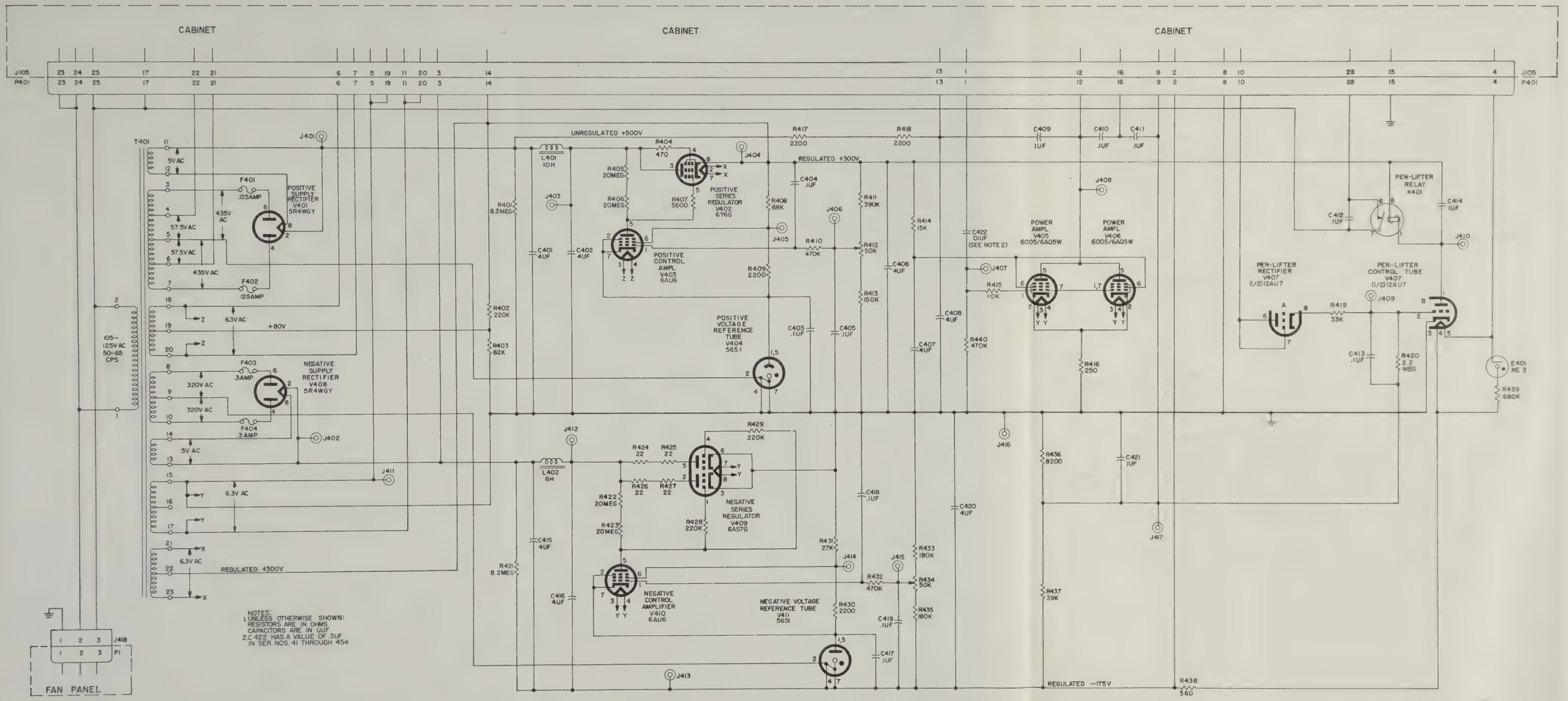
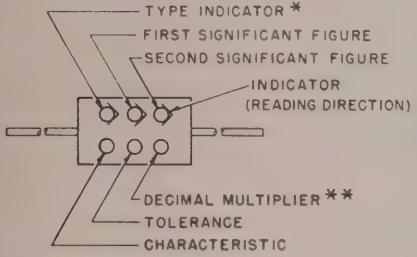


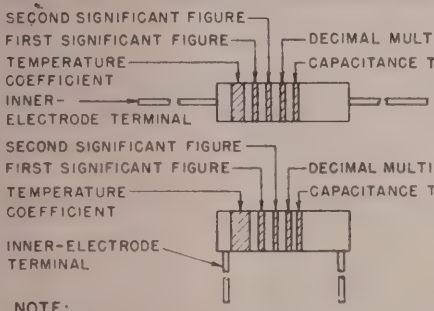
Figure 81. Power Supply PP-968/TMQ-5, schematic diagram.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



