SECTION I

DIVERSITY RADIO RECEIVING EQUIPMENT

MODELS RBP-1 AND RCP

TECHNICAL SUMMARY

ELECTRICAL CHARACTERISTICS—

Tuning Range	3 to 24 megacycles
Number of Bands	3
Band Coverage	3 to 6 mc, 6 to 12 mc, and 12 to 24 mc
Antenna Matching Impedance	125 ohms, balanced
Overall R-F Gain (midband minimum)	3000
Conversion Gain	1.0 to 2.0
Overall I-F Gain (average)	25,000
R-F Selectivity	Does not influence overall; see "I-F Selectivity"
I-F (or overall) Selectivity	See Figure 1, Section IV
Band-Pass Filters Available	5 band widths: 1, 2, 4, 6, and 10 kc
Band-Pass Filters Supplied	3 band widths: 1, 2, and 4 kc
Noise Equivalent (with 4 kc band width)	Less than 0.8 microvolt
Image-to-Signal Ratio (up to 20 mc)	Not less than 10,000
Automatic Gain Control (AGC) Regulation	See Figure 11, Section I

AGC Time Constant (in seconds):	Slow	Medium	Fast
Telegraph	1.0	0.1	0.01
Telephone	—	0.2	0.02

Maximum Ambient Temperature	45°C. (113° F.)

Telegraph Operation:

Keying Speed	Up to 500 dots per second
Sensitivity (Keyer)	Less than 0.15 ma change for full keying
Output Level (referred to 6 mw in 600 ohms):	
Pad Out	6 db above 1.5-12.0 milliwatts
Pad In	1.5-12.0 milliwatts
Output Impedance	600 ohms
Tone Frequency Range Permissible	Up to 5,000 cycles
Frequency Range of Internal Oscillator	400 to 5,000 cycles
External Tone Frequency Input (minimum)	Approx. 0.7 volt r-m-s

Telephone Operation:

Overall Fidelity	See Figure 2, Section IV
Output (maximum undistorted)	60 milliwatts
Output Impedance	600 ohms
Hum Level	50 db below 100 per cent modulation
Harmonic Content (total at full output, 50-5,000 cycles)	Less than 3 per cent

Power Supply:

Line Rating	98 to 125 volts, 60 cycles, 1 phase
Power Input (per diversity group)	490 volt-amperes
Power Factor (input)	approximately 83 per cent
Voltage Regulation (98 to 125 volts)	±3 per cent

MECHANICAL SPECIFICATIONS—

Dimensions:

Model RBP-1 Equipment	See Figure 14, Section I
Model RCP Equipment	See Figure 15, Section I

Weight (approximate):

Model RBP-1 Equipment	3,000 pounds
Model RCP Equipment	1,700 pounds

MODEL RBP-1 EQUIPMENT

The Model RBP-1 Diversity Radio Receiving Equipment described in this instruction book consists of two groups of three radio receivers, together with the associated power-supply equipment. As illustrated in Figures 1 and 12, Section I, the equipment is mounted in seven cabinet racks, assembled in a row, with the power-supply rack mounted in the center. Each equipment contains the major components listed in the following tabulation:

Quantity	Item	Designation	
		Navy	RCA
7	Antenna Panel	CRV-23276	MI-16007-A
6	Radio-Frequency Amplifier Unit	CRV-50096	MI-16003-A
6	Intermediate-Frequency Amplifier Unit	CRV-50097	MI-16004-A
1	Signal Control Panel	CRV-50099	MI-16002-A
1	Signal Control Panel	CRV-50120	MI-16002-B
1	Tone Keyer Unit	CRV-35007	MI-16006-A
1	Tone Keyer Unit	CRV-35007	MI-16006-B
1	Tone Keyer Unit	CRV-35007	MI-16006-C
1	Audio-Frequency Amplifier Unit	CRV-50098	MI-16005-A
1	Audio-Frequency Amplifier Unit	CRV-50098	MI-16005-B
1	Power Control Panel	CRV-23275	MI-16001-A
1	Power Control Panel	CRV-23275	MI-16001-B
2	Rectifier Power Unit	CRV-20136	MI-16000-A
2	Transformer-Voltage Regulating	CSY-30815	MI-16011-A
6	Cabinet Rack		MI-16013-A
1	Cabinet Rack		MI-16012-A
4	Rack Steps		MI-16008-A
4	Rack Handles		MI-16009-A
5	Blank Panel (10½ inches high)		MI-16016-A
2	Blank Panel (7 inches high)		MI-16015-A
6	Shielded Leads		MI-16010-A
5	Battery (45 volt)		K-870747-1
1 set	Trim Strips		MI-16014-A
1 set	Spare Parts		MI-16017-B
1 set	Adjustment Tools		MI-8410-A
2 sets	Vacuum Tubes		MI-16018-B

TUBE COMPLEMENT (Equipment requirements)

Location	RCA Type					G. E. Type
	36	37	78	83	89	16X897
R-F Units (6)	54	18	18			
I-F Units (6)		30	78			
A-F Units (2)	2	2			2	
Tone Keyer Units (3)	6	9				
Rectifier Units (2)				2		2

FUSE COMPLEMENT (Equipment requirements)

Location	Quantity	Rating	
		Amperes	Volts
A-C Supply (2)	4	10	250
Rectifier Unit (2)	4	5	250
Power Control Panel (2)			
Metering	2	1/32	250
Bias	8	1/8	250
Plate	8	1/4	250
Filament	16	10	125

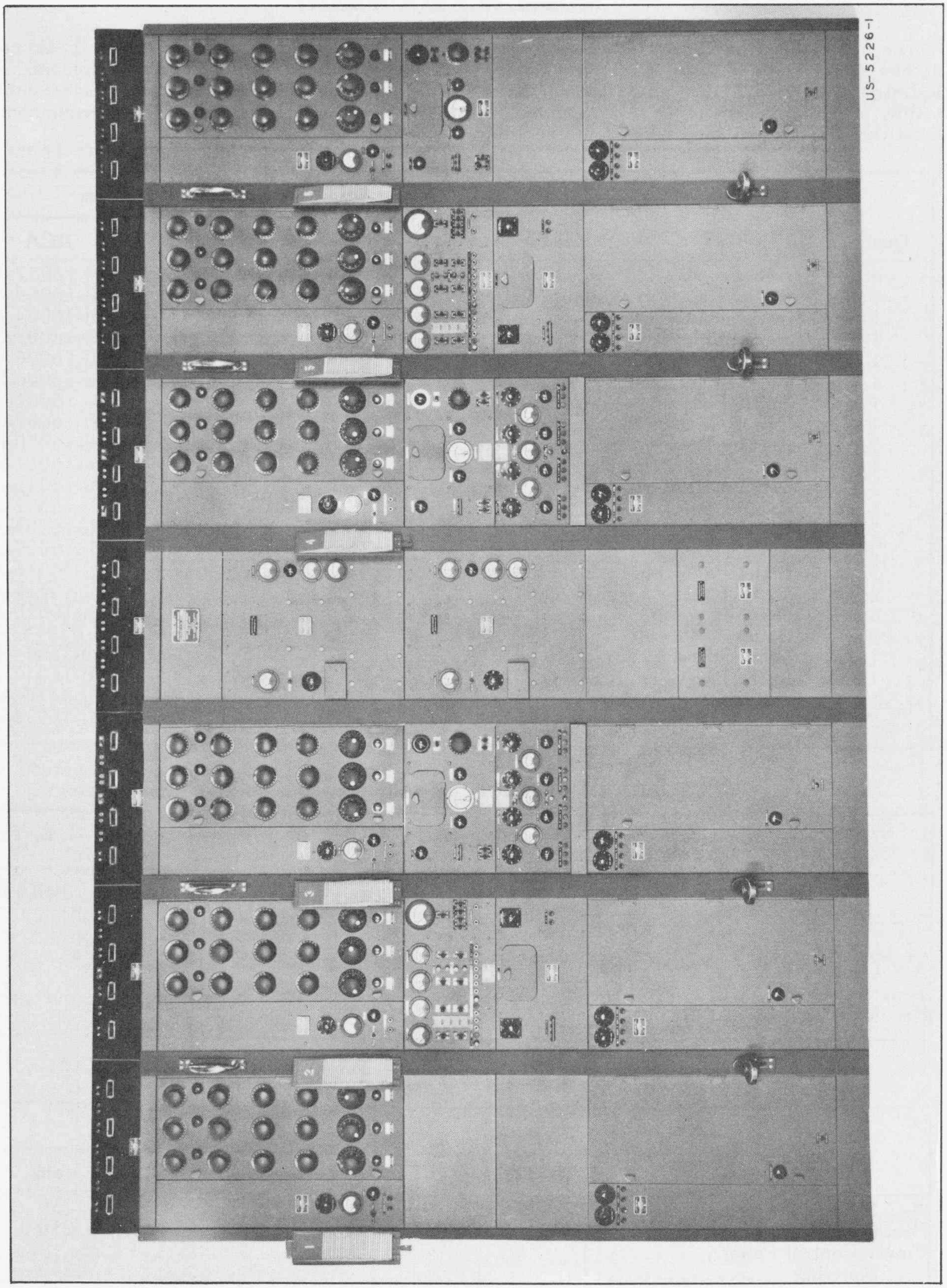

Figure 1—Model RBP-1 Diversity Radio Receiving Equipment (Front View)

