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SECURITY INFORMATION

# OPERATION AND MAINTENANCE FOR Y-10980 TELEMETERING RECEIVING STATION

Bendix Aviation Corporation
Pacific Division
NORTH HOLLYWOOD, CALIF.

[redacted]

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DLM-17
AFSWP-221

# OPERATION AND MAINTENANCE

# FOR

# Y-10980 TELEMETERING RECEIVING STATION

PACIFIC DIVISION DEVELOPMENT LABORATORIES
Bendix Aviation Corporation
North Hollywood, California

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# OPERATION AND MAINTENANCE

# FOR

# Y-10980 TELEMETERING RECEIVING STATION

## INTRODUCTION

Six Bendix Y-10980 telemetering receiving stations have been installed in three USAF mobile trailer, Meteor Motor type K-35, (See Figure 1) and the purpose of this instruction manual is to facilitate the operation and maintenance of these stations and trailers.

The trailers are designated as trailer No. 1, USAF 091088; trailer No. 2, USAF 091100; and trailer No. 3, USAF 091133. Trailer No.'s 1 and 2 are equipped with two complete and independent telemetering receiving stations, each station capable of receiving four separate telemetering channel frequencies. Each station consists of one control cabinet and four receiving cabinets, each of the four containing a crystal-controlled receiver. Trailer No. 3 differs in that it is equipped with one four-channel station, plus one two channel station which is intended to be used as a standby emergency station. This standby station differs from the others in that it consists of only two receiving cabinets. The receivers are tuneable, making it possible to use either of these channels in place of any one of the twenty crystal-controlled channels in the eventuality that a failure occurs. The receiving stations are numbered the same as the trailer in which they are installed with the added designation of "R" or "L" for right or left station.

This manual is divided into two parts: Part I, Y-10980 Telemetering Receiving Station which will deal with the Y-10980 station. Part II, Mobile Telemetering Receiving Trailer will cover the installation external to the Y-10980 stations.

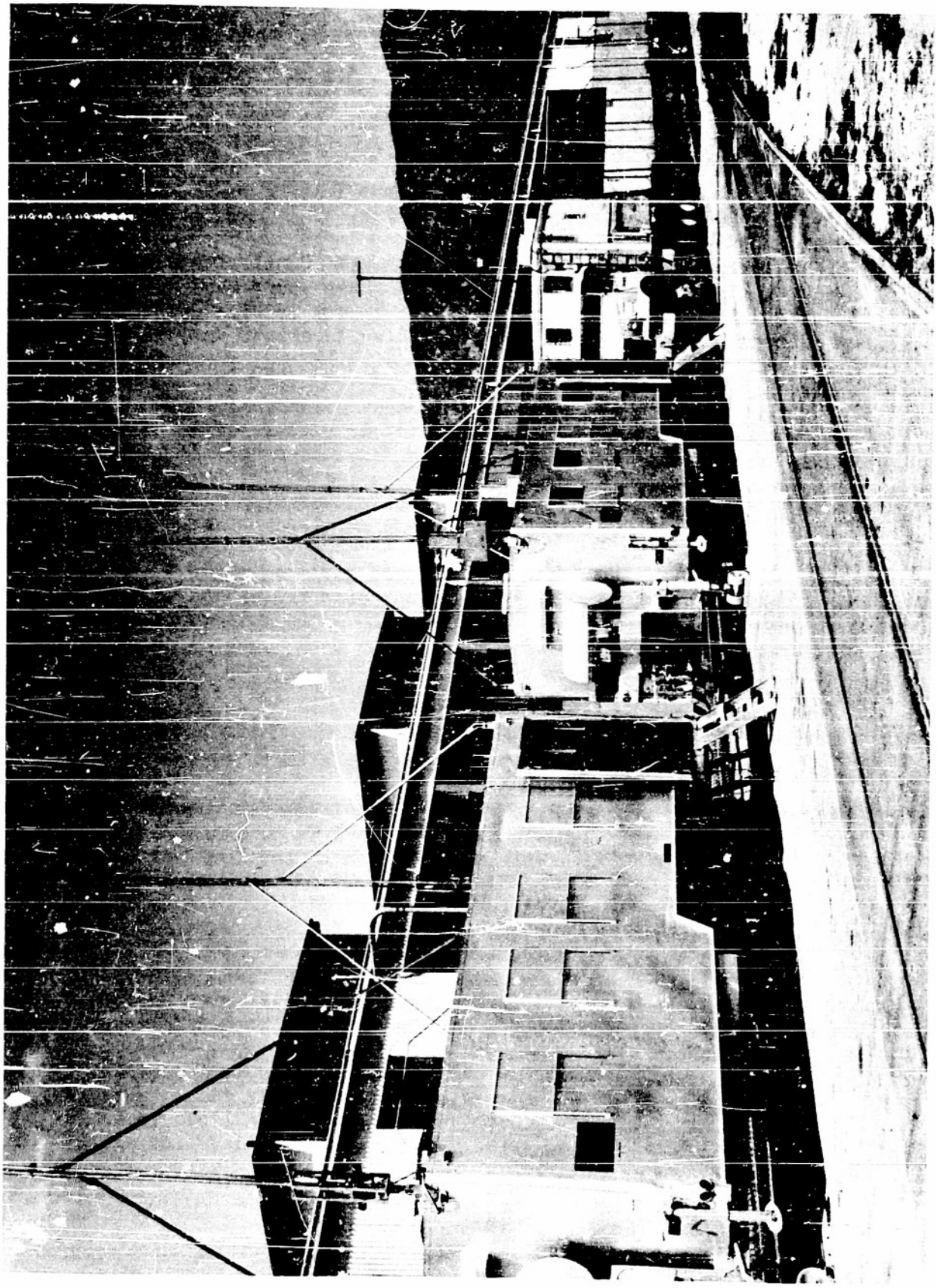


Figure 1 - TRAILER EXTERIOR

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PART I

SECTION I

GENERAL DESCRIPTION

## 1.0 Purpose and Description

### Purpose

The Bendix Y10980 Telemetering Receiving Station provides a reliable system for receiving, demodulating and recording telemetered data. The engineering features embodied in this equipment combine to produce an unusually high degree of reliability, accuracy, flexibility and easeof operation.

Bendix telemetering receiving stations are designed to receive frequency modulated radio signals employing continuous or commutated subcarriers, the frequency of each subcarrier being varied in accordance with the quantity being measured (FM/FM telemetering system). A maximum of four radio frequency signals each modulated with three subcarriers can be received and recorded simultaneously on the Y-10980 Receiving Station.

The station receives signals in the frequency range from 235 to 260 megacycles per second which have been frequency modulated by up to three audio subcarriers. After detection, the audio subcarriers are separated by band pass filters. Each subcarrier is then fed to an audio discriminator. The output of each discriminator is an electrical signal whose sense and magnitude is a function of the deviation of the subcarrier from its nominal center frequency.

The output signals are recorded by means of galvanometer oscillographs.

Frequency determining and filter components are supplied for a nominal modulation range of $\pm 7\frac{1}{2}\%$ of center frequency. The subcarrier center frequencies employed in this station are:

| | |
|---|---|
| Band 1 | 7.35KC |
| Band 2 | 10.5KC |
| Band 3 | 14.5KC |

Other modulation bandwidths and subcarrier frequencies may be employed by substitution of the proper frequency determining and filter components.

Integral vacuum-tube voltmeter, oscilloscope, and channel selector switches permit visual monitoring of any subcarrier channel. A variable-frequency oscillator and a counter-type frequency meter provide rapid station calibration and subcarrier frequency measurements. Individual channel controls permit independent selection and adjustment of each channel.

1.2 Station Layout - See Figure 2 and 3

The telemetering receiving station consists of four 68 in. cabinets, one 44" cabinet, and two oscillographs. One voltage regulator is supplied for each two receiving stations as these stations were specifically designed to mount two stations to a trailer.

A station assembly is shown in Figure 4. The first three receiver cabinets are identical and provide mountings for the following units in each cabinet:

| | |
|---|---|
| Regulated Power Supply | 1 |
| FM Receiver | 1 |
| Subcarrier Amplifier | 1 |
| Discriminators | 3 |
| Low Pass Filter Chassis | 1 |
| Blower Panel | 1 |

The fourth cabinet provides mountings for:

| | |
|---|---|
| Monitor Panel | 1 |
| FM Receiver | 1 |
| Subcarrier | 1 |
| Discriminators | 3 |
| Low Pass Filter Chassis | 1 |
| Blower Panel | 1 |

The 44" cabinet provides mountings for:

| | |
|---|---|
| Frequency Meter | 1 |
| Audio Oscillator | 1 |
| Oscillograph Control Panel | 1 |
| Master Power Panel | 1 |
| Small Blowers | 2 |

1.3 Physical Characteristics

Construction: Heavy gage, welded chassis and cabinets. Standard 19 inch width rack mounting panels. All units are supported on slide assemblies and fitted with handles permitting convenient withdrawal for inspection and maintenance. In addition some units can be tilted 90° when withdrawn from the cabinet to further improve the accessibility. Units are locked into position by a hinged bar which folds over the edge of the front panels. Dzus Fastener Locks permit convenient release.

Finish: Black wrinkle finish with chromium trim and permanently engraved lettering.

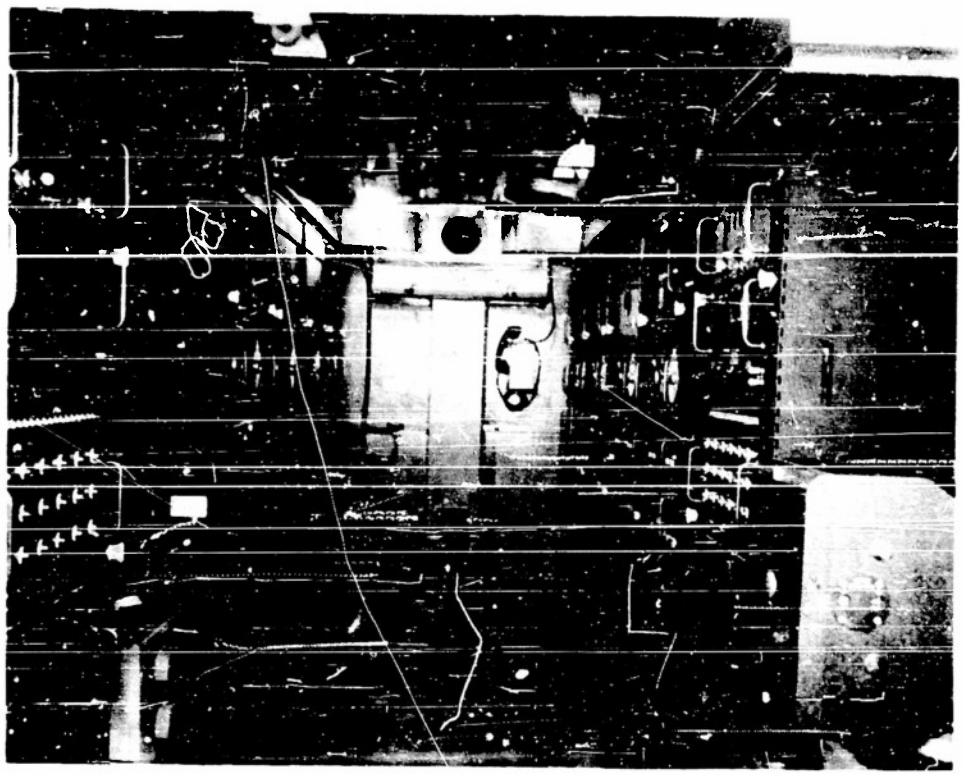


Figure 2 - Trailer Receiving Station Looking Forward

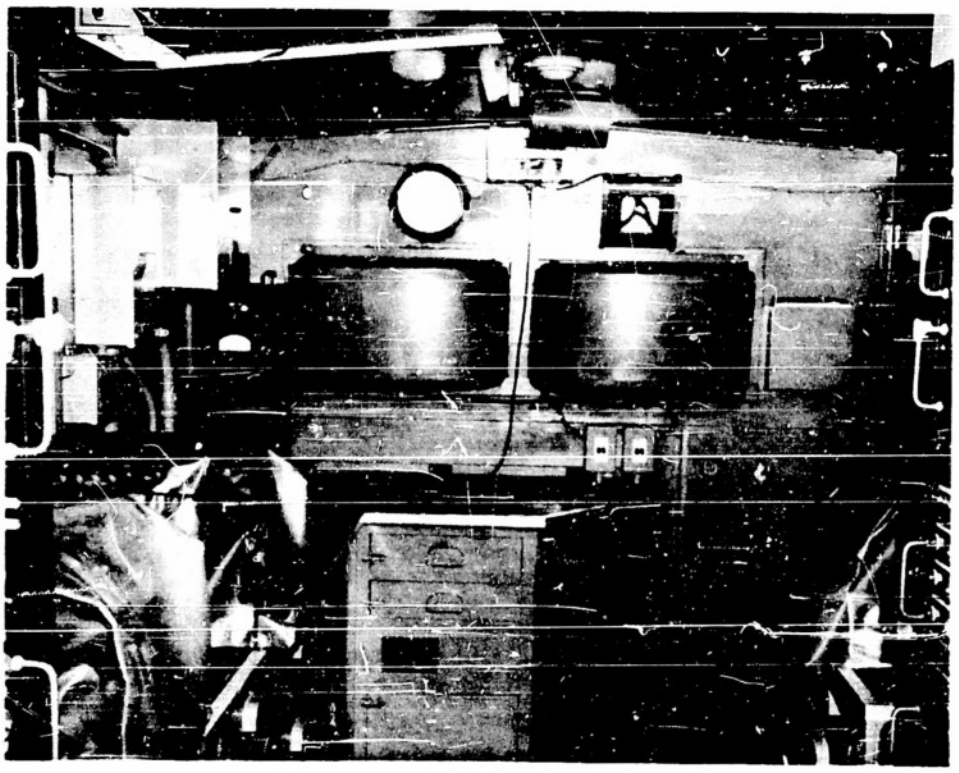
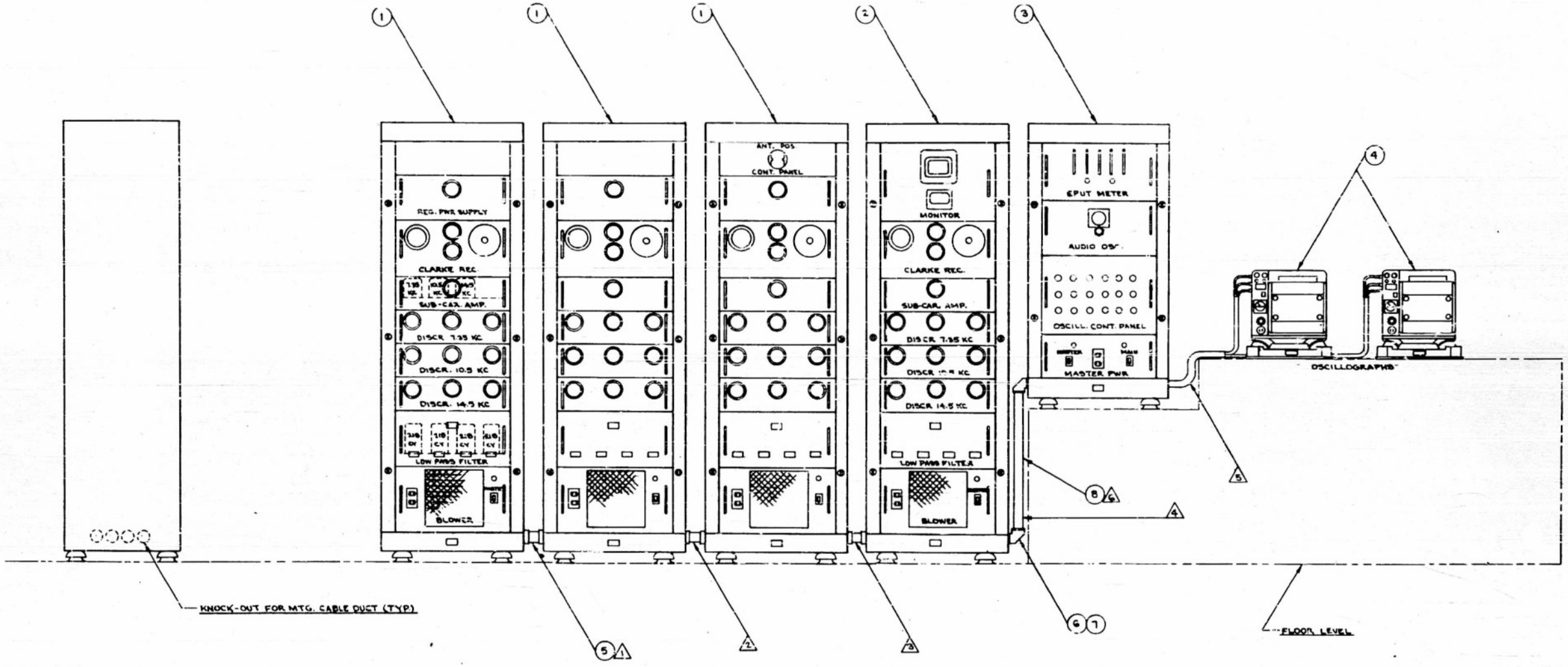


Figure 3 - Trailer Receiving Station Looking Aft




| | | | | | |
|---|---|---|---|---|---|
| 12 | | 36 | TYPE 410 | RESISTOR, | 6 |
| 11 | | 2 | TYPE 116-G2 | CABLE ASSEM., | 1 |
| 10 | | 36 | W.E. 72 | PLUG, | |
| 9 | | 3 | RGA9-72C-½ | PLUG, | |
| 8 | | 1 | 1½ I.D. | HOSE, RADIATOR | |
| 7 | | 2 | SP 145 | L'NUT, GALV. 1½, GEN. ELEC. | |
| 6 | | 2 | N150 | CONNECTOR, | |
| 5 | | 3 | Y112823 | DUCT, CABLE | |
| 4 | | 2 | TYPE 5-114 | OSCILLOGRAPH, | |
| 3 | | 1 | Y10982 | CABINET ASSEM. | |
| 2 | | 1 | Y10983 | CABINET ASSEM. | |
| 1 | | 3 | Y10984 | CABINET ASSEM., REC. | |

6 DAMPING RESISTOR FOR GALV. MOUNTED INSIDE PLUG (ITEM 10)
5 SUPPLIED BY VENDOR WITH OSCILLOGRAPH (ITEM 4)
4 CUT TO FIT; PAINT FLAT BLK PER BX FINISH #17
3 FOR WIRING DIAGRAM (E-OSCILL.) SEE DWG Y12630
2 FOR INTER-CABINET WIRING DIAGRAM (D-E) SEE DWG Y12629
1 FOR INTER-CABINET WIRING DIAGRAM (C-D) SEE DWG Y12628
FOR INTER-CABINET WIRING DIAGRAM (B-C) SEE DWG Y12627
FOR INTER-CABINET WIRING DIAGRAM (A-B) SEE DWG Y12626

NOTES:

Figure 4 - Receiving Station Assembly, Project 1.3G

Connections: Connections between chassis and cabinet are provided by a multi-conductor plug mounted on the chassis which engages a receptacle mounted at the rear of the cabinet when the chassis slides into operating position. Receptacles are wired to accessible terminal blocks located on the bottom of the cabinet: intercabinet connections are made between these terminal blocks and routed through flexible conduit.

Power Wiring: The main AC line is connected to the Main circuit breaker located on the Master Power Panel in the short cabinet. Branch AC lines extend from the Main control to a separator Master circuit breaker in each cabinet.

Temperature Control: Each cabinet is equipped with a centrifugal blower. Replaceable dust filters are mounted at air inlets.

## 2.0 Description and Function of Major Units

### 2.1 FM Receiver See Figure 5

The FM/FM telemetering signals picked up by the antenna are amplified and demodulated by a Clarke, Model 167E receiver. The receiver output is a composite subcarrier signal which is fed to subcarrier amplifier units for separation of the individual subcarrier signals. The output also is fed to a speaker to provide aural monitoring signals. The receiver occupies 8-3/4" of vertical mounting space.

### 2.2 Subcarrier Amplifier See Figure 6

Each subcarrier amplifier unit provides for separation and amplification of up to four individual audio subcarrier signals. Only the first three channels are used in this station. Installation of the proper plug-in band pass filter is required. Each unit requires 5-1/4 in. of panel space.

### 2.3 Band Pass Filters See Figure 6

Plug-in Band pass filters mounted in the subcarrier amplifier chassis provide for separation of the individual subcarrier signals from the composite subcarrier signal.

### 2.4 Regulated Power Supply See Figure 7

The electronically regulated power supply which provides plate power for the filter amplifier units, is conventional in design and is completely contained in one chassis and panel. The Power Supply requires 8-3/4" of panel space.

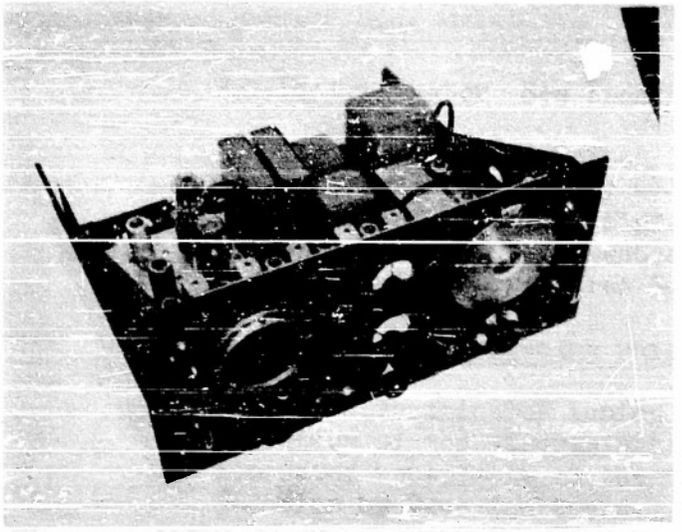


Figure 5 - Clarke 167-E Receiver

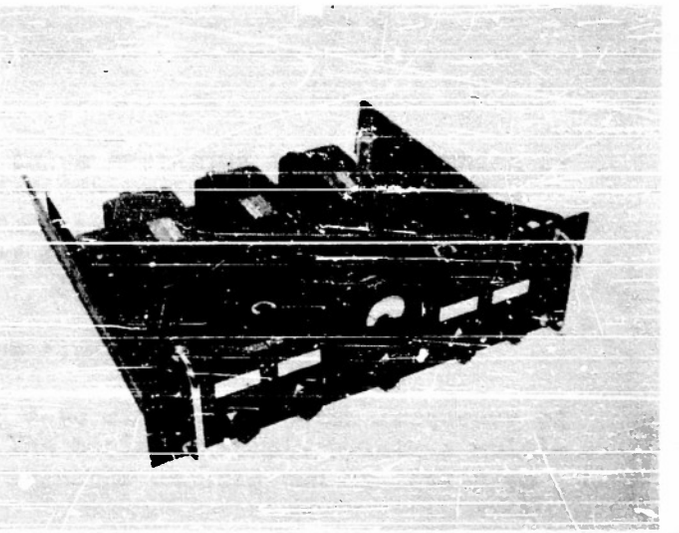


Figure 6 - Subcarrier Amplifier and Band Pass Filter

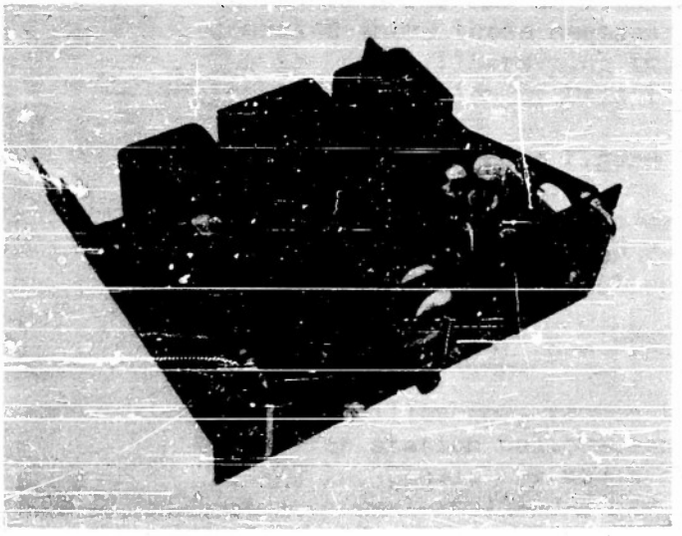


Figure 7 - Regulated Power Supply

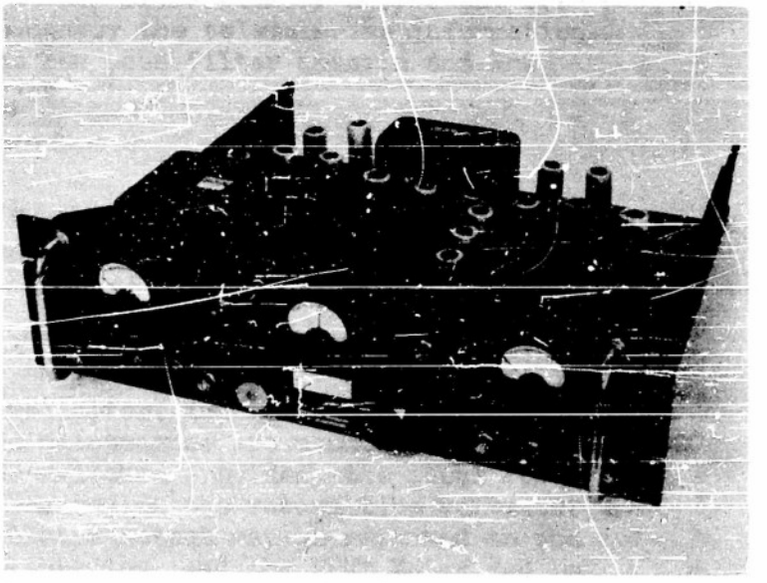


Figure 8 - Pulse Averaging Discriminator and Tuning Unit

2.5 Discriminator See Figure 8

The TDA-4 discriminator is a pulse averaging instrument which is responsive to a frequency modulated subcarrier audio signal. Its output is an electrical signal whose sense and magnitude is a function of the deviation of the subcarrier from its nominal center frequency. The discriminator requires 5-1/4 " of panel space.

2.6 Discriminator Tuning Unit See Figure 8

The discriminator tuning unit determines the center frequency of operation of the discriminator. The tuning unit plugs into a multiconductor receptacle on the discriminator chassis and is locked in position by Dzus fasteners.

2.7 Low Pass Filter Chassis See Figure 9

Low pass filter chassis provides mounting space for four low pass filters and a means of switching filters in or out. Only the first three channels are used in this station. The L.P. filter chassis requires 10-1/2 in. of panel space.

2.8 Low Pass Filter See Figure 9

The output signal from each discriminator maybe fed to its associated recording galvanometer through a type TFL-2A low pass filter to reduce noise and to attenuate at the discriminator output all frequencies above those necessary to convey the telemetering information. The low pass filters plug into the low pass filter chassis and are locked in position by Dzus fasteners.

2.9 Blower Panel See Figure 10

This unit contains the centrifugal blower with dust filters and the master circuit breaker for each cabinet. The blower panel requires 10-1/2 in. of panel space.

2.10 Monitor Panel See Figure 11

An oscilloscope, vacuum tube voltmeter, and the switching necessary for station calibration, and maintenance are mounted on a 12-1/4 in. panel. By means of the switches provided, the input for output signal amplitudes may be measured on the vacuum tube voltmeter, and viewed on the scope; the oscillator output may be switched to the subcarrier amplifier input for calibration, and the EPUT Meter can be switched to indicate oscillator output or subcarrier output. A switch is also provided to control the recording oscillograph drive motor.

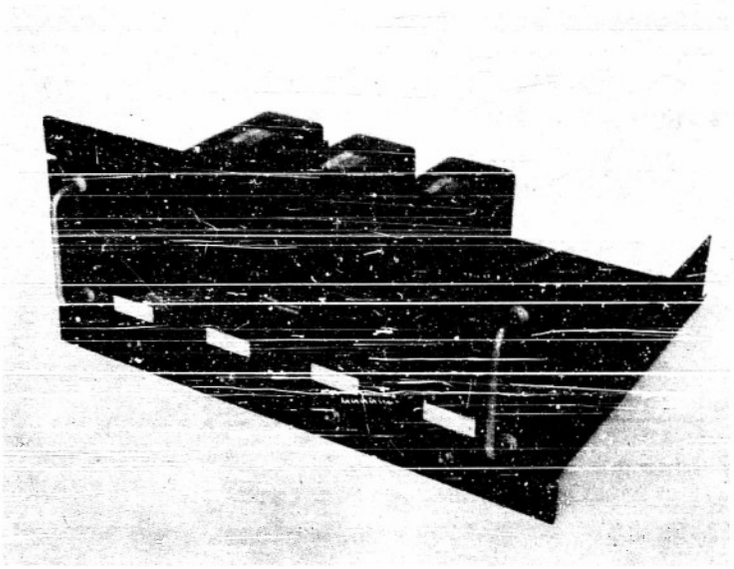


Figure 9 - Low Pass Filter Chassis and Low Pass Filters



Figure 10 - Blower Panel



Figure 11 - Monitor Panel

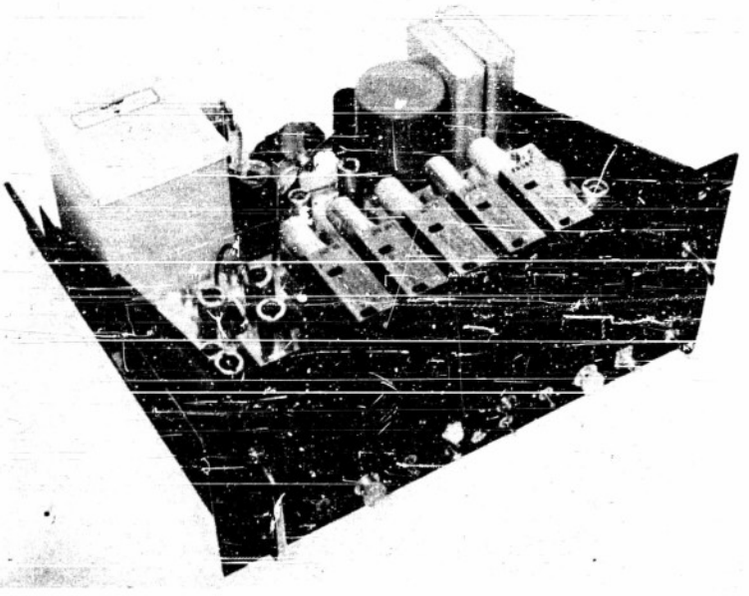


Figure 12 - Berkeley EPUT Meter

2.11 Frequency Meter See Figure 12

A counter-type frequency meter registers the number of sine waves or pulses which occur in an interval of one second. A single count may be displayed continuously or the count may be repeated at approximately two second intervals. The frequency meter requires 8-3/4" of panel space.

2.12 Audio Oscillator See Figure 13

The audio oscillator provides a source of sine wave audio frequency signals for calibration and test of the various subcarrier units in the telemetering receiving station. The audio oscillator requires 8-3/4 in. of panel space.

2.13 Oscillograph Control Panel See Figure 14

The oscillograph control panel provides level control, polarity reversing, signal interruption and patching jacks for a total of eighteen channels. The oscillograph control panel requires 14 in. of panel space.

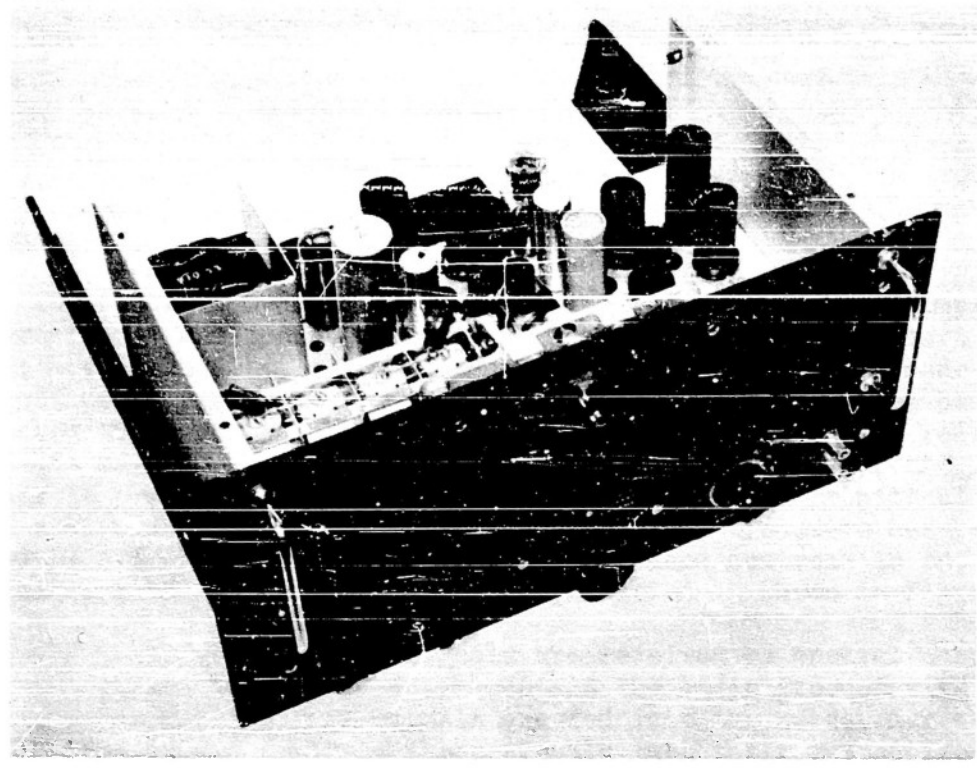


Figure 13 - Audio Oscillator

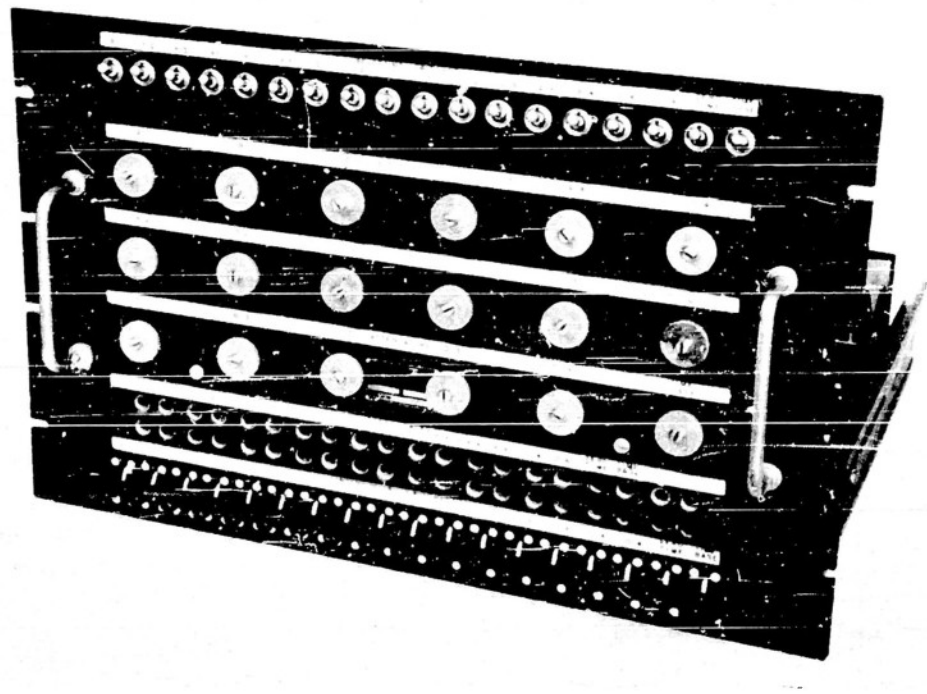


Figure 14 - Oscillograph Control Panel

# SECTION II

## THEORY OF OPERATION

### 1.0 General

The Bendix Y10980 FM/FM telemetering receiving station employs conventional and proven circuitry. The design objectives have been accuracy, stability, and ease of operation. Use has been made of recent developments in the telemetry field where evaluation has indicated that use of such developments would enhance system reliability. The discriminator employs the pulse averaging type of circuitry in order to provide increased stability, low drift with or without a signal, and a high degree of linearity. The operating procedure has been simplified by concentrating the most frequently used controls in one area. A block diagram of the Y10980 receiving station is shown in Figure 15.

The radio frequency FM signals are received by special purpose receivers, the outputs of which contain the audio frequency FM signals. These audio frequency FM signals are fed into the subcarrier amplifiers, which amplify and separate these signals into their respective bands. These separated signals are then fed into discriminators, one for each band. The discriminator demodulates the audio frequency FM signal producing an electrical signal whose sense and magnitude is a function of the deviation of the subcarrier from its nominal center frequency, and with proper adjustment of the complete system is a replica of the original signal being telemetered. Provision is made to obtain a permanent record of this signal by connecting the output of the discriminator to a recording galvanometer through a low pass filter, to remove any undesired noise, a reversing switch, for convenience in reversing the deflection of the galvanometer, a "T" pad, to control the level, and a switch, to interrupt the signal. Test equipment has also been included as part of the station for convenience in calibration and maintenance. The following units are supplied: an oscillator to provide a calibration signal, a frequency meter for accurately determining the frequency of the calibration or received signal, and a monitor panel consisting of a VTVM and Scope, associated with the necessary switches to provide a convenient means of calibration and check of the station.

### 2.0 Model 167-E Clarke Receiver

#### 2.1 General

The special-purpose receiver is designed for a telemetering system employing a radio link and receiving intelligence in the form of frequency-modulated signals. The specified tuning range is from 180 to 260 mc. See Figure 16. Some of the receivers used have been modified for fixed frequency operation, by the addition of a crystal controlled oscillator.

The antenna circuit is arranged for single or unbalanced input.

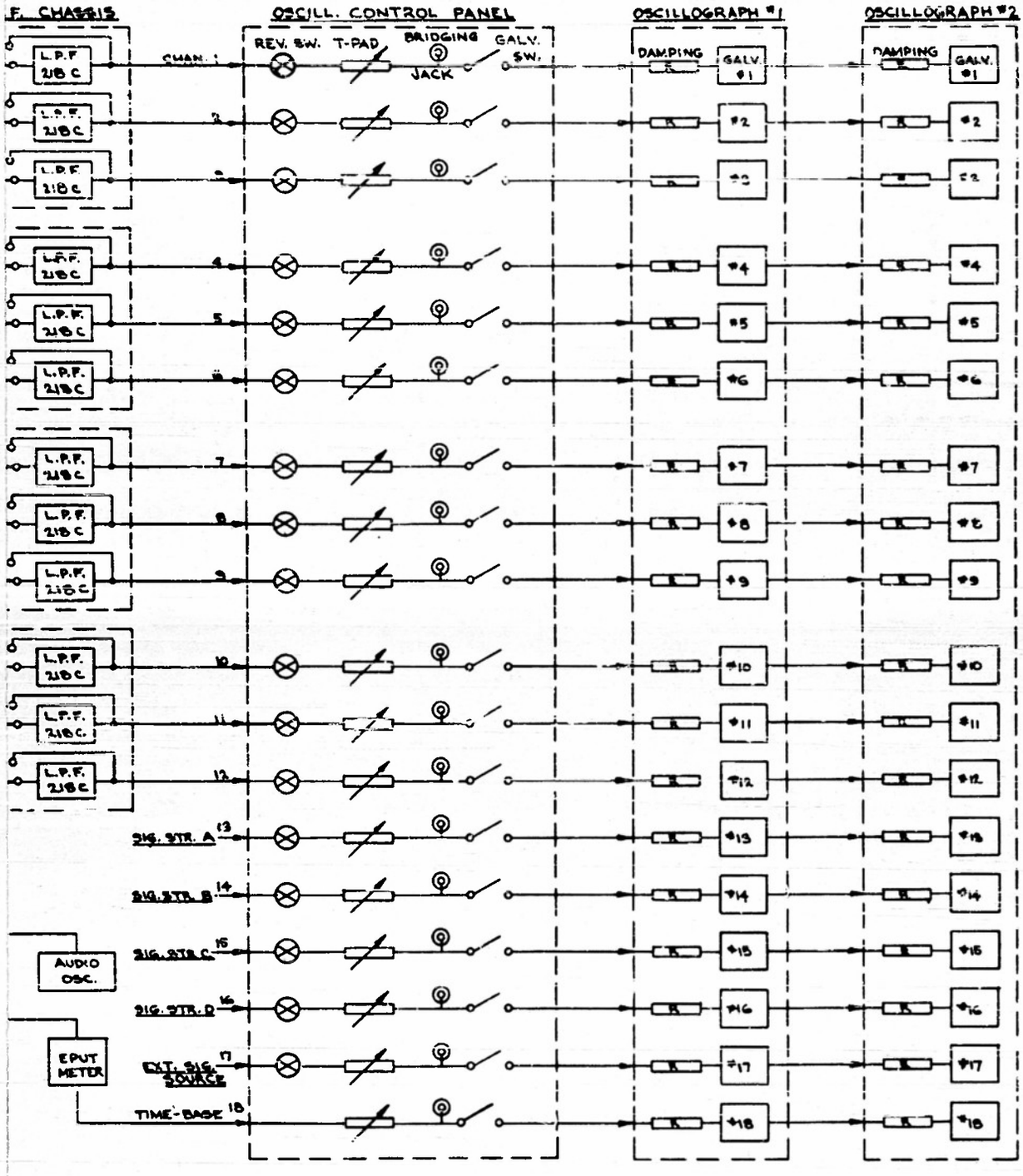
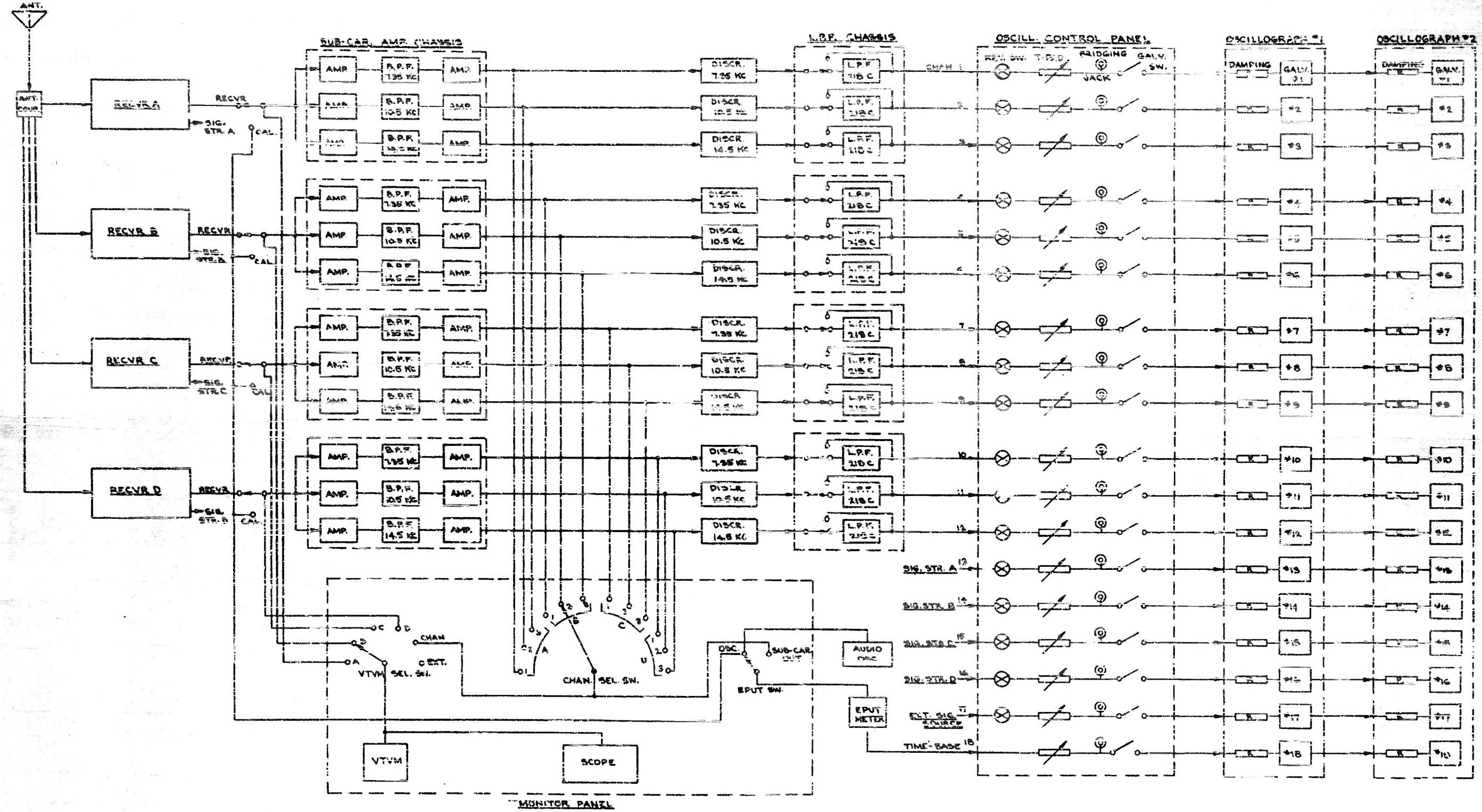



Figure 15 - Block Diagram, Y-10980 Receiving Station
Project 1.30




NOTE:
1. DIAGRAM SHOWS SIGNAL CIRCUITS ONLY

Figure 15 -- Block Diagram, Y-10980 Receiving Station
Project 1.3G

R.F. UNIT

I.F. UNIT

AUX. XTAL OSC.

| CRYSTAL | OSC. FREQ. | XTAL FREQ. |
|---|---|---|
| Y-1 | 256.90 MC | 64.225 MC |
| Y-2 | 256.15 | 64.5375 |
| Y-3 | 259.4 | 64.85 |
| Y-4 | 260.65 | 65.1625 |
| Y-5 | 261.9 | 65.475 |
| Y-6 | 263.15 | 65.7875 |
| Y-7 | 264.4 | 66.1 |
| Y-8 | 265.65 | 66.4125 |
| Y-9 | 266.9 | 66.725 |
| Y-10 | 268.15 | 67.0375 |
| Y-11 | 269.4 | 67.35 |
| Y-12 | 270.65 | 67.6625 |
| Y-13 | 271.9 | 67.975 |
| Y-14 | 273.15 | 68.2875 |
| Y-15 | 274.4 | 68.6 |
| Y-16 | 275.65 | 68.9125 |
| Y-17 | 276.9 | 69.225 |
| Y-18 | 278.15 | 69.5375 |
| Y-19 | 279.4 | 69.85 |
| Y-20 | 280.65 | 70.1625 |

2. CONVERSION OF RECVR BACK TO STD OPERATION IS AS FOLLOWS:
   a. DISCONNECT C-109 FROM L-601 & RECONNECT C-109 TO L-105 (SEE PT. B).
   b. DISCONNECT PWR LEADS TO XTAL OSC.
   c. INSERT 6J6 OSC TUBE.
1. SCHEMATIC COVERS MODIFICATION OF STD. CLARKE RECVR BY ADDITION OF AUX. XTAL OSC. & REMOVAL OF 6J6 OSC. TUBE

NOTES:

Figure 16 - Schematic, Modified Clarke Receiver with Crystal Controlled Oscillator

The basic tuning element around which the front end assembly is designed is a standard Mallory S-4 Spiral Inductuner. A stop assembly is arranged to restrict rotation of the spiral tuner to the last one and one quarter clockwise turn of its normal 5- turn rotation. The signal frequency is tuned by L-101 and the input capacity of the 6J4 plus wiring capacities. A double tuned band-pass circuit is used between the 6J4 r-f amplifier and the 6AK5 mixer to provide high image and i-f rejection. The coupling between the two circuits is capacitive and consists of C104, C105, and C106. C105 is adjustable to provide accurate control of bandwidth. The 6J4 R-F stage is operated at maximum gain at all times to produce maximum signal-to-noise ratio. Bias for the 6AK5 mixer is obtained from the local oscillator. This method produces more uniform operation at all frequencies, allows for considerable variation in local oscillator amplitude due to tube aging, A.F.C. pulling, etc., and allows direct grounding of both cathode terminals to minimize cathode lead inductance and produce maximum input resistance which is necessary at these frequencies. The mixer is pentode connected to prevent distortion of the I-F response due to changes in plate resistance which may be caused by variation of local oscillator amplitude, tube aging, etc. A rather unconventional oscillator configuration is used because of the high frequency of operation and the necessity of A.F.C.