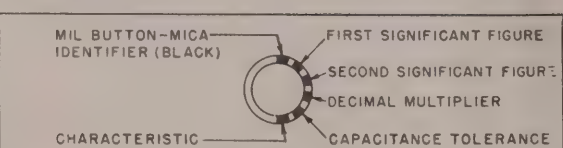
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

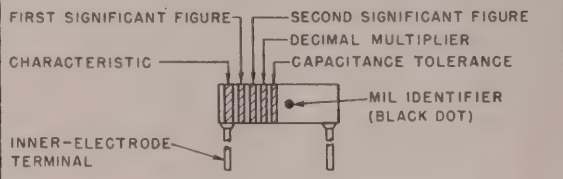


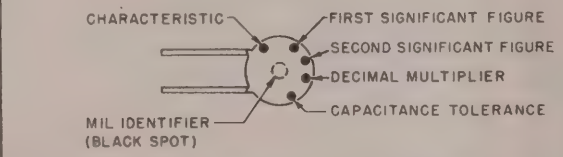
NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



BUTTON-MICA (CB)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 70. Capacitor color codes.

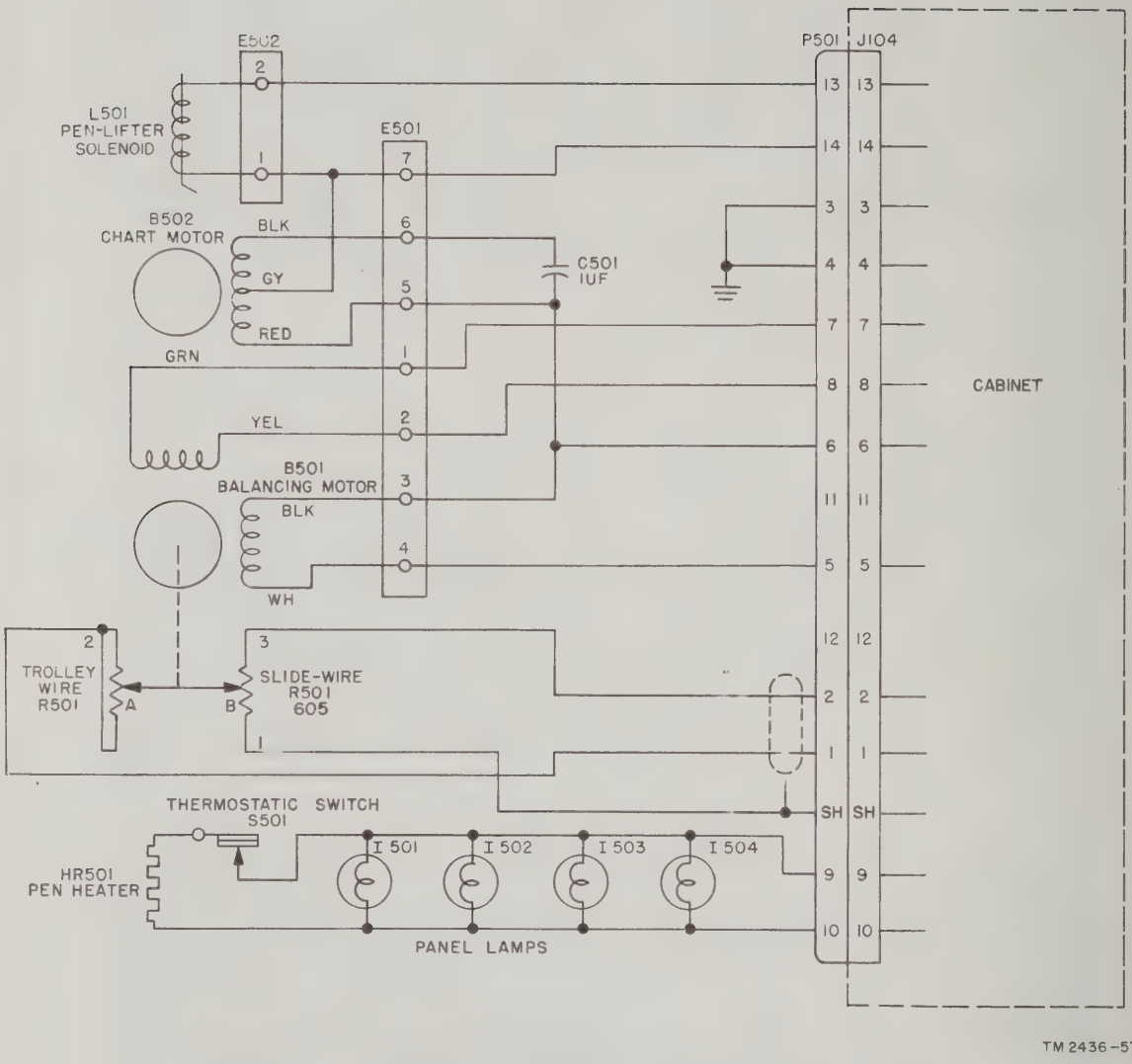


Figure 79. Frequency-Time Recorder RD–88/TMQ–5, schematic diagram.



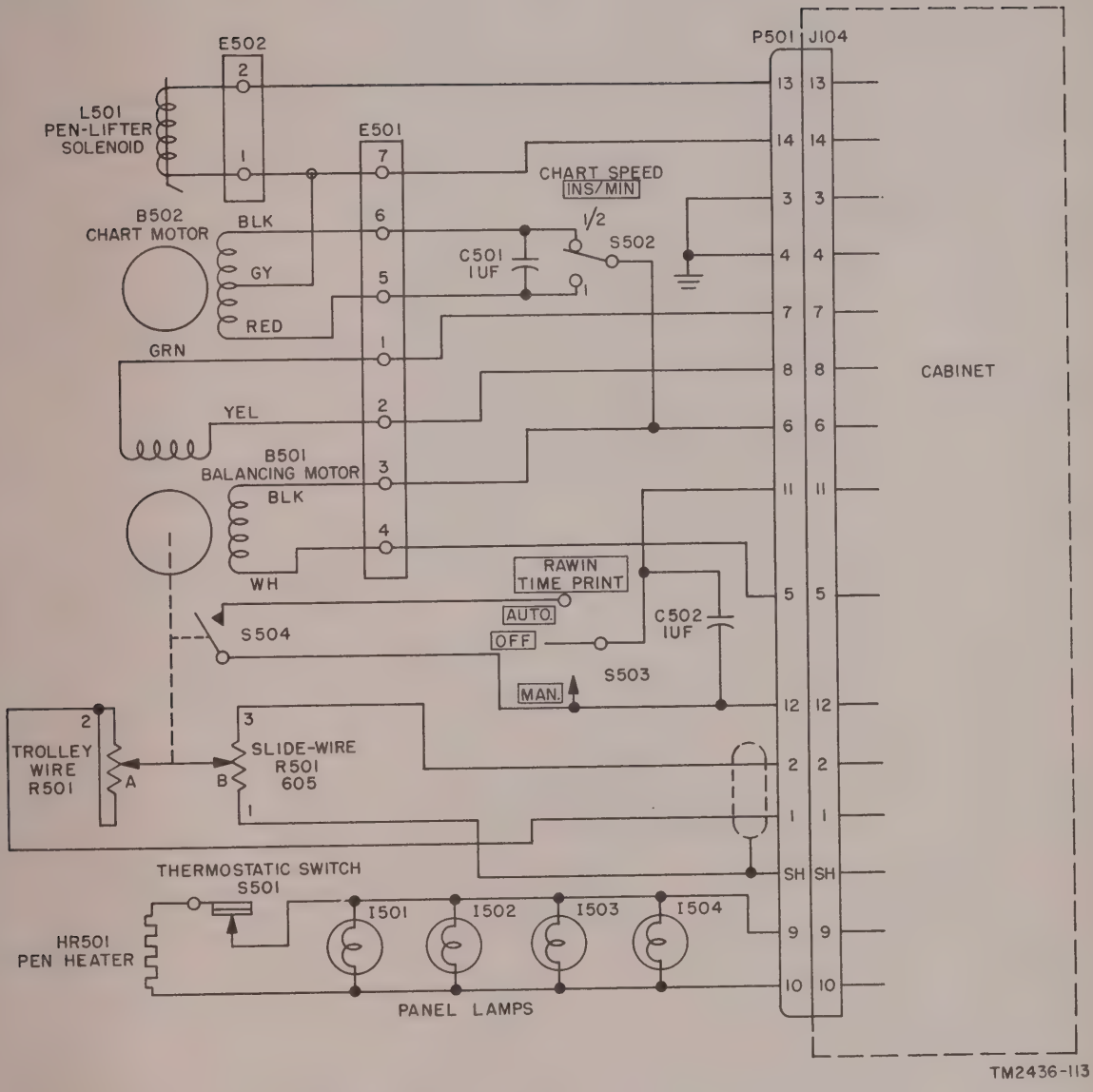


Figure 80. Frequency-Time Recorder RD–88A/TMQ–5, schematic diagram.