MODEL RCP EQUIPMENT

The Model RCP Diversity Radio Receiving Equipment described in this instruction book consists of one group of three radio receivers together with the associated power-supply equipment. As illustrated in Figures 2 and 13, Section I, the equipment is mounted in four cabinet racks, assembled in a row, with the power-supply rack mounted at the left-hand end of the group. Each equipment contains the major components listed in the following tabulation:

Quantity	Item	Designation	
		Navy	RCA
4	Antenna Panel	CRV-23276	MI-16007-A
3	Radio-Frequency Amplifier Unit	CRV-50096	MI-16003-A
3	Intermediate-Frequency Amplifier Unit	CRV-50097	MI-16004-A
1	Signal Control Panel	CRV-50157	MI-16002-C
1	Tone Keyer Unit	CRV-35007	MI-16006-A
1	Tone Keyer Unit	CRV-35007	MI-16006-B
1	Audio-Frequency Amplifier Unit	CRV-50098	MI-16005-A
1	Power Control Panel	CRV-23275	MI-16001-C
1	Rectifier Power Unit	CRV-20136	MI-16000-A
1	Transformer-Voltage Regulating	CSY-30815	MI-16011-A
3	Cabinet Rack		MI-16013-A
1	Cabinet Rack		MI-16012-A
2	Rack Steps		MI-16008-A
2	Rack Handles		MI-16009-A
5	Blank Panel (10½ inches high)		MI-16016-A
2	Blank Panel (7 inches high)		MI-16015-A
3	Shielded Leads		MI-16010-A
3	Battery (45 volt)		K-870747-1
1 set	Trim Strips		MI-16014-B
1 set	Spare Parts		MI-16017-A
1 set	Adjustment Tools		MI-8410-A
2 sets	Vacuum Tubes		MI-16018-A

TUBE COMPLEMENT (Equipment requirements)

Location	RCA Type					G. E. Type
	36	37	78	83	89	16X897
R-F Units (3)	27	9	9			
I-F Units (3)		15	39			
A-F Unit (1)	1	1			1	
Tone Keyer Units (2)	4	6				
Rectifier Unit (1)				1		1

FUSE COMPLEMENT (Equipment requirements)

Location	Quantity	Rating	
		Amperes	Volts
A-C Supply	2	10	250
Rectifier Unit	2	5	250
Power Control Panel			
Metering	1	1/32	250
Bias	4	1/8	250
Plate	4	1/4	250
Filament	8	10	125

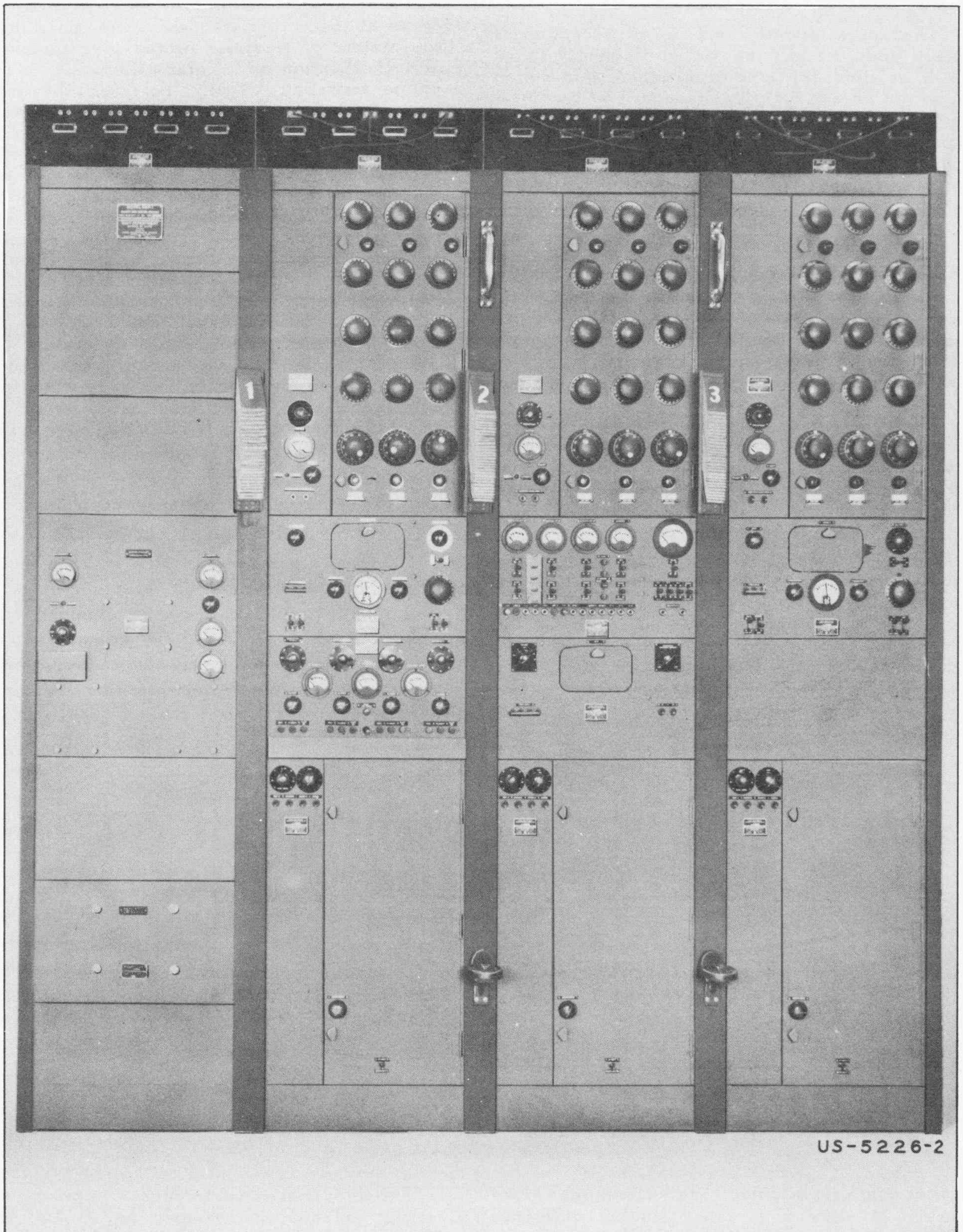

Figure 2—Model RCP Diversity Radio Receiving Equipment (Front View)

DESCRIPTION

THEORY

The space diversity system of reception is based upon the fact that a high-frequency signal such as used for long-distance communication does not always fade simultaneously at two locations separated even as little as several wave lengths. With three antennas, spaced approximately 1,000 feet apart in a triangular arrangement, the signal will seldom fade out on all three at the same time. Thus, by feeding the signal from each antenna through a separate receiver and combining the three rectified outputs, a relatively constant output level can be maintained.

Throughout these instructions, the term "fading" is employed to denote variations in signal strength over periods of from several seconds down to only a few thousandths of a second or less, or frequencies of fading of from about one-tenth of a cycle per second up to hundreds of cycles per second. This restriction is made so that the term will not be construed as applying to the slow variations in signal strength taking place from hour to hour, day to night, day to day, and season to season.

It is generally agreed that fading is due to multi-path transmission; that is, the radio waves travel over two or more paths between the transmitting and receiving antennas. The difference in length of these paths causes the relative phases of the waves arriving over them to differ. These phase differences between the two or more waves, and variations in these differences, result in partial or complete addition or cancellation at a given instant at any point. The resulting difference or diversity of fading at the several receiving antennas is utilized in the manner already described to maintain a usable signal in spite of the fading.

If the differences in path length were such as to result in phase differences between the several waves of only a fraction of a cycle, or of several cycles at the carrier frequency, the space diversity system of reception would give practically perfect reception on telegraph, facsimile, or telephone services. Actually, however, the differences in path length amount in some cases to several thousandths of a second. This means that the signal arrives first over the shortest path, then perhaps a millisecond later over a second path, and possibly another millisecond later over a third path. The effect of such multi-path transmission on a telegraphic character, or a pulse as used in facsimile, is shown in Figure 3. It will be apparent that a high-speed signal can easily be ruined by such transmission conditions since the character recorded on the tape or on the facsimile recorder will be badly distorted. Telephone modulation also is badly distorted by multi-path transmission of this sort. Slow-speed telegraph signals, on the other hand, are not seriously bothered because the duration of each character is so great, compared to the difference in the time of transmission over the several paths, that the resulting elongation or shortening of the characters is negligible.

Experience has demonstrated that a three-unit space diversity system of reception gives decidely better results than can be obtained with a single receiver. This is due primarily to the spaced antennas, and partly also to the method of combining the signals from these spaced antennas.