The oscillator circuit used is essentially a Colpitts with an unbypassed resistor connected in the cathode to damp tube resonance. The A.F.C. reactance tube is connected directly across the combination of the grid-plate capacity and a 27 ohm carbon resistor. Input resonance in the reactance tube is not damped by the cathode resistor since the grid circuit must return to the cathode. The use of a small resistor (27 ohms) in the grid circuit extends the operating range through 285 mc. A.F.C. may be turned on or off or supplied from an external source by a front-panel control.

The crystal-controlled oscillator, See Figure 16, which is used when fixed-frequency operation of the Clarke receiver is desired, employs an overtone crystal in a cathode-coupled circuit, and three type CK5703 subminiature tubes.

The crystal frequency was chosen so that adequate oscillator injection could be obtained by doubling twice. A test to determine optimum oscillator injection for maximum sensitivity showed that the optimum value of oscillator voltage was between 4 and 5 volts, and that the injection voltage could vary from 3.0 to 6.0 volts with about a 10% loss in sensitivity.

The link coupling and double-tuned coupling circuit employed permits adjustment of the link so that the optimum value of oscillator voltage may be obtained upon installation in the receiver. A high impedance type of voltmeter is employed to read the rectified grid voltage at TP117. Since TP117 is the midpoint of the mixer grid resistor, whatever voltage is observed must be multiplied by two to obtain the correct injection voltage.

The r-f unit is a complete assembly with input and output signals available through coaxial connectors and with power and A.F.C. leads through a small cable.

The i-f amplifier is a separate, completely shielded assembly which is conventional in most respects. Two high-gain stages using 6CB6 tubes are followed by a 6CB6 first limiter and a 6AK5 second limiter. A 6AL5 is used in a balanced phase discriminator.

The discriminator circuit is a conventional balanced phase shift type. In order to obtain balance the secondary is bifilar-wound and link-coupled to the primary. This link is adjusted in production for minimum distortion. For stability a self-resonant choke is connected to the output lead.

Signal level monitoring is provided by sampling the rectified signal current of both limiter grids. The second limiter developes a voltage proportional to the input signal up to about 10 uv. Above this level the voltage on the second limiter is constant, and a voltage proportional to the logarithm of the input exists at the first limiter. These voltages are combined to produce an easily read logarithmic signal strength scale.

A 12AU7 is used as a DC bridge to indicate discriminator output for tuning purposes and as a direct coupled video amplifier. V110 is used as a cathode follower output stage and is direct coupled from the video amplifier. The output is 10-15 volts RMS for $\pm$ 125kc deviation.

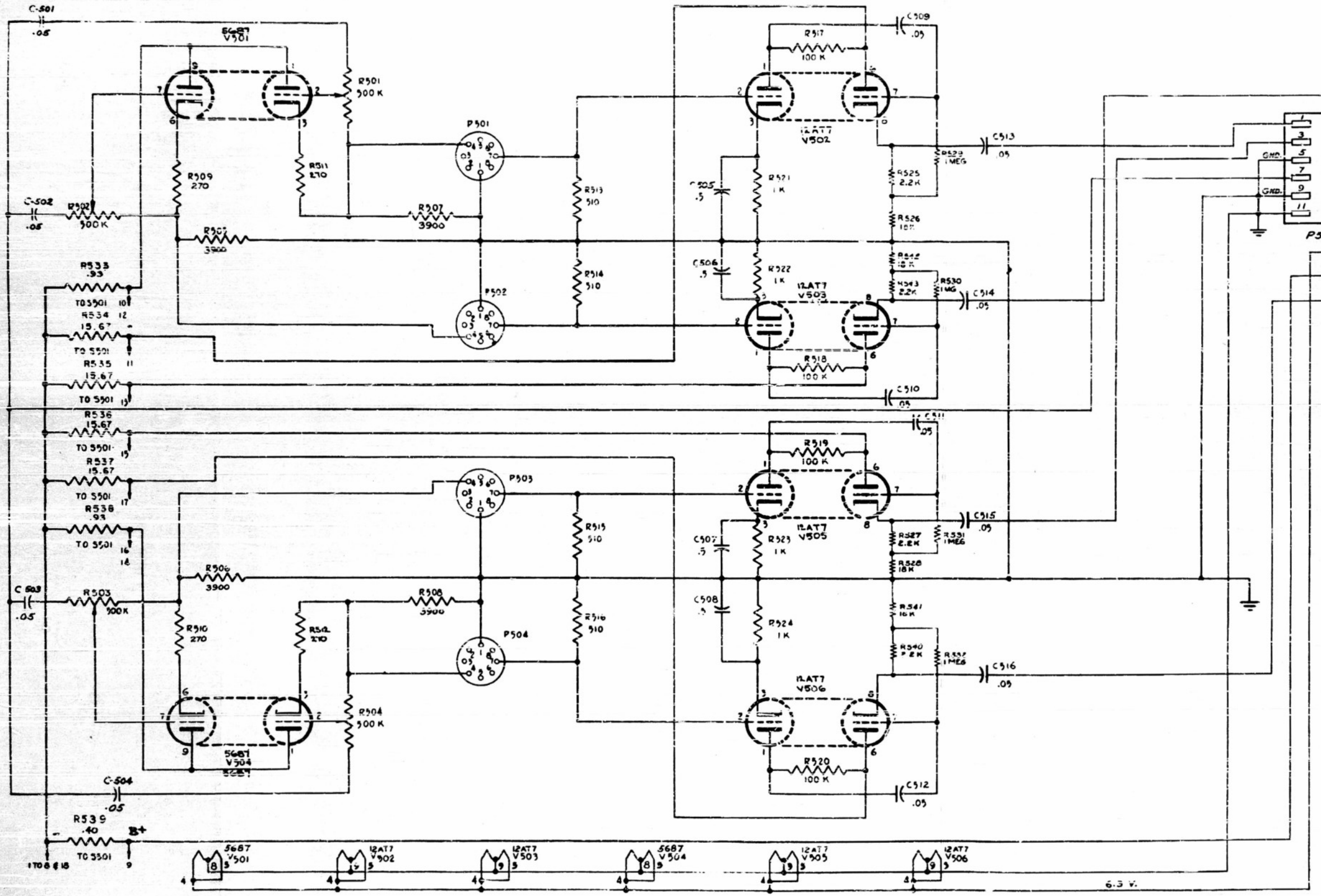
A conventional two-stage amplifier with built-in loudspeaker is provided for monitoring.

## 2.2 External Signal Strength Recording

Provision has been made for supplying 10 ma to record variations in signal strength. This signal is the combined plate and screen currents to V104, and it is adjusted to 10 ma with no signal by varying the screen voltage with R150. The signal thus obtained is reverse reading; i.e., 10 ma is obtained with no signal, and minimum current is obtained at maximum signal. The signal strength circuits are connected to channels 13 to 16 inclusive on the oscillograph control panel.

# 3.0 Subcarrier Amplifier

The subcarrier amplifier provides for separation of up to four audio subcarrier signals from the composite video subcarrier signal. The four subcarrier amplifier units contained in the telemetering receiving station thus provides sixteen subcarrier amplifier (separation) channels. Each channel consists of a cathode follower input stage, filter, a signal amplifier stage, and a cathode follower output stage. The composite subcarrier signal from the receiver is parallel fed to the subcarrier amplifier channels. See Figure 17.




NOTES:

1. CAPACITY IN M.F.
2. RESISTANCE IN OHMS; SUFFIX K = KILOHMS (1000 OHMS)

Figure 17 - Schematic, Sub-Carrier Amplifier

The cathode follower input stage of each subcarrier amplifier channel provides high impedance input. Thus the receiver output stage is lightly loaded even though it drives the fourstages in parallel. The cathode follower input stages also provide the proper driving impedances for the filters.

Twelve of the channels are equipped with plug-in band pass filters. The filters normally provided with the station have center frequencies. as noted in Section I. Filters are available on special order with center frequencies ranging from 0.4 to 70.0 kilocycles per second, and with bandwidths to provide for deviation of ±7½ or ±15 percent of center frequency. Each filter passes the subcarrier channel for which it was designed while rejecting all others. Representative performance of the filters is shown in Figure 18. Attenuation from the band edge of each filter to the cross over point with the adjacent pass band is not less than 45 db.

## 4.0 Discriminator

### 4.1 General

The TDA-4 discriminator is a pulse averaging instrument which is responsive to a frequency modulated subcarrier audio signal. Its output is an electrical signal whose sense and magnitude are a function of the deviation of subcarrier from its nominal center frequency. Each discriminator is tuned to one of the subcarrier channels by an interchangeable plug-in tuning unit. The schematic of the discriminator is shown in Figure 19.

### 4.2 Characteristics

4.2.1 Input Range: Full limiting with 0.3 to 50 volts rms input. Nominal range 2.0 to 8.0 volts rms.

4.2.2 Center Frequency Range: 400 cps to 70 kc, center frequency determined by plug-in tuning unit employed.

4.2.3 Input Impedance: 500 K ohms.

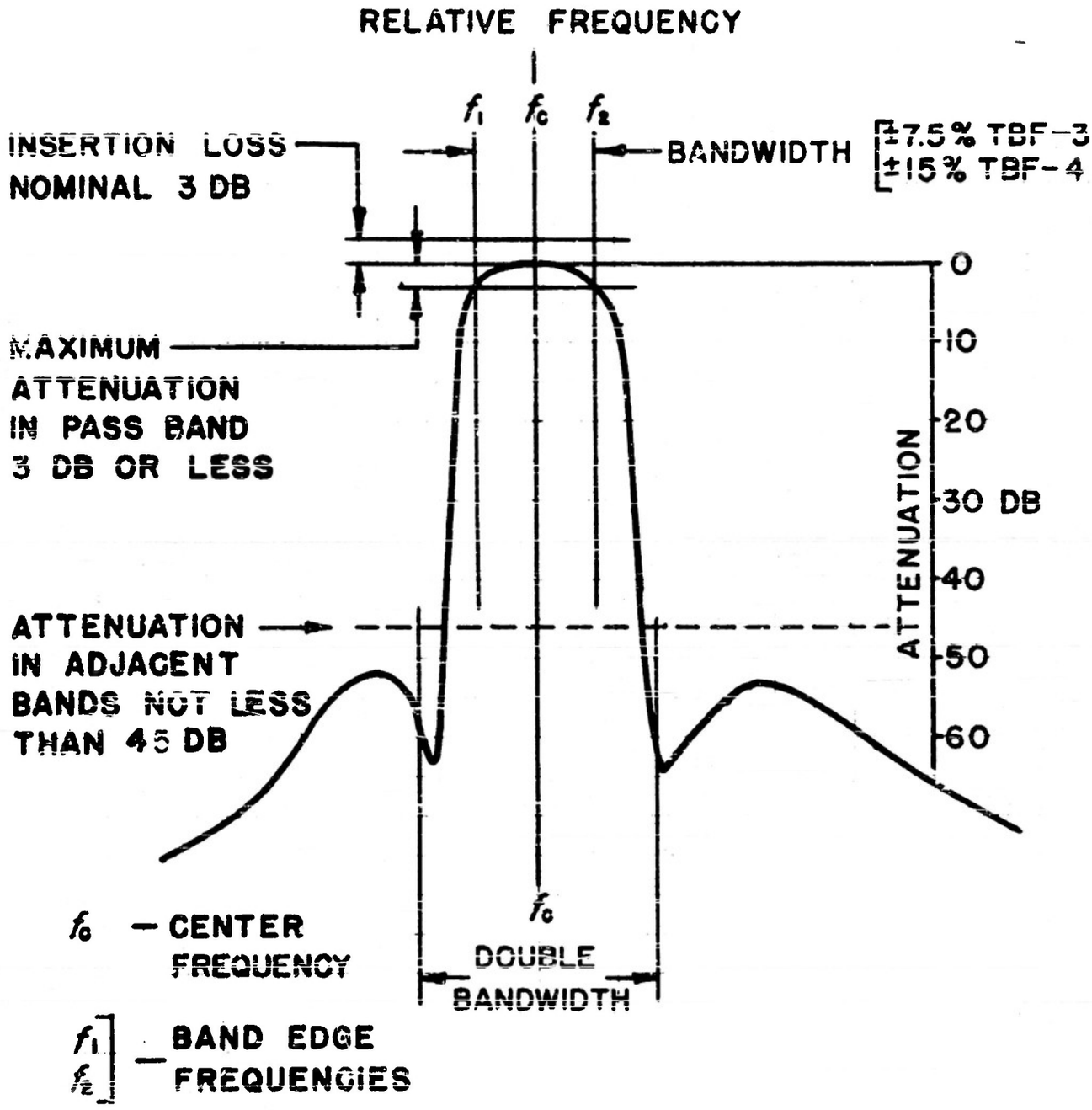
4.2.4 Subcarrier Frequency Deviation: Determined by tuning unit employed. Tuning units providing for ±7 1/2% or ±15% of center frequency are normally employed.

4.2.5 Intelligence Frequency: Modulation may be dc to as much as 50% of bandwidth, determined by tuning unit employed.

4.2.6 Output Level: Minimum of ±10 milliamperes corresponding to ± full subcarrier deviation from center frequency.

4.2.7 Output Impedance: 330 ohms nominal.

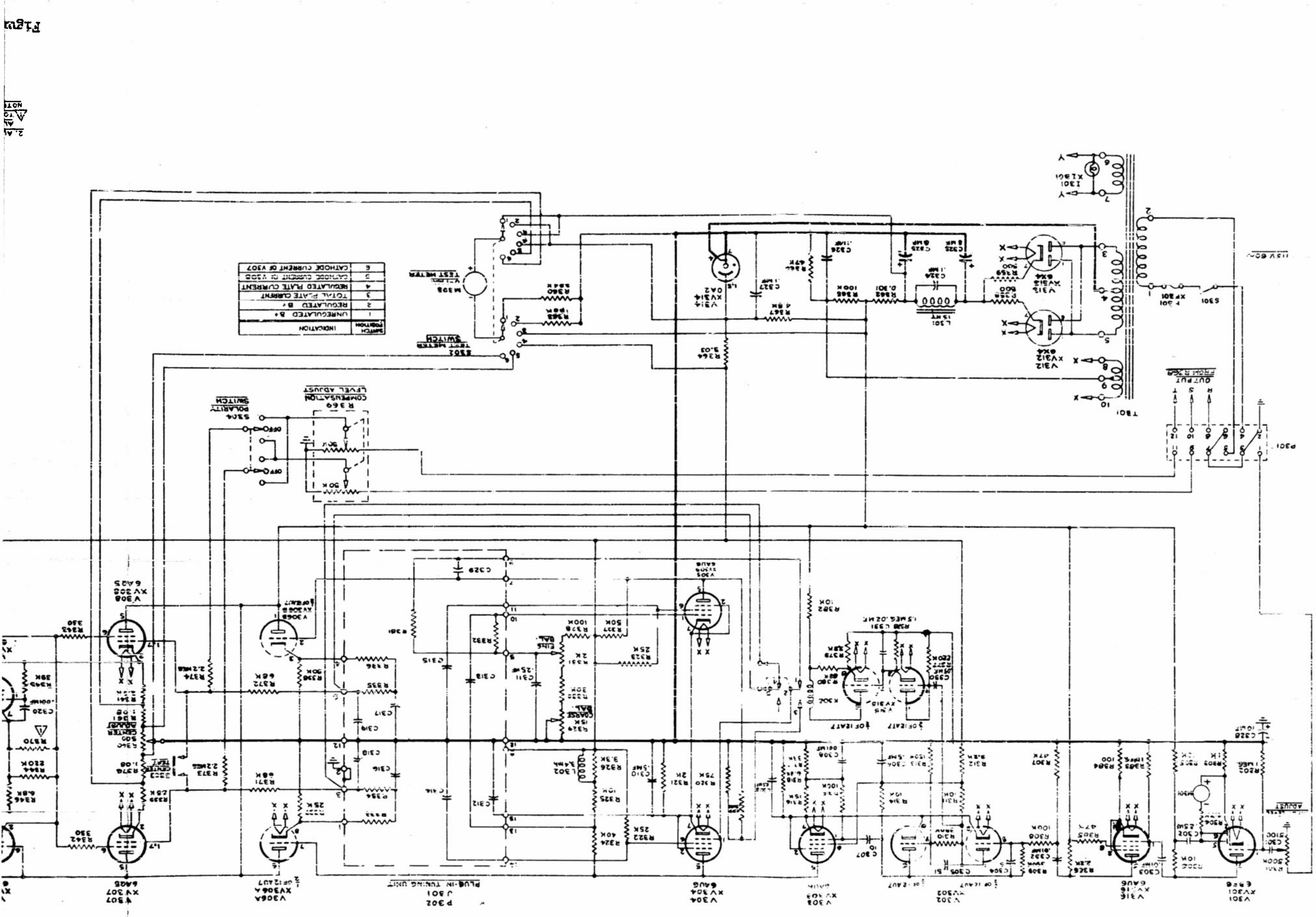
4.2.8 Type of Output: Push-pull cathode followers, balanced to chassis ground.

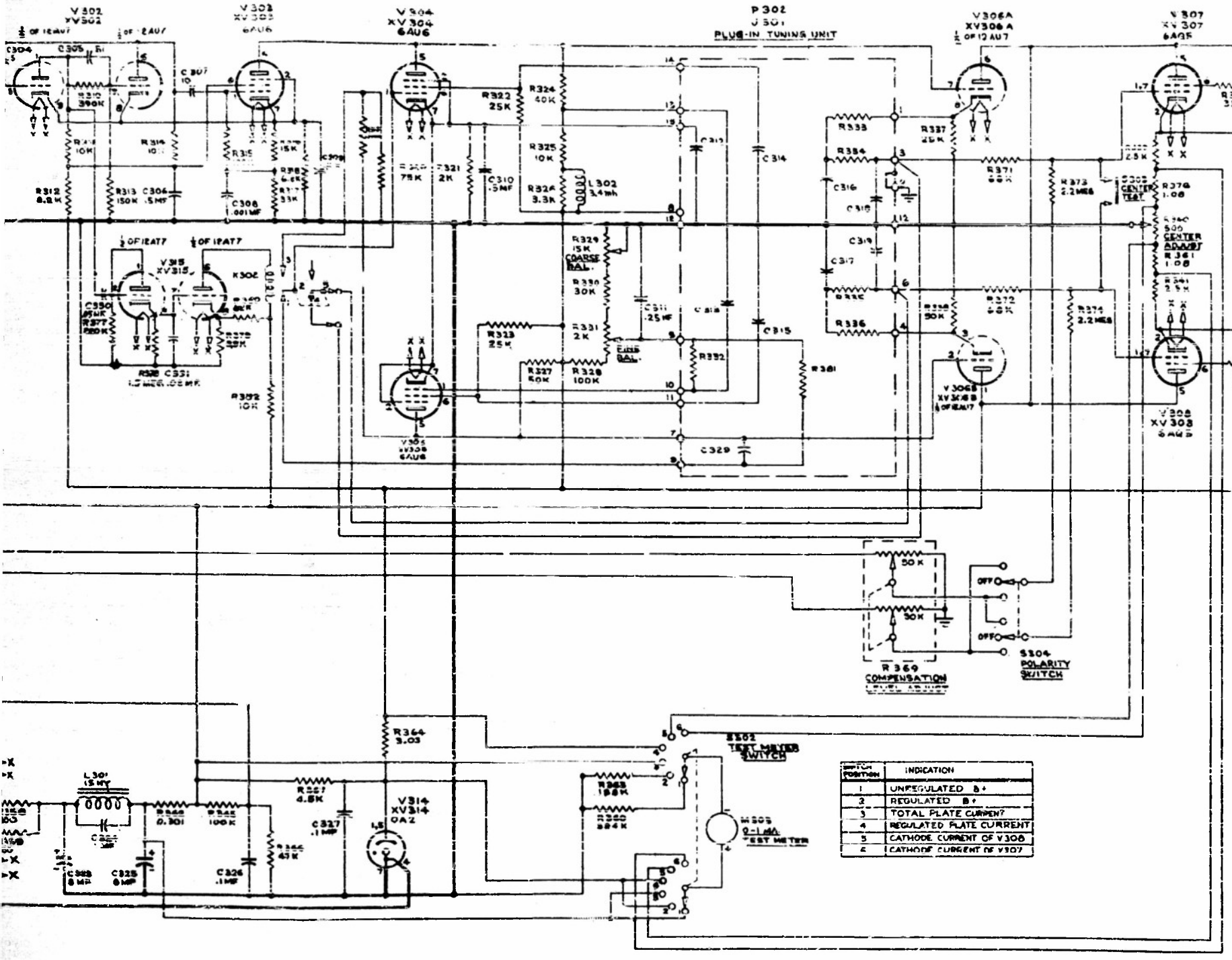



TYPICAL RESPONSE OF BAND PASS FILTER

MODELS TBF-3 & TBF-4

Figure - 18


SWITCH POSITION
INDICATION
1 UNREGULATED B+
2 REGULATED B+
3 TOTAL PLATE CURRENT
4 REGULATED PLATE CURRENT
5 CATHODE CURRENT OF V308
6 CATHODE CURRENT OF V307
METER SWITCH
R369 COMPENSATION LEVEL ADJUST
S304 POLARITY SWITCH
T301
V312 6X4
V313 6X8
V314 0A2
V307 6AQ5
V308A 6AQ5
V304 6AU6
V303 12AU7
V302 12AU7
V316 6AU6
V301 6BH6
P301
J301
P302
115V 60~
OUTPUT FROM R-388




| SWITCH POSITION | INDICATION |
|---|---|
| 1 | UNREGULATED B+ |
| 2 | REGULATED B+ |
| 3 | TOTAL PLATE CURRENT |
| 4 | REGULATED PLATE CURRENT |
| 5 | CATHODE CURRENT OF V308 |
| 6 | CATHODE CURRENT OF V307 |

| CENTER FREQ. | C312 | C313 | C314 AND C315 | C316 AND C317 | C318 AND C319 | R332 | R333 AND R336 | R334 AND R335 | R381 | C329 |
|---|---|---|---|---|---|---|---|---|---|---|
| 400 CPS | 10 MF | .002 MF | 0.5 MF | .05 MF | .095 MF | 1 MEG | 68 K | 220 K | 1.5 MEG | 5000 MMF |
| 560 CPS | 10 MF | .0015 MF | 0.5 MF | .05 MF | .095 MF | 1 MEG | 68 K | 150 K | 1.5 MEG | 3900 MMF |
| 780 CPS | 10 MF | .001 MF | 0.5 MF | .05 MF | .095 MF | 1 MEG | 68 K | 470 K | 1.5 MEG | 2700 MMF |
| 988 CPS | 10 MF | 500 MMF | 0.5 MF | .02 MF | .095 MF | 1 MEG | 68 K | 390 K | 1.5 MEG | 1800 MMF |
| 1.5 KC | 10 MF | 500 MMF | 0.25 MF | .02 MF | .092 MF | 1 MEG | 68 K | 560 K | 1.5 MEG | 1270 MMF |
| 1.7 KC | 1.0 MF | 440 MMF | 0.25 MF | .016 MF | .092 MF | 1 MEG | 68 K | 470 K | 1.5 MEG | 1000 MMF |
| 2.2 KC | 0.5 MF | 350 MMF | 0.25 MF | .01 MF | .091 MF | 1 MEG | 68 K | 680 K | 1.5 MEG | 680 MMF |
| 3.0 KC | 0.5 MF | 250 MMF | 0.1 MF | .008 MF | .09 MF | 1 MEG | 68 K | 470 K | 1.5 MEG | 470 MMF |
| 3.9 KC | 0.5 MF | 200 MMF | 0.1 MF | .06 MF | 430 MMF | 1 MEG | 68 K | 680 K | 1.5 MEG | 360 MMF |
| 5.4 KC | — | 150 MMF | 0.1 MF | .035 MF | 430 MMF | 1 MEG | 68 K | 560 K | 1.5 MEG | 270 MMF |
| 7.35 KC | — | 100 MMF | 0.1 MF | .093 MF | 430 MMF | 1 MEG | 68 K | 390 K | 1.0 MEG | 220 MMF |
| 10.5 KC | — | 75 MMF | .05 MF | .002 MF | 100 MMF | 1 MEG | 68 K | 680 K | 820 K | 120 MMF |
| 14.5 KC | — | 51 MMF | .05 MF | 430 MMF | 100 MMF | .1 MEG | 68 K | 470 K | 820 K | 75 MMF |
| 22.0 KC | — | 33 MMF | .05 MF | 330 MMF | 50 MMF | .12 MEG | 75 K | 680 K | 390 K | 110 MMF |
| 30.0 KC | — | 25 MMF | .05 MF | 220 MMF | 39 MMF | 1.0 MEG | 82 K | 470 K | 180 K | 62 MMF |

2. ALL CAPACITORS ARE IN MMF EXCEPT AS OTHERWISE NOTED; ALL RESISTORS ARE IN OHMS; K=1000 OHMS.
⚠ TO BE DETERMINED DURING TEST AND CALIBRATION.

Figure 19 – Schematic, Discriminator Pulse Averaging

4.2.9 Linearity of Output vs Subcarrier Frequency: 0.5% of bandwidth.

4.2.10 Output Response vs Intelligence Frequency: Flat within ±1 db.

4.2.11 Output Stability: ±0.5% of bandwidth per hour for two hours, after 15 minute warmup period.

4.2.12 Maximum Output Noise Level: Less than 5 millivolts.

4.2.13 Power Source: 115 volts regulated, 60 cps, 100 v.a. Regulation within ±1% is required for specified performance. Nominal output variation is ±0.2% of bandwidth per volt line variation.

4.2.14 Panel Size: 5-1/4 inch x 19 inch.

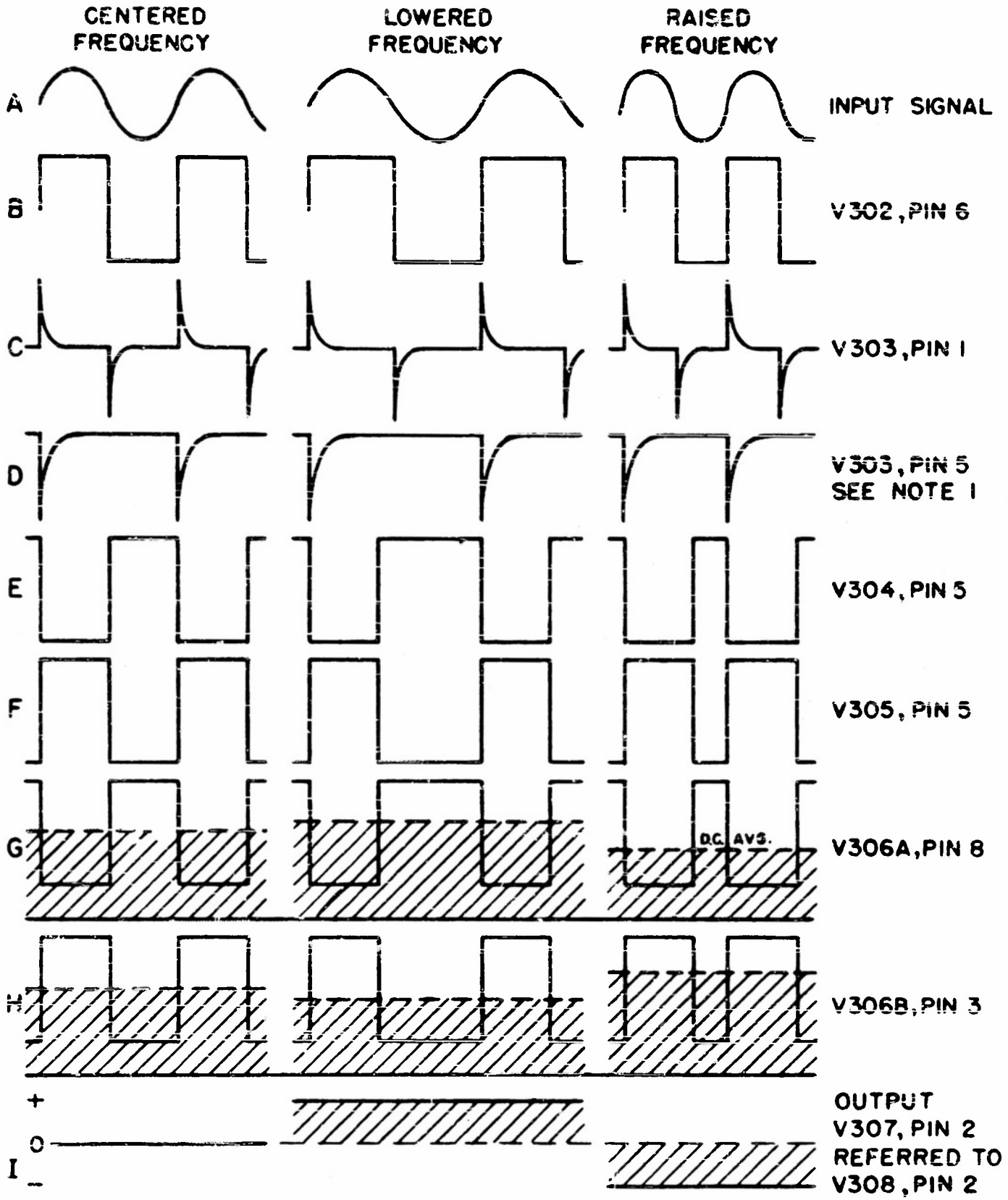
4.2.15 Chassis Size: 13 inch x 17 inch x 2 inch.

4.2.16 Weight: 28 pounds.

## 4.3 Circuit Theory:

Tube, V301, is a linear preamplifier with an input level control, R301, appearing on the front panel. This tube includes a diode which rectifies part of the signal voltage to operate the signal level meter, M301. V316 is a clipper-driver stage using a 6AU6 which clips the input sine wave. Tube V302 is a 12AU7 twin triode and is used in an Eccles Jordan trigger circuit having two stable limiting conditions. The amplified frequency modulated subcarrier signal, shown as waveform A in Figure 20 is clipped by V316, then triggers the E.J. circuit on each half cycle, and produces a rectangular output from the trigger circuit, wave B. This signal is differentiated by means of the 10 uuf capacitor, C307, and the 100K ohm resistor, R315, to produce waveform C. The signal is applied to the grid of V303, which is normally in a plate current cutoff condition. The cathode return of V302 is common with V303 through resistor R318. The voltage drop across this resistor due to the plate current through V302 holds V303 at cutoff. V303 conducts only on the positive half cycles of waveform C, clipping the negative half cycles. Its pulse output is shown as waveform D. The pulse repetition rate is the same as the subcarrier frequency.

This pulse is applied to a univibrator including tubes V304, and V305, having one stable limiting condition, and one unstable condition. In the stable condition V305 is conducting and V304 is conducting and V304, is cut off. The negative pulse of waveform D is applied to the grid of V305 through resistor R324 and capacitor C313. This cuts off V305 which causes V304 to conduct. This is the unstable limiting condition and continues for an interval determined by the time constant of C313 and R332 and the threshold voltage on the grid of V305. This voltage is adjustable and is controlled by the balance controls R329 and R331. These are available on the instrument panel. At the end of the unstable




NOTE: 1. UNIVIBRATOR WAVEFORM IS SUPERIMPOSED. REMOVE V304 TO OBSERVE WAVEFORM ILLUSTRATED.

## TDA-4 DISCRIMINATOR WAVEFORMS

Figure - 20

period V305 returns to the conducting condition which causes V304 to again go to cut off. This sequence of operations is repeated for every cycle of the subcarrier frequency.

The pulse form at the plate of V304 is shown in waveform E and that at the plate of V305 in waveform F. These two pulses are applied to the grids of two cathode followers V306A and V306B, a 12AU7 twin triode. As shown in waveform E, when the grid of the upper triode A moves negatively with the first half cycle of the subcarrier signal, the grid of the lower triode B moves in a positive direction, F. Waveforms E and F also represent the pulse forms present at the cathode of the two triodes. The average DC voltage at the grid or cathode is represented by the dashed lines in E and F. This line is located when the shaded area under the curve of the negative pulse is equal to the shaded area under the positive pulse. Elongation of the positive in E will thus move the DC average line upward as in G. This represents a lowering of the subcarrier frequency. Increasing the frequency will shorten the positive pulse and lower the average DC voltage at the cathode of triode A as in I.

Similarly in waveform H elongation of the negative pulse caused by lowered frequency will lower the average DC positive potential at the cathode of triode B, and increase frequency will raise it, as in J. These voltages are measured from the negative return or copper ground, and not from the chassis.

The DC average at the grid of triode V306A shown at E, is somewhat positive with respect to the DC average at the grid of triode B shown at F. This is the voltage condition at center frequency. As an example, the average positive potential on the grid of upper triode A is approximately +87 volts and that on the lower triode is +82 volts at center frequency. Since center frequency is represented by equal voltages at the cathodes of these triodes, cathode resistor R337, used with triode A is smaller than resistor R338, used with lower triode B. Thus due to the different cathode currents in the two triodes the average DC voltage drops across these resistors are approximately equal at center frequency.

Increase of subcarrier frequency will thus produce a cathode voltage unbalance, with the cathode of triode A negative with respect to cathode B. A frequency lower than center frequency reverses this unbalance, with the lower cathode negative with respect to the upper cathode.

An average DC voltage difference between the two cathodes is thus brought about by a change in frequency. These two DC voltages are applied to the grid of V307 and V308 through RC filters in the plug-in tuning unit which serve to filter the pulses from the DC voltages. These tubes are used in a voltage measuring, bridge circuit, and the 100-0-100 output meter, M302, is connected between their cathodes.

This is a zero center meter and when there is no voltage difference between the cathodes of V307 and V308, the meter indicates zero (center scale). Zero meter reading indicates center frequency. Lower frequency moves the meter pointer to the left of zero. Frequencies higher than center frequency will move the pointer to the right.

A protective thermal delay relay, K301, and the 330 ohm output T-pad, R368, are connected in series with the meter M302. The relay delays closing the circuit through the meter and output circuit until all tubes have reached a stable operating condition. This is to protect the meter and the galvanometer connected to the output circuit from current surges during the tube warmup period.

A center adjust control, R340, and test switch, S303, are provided on the front panel for adjusting the voltage balance at the cathodes of V307 and V308. For balancing, switch S303 is closed, connecting the girds of V307 and V308 together. The center adjust control is then adjusted until the output meter M302 and the recording galvanometer read zero. The test switch S303 is then opened. When the incoming subcarrier is known to be on center frequency, the balance controls R329 and R331 are adjusted to bring the meter and galvanometer again to zero readings. The meters will now accurately indicate frequency deviations above or below center frequency.

With a discriminating circuit of this type, circuit failure or off band operation of the input signal might damage the indicating meters. Therefore, protective circuits are provided. If the pulse amplifier tube, V303, fails, the univibrator remains in its stable limiting condition. Tube, V304, would be cut off and the grid cathode of V306A would be highly positive. Tube V305 would be conducting and the grid and cathode of V306B would remain negative with respect to the grid and cathode of V306A. A serious and continued unbalance at the cathodes of V307 and V308 would result. Much higher than normal current would flow through the indicating and recording meters with resultant damage to the meters. To prevent this damage if this unbalance should occur, tubes V309, V310, and V311 will operate to protect the meters as follows: The screen current for tubes V307 and V308 passes through V309 from the plate supply. Since the grid of V309 is connected to the positive plate supply through R349, the plate resistance of this tube will normally be low. The plates of tubes V310 and V311 also connect to the grid of V309. The cathodes of these tubes return to the cathodes of V307 and V308 and their grids connect to the opposite cathodes. Thus the cathode of V311 connects to the cathode of V308 through R351, and its grid to the opposite cathode V307. V310 is connected symetrically opposite with its grid to V308 and cathode to V307.

Tubes V310 and V311 are normally held at cutoff by means of DC bleeder current through R350 and R351 for one tube, and through R344 and R346 for the other tube. Tubes V310 and V311 therefore measure the DC unbalance which may occur between the cathodes of V307 and V308. If that unbalance exceeds the threshold bias voltage on

either tube, it draws plate current through R349. This places negative bias on V309, reducing its plate current and also the screen current to tubes V307 and V308. Cathode voltages at these tubes are thereby reduced thus limiting the current through the meters to a safe value. If the subcarrier shifts too far out of the band on the low frequency side, V311 operates to protect the meters. If on the high frequency side, then V310 comes into operation.

The leads to the low pass filter are connected to terminals 8 and 10 on connector P301. Full output signal, unaffected by the setting of this output T-pad, may be obtained between terminals 10 and 12.

4.4 Standby Stabilization Circuit:

During normal operation of the station the equipment may stand for extended periods without being in actual use, although the power is on. Under these conditions, the hysteresis of electron emission of tubes V304 and V305 may cause some difficulty in maintaining balance. In the "no signal" condition tube V305 is in a conducting condition and tube V304 is cutoff. When later the circuit is balanced while receiving an incoming signal, it may be found that the balance will drift with time due to the hysteresis of V304 and V305 and also to some extent, V306, V307 and V308. This of course necessitates rebalance.

To minimize this difficulty a standby stabilization circuit is provided using tube V315 and relay K302. The relay is shown in its non-operated position, with no incoming subcarrier present. With the arrival of a subcarrier signal, rectified voltage is applied to the grid of V315, causing this tube to conduct, and to operate the relay. The relay closes contacts 2 and 3, connecting the plate of V305 to the grid of V304 through the voltage divider of R319 and R320. Contacts 4 and 5 of the relay are opened, removing the short circuit between the grids of V307 and V308. This prepares the circuit for normal operation as previously described.

During periods of no incoming signal, there will be no rectified signal voltage on the grid of V315. The relay K302 will thus be non-operated, and with circuit connections as shown. Contacts 1 and 2 will thus be closed, making a circuit from the grid of V304 back through capacitor C329, to the plate of V305. A positive feedback loop is thus established from the plate of V304 through R324, C313, V305, C329, contacts 1 and 2 of relay K302, to the grid of V304. This circuit thus oscillates at a frequency determined by these circuit constants and also the DC voltage at the grid of V305. This voltage, as previously mentioned, is controlled by the settings of the balance controls R329 and R331. When these controls are previously balanced for center subcarrier frequencies, this circuit will oscillate at approximately center frequency. Thus when the incoming signal fails, and also during

standby periods, tubes V304 and V305 will continue to function, and draw the same plate currents, as when normal signal reception is occurring. The cathode emission characteristics of these tubes will thus not be changed due to extended periods of quiescent standby operation.

Contacts 4 and 5 of relay K302 are wired to terminals 3 and 6 of jack 308. Therefore in the standby condition, the grids of V307 and V308 are connected together, and these tubes will thus draw approximately equal plate currents. Average cathode emission requirements of these tubes will also be the same, with or without subcarrier signal. Similarly the triodes of V306 operate at approximately equal plate currents with or without subcarrier signal, because tubes V304 and V305 are always in an operative condition. Center frequency balance is thus stabilized over long periods of standby operation, through elimination of cathode emission hysteresis. In the event of signal failure the indicating meters return to zero or center frequency.