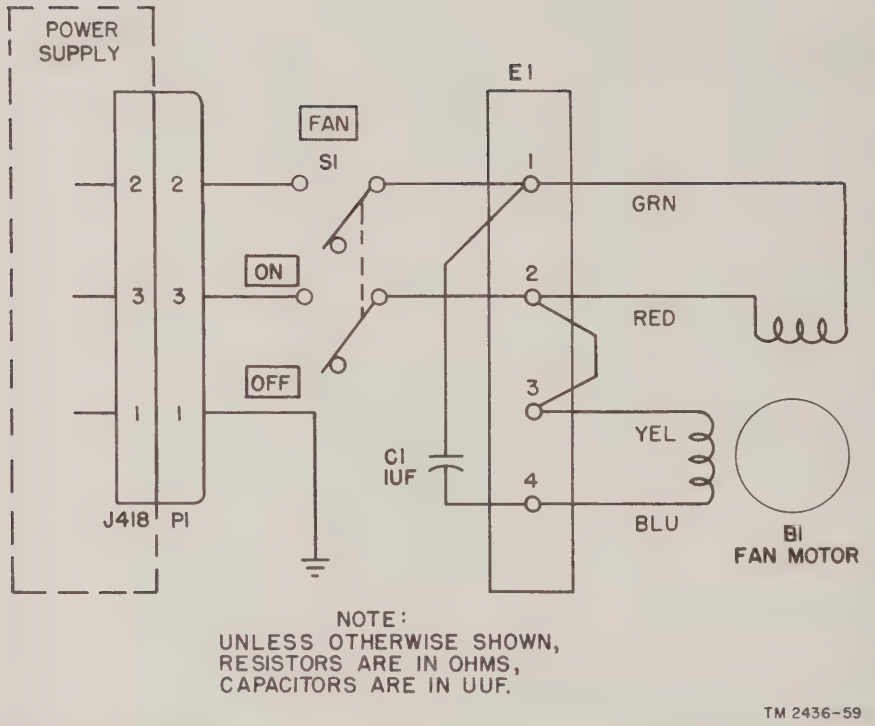


Figure 82. Electrical Equipment Cabinet Subassembly MX–1482/TMQ–5, schematic diagram.