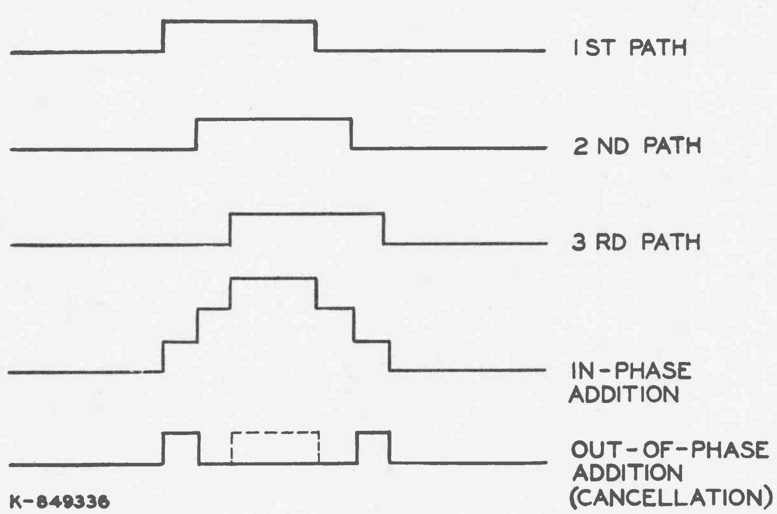

Figure 3—Phase Relations in Multi-Path Reception (*K*-849336—*Sub.* 0)

The three individual antennas comprising a diversity antenna system may be of any type. Where available space is very limited, the use of one horizontal doublet and one vertical doublet located quite close to each other will give a worthwhile diversity effect. For best results, however, three horizontally polarized antennas of a type

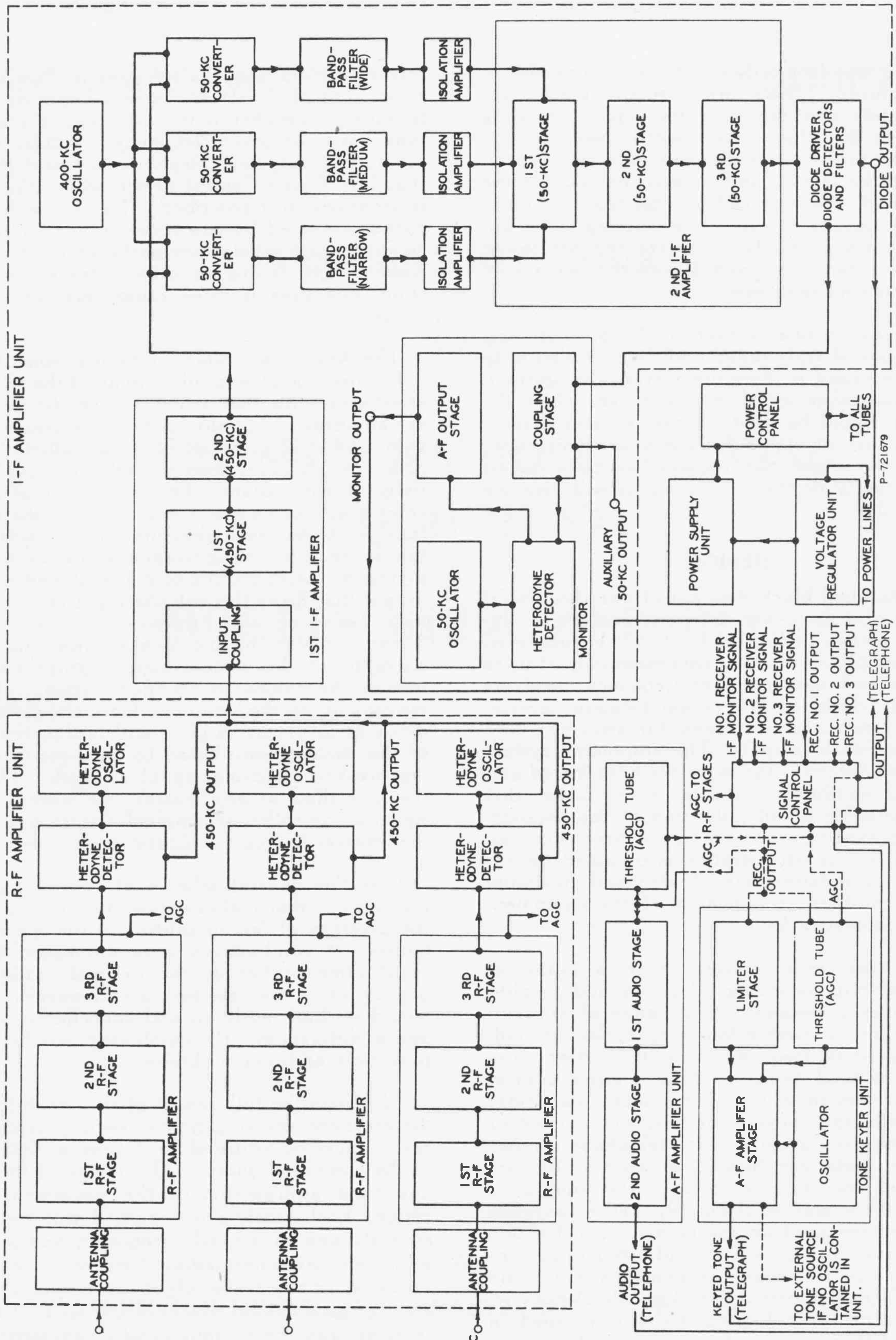

Figure 4—Functional Block Diagram of Diversity Receiving System
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affording good directional characteristics should be employed. These are normally placed approximately one thousand feet apart. Spacing much less than this would result in less improvement due to the lesser diversity of fading experienced at the less distantly spaced points. On the other hand, spacing much greater than the nominal one thousand feet, while offering some improvement is generally not warranted due to the increase in land area and loss in the necessarily longer transmission lines.

Antennas ordinarily used in the diversity system are not sharply tuned and the so-called optimum frequency is therefore merely the approximate mid-frequency of the band over which the antenna should be used. Where several sizes of antennas are available for the desired direction, the one whose nominal frequency rating is nearest the frequency of the desired signal will give the best results.

DESIGN

A functional block diagram of one three-band receiver of a three-unit diversity receiving equipment is shown in Figure 4. It will be observed that a complete group consists essentially of three separate and identical high-frequency receivers especially designed for communication service, together with auxiliary units for switching and combining their outputs. The combining system employed, which is the same for both keyed and amplitude-modulated signals, is the factor that makes possible a full utilization of the diversity of fading existing at the site of the three antennas. Unusual facility of operation is obtained by adherence to requirements of electrical flexibility and to compact arrangement of the equipment in steel cabinet racks.

Each receiver comprises: First, a radio-frequency system providing selectivity and amplification over a nominal tuning range of approximately three to twenty-four megacycles; second, an intermediate-frequency amplifier system containing the final detector; third, a signal control panel for switching, combining, and monitoring; and fourth, tone keyers for telegraph service or audio-frequency amplifiers for telephone service. Filament, plate, and bias potentials may be connected to the various units in the equipment through the operation of suitably marked switches which are mounted on the power control panel. The filament voltage may be adjusted to the operating value by means of rheostats which are mounted on the power control panel. Automatic gain control (AGC) potential is developed in the tone keyer or audio-frequency amplifier unit.

The rectified outputs from the diode detectors of the separate receivers are fed to the signal control panel, where their amplitudes are indicated by individual milliammeters. For diversity reception, the diode output from either two or three receivers is combined (after passing through the signal control panel) at the tone keyer or audio-frequency amplifier unit. The output from the tone keyer or audio-frequency amplifier unit is fed to the outgoing telephone line and through that line to the Central Office where the signal is recorded or transcribed. The space-diversity output provided by two receivers is usually sufficient to insure satisfactory performance, however, when severe fading or other adverse receiving conditions prevail three radio receivers should be used.

The AGC bias voltage obtained from the signal control panel is supplied to all of the r-f stages associated with that panel. Since the receivers are all adjusted initially to the same sensitivity or gain and are automatically controlled by the common AGC bias, they will all have equal sensitivity at any instant. This sensitivity of all receivers will, of course, rise and fall as the signals fade, with the result that the receiver which has the strongest incoming signal at any instant is supplying the major portion of the combined rectified output that flows through the input circuit of the tone keyer or audio-frequency amplifier unit. Those receivers having weaker incoming signal strengths at this instant supply proportionately less to the combined rectified output. The arrangement of the common load circuit for the diode of all receivers gives still further reduction of the current contributed by the receivers having weaker incoming signal strength. The net result is that, at any instant, the useful output signal is controlled or supplied almost entirely by the receiver having the highest input level.

It is this general scheme of combining after rectification that makes it possible to utilize fully the diversity of fading existing at the spaced antennas. If combination were attempted before rectification, either at the original carrier frequency or at an intermediate frequency, there would be both addition and cancellation due to phase differences. By combining rectified outputs, only addition is obtained.