## 4.5 Power Supply Circuit

A conventional power supply is provided on the chassis to supply all heater and plate voltages for the discriminator circuits. Two 6 X 4 rectifiers V312 and V313 are used to conduct the approximate 130 milliamperes required. Tubes V301, V306, V307, V308, V309, V310 and V311 receive 300 plate volts unregulated. Supply voltage to all other tubes is 150 volts regulated. V314 is the regulator tube. This is an OA2, 150 volt regulator, and the socket is so wired that the negative return to the power transformer is opened when the tube is removed from it.

A test meter and test switch are provided on the front panel for checking plate supply voltages and currents. The switch is a six-position switch and is wired to measure the following:

Position 1 - Unregulated plate voltage
2 - Regulated plate voltage
3 - Total plate current
4 - Regulated plate current
5 - Plate current-tube V308
6 - Plate current-tube V307

Optimum operation of the equipment occurs with meter readings within the marked green range, but entirely satisfactory operation can be expected with meter readings between .7 and .9.

## 4.6 Discriminator Compensation Circuit.

A compensation input connection is provided in the discriminator. This may be used in making permanent oscillograph records from composite subcarrier signals which have been previously recorded on tape. External controls and connections for this circuit appear on the rear chassis wall adjacent to the power connector. In making a tape recording of

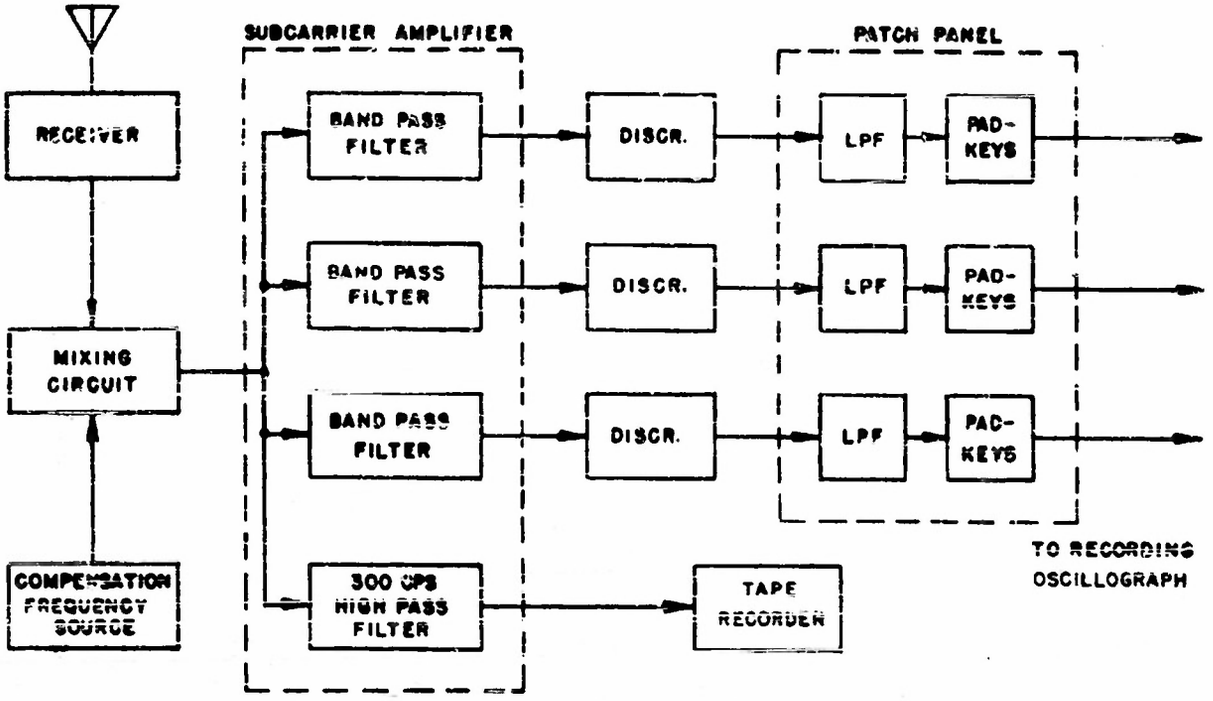
a composite telemetering signal, the recording mechanism sometimes introduces a frequency instability or wow. To minimize this effect when the recording is played back, and when the permanent separation record is made on the recording oscillographs, frequency compensation may be provided. The circuits which may be used are shown in Figure 21.

Circuit A shows a method of tape recording a composite telemetering signal. This method includes recording along with the composite video signal, a signal from the audio oscillator of selected frequency. The frequency used must be one which is not present in the composite video, but one for which a band pass filter is available. The signal from the receiver and audio oscillator must be mixed in a linear mixing circuit (not supplied) and fed to the 300 cycle high pass filter, and then to the recorder as shown. Other filters and discriminators may be used simultaneously if desired. The amplitude of the oscillator signal must be comparable to that of the composite signal. The frequency of the oscillator must be accurately adjusted to the center frequency of one subcarrier channel.

When at a later time, it is desired to obtain oscillograms from the composite tape recording, circuit B is used. As shown, the output from the tape recorder is connected to the filter/amplifier input jack in the receiver cabinet. Band pass filter/amplifiers and discriminators are connected for all subcarrier frequencies in the composite video signal. One additional band pass filter/amplifier (2) is used, with center frequency equal to that of the audio oscillator used during the original recording. The signal from this filter feeds and additional discriminator. Signals from terminals 8 and 10 (connector P301) of this discriminator are amplified in a DC amplifier (not supplied) and connected as shown to terminals 9 and 11 of P301 of all discriminators in use. Referring to the discriminator schematic, terminals 9 and 11 of connector P301 bring the signal from the DC amplifier to the compensation level adjusted R369. From there the DC voltage is applied through resistors R373 and R374 to the grids of the discriminator output tubes V307 and V308.

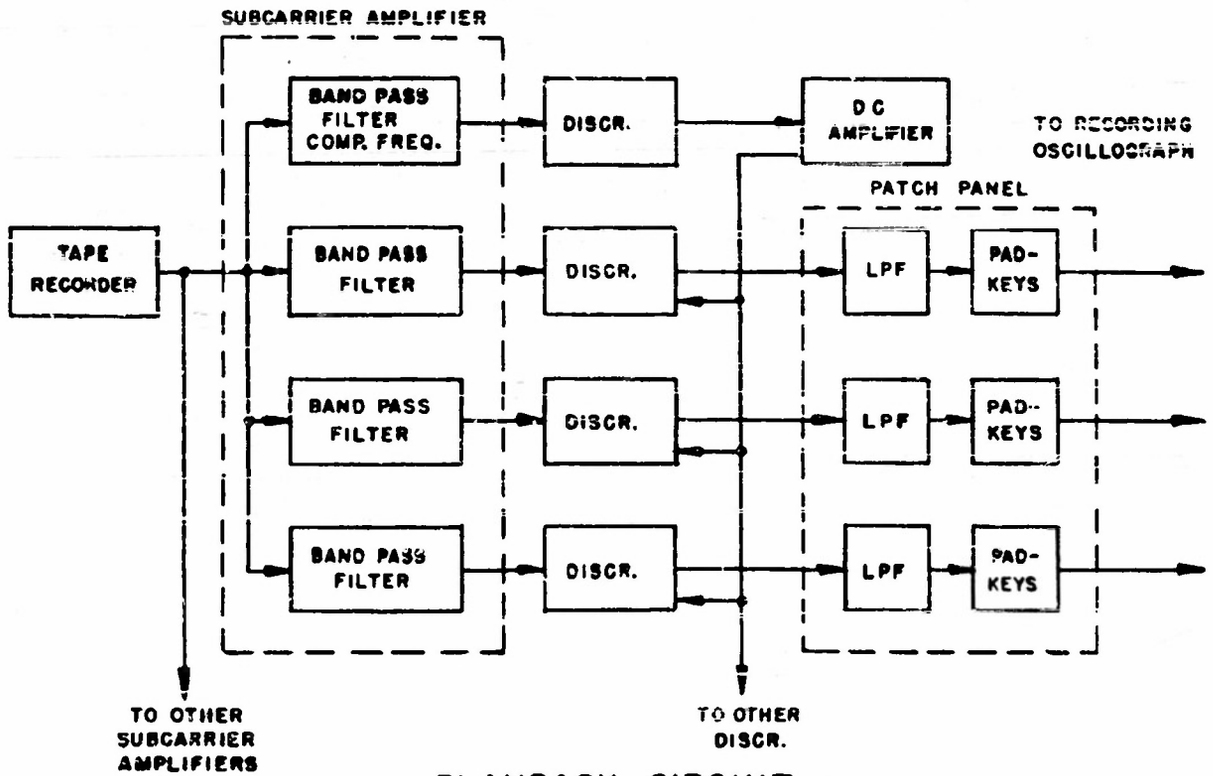
In operation, the signal from the audio oscillator is recorded on the tape together with the composite video signal. During the recording, any irregularity in tape velocity will cause frequency instability in the recorded signals. Again during playback additional frequency instability may be introduced. This effect may be minimized by proper use of the circuits shown.

In circuit B the DC output voltage from discriminator (1) will be a function of the recorded signal of the audio oscillator in circuit A. If during playback the frequency of this signal varies, the DC output voltage from the discriminator will vary. Similarly the frequencies of all subcarrier signals to all discriminators will vary and will cause a corresponding variation in all discriminator output voltages. The amplified output voltage from discriminator (1) is




AN OSCILLOGRAPHIC RECORDING MAY BE MADE
SIMULTANEOUSLY WITH THE COMPOSITE TAPE RECORDING

RECORDING CIRCUIT




PLAYBACK CIRCUIT

Figure - 21

SUGGESTED RECORDING COMPENSATION CIRCUITS I16316

applied to all other discriminator compensation circuits. When this voltage is of the correct polarity and amplitude, it will counteract the instability of output voltages from these discriminators, which is due to the recording instability. A polarity reversing switch S304, mounted on the front panel of the unit permits selection of the proper compensation polarity, and R369 permits adjustment of proper amplitude.

External phasing circuits may be required if the compensation signal frequency differs greatly from the subcarrier frequency, or frequencies in the composite signal. Since the amount and phasing of the distortion will depend on the recording equipment employed, it is suggested that initial adjustments be made with simulated signals. Incorrect wiring or adjustment could result in loss of an irreplaceable recording.

## 5.0 Oscillograph Control Panel See Figure 22

For ease of calibration and checkout all output signals are brought to the oscillograph control panel. Each channel has a reversing switch, a 330 ohm "T" pad, a signal interrupting key switch and, an output bridging jack.

The twelve discriminator outputs are connected to channels 1 to 12 inclusive, the receiver signal strength outputs to channels 13 to 16 inclusive. Channel 17 is used for timing signals and channel 18 is used for the 1 cps time base signal.

## 6.0 Oscillograph

The oscillographs are Consolidated Type 5-114 which are equipped to record 18 channels of information. Two oscillographs are used with each station. The galvanometers in one unit are in series with those in the other unit, to insure two identical records. Refer to CEC Instrument Manual.

## 7.0 Test and Calibration Equipment

### 7.1 Audio Oscillator See Figure 23

Accurately measured audio frequency calibration signals for the subcarrier amplifiers and discriminators are obtained from a Hewlett-Packard Audio Oscillator. Switches on the monitor panel connect the oscillator to any of the subcarrier amplifiers.

### 7.2 Frequency Meter See Figure 24 and 25

The frequency meter is a Berkeley Scientific Co. Model 554 Events-Per-Unit-Time-Meter which consists of five decade scaling units, a one second time base derived by division from a 100 kilocycle crystal standard, appropriate gating circuits, and a regulated power supply. Signals of unknown frequency, of sine wave or other recurring wave form are shaped by input amplifiers and are then fed to a gating circuit which is controlled from the one second time base. The count, equal to

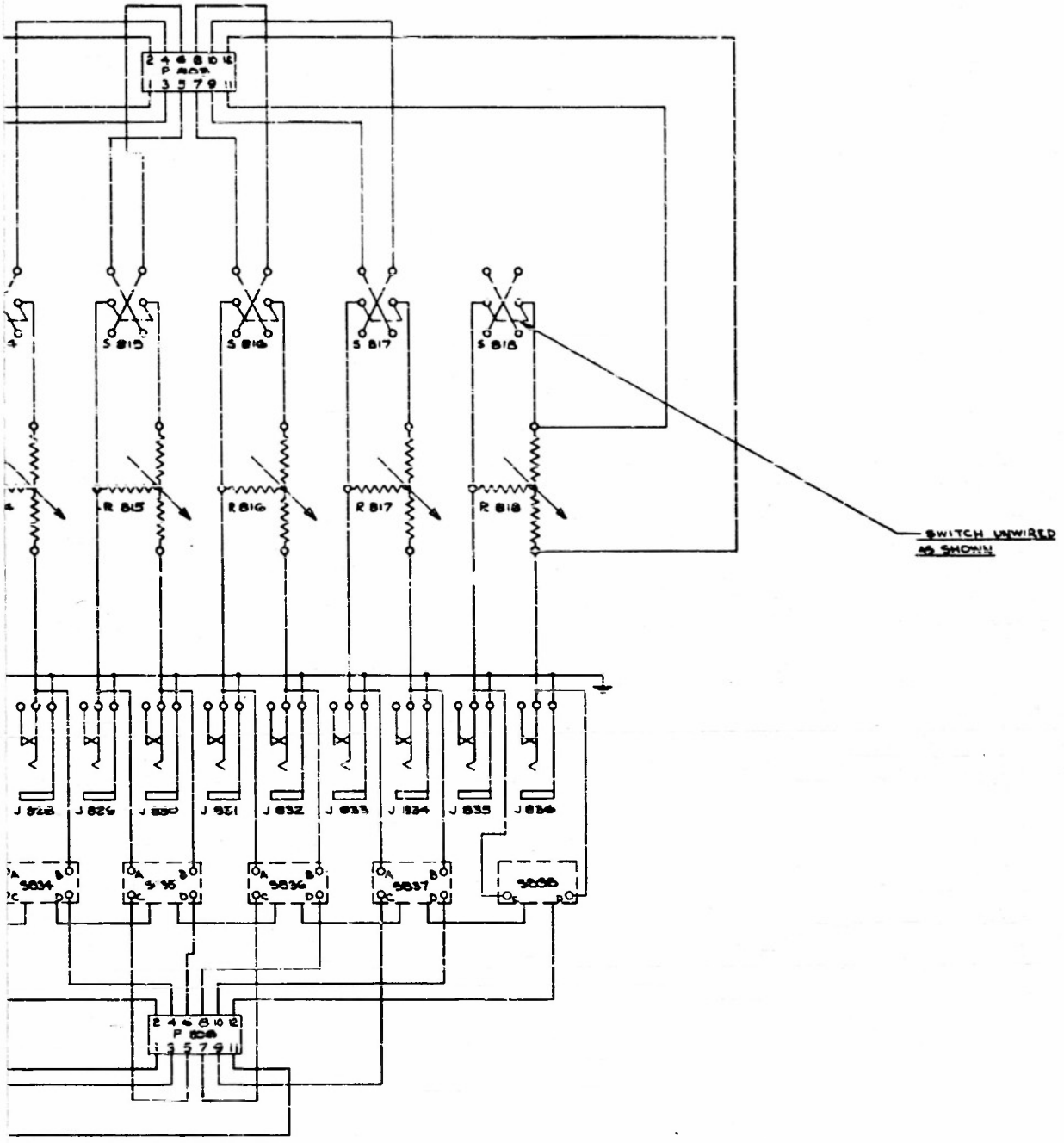



Figure 22 - Schematic, Oscillograph Control Panel

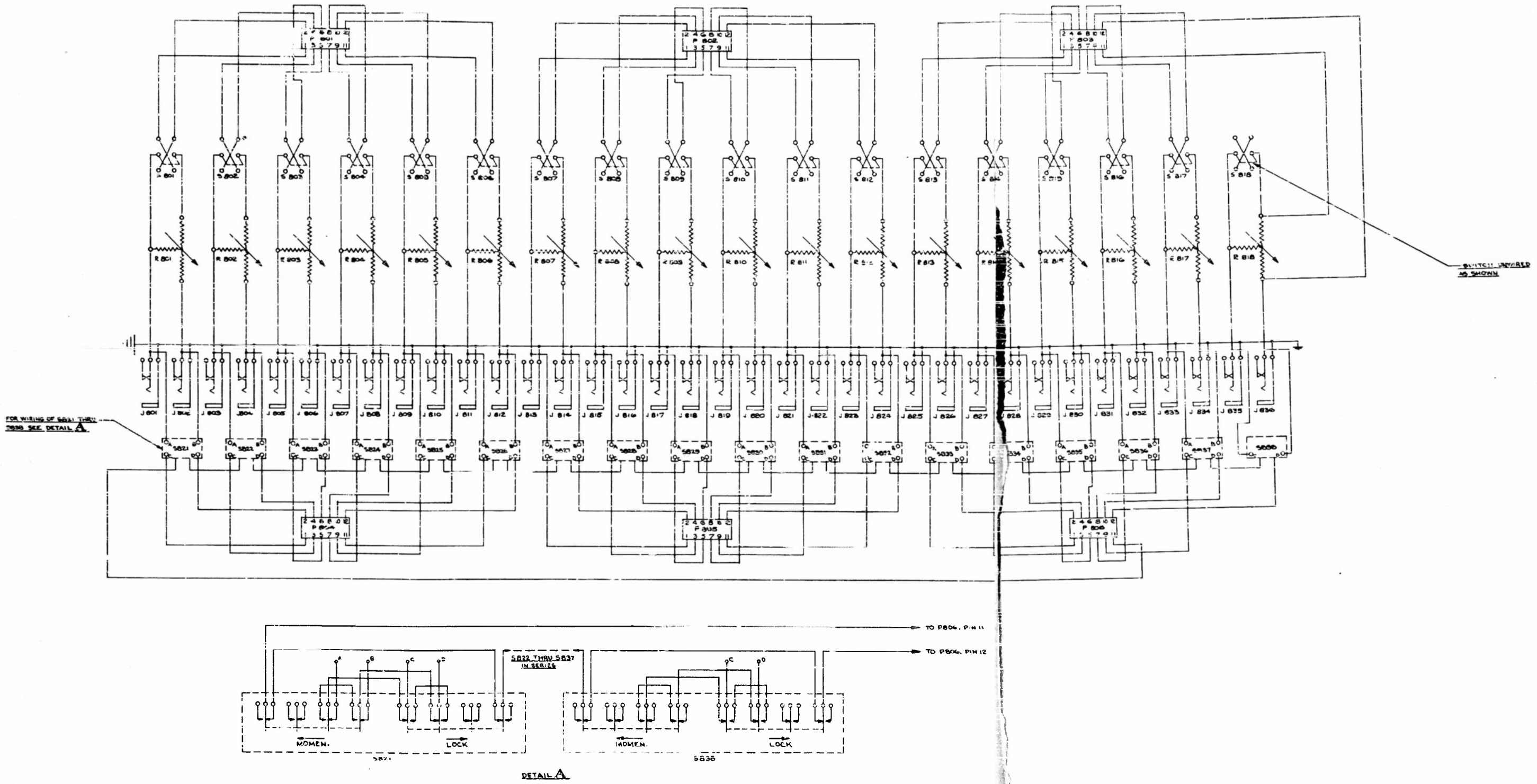



Figure 22 - Schematic, Oscillograph Control Panel

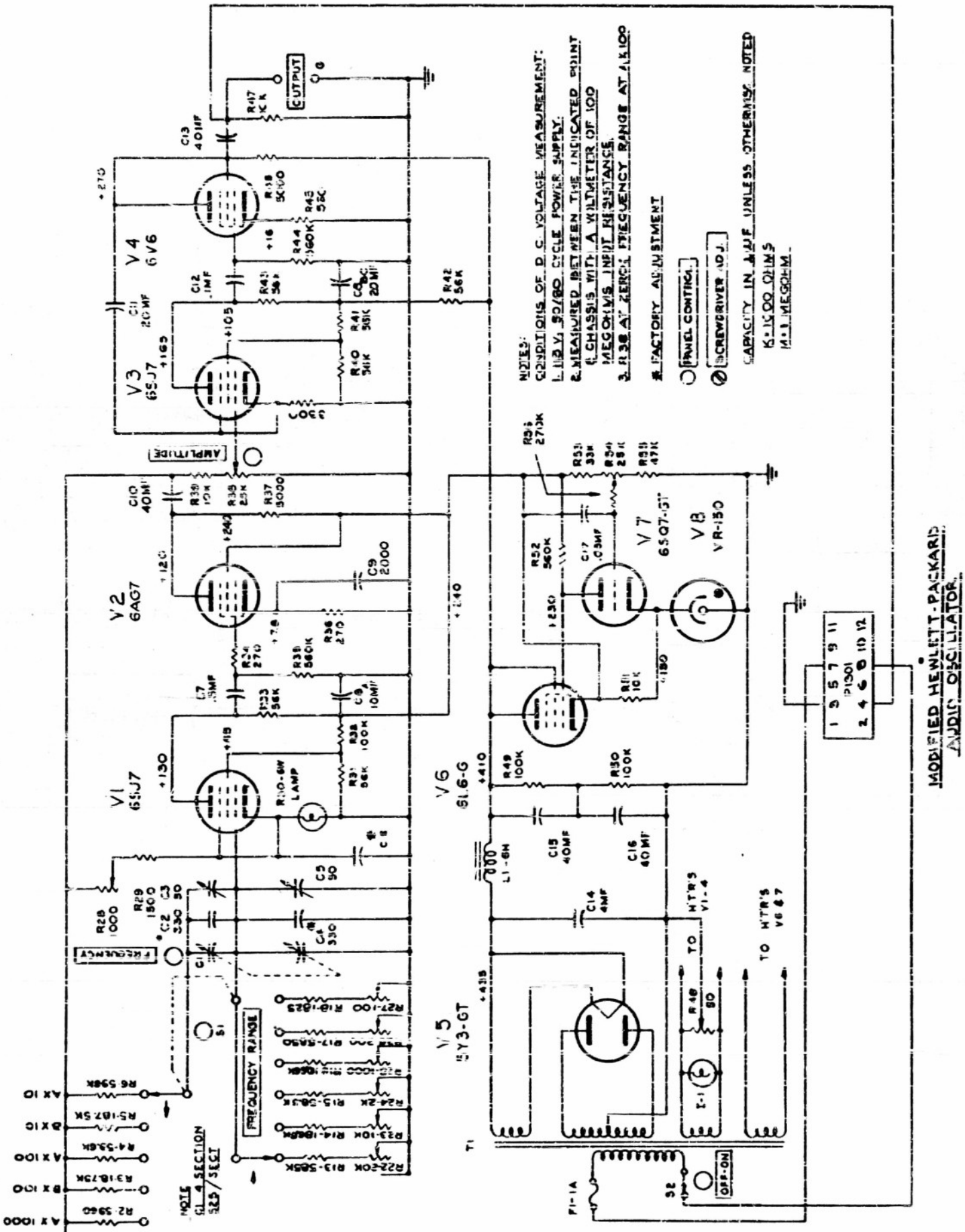



Figure 23 - Schematic, Modified Audio Oscillator

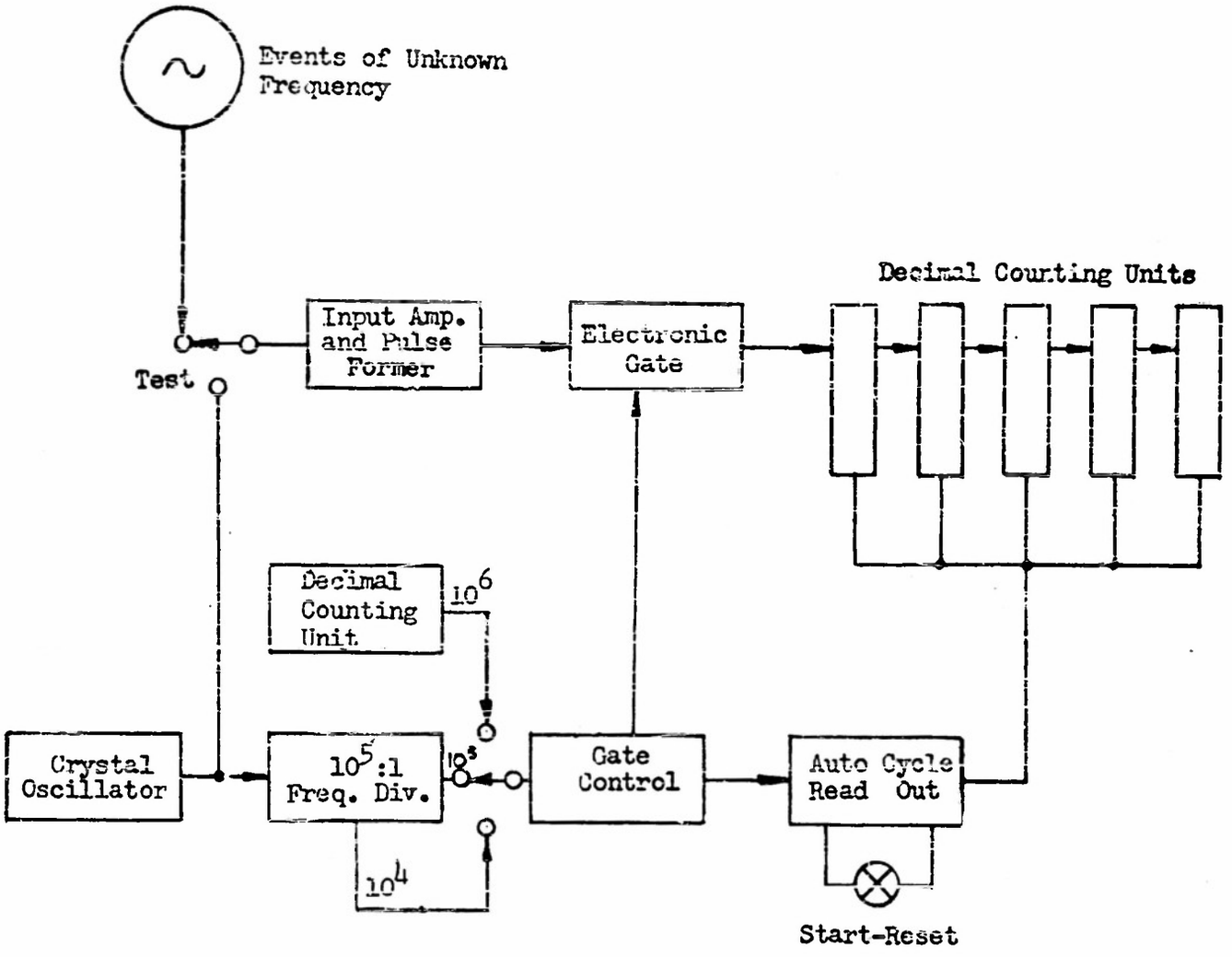
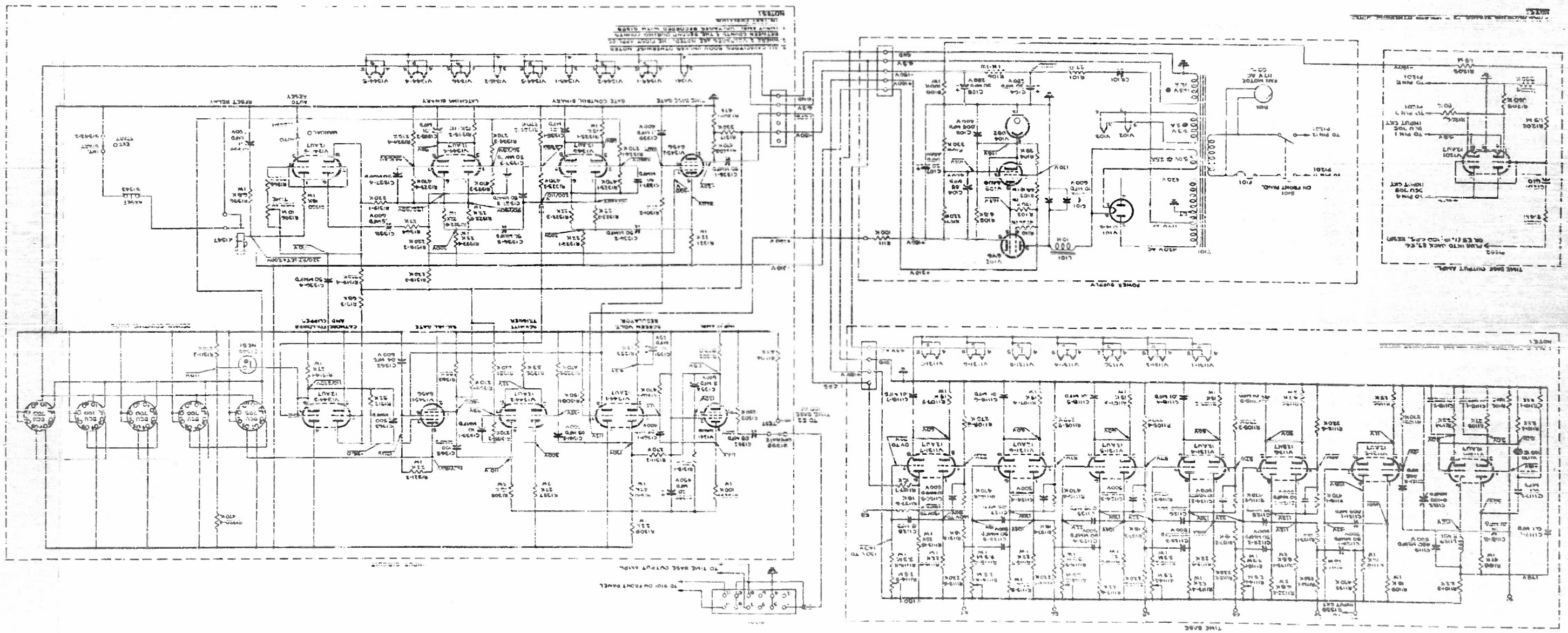
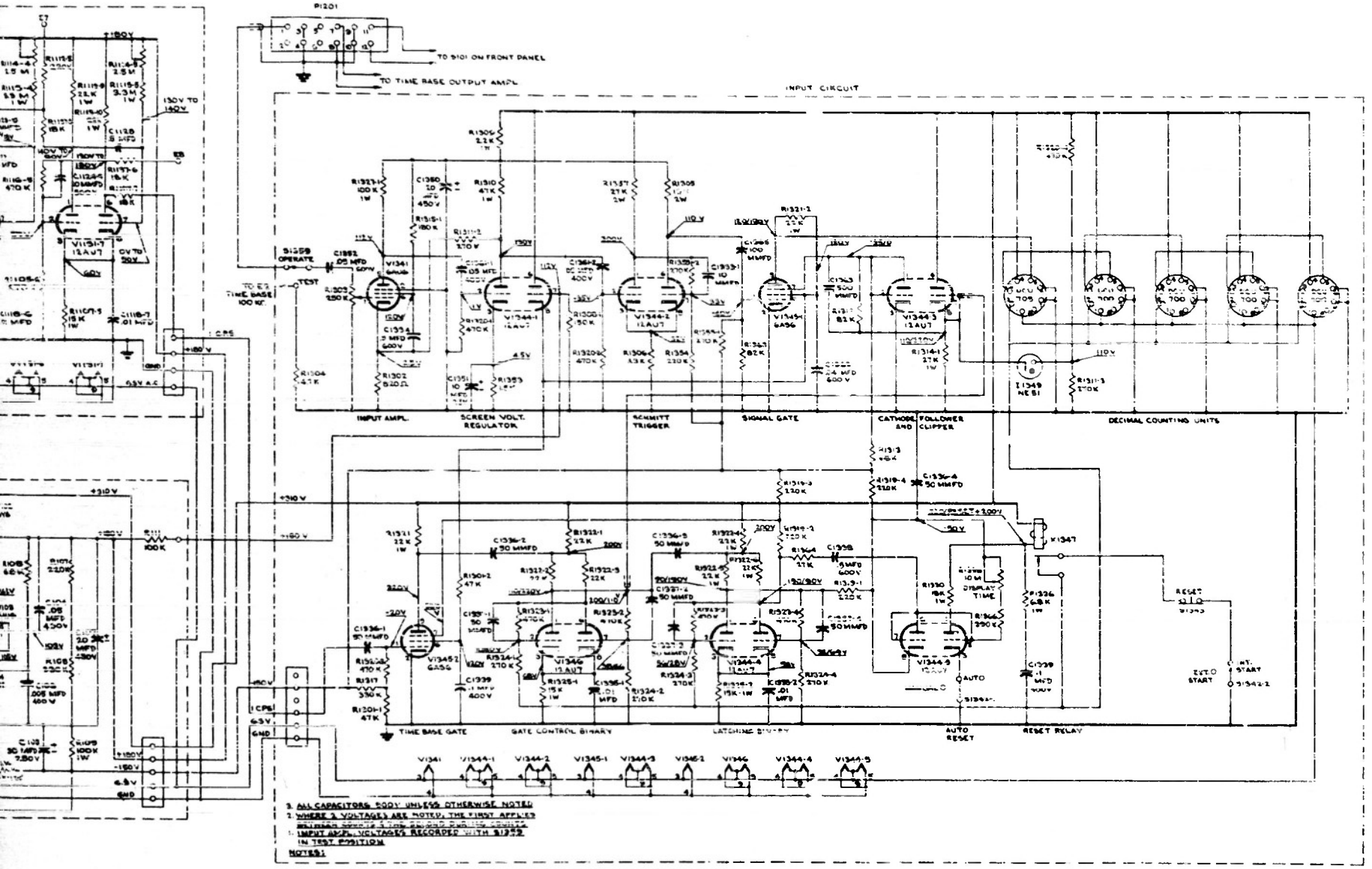


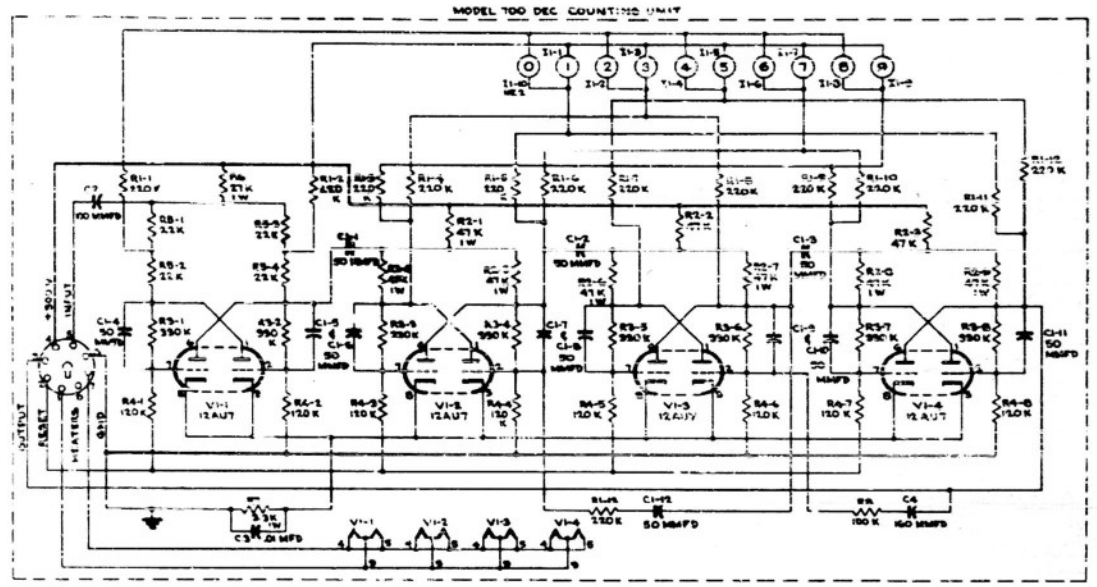

Figure - 24 BLOCK DIAGRAM EPUT METER

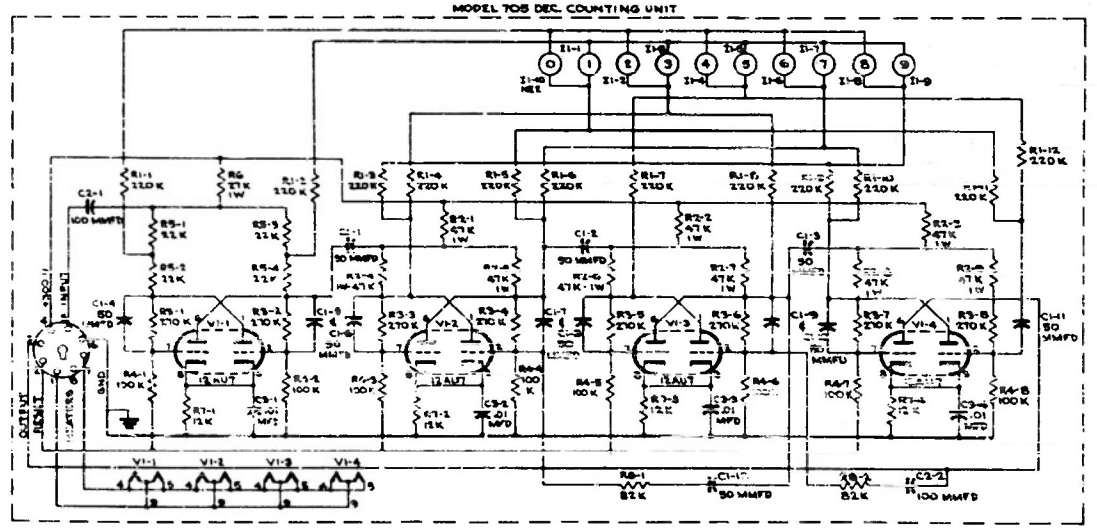


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SCHEMATIC, MOD. EPUT METER

Figure 25 - Schematic, Berkeley EPUT Meter

the unknown frequency, is displayed until the unit is reset or turned off. The unit may be reset manually or automatically. The automatic reset may be adjusted to display the count (unknown frequency) from about one to three seconds. Since the count requires one second, a one second display means that the unit recycles at a two second rate. This rate permits rapid adjustment of the audio oscillator and calibration of discriminators and galvanometers. Accuracy of the unit is ±10 parts per million plus one cycle.

7.3 Monitor Panel See Figure 26

The Monitor Panel combines a Millen Oscilloscope, a Measurements Corporation Vacuum Tube Voltmeter, function and selector switches.

Signal output from the receivers and the subcarrier amplifiers may be viewed on the oscilloscope, and measured on the V.T.V.M. Calibration voltages from the audio oscillator may be switched to each channel. Frequency meter may be switched to calibration or received signal for accurate determination of frequency. A recorder control switch is provided to control the recording oscillograph motor.

8.0 Miscellaneous Equipment

8.1 Regulated Power Supply See Figure 27

The regulated power supply furnishes plate and filament power for the subcarrier amplifier.

8.2 Low Pass Filter Chassis See Figure 28

The low pass filter chassis provide mounting and connections for four output channels. Only three are used in this station, each channel being equipped with a low pass filter of 210 cycles cutoff frequency. A switch to bypass the L.P. filter is also provided. The low pass filter frequency response curve is shown in Figure 29.

8.3 Blower Panel See Figure 30

The blower panel contains a centrifugal blower and a dust filter arranged to supply filtered air to two air ducts at the back of the cabinet. Also provided is a master power circuit breaker for control of power to the cabinet and a duplex output receptacle for convenience.

8.4 Blower Units

Two small centrifugal blower units are mounted at the rear of the small cabinet to provide ventilation. In this case the dust filters are mounted on the side of the cabinet.