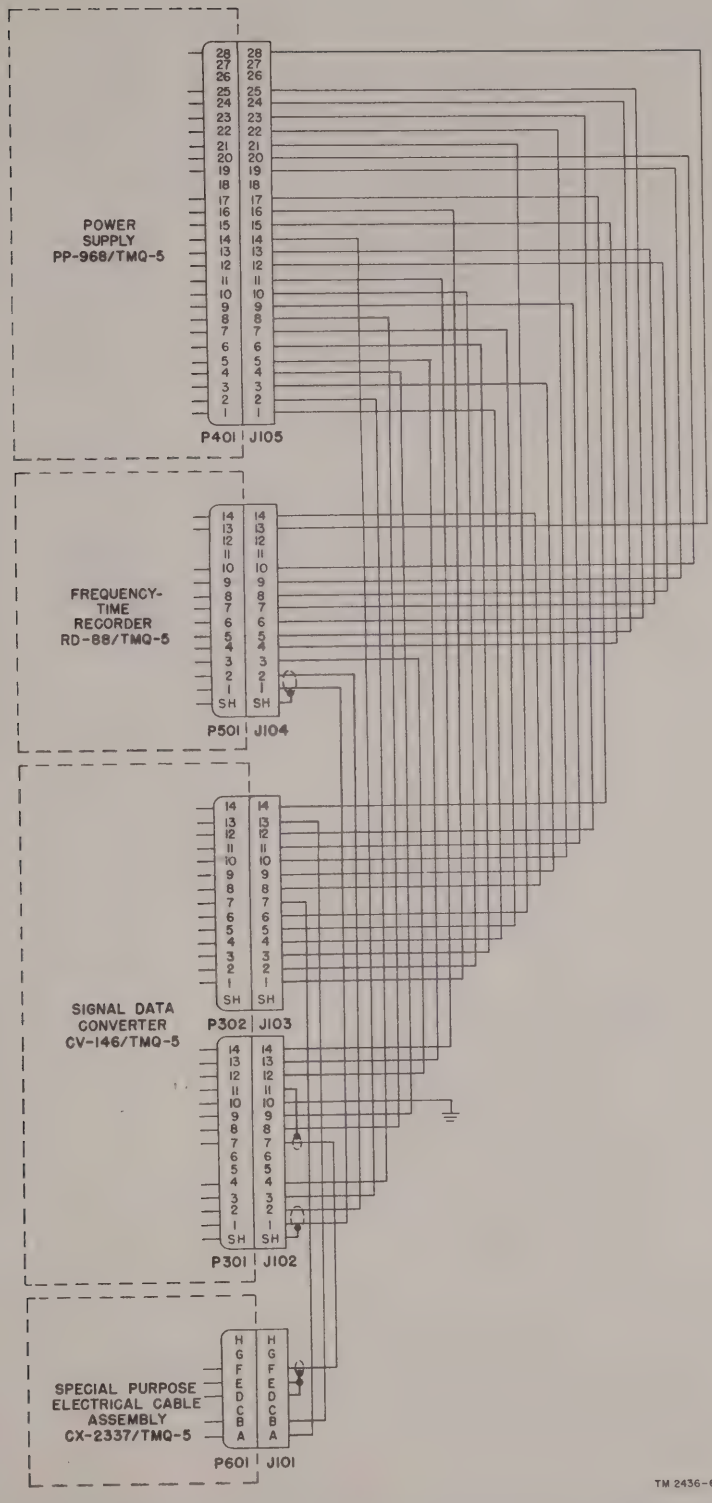


Figure 83. Electrical Equipment Cabinet CY–1390/TMQ–5, schematic diagram.