To obtain the full benefit of the capabilities of the diversity receiving system, each individual receiver must be adjusted to deliver its full share of the combined output. This is one of the most important adjustments of the equipment as a whole. Each receiver is equipped with two gain controls, one on the radio-frequency unit and the other on the intermediate-frequency unit, the former normally being left at maximum. Adjustment of gain should not be made until after the receiver has been individually adjusted and switched to a common tone keyer or audio-frequency amplifier circuit. When this adjustment has been made correctly, the individual output meters on the signal control panel should be swinging equally, showing that each receiver is delivering its share of the output.

The time constant of the AGC system may be adjusted at the signal control panel. A choice of three values is provided; namely, slow, medium and fast, such alternatives being necessary in facsimile and telegraph services to handle properly all types of fading, noise, echoes and interference. Details of the AGC circuit and correct selection of values are treated under "Operation" and in the instructions for the individual units in the succeeding sections of this book.

INSTALLATION

LOCATION

The first consideration in making an installation of the diversity receiving equipment is to select the most desirable location. Assuming previous choice of a station site accommodating the required antenna array, suitable housing for the equipment proper must be provided. For detailed outline dimensions of the Model RBP-1 Equipment see Figure 14 and for the Model RCP Equipment see Figure 15 at the rear of this section. The approximate weight of each equipment is given in the "Technical Summary" at the beginning of this section.

In choosing the interior location, attention should be given to accessibility of the various racks both from the front and rear. It is also important to consider the proximity of associated equipment racks, such as required for a tone channel system, with a view to ultimate operating facility. Direction of the incoming antenna transmission lines, illumination (both natural and artificial) and power supply facilities are other factors which should not be overlooked.

ASSEMBLY

As shipped from the factory the equipment described in this book is partially disassembled and the various components then packed in strong wooden cases.

At the time of installation the equipment should be carefully unpacked, inspected for possible damage caused by shipment, and then mounted in the position it is to occupy. As shown in Figures 1 and 14, the rectifier power supply bay should be mounted at the center of the Model RBP-1 Equipment assembly. For a Model RCP Equipment assembly this bay should be mounted at the left-hand end of the group as shown in Figures 2 and 15.

All cabinet racks are constructed with a slight bow in the sides to insure a snug fit between adjacent racks when bolted together. A large opening is provided in the bottom of each cabinet for sub-floor wiring. Six elongated clearance holes for lag bolts also are provided in the bottom to insure proper stability.

To insure adequate grounding of the assembly, the base of each rack should be scraped clean along the rear line of mounting holes and a thin brass or copper strip placed under the group assembly along this line. Clearance holes for the mounting bolts should be provided in the grounding strip and the entire assembly should be securely attached to the mounting surface by means of bolts or lag screws. A solid connection between the grounding strip and an external ground should be provided.

The antenna transmission line distribution panels are equipped with brackets for mounting on the top of the respective cabinets. For best appearance, the front surfaces of all panels should be aligned and flush with the cross piece forming the top of the rack framework. Three holes, fitted with rubber grommets, are provided in the top of each receiver cabinet rack for entrance of the twin conductor cables which are used to interconnect the radio-frequency amplifier unit and the antenna panel.

Rack steps and handles are employed on these cabinets so that the operator can raise himself conveniently within reach of the controls at the top of the rack. As shown in Figures 1 and 2, one step and one handle are located between each pair of receiver racks. These items are furnished ready to mount, each being secured by means of four, oval-head, No. 12-24 screws. The cabinets have been drilled and tapped at the proper locations to receive these screws. When installed the rack steps are approximately 13 inches above the floor and the center of the handles approximately 74 inches above the floor.

Upon completing the equipment assembly, a set of tubes should be installed in the various units. All sockets are plainly marked with the respective tube type numbers. The tube complement of each equipment is listed at the front of this section. It should be noted that the covers on the bottom row of shield cans in the r-f amplifier unit (see Figure 3, Section III) must be removed to install the oscillator tubes.

It is also important when installing or replacing tubes in the r-f amplifier unit (particularly in the 24 mc band) to see that the control grid lead is dressed in the center of the hole in the tube can shield, thus maintaining the original calibration of the unit.

WIRING

After the assembly of the equipment has been completed, the inter-bay leads which were disconnected at the time of shipment should be reconnected as shown in the interconnection diagram for the particular assembly (see Figures 16 and 17, this section). The particular terminal board to which a given cable should be attached is indicated by a tag on the end of the cable. The color and type of wire used in making the inter-bay connections is indicated in the "Inter-Bay Wiring" tabulation below.

When the cables have been reconnected to the indicated terminals they should be secured in position by means of the cable clamps which are supplied for this purpose. Additional neatness and security may be obtained by lacing.

As shown on the interconnection diagrams (Figures 16 and 17) the outgoing lines from the signal control panel or panels should be attached to the terminal board or boards located at the bottom of the rectifier power supply bay. The fuse blocks for the incoming power supply lines are located at the bottom of the rectifier power supply bay.

INTER-BAY WIRING

Circuit	Wire Type	Nominal Voltage	Size A.W.G.	Insulation	
				Type	Color
Plate Supply	*	136	18	Cotton Braid	Red
Filament Supply	*	8	18	Cotton Braid	Blue Blue-Yellow
Bias Supply	*	14	18	Cotton Braid	Yellow
A.G.C.	*	..	18	Cotton Braid	Green
General or Ground	*	..	18	Cotton Braid	Black
I-F Output (Diode)	Low Loss	..	18	Rubber	....
A-F or Keyer Input	Low Loss	..	18	Rubber	....
A-F Output	Twisted Pair	..	19	Rubber	....

* Six conductor power distribution cable, Belden Spec. No. FR-3167.

OPERATION

Throughout the following instructions the operation of a diversity receiving system will be described in terms of a single group equipment. In a dual group installation the operation is fundamentally the same as that described for a single group. The principal difference between a single and a dual group installation is in the wiring of the signal control panels. In a dual group installation these panels are wired in such a way as to permit one tone keyer unit (Keyer "C") to be cross switched from one group to the other. The reader should make a careful study of the circuit diagrams, layout of units, location of parts, theory of operation, function of controls and all other pertinent data before attempting to operate the equipment.

INITIAL START

All circuits requiring fusing are equipped with readily replaceable fuses. Nominal fuse ratings are listed in the "Fuse Complement" and in the parts list. Before connecting the 120 volt, 60 cycle power supply lines to the fuse block which is located at the bottom of the rectifier power supply bay, all of the fuses in the equipment should be checked for rating and continuity.

When starting the equipment for the first time, it is important that the normal receiver load shall be removed initially to safeguard the plate rectifier (Tungar) tube. Removal of the loading may be accomplished by turning all four switches at the top of the power control panel to the "OFF" position. The main power switch on the power supply unit then should be turned to "On" and a sufficient period allowed to elapse until sputtering of the plate rectifier tube has ceased. This interval may be ten minutes or longer, after which time the plate load may be applied by turning the four switches on the power control panel to "ON." The same procedure is necessary in the event of replacing the Tungar tube, but not in normal operation where the complete equipment is controlled by the single switch on the power supply unit. If the equipment has been shut down for some hours, it should be started at least a half-hour before the desired signal is scheduled so that all tubes may become thoroughly warm and stable in operation.

OPERATING VOLTAGES

Rectifier Power Unit—Three voltmeters and a milliammeter are provided on the front panel of the rectifier power unit. These instruments are employed to indicate the a-c input and output voltage at the terminals of the voltage regulating transformer (line and load), the d-c plate and bias voltages, and the total plate current. Normal indications on these instruments are as follows:

A-C Supply (M601):
- Line .... 95 to 130 volts a-c
- Load .... 115 volts a-c

D-C Supply:
- Plate (M603) ....136 volts d-c
- Bias (M604) .... 14 volts d-c
- Total Plate Current (M602) approx. 400 milliamperes

The bias voltage may be adjusted through a range of several volts by means of the rheostat (R601); no provision has been made for adjustment of the other voltages. Operating and maintenance instructions for this unit are located in Section IX.

Power Control Panel—The filament, plate, and bias potentials furnished by the rectifier power unit are divided into four similar channels at the power control panel. Each of these channels is equipped with an "ON-OFF" switch and contains filament, plate, and bias potentials. The filament potential in each channel may be controlled by means of a rheostat which is connected in series with that circuit.

Four sets of push-button switches and two voltmeters provide the means for measuring the filament, plate, and bias voltages in any one of the four channels. Assuming that the power supply line voltage and frequency are normal, the following voltages should be indicated for any channel:

Filament (M701) .... 6.7 volts a-c
Plate (M703) .... 135 volts d-c
Bias (M703) .... 14 volts d-c

A milliammeter, connected through a retractable drop cord to a standard telephone plug, provides the means for measuring the plate current in the various circuits of the equipment. Normal values of plate current at the various telephone jacks are listed under "Maintenance."

TUNING

Radio-Frequency Amplifier — Assuming that the equipment has had a proper warm-up period and that the operating voltages are normal as outlined in the preceding paragraphs, the receivers may be tuned to any desired signal within the frequency range of three to twenty-four megacycles. A full diversity combination of the three receivers will be described hereunder, although it should be appreciated any two may be used in diversity or that each may be operated independently as desired to handle unusual traffic conditions.