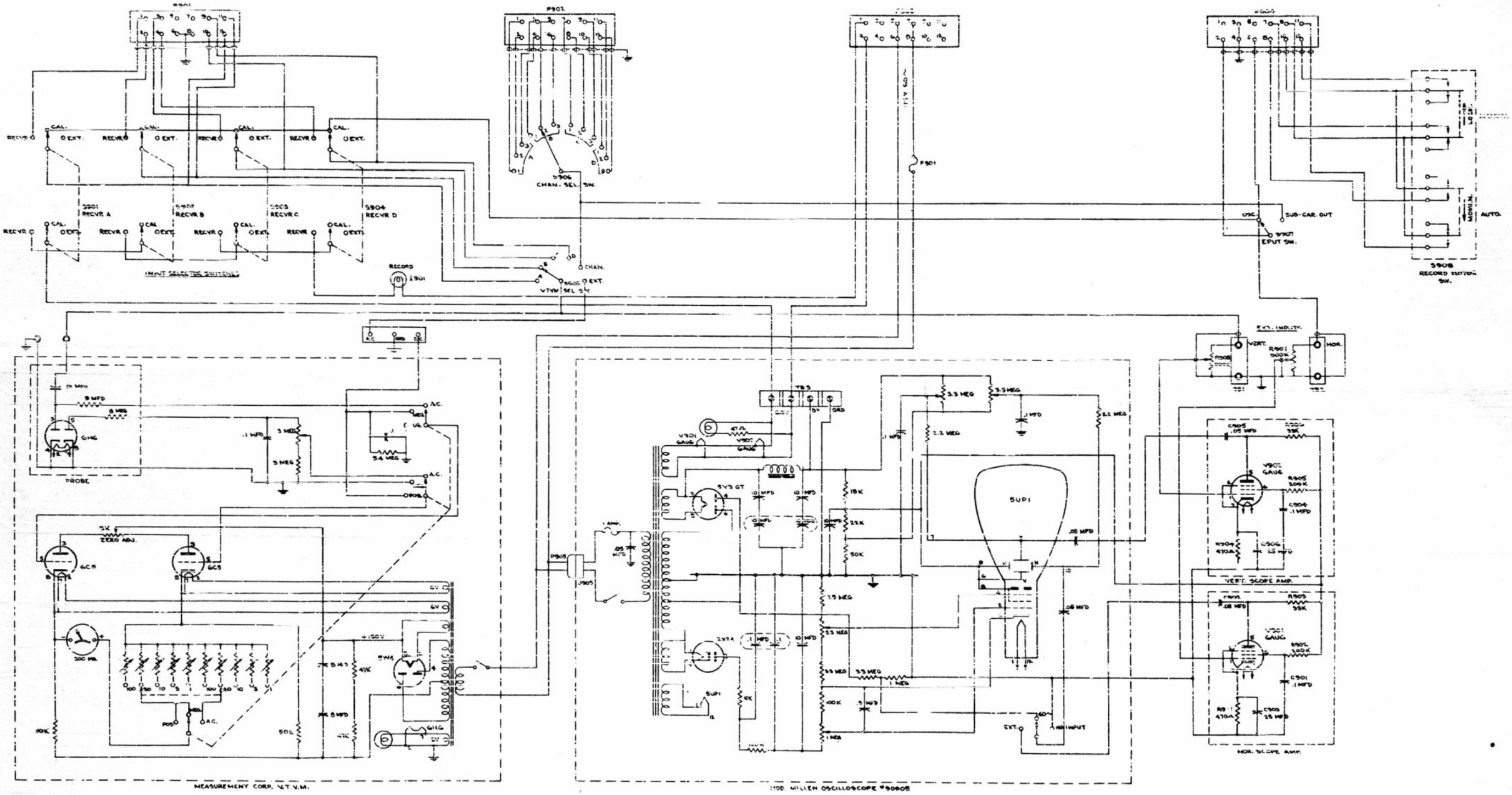
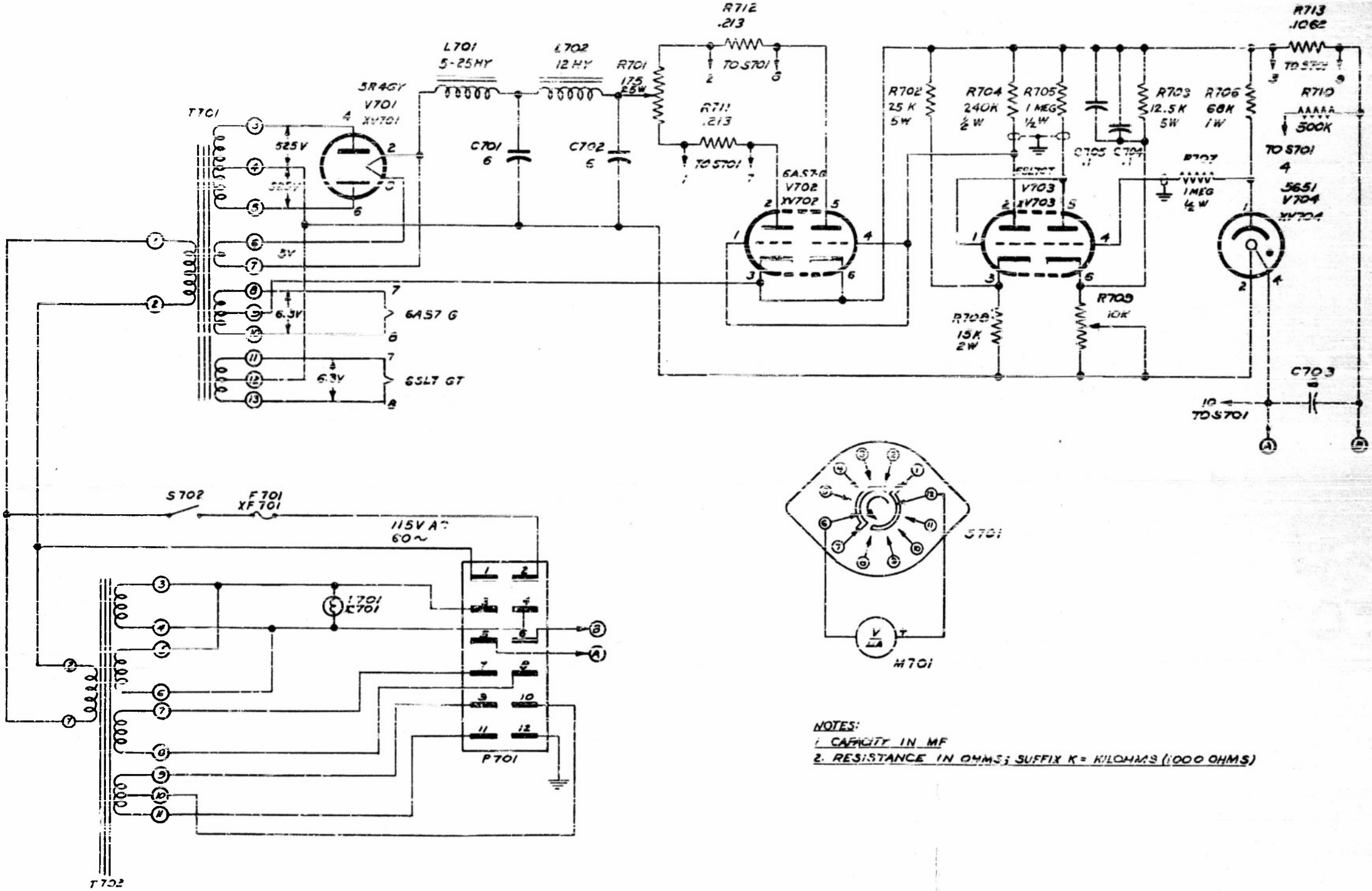


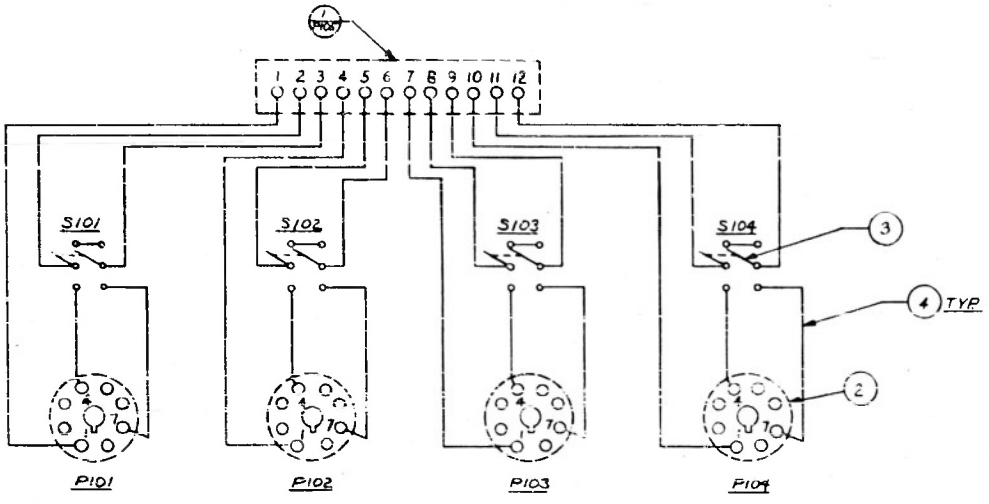

Figure 26 - Schematic, Monitor Panel




NOTES:
1. CAPACITY IN MF
2. RESISTANCE IN OHMS; SUFFIX K = KILOHMS (1000 OHMS)

Figure 27 - Schematic, Regulated Power Supply

| CIR. SYM. | REQ'D NO. | NO. USED | PART NO. | DESCRIPTION |
|---|---|---|---|---|
| P105 | 1 | 1 | [illegible] | PLUG, CANNON |
| P101 THRU P104 | 2 | 4 | 86CP8 | PLUG, AMPH. - OCTAL |
| S101 THRU S104 | 3 | 4 | TYPE 2081-0 | SWITCH, TOGGLE - 4 METH - DPDT |
| | 4 | AS REQ | 560243 | WIRE #22 GAGE WHITE NEOLAN |




| CIR. SYMB. | P101 | P102 | P103 | P104 |
|---|---|---|---|---|
| INPUT | 2 | 5 | 8 | 11 |
| OUTPUT | 3 | 6 | 9 | 12 |
| COMMON | 1 | 4 | 7 | 10 |

Figure 28 - Schematic, Low Pass Filter Mounting Assembly

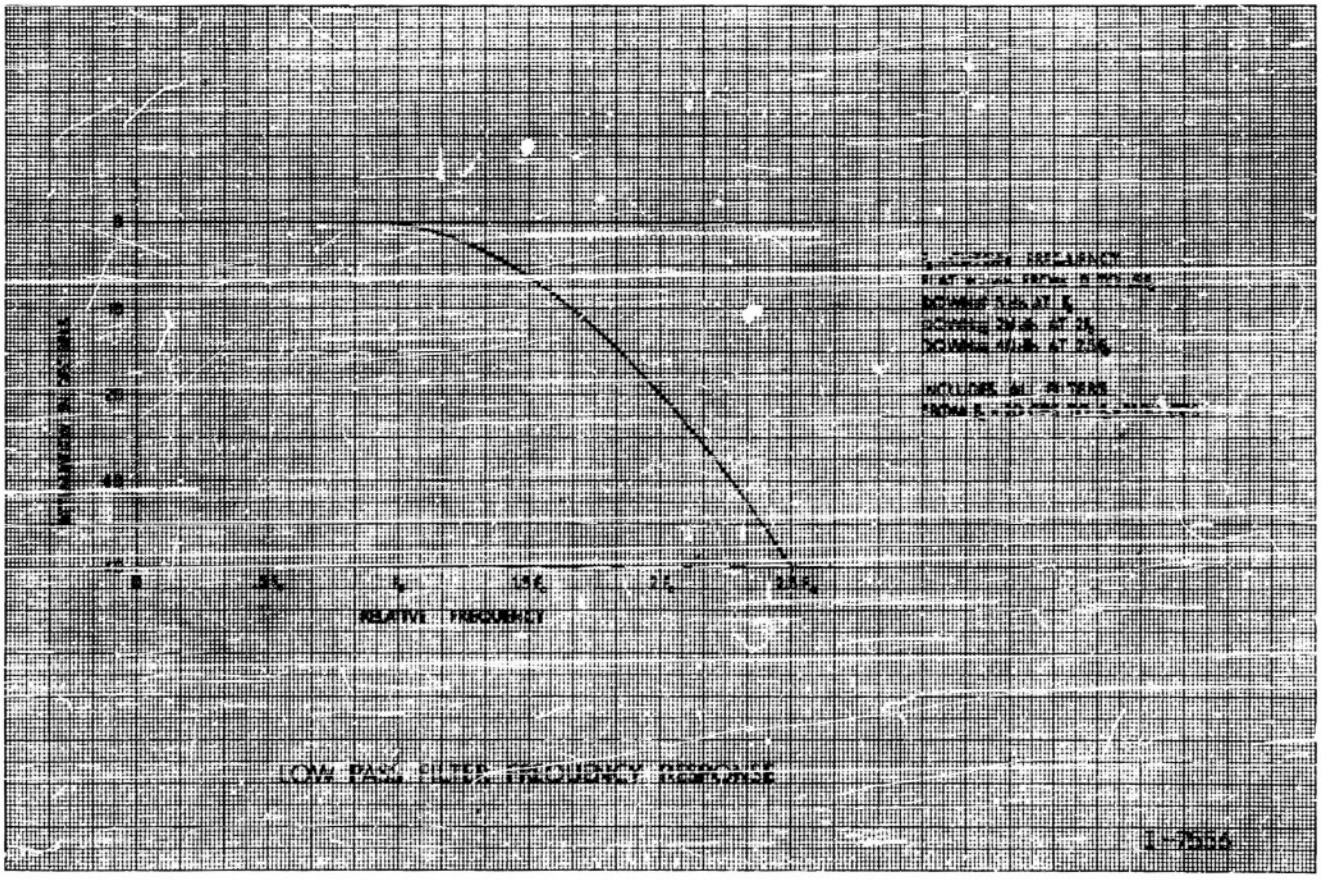



Figure 29 - Low Pass Filter Frequency Response

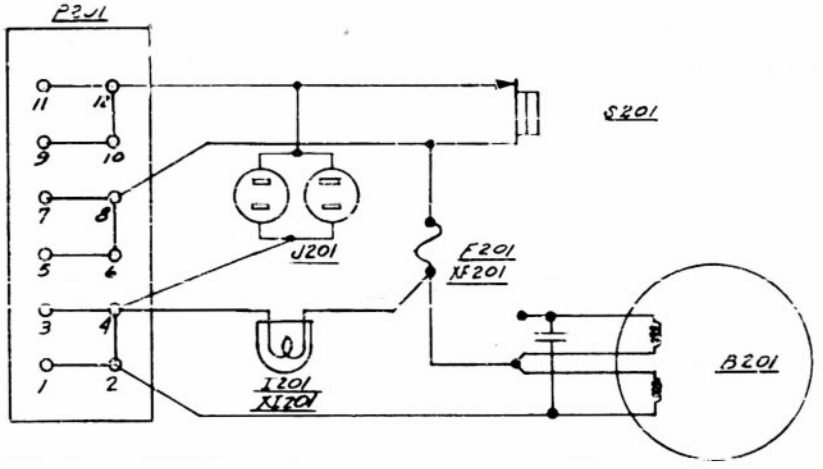



Figure 30 - Wiring Diagram, Panel Intake Blower

| CIRC. SYM. | ITEM NO. | NO. REQ. | PART NO. | DESCRIPTION |
|---|---|---|---|---|
| S401 | | 1 | 0411 | BREAKER- SINGLE POLE MINIATURE, 30 AMP |
| S402 | | 1 | 0611 | BREAKER- SINGLE POLE HEINEMAN-15 AMP |
| I401 I402 XI401 XI402 | | 2 | 656 | LIGHT, PILOT- 115 V MAZDA |
| J401 | | 1 | 1913 | OUTLET, DUPLEX, A.N.S.N. |
| | | AS REQ. | 533285 | WIRE- #14GA. WHITE NEOLAY (COND. STRAND) |
| | | AS REQ. | | WIRE- #10GA. WHITE NEOLAY (COND. STRAND) |
| | | AS REQ. | 533283 | WIRE- #18GA. W.H. NEOLAY (COND. STRAND) |

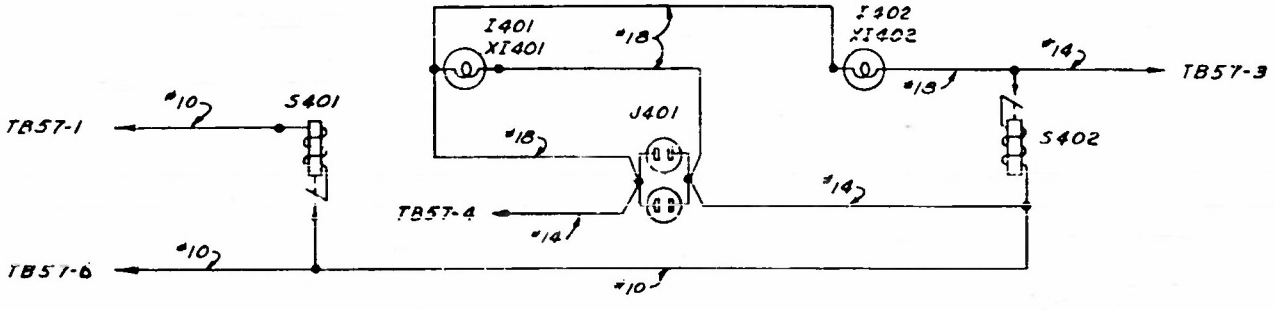



Figure 31 - Wiring Diagram, Master Power Control Panel

8.5 Master Power Control Panel See Figure 31

The master power power panel contains two power circuit breakers; one for the control of power to the control cabinet and the other for control of power to the entire station.

# SECTION III

# OPERATION

## 1.0 General

The Bendix Y10980 Telemeter Receiving Stations are installed in special trailers, two stations and a voltage regulator to each trailer.

The stations are entirely separate and can be operated independently or similtaneously. They are mounted along each side of the trailer. The right hand side layout is shown in Figure 2. The left hand side is a mirror image of the right, with the exception of the location of one recorder. For convenience in operation, all controls are located near the recorders.

The equipment is so arranged that under normal operating conditions no external connections, cords or plugs are required for operation or calibration. Calibrate and operate switches are interconnected to indicate by means of a "RECORD" light the proper operating position.

The station is assembled with a separate RF channel for each large cabinet. The RF channel consists of a receiver, subcarrier amplifier, three discriminators and three low pass filters. The first and second subcarrier amplifiershave separate power supply unit mounted in the third cabinet. Accordingly each RF channel can be operated separately or in combination with one or more of the others. The Monitor Panel which includes the calibration switches,VTVM and Scope is mounted in the fourth cabinet. The calibration oscillator, frequency meter and the oscillograph control panel are mounted in the fifth or short cabinet.

In addition each large cabinet is equipped with a Blower Panel which includes a master circuit breaker for the equipment in that cabinet. The short cabinet is equipped with a Master Power Panel which includes a master circuit breaker for the equipment in the cabinet and also the main circuit breaker for the complete station. All circuit breakers and AC switches are equipped with pilot lights to indicate operating conditions.

## 2.0 Energizing Station

2.1 Turn "ON" main breaker on master power panel; pilot light should indicate.

2.2 Turn "ON" master breaker for each cabinet; pilot light should indicate and blowers should operate.

2.3 Turn "ON" power switches of each unit. All power switches have associated pilot lights which should indicate.

## 3.0 Check on Station Operating Condition

3.1 Note that all pilot lights are lighted.

3.2 Check that line voltage on voltage regulator is 115 to 120 volts. This voltage may be adjusted at the voltage regulator by means of the voltage control at the left of the meter on its front panel. The regulation or sensitivity control is located to the right of the meter. To set this control properly, turn the control clockwise until the regulator begins to hunt. Then back off the control until the hunting stops.

3.3 Use the built-in testing circuits for rapid checking of the units.

3.3.1 **Filter Amplifier:** A nine point test switch on the front of each filter amplifier chassis permits checking the plate current to each of the six tubes. In the T position the total plate current to all these tubes is measured. The meter reading should lie between .7 and .9 in each test position.

3.3.2 Regulated Power Supply: The regulated power supply has a testing circuit controlled by the four position switch on the panel. Positions 1 and 2 check the current through each triode of V702. The currents should be approximately equal. Position 3 checks the total plate current output. Position 4 checks output voltage. This should be approximately 250 volts.

3.3.3 Discriminators: Each discriminator also has its own testing circuit controlled by the 6-point panel switch. This circuit checks regulated and unregulated plate currents and voltages. All switch positions should indicate between .7 and .9 on the test meter. The output meter should read center scale, and the input meter should indicate zero when the input control is set to zero input.

## 4.0 Qualitive Check of Station Performance

### 4.1 Discriminators

4.1.1 The switching circuit on the monitor panel is arranged to test each subcarrier amplifier with its three associated discriminators. There are four subcarriers amplifier chassis A to D inclusive. The following procedure is given to test A channel and should be repeated for the other channels using the switches for that channel.

4.1.2 On mointor panel turn input selector switch for receiver A (S901) to calibrate, ("CAL and VTVM selector switch (S905) to A. (This connects the audio oscillator to the input of the subcarrier amplifier and bridges the VTVM across the input).

4.1.3 Set audio oscillator to 7350 cycles and adjust the output for 1 volt.

4.1.4 Set gain of all discriminators to maximum.

4.1.5 Adjust gain of No. 1 subcarrier amplifier until input meter on No. 1 discriminator (7.35kc) reads approximately midscale.

4.1.6 Repeat (4.1.5) for #2 channel with the oscillator set at 10500 cycles.

4.1.7 Repeat (4.1.5) for #3 channel with the oscillator set at 14500 cycles.

4.1.8 Swing oscillator frequency from 6000 cycles to 9000 cycles. The No. 1 discriminator output meter should swing to extreme left scale, back to center as 7350 cycles is approached, to extreme right scale and back to center as the frequency is increased. No. 2 and 3 discriminators should indicate zero (center scale).

4.1.9 Continue to increase oscillator frequency and watch the performance of successive discriminators. Each input meter should read, in the proper band of frequencies.

4.1.10 Each meter should swing to extreme left scale to extreme right scale and back to center as frequency is increased and should swing through center at the center frequency of the discriminator. If the discriminator frequency does not stay within limits, the discriminator should be replaced or recalibrated in accordance with calibration procedure given in Section IV.

4.1.11 Repeat complete procedure for group B, C, and D equipment.

## 4.2 Filter Amplifier

The filter amplifier can be checked separately by reading input and output voltages on the VTVM.

4.2.1 On monitor panel turn input selector switch for receiver A (S901), function selector switch (S907), and VTVM selector switch (S905) to the calibrate position ("CAL").

4.2.2 Adjust the audio oscillator output for a 1 volt reading on the VTVM.

4.2.3 Turn gain control of each channel of the filter amplifier to maximum.

4.2.4 Switch VTVM to output of filter amplifier by switching VTVM selector switch (S905) to "CHAN", and channel selector switch (S906) to channel "A1".

4.2.5 Set the oscillator to 7350 cycles and note output voltage on VTVM. It should measure approximately 12 volts.

4.2.6 Repeat 4.2.4 and 4.2.5 for channels "A-2" and "A-3", using frequencies of 10500 and 14500 cycles respectively.

4.2.7 Repeat 4.2.4, 4.2.5 and 4.2.6 for B, C, and D filter amlifiers.

4.2.8 Response of band pass filters may be checked by slowly swinging oscillator over the appropriate band and noting a decrease in discriminator output at the band edge frequencies.

## 4.3 Receiver

Turn up the audio gain on the receiver and tune in a signal. Listen for audio signal from the speaker. Observe operation of the two meters on the receiver panel as the tuning dial is rotated through a signal. For turnable receivers only, the zero center meter should swing right, then left, as the receivers is tuned through a carrier. The other meter indicates carrier signal strength. Check antenna system for proper connection and orientation.

## 4.4 Vacuum Tube Voltmeter

To check the vacuum tube voltmeter, turn input selector switch (S901) for receiver "A" to calibrate position and the VTVM selector switch (S905) to "A". Set the VTVM on AC and as the oscillator output is varied, the VTVM reading should vary also.

## 4.5 Audio Oscillator and EPUT Frequency Meter

The oscillator and frequency meter may be used as a check on each other. Set EPUT selector switch on oscillator. After warmup period, indicated frequency on oscillator should appear on the frequency meter. The frequency meter may also be self checking using an internal test circuit. Set the controls of the frequency meter as follows: Auto-manual on manual, display time, extreme counter clockwise. Start, on Internal Start. Operate-TEST, on test. Sensitivity, extreme clockwise. The frequency meter should display a number every two seconds. The number should be either 00000 or 99999. Move Operate-Test to operate. Set the audio oscillator successively to various frequencies from about 400 cycles to 30,000 cycles. The frequency of the oscillator

should be reliably indicated on the frequency meter. Differences of one cycle on successive counts of the same frequency will sometimes occur. This is a normal condition. Adjustment of sensitivity control may be required to obtain satisfactory counting action. The audio oscillator may also be checked for voltage and waveform of output by patching to the VTVM and the oscilloscope.

## 5.0 Telemetering Pre-operation Program

### 5.1 Operational Plan

In most cases it will never be possible to repeat an operation. The greatest possible care and precaution must therefore be exercised in preparing for, and in operating the station during the operation. The most experienced station operator will occasionally overlook some important detail. Therefore, there are a number of precautions which should be taken.

There must be two qualified station operators present, prior to and during the operation. Each man must have a check list of operations and adjustments for which he is responsible. He must check off each item on the sheet as he makes the adjustments. These sheets must be dated, signed, and provide a permanent record for future reference, of the station operation.

A complete and detailed operation plan must be prepared prior to the flight. This plan should show every step and operation to be made, preparatory to the launching, and may cover a period of several hours, depending upon the amount of preparation required. The times of major operations must be shown. As a part of the flight plan, detailed application information showing galvanometer setup must be prepared. Because the telemetered functions, the recording medium, and the recording galvanometers are intimately related, this must be prepared by those in charge of the telemetering station, in close cooperation with those in charge of the project. A knowledge of what functions are to be telemetered, their amplitudes, and frequencies or rates of change, is required. Familiarity with the characteristics of the galvanometers, such as sensitivity, element frequency response, and damping characteristics is necessary, in addition to a knowledge of the setting up of the galvanometers in the recording oscillograph. Also, experience in the use of recording mediums, is required. Information regarding films and papers, types, speeds, and exposure characteristics is obtainable from the manufacturers. Paper for telemeter recording is manufactured by Eastman.

Film for telemeter recording is manufactured by Eastman, Ansco, and DuPont. Ozalid paper is obtainable for making paper records from films.

## 5.2 Station Preoperation Checkout

To minimize the possibility of telemetering failure, resulting from station operating errors, the following checkout procedure is suggested. Additions or modifications may be necessary in order to conform to the firing schedule, or to special requirements of a particular flight. Operators must check each item deliberately, regardless of previous checks or inspections.

5.2.1 Not later than minus one day preceding test.

5.2.1.1 Check all reference circuits such as zero time, range time, and 1 cps time base signals.

5.2.1.2 Check communication facilities.

5.2.1.3 Inspect antenna system. Check all coaxial connectors. Check movement and orientation of rotatable antennas and measure leakage resistance.

5.2.1.4 Check power facilities. Check fuel, lubrication and battery levels, PE-95K engine-generator. Check frequency and voltage output of unit under full load conditions.

5.2.1.5 Check all connections, switches and fuses.

5.2.1.6 Check performance of telemetering receivers.

5.2.1.7 Check test meter readings on filter amplifier chassis.

5.2.1.8 Check operation of all discriminators for:

Correct setting of sensitivity control (Full scale meter deflection at band limits.)

Linearity and zero deflection at band center-frequency.

Limiting action.

Correct test meter readings.

5.2.1.9 Adjust oscillograph recorders for desired film or paper speed. Check take-up system.

5.2.1.10 Adjust recording lamp intensity to correct value for paper or film and recorder speed.

5.2.1.11 Load and install oscillograph magazines. (Run five-foot leader while observing paper feed operation. Load at least one spare magazine per trailer.

5.2.1.12 Check operation oscillogram numbering device.

5.2.1.13 Adjust galvanometer band center frequency setting and polarities in accordance with predetermined band requirements, as given in the oscillograph set-up forms for a specified operation. Adjust input attenuators to provide desired galvanometer deflections.

5.2.1.14 Check galvanometer band end limit points for equal distance from band center frequency point.

5.2.1.15 Determine that all spare materials and equipment are on hand and ready for immediate use.

5.2.1.16 Compile a detailed RECEIVING STATIONS OPERATIONAL PLAN.

5.2.2 At approximately -5 hours, turn on all equipment and check for proper operation at frequent intervals.

5.2.3 At approximately -4 hours --

5.2.3.1 Check oscillograph paper feed.

5.2.3.2 Check operation of timing lines motor.

5.2.3.3 Check recording lamp voltage and operation.

5.2.3.4 Check galvanometer identification system operation.

5.2.3.5 Make preliminary balance on discriminators and check band center frequency setting, polarity and excursion of galvanometers.

5.2.3.6 Check setting, polarity and excursion of zero time, functions range time, and 1 cps time base galvanometer traces.

5.2.3.7 Check inter-trailer communications.

5.2.3.8 Fill out oscillogram identification record in preparation to making entries through the test.

5.2.4 At approximately -3 hours.

5.2.4.1 Make signal strength calibration on all receivers using the following steps: 0, 5, 10, 25, 50, 250, and 500 microvolts.

5.2.4.2 Obtain accurate time check and synchronize all clocks.

5.2.4.3 Scan frequency spectrum to determine possible presence of interfering signals.

5.2.5 At approximately - 2 hours.

5.2.5.1 Recheck communication facilities.

5.2.5.2 Recheck engine-generator performance.

5.2.5.3 Recheck performance of all receiving station equipment.

5.2.5.4 Recheck all reference signals.

5.2.5.5 Recheck antenna system.

5.2.5.6 Recheck clock time and clock synchronization.

5.2.6 At approximately - 1 hour

5.2.6.1 Recheck zero balance with center test switch operated on each discriminator.

5.2.6.2 Make final center frequency (zero output voltage) balance of each discriminator, using fine balance control with center frequency applied. Use galvanometer trace as indicator.

5.2.7 At approximately - 45 minutes.

5.2.7.1 Calibrate all discriminators, making three recordings; +7.5% of center frequency, center frequency, ar' -7.5% of center frequency for each subcarrier frequency used.

5.2.7.2 Scan frequency spectrum for interfering signals.

5.2.8 At approximately - 15 minutes (Final equipment check)

5.2.8.1 Recheck all equipment operation as time permits.

5.2.8.2 Turn on the telemetering receivers.

5.2.8.3 Audio oscillator gain control in off position.

5.2.8.4 Check presence of reference signals.

5.2.9 At - 5 minutes (Approximate time of receiving signals.)

5.2.9.1 Set RCVR-CAL selector switch to RCVR.

5.2.9.2 Turn on all galvanometer switches.

5.2.9.3 Rotate antennas for best signals on all receivers.

5.2.9.4 Standby to record.

5.2.10 At approximately - 1 minute

5.2.10.1 Begin continuous recording of oscillograph recorder until loss of all signals or until a minimum of 25 feet of paper remains for a post-test calibration.

5.2.11 At end of test.

5.2.11.1 Calibrate all discriminators using the nine-point calibration as outlined in the Receiving Station Calibration section of this manual.

## 6.0 Calibration and Data Reduction Procedures

### 6.1 Receiving Station Calibration

Calibration of the receiving station is accomplished by feeding a series of known audio frequency signals into the appropiate station discriminators. By feeding a series of nine frequencies for each subcarrier channel into the discriminators, a series of nine voltage outputs, and consequently nine galvanometer deflections will be obtained and hence a calibration curve of frequency versus galvanometer deflection will be obtained. The values of the calibrating frequencies used for each of the allotted subcarriers are as follows:

| 7.35kc | 10.5kc | 14.5kc |
|---|---|---|
| 6800 | 9700 | 13,400 |
| 6900 | 9800 | 13,600 |
| 7000 | 10,000 | 13,900 |
| 7150 | 10,200 | 14,200 |
| 7350 | 10,500 | 14,500 |
| 7550 | 10,800 | 14,800 |
| 7700 | 11,000 | 15,100 |
| 7800 | 11,200 | 15,400 |
| 7900 | 11,300 | 15,600 |

A short recording is made on the oscillograph for each different calibrating frequency fed into the discriminators. Since the output of each discriminator is connected to galvanometer in the oscillograph, each change in the frequency of the signal introduced to the discriminator results in a corresponding change in the deflection of that particular galvanometer's trace on the recording paper. After these records are developed, the galvanometer deflection of each channel is measured from a reference trace and recorded for each input frequency to the discriminator. Thus a discriminator calibration curve of galvanometer deflection versus frequency can be plotted to be used in data reduction.

## 6.2 Pickup Calibration

The various types of telemetering pickups are used as the frequency-determining component of an oscillator. By applying accurately measured function values to the pickup, a calibration curve of function value versus oscillator frequency can be obtained. When the pickups are installed in a missile, the subcarrier oscillators are padded to the frequency taken from the calibration curve for the function value which exists (or applied) on the pickup in order for the calibration curve to apply.

## 6.3 Data Reduction

After each telemetered flight, the oscillograph record is processed and marked, and the important task of data reduction begins. The data reduction procedure consists of three fundamental steps:

6.3.1 A record calibration curve is prepared by combining the discriminator calibration (trace displacement versus frequency) and the pickup calibration curve (frequency versus function value). This new calibration curve, therefore, indicates trace displacement as a function of the quantity under measurement.

6.3.2 The displacement of each trace from the fixed reference line is measured at all significant points throughout the length of the record. The displacement measurements are tabulated and plotted on graphs which show the variations in measured quantity against time.

6.3.3 The application of appropriate correction factors to the reduced data is sometimes necessary. The magnitude and nature of these corrections will depend upon a knowledge of (a) the stability of the discriminators and recording equipment, (b) the characteristics of the pickups, and (c) the natural frequencies and coefficients of damping of the recording galvanometers.

# SECTION IV

# MAINTENANCE

## 1.0 General

All units in the receiving station are of panel and chassis construction. For convenience in maintenance or inspection all units are equipped with slides which enable them to be pulled out clear of the cabinet. A spring operated stop pin prevents the unit from being inadvertently pulled completely out. To remove the unit from the cabinet it is only necessary to release this stop pin. Connections are made through one or more multiconductor plugs mounted on the rear of the chassis, which engage with receptacles mounted in the cabinet. Plugs and receptacles disconnect when units are pulled forward.

Units are held locked in position by means of a hinged bar which folds over the edge of the front panel and is held locked by fasterners, permitting quick unlocking.

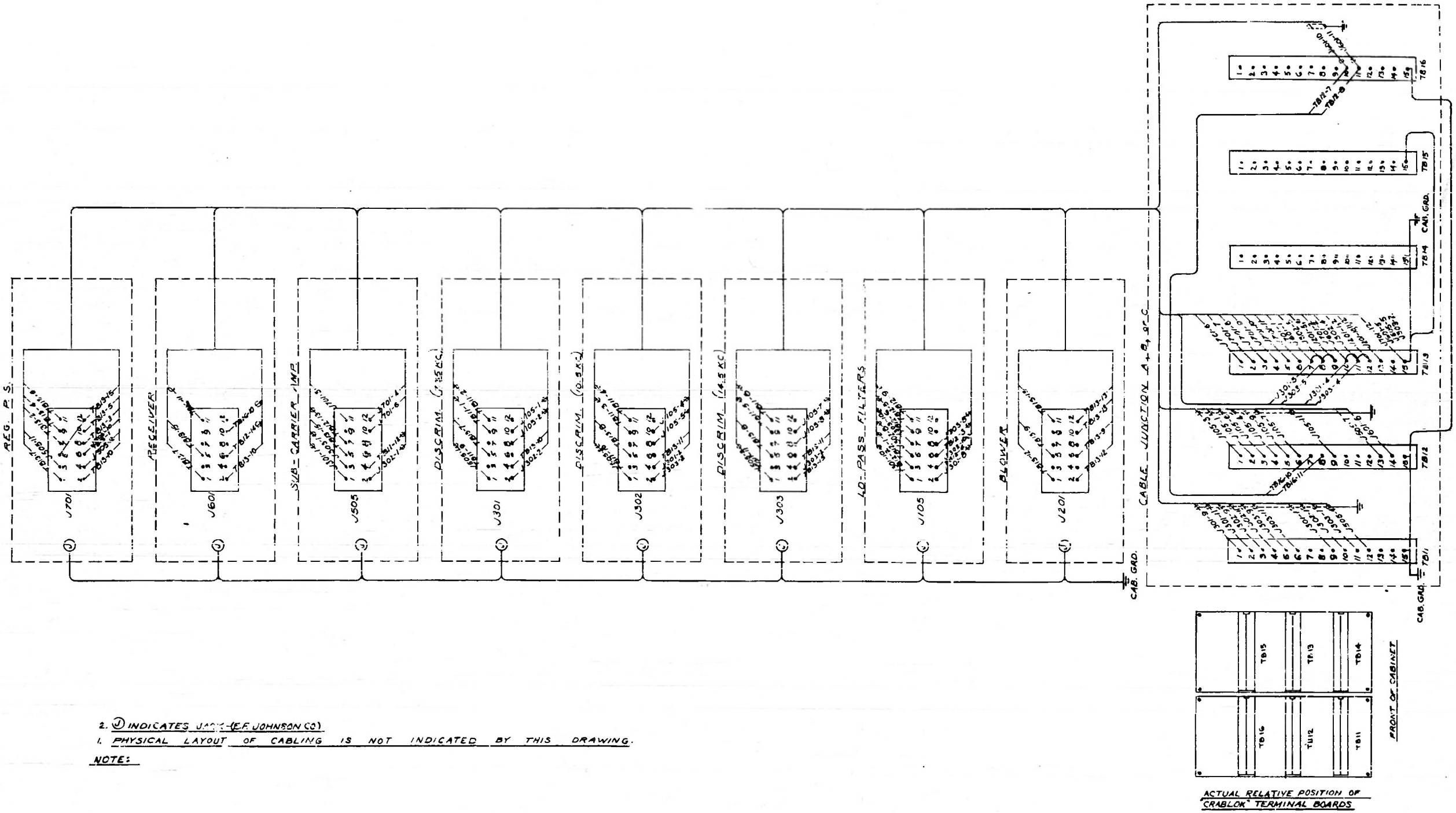
For better accessibility some of the units can be tilted 45° or 90° when in the forward position; they are held in position by means of a spring latch on the side of the chassis, which can be released to tilt the chassis. For testing or trouble shooting, a multiconductor cable with connector is supplied which enables the unit to be connected in the out position. Connections from the receptacles in the cabinets are brought down to "Crablok" terminals strips mounted on the bottom of the cabinet. These connections are shown in the following drawings:

| | | |
|---|---|---|
| Receiver Cabinet | Y 12623 | Figure 32 |
| Monitor Cabinet | Y 12624 | Figure 33 |
| Control Cabinet | Y 12625 | Figure 34 |

Intercabinet connections are between these terminal strips and are shown on the following drawings:

| | | |
|---|---|---|
| Cabinet A to B | Y 12626 | Figure 35 |
| Cabinet B to C | Y 12627 | Figure 36 |
| Cabinet C to D | Y 12628 | Figure 37 |
| Cabinet D to E | Y 12629 | Figure 38 |
| Cabinet E to Oscillograph | Y 12630 | Figure 39 |

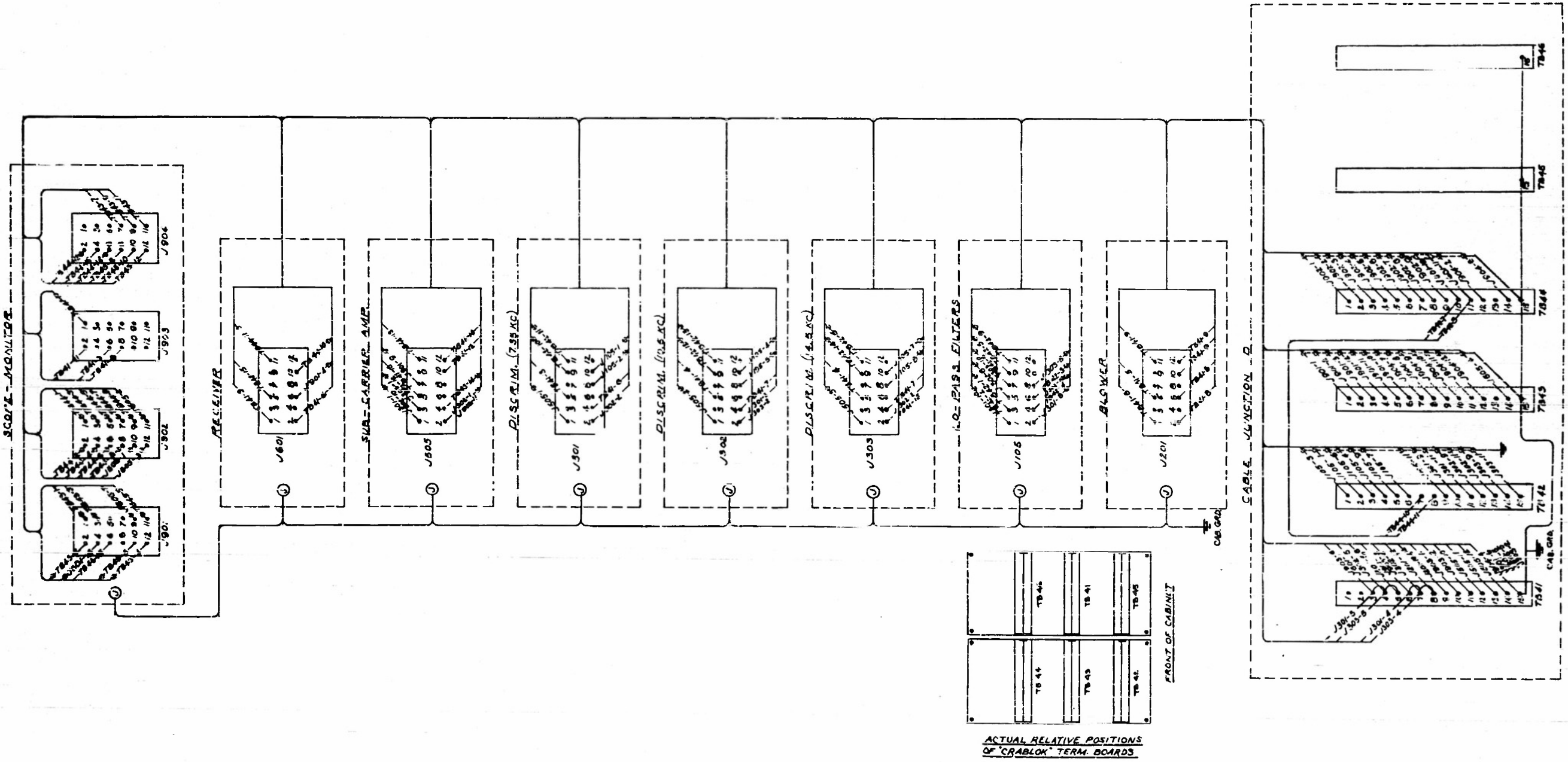
In addition for convenience in testing or trouble shooting a terminal designation diagram is shown in Figure 40.




2. (J) INDICATES JACK (E.F. JOHNSON CO.)
1. PHYSICAL LAYOUT OF CABLING IS NOT INDICATED BY THIS DRAWING.

NOTE:

Figure 32 - Wiring Diagram, Receiving Cabinet (A, B and C)




ACTUAL RELATIVE POSITIONS OF "CRABLOK" TERM. BOARDS

NOTE:
1. ⊙ INDICATES JACK - (E.F. JOHNSON CO.)