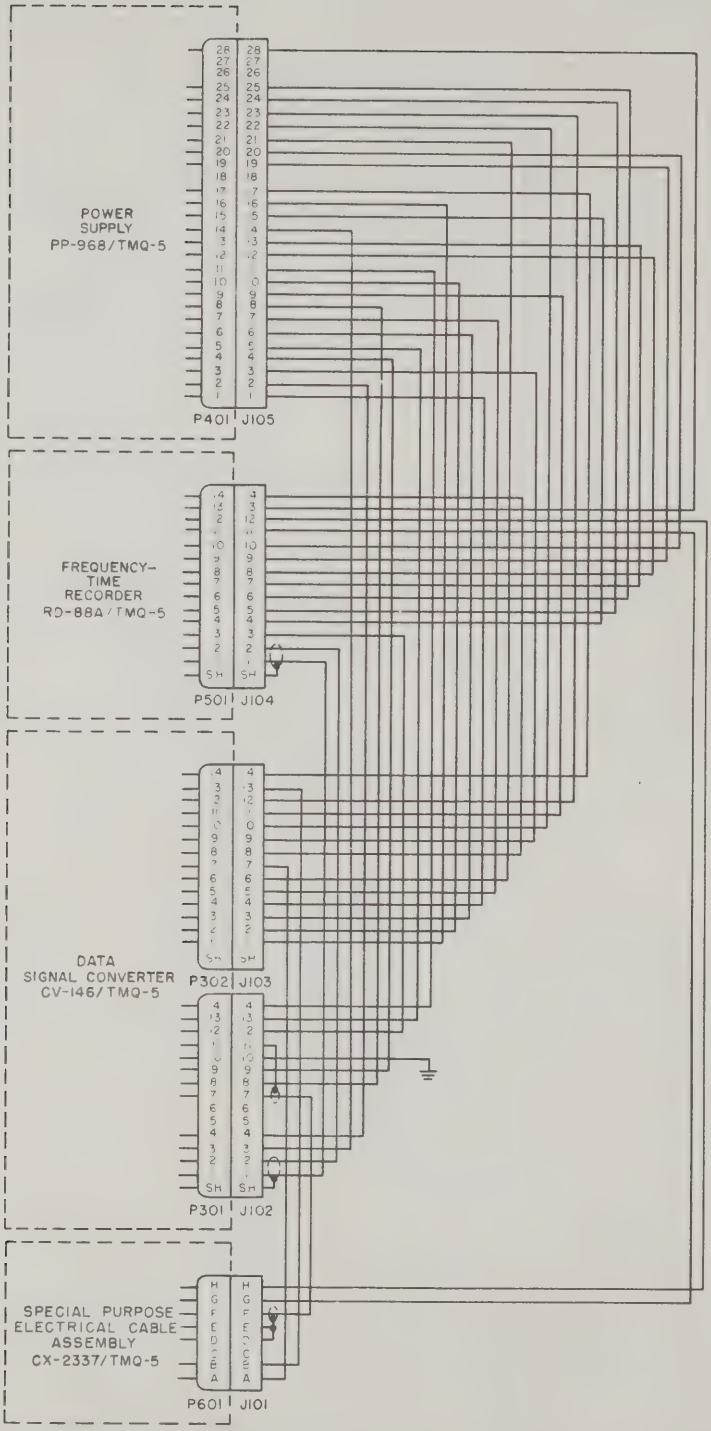


Figure 84. Electrical Equipment Cabinet CY–1390A/TMQ–5, schematic diagram.

INDEX

	Paragraph	Page
Accessories	9*f*	14
Adjustments,		
Chart feed	81	80
Negative regulated power supply	87	91
Pen heater contact bar	16	22
Positive regulated power supply	87	91
Recorder pen	92	95
Sensitivity	93	95
Time print	94	95
Alinements:		
Chart	18	24
Noise suppression diode	90	94
Recorder pen	91	94
Slide and trolley wires	91	94
Univibrator	89	91
Voltage discriminator	88	91
Application, system	4	5
Arctic operation	40	39
Audio output	64	58
Balancing:		
Circuit	68	63
Motor	68*c*	64
Block diagram	57	50
Cables and cabling	19, 44, 79	25, 40, 77
Cathode follower:		
V301A	58	52
V302A	60	55
Characteristics, technical	5	9
Chart:		
Controls and instruments	23	29
Dc resistance of coils, transformers, and motors	83	85
Equipment performance check list	55	47
Packaging data	6	10
Table of components	7	10
Troubleshooting	80	78
Troubleshooting data	76	76
Chart drift	32	35
Chart feed:		
Alinement	81	80
Test	97	96
Chart guide rods	73*a*	73
Chart installation	17	23
Chart, intermittent operation	81*b*	80
Chart:		
Operation	73*a*	73
Speeds	23, 29*b*	29, 33
Check list, performance	55	47
Checks		
Flight	29	33
Ground (preflight)	28	33
Circuit breakers, power	23	29
Clipper amplifier	61	55
Clutch assembly	73*a*(4)	73
Coils, dc resistance	83	85
Cold weather operation	43	40
Common names	8	11
Component:		
Localization	53, 75	46, 75
Sectionalization	53, 75	46, 75
Components, table	7	10
Connections, system	19	25
Control panel	74	74
Controls	23	29
Dc resistance of coils, transformers, and motors	83	85
Demolition	108	99
Descent record	31	35
Descriptions:		
Accessories case	9*f*	14
Balancing motor	57*f*, 68*c*	51, 64
Cabinet	9*e*	14
Control panel	9*a*	11
Converter amplifier	9*b*	11
Detector	57*c*	50
Differences in models	11	15
Fan panel	9*e*	14
Frequency-time recorder	9*c*	11
Measuring circuit	57*d*	50
Pen lifter	57*g*	52
Power supply	9*d*	12
Radiosonde Recorder AN/TMQ–5	9	11
Recorder	57*g*	52
Servo amplifier	57*e*	51
Signal converter	57*b*	50
Simplified	4	5
Desert:		
Maintenance	49*d*	45
Operation	41, 42	39
Destruction methods	108	99
Detector circuit	68	63
Detector, to unbalance	75*c*	75
Differences in models	11	15
Dimensions of packaged sets	6	10
Equipment performance check list	55	47
Evaluation of chart recording	33, 34, 36, 37	35, 36, 37, 38
Evaluator ML–420A/TMQ–5	35	36
Fan panel	9*e*	14
Feedback, line-compensating	69*f*	66
Final testing	95	96
Filling, pen	15	21
Flight check	29	33
Forms and records	2	3
Frequency-time recorder	73	73
Fuse replacement	85	88
Gear replacement	84	85
Ground check	28	33