The first step in tuning is to select the required frequency band by turning the range switch on each receiver to the position which includes the desired frequency. It is also necessary to select the appropriate antenna for each receiver. The antenna selected at each position should have suitable directional properties. To minimize loading on the lines and also to protect the input coupling coils from needless damage in case of lightning, the r-f input connections should be made only to lines actually in use.

Preliminary tuning of the r-f circuits is accomplished by setting the dials to the approximate points as determined from the calibration INDEX card pertaining to the frequency band in use. It will be observed that these calibration cards are arranged in three groups, each having a different color to identify the frequency band. Each group is preceded by an INDEX card on which are given the settings of the five dials for nominal frequencies throughout the entire band. The subsequent signal calibration cards permit logging of these settings as required for reception of specific stations at intermediate points.

With the dials set at tentative positions determined by rough interpolation from the calibration INDEX card, the remaining controls on the r-f amplifier units should each be adjusted as follows:

1. Turn the input coupling controls—the small knobs between the two top rows of dials—to the maximum or fully clockwise position.

2. Turn the "GAIN" control to the maximum, or fully clockwise position.

3. Throw the "AGC-FIXED" toggle switch to the "AGC" position.

4. Set the oscillator vernier controls—the small knobs at the bottom of the unit—with the arrows pointing upward. It should be noted that a given signal can be detected at two positions of the oscillator tuning dials. Adjustments should be made so that these dials are set for the lower scale reading.

The preceding adjustments having been made, the radio-frequency amplifier is ready for the reception of signals and, with a signal input from the antenna, it should feed voltage to the input of the intermediate-frequency amplifier.

Intermediate-Frequency Amplifier—Proceeding to the i-f amplifier unit, select the desired band-pass filter by turning the "BAND WIDTH" control to the indicated position. In each of these units three band-pass filters are installed at the factory (selected by customer—see foregoing "Technical Summary"), which provide the requisite choice of band width to accommodate the required services. There are available, however, a total of five different filters, with band widths of 1, 2, 4, 6 and 10 kc respectively, any three of which may be supplied. The normal uses of these five band widths are as follows:

Band Width	Service
10 KC	—Program and high-quality telephone.
6 KC	—Commercial telephone; also program with extreme noise or interference conditions.
4 KC	—Telegraph and facsimile; also phone with extreme noise or interference conditions.
2 KC	—Telegraph only.
1 KC	—Telegraph only.

The remaining controls on each i-f amplifier unit should be adjusted to the following positions:

1. Turn the "GAIN" control to a setting at about three-quarters of the maximum or fully clockwise position.

2. Turn the "MONITOR VOLUME" control to a setting between one-quarter and one-half of the maximum or fully clockwise position.

3. Set the monitor toggle switch at the bottom of the unit to the "ZERO BEAT" position.

Tone Keyer Unit—This unit should be used only when telegraph or facsimile signals are being received. To place the tone keyer in operation proceed as follows:

1. Operate the "POWER SWITCH," S406, to the **on** (up) position.

2. Place the tone source selector switch, S401 (marked "OSC.-EXT. TONE") in the "OSC." position.

3. Operate the oscillator frequency control switches to the positions indicated below:
"HIGH-LOW" (S404) to "HIGH"
"10-20" (S405) to "10"
"OSC. FREQ. (S407) to "5"

4. Rotate the "OSC. OUTPUT" control (R418) to the extreme clockwise position and the oscillator tuning dial (C404) to 50.

5. Place the "NORMAL-TEST" key switch (S402) in the "NORMAL" position.

6. Rotate the "INPUT" control (R406) and the "THRESHOLD" bias control (R403) to the extreme clockwise and mid-point positions respectively.

7. Place the output attenuator "PAD IN-PAD OUT" key-switch (S403) in the "PAD IN" position.

When the preceding adjustments have been made the audio-frequency oscillator should produce a tone of approximately 1000 cycles and signals having this frequency should be present at the output terminals of the keyer when the audio-frequency amplifier stage is keyed by the action of the limiter tube. Further adjustments are described under "Operation" and in Section VI.

Audio-Frequency Amplifier Unit—This unit is equipped with three controls, all of which extend through the front panel. To place the unit in operation the "POWER SWITCH" (S501) should be operated to the **on** (up) position, the "VOLUME" control (R506) set at zero, and the "THRESHOLD SWITCHED CARRIER" control (R504) rotated to the mid-point position. Further adjustments are described under "Operation" and in Section VII.

Signal Control Panel—At the signal control panel, the output diode of each intermediate-frequency amplifier in a diversity group is connected through a milliammeter to a pair of key-switches which are located directly beneath that instrument. A nameplate, located above each milliammeter, indicates the particular receiver with which that instrument and the switches beneath it are associated. By operating the upper key-switch the output of the associated radio receiver may be connected to the input of the audio-frequency amplifier in that receiver group. By operating the lower key-switch, the output of the associated radio receiver may be connected to the input of either one of two tone keyers.

A fourth milliammeter (marked "COMBINED") and the associated pair of switches provide the means for measuring and switching the combined output of all receivers in the group to an audio-frequency ampylifier or tone keyer.

For diversity reception of voice modulated signals all key-switches in the upper row should be operated, thus connecting the combined output from all receivers in the group to the audio-frequency amplifier associated with that group.

For diversity reception of telegraphically keyed or facsimile signals all key-switches in the lower row should be operated in the same direction (either up or down) thus connecting the combined output from all receivers in the group to the same tone keyer.

Two tone keyer units are included as part of a single group assembly. In such an assembly the output from any or all receivers in the group may be connected to either one of the tone keyers through appropriate operation of the switches which are provided for this purpose on the signal control panel.

Three tone keyer units are included as part of a dual group assembly (one in receiver bay number three, one in receiver bay number five, and one in receiver bay number six.) In such an equipment the output from any or all receivers located to the right of the rectifier power supply bay may be connected to the tone keyer unit in receiver bay number six by placing the appropriate switches on the signal control panel in receiver bay number five in the "KEYER B" position. Output from any or all receivers located to the left of the rectifier power supply bay may be connected to the tone keyer in receiver bay number three by placing the appropriate switches on the signal control panel in receiver bay number two in the "KEYER A" position.

In a dual group assembly, output from the receivers in either group may be connected to the tone keyer in receiver bay number four by placing the appropriate switches on the signal control panels in the "KEYER C" position.

Although the switching arrangement in a dual group assembly is such as to permit the output from all receivers in both groups to be simultaneously connected to "KEYER C" such operation is not recommended. Nothing is gained by using more than three receivers in diversity on one signal.

Additional details of adjustment are described under "Operation" and in Section V.

Overall Tuning and Monitoring—When the previously described preliminary adjustments have all been made, the equipment is ready for final precise adjustment. It is assumed that a radio-frequency signal, at or near the frequency to which the radio-frequency amplifiers were tuned, is available at the input to the system.

To obtain a monitoring signal for tuning adjustment, a pair of headphones should be plugged into one of the two paralleled "MONITOR" jacks on the signal control panel. The left-hand monitor switch then should be thrown to the "IF-1" position, thus connecting the headphones to the i-f monitor output of receiver No. 1. The functions of the entire group of monitoring switches are described in Section V. Final adjustments of r-f tuning and i-f gain may now be undertaken.

The tuning of the r-f heterodyne oscillator should be varied until the desired signal is located and identified and the r-f circuits then adjusted to give maximum output (one milliampere) as indicated by the milliammeter on the signal control panel. If the signal is on high-speed traffic or dots or is the steady carrier of a telephone signal tuning can be done with fast AGC action (the time constant of the AGC is adjusted by means of switches on the signal control panel, one switch for each tone keyer unit or audio-frequency amplifier unit. Each of the r-f circuits should be tuned to a position where minimum plate current is indicated by the milliammeter on the r-f amplifier unit. During the tuning process, it may be necessary to adjust the i-f gain to obtain a usable deflection on the latter meter. In the case of a signal which is being keyed rather slowly, it may be necessary to use either very slow AGC or fixed bias on the r-f circuits. Correct tuning must then be judged by the output shown on the milliammeter on the signal control panel.

The r-f heterodyne oscillator may be tuned either above or below the signal frequency by an amount equal to the first intermediate frequency of the i-f amplifier unit (450 kc). Although there are two dial settings which will give correct operation, the lower-frequency one is normally used. In addition to these two main tuning points, there will sometimes be found two or more spurious tuning points at which a beat note will be obtained with the desired signal. Before proceeding, therefore, it should be definitely ascertained that the oscillator frequency selected is not at one of these spurious settings. There should be only two dial settings at which the desired signal can be heard. If more than two are observed, the setting of the r-f input coupling control or the r-f gain potentiometer should be reduced and the oscillator tuning again checked. This process should be repeated until a condition is obtained where only two settings give a beat with the desired signal, the lower-frequency adjustment should then be selected and the gain adjustments returned to maximum. Such a check check need be made only when preliminary tuning has been performed without the aid of an accurate tuning calibration. Once the signals are logged and the calibration points entered on the calibration chart, these settings can be used for final tuning with only slight readjustment of the tuning controls.