Figure 33 - Wiring Diagram, Monitor Cabinet (D)

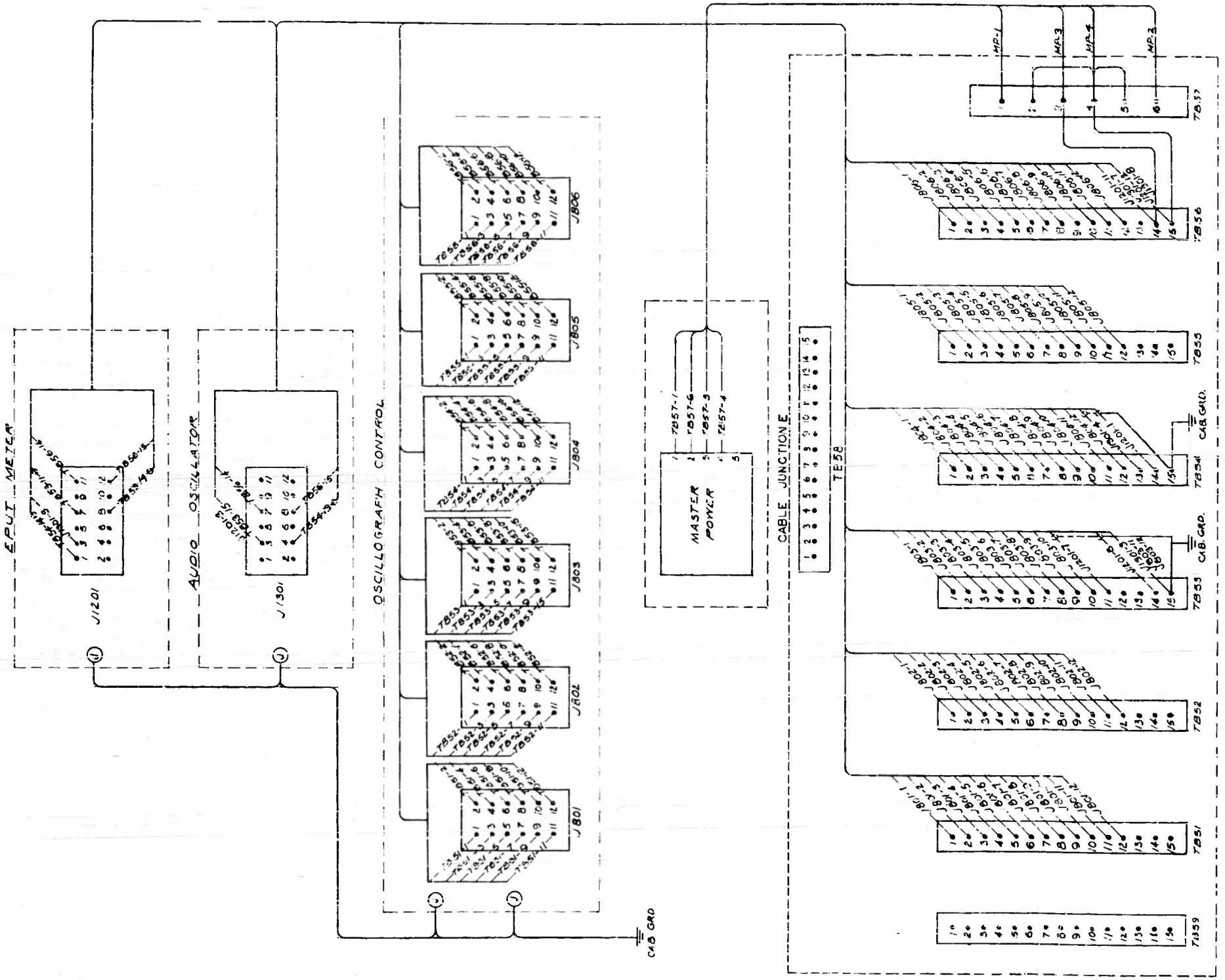
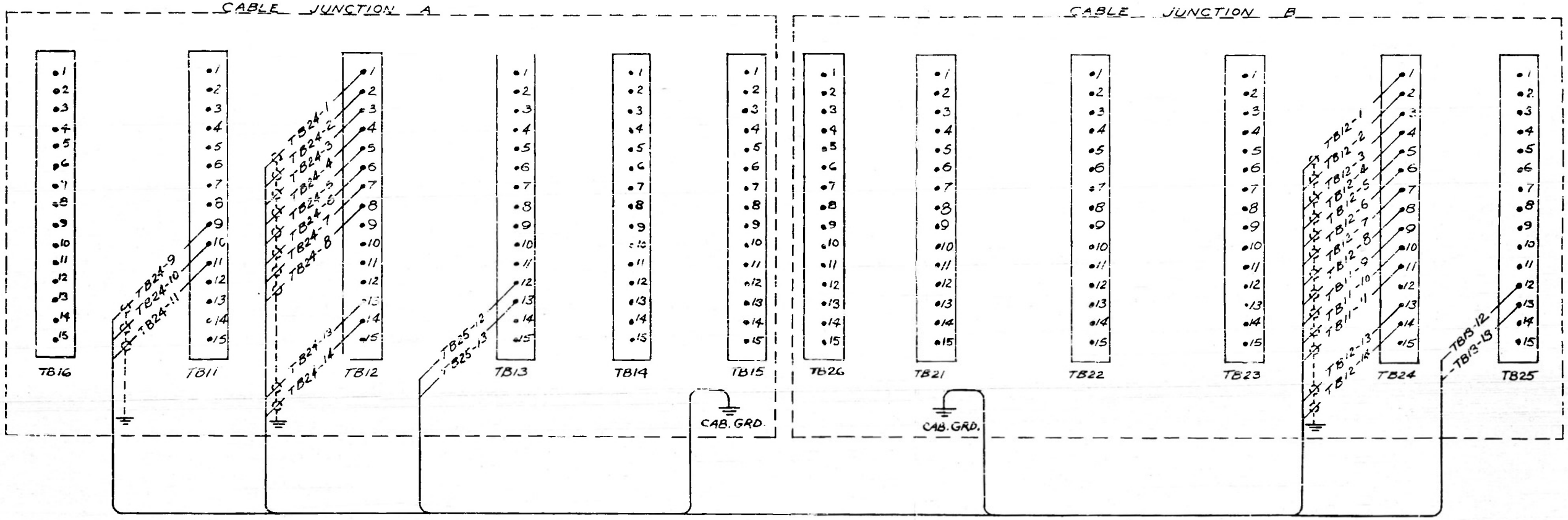
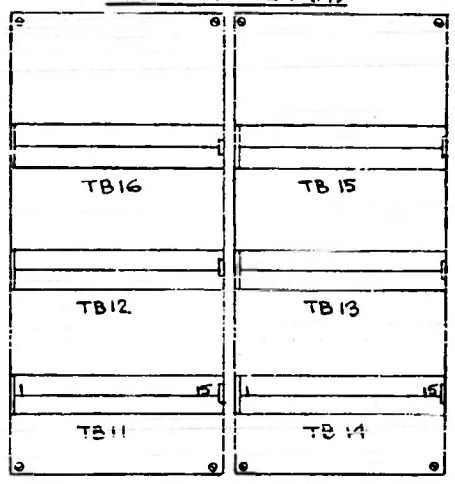



Figure 34 - Wiring Diagram, Control Panel (E)



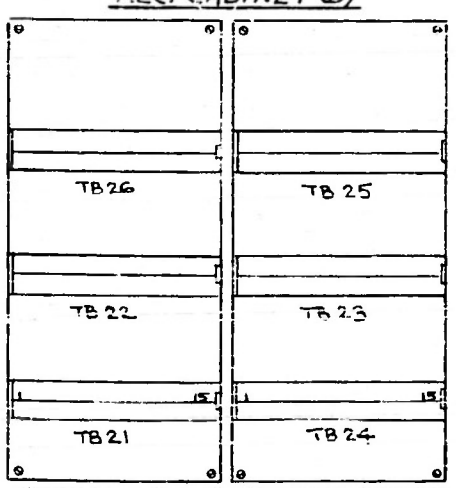
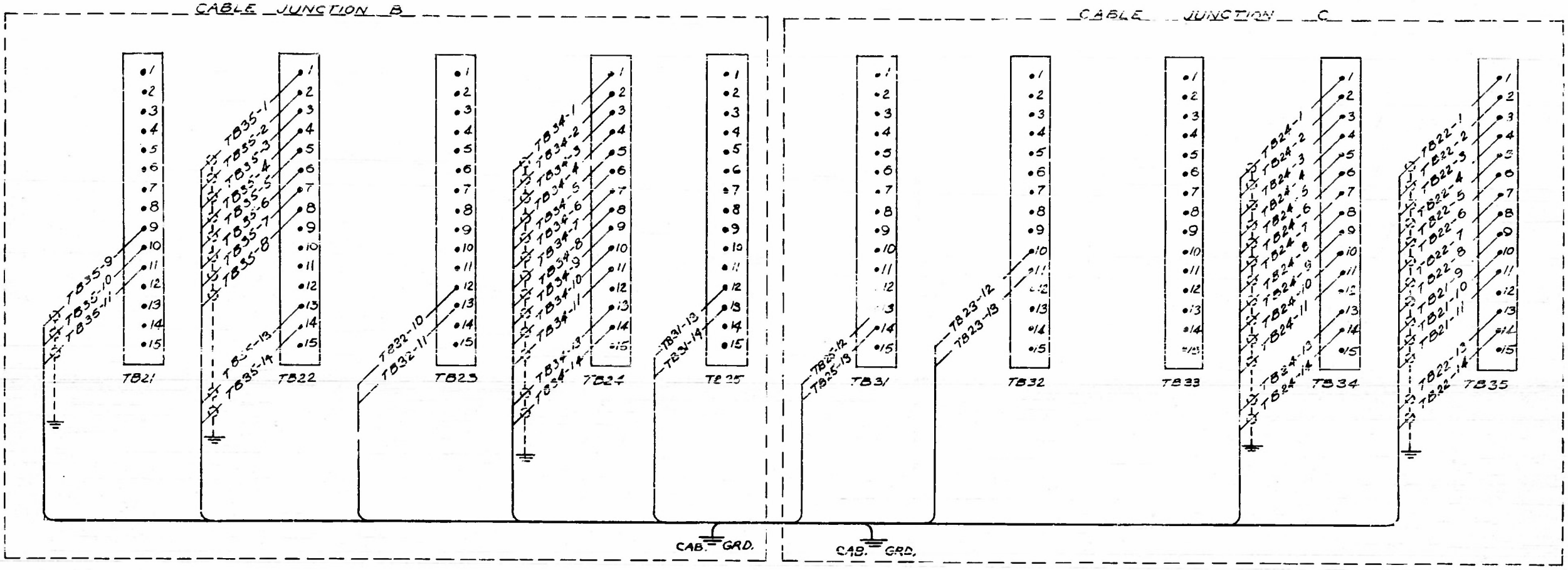
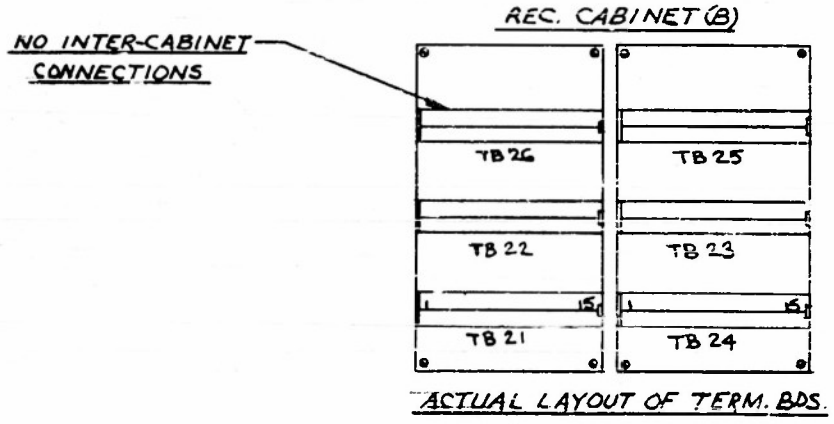




Figure 35 - Wiring Diagram, Inter-Cabinet (A - B)



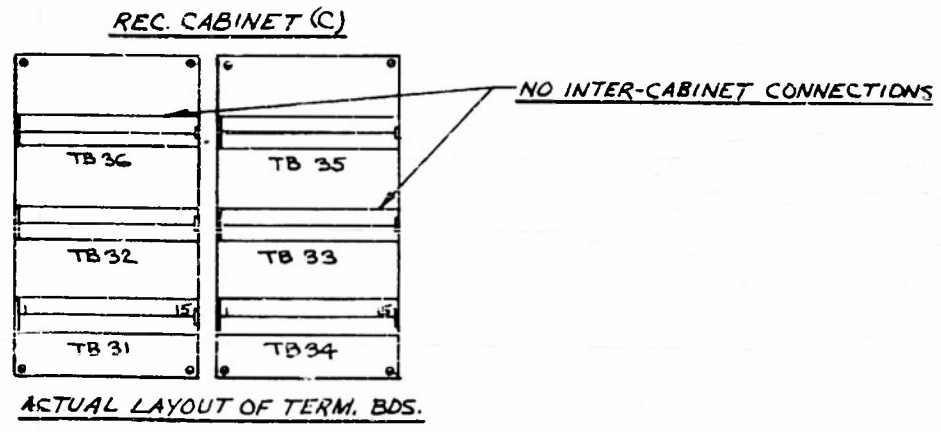
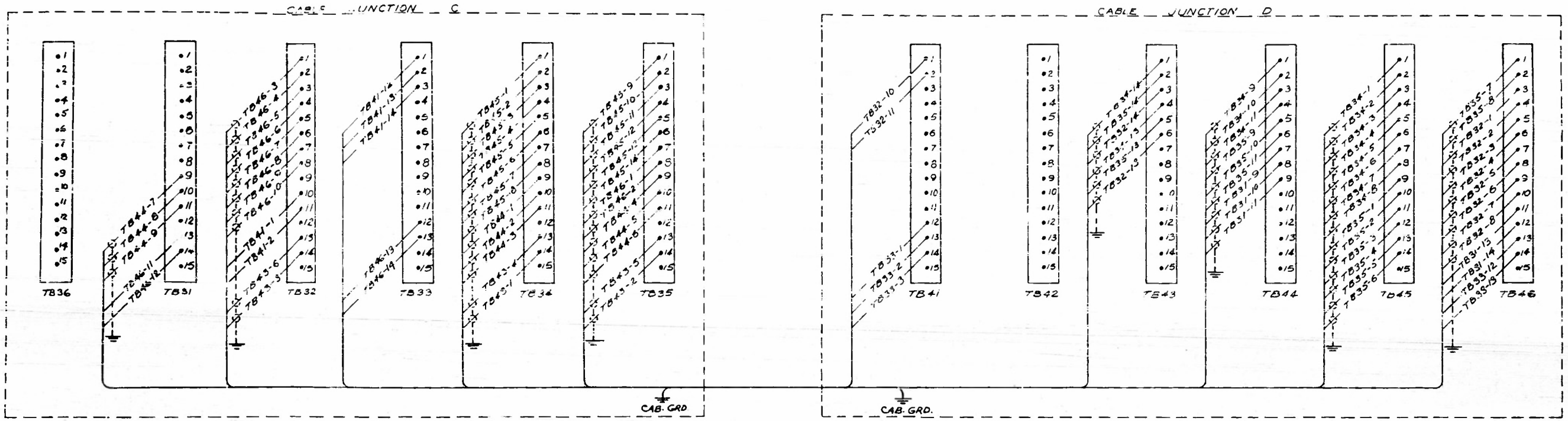
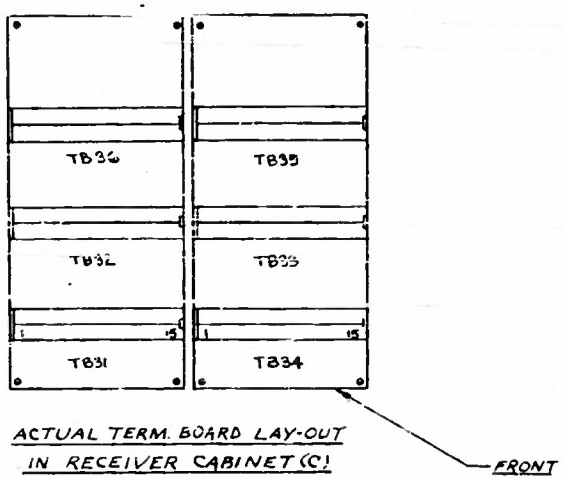
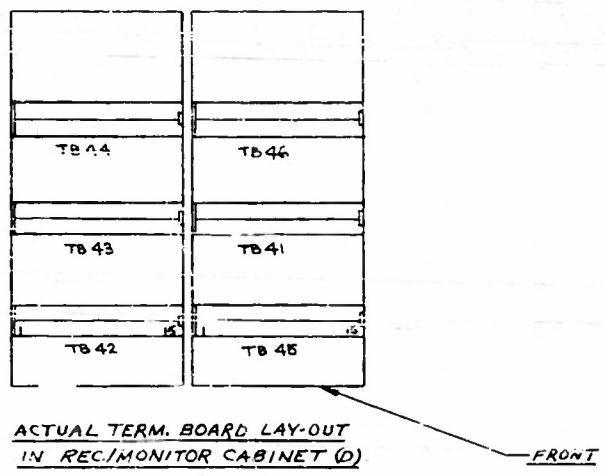




Figure 36 - Wiring Diagram, Inter-Cabinet (B - C)



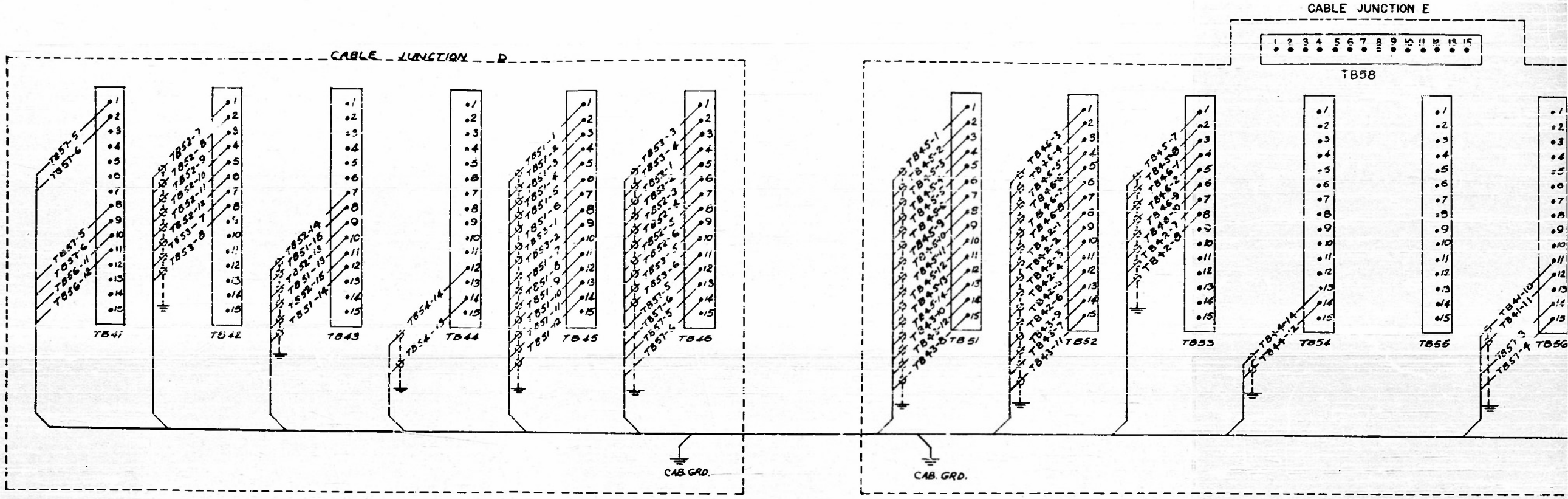



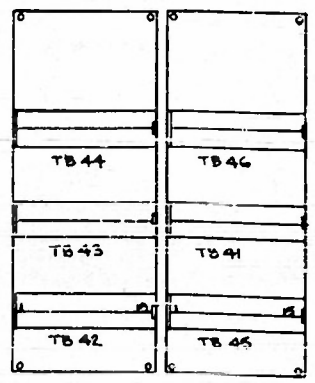

ACTUAL TERM. BOARD LAY-OUT
IN RECEIVER CABINET (C)



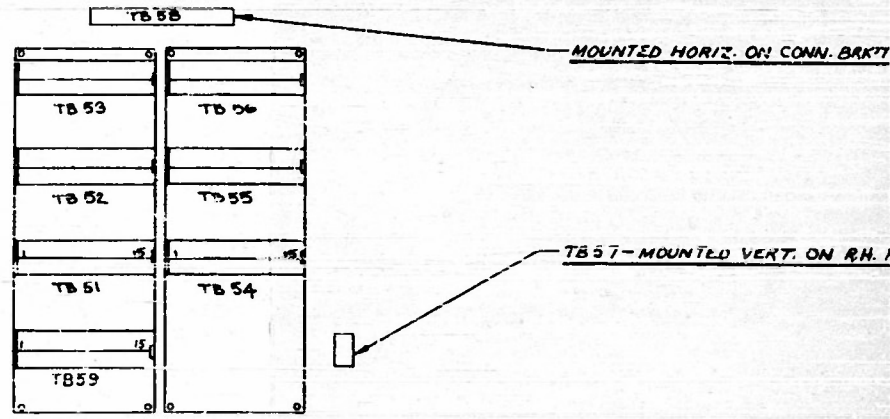

ACTUAL TERM. BOARD LAY-OUT
IN REC./MONITOR CABINET (D)

Figure 37 - Wiring Diagram, Inter-Cabinet (C - D)



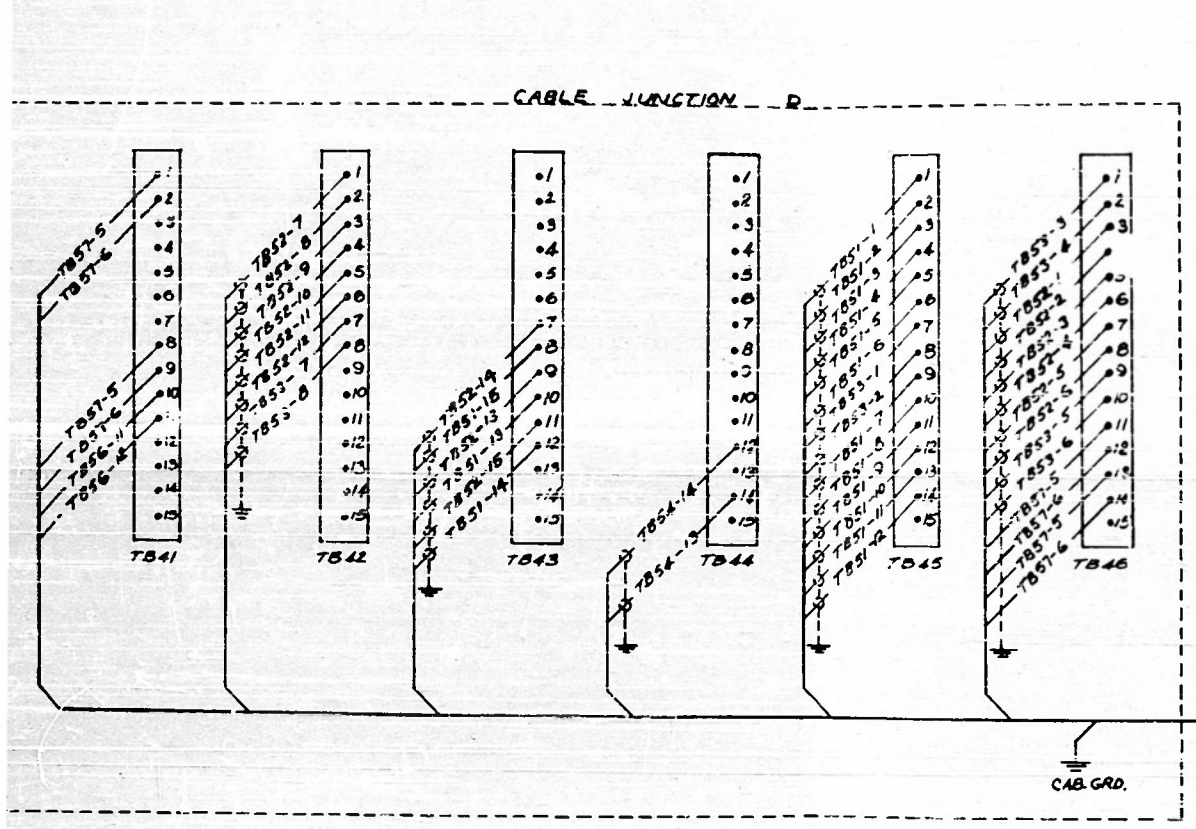

ACTUAL LAYOUT OF TERM. BDS. IN REC./MONITOR CABINET

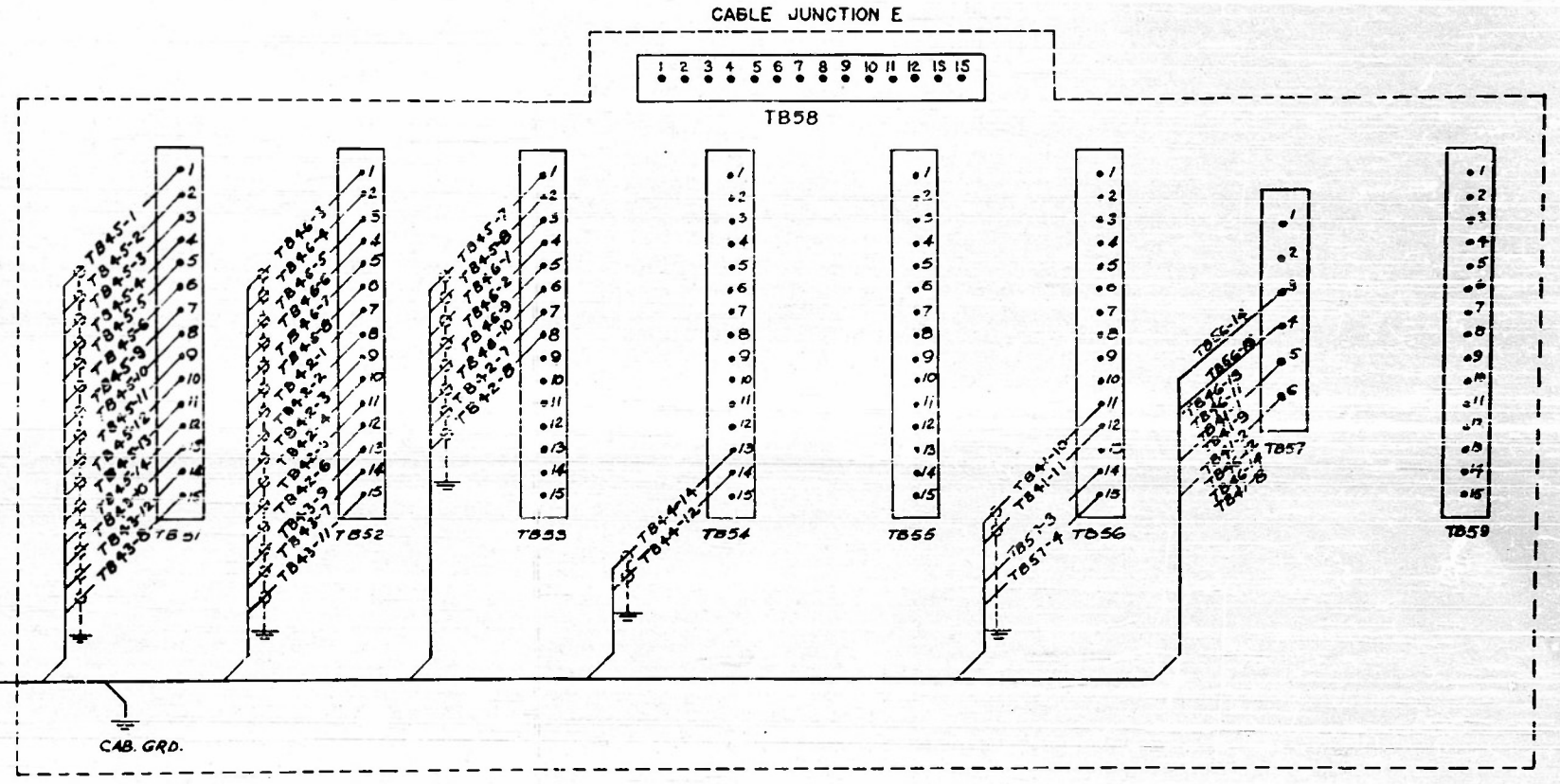


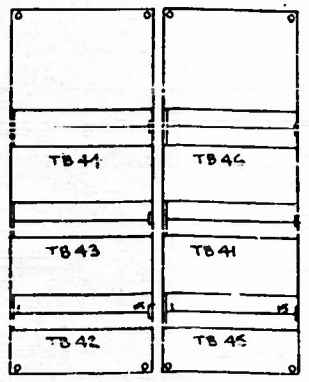

ACTUAL LAYOUT OF TERM. BDS. IN REC./CONTROL CABINET

1

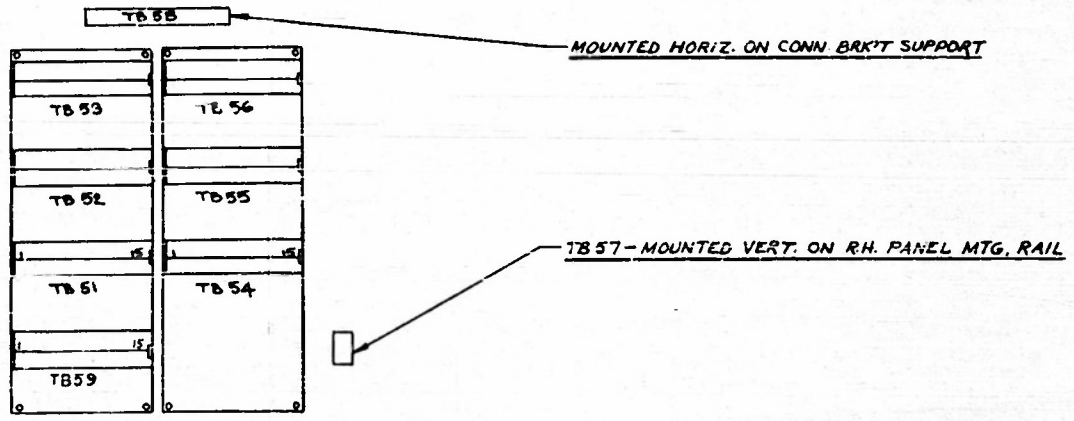
Figure 38 – Wiring Diagram,




ACTUAL LAYOUT OF TERM. BDS. IN REC./MONITOR CABINET




ACTUAL LAYOUT OF TERM BDS. IN REC/CONTROL CABINET

Figure 38 - Wiring Diagram, Inter-Cabinet (D - E)

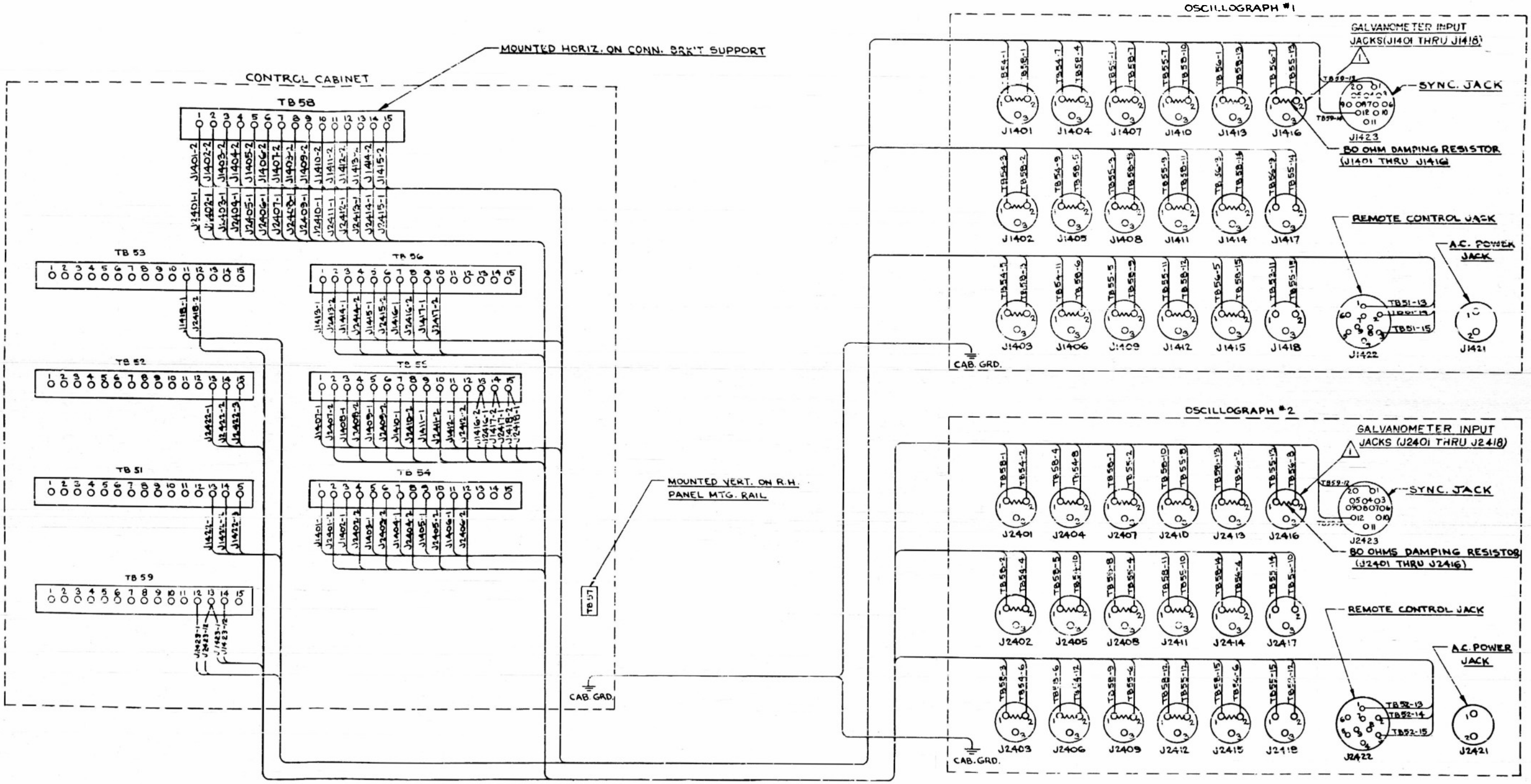
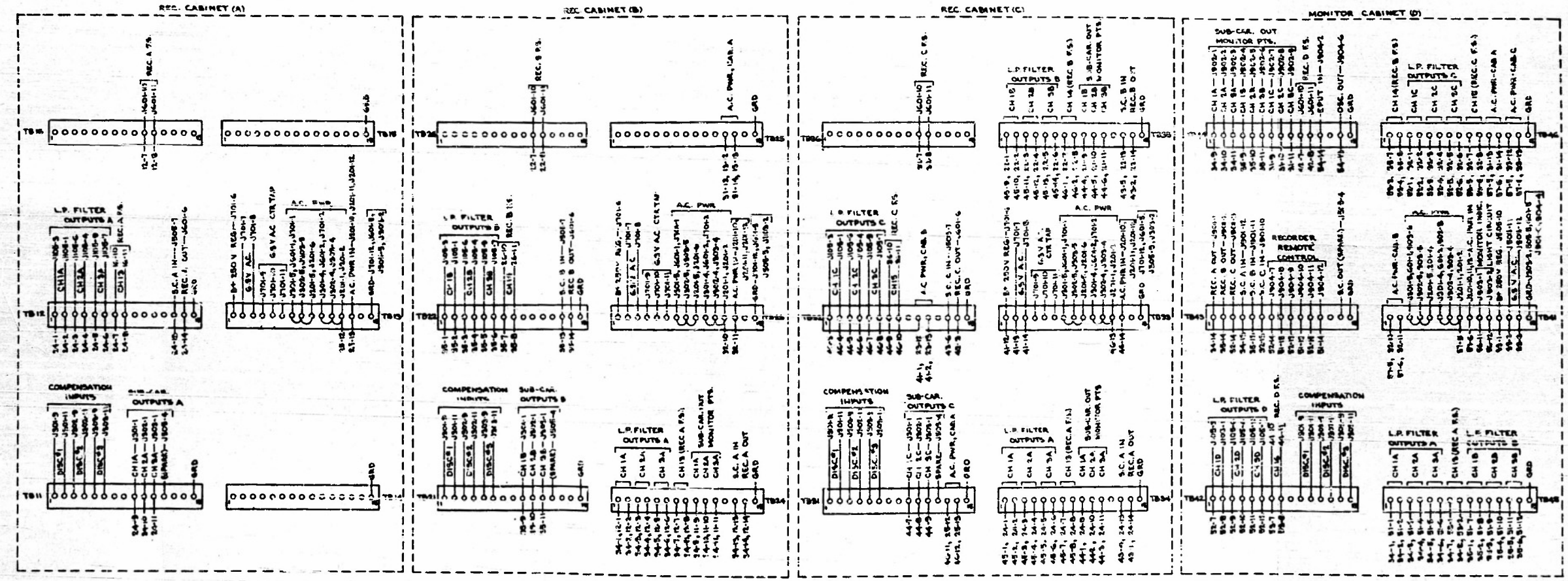
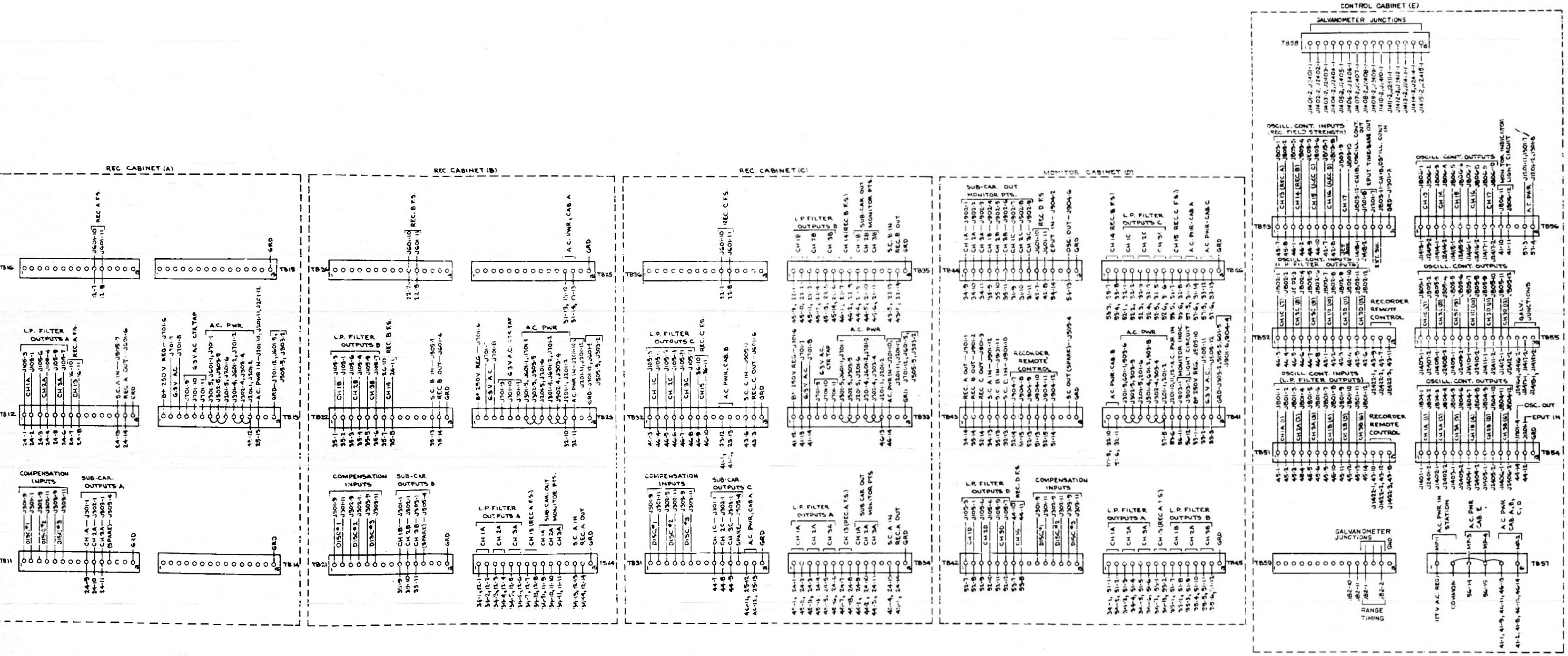



Figure 39 – Wiring Diagram, Inter-Cabinet (E-Oscillator)




4. FOR CONNECTIONS TO RECORDING OSCILLOGRAPHS SEE WIRING DIAGRAM Y12690.
3. LEGEND: SCA.- SUB-CARRIER AMP.
L.P.- LOW PASS (FILTER)
F.S.- FIELD STRENGTH SIGNAL.
2. DESIGNATION NOS. WITH NO LTR. PREFIX INDICATE TERMINAL INBOARD CONNECTIONS.
1. IN GENERAL, FUNCTIONS & DESTINATIONS OF INNER-CABINET WIRING ARE INDICATED ABOVE EACH TERM. BD. WHILE DESIGNATIONS BELOW INDICATE INTER-CABINET & EXTERNAL WIRING.
NOTES:

Figure 40 – Terminal D
Receiving




NECTIONS TO RECORDING OSCILLOGRAPHS
RING DIAGRAM Y12630
S.C. - SUB-CARRIER AMP.
L.P. - L/W PASS (FILTER)
S.S. - FIELD STRENGTH SIGNAL
ATION NO'S WITH NO LTR. PREFIX INDICATE
N BOARD CONNECTIONS
NAL, FUNCTIONS & DESTINATIONS OF
INET WIRING ARE INDICATED ABOVE EACH
S. WHILE DESIGNATIONS BELOW INDICATE
INET & EXTERNAL WIRING

Figure 40 - Terminal Designation Diagram, Receiving Station

RESTRICTED

## 2.0 Model 167-E Clarke Receiver

### 2.1 General

The Model 167-E special-purpose receiver is designed as terminal equipment for a telemetering system employing a radio link and receiving intelligence in the form of frequency-modulated signals consisting, for example, of one or more frequency-modulated subcarriers. Over the specified tuning range of 180 to 260 mc the antenna input impedance of the 167-E receiver is approximately 75 ohms. The circuit is arranged for single or unbalanced input. The antenna is connected to a SO-239 type jack, located on the rear apron of the chassis. The basic tuning element around which the frontend assembly is designed is a standard Mallory S-4 Spiral Inductuner. A stop assembly is arranged to restrictrotation of the spiral tuner to the last one and one-quarter clockwise turn of its normal 5-turn rotation. The signal frequency is tuned by L101 and the input capacity of the 6J4 plus wiring capacities. A double-tuned band-pass is used between the 6J4 R.F. amplifier and the 6AK5 mixer to provide high image I.F. rejection. The coupling between the two circuits is capacitive and consists of C104, C105, and C106. C105 is adjustable to provide accurate control of bandwidth. The 6J4 R.F. stage is operated at maximum gain at all times to produce maximum signal-to-noise ratio. Bias for the 6AK5 mixer is derived from the local oscillator. This method produces more uniform operation at all frequencies and allows for considerable variation in local oscillator amplitude due to tube aging, A.F.C. pulling, etc. This also allows direct grounding of both cathode terminals to minimize cathode lead inductance and produce maximum input resistance so necessary at these frequencies. The mixer is pentode connected to prevent distortion of I . F . response due to changes in its plate resistance which may be caused by variation of local oscillator amplitude, tube aging, etc. A rather unconventional oscillator configuration is used due to the high frequency of operation and the necessity for A.F.C.

The oscillator circuit used is essentially a Colpitts with an unbypassed resistor connected in the cathode to damp tube resonance. The A.F.C. reactance tube is connected directly across the oscillator. Phase shift is produced in the grid by the series combination of grid-plate capacity and a 27 ohm carbon resistor. Input resonance in the reactance tube is not damped by the cathode resistor since the grid circuit must return to the cathode. The use of a small resistor (27 ohms) in the grid circuit extends the operating range through 285 mc. A.F.C. may be turned on or off or supplied from an external source by a front-panel control.

The R.F. unit is a complete assembly with input and output signals available through coaxial connectors and with power and A.F.C. leads through a small cable.

## 2.2 I.F. Amplifier

The I.F. amplifier is a separate, completely shielded assembly. It is conventional in most respects. Two high-gain stages using 6CB6 tubes are followed by a 6CB6 first limiter and a 6AK5 second limiter. A 6AL5 is used on a balance phase discriminator.

The discriminator circuit is a conventional balanced phase shift type. In order to obtain balance the secondary is bifilar wound and link coupled to the primary. This link is adjusted in production for minimum distortion. For stability reasons a self-resonant choke L108 is connected to the output lead.

Signal level monitoring is provided by sampling the developed voltage at both limiter grids. The second limiter developes a voltage proportional to the input signal up to about 10 uv. About this level the voltage on the second limiter is constant, and a voltage proportional to the logarithm of the input exists at the first limiter. These voltages are combined to produce an easily read logarithmic signal-strength scale.

## 2.3 Output and Monitoring

A 12AU7 (V109) is used as a d.c. bridge to indicate discriminator output for tuning purposes and as a direct coupled video amplifier. V110 is used as a cathode follower output stage and is direct coupled from the video amplifier. The output is 10-15 volts RMS for ±125 kc deviation.

A conventional two-stage amplifier with built-in loudspeaker is provided for monitoring.

## 2.4 External Signal Strength Recording

Provision has been made for supplying 10 ma to record variations in signal strength. This signal is the combined plate and screen currents to V104, and it is adjusted to 10 ma with no signal by varying the screen voltage with R150. The signal thus obtained is reverse readings; i.e., 10 ma is obtained with no signal, and minimum current is obtained at maximum signal. This current can be recorded on channels 13 to 16 inclusive.

## 2.5 Alignment Procedure

2.5.1 Align discriminator.

2.5.2 Align I.F. transformers.

2.5.3 Check dial steps and mechanism.

2.5.4 Adjust oscillator

2.5.5 Align R.F. amplifier

2.5.6 Repeat adjustment of local oscillator

2.5.7 Calibrate signal-strength meter

## 2.6 Discriminator Alignment

In preparation for alignment of the discriminator transformer T105 (at left end of I.F. assembly as receiver is viewed from the front), remove the second limiter 6AK5 tube from the assembly and note the reading of the center frequency or zero center meter. If it is off center, it should be centered by means of the adjustment (R153 potentiometer) on the rear apron of the chassis. Difficulty in readily securing an exact center reading is indicative of a defect in the 6AL5 tube (V108), the 12AU7 tube (V109), or their associated components, and must be corrected before proceeding further. Other steps are as follows:

2.6.1 Remove oscillator tube to prevent mixing at signal generator harmonic frequencies.

2.6.2 Set receiver dial to 200 mcs.

2.6.3 Set signal generator to 21.4 mcs and connect to antenna terminals. If sufficient output indication is not secured, connect to mixer grid instead.