	Paragraph	Page
Heater, pen	16	22
Hot weather operation	40, 41	39
Hysteresis test	101	97
Inspection, visual	52	45
Installation:		
AN/GMD–1	19	25
R–228/FMQ–2	19	25
SCR–658	19	25
Installation:		
Chart	17	23
Equipment	14	21
Instructions, operating	30	33
Instruments	23	29
Interchangeability of components	11*b*	17
Intermittents	75*b*	75
INTER S.C.-OUTPUT S.C. switch	23	29
Level, significant	33	35
Limited storage	106	99
Linearity test	103	97
Line-compensating feedback	69*f*	66
Localization of trouble	53, 75	47, 75
Loudspeaker	23	29
Lubrication	49	45
Maintenance, preventive	43, 50	40, 45
Measuring circuit	67	61
Meters	23	29
Methods of destruction	108	99
Motor, balancing	68*c*	64
Motors, dc resistance	83	85
Names, common	8	11
Negative power supply	72	69
Adjustment	87*b*	91
Noise control	23	29
Noise suppression diode	59	54
Alinement procedure	90	94
Nomenclature assignments	8	11
Operating instructions	30	33
Operation:		
Arctic climates	40	39
Chart	73*a*	73
Desert conditions	41, 42	39
Recorder pen	73*b*	74
Starting procedure	27	32
Stopping procedure	38	38
Tropical climates	41	39
Operational tests	52–55, 75*b*	45, 75
Output:		
Audio	64	58
Gate	66	60
Packaging data	6	10
Painting	50	45
Panel, control	74	74
Pen:		
Alinement with slide-wire	91	94
Filling	15	21
Heater	16	22
Performance	81	80
Pen-lifter:		
Adjustment	92*c*	95
Control	23	29
Test	100	97
Pen-lifting solenoid	73*b*	74
Performance check list	55	47
Positive:		
Power supply	87*a*	91
Pulse-selector stretcher	63	57
Power amplifier	70	67
Power line:		
Circuit breakers	23	29
Frequency meter	23	29
Voltmeter	23	29
Power requirements	5	9
Power supply:		
Adjustment	87	91
Negative	72*c*	71
Positive	72*b*	70
Power switches	23	29
Preflight check	28, 29	33
Preliminary starting	26	32
Preparatory procedures	24	31
Presetting procedures	25	32
Pressure evaluation	34	36
Preventive maintenance:		
Definition	45	40
Desert	49	45
Forms	47	40
General	46, 48	40, 41
Lubrication	49	45
Painting	50	45
Rustproofing	50	45
Tropical	49	45
Winter	49	45
Purpose of recorder	3*b*	3
Radio Set SCR–658	19*c*	26
Radiosonde:		
AN/AMT–4	4	5
Receiver R–228/FMQ–2	19*a*	25
Recorder AN/TMQ–5:		
Description	9	11
Purpose	3*b*	3
Use	3*c*	3
Systems	4	5
Rawin Set AN/GMD–1	19*b*	25
Reconditioned equipment	20	28
Recorder adjustments:		
Pen lifter	92*b*	95
Recorder:		
Pen	92	95
Test	92*a*	95
Zero	23, 92*a*	29, 95
Record evaluation	53	46
Recorder, frequency-time	73	73
Recorder pen:		
Adjustment	92	95
Difficulties	81	80
Filling	15	21
Heater	16	22
Mechanical alinement	91	94
Operation	73*b*	74
Recorder sensitivity test	102	97
Recorder test:		
Adjust control	23	29
Circuit	67*d*	63
Switch	23	29