Accurate tuning on a signal which is being keyed intermittently or is fading badly is possible by the use of an auxiliary signal generator located in close proximity to the equipment. The desired signal should first be located and roughly tuned in and the beat note adjusted to zero beat. The receiver then should be disconnected from the antenna and connected to the signal generator. The frequency of the signal generator is then adjusted to obtain zero beat in the monitor output of the receiver and the final tuning of the receiver accomplished by tuning to this stable auxiliary signal.

The frequency of the r-f heterodyne oscillator should be adjusted to give zero beat in the i-f monitor output. By throwing the beat-note switch on the i-f amplifier unit to the "AF-BEAT" position, there will result a beat-note signal at a frequency of approximately 1,000 cycles, which can then be used for monitoring or for aural reception of a telegraph signal.

The i-f gain should next be adjusted to give the minimum noise level consistent with freedom from drop-outs. With a telegraph signal, preliminary adjustment must be made by judging the signal as heard in the i-f monitor (beat-note) output. A final adjustment should be made simultaneously with the adjustment of the tone keyer unit as described subsequently under "Telegraph Operation."

Very strong signals will sometimes cause interference because of overloading of the tubes in the earlier stages of the receiver. This is most likely to occur in the r-f heterodyne detector, where inter-modulation between signals may result from too high a signal level at the grid of this detector. Existence of such overloading of the r-f heterodyne detector is easily checked by observing its plate current. For this purpose, it is necessary only to plug the drop cord on the power control panel into the "DETECTOR" jack on the r-f amplifier unit of the receiver in question, observing the milliammeter on the power control panel. Its pointer should not fluctuate as the signal (or any other signal) keys on and off; any appreciable variation is indicative of overloading. Assuming that the proper antenna is in use and in good condition, and that the r-f tuning and heterodyne oscillator are correctly adjusted, the usual remedy for overloading of this sort is to reduce the input coupling to the r-f amplifier unit. The only condition under which this procedure cannot be used successfullly is when the desired signal is quite weak. In such cases, reduction of the r-f input coupling will increase the effective noise equivalent of the receiver and thereby give a poor signal-to-noise ratio on the desired weak signal.

All individual receivers being used in diversity should be tuned and adjusted as described and their rectified outputs then switched, at the signal control panel, to either a tone keyer unit or an audio-frequency amplifier unit—for telegraph or telephone operation respectively. The i-f gain of each receiver finally should be readjusted slightly to obtain equal outputs from each. This condition may be judged by observing the deflections of the three individual milliammeters on the signal control panel, The pointers of all meters being used in diversity should be swinging equally as the signal is keyed, or as it fades from antenna to antenna. This equalizing of rectified outputs of the receivers being used in diversity combination on one signal is very important. If it is not given proper attention, the full benefits of the diversity system and the equipment will not be obtained.

The combined rectified output of the several receivers may be observed at the signal control panel, on the fourth milliammeter which can be switched into the input circuit of a tone keyer or audio-frequency amplifier unit.

TELEGRAPH OPERATION

When receiving a telegraph signal, the tone keyer unit employed must be adjusted for satisfactory output, keying operation, and AGC level. It is also necessary to tune the internal oscillator to the desired tone frequency or to obtain the tone from an external source. Selection of the tone source is provided by the "OSC.-EXT. TONE" switch in the lower right-hand corner, and reference should be made to Section VI for instructions pertaining to adjustment of the internal oscillator where required.

Power should be applied to the keyer unit by throwing the triple-toggle "POWER SWITCH" to the up position. Initially, the "INPUT" and "THRESHOLD" controls should each be set at about mid-rotation. A standard telephone plug, to which a pair of headphones have been attached, should be inserted into one of the "MONITOR" jacks on the signal control panel and the associated "MONITOR" key-switch should be operated to the position which enables aural monitoring of the output tone while adjustments are being made.

Final adjustment consists of regulating the keyer "INPUT" control together with the i-f amplifier "GAIN" control to obtain full keying of the tone output signal from the keyer unit. The AGC "THRESHOLD" control on the keyer unit and the time constant selector switch on the signal control panel should be adjusted so that noise or interference will not force through during spaces or pauses in transmission.

Proper adjustment of the "THRESHOLD" control may be checked by observing the plate current in the r-f stages. Due to changes in the AGC potential, produced by changes in the strength of the impressed signal, the current indicated by the "R.F. I_p" milliammeter (located on the radio-frequency amplifier unit) should decrease as the strength of the received signal increases. Maximum current should be indicated when no signal is being received. In extreme combinations of adjustment of the keyer "INPUT" and "THRESHOLD" controls, the effect of reverse keying of the tone frequency may be observed. However, since such effects cannot occur with normal plate current variations, the readings of the plate milliammeters in the r-f amplifier units constitute a valuable check on the overall adjustments of the equipment. It must be remembered that these four adjustments—keyer input, AGC threshold, i-f gain and AGC time constant—are, to a great extent, interlocking.

Choice of a suitable AGC time constant is of special importance in telegraph service, and for this reason three values are available. These are indicated on the signal control panel as "SLOW," "MEDIUM" and "FAST," having time values of 1.0, 0.1 and 0.01 second respectively. The "FAST" setting should be used only for high-speed telegraph traffic and under conditions of rapid fading. For normal-speed traffic and normal fading, the "MEDIUM" setting should be employed. The "SLOW" setting will be advantageous on slow-speed traffic; also under severe echo conditions and on certain types of interference.

In telegraph service, better results will sometimes be obtained with fixed gain on the r-f stages. Although this is the exception rather than the rule, there should be no hesitation about switching over to fixed gain when the desired results cannot be obtained using AGC operation.

When such necessity has passed, the AGC bias should be replaced. The tone output level from the keyer unit should be adjusted on a steady dash to the level specified for the particular line or filter channel. When making this adjustment, the keyer output should be connected to the line or filter intended or to an equivalent resistive (600-ohm) load. For further details on the operation of the keyer unit, see Section VI.

TELEPHONE OPERATION

For reception of a telephone signal the audio-frequency amplifier unit employed should be adjusted for satisfactory output and AGC level. The output level will be that required for proper operation over the telephone line and may depend entirely upon the condition of use of that line. Adjustment may be made with the output circuit connected either to the line or to an equivalent resistive (600-ohm) load. The volume indicator meter on the signal control panel should be bridged across the output circuit while setting the "VOLUME" control on the audio-frequency amplifier unit.

AGC operation always should be employed in telephone service. Adjustment of threshold and time constant is much the same as that described for telegraph service, except with respect to actual values. The "FAST" setting of time constant allows about 0.02 second and is advantageous for tuning but seldom for operation. For normal operation, the "MEDIUM" setting (0.2 second) should be employed. Time constants slower than 0.2 second are of little or no use in diversity receiving equipment on telephone service.

MAINTENANCE

ROUTINE CHECKS

These receivers have been carefully adjusted and aligned by the manufacturer before shipment and should maintain these adjustments over reasonably long periods of time. MAJOR ADJUSTMENTS SHOULD BE MADE ONLY BY EXPERIENCED PERSONNEL AND THEN ONLY WHEN THE NECESSARY SERVICING TOOLS AND EQUIPMENT ARE AVAILABLE.

Operational interruptions due to failure of the equipment can be minimized by adherence to a regular schedule of inspection. It is important that the interior as well as the exterior shall be kept clean and that all connections shall be examined and tightened as necessary.

By reference to the meters which are conveniently located on the front panels of the equipment and by the use of the push-buttons and plug-in cord which are located on the power control panel, a complete check of the voltages applied and the current flowing in the various components of the equipment may be obtained. Such information should be recorded daily and checked against similar readings previously recorded.