2.6.4 Connect high-resistance voltmeter (Volt Ohmyst type) to second limiter grid return (orange lead from I.F. assembly connected to tie point T-111). The signal-strength meter may be used as an output indicator with equal accuracy.

2.6.5 Set generator to produce approximately 1 volt on VTVM or 5 uv on signal-strength meter.

2.6.6 Connect the VTVM to the discriminator output lead (TP-113).

2.6.7 Detune or back out the bottom or secondary slug of T105 until the VTVM shows a reading of .5 volt.

2.6.8 Peak top of primary slug of T105 to give maximum reading.

2.6.9 Retune bottom or secondary slug to center frequenc or zero reading on the VTVM.

2.6.10 When the visual alignment equipment is available, a sweep generator should be connected to the second limiter grid and the oscilloscope connected to TP-113 or the output connector. Primary and secondary should then be adjusted for maximum output with symmetry around a 21.4 mc center frequency.

## 2.7 I.F. Alignment

The characteristic of cascaded critical coupled amplifier stages is such as to make alignment difficult; however, the advantages of response stability, gain, and adjacent-channel selectivity make this type of coupling most desirable. Alignment has been kept as simple as possible by using transformers with almost identical characteristics. The primary and secondary Q's have been kept high and, therefore, the mutual coupling low for the required bandwidth. These factors suggest a rather simple alignment procedure with a minimum of equipment. The resonant frequency of the primary or secondary in the absence of the other (no coupling) is very nearly the proper tuning when the circuits are coupled.

If the primary circuit is detuned and the secondary adjusted to maximum output and then the primary tuned to maximum, the overall response will be approximately correct. The procedure is then as follows:

2.7.1 Remove oscillator tube to prevent mixing at a signal generator harmonic frequency.

2.7.2 Set receiver dial to 200 mcs.

2.7.3 Set signal generator to 21.4 mcs and connect to antenna terminals. If sufficient output is not obtained, connect to mixer grid.

2.7.4 Connect high-resistance voltmeter (Volt Ohmyst type) to second limiter grid return (test point TP-111). The signal strength meter may be used as an output indicator with equal accuracy.

2.7.5 Set generator to produce approximately 2 volts on VTVM or 5 uv on signal-strength meter.

2.7.6 If the I.F. amplifier is known to be considerably out of adjustment, it is desirable to peak T101, T102, T103, and T104 to provide adequate gain.

2.7.7 Detune primary by tuning the bottom slug of T104 counterclockwise against the stop.

2.7.8 Increase signal generator output to produce approximately 2 volts on VTVM or 5 uv on the signal-strength meter.

2.7.9 Adjust secondary (top) of T104 for maximum indication.

2.7.10 Adjust primary (bottom) of T104 for maximum indication, keeping signal generator adjusted for 2 volts output indication. DO NOT readjust secondary for maximum, as this will result in improper adjustment.

2.7.11 Repeat steps 2.7.9 and 2.7.10 for T103, T102, and T101.
NOTE: It is not necessary that this sequence be followed, as any transformer may be adjusted without affecting the other.

The alignment may be checked by varying the signal generator frequency ±240 kc. The output voltage should be constant ±1 db over this range.

If a sweep generator and an oscilloscope are available, they may be used to check the response; however, the above procedure should first be performed and then the shaping checked or retouched as required in the light of the visual display. For this test, replace the signal generator with the sweep generator and the VTVM with the oscilloscope. Slight retouching of the transformers may give some improvement in response shape.

## 2.8 Check of Dial Stops

2.8.1 Loosen (4) screws on flexible coupling between dial and tuner.

2.8.2 Rotate knob clockwise to stop position.

2.8.3 Loosen set screws on dial.

2.8.4 Set dial to read "zero" and tighten set screws.

2.8.5 Rotate knob counterclockwise until dial returns to zero.

2.8.6 Set stop nut if necessary.

2.8.7 Rotate tuner shaft clockwise until tuner is stopped by its own mechanism.

2.8.8 Tighten screws on flexible coupling.

## 2.9 Local Oscillator Adjustment

The only adjustments to be made in the local oscillator are to make the tuning dial read properly. If the dial reading is correct, disregard this section. If a tube has been replaced and an error is noted, it may be corrected by adjustment of C116 (screwdriver adjustment adjacent to oscillator tube). This adjustment should be made with a signal generator of high accuracy with crystal check points spaced 2 to 10 mc and should be made at about 200 mcs. If component parts have been replaced or wiring disturbed, the dial may show an error at the high end (260 mcs.). This is correct by adjusting L105A (a short hairpin loop made of bus wire). Sufficient range may be obtained by adjusting the shape of this hairpin. The 200 mc point should then be rechecked since the adjustments are related.

The modification of the Clarke receiver was planned with a view to making the restoration to variable tuning as simple as possible. The bracket which mounts the coupling coil and the coaxial cable may be removed by taking out two screws, and unsoldering the 1 uuf coupling capacitor from the coupling coil. The free end of the coupling capacitor is then soldered back to the lug of L 105. The original 6J6 oscillator tube which was removed when the crystal oscillator was installed has been taped to its shield and to the top of the R.F. shield in the receiver. Insertion of this tube in the socket restores to operation the tunable oscillator. The three power leads to the crystal oscillator are then unsoldered and the crystal oscillator may be removed from the receiver. If it is not necessary to remove the crystal oscillator completely, variable tuning may be restored merely by changing the connection of the 1 uuf coupling capacitor, inserting the 6J6 tube, and disconnecting the red B+ lead to the crystal oscillator.

In some receivers after the crystal oscillator was installed, the VR150 regulator, V-112, ceased to function, since the three 5703 tubes draw about 8 ma more than the 6J6. When this conditon occured, R165 was adjusted until minimum current necessary to regulate was obtained. This adjustment was of the order of about 10%.

If it is necessary to change tubes, the leads of the replacement 5703 should be cut to .2 inches. A red dot on the socket shows which end the red dot on the tube should face. A seven pin socket is used in order to avoid bending the tube leads. Since there are only five leads on the tube, care should be observed in inserting the tube so that the leads go into the proper holes. Generally, little difficulty should be encountered as the supports and sockets are lined up to minimize error.

## 2.10 R.F. Amplifier Alignment

The band pass circuit between the R.F. amplifier and mixer need only be adjusted at the low end of the frequency range as the coupling and band pass are great enough at the high end to take care of all normal variations encountered. To adjust these circuits (C103 and C107) it is necessary only to tune in a signal at about 200 mcs (from a distant transmitter or loosely coupled signal generator) and adjust for maximum reading on the signal-strength meter. It will be noted that variation of C107 will affect the local oscillator frequency, and the dial should be adjusted to keep the signal in tune. The input circuit is sufficiently broad not to require adjustment. C105 should be adjusted only with visual equipment. The sweep generator should be connected to the antenna terminals and an oscilloscope to TP-117. The coupling should then be adjusted until a slightly overcoupled shape is observed.

2.11 Signal Strength Meter Calibration

This requires a signal generator with a 75 ohm output impedance and calibrated from 1 uv to 10 mv. Connect signal generator to antenna terminals and set to 215 mcs and 10 mv. across the output line. Tune receiver and set control in rear labeled "10 mv adjust" to read properly on signal-strength meter. The scale should be checked, but if considerable inaccuracy is noted, V104 should be replaced. If high accuracy is required, the calibration curve must be used.

3.0 Subcarrier Amplifier

3.1 General

The output from the Clarke FM receiver is fed into a subcarrier amplifier. Each amplifier has circuits for individually amplifying and separating four different subcarriers from the FM/FM composite telemetering signal coming from the receiver. In this station only the first three channels are used, the fourth is a spare.

As shown in Figure 17 the input lead supplies the composite signal through individual 500K gain controls, R501 through R504, to each of four cathode followers, V501 through V504. These tubes are mounted on the chassis immediately behind the front panel. The output circuits of these cathode followers connect through plug-in band pass filters to amplifier-cathode follower output tubes V502, V503, V505 and V506. These filters are mounted in individual cases and are plugged into four receptacles on the chassis. Heater voltage and 250 volts plate voltage are supplied by a separate regulated power supply. Connections are made through a 12 pin connector mounted at the rear of the chassis.

The meter M501 on the front panel can be connected by means of switch SW501, mounted immediately below it, to measure plate current to the various tubes.

In operation, the first cathode followers in the four channels serve principally to isolate the individual filter loads from the receiver output circuit and from each other. As the impedance of each filter is 510 ohms, four such filters in parallel would present a very low impedance load to the receiver output circuit, and would produce a very bad impedance mismatch. A further purpose in isolating the filter input circuits is to prevent the return of reflections from the filters to the receiver output circuit. The output signal from the filter drives the output tube. In the output tubes, which are 12AT7 twin triodes, the first triode is used as a linear amplifier to drive the second section which functions as a cathode follower output coupling means.

NOTE: Mounted above the gain control of each of the [illegible] channels is a white designation [illegible] frequency is to be written in pencil on this plate when the filter is installed or replaced.

## 4.0 Regulated Power Supply

### 4.1 Theory of Operation

The regulated power supply provides AC filament voltage and a regulated DC plate voltage for the filter amplifier.

A [illegible] choke input, two section filter provides good regulation and filtering. A 6AS7 variable resistance tube is used to regulate the output voltage. Changes in load or supply voltage are compensated for by varying the transconductance of this tube to maintain constant output. The 6SL7 tube (V703) using the voltage across V704 as a fixed reference, operates to change the bias voltage on V704 in such a direction as to oppose any change in output. Thus, if the line voltage falls, the bias on the grids of V702 goes more positive. This increases the transconductance of V702, thus tending to maintain constant output current. The two triode sections of V702 are used in parallel, and a balance control R701 is provided to divide the current equally between the two triode sections. R701 is a screw driver adjustment located on the front panel. The panel meter in switch position 1 and 2 indicates separately the current through each triode section. With this switch in position E the meter indicates total output current, and in position [illegible] the output voltage. The rated power output of the unit is 250 milliamperes. A screw driver adjustment R709 is available on the front panel for adjusting the output voltage to 250 volts.

The rated input power is 200 watts 115v 50-60 cycles. The 3Ag 5 ampere fuse is replaceable from the front panel.

A source of 6.3 volts AC heater current is also provided in the unit for use in external circuits.

### 4.2 Adjustment

After the power has been applied and the load with which the power supply is normally to be used is connected to P701, two adjustments are required. With meter switch S702 in position E, adjust "voltage adj." control R709 on front panel until meter reads 250 volts. With meter switch first in "Bal" position 1 and then position 2, adjust R701 until the meter reading is the same for both positions. These two adjustments must be repeated when any tubes are replaced.

### 4.3 Maintenance

4.3.1 No output AC or DC.

4.3.1.1 If the tubes including the pilot, do not light, replace fuse.

4.3.1.2 Check continuity of transformer primary and secondaries.

4.3.1.3 Check continuity of primary circuit from P701 through S701 and fuse F701.

4.3.1.4 Replace defective parts.

4.3.2 No DC output.

4.3.2.1 Replace tubes V701 (5R4GY) or V702 (6AS7).

4.3.2.2 Check continuity of power transformer secondary (T701).

4.3.2.3 Check continuity of chokes L701 and L702.

4.3.2.4 Check continuity of potentiometer R701 and resistors R711, R712, and R713.

4.3.3 Wrong DC output voltage.

4.3.3.1 If the tubes, transformer and chokes check satisfactorily, the circuit operation must be checked.

4.3.3.2 Using a vacuum tube voltmeter, measure the voltage across the 5651 voltage reference tube V704. It must measure between 82 and 89 volts.

4.3.3.3 If the voltage measures outside these limits replace the tube.

4.3.3.4 Check all capacitors for possible short circuits.

4.3.3.5 Using an accurate ohmmeter, measure the resistance value of each resistor on the terminal board. Any resistor which deviates from the indicated value by more than 20% should be replaced.

4.3.3.6 Variable resistor R709 on the front panel should also be checkedfor resistance value (10K).

## 5.0 Discriminator

### 5.1 Theory of Operation

The TDA-4 discriminator is capable of being tuned to any one of the subcarrier channels by means of a discriminator plug-in tuning unit. The functioning of the discriminator is the same for any subcarrier frequency employed.

The discriminator input stage employs a dual purpose vacuum tube with a triode section for signal amplification and diode section for rectification of a portion of the amplified input signal. This rectified signal is applied to a meter on the front panel for input signal level indication. The amplified signal from the triode section is fed to a clipper stage which limits the sine wave and feeds it to an Eccles Jordan trigger circuit having two stable limiting conditions. This stage functions as a signal limiter and wave shaper to provide a rectangular waveform.

The Eccles Jordan trigger output, after being differentiated, drives an amplifier stage which is biased to plate current cut-off. This amplifier performs the dual function of clipping the negative peaks while amplifying and inverting the phase of the positive peaks. The resulting negative signal pulses trigger a univibrator which has one stable limiting condition. The interval required for the univibrator to return to its stable condition after receiving a triggering pulse is controlled by a resistance capacitance network. Components in a plug-in tuning unit, in conjunction with controls on the front panel, determine the length of the unstable interval of the univibrator. The length of the unstable interval is, therefore, independent of the repetition rate of the driving signal pulse. The length of the stable period is dependent on the repetition rate of the signal pulse, since it is equal to the time of the unstable interval subtracted from the time interval between successive signal pulses. When the repetition rate of the signal pulses (equal to the input signal frequency) changes, the stable period of the univibrator is changed.

The two plates of the univibrator are coupled to the grids of a pushpull cathode follower. The rectangular signals from the cathodes of the cathode follower are fed through a resistance-capacitance low pass filter to the grids of another cathode follower.

The areas under the curves of the filtered positive and negative half cycles, applied to the grids of the cathode follower, vary relative to one another as a function of signal frequency. The output signal is taken from the cathodes of the second cathode follower. For a center frequency input signal, no output is developed because the area under the curve of the positive half cycle is equal to the area under the curve of the negative half cycle. For signals differing from center frequency, an output signal is developed whose polarity and magnitude are a function of the direction and amount of deviation of the input signal from the nominal center frequency. A zero center meter is located on the front panel and connected in series with one output lead to indicate output current and polarity.

Circuit constants and voltages are so chosen that, when the subcarrier signal is at center frequency, the voltage difference at the cathodes of the output cathode follower is essentially zero. Balance controls are provided to permit adjustment of the zero condition. Shifting of the subcarrier frequency above or below center frequency will thus cause a voltage difference at the cathodes to be indicated on the output meter as a shift in reading above or below the midscale zero reading.

Circuits are provided in the discriminator to protect the tubes and meters. These circuits function when the unit is first turned on, when an input signal outside the normal pass band is applied, and when the input signal is removed. The circuits performing the last two functions increase the stability of the discriminator by limiting the cathode current of the output stages to safe values.

## 5.2 Operational Check of Discriminator

### 5.2.1 General Functional Check

5.2.1.1 Connect discriminator in circuit shown in Figure 41 and tune the audio oscillator to the center frequency of the tuning unit in the discriminator. The total resistance of the meter and resistor must be 330 ohms. The meter should read 15 milliamperes each side of center.

5.2.1.2 Turn input control, R301, to zero.

5.2.1.3 Adjust output control R368 to 70.

5.2.1.4 Compensation polarity switch S304 should be in "OFF" position (center position).

5.2.1.5 Turn power switch, S301, "ON".

5.2.1.6 After two minutes warmup, check each position of the test meter switch, S302, to insure that the reading on the test meter, M303, are between .7 and .9.

5.2.1.7 Allow a 15 minute warmup period.

5.2.1.8 Turn input control, R301 to 100% and adjust audio oscillator output control to give midscale indication on the discriminator input meter, M301.

5.2.1.9 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of the center adjust, R340. Then release switch, S303.

5.2.1.10 Rotate the fine balance control, R331, throughout its full range and set it to its approximate center position.

5.2.1.11 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.1.12 Decrease slowly the frequency of the audio oscillator to approximately -7 1/2% of center frequency and note the negative swing on the output meter, M302, which should vary in proportion to the input frequency change.

5.2.1.13 Increase the frequency of the audio oscillator slowly to approximately +7 1/2% of center frequency and note the positive swing on the output meter, M302, which should vary in proportion to the input frequency change.

5.2.1.14 Adjust the input frequency to +7 1/2% of center frequency. With total external load including meter, load resistor, and low pass filter (if any used) equal to 330 ohms, vary the output control R368 from 0 to 100 and note the logarithmic increase in current through the external meter.

5.2.1.15 Leave the output control R368 at 100 and note that the output current through the external meter is greater than +10 ma at +7 1/2%. Change the frequency to -7 1/2% and note that the external output current exceeds -10 ma at this point.

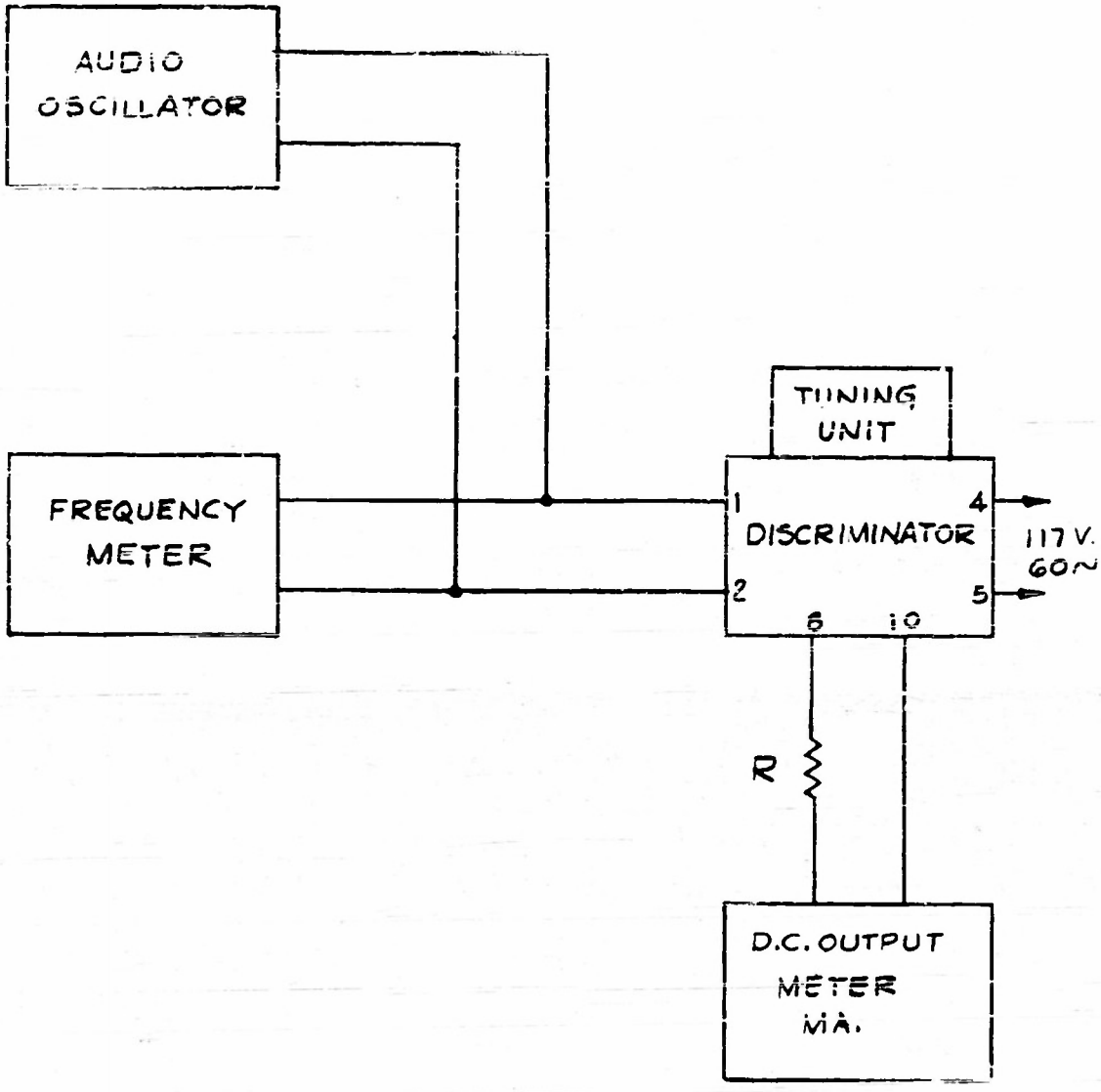
5.2.1.16 Again, with the output control R368 at 100, increase the frequency beyond the 7 1/2% and note the current through the external meter at which further increase in frequency will not change the output current. The output limiter should come into effect at approximately +15 ma. Repeat by decreasing the frequency, this limiter operating at -15 ma.

5.2.1.17 Check the standby stabilization circuit by observing the waveform on pin No. 5 of V303 when the input control R301 is turned to zero. It should be a square wave. The output meter M302 should indicate zero or center scale.

5.2.2 Linearity Check

5.2.2.1 Use the test setup as shown in Figure 41

5.2.2.2 Turn input control, R301, to 100% and adjust audio oscillator output control to give midscale indication on the discriminator input meter, M301.




1. THE OUTPUT METER SHOULD BE CAPABLE OF INDICATING 15 MA. EACH SIDE OF CENTER OR A POLARITY REVERSING SWITCH MUST BE INSERTED.
2. THE RESISTANCE (R) PLUS THE INTERNAL RESISTANCE OF THE METER SHOULD BE 330 OHMS.

## DISCRIMINATOR TEST CIRCUIT

Figure - 41

5.2.2.3 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of the center adjust, R340. Then release switch, S303.

5.2.2.4 Rotate the fine balance control, R331, through its full range and set it to its approximate center position.

5.2.2.5 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.2.6 Set the output control to 100.

5.2.2.7 Adjust the input frequency to +7 1/2%, +2 1/2%, 0, -2 1/2%, -5%, -7 1/2% and record the output current on the external meter at each frequency.

5.2.2.8 Plot a curve of output current vs frequency. This curve should be linear within 0.5% of full scale reading.

5.2.3 Output Stability

5.2.3.1 Operating Stability

5.2.3.1.1 Use the test setup as shown in Figure 44.

5.2.3.1.2 Turn input control, R301, to 100% and adjust audio oscillator output control to give mid-scale indication on the discriminator input meter, M301.

5.2.3.1.3 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of center adjust, R340. Then release switch, S303.

5.2.3.1.4 Rotate the fine balance control, R331, throughout its full range and set it to its approximate center position.

5.2.3.1.5 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.3.1.6 Set the output control to 100.

5.2.3.1.7 Adjust the input frequency to center frequency.

5.2.3.1.8 Record the output current on the external meter after one-half hour, one hour, one and one-half hours, and two hours. Make sure that the center frequency is being applied when the reading is being taken.

5.2.3.1.9 The output current should not drift in excess of ±0.5% per hour.

5.2.3.2 Standby Stability

5.2.3.2.1 Use the test setup as shown in Figure 41.

5.2.3.2.2 Turn input control, R301, to 100% and adjust audio oscillator output control to give mid-scale indication on the discriminator input meter, M301.

5.2.3.2.3 Press center test switch, S303, to momentary position and adjust output on M302 for zero (center scale) by means of the center adjust, R340. Then release switch, S303.

5.2.3.2.4 Rotate the fine balance control, R331, throughout its full range and set it to its approximate center position.

5.2.3.2.5 With center frequency applied to the discriminator from the oscillator, adjust the coarse balance control, R329, to give approximately zero output on the output meter, M302. Make final adjustment to zero with the fine control, R331.

5.2.3.2.6 Set the output control to 100.

5.2.3.2.7 Adjust the input frequency to center frequency and record the output current on the external load meter.

5.2.3.2.8 Reduce the input control, R301, to zero.

5.2.3.2.9 After one-half hour, check the frequency to center frequency. Turn the input control to 100% and record the output current on the external meter.

5.2.3.2.10 Repeat steps (e) and (f) after one hour, one and one-half hours, and two hours.

5.2.3.2.11 The output current should not drift in excess of ±0.5% of bandwidth per hour.

5.2.3.3 Troubleshooting Procedure

5.2.3.3.1 General

Make a preliminary test by attempting to run through the operational check. The point in the procedure at which a peculiar characteristic is noted may indicate the circuit where the trouble exists. If this fails to disclose the source of the trouble, check individual circuits.

Connect the discriminator in a circuit as shown in Figure 41 and tune the audio oscillator to the center frequency of the tuning unit that is mounted in the discriminator.

Turn the input control, R301, 100% and the output control, R368, to 70.

Adjust the audio oscillator voltage to 5V rms.

Turn the compensation polarity switch, S304 to the "OFF" position.

Turn the power switch, S301, to the "ON" position. If the pilot light fails to light, check the fuze F301 and the indicator light I301.

Allow unit to warmup at least two minutes.

5.2.3.4 Discriminator voltages

This table indicates the DC voltages which can be expected at each pin of the tubes in the discriminator. The VTVM used to make these measurements must have a high impedance input such as the General Radio type 1800A. Voltages must be checked in the order given in the procedure in order to localize the trouble. The portion of discriminator circuit preceeding the points being tested must be functioning properly. The discriminator must be driven by the center frequency of the tuning unit being used, and be correctly balanced frequency.

NOTE

These voltages are measured positive with respect to the power supply or copper ground, and not chassis ground.

TABLE I

PIN NO.

| Tube | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| V301 | 0 | 5.9 | 98 | 98 | 4.8 to -1.8 | 4.8 to -1.8 | 185 | - | - |
| V302 | 70 | 28 | 28 | 98 | 98 | 110 | 18.5 | 28 | 98 |
| V303 | 20.5 | 29 | 98 | 98 | 86 | 118 | 29 | - | - |
| V304 | 8.7 | 14.5 | 98 | 98 | 86 | 97 | 14.5 | - | - |
| V305 | 8.1 | 14.5 | 98 | 98 | 82 | 108 | 14.5 | - | - |
| V306 | 310 | 82 | 98 | 98 | 98 | 310 | 85 | 97 | 98 |
| V307 | 97 | 105 | 98 | 98 | 310 | 275 | 97 | - | - |
| V308 | 97 | 105 | 98 | 98 | 310 | 280 | 97 | - | - |
| V309 | 278 | 278 | 176 | 176 | 310 | 310 | 280 | - | - |
| V310 | 105 | 112 | 98 | 98 | 275 | 158 | 112 | - | - |
| V311 | 105 | 112 | 98 | 98 | 277 | 158 | 112 | - | - |
| V312 | - 4 | 0 | 98 | 98 | 0 | - 4 | 280 | - | - |
| V313 | - 4 | 0 | 98 | 98 | 0 | - 4 | 280 | - | - |
| V314 | 150 | - | - | 0 | 150 | - | 0 | - | - |
| V315 | 0.1 | 0.1 | 0.69 | 98 | 98 | 280 | 0.69 | 12 | 98 |
| V316 | 0.12 | 1.25 | 98 | 98 | 290 | 150 | 1.25 | | |

These voltages vary between the extremes shown as the input meter is varied from .2 to .8 ma.

5.2.3.5 Power Supply

Check each position of the test meter switch, S302 for a .7 to .9 ma reading on the test meter M303

If any of the readings are incorrect use an external VTVM to measure the DC voltage C325 (approximately 300 volts) and across V314 (approximately 150 volts).

If these voltages are incorrect, check the power supply components, including V312, V313, V314, R358, R359, R362, R367, C323, C324, C329, L301, and T301.

If these voltages measured correctly, check the test meter resistors associated with the position for which an incorrect reading was taken in step 1. These resistors include:

| Position | Resistor |
|---|---|
| 1 | R360 |
| 2 | R363 |
| 3 | R362 |
| 4 | R364 |
| 5 | R361 |
| 6 | R376 |

5.2.3.6 Tuning Unit

Replace the tuning unit and start a general functional check. If the discriminator now checks satisfactory the trouble may be assumed to exist in the tuning unit.

5.2.3.7 Pre-Amplifier Stage

Use an oscilloscope across pins 1 and 2 of the input connector J301. If the sine waveform is not received, check output of the audio oscillator and the resistance of the input level adjustment, R301.

On pin 1 of V301 the waveform should be as shown at A in Figure 20. If not check R302 and V301.

On pin of V316 the waveform should be similar but the top could be slightly flattened. If it is not, measure the DC voltage on pin 7 of V301. Check V301, R303, R305, R306, R383, and C303.

If no input is shown on the input meter, check V301, R304, C302, and M301.

5.2.3.8 Clipper-Driver Stage

The waveform on pin 5 of V316 should be a square wave. If not, measure the DC voltages for this tube and check the associated circuit components.

5.2.3.9 Eccles Jordan Limiter Stage

The waveform on pin 2 of V302 should be as shown at B in Figure 20. Measure the DC voltages for tube V302, and check associated circuit components.

5.2.3.10 Pulse Amplifier Stage

Check the waveform on pin 1 of V303 which should be shown at C in Figure 20. If not, check C307 and R315.

Also check the operation of relay K302 which should close contacts 2 and 3 when a square wave is seen on pin 2 of V302. Contacts 1 and 2 should be closed, and 4 and 5 should be closed with no input signal.

If the relay does not operate check the DC voltages on V315 and the associated components, C330, C331, R377, R378, R379, R380, and K302.

If the relay is operating correctly but there is no continuity between pins 2 and 3 in the operating position, clean contacts.

5.2.3.11 Univibrator Stage

Check the waveform on pin 5 of V304 which should be similar to E in Figure 20. If it is, vary the coarse balance control, R329, and the fine balance control, R331, and note the shift in half period K of the square wave G. If varying R329 and R331 causes no effect on the waveform, check the voltage divider network.

If the rectangular wave if not observed, remove V306 from the circuit and again check pin 5 of V304. If this produces the square wave, check V306 and replace if necessary.

If the square wave is not obtained, remove V304 and observe the waveform on pin 5 of V303. It should be similar to D. If it is not, measure the DC voltage on pin 5 of V303 and measure the resistance of R305, R316, R317, R324, R325, C308, C309 and L302.

If the negative pulses are similar to D in step 3, observe the same waveform (reduced in amplitude) on pin 13 of J303. If not seen check R325 and R326 and L302.

Proceed to pin 1 of V305 and note the negative pulse. If the pulse is not seen check V305.

If the pulse is observed on pin 1, observe pin 5 for an amplified positive pulse, similar to D but inverted. If this is not seen check the DC voltage on pin 5 of V305, which should read approximately 20 volts in this condition, and R319, R320, R323, R327 and C310.

After observing the pulse on pin 5 of V305, note the waveform on pin 1 of V304 which should also be a positive pulse, but of smaller amplitude. If this is not seen, check R319, R320, and the operation and contacts of relay K302 (note part 5.2.3.10)

If this waveform is satisfactory, check V304 and replace it in the tube socket if it checks good. Then check R322 and R324.

Adjust the coarse and fine balance controls R329 and R331 to give the maximum DC voltage on pin 5 of J303 and then the minimum voltage. These extreme voltages should be approximately 30 and 45 volts. If they are not correct, check R328, R330, and R331.

5.2.3.12 Push-Pull Cathode Follower Amplifiers

After a square wave has been obtained on pin 5 of V304, observe the waveform on pin 8 of V306, which also should be a square wave. If it is not check V306 and R337.

Observe the waveform on pin 3 of V306 which should be a square wave. If it is not check V306 and R338.

If the square wave is noted on both of these cathodes, it should then be possible to obtain equal DC voltages on pins 3 and 8 of V306 by variation of the coarse and fine balance controls R329 and R331.

5.2.3.13 Output Cathode Follower Amplifiers

After making the adjustment in 5.2.3.12 above, measure the DC voltages on pin 1 of V307 and 1 of V308 which should be equal and of the magnitude listed in Table 1. Vary the input frequency from -7 1/2% to +7 1/2% of center frequency and note that the DC voltage on pin 1 of V307 goes from positive to negative with respect to pin 1 of V308. If either of these tests fails, check V307, V308, R371, R372, R373, R374, S303, and S304.

Repeat the adjustment made in part 5.2.312 para. 9 above measure the DC voltage on pin 2 of V307 and 2 of V308 which should be equal and the same as indicated in Table 1. If this is obtained, then vary the input frequency and note that the DC voltage on pin 2 of V307 goes from positive to negative with respect to 2 on V308. If these two tests are satisfactory, check K301, M302, and R368.

5.2.3.14 Protective Circuit

If the tests in part 5.2.3.13 above fail, remove tubes V310 and V311 from the circuit and repeat set B. If satisfactory results are now obtained check V308, V307, R345, R346, R347, R348, R349, R351, R352, R353, R354, C320, C321, and C322.

If step (1) above fails, check V309, measure the DC voltage on pin 6 of V307 and V308 and check R339, R340, R341, R342, R343, R344, R346, R349, R350, R351, R356, R357 R375, C320, C321, and C322. If the DC voltage between chassis ground and the power supply is not correct as shown in Table 1, but the discriminator is functioning properly, check R356, R357, and C328.

## 6.0 Filters

### 6.1 Band pass

#### 6.1.1 Theory of Operation

The band pass filters are used in the Filter Amplifier units to separate the individual subcarrier frequencies from the composite frequency modulated signal. The filters are made in two band widths, ±7½% and ±15% of center frequency. Attenuation within the adjacent filter bands is not less than 40 db.

#### 6.1.2 Installation

The band-pass and high-pass filters are all packaged in similar cases, fitted with an octal socket. A flange on each end of the case contains a single twist type fastener having a slotted head. The filter is plugged onto an octal male receptacle mounted on the chassis of the amplifier filter, and a screw driver used to tighten the fasteners. Four filters are mounted side by side on the chassis.

#### 6.1.3 Maintenance

Design of these filters is such that no maintenance is possible. Failures will not occur even with intermittent voice pulsed up to 100 volts peak amplitude. The filters will operate satisfactorily with continuous signal on noise levels up to 40 volts peak amplitude. Failure will occur only if the filters are used with voltages higher than their maximum ratings, and in this event they must be returned to the manufacturer for repair.

### 6.2 Low Pass Filter

#### 6.2.1 Theory of Operation

The output signal from each discriminator is fed to its associated recording galvanometer through a low pass filter, Type TFL-2A. These filters are used for noise reduction, and attenuate at the discriminator output all frequencies above those necessary to convey the telemetering information. They greatly

attenuate any fundamental or harmonics of the subcarrier which may get through the discriminator. These filters are available with 15 different cutoff frequencies from 20 cycles to 1050 cycles for use in conjunction with the ±7.5% band pass filters, and with additional five cutoff frequencies from 660 cycles to 2100 cycles, for use with ±15% band pass filters. Filters with a cutoff frequency of 218 cycles are supplied with this station. Figure 29 shows a representative performance curve for any of these filters.

6.2.2 Installation

TFL-2A low pass filter is housed in a metal case, with a 5-pin female receptacle on the bottom of the case. A flange on each end of the case contains a single twist type fastener with a slotted head. The filter is plugged onto a 5-pin male receptacle, mounted on the filter tray and secured by turning the fasteners with a screwdriver. Four filters can be mounted side by side on this tray.

6.2.3 Maintenance

Design of these filters is such that intermittent peaks of 100 volts, or continuous 40 volt signals, will not cause breakdown. If higher voltages are used and breakdown occurs, the filter must be returned to the manufacturer for repair.

## 7.0 Monitor Panel

### 7.1 Introduction

This assembly consists of an oscilloscope, a vacuum tube voltmeter and an associated switching system. Its purpose is to permit observations of signals from the receiver outputs and from the subcarrier amplifier outputs throughout that station.

### 7.2 Operation

The VTVM and Scope power switches should be on. Intensity, focus and positioning controls function to control the cathode ray beam in the usual manner, and normally require only initial adjustments. The vertical and horizontal gain controls may require readjustments from time to time to provide convenient size pattern. The VTVM voltage selector switch should be left on "AC" position for all following measurements.

## 7.3 Measurements

### 7.3.1 Receiver Outputs

To measure the outputs of any of the four receivers set the appropriate receiver switch (S901, S902, S903, or S904) in "RECVR" position, and set the VTVM selector switch (S905) to the corresponding position "A", "B", "C", or "D".

### 7.3.2 Subcarrier Amplifier Outputs

To monitor the outputs of any subcarrier amplifier set the VTVM selector switch to "CHAN" and index the channel selector switch (S906) to the desired channel. (In normal operation the receiver switches should be placed in "RECVR" position for these measurements so that the receiver outputs are applied to their respective subcarrier amplifiers.

These subcarrier outputs may be visually observed. A choice of 60 cps sinusoidal sweep or external (audio oscillator) sweep is available for this purpose.

### 7.3.3 Calibration

To test the subcarrier amplifiers and to calibrate the station a locally generated signal from the audio oscillator is applied to the subcarrier amps while the outputs are measured on the VTVM.

Index the function switch and the desired receiver switch to "CAL". (This injects the oscillator signal.) Placement of the VTVM selector switch to "A", "B", "C", or "D", according to the subcarrier amplifier employed, will allow measurement of this subcarrier amplifier input voltage. This should not exceed 1 volt in order to avoid overloading.) With the EPUT selector switch on "OSC" the oscillator frequency can be read on the EPUT frequency meter.

The outputs are observed as follows: Set the VTVM selector switch to "CHAN,"; then, as the channel selector switch is successively indexed to the desired positions, the subcarrier amp. outputs may be measured. (Shift the oscillator frequency as required for this test.)

### 7.3.4 Subcarrier Frequency Measurements

#### 7.3.4.1 Direct Method

With the receivers and subcarrier amps. operating normally, the subcarrier frequencies generated at the telemeter transmitter are directly measureable with the EPUT meter. Set the function switch to "SUB.CAR.OUT" and position the channel selector switch to required channel.

7.3.4.2 Indirect Method

By the observance of oscilloscope Lissajous patterns the transmitted subcarrier frequencies can be indirectly measured. This method is especially advantageous where considerable carrier-frequency signal fading is experienced, or where the subcarrier waveforms are distorted, either of which condition could render the direct measurement by the EPUT meter unreliable.

With normal operation set the function switch to "OSC" and select the desired channel by means of the channel selector switch. The horizontal input switch should be placed on "EXT". These settings cause the sinusoidal oscillator output to be applied to the horizontal deflection plates, and the subcarrier signal to be applied to the vertical deflections plates. The EPUT meter reads the oscillator frequency, which can be varied as required.

7.4 Recording

After completion of all preliminary adjustments the four receiver switches should be placed in "RECVR" position, and the function switch in "RECORD". Check that all galvanometer interrupting switches of the oscillograph control assembly are in the center (open) position. With these settings preparedness to record will be indicated by the green record lamp. (Disturbance of any of these 5 switches on the monitor unit or of any of the 18 key switches on the oscillograph control unit will cause the "ready to record" lamp to extinguish.

7.5 Remote Control

Operation of the oscillograph control switch (S908) remotely control both recorder motors. The upward or manual (locking) position of the switch causes continuous operation of the recorders, whereas the downward position causes intermittent operation.

8.0 Audio Frequency Oscillator

8.1 Theory of Operation

The audio frequency oscillator is a wide range instrument having output frequencies from 200 to 200,000 cycles. This range is available in six bands 200-600, 600-2000, 2000-6000, 6000-20000, 20000-60000, and 60000-200,000 cycles. Output voltage is constant +1db up to 6000 cycles. Maximum output is 10 volts across rated 1000 ohm resistive load. Distortion is less than 1% up to 6000 cycles, with rated load.

The circuit consists of an oscillator, an amplifier, and a regulated power supply. The oscillator section is basically a resistance coupled amplifier over which both positive and negative feedback are applied. The positive feedback network is a variable frequency selective resistance capacitance mesh, and is used to control the frequency of oscillation. The negative feedback network which is used for stabilization includes a lamp filament also rises, increasing the negative feedback, thus tending to offset the rise in amplitude.

The output amplifier uses two tubes. Negative feedback is used in this circuit to minimize distortion to provide uniform frequency response and to obtain low impedance.

The power supply provides unregulated B voltage to the output amplifier. The conventional regulator circuit provides regulated B voltage to the two oscillator tubes.

## 8.2 Maintenance

### 8.2.1 Tubes

Tubes can be replaced by removing the 8 screws which hold the cover to the top and back of the oscillator and the 4 screws in the top. All corrective adjustments are made from the bottom of the chassis.

### 8.2.2 Trouble Shooting

#### 8.2.2.1 Complete Failure

Complete failure may be caused by a defective fuse, defective power rectifier V5, or defective tubes, VI, V2, V3, or V6.

#### 8.2.2.2 Erratic Operation

Erratic operation such as signal too high or too low may occur if V7 is defective or if R56 requires adjustment. R56 should be set so that the regulated +240 B voltage to the oscillator measures that voltage, using a high resistance DC voltmeter such as a Simpson Model 260. Failure of V4 will greatly reduce the output voltage. Failure of V8, the regulator tube, will cause the +240 regulated voltage to rise, with consequent increase in output signal and increased distortion. If either V1, V2, V3 or V4 are defective, increased distortion in the output signal may result. Excessive distortion may also be caused by leaking capacitors, or open bypass capacitors.

## 9.0 Frequency Meter

### 9.1 Theory of Operation

The frequency meter is a counter type instrument which counts and displays the number of events-per-unit-time (EPUT). The time interval of measurement is one second and the frequency range is from 20 to 100,000 cycles per second. The basic accuracy of the instrument is ±1 event.

The input circuit consists of two-stage amplifier and a trigger circuit. The differentiated output signal from this trigger is fed through the Input Gate to a series of five Berkeley Decimal Counting Units.

The time base which controls the Input Gate derives its accuracy from a 100,000 cycle crystal-controlled oscillator. This frequency is divided-down by a factor of 105 through a series of "locked in" one-shot multivibrators, resulting in an output of one pulse per second. The supply voltage for the time base is electronically regulated so that stability against line voltage variations is insured. A test switch is supplied for a direct check of proper operation. Pin jacks are provided inside the cabinet for making connections so that the instrument is self-checking for proper operation of each frequency divider stage. Screwdriver adjustments are provided for making corrections whenever they become necessary because of tube replacement, etc.

Control of the display time is accomplished by means of a system which opens and closes a Time Base Gate. As the gate can only be actuated by one second pulses from the dividing chain, the time between successive starts of counting is therefore an integral number of accurately controlled time units. Thus, although the readout time control is continuously adjustable, actual time between counts will be in multiples of one second over a range of one to five seconds.

The accuracy of each single measurement of events-per-unit-time depends upon the accuracy of the time base and upon the total number of events (or counts) received.

The time base accuracy is dependent upon the stability and accuracy of setting of the 100 kc. oscillator controlled by the crystal. The short term stability of the circuit used is better than 1 part in 105 under thermal conditions normal to indoor use. The frequency can be adjusted by the operator to any desired degree of accuracy within the limit of stability.

9.2 Test Information

The Operate-Test switch permits normal counting operation in position. In the Test position, a 100 kilocycle signal from the crystal oscillator in the time base is connected to the input of the frequency meter. With no input the count displayed should be either 99999 or 00000.

If the count is wrong, check the decimal counters, and the frequency dividers of the time base.

9.2.1 Set the sensitivity control at maximum.

9.2.2 Remove the units counter from the plug-in socket.

9.2.3 Replace with spare Model 705 counter.

9.2.4 After at least five minutes warmup, check the count. If the count is 99999 or 00000, the 705 counter was defective.

9.2.5 If the count is incorrect, exchange the tens counter (Model 700 second from right) with the fifth digit counter (Extreme left). If the count is now correct excepting for the highest digit, then the trouble lies in that decimal counter.

9.2.6 If the count is still incorrect, then exchange the tens counter with the fourth digit counter, and again check the count.

9.2.7 If the count is still incorrect, after exchanging all three higher digit counters with the second digit counter, check the time base frequency dividers.