	Paragraph	Page
Recorder zero control	23	29
Records	2	3
Reference adjustment	23	29
Repacking for:		
Limited storage	106	99
Shipment	106	99
Replacement:		
Fuses	85	88
Parts	84	85
Split gear assembly	84	85
Tubes	86	88
Report forms	2	3
Resistance measurements	83	85
Running spares	10	15
Rustproofing	50	45
Sectionalization of trouble	53, 75	46, 75
Sensitivity:		
Adjustment	93	95
Control	23	29
Servo amplifier	67, 68	61, 63
Shipment	106	99
Shop Van M–109	21	28
Signal:		
Requirements	5	9
Selector switch	23, 56	29, 50
Significant levels	33	35
Siting	12	18
Slide and trolley wires, mechanical alinement	91	94
Solenoid, pen-lifting	73*b*	74
Spares, running	10	15
Speaker:		
Output test	98	96
Volume control	23	29
Special tools	44	40
Standard test conditions	96	96
Starting procedure	26, 27	32
Stopping procedure	38	38
Storage, limited	106	99
Support MT–1335/TMQ–5	21	28
System:		
Application	4	5
Connections	19	25
Sectionalization	53	46
Table of components	7	10
Technical characteristics	5	9
Temperature-Humidity Evaluator ML–420A/AMT–4	35	36
Test:		
Chart feed	97	96
Hysteresis	101	97
Linearity of recorder	103	97
Pen:		
Lifter	100	97
Performance	99	96
Sensitivity of record	102	97
Speaker output	98	96
Test cables	44	40
Connection	79	77
Test equipment	77	77
Theory:		
Audio output	64	58
Balancing circuit	68	63
Cathode follower:		
V301A	58	52
V302A	60	55
Clipper amplifier	61	55
Detector circuit	68	63
Gate, output	66	60
Line-compensating feedback	69*f*	66
Measuring circuit	67	61
Noise-suppression diode	59	54
Output gate	66	60
Pen-lifter circuit	71	68
Positive pulse-selector stretcher	63	57
Power:		
Amplifier	70	67
Supply	72	69
Recorder	73	73
Univibrator	65	58
Voltage:		
Amplifiers	69	65
Discriminator	62	56
Switch	66	60
Thermostat	16*a*, 73*b*(3)	22, 74
Time print	30*e*	35
Adjustment	94	95
Tools	43, 44	40
Transformers, dc resistance	83	85
Tropical:		
Maintenance	49	45
Operation	41	39
Troubleshooting:		
Chart	55, 80	47, 78
Data	76	76
Precautions	78	77
Procedures	53, 75	46, 75
Test equipment required	77	77
Tube replacement	86	88
Univibrator, theory	65	58
Adjustment	89	91
Unpacking	13	18
Unsatisfactory report forms	2	3
Used equipment	20	28
Use of recorder	3*c*	3
Van, Shop, M–109	21	28
Visual inspection	52, 72*b*	45, 69
Voltage:		
Amplifiers	69	65
Discriminator	62	56
Alinement	88	91
measurements	75*d*	76
switch	66	60
Wave forms	75*c*	75
Weatherproofing	49	45
Winter maintenance	49	45
Zero adjustment	92*a*	95
Zero adjustment circuit	67*d*	63

By order of the Secretaries of the Army and the Air Force:

M. B. RIDGWAY,
General, United States Army,
Chief of Staff.

Official:
JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General.

N. F. TWINING,
Chief of Staff, United States Air Force.

Official:
E. E. TORO,
Colonel, United States Air Force,
Air Adjutant General.

Distribution:

Active Army:

Tec Svc, DA (1)
Tec Svc Bd (1)
CONARC (5)
CONARC Bd (Incl ea Test Sec) (1)
Army AA Comd (2)
OS Maj Comd (5)
OS Base Comd (5)
Log Comd (5)
MDW (1)
Armies (5)
Corps (2)
Tng Div (2)
Ft & Cp (2)
Gen & Br Svc Sch (5)
SigC Sch (25)
USMA (5)
Gen Depots (2)
SigC Sec, Gen Depots (10)
SigC Depots (20)
POE (2)
OS Sup Agencies (2)
SigC Fld Maint Shops (3)
SigC Lab (5)
Mil Dist (1)
Units organized under following TOE's:
6–576, Hq & Hq Btry, FA Obsr Bn (2)
11–127, Sig Rep Co (2)
11–128A, Sig Depot Co (2)
11–500A (AA–AE), Sig Admin Teams (2)
11–587A, Sig Base Maint Co (2)
11–592A, Hq & Hq Co, Sig Base Depot (2)
11–597A, Sig Base Depot Co (2)
44–12A, Hq & Hq Btry AAA Gp (2)
Units organized under following TOE's—Continued
44–16A, Hq & Hq Btry AAA Bn, 90mm Gun (2)
44–36A, Hq & Hq Btry, AAA Bn Lt, 75mm, Mbl (2)
44–101A, Hq & Hq Btry, AAA Brig (2)
44–112, Hq & Hq Btry, AAA Gp, Static-ConUS (2)
44–116, Hq & Hq Btry, AAA Gun Bn, 120mm Gun (2)
44–201, Hq & Hq Btry AAA Brig Static-ConUS (2)
44–316, Hq & Hq Btry, AAA Bn, 90mm Gun, ConUS (2)
44–416, Hq & Hq Btry, AAA Gun Bn, 120mm Static (2)

NG: Same as Active Army except allowance is one copy for each unit.
USAR: None.
Unless otherwise noted, distribution applies to ConUS and overseas.
For explanation of abbreviations used, see SR 320–50–1.

U. S. GOVERNMENT PRINTING OFFICE: 1955 O—331892