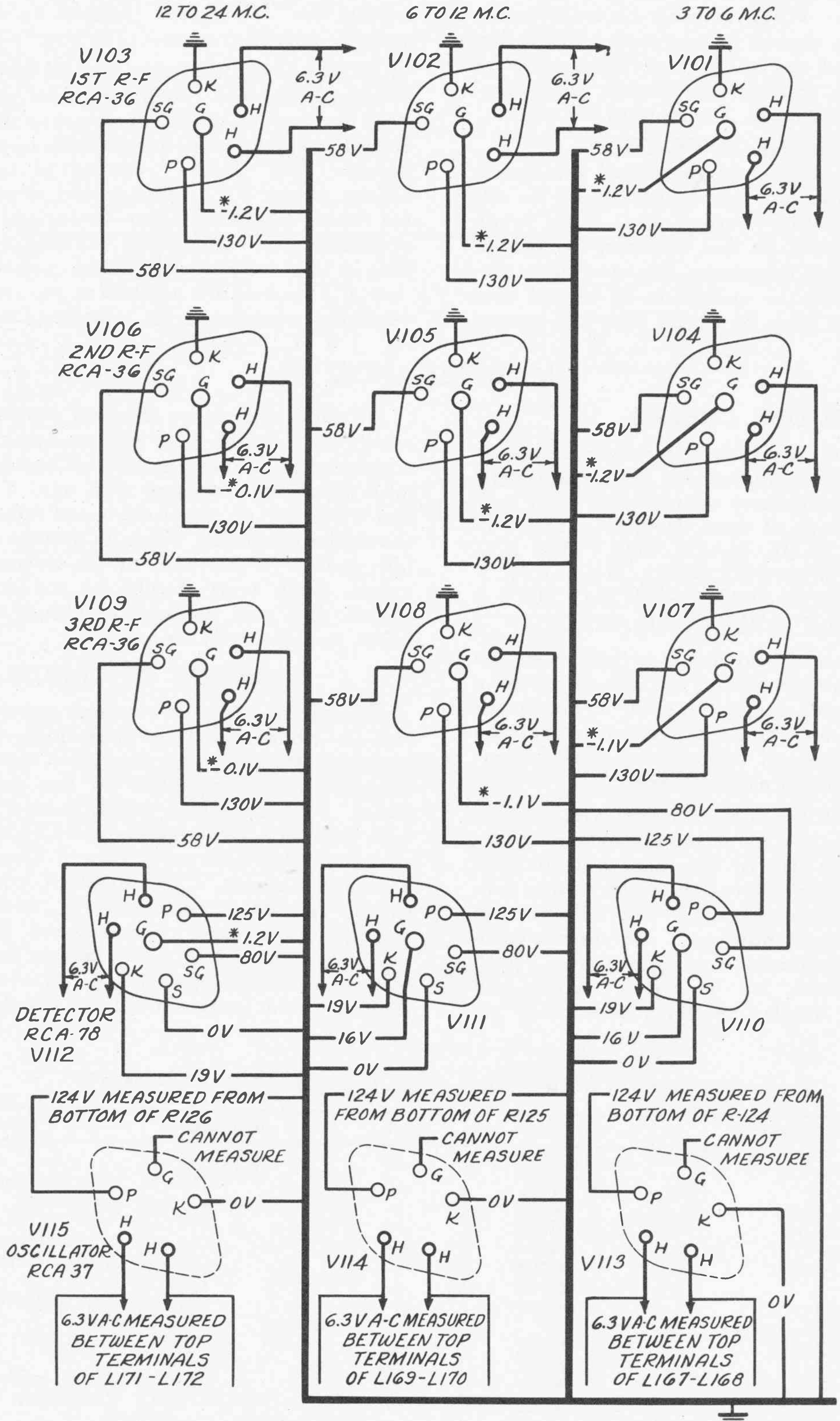
All tubes should be checked periodically, preferably in a tester that will measure the mutual conductance. Since the mutual conductance of a tube normally decreases with age, it is an excellent criterion of the tube condition. Any tube should be discarded when its mutual conductance falls below 70 per cent of the average new-tube value. Such tests should be made with plate, screen, and grid voltages of values at which the tubes are normally operated.

LOCATION OF TROUBLES

Failure of a circuit element generally will result in abnormal tube-operating voltages and currents. Facilities for complete metering of the equipment are available on the power control panel. Normal values which should be obtained with normal a-c load voltage of 115 volts are as shown in the table of "Normal Operating Voltages and Current." The filament, plate, and bias supply circuits to each receiver, audio-frequency amplifier, and tone keyer are fed through fuses which are located in a row across the bottom of the power control panel. In the event of circuit failure, these fuses should be checked for continuity.

NORMAL OPERATING VOLTAGES AND CURRENT

Measurement	Meter	Jack	Reading	Remarks
Line Voltage (a-c)	M601	—	98 to 125	
Load Voltage (a-c)	M601	—	115	Line frequency, 60 cycles
D-C Load Current (ma)	M602	—	approx. 400	3 receivers
Plate Supply Voltage	M603	—	136	
Bias Supply Voltage	M604	—	–15	Approximate
Filament Voltage (a-c)	M701	—	6.3	Approximate
Plate Voltage	M703	—	136	
Bias Voltage (AGC)	M703	—	–15	Approximate
PLATE CURRENTS (ma)—				
R-F Amplifier (3 tubes)	M101	—	6.4	Fixed bias; maximum gain
R-F Detector	M702	J101	2.8	
R-F Oscillator	M702	J102	2.2	Mean; varies with tuning
1st I-F Amplifier (2 tubes)	M702	J301	6.0	Fixed bias; maximum gain
Converter Selected and 400-KC Oscillator (2 tubes)	M702	J303	6.3	
Filter Isolation Tube Selected, 2nd I-F Amplifier (2 tubes) and Diode Driver (total 4 tubes)	M702	J302	16.0	Full gain
Monitor Coupling Tube, Detector, 50-KC Oscillator and Monitor Output (total 4 tubes)	M702	J304	17.5	
Keyer Output (balance)	M401	—	0	
A-F Amplifier, 1st Stage	M702	J501	4.3	
A-F Amplifier, 2nd Stage	M702	J502	18.0	



REAR VIEW OF SOCKETS — NO SIGNAL - MAX. GAIN - FIXED BIAS

ALL VOLTAGES MEASURED WITH AN EXTERNAL 20,000 OHM/VOLT METER

HEATER VOLTAGES MEASURED PIN TO PIN, ALL OTHER VOLTAGES MEASURED PIN TO GROUND, EXCEPT AS NOTED OTHERWISE.

*USE 10 VOLT SCALE — TOLERANCE ±10%

Figure 5—Radio-Frequency Amplifier Unit
(Tube Socket Voltages, M-429638—Sub. 0)

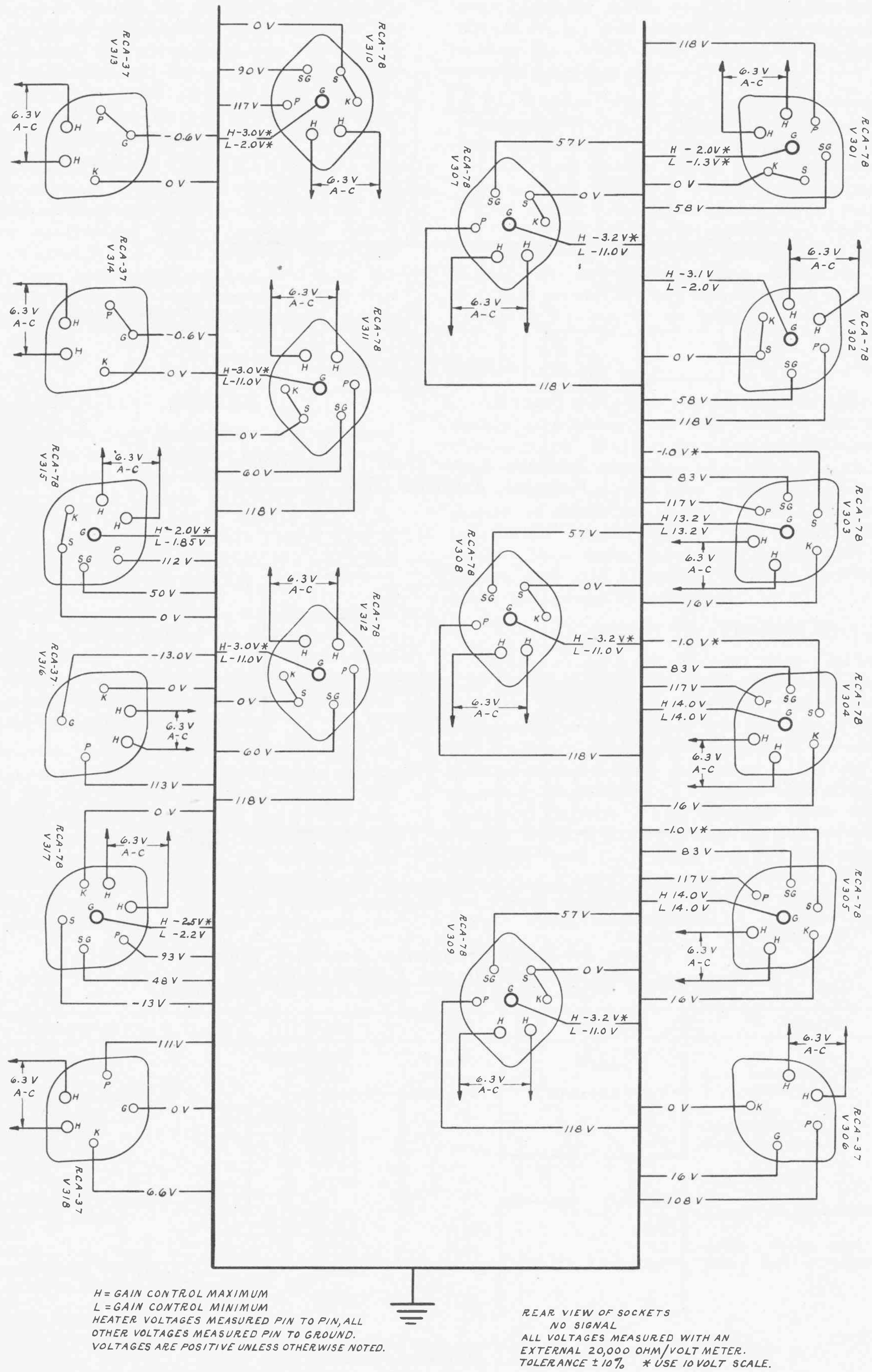


Figure 6—Intermediate-Frequency Amplifier Unit (Tube Socket Voltages, P-727193—Sub. 1)

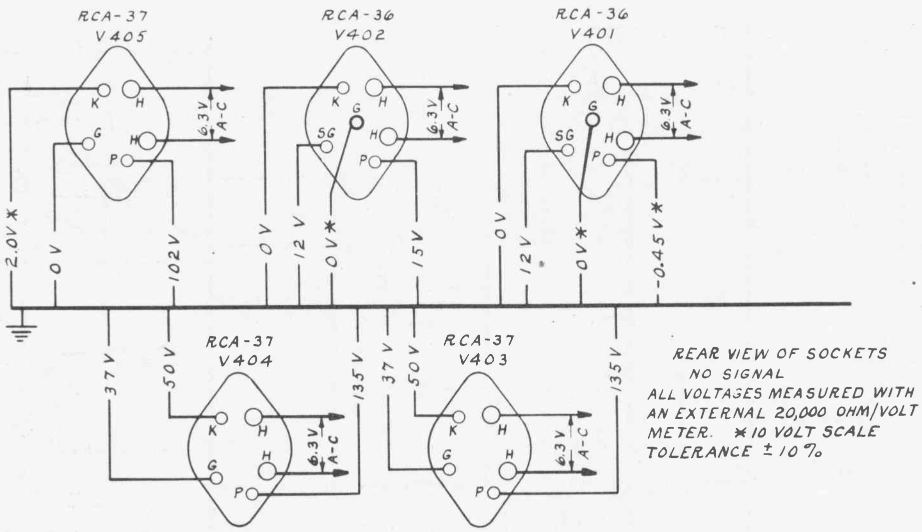


Figure 7—Tone Keyer Unit (Tube Socket Voltages, K-870657—Sub. 0)

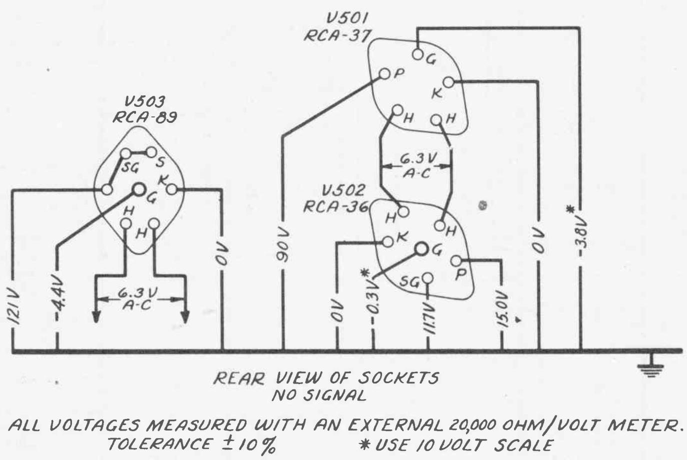


Figure 8—Audio-Frequency Amplifier Unit (Tube Socket Voltages, K-870653—Sub. 0)

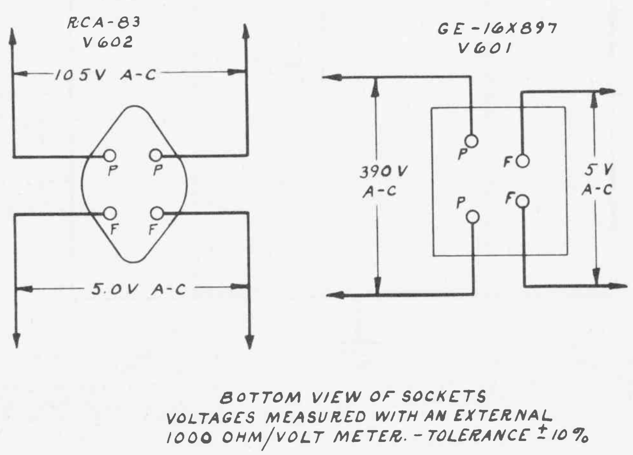


Figure 9—Rectifier Power Unit (Tube Socket Voltages, K-870658—Sub. 0)

Voltage and current measurements normally will suffice to locate the faulty stage, or at least the faulty unit, of the equipment. Location of the defective component in a given unit is most easily accomplished by measuring the tube-socket voltages with an external high-resistance multi-range voltmeter. The test voltmeter should have a resistance of at least 20,000 ohms per volt and ranges of 0 to 10, 0 to 50, and 0 to 250 volts. Potentials up to 10 volts should be measured on the 10-volt range, from 10 to 50 volts on the 50-volt range, and above 50 volts on the 250-volt range. With normal line voltage and frequency, the voltages to be expected within the various units are indicated in Figures 5 to 9, inclusive.

Replacement of defective parts should be made only with exact duplicates of the original, as specified in the parts list for the individual units concluding each of the subsequent sections of this book. A list of the various manufacturers from whom replacement parts may be obtained is included in Section XI. The numbers assigned to these manufacturers are used for purposes of identification in the unit lists.

The design of this equipment is such that, with a few minor exceptions, all normal maintenance work and repair work can be done without removing the units from the racks. However, should it become necessary to remove a unit from the rack, or to install a new one, the following procedure should be employed: First remove the external connections, then remove two of the panel mounting screws, one from each side of the panel, and screw into each tapped hole one of the steel studs furnished with the equipment. Then remove the remaining mounting screws and slide the unit forward on these studs. By employing this procedure, it is possible for one man to remove or install any of the units with the possible exception of the power-supply panel. When removing any unit that is enclosed by a rear cover box, the chassis of the unit is generally the only part removed, the cover box remaining in the rack.

Any repairs or changes to panels, chassis and like parts should be made with aluminum stock and aluminum rivets. Soldering, even with special solders and fluxes, is not recommended. Brass parts such as screws which make contact with aluminum should first be nickel-plated.

PERFORMANCE TESTS

All measurements, except for AGC, should be made with the r-f amplifier unit switched to fixed gain—not AGC—and with the input coupling and r-f "GAIN" controls set at maximum. To avoid any possibility of overloading, the input signal should not exceed 20 microvolts and the overall receiver gain should be adjusted to a suitable value by means of the i-f "GAIN" control to make certain that the rectified output of the receiver does not exceed the limit of linearity of the input/output characteristics. This limit is approximately 1.2 milliamperes and is indicated by the respective milliammeter on the signal control panel for the receiver in use. Since the noise equivalent of the receiver is proportional to the square root of the overall band width, it is necessary that all measurements be made with a specified i-f band width.

Sensitivity: Sensitivity measurements may be made as follows:

(a) **Overall** (at 2/1 signal-to-noise ratio)—

1. Rotate the "GAIN" control on the radio-frequency amplifier to the maximum clockwise position (maximum gain).

2. Operate the "AGC-FIXED" toggle switch (located on the radio-frequency amplifier panel) to the "FIXED" position.

3. Rotate the "BAND WIDTH" switch (located on the intermediate-frequency amplifier panel) to the "4 KC" position.

4. Place all switches on the signal control panel in the neutral position, then operate the appropriate channel switch to the "AF-1" position.

5. Connect a 0.1 mfd capacitor in series with a high-resistance a-c voltmeter which has a full scale range of about three volts, then connect the combination between the input terminal on the audio-frequency amplifier unit and ground.

6. Connect a 100-ohm resistor in series with each of the two output leads from a signal generator, then connect the combination to the input terminals on the radio-frequency amplifier.

7. Rotate the input coupling control (small knob, located near the top of the radio-frequency amplifier unit) to the maximum clockwise position (maximum coupling), then, with the signal generator adjusted to deliver a nine megacycle signal, modulated 30 per cent at 400 cycles, carefully adjust the tuning controls on the radio-frequency amplifier to the position at which maximum voltage is indicated on the externally connected voltmeter.

8. Using low input from the signal generator, and without changing the position of the tuning controls, proceed as follows:

(a) With the modulation of the signal generator turned **on,** adjust the microvolts input to the receiver and the setting of the "GAIN" control on the intermediate-frequency amplifier to the value and position at which a current of 0.5 milliampere is indicated on the channel milliammeter (located on the signal control panel). Note the output voltage indicated on the externally connected voltmeter.

(b) Without changing the position of any other control, turn the modulation of the signal generator **off** and again note the output voltage.

(c) Repeat steps (a) and (b) until the output voltage indicated in step (a) is twice the value of that indicated in step (b).

When the requirement of step (c) has been fulfilled, the number of microvolts input to the receiver is a measure of its sensitivity. With average new tubes installed, not more than three microvolts input should be required to produce standard output.

THIS SENSITIVITY WILL, OF COURSE, BE SUBJECT TO VARIATIONS DUE TO TUBE AGING, THEREFORE, IT IS RECOMMENDED THAT NO ATTEMPT BE MADE TO RE-