9.3 Time Base Adjustment

There are seven twin diodes. The first, is the crystal oscillator, the second is the wave shaper, the third is the first frequency divider, the fourth is the second frequency divider, the fifth is the third frequency divider, etc. The time base channel is the middle vertical channel and the five frequency divider tube sockets are located to the left of their associated frequency adjustment potentiometers. The crystal oscillator is at the top, and frequency divider number five is at the bottom.

9.3.1 Remove the frequency meter from the cabinet and place it on a test bench.

9.3.2 After the warmup period, set Test-Operate switch on Test.

9.3.3 Set the sensitivity at maximum.

9.3.4 Adjust the time base frequency dividers.

9.3.5 Connect a 50 capacitor with short clip leads from pin 1 on V1345-2, the time base gate, to pin 6 on the second frequency divider tube V1131-4, the fourth tube from the bottom on the divider channel.

9.3.6 Adjust divider controls R1114-1 and R1114-2 until a count of 00100 is obtained.

9.3.7 Move the clip lead to pin 6 on the third frequency divider (third from the bottom).

9.3.8 Adjust R1114-3 until a count of 01000 is obtained.

9.3.9 Move the clip to pin 6 on the fourth divider and adjust R1114-5 for a count of 00000 or 99999.

9.3.10 Remove the capacitor and clip leads.

9.3.11 While watching the count, readjust each potentiometer to find the upper and lower limits of satisfactory operation.

9.3.12 Set the adjustment midway between these limits.

9.3.13 Reinstall the frequency meter in the cabinet.

## SECTION V

## PARTS LIST

1.0 The Y10980 Receiving Station consists of:

| | | | |
|---|---|---|---|
| 3 | Y10984 | Receiver Cabinet Assembly | (Cabinet A, B And C) |
| 1 | Y10983 | Monitor Cabinet Assembly | (Cabinet D) |
| 1 | Y10982 | Control Cabinet Assembly | (Cabinet E) |
| 2 | Type 5-114 | Consolidated Oscillographs | |
| 1 | Y12705 | Cable Assembly | (Cabinet A to B) |
| 1 | Y12706 | Cable Assembly | (Cabinet B to C) |
| 1 | Y12707 | Cable Assembly | (Cabinet C to D) |
| 1 | Y12708 | Cable Assembly | (Cabinet D to E) |
| 1 | Y12709 | Cable Assembly | (Cabinet to Oscillographs) |

2.0 The Y10984 Receiver Cabinet Assembly contains:

| | | |
|---|---|---|
| 1 | 555190 | Regulated Power Supply |
| 1 | Y12381 | Receiver Assembly |
| 1 | Y10992 | Amplifier Assembly |
| 1 | 555160-10 | Filter Assembly Band Pass 7.35 KC. |
| 1 | 555160-11 | Filter Assembly Band Pass 10.5 KC. |
| 1 | 555160-12 | Filter Assembly Band Pass 14.5 KC. |
| 3 | 555180 | Discriminator Assemblies |
| 1 | 555185-11 | Tuning Unit Assembly 7.35 KC. |
| 1 | 555185-12 | Tuning Unit Assembly 10.5 KC. |
| 1 | 555185-14 | Tuning Unit Assembly 14.5 KC. |
| 1 | Y11236 | Low Pass Filter Chassis Assembly |
| 3 | 555170-9 | Filter Assembly Low Pass 218 cps. |
| 1 | Y11156 | Blower Assembly |
| 1 | Y12704 | Cable Assembly |

3.0 The Y10983 Monitor Cabinet Assembly contains:

| | | |
|---|---|---|
| 1 | 555600 | Monitor Panel |
| 1 | Y12381 | Receiver Assembly |
| 1 | Y10992 | Amplifier Chassis Assembly |
| 1 | 555160-10 | Filter Assembly Band Pass 7.35 KC. |
| 1 | 555160-11 | Filter Assembly Band Pass 10.5 KC. |
| 1 | 555160-12 | Filter Assembly Band Pass 14.5 KC. |
| 3 | Y11553 | Discriminator Assemblies |
| 1 | 555185-11 | Tuning Unit Assembly 7.35 KC. |
| 1 | 555185-12 | Tuning Unit Assembly 10.5 KC. |
| 1 | 555185-14 | Tuning Unit Assembly 14.5 KC. |
| 1 | Y11236 | Low Pass Filter Chassis Assembly |
| 3 | 555170-9 | Filter Assemblies Low Pass 218 cps. |
| 1 | Y11156 | Blower Assembly |
| 1 | Y12702 | Cable Assembly |

4.0 Y10982 Control Cabinet Assembly contains:

| | | |
|---|---|---|
| 1 | Y11800 | Audio Oscillator Assembly |
| 1 | Y11461 | EPUT Meter Assembly |
| 1 | 555220 | Oscillograph Control Panel |
| 1 | Y11744 | Master Power Panel |
| 1 | Y12703 | Cable Assembly |
| 2 | Y14317 | Blowers |
| 2 | 10X10X1 | Dustop Air Filters |

5.0 Y-12381 RECEIVER ASSEMBLY

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C101 | .001 uf, 500 v, ceramic disc. | CL1000 | Radio Materials Co. |
| C102 | 500 uuf, ceramic | Style 331 | Erie Resistor Corp. |
| C103 | 0.5-3 uuf, ceramic trimmer | 7XA1482 | Centralab Div. of Globe Union, Inc. |
| C104 | 1 uuf, ±10%, NPO, Ceramic | Style 301 | Erie Resistor Corp. |
| C105 | Same as C103 | | |
| C106 | Same as C104 | | |
| C107 | 1-4 uuf, ceramic trimmer | 7XA1482-003 | Centralab Div. of Globe Union, Inc. |
| C108 | 10 uuf, ±5%, NPO, ceramic | Style A | Erie Resistor Corp. |
| C109 | Same as C104 | | |
| C110 | Same as C101 | | |
| C111 | .005 uf, 500v, ceramic | CL 5000 | Radio Materials Co. |
| C112 | Same as C111 | | |
| C113 | Same as C111 | | |
| C114 | Same as C108 | | |
| C115 | 5 uuf, ±5%, NPO, ceramic | Style A | Erie Resistor Corp. |
| C116 | Same as C107 | | |
| C117 | Same as C115 | | |
| C118 | Same as C101 | | |
| C119 | Same as C101 | | |
| C120 | Same as C101 | | |
| C121 | Same as C101 | | |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C122 | 8 uuf, silver mica, built into T101 as integral part | | |
| C123 | 40 uuf, silver mica, built into T101 as integral part | | |
| C124 | Same as C101 | | |
| C125 | 200 uuf, N750, ceramic | Style B | Erie Resistor Corp. |
| C126 | Same as C102 | | |
| C127 | Same as C111 | | |
| C128 | Same as C102 | | |
| C129 | Same as C102 | | |
| C130 | Same as C111 | | |
| C131 | Same as C122, built into T102 as intergral part | | |
| C132 | Same as C123, built into T102 as integral part | | |
| C133 | Same as C111 | | |
| C134 | Same as C102 | | |
| C135 | Same as C111 | | |
| C136 | Same as C102 | | |
| C137 | Same as C102 | | |
| C138 | Same as C122, built into T103 as integral part | | |
| C139 | Same as C123, built into T103 as integral part | | |
| C140 | 50 uuf, ±5%, NPO | Style T | Erie Resistor Corp. |
| C141 | 50 uuf, ±20%, N750K | | Erie Resistor Corp. |
| C142 | Same as C102 | | |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C143 | Same as C102 | | |
| C144 | Same as C102 | | |
| C145 | Same as C122, built into T104 as integral part | | |
| C146 | Same as C123, built into T104 as integral part | | |
| C147 | Same as C111 | | |
| C148 | Same as C140 | | |
| C149 | 33 uuf, ±5% | N220 CN | Electrical Reactance Corp. |
| C150 | Same as C101 | | |
| C151 | Same as C101 | | |
| C152 | 20 uuf, ±5%, NPO | CN796C | Electrical Reactance Corp. |
| C153 | Same as C122, built into T105 as integral part | | |
| C154 | Same as C123, built into T105 as integral part | | |
| C155 | Same as C140 | | |
| C156 | Same as C111 | | |
| C157 | Same as C111 | | |
| C158 | Same as C111 | | |
| C159 | Same as C111 | | |
| C160 | Same as C111 | | |
| C161 | .01 uf, 500 v | D6-103 | Centralab Div. of Globe Union, Inc. |
| C162 | Same as C140 | | |
| C163 | Same as C111 | | |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C164 | Same as C161 | | |
| C165 | .1 uf, 600 v | TVC6P1 | Cornell-Dubilier Electric Corp. |
| C166 | Same as C161 | | |
| C167 | 10 uf, 600v, paper | Type T6100 | Cornell-Dubilier Electric Corp. |
| C168 | Same as C167 | | |
| C169 | Same as C140 | | |
| C170 | Same as C111 | | |
| R101 | 120 ohms, ½ watt | Type F-B | Allen-Bradley Co. |
| R103 | 470 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R104 | Same as R103 | | |
| R105 | 150 K, ½ watt | Type F-B | Allen-Bradley Co. |
| R106 | 150 ohms, ½ watt | Type E-B | Allen-Bradley Co. |
| R107 | Same as R106 | | |
| R108 | 3.3 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R109 | 27K, ½ watt | Type E-B | Allen-Bradley Co. |
| R110 | 27 ohms, ½ watt | Type E-B | Allen-Bradley Co. |
| R111 | 220 ohms, ½ watt | Type E-B | Allen-Bradley Co. |
| R112 | 100 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R113 | 1 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R114 | Same as R103 | | |
| R115 | 10 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R116 | 51 ohms, ½ watt | Type E-B | Allen-Bradley Co. |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R117 | 4.7 K, ½ watt | Type G-B | Allen-Bradley Co. |
| R118 | Same as R113 | | |
| R119 | Same as R115 | | |
| R120 | Same as R106 | | |
| R121 | 47 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R122 | Same as R113 | | |
| R123 | 1 M, ½ watt | Type E-B | Allen-Bradley Co. |
| R124 | Same as R123 | | |
| R125 | 18 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R126 | 10 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R127 | Same as R112 | | |
| R128 | Same as R116 | | |
| R129 | Same as R121 | | |
| R130 | Same as R121 | | |
| R131 | Same as R113 | | |
| R132 | Same as R103 | | |
| R133 | Same as R121 | | |
| R134 | 22 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R135 | Same as R109 | | |
| R136 | 33K, ½ watt | Type E-B | Allen-Bradley Co. |
| R137 | Same as R113 | | |
| R138 | 13 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R139 | 100 K, ±2%, ½ watt | Type E-B | Allen-Bradley Co. |
| R140 | Same as R139 | | |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R141 | Two 10 ohms, ½ watt, in parallel | Type E-B | Allen-Bradley Co. |
| R142 | 220 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R143 | Same as R142 | | |
| R144 | Same as R112 | | |
| R145 | 1M, U Taper, Potentiometer | Type J | Allen-Bradley Co. |
| R146 | Same as R103 | | |
| R147 | Same as R142 | | |
| R148 | 130 K, ½ watt | Type E-B | Allen-Bradley Co. |
| R149 | Same as R142 | | |
| R150 | 50 K, Linear | CU 5031 | Ohmite Mfg. Co. |
| R151 | Same as R121 | | |
| R152 | Same as R134 | | |
| R153 | Same as R150 | | |
| R154 | Same as R108 | | |
| R155 | Same as R136 | | |
| R156 | Same as R108 | | |
| R157 | 10 K, 1 watt | Type G-B | Allen-Bradley Co. |
| R158 | 6.8 K, 1 watt | Type G-B | Allen-Bradley Co. |
| R159 | Same as R123 | | |
| R160 | 500 K, A Taper, Potentiometer | Type J | Allen-Bradley Co. |
| R161 | Same as R126 | | |
| R162 | Same as R142 | | |
| R163 | Same as R113 | | |
| R164 | Same as R123 | | |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R165 | 2 K, 25 watts, Adjustable | #0377 | Ohmite Mfg. Co. |
| R166 | 5 K, 25 watts | #0212 | Ohmite Mfg. Co. |
| | **Connectors** | | |
| J101 | Female, Coaxial | SO-239 | American Phenolic Corp. |
| J102 | Female, Coaxial, BNC Series | UG 290/U | Industrial Prod. Co. |
| J103 | Same as J102 | | |
| J104 | Same as J101 | | |
| P102 | Male. coaxial, BNC Series | UG88/U | Industrial Prod. Co. |
| P103 | Same as P102 | | |
| P601 | Plug | 16812-15 | Cannon |
| | **Inductances** | | |
| L101 | Spiral Inductuner | S-4 | P.R.Mallory Co. Inc. |
| L101A | Inductance in Connecting Leads | | |
| L102 | Same as L101 | | |
| L102A | Inductance in Connecting Leads | | |
| L103 | Inductance in Connecting Leads | | |
| L104 | Same as L101 | | |
| L104A | Inductance in Connecting Leads | | |
| L105 | Same as L101 | | |
| L105A | Inductance in Connecting Leads | | |
| L106 | 3.8 uh R.F. Choke | A-167-101 | Clarke Instrument Corp. |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| L107 | 2.5 uh, R.F. Choke | A-167-103 | Clarke Instrument Corp. |
| L108 | 28 uh, R.F. Choke | A-167-102 | Clarke Instrument Corp. |
| L109 | Same as L108 | | |
| L110 | 10 h, Filter Choke | PH 1085 | Chicago Transformer Co. |
| L111 | Same as L110 | | |
| | **Meters** | | |
| M101 | 50 Microamperes Scale according to Clarke Instrument Drawing No. B-167-501 | HM2 | Marion Electrical Instrument Co. |
| M102 | 100-0-100 microamperes | HM2 | Marion Electrical Instrument Co. |
| | **Speaker** | | |
| LS101 | 4" Permanent Magnet Type | Type 404S2 | RCA |
| | **Transformers** | | |
| T101 | I.F. Transformer | A-167-110 | Clarke Instrument Corp. |
| T102 | Same as T101 | | |
| T103 | I.F. Transformer | A-167-109 | Clarke Instrument Corp. |
| T104 | Same as T103 | | |
| T105 | Discriminator Transformer | B-167-524 | Clarke Instrument Corp. |
| T106 | Audio Output Transformer | A-167-108 | Clarke Instrument Corp. |
| T107 | Power Transformer | PHC-85 | Chicago Transformer Co. |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| | **Hardware** | | |
| | Handle | 1020 | USECO |
| | Plug | 106-73A | E.F.Johnson |

NOTE: For receivers equipped with crystal oscillator units add the following parts.

| | | | |
|---|---|---|---|
| C1 | 1000 uuf +100%-0% Silver Mica | 906A | Centralab |
| C2 | 22 uuf ±10% Mica | 463065 | Standard |
| C3 | 100 uuf ±10% Mica | 463097 | Standard |
| C4 | 10 uuf ±10% Mica | 463065 | Standard |
| C5 | 1000 uuf +100%-0% Silver Mica | 906A | Centralab |
| C6 | 500 uuf ±20% ceramic | CP2-A | Erie |
| C7 | 1000 uuf +100%-0% Silver Mica | 906A | Centralab |
| R1 | 680 ±10% ½ W | RC20AE681K | Standard |
| R2 | 220 ±10% ½ W | RC20AE221K | Standard |
| R3 | 8.2 ±10% ½ W | RC20AE823K | Standard |
| R4 | 33 K ±10% ½W | RC20AE333K | Standard |
| R5 | Same as R4 | | |
| R6 | Same as R2 | | |
| L1 | 64.2-70.1 MC Coil | Y12119 | Bendix |
| L2 | 1284-140.2 MC Coil | Y12120 | Bendix |
| L3 | 250.8-280.4 MC Coil | Y12121 | Bendix |
| L4 | .74-.76 uh Coil | Y12127 | Bendix |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| L5 | Coil Assembly Coupling | Y12798 | Bendix |
| P1 | Plug, R.F. Cable | VG-89V | Standard |
| J1 | Connector Coaxial | 31-003 | Amphenol |
| V1 | Vacuum Tube-Submin. | CK5703 | Raytheon |
| V2 | Same as V1 | | |
| V3 | Same as V1 | | |
| Y | Crystal, Quartz ±.01% (See table for frequency desired) | H17 | James Knight |

6.0 555150 SUBCARRIER AMPLIFIER

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C501, C502, C503, C504 | Capacitor .05MF 400V | P488 | Aerovox |
| C505, C506, C507, C508 | Capacitor .5MF 200V | P288 | Aerovox |
| C509, C510, C511, C512, C513, C514, C515, C516 | Capacitor .05MF 400V | P488 | Aerovox |
| | Handle, Panel | 1020 | USECO |
| | Knob, Pointer | 4101-P | H.Davies Mold. |
| M501 | Meter, Test | 556456 | Bendix |
| P501, P502 P503, P504 | Plug, Octal | 86-CP8 | Amphenol |
| P505 | Plug | 16812-15 | Cannon Elec. |
| R501, R502, R503, R504 | Potentiometer 500K | AB | Ohmite |
| R505, R506 R507, R508 | Resistor 3900-2W | RC42BF392K | Standard |
| R509, R510 R511, R512 | Resistor 270-1W | RC30BF271K | Standard |
| R513, R514, R515, R516 | Resistor 510-½ | RC20BF511K | Standard |
| R517, R518, R519, R520 | Resistor 100K - ½W | RC20BF104K | Standard |
| R521, R522 R523, R524 | Resistor 1K - ½W | RC20BF102K | Standard |
| R525, R527 R540, R543 | Resistor 2.2K - ½W | RC20BF222K | Standard |
| R526, R528 R541, R542 | Resistor 18K - ½W | RC20BF183K | Standard |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R529, R530<br>R531, R532 | Resistor 1 Meg. - ½W | RE20BF105K | Standard |
| R533, R538 | Resistor .93 - ½W | 60 | Hycor |
| R534, R535<br>R536, R537 | Resistor 15.67 - ½W | 60 | Hycor |
| R539 | Resistor .40 - ½W | 60 | Hycor |
| | Tube Shield 1½" long | 5-405 | Amphenol |

NOTE: All Resistor part Nos. with RC prefix are per JAN-R-11

| | | | |
|---|---|---|---|
| S501 | Switch, two circuit<br>9 position | 3229J | Mallory |
| V501, V504 | Tube, Vacuum | 5687 | Standard |
| V502, V503<br>V505, V506 | Tube, Vacuum | 12AT7 | Standard |
| XV501 thru<br>XV506 | Socket, 9 pin miniature | 53F12621 | Cinch |

7.0 555180 DISCRIMINATOR

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| | Cap, Switch | 1343 | H & H |
| C301 | Capacitor, 5100 uuf 500V ±20% | RCM30D512J | El Menco |
| C302 | Capacitor, .25 uf 400V | "Aerolite"P82 | Aerovox |
| C303 | Capacitor, .01 uf 500V ±20% | RCM30D103K | El Menco |
| C304 | Capacitor, 5 uuf 500V±5% | CM15D050J | El Menco |
| C305 | Capacitor, 51 uuf 500V ±5% | CM15D510J | El Menco |
| C306 | Capacitor, .5uf 400V | "Aerolite"P82 | Aerovox |
| C307 | Capacitor, 10 uuf 500V ±5% | CM15D100J | El Menco |
| C308, C320, C322 | Capacitor, .001 uf 300V ±20% | RCM20B102M | El Menco |
| C309, C311 | Capacitor, .25 uf 200 | "Aerolite"P82 | Aerovox |
| C310 | Capacitor, .5 uf 200V | "Aerolite"P82 | Aerovox |
| C321 | Capacitor, 430 uuf 300 ±5% | CM15D431J | El Menco |
| C323, C325 | Capacitor, 8 uf 600V Electrolytic | TJU6080 | Cornell-Dubilier |
| C324, C326, C327 | Capacitor, 0.1 uf 400V | "Aerolite"P82 | Aerovox |
| C328 | Capacitor, 10 uf 450V Electrolytic | BR1045A | Cornell-Dubilier |
| C330 | Capacitor, .05uf 400V | "Aerolite"P82 | Aerovox |
| C331 | Capacitor, .02 uf 200V | "Aerolite"P82 | Aerovox |
| C332 | Capacitor, .01 uf 500V +10% | RC30D103M | El Menco |
| C312, C319, C329 | Capacitor - See Note | | |

NOTE: 1. Capacitors C312 thru C319, and C329 are components of the tuning unit which is to be replaced in whole.

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| L301 | Choke, Filter: 15H | HS-307 | Triad |
| L302 | Choke: 3.4 MH | CH-1213 | Bud Radio Inc. |
| J301 | Connector, Jack: 15 contacts | S-315-AB | Jones |
| F301 | Fuse, 3 amp 3 AG "Slo-Blo" | 312003 | Littlefuse |
| F301 | Fuse Holder, Finger type | 342001 | Littlefuse |
| | Handle, Panel | 1020 | USECO |
| | Knob, Black with Pointer | 4100P | Davies Mold |
| I301 | Lamp, Pilot | #47 | G.E. |
| M301 | Meter, Input | 556458 | Bendix |
| M302 | Meter, Output | 556459 | Bendix |
| M303 | Meter, Test | 556457 | Bendix |
| R331 | Potentiometer, 2K wirewound | 43-2000 | Clarostat |
| R329 | Potentiometer, 15K wirewound | 58-15000 | Clarostat |
| R301 | Potentiometer, 500K | Type A-B | Ohmite |
| R369 | Potentiometer, Dual 50K each | PQ11-123 & M-11-123 | IRC |
| R340 | Potentiometer, 500 ohm wirewound | 43-500 | Clarostat |
| P301 | Plug, Rack Type | 16812-15 | Cannon |
| | Plug, Index | 106-73A | E.F.Johnson |
| K301 | Relay, Thermal Delay 6.3V | 6N060 | Amperite |
| K302 | Relay, Telephone Type | Type 6204 | Advance |
| R302, R383 | Resistor - 1 meg ±10% ½W | RC20BF105K | Standard |
| R303 | Resistor - 1K ±10% ½W | RC20BF102K | Standard |
| R304, R307 | Resistor - 4.7K ±10% ½W | RC20BF473K | Standard |
| R311, R314, R382, R305, R306, R356, R357 | Resistor - 10K ±10% 1 W | RC20BF103K | Standard |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R305, R308, R315 | Resistor - 100K ±10% ½W | RC20BF104K | Standard |
| R309, R310 | Resistor - 390K ±10% ½W | RC20BF394K | Standard |
| R312 | Resistor - 8.2K ±10% ½W | RC20BF822K | Standard |
| R313 | Resistor - 150K ±10% ½W | RC20BF154K | Standard |
| R316 | Resistor - 15K ±10% ½W | RC20BF153K | Standard |
| R317 | Resistor - 33K ±10% ½W | RC20BF333K | Standard |
| R346, R351, R318 | Resistor - 6.8K ±10% ½W | RC20BF682K | Standard |
| R319 | Resistor - .5 meg ±1% ½W | 70-L | Hycor |
| R320 | Resistor - 75K ±1% ½W | 70-L | Hycor |
| R321 | Resistor - 2K ±1% ½W | 70-L | Hycor |
| R322, R323, R337 | Resistor - 25K ±1% ½W | 70-L | Hycor |
| R324 | Resistor - 40K ±1% ½W | 70-L | Hycor |
| R325 | Resistor - 10K ±1% ½W | 70-L | Hycor |
| R326, R379 | Resistor - 3.3K ±10% ½W | RC20BF332K | |
| R327, R338 | Resistor - 50K ±1% ½W | 70-L | Hycor |
| R328 | Resistor - 100K ±1% ½W | 70-L | Hycor |
| R330 | Resistor - 30K ±1% ½W | 70-L | Hycor |
| R339 R341 | Resistor - 2.5K ±1% 7W | 6B-13 | Cinema Eng. |
| R342, R343 | Resistor - 330 ohms ±10% ½W | RC20BF331K | Standard |
| R344, R350 | Resistor - 220K ±10% ½W | RC20BF224K | Standard |
| R345, R354 | Resistor - 39K ±10% ½W | RC20BF393K | Standard |
| R347, R348, R352, R353 | Resistor - 4.7 ohms ±10% 1W | Type BTA | IRC |
| R349 | Resistor - 470K ±10% ½W | RC20BF474K | Standard |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R358, R359 | Resistor, 500 ohm ±10% 10W wirewound | "Brown Devil" | Ohmite |
| R355 | Resistor - 2.74 ohms ±1% | Type 53 | Hycor |
| R360 | Resistor - 394K ±1% ½W | 70-L | Hycor |
| R361, R376 | Resistor - 1.08 ohms ±1% ½W | 70-L | Hycor |
| R362 | Resistor - .301 ohm ±1% ½W | 70-L | Hycor |
| R363 | Resistor - 188K ±1% ½W | 70-L | Hycor |
| R364 | Resistor - 3.03 ohms ±1% | 70-L | Hycor |
| R366, R385 | Resistor - 47K ±10% ½W | RC20BF473K | Standard |
| R367 | Resistor - 4.5K ±10% 10W wirewound | "Brown Devil" | Ohmite |
| R368 | Resistor - variable - 300 ohm, T-Pad Spec. | CIT-58 | Clarostat |
| R370, R375 | Resistor (Determined during test and calibration) | Replace in kind. | |
| R371, R372 | Resistor - 68K ±10% ½W | RC20BF683K | Standard |
| R373, R374 | Resistor - 2.2 meg ±10% ½W | RC20BF225K | Standard |
| R377 | Resistor - 220K ±10% ½W | RC20BF224K | Standard |
| R378 | Resistor - 1.5 meg ±10% ½W | RC20BF155K | Standard |
| R380 | Resistor - 82K ±10% 2W | RC20BF823K | Standard |
| R384 | Resistor - 100 ohms ±10% ½W | RC20BF101K | Standard |
| R386 | Resistor - 2.2K ±10% ½W | RC20BF222K | Standard |
| R381 & R332 thru R336 | Resistor - See note. | | |

NOTE: 1. Resistors R332 thru R336, and R381 are components of the tuning unit which is to be replaced in whole.

2. Resistor part numbers with RC prefix per JAN-R-11.

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| | Shaftlock, Wrench type | 1510 | USECO |
| | Shaftlock, Hand type | 1520 | USECO |
| | Shield, Tube 2-¼ lg | 754 | Cinch |
| | Shield, Tube 1-3/4 lg | 753 | Cinch |
| | Shield, Tube 1-15/16 lg | 952 | Cinch |
| XI301 | Socket, Panel Lamp (red) | 81410-111 | Dialco |
| XV301, XV302, XV304 XV305, XV307 thru XV314 | Socket, Tube 7 Pin Miniature | 9319 | Cinch |
| XV302, SV306 XV315 | Socket, Tube 9 Pin Miniature | 53F12621 | Cinch |
| XK301 | Socket, Octal | 77-MIP8 | Amphenol |
| S301 | Switch, Power | 7500 K14 | Cutler, Hammer |
| S302 | Switch, Rotary 2 CIR. 6 POS. | 3226J | Mallory |
| S303 | Switch, Momentary | 1340 | Arrow Hart & Hedgeman |
| S304 | Switch, Toggle DPDT CTR OFF 115V, 10A | | Cutler-Hammer |
| T301 | Transformer | 6913 | Triad |
| V301 | Tube, Vacuum | 6BF6 | Standard |
| V303, V304, V305, V310, V311, V316 | Tube, Vacuum | 6AU6 | Standard |
| V302, V306 | Tube, Vacuum | 12AU7 | Standard |
| V307, V308. V309 | Tube, Vacuum | 6AQ5 | Standard |
| V312, V313 | Tube, Vacuum | 6X4 | Standard |
| V314 | Tube, Gas Regulator | OA2 | Standard |
| V315 | Tube, Vacuum | 12AT7 | Standard |

8.0 555190 REGULATED POWER SUPPLY

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C701, C702, C703 | Capacitor, 6 uf 1000V | JAN CP70 BIEG605K | Standard |
| C704, C705 | Capacitor, 0.1 uf 600V | CMIC-610 | Tobe |
| L701 | Choke, filter | 555029 | Bendix |
| L702 | Choke, Filter | 555031 | Bendix |
| F701 | Fuse, 5 amp. | 312005-3AG | Littlefuse |
| XF701 | Fuse, holder | 342001 | Littlefuse |
| | Handle, Panel | 1020 | USECO |
| | Knob, Instrument | S-308-64 | Kurz-Kasch Co. |
| I701 | Lamp, Pilot | 47 | Mazda |
| M701 | Meter | Y09413 | Bendix |
| | Plug | 106-73A | E.F.Johnson Co. |
| P701 | Plug | 16812-15 | Cannon |
| R701 | Potentiometer, 175 ohm, 25W | 0153 | Ohmite |
| R702 | Resistor, 25K 5W | 5KT-25K | Sprague |
| R703 | Resistor, 12.5K 5W | 5KT-12.5K | Sprague |
| R704 | Resistor, 240K ½W | RC20BF244 | Standard |
| R705 R707 | Resistor, 1 Meg. ½W | RC20BF105M | Standard |
| R706 | Resistor, 68K 1W | RC30BF683M | Standard |
| R708 | Resistor, 15K 2W | RC42BF153M | Standard |
| R709 | Potentiometer, 10K | 58-10,000WW | Clarostat |
| R710 | Resistor, Precision 500K | 60-500K | Hycor |
| R711, R712 | Resistor, Precision 0.213 ohm | 60-0.213 | Hycor |
| R713 | Resistor, Precision 0.1062 ohm | 60-0.1062 | Hycor |
| S701 | Switch, Meter | 173C | Mallory |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| S702 | Switch, Toggle | 1330 | H & H |
| | Shaftlock | 1510 | UESCO |
| XI701 | Socket, Pilot Lamp | 147-111 | Gothard-Johnson |
| T701 | Transformer, Power | 5916 | Altec Lansing |
| T702 | Transformer, Filament | 9305 | Triad |
| | Tube, Shield, 7 pin medium 1 3/4 in. | 7S3 | Cinch |
| V701 | Tube, Vacuum | 5R4GY | Standard |
| V702 | Tube, Vacuum | 6AS7G | Standard |
| V703 | Tube, Vacuum | 6SL7GT | Standard |
| V704 | Tube, Gas Regulator | 5651 | Standard |

9.0 555600 MONITOR PANEL

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C901, C904 | Capacitor, .1 uf 400V | P82 | Aerolite |
| C902, C905 | Capacitor, .05 uf 600V | P82 | Aerolite |
| C903, C906 | Capacitor, 25 uf 25V | | Aerovox |
| F901 | Fuse, 3 amp, 3AG | 312003 | Littlefuse |
| XF 901 | Fuse Holder, Finger Type 3 AG | 342001 | Littlefuse |
| | Handle, Panel | 1020 | U.S.Engr. Co. |
| | Knob, Instrument | 4100 | Davies Mold |
| | Knob, Instrument w/pointer | 4100 P | Davies Mold |
| I 901 | Lamp, Pilot Light | #47 | G.E. |
| | Oscilloscope Assembly | 90905 | James Millen |
| XI 901 | Pilot Assembly, Grn jewel | 810-BF | Dial Co. |
| | Plug, Index | 106-73A | E.F.Johnson |
| P901 thru P904 | Plug, Rack Type | 16812-15 | Cannon Electric. |
| P905 | Plug, AC | 2717 | G.E. |
| R906 | Plug, Banana | 108-75c | E.F.Johnson |
| R907, R908 | Potentiometer, .5 Meg Type | CU-5041 | Ohmite |
| J 905 | A-B Receptacle, AC | 2716 | G.E. |
| R 901, R904 | Resistor, 470 ohms ½W | | Standard |
| R 902, R905 | Resistor, 200K 1W | | Standard |
| R 903, R906 | Resistor, 33K 1W | | Standard |
| | Shield, Tube Miniature | 8661 | Cinch |
| XV 901, XV902 | Socket, 7 Pin miniature Tube | S01OM | Cinch |
| S901 thru S904 | Switch, Rotary | 1405 | Centralab |
| S905 | Switch, Rotary - 2 gang 1 Circuit, 1 gang | 1411 | Centralab |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| S906 | Switch, Rotary 1 gang 1 circuit | 32117J | Mallory |
| S907 | Switch, Rotary 3 gang 2 circuit/gang | 1425 | Centralab |
| S908 | Switch, Telephone Type | 1044B | Cinema Engr. |
| | Vacuum Tube Voltmeter | Model 62 | Measurement Corp. |
| V901, V902 | Tube, Vacuum | 6AU6 | Standard |
| Scope | Tube, Rectifier | 2X2A | Standard |
| VTUM | Tube, Rectifier | 5W4 | Standard |
| Scope | Tube, Rectifier | 5W3 | Standard |
| VTVM | Tube, Vacuum | 6C5 | Standard |
| VRVM | Tube, Vacuum | 6H6 | Standard |
| Scope | Tube, Cathode-Ray | 5UP1 | Standard |

10.0 Y11461 EPUT METER

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1201 | Capacitor - 610 uuf ±10% 300 V | | |
| | Handle, Panel | 1020 | USECO |
| | Plug, Index | 106-73A | E.F.Johnson |
| P1201 | Plug, Rack Type RTC 12-34-3 | 16812-15 | Cannon |
| R1206 | Potentiometer, 50K Carbon | Type AB | Ohmite |
| P1202 | Prod, Test - Phone tip | 94 | Bud Radio Inc. |
| R1201 | Resistor, 2.4 meg ±10% ½W | RC20BF245K | Standard |
| R1202, R1203 | Resistor, 1.5 meg ±10% ½W | RC20BF155K | Standard |
| R1204 | Resistor, 330K±10% ½W | RC20BF334K | Standard |
| R1205 | Resistor, 560K ±10% ½W | RC20BF564K | Standard |
| | Shield, Tube - 1-15/16 lg | 952 | Cinch |
| XV1201 | Socket, Tube 9 Pin Miniature | 53F12621 | Cinch |
| V1131-1, V1131-2 V1344-1 thru V1344-5 V1346, V1 thru V4 V1131-4 thru V1131-7, V1201 | Tube, Vacuum - Miniature | 12AU7 | Standard |
| V1136 | Tube, Vacuum | 12BH7 | Standard |
| V101 | Tube, Rectifier | 5U4G | Standard |
| V102 | Tube Vacuum | 6Y6 | Standard |
| V103, V1341 | Tube Vacuum | 6AU6 | Standard |
| V104 | Tube, Gas Regulator | OB2 | Standard |
| V1345-1, V1345-2 | Tube, Vacuum | 6AS6 | Standard |

NOTE: 1. For parts not listed see schematic.
2. Resistor part numbers with RC prefix per JAN-R-11

11.0 Y11800 AUDIO OSCILLATOR

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1 | Tuning Capacitor and Drive Assembly | I-100 | Hewlett-Packard |
| C2, C4 | Capacitor: fixed, sliver mica, 330 uuf; 500vdcw; Electrical value adjusted at factory | | |
| C3, C5 | Capacitor, variable, air, 50 uuf | J-55L | Sarkes Tarzian |
| C6 | Capacitor: Electrical value adjusted at factory | | |
| C7 | Capacitor: fixed, paper, .5 uf, -10% +20% 600 vdcw | 684 | Aerovox |
| C8 abc | Capacitor: fixed, electrolytic, 10, 10, 10 uf, 400 vdcw | FPT-389 | Mallory |
| C9 | Capacitor: fixed, paper, 2000 uuf, -25% +50% 600 vdcw | 684 | Aerovox |
| C10, C13, C15, C16 | Capacitor: fixed, electrolytic 40 uf, 450 vdcw | FPS-146 | Mallory |
| C11 | Capacitor: fixed, electrolytic 20 uf, 450 vdcw | FPS-144 | Mallory |
| C12 | Capacitor: fixed, paper, .1 uf, ±10% 600 vdcw | P688 | Aerovox |
| C14 | Capaciator: fixed, paper 4 uf, ±10% 600 vdcw | | Girard Hopkins |
| C17 | Capacitor: fixed, paper .05 uf, -10% +30% 600 vdcw | P688 | Aerovox |
| R1-R6, R13-R18 | Part of Range Switch Assembly | | |
| R7-R12 | These circuit references not assigned. | | |
| R19-R21 | These circuit references not assigned. | | |
| R22 | Resistor: variable, composition 20,000 ohms, linear taper | 33-010-725 | Centralab |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R23 | Resistor: variable, composition 10,000 ohms, linear taper | JLU 1031 | Allen-Bradley Co. |
| R24 | Resistor: variable, composition 2000 ohms; linear taper | 37 | Clarostat |
| R25 | Resistor: variable. wirewound 1000 ohms; linear taper | 21-010-355 | Centralab |
| R26 | Resistor: variable, 200 ohms | | |
| R27 | Resistor: variable, wirewound 100 ohms; linear taper | 21-010-354 | Centralab |
| R28 | Resistor: variable, wirewound 1000 ohms; linear taper | 27-010-355 | Centralab |
| R29 | Resistor: fixed, wirewound 1500 ohms; ±10% 1W | BW | InternationalRes. |
| R30 | Lamps: 6W 120V | | G.E.Supply Corp. |
| R31, R33, R40, R41, R42, R43 | Resistor: fixed, composition 56,000 ohms; ±10% 1W | GB 5631 | Allen-Bradley |
| R32 | Resistor: fixed, composition, 100,000 ohms; ±10% 2W | HB 1041 | Allen-Bradley |
| R34, R36 | Resistor: fixed, composition 270 ohms; ±10% 1W | GB 2711 | Allen-Bradley |
| R35, R44 R52 | Resistor: fixed, composition 560,000 ohms; ±10% 1W | GB 5641 | Allen-Bradley |
| R37 | Resistor: fixed, wirewound 5000 ohms; ±10% 20W | A 2580 | Sprague |
| R38 | Resistor: variable, composition, 25,000 ohms; linear taper | JU 2531 | Allen-Bradley |
| R39, R47 | Resistor: fixed, composition, 10,000 ohms; ±10% 1W | GB 1031 | Allen-Bradley |
| R45 | Resistor: fixed, composition, 560 ohms; ±10% 1W | GB 5611 | Allen-Bradley |
| R46 | Resistor: fixed, wirewound, 5000 ohms; ±10% 10W | 1-3/4E | Lectrohm, Inc. |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| R48 | Resistor: variable, wire-wound, 50 ohms: linear taper | Z1-010-067 | Centralab |
| R49, R50 | Resistor: fixed, composition 100,000 ohms; ±10% 1W | GB 1041 | Allen-Bradley |
| R51 | Resistor: fixed, composition 10,000 ohms; ±10% 2W | HB 1031 | Allen-Bradley |
| R53 | Resistor: fixed, composition 33,000 ohms; ±10% 1W | GB-3331 | Allen-Bradley |
| R54 | Resistor: variable, composition, 25,000 ohms linear taper | BAI-010-1990 | Centralab |
| R55 | Resistor: fixed, composition 47,000 ohms; ±10% 1W | GB 4731 | Allen-Bradley |
| R56 | Resistor: fixed, composition 270,000 ohms; ±10% 1W | GB 2741 | Allen-Bradley |
| | Binding Post: | 312-3 | Hewlett-Packard |
| | Dial Indicator: | I-100N | Hewlett-Packard |
| | Escutcheon: | G-99A | Hewlett-Packard |
| F1 | Fuse, 1A, | 3 AG | Bussman Mfg.Co. |
| | Fuseholder: | 342001 | Littlefuse, Inc. |
| | Indicator Lamp Assembly | 807BS | Singal Indicator Co. |
| | Knob: 1-5/8" diam. | 37-12 | Hewlett-Packard |
| | Knob: 1-1/2" diam. | 37-11 | Hewlett-Packard |
| | Knob: 2" diam. | 37-13 | Hewlett-Packard |
| I1 | Lamp, Mazda | 47 | G.E.Supply Co. |
| | Lampholder | 659-1 | Leecraft MFG. |
| | Handle, Panel | 1020 | USECO |

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| P1301 | Plug | 16812-15 | Cannon |
| L1 | Reactor: 6H at 125 ma, 240 ohms | 911-12 | Hewlett-Packard |
| S1, R1-R6 R13-R18 | Range Switch Assembly | | Hewlett-Packard |
| S2 | Rotary Switch | 81715 | Arrow, Hart and Hegeman |
| T1 | Power Transformer | 910-55 | Hewlett-Packard |
| V1, V3 | Tube: Vacuum | 6SJ7 | Standard |
| V2 | Tube: | 6AG7 | Standard |
| V4 | Tube: | 6V6 | Standard |
| V5 | Tube: | 5Y3GT | Standard |
| V6 | Tube: | 6L6G | Standard |
| V7 | Tube: | 6SQ7GT | Standard |
| V8 | Tube: Gas Regulator | VR150 | Standard |

12.0 Y11236 LOW PASS FILTER CHASSIS ASSEMBLY

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| P101 | Socket Octal | 78-S8 | Amphenol |
| P102 | Same as P101 | | |
| P103 | Same as P101 | | |
| P104 | Same as P101 | | |
| P105 | Plug | 16812-15 | Cannon Elec. |
| | Plug | 106-73A | E.F.Johnson |
| S101 | Switch-DPDT | 20510 | Arrow H&H |
| S102 | Same as S101 | | |
| S103 | Same as S101 | | |
| S104 | Same as S101 | | |

13.0 555220 OSCILLOGRAPH CONTROL PANEL

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| J801 thru J836 | Jack | 1399B | Cinema Engr. |
| S801 thru S838 | Key, Lever | 1044H | Cinema Engr. |
| P801 thru P806 | Plug, Rack Type | 16812-15 | Cannon Elec. |
| S801 thru S818 | Switch, Toggle DPDT Bat Handle | 20510 | Arrow H&H |
| R801 thru R818 | T-Pad - 330 Ohms | CTT-58 | Clarostat |
| | Handle, Panel | 1020 | USECO |
| | Plug, Index | 106-73A | E.F.Johnson |
| | Shaftlock, Hand Type | 1520 | USECO |

14.0 Y11156 BLOWER PANEL

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| B201 | Blower | 3B08 | Ilg Elec. |
| F201 | Fuse, 5 amp | 3AG | Littlefuse |
| I201 | Light Pilot 115V | 1686 | Mazda |
| J201 | Receptacle | 1913 | Arrow H&H |
| P201 | Plug | 16812-15 | Cannon Elec. |
| S201 | Breaker, Circuit | 0411 | Heineman Elec. |
| XF201 | Holders, Fuse | 342001 | Littlefuse |
| XI201 | Socket, Lamp | 147-1201 | Johnson-Gothard |
| | Filter, Fiberglass | 10X10X1 | Owens-Corning |
| | Handle, Panel | 1020 | USECO |

15.0 Y11744 MASTER POWER PANEL

| Circuit Designation | Description | Part Number | Manufacturer |
|---|---|---|---|
| IL401 | Light, Pilot 115V | 6S6 | Mazda |
| IL402 | Same as IL401 | | |
| J401 | Outlet, Duplex | 1913 | Arrow H&H |
| S401 | Breaker, Circuit 30 amp. | 0411 | Heinemann Elec. |
| S402 | Breaker, Circuit 15 amp. | 0411 | Heinemann Elec. |
| XIL401 | Socket, Lamp | 147-1201 | Johnson-Gothard |
| XIL402 | Same as XIL401 | | |

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PART II

MOBILE TELEMETERING RECEIVING TRAILER

SECTION I

GENERAL DESCRIPTION

1.0 Electrical Power System

1.1 External Power Source

Since these telemetering trailers are often required to operate at remote locations where there is no source of commercial power, four portable 12.5 KVA gasoline engine- generator units, type PE 95K are provided to supply power to the three trailers. Four 100 ft., 2-conductor power cables are fitted at one end with lugs to connect to the generators and at the other with a Crouse-Hinds Arktite plug which mates a receptacle mounted on the right side of each trailer.

1.2 Internal Power Connections

From the trailer receptacle, the power is fed to a 100 amp. enclosed circuit breaker where it is distributed to a 28 volt power supply, a Stabiline voltage regulator and bank of three switches which supply the lights, the outlet strips and the air-conditioning system. The outlet strips are fed directly from the switch bank where as the lights and the air-conditioning system have individual switches to facilitate combined or independent operation.

1.3 Power Supply - 28 V.D.C.

The 10 amp 28 volt DC power supply is a selenium type rectifier operating from a 110/28 volt transformer, and supplies two antenna position control panels. (APCP)

1.4 Stabiline Voltage Regulator

The Stabiline Automatic Voltage Regulator, Type EM 4106, 6.0 KVA single phase, which supplies a regulated voltage to the two trailer telemeter stations and consists of a bridge and thyratron circuit controlling a motor-operated powerstat variable transformer. This electronically controlled regulator delivers a constant output voltage independent of line voltage, load current and load power factor, considerations very important to the operational stability of the telemetering stations. The output voltage is a faithful and distortionless reproduction of the applied waveform. Although the regulator provides high speed correction, if the line voltage constantly varies a small amount due to transients, possibly caused by heavy starting loads, the regulator will not be able to smooth out these variations.

### 1.5 Air-Conditioning System

The air-conditioning system consists of two CARRIER model 51S3 refrigerated air-conditioners and one trailer exhaust fan. Due to the excessive amount of heat dissipated by the two telemetering stations into the confined space of the trailer, it was necessary to install two air-conditioning units to maintain a suitable working temperature for the equipment and the operating personnel. The second air-conditioner is energized from a separate motor-generator unit through a separate power cable and trailer, receptacle circuit in order to prevent overloading of the E-G set supplying power to the telemetering stations. The air-conditioners operate on 220 volts and a 110/220 volt step-up transformer is used with each unit.

## 2.0 Antenna System

### 2.1 General

The trailer antenna system can be classified into two categories: The receiving antenna system and the antenna position control system. The receiving antenna system consists of two antenna masts, two receiving antennas, the antenna coax lead-ins and two antenna couplers. The antenna position-control system consists of the position-control transmitters and drive motors, and two antenna position-control panels on which are mounted the position-control switches and indicators.

### 2.2 Receiving Antenna System

#### 2.2.1 Antenna Masts

Two masts are located on the top of each trailer positioned diagonally across from each other to provide maximum spacing between the two, each of which is for one T/M station. The two masts are so hinged at the base that they can be folded down and attached to the top of the trailer. When extended in the up position, the antenna projects 20 ft. above the top level of the trailer.

#### 2.2.2 Receiving Antenna Assembly Y-15477

The receiving antenna is a stacked antenna consisting of two 3 element parasitic arrays, vertically polarized with folded dipoles as the radiators, a reflector and director. This type provides high gain and a high front-to-back ratio. The two arrays are spaced a half wavelength apart and are fed 90 degrees out of phase to obtain the desired radiation pattern. The two arrays are fed through ballon transformers, for the purpose of balancing the antenna feed to ground thus reducing the standing wave ratio.

2.2.3 Coax Lead-in

Each of the two arrays of one antenna feeds separate RG-11/U coaxial cables which differ in length by a quarter-wavelength at the operating frequency as measured on a slotted line, thus obtaining the 90 degrees phasing in the feed to the antenna coupler.

2.2.4 Antenna Couplers - Y-15478

Two antenna couplers are used, one for each station. It is a quadruplexing balanced-bridge type employing three "magic T" coaxial rings each of which consist of eight specific lengths of coaxial cable and two RLC circuits enclosed in a metal housing.

2.3 Antenna Position-Control System

2.3.1 Antenna Position-Control Panel Y-16317

The antenna position-control panel is mounted at the top of cabinet "C" in each station and consists of a position - indicator which indicates the azimuth and elevation position of the antenna, and azimuth and elevation switch control which affords movement of the antenna to the desired position, and an elevation and azimuth calibration adjust for the purpose of indicator position correction.

The position indicator is a dual indicating type meter, one indicator for azimuth position from 0 to ±90 degrees and the other for elevation from 0 to +90 degrees. It is possible to adjust the antenna mechanically in order that 180 degrees can scanned.

2.3.2 Position-Control Motors and Gearing

Each antenna mast is equipped with two 28 volt drive motors, one to move the antenna in azimuth and the other, in elevation. Each motor has two field windings such that the direction of motor rotation can be selected by energizing the proper winding. Micro-switches enclosed in the motor unit limit the amount of travel in both direction such that by the proper gearing the antenna is limited to 180 degrees azimuth rotation and 90 degrees in elevation.

The position-control drive motors are mounted in a housing at the base of the mast and are geared to the gear housing at the top of the mast by drive-shafts; the elevation control is brought through the center of the main mast and the azimuth control through a shaft alongside the main mast.

2.3.3 Position Control Switches

The position-control switches, mounted on the antenna control panel are 4PDT, momentary ON-OFF-ON switches with the normal position being off. Thus depending on which switch is energized and in which position, the antenna will move either right, left, up or down.

2.3.4 Position-Control Transmitters

The position-control transmitters are mounted in the motor housing at the base of the antenna mast and consist of two 100 ohm potentiometers which are spring loaded and geared to the antenna drive motors by a phosphor-bronze cable such that the antenna movement is translated into a resistance change which results in a change of meter indication.

## 3.0 Inter and Intra Trailer Wiring

### 3.1 Inter-Trailer Wiring

A junction box is located on the right side of the trailer in which all electrical circuits external to the T/M receiving stations are located. In addition to containing junction points for the inter-com, and timing circuits cables between trailers, this box also serves as a junction box for the antenna-position control system.

The cable connectors are wired for an inter-com circuit and three timing circuits. The inter-com circuit feeds two field phones and an amplifier in each trailer for the purpose of communicating between trailers and three timing circuits for the purpose of synchronizing the oscillograph records of all the stations. Each trailer is equipped with two parallel plugs so that irrespective of which trailer may be located between the other two, a cable may be run from that trailer to the other two.

### 3.2 Time Base

The three timing circuits include time base, range time, and zero time signals. The time base signal originates in the telemetering ground station and is a 1 cps pulse signal which is fed to a switch in the trailer junction box. This switch is a DPDT, ON-OFF-ON, switch which selects the 1 cps signal which is to be used in the system as a common time base.

### 3.3 Zero Time

The zero time signal is a pulse signal which originates from a photo-electric cell unit which has to be set up external to the trailer exposed to ground zero so that at the time of the flash a pulse will be fed to the system and hence recorded on the telemetering record synchronizing all telemetering records.

3.4 Range Time

The range time signal is a signal originating external to the telemetering system for the purpose of synchronizing the telemetering records with any other records which may be taken simultaneously using the same range time signal source.

## SECTION II

## PREPARATION TO OPERATION

### 1.0 Electrical Power System - Y-16331

#### 1.1 Trailer Location

The desired location of one trailer with respect to the others is such that the antennae are the maximum distance apart with respect to the signal source which is a pattern such that the receiving trailers are in a line (See Figure 43) with the signal source being in a direction, broadside from the trailer. The desired location of the power units, PE-95K's, would be at a maximum distance from the trailers and in the opposite direction from the signal source in order to reduce the possibility of interference from the ignition system.

#### 1.2 Power Connections

The two conductor, four gage, rubber covered cable provided with each trailer is connected to the 110V output terminals of a PE95K power unit and the other end with the Crouse-Hinds 3-pin plug, is connected to the proper receptacle on the side of the trailer. Each power unit will then provide power to one trailer for its operation. (See Figure 43 ).

The smaller power cable provided with each trailer has a 2-pin Crouse-Hinds plug and that cable is connected to the proper receptacle on the side of the trailer and the three cables are connected in parallel to the fourth power unit provided for this purpose. This power unit will then provide power for the operation of the second air-conditioner unit in each trailer.

Each trailer and power unit chassis must be grounded to earth to prevent the buildup of a charge between the trailer and earth. A precaution which must be taken prior to connecting the ground to each trailer is to measure the voltage between the trailer chassis and ground with all power units operating. A reading of 110 volts indicates that the output connections on the respective power unit should be reversed.

### 2.0 T/M Trailer Antenna System

#### 2.1 Receiving Antenna Installation

##### 2.1.1 Antenna Locations

Each trailer is equipped with two folding antenna masts on each of which is mounted one antenna. Below is a table listing the antenna location, the antenna number, the coax pair number, the corresponding receivers which it feeds and the channels which the combination covers:

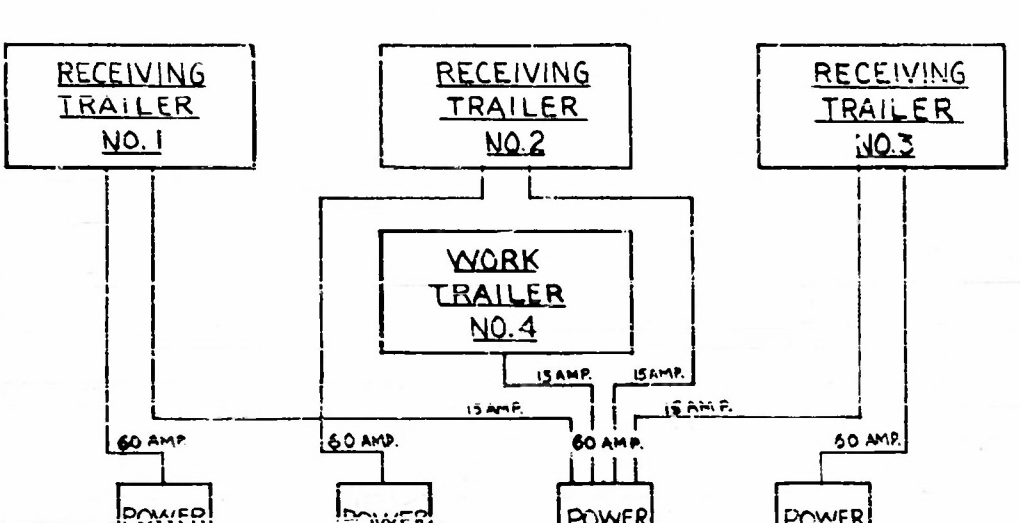



Figure 42 - Block Diagram, Trailer Power Distribution

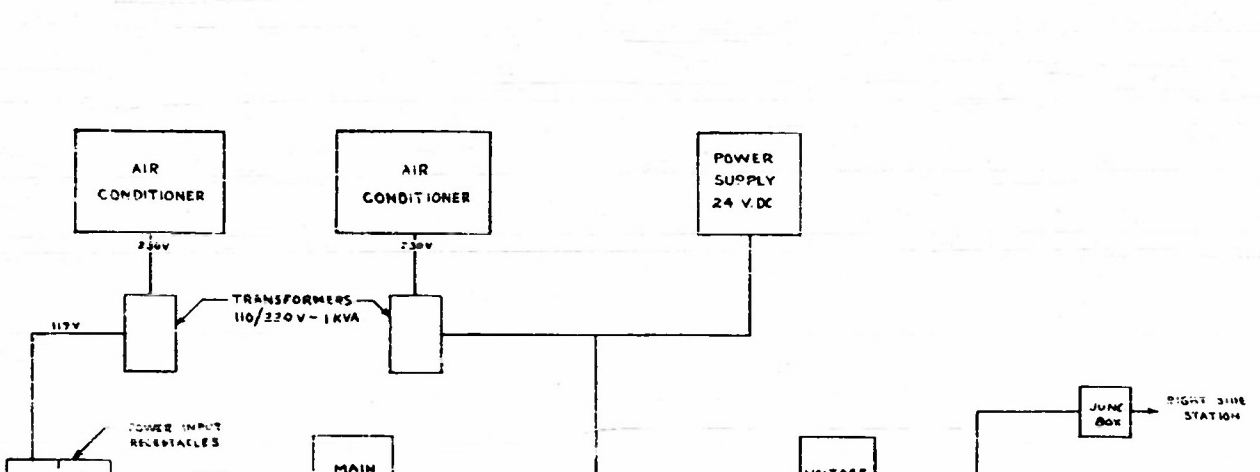



Figure 43 - Block Diagram, Power Distribution
Trailers 1, 2 and 3

| | ANTENNA LOCATION | ANTENNA NUMBER | COAX PAIR NO. | RECEIVER NUMBER | CHANNEL COVERAGE |
|---|---|---|---|---|---|
| 1. | Trailer No. 1 (R) | 1 | 1 | 1-4 | 1-4 |
| 2. | Trailer No. 1 (L) | 2 | 2 | 5-8 | 5-8 |
| 3. | Trailer No. 2 (R) | 3 | 3 | 9-12 | 9-12 |
| 4. | Trailer No. 2 (L) | 4 | 4 | 13-16 | 13-16 |
| 5. | Trailer No. 3 (R) | 5 | 5 | 17-20 | 17-20 |
| 6. | Trailer No. 3 (L) | 3 | 3 | 21-22 | 1-20 |

It is to be noted that the antenna listed under item 6 bears an antenna number of 3. This is due to the fact that this antenna feeds the standby station in trailer No. 3 which is equipped with tuneable receivers, 21 and 22. Therefore, this antenna is designed to the center frequency of twenty allocated channels which thus makes it identical to antenna No. 3. Although it does not operate at maximum efficiency through out the twenty channel band, it does operate satisfactorily.

2.1.2 Antenna Installation Procedure

The proper antenna is selected and mounted on the antenna mast while the antenna is in the folded down position. The gear box at the top of the antenna has two arms with clamps to which the antenna is attached. The azimuth position of the antenna is fixed by the position of the antenna mount however, the antenna is adjustable in elevation. The antenna should be clamped into position such that the mounting arms when in the full down position the antenna will be in the lowest angle which is desired to be scanned.

The proper coax pair is connected to the antenna and the leads clamped to the antenna mast near the top with sufficient slack to allow full movement of the antenna in azimuth and elevation. The leads are then fed thru the opening on the side of the trailer and connected to the antenna coupler.

The antenna mast may now be raised to the "UP" position and secured in position and the system is ready for operation.

2.2 Antenna Position Control Installation

The antenna position control system requires no preparation for operation as all equipment is permanently installed and requires only a system check which is explained in the section on operation of this system.

3.0 Inter and Intra Trailer Wiring

3.1 Inter-trailer Wiring

The inter-trailer cables are connected between trailers whereupon the inter-com and three timing circuits are ready for inter-trailer operation.

3.2 Intra-trailer Wiring

The only two circuits within the trailer junction box which are not complete are the ZERO and RANGE TIME signals and to make them complete requires that their signal source be connected to the system.

The ZERO TIME signal is generated by a photo-electric cell unit which must be mounted exposed to ground zero so that at the time of the flash and pulse signal will be generated and fed through a pair of leads to a trailer junction box and hence fed to the inter-trailer system. It is necessary to have only one photo-electric unit as its signal will be fed to all ground stations through the inter-trailer wiring system.

The RANGE TIME signal (if used) originating external to the telemetering is connected to the proper terminals in the junction box of one of the trailers and hence is fed to the system.

SECTION III

OPERATION

## 1.0 T/M Trailer Power System

### 1.1 Supplying Power to Trailer

1.1.1 Check power cable connections and position of line circuit breakers (OFF) and also make check of fuel and oil levels of power unit engine.

1.1.2 Energize engine-generator power unit as per posted instructions and allow a warm-up period.

1.1.3 Adjust voltage and frequency output of power unit as per posted instructions.

1.1.4 Turn "ON" power unit output circuit breaker and power is now supplied to the trailer.

### 1.2 Supplying Power to Trailer Components

1.2.1 Turn "ON" main circuit breaker.

1.2.2 LIGHTS - Turn "ON" lights switch on switch bank.

1.2.3 EXHAUST FAN - Turn - "ON" blower switch on switch bank.

1.2.4 OUTLET STRIP - Turn "ON" outlets switch on switch bank.

1.2.5 TELEMETERING STATIONS - Turn "ON" circuit breaker on Stabiline voltage regulator.

1.2.6 AIR-CONDITIONERS - Turn "ON" air conditioner circuit breakers.

1.2.7 ANTENNA CONTROL SYSTEM - Turn "ON" switch on 28 volt power supply.

### 1.3 Supplying Power to Auxiliary Air-Conditioner

1.3.1 Check power cable connections and position of line circuit breakers (OFF) and also make check of fuel and oil levels of power unit engine.

1.3.2 Energize engine-generator power unit as per posted instructions and allow a warm-up period.

1.3.3 Adjust voltage and frequency output of power unit as per posted instructions.

4. Turn "ON" power unit output circuit breaker and power is now supplied to auxiliary air-conditioner units.

## 2.0 Trailer Antenna System

### 2.1 Receiving Antenna System - See Figure 44

The two arrays of the receiving antenna are spaced a half-wavelength apart and the coax leads from the antenna to the antenna coupler differ in length by a quarter-wavelength. This combination gives a fairly broad antenna radiation pattern since it is necessary to simultaneously receive as many as four signals from airborne telemetering units on a single antenna.

The antenna coupler (See Figure 45 and 46) used to affords the use of four receivers feeding from a single antenna array. Actually the antenna is comprised of two antenna arrays, each having a coax lead to the coupler. The coupler consists of three balanced bridge circuits and when employed in multiple receiver installations such as this, the coupler affords excellent isolation between receivers, thereby reducing the spurious signals caused by local oscillator inter-action and the pulling in effect between receivers connected to a common antenna system and tuned to adjacent frequencies. The insertion loss inherent in this type of unit is more than compensated for by antenna gain.

### 2.2 Antenna Position - Control System - See Figure 47

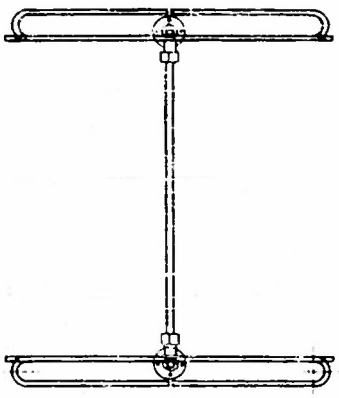
Operation of the antenna control system is from the ANTENNA POSITION CONTROL PANEL. After the antenna has been properly mounted the 28 volt power supply is energized, the elevation and azimuth indicated positions on the position indicator is corrected by means of the elevation and azimuth CALIBRATION ADJUST so that the indicator will indicate the antenna's true position in relation to the trailer.

Antenna movement can be effected by actuating the proper switch on the ANTENNA POSITION CONTROL PANEL for either azimuth or elevation movement. Prior to an actual operation, the antenna is positioned in the anticipated direction of radiated signals and then during the operation the antenna position is adjusted for maximum signal strength indication on the receivers. However, since four receivers are operated on one antenna array it may not be possible to peak the signal strength indication on all four receivers therefore, it will be necessary to compromise on the levels.

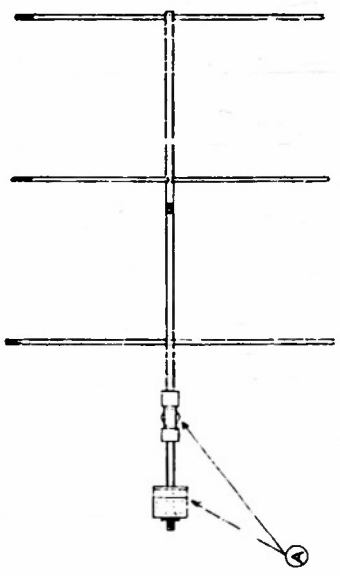
## 3.0 Inter and Intra - Trailer Wiring - See Figure 48

### 3.1 Inter-trailer Wiring

The inter-trailer cables parallels the inter-com, zero time, range time, and 1 cps time circuits in the three trailers so that communications, synchronizing and timing is possible between all the trailers.



| ITEM | AS REQD | DESCRIPTION | PART NO. | NO. REQD |
|---|---|---|---|---|
| 1 | 2 | ASSY. ANT. ELEMENTS & SUPPORT | Y-8051-1 | -- |
| 1 | -- | " | Y-8051-2 | -- |
| 1 | -- | " | Y-8051-3 | -- |
| 1 | -- | " | Y-8051-4 | -- |
| 1 | -- | " | Y-8051-5 | -- |
| 2 | 1 | ANT. CROSSBAR SUPPORT | Y-2963-1 | -- |
| 2 | -- | " | Y-1291.3-2 | -- |
| 2 | -- | " | Y-1291.3-3 | -- |
| 2 | -- | " | Y-1291.3-4 | -- |
| 2 | -- | " | Y-1291.3-5 | -- |
| 3 | 2 | ASSY. COAX TERMINATION | Y-18030 | 2 |
| 4 | 2 | TEE | AN 824-10D | 2 |



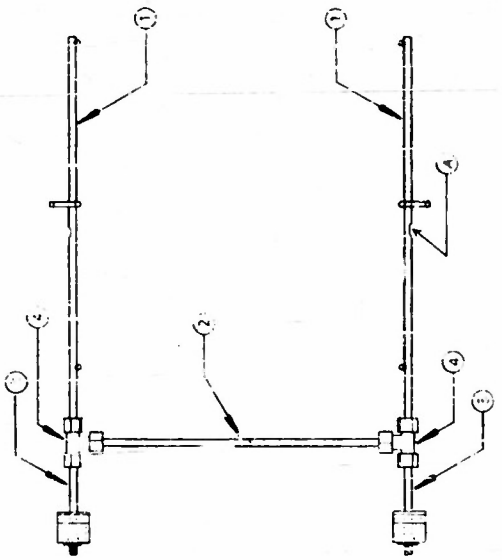
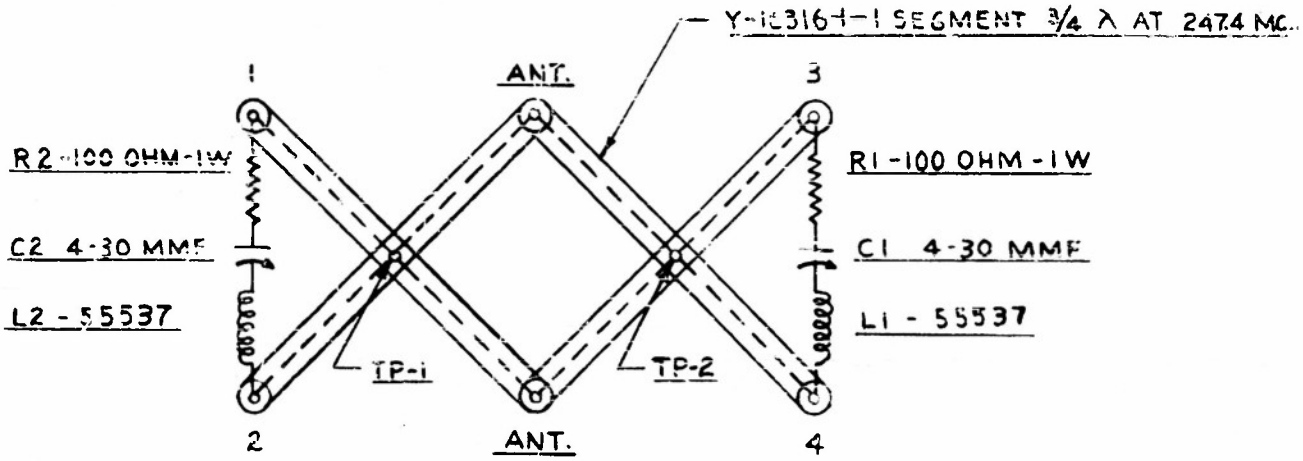
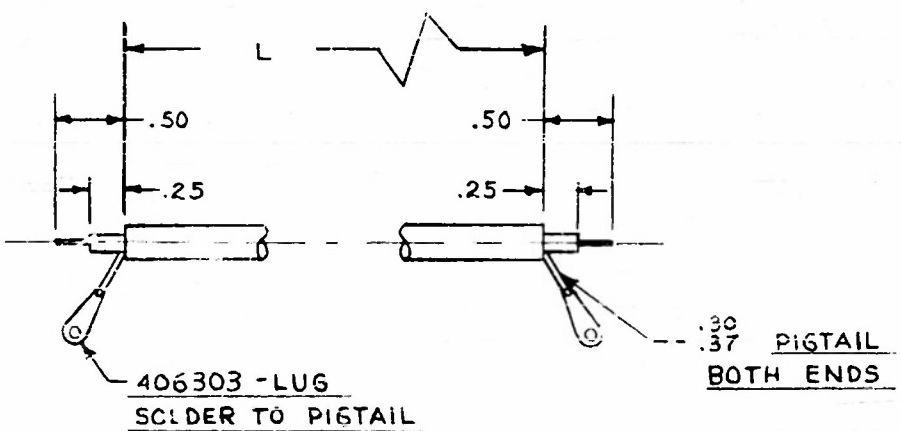


Figure 44 - Trailer Receiving Antenna Assembly




NOTE:
ALL LINE SEGMENTS Y-16316 1/4 λ AT 247.4 MC. EXCEPT AS NOTED

Figure 45 - Schematic, Antenna Coupler




1. DIM. "L" 9.50 IN. FOR Y 16316 WITH RG 62/U
2. DIM. "L" 30.16 IN. FOR Y 16316-1 WITH RG 62/U

Figure 46 - Segments, Antenna Coupler

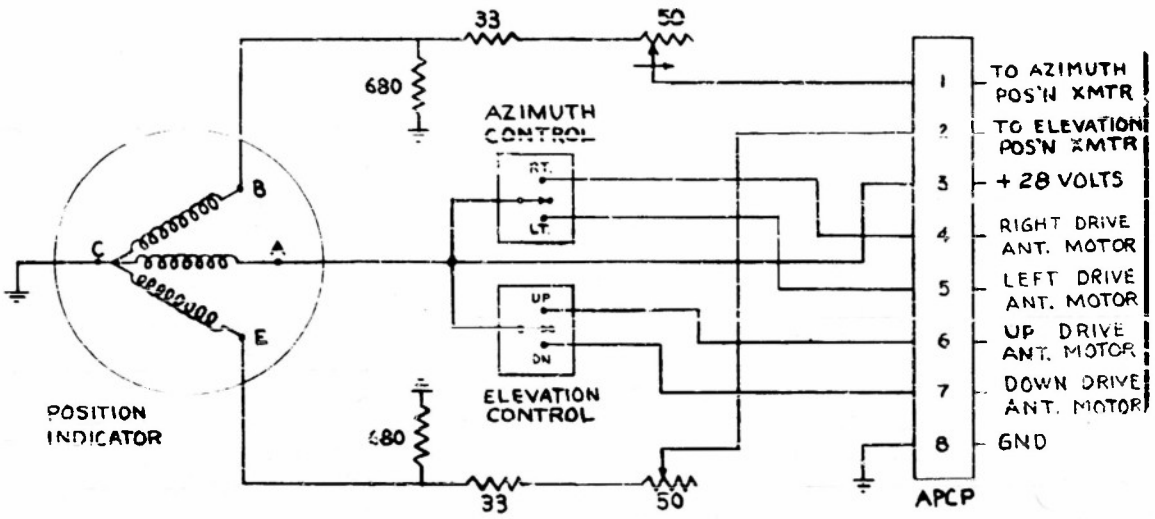



Figure 47 - Schematic, Antenna Position Control Panel

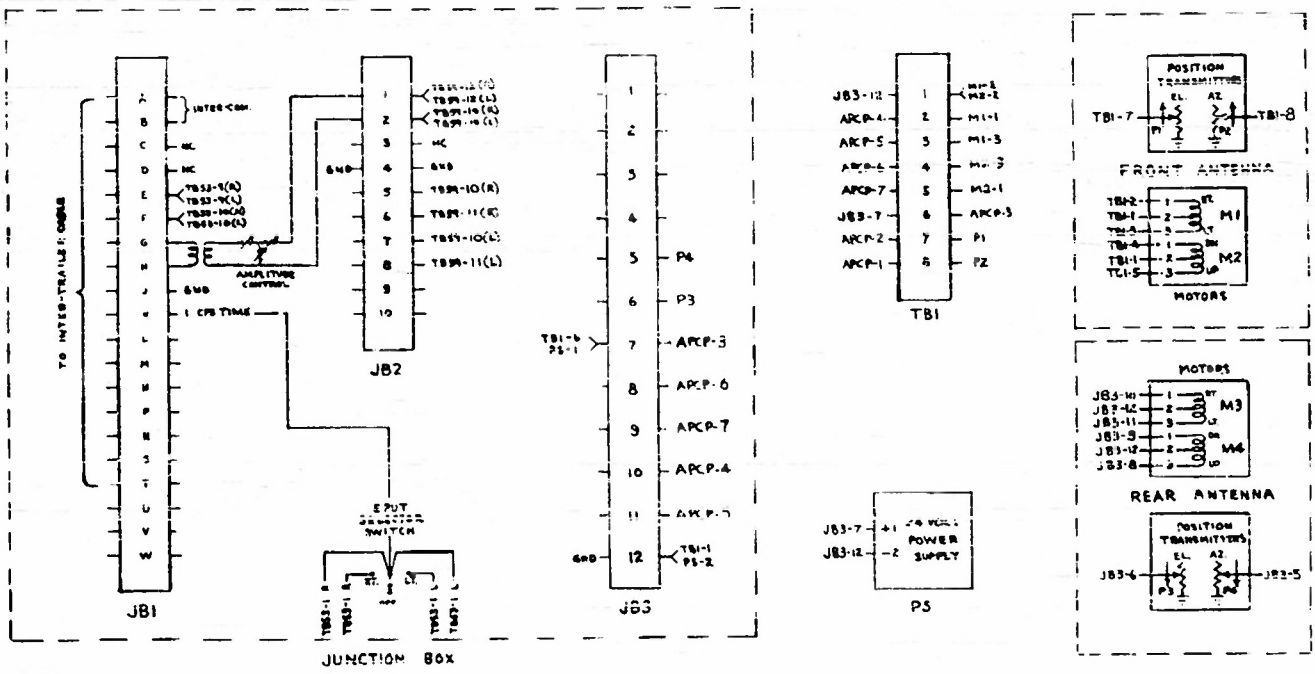



Figure 48 - Wiring Diagram, Intra Trailer

## 3.2 Intra-Trailer Wiring

### 3.2.1 Inter-communications

Within each trailer, there are two field phones and an amplifier. By turning the amplifier on, it is possible to monitor the inter-com without using the field phones.

### 3.2.2 Time Base

Basically the timing used, is the TIME BASE which is a 1 cps pulse taken off from the EPUT meter in each station. In each trailer there is mounted on the junction box, an EPUT SELECTOR SWITCH. Each of the two EPUTS in each trailer feeds a 1 cps timing signal to this switch such that it is possible to select one signal but not both, and feed this signal to the two oscillograph control panels and hence to all recorders. However, its desirable to have the same timing signals on all the recorders of the three trailers therefore, all trailers have their time base circuits in parallel. Since it is possible to have three time base signals simultaneously on the system, during an actual operation only one trailer will have their switch in the "ON" position and the other two will be in the "OFF" position. In case of a failure in the trailer, one of the other trailers will turn their switch to the "ON" position and a time base signal will continue to be fed to the system.

### 3.2.3 Range Time

The RANGE TIME SIGNAL is fed thru an isolation transformer and an amplitude control in the trailer junction box and then goes directly to the oscillograph, sync. plug via the station control cabinet.

SECTION IV

MAINTENANCE

## 1.0 Electrical Power System

### 1.1 Engine - Generator Power Units

Proper maintenance of the engine-generator power units is a prime prerequisite for satisfactory and dependable operation of the units and hence the telemetering stations since a power failure at a critical time would decommission the entire telemetering trailer.

A War Department technical manual, TM 11-904, is included in the catalog file of each trailer for the PE-95K power units.

### 1.2 Air-Conditioner Units

A manufacturer's operational and maintenance manual, is included in the catalog file of each trailer for the PE-95K power units.

### 1.3 Voltage Regulator

The regulator is fitted with a quick-trip magnetic circuit breaker, which serves as an "ON-OFF" switch for the control circuit as well as the power circuit. Figure 49 shows a schematic of the regulator.

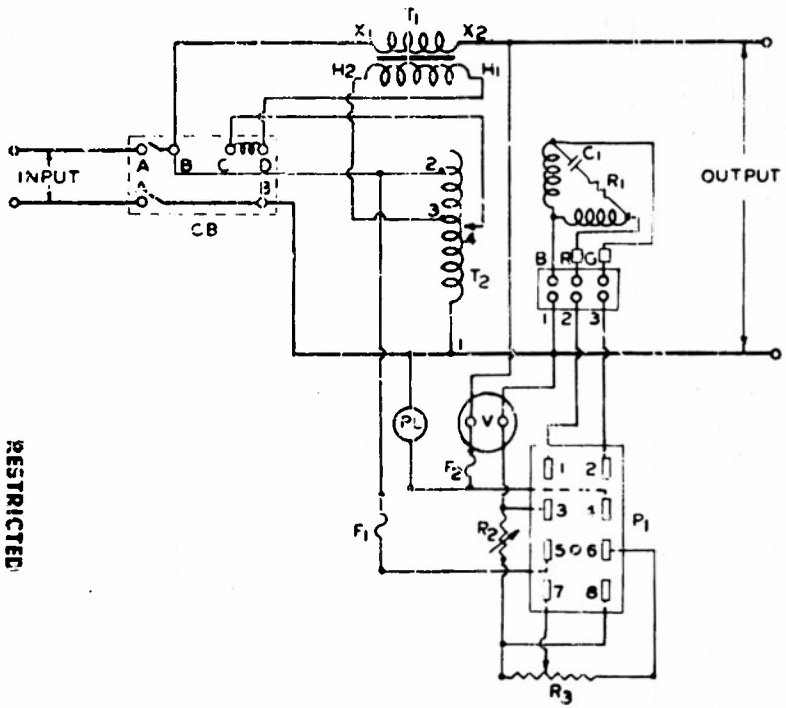
By closing the circuit breaker "ON-OFF" switch the control circuit will be energized and the pilot light will light, indicating that the control circuit is receiving power. In 15 or 20 seconds either the raise or lower thyratron tube will conduct causing the regulator to operate if correction is required.

#### 1.31 Sensitivity Control

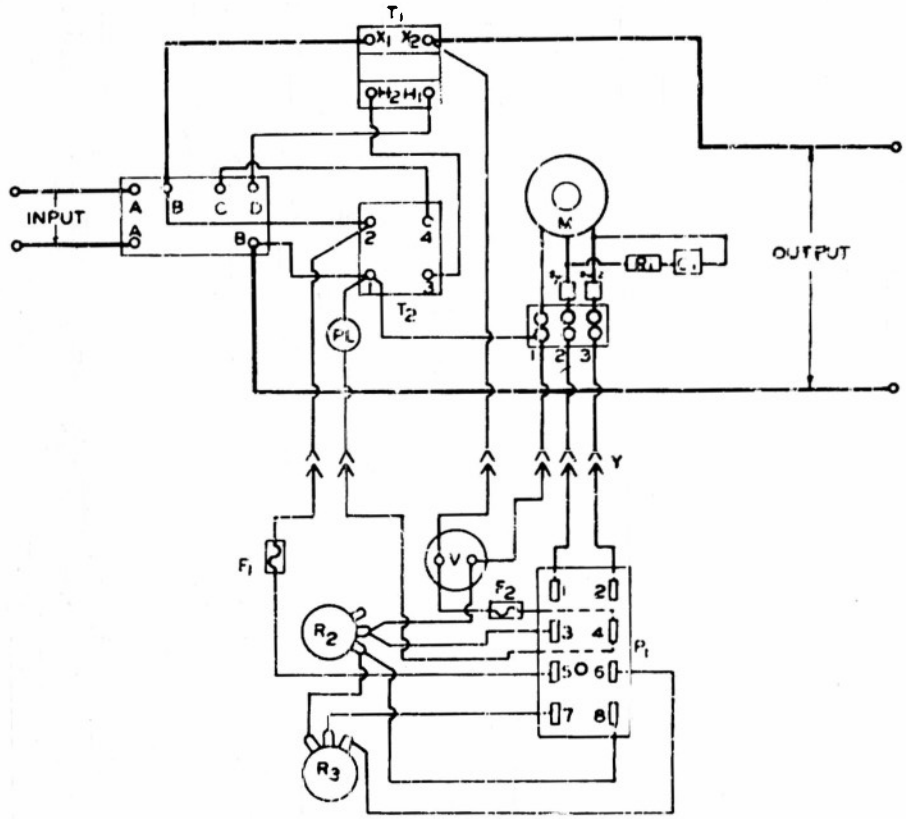
The setting of the control on the right front panel marked "Sensitivity" controls the sensitivity of the regulator. The term "Sensitivity" defines the value of voltage departure from the nominal output which will cause the regulator to correct. Increasing the setting of the sensitivity control causes the regulator to correct for smaller voltage variations. This control may be adjusted with a coin or a screw driver after removing the dress cap which is screwed over the control. Figure 50 is a schematic of the control circuit.

In starting the regulator the setting of the control should be increased to a point at which the regulator continuously "hunts" (i.e., motor does not cease operating). The control should then be "backed-off" a small amount causing the regulator to stop hunting. Experience in each application will best determine the amount to be "backed-off."

RESTRICTED




RATING FOR EM- 4102
INPUT 95 - 135 V 50/60 CYCLES 1 PHASE
OUTPUT 115 V MAX. CURRENT 20A.
MAX. KVA 2.3




RESTRICTED
SECURITY INFORMATION

**Figure 49** - Schematic and Wiring
Stabiline Voltage Regulator

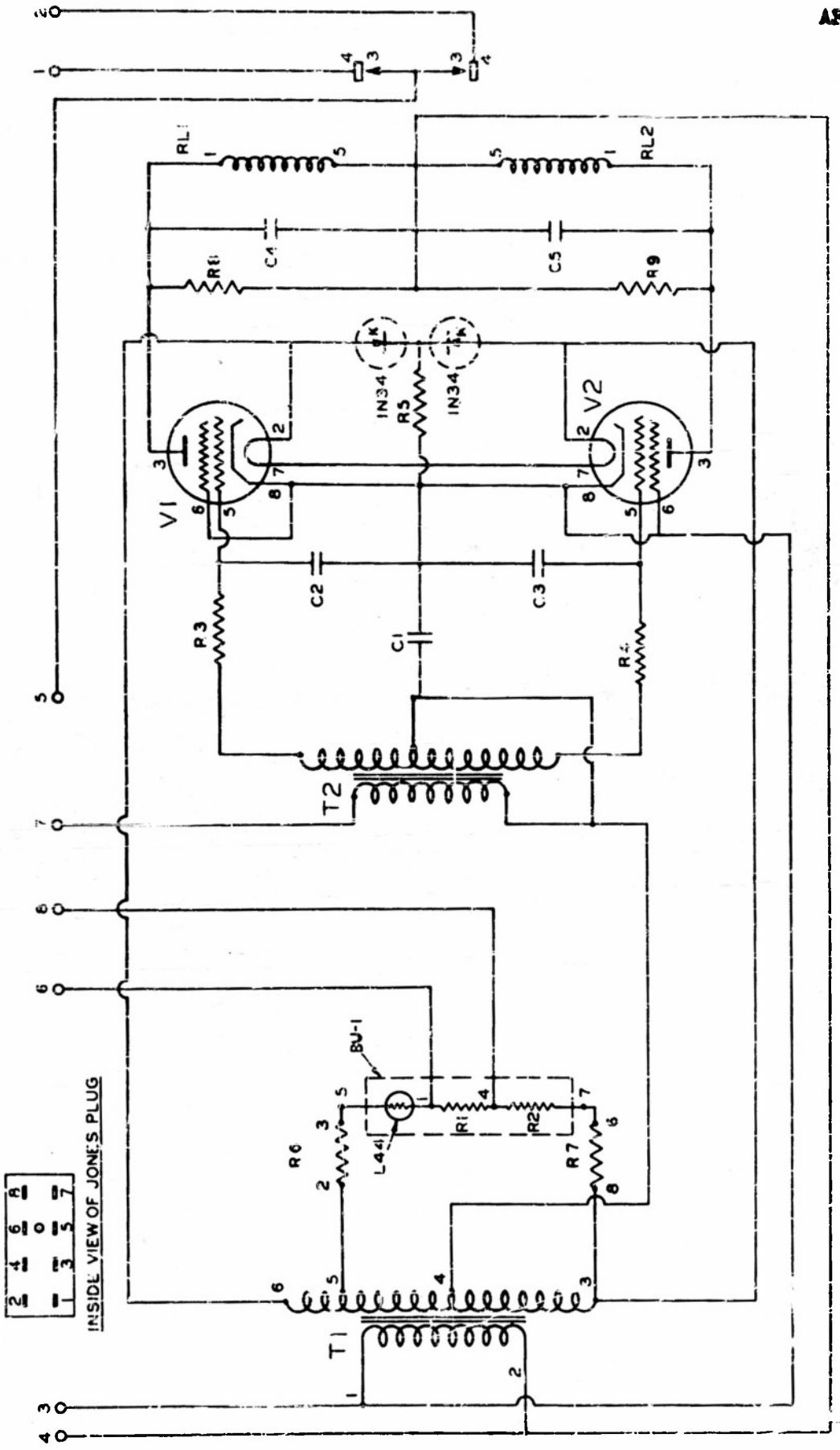



Figure 50 - Schematic and Wiring
Control Circuit Voltage Regulator

1.3.2 Range Control

The setting of the control on the left front panel marked "Output Voltage" determines the nominal output voltage of the regulator. It is covered as mentioned above under "Sensitivity Control". In setting the output voltage reference should be made to the voltmeter indication. The range control should be set so that the desired output voltage is indicated on the meter.

1.3.3 Maintenance

Routine maintenance will consist of replacing the thyratron type 2050 tubes, the BU-1 voltage sensitive element, and the small relays. These are all plug-in components.

1.3.4 If the regulator appears to be inoperative or operating improperly, the following steps should be taken in the order given:

1.3.4.1 Check fuses.

1.3.4.1.1 Incoming line.

1.3.4.1.2 Brush lead fuse or fuses if used (see Figure 49)

1.3.4.1.3 Control circuit type 3AG, 3 amps., (see wiring diagram as above. If pilot light is "ON" this fuse is good).

1.3.4.1.4 Motor circuit type 3AG, 3 amps., (see wiring diagram as above.)

1.3.4.2 Check incoming line and compare with nameplate data.

1.3.4.2.1 Voltage

1.3.4.2.2 Frequency

1.3.4.2.3 Number of phases.

1.3.4.3 Replace type 2050 tubes in control circuit.

1.3.4.4 Replace BU-1 in control circuit.

1.3.4.5 Replace relays in control circuit.

1.3.4.6 If trouble still persists, remove the control circuit. This is accomplished by unscrewing the "hold-in" screws located near the top and bottom of the chassis. The control circuit may be removed by pulling it out of its mounting socket.

1.3.4.6.1 Set the control circuit aside.

1.3.4.6.2 Locate the motor terminal board mounted on the motor mounting plate and remove the three motor connections after noting their positions so that replacement may be made.

1.3.4.6.3 Apply 115 volts from an external source to the black and green leads and then to the black and red leads of the motor.

1.3.4.6.4 It should be possible to cause the motor to turn the POWERSTAT shaft through its complete range. This will change the output voltage of the regulator as indicated by the panel voltmeter. It should be possible to manually select the proper position to give the desired output voltage indicating that the motor and power circuit are in proper operating condition. If this is found to be true it will be desirable to obtain an exchange control circuit. These exchange units are available for immediate shipment from the manufacturer.

1.3.4.7 In case the tests performed under item 1.3.4.6 show that there is trouble in the motor or power circuit, it can usually be found quite easily if reference is made to Figure 46.

## 2.0 Antenna System

### 2.1 Antenna Mast

The motorized masts require periodic inspection and lubrication especially after adverse weather conditions.

### 2.2 Receiving Antenna Assembly

All connections should be periodically inspected and cleaned to prevent corrosion.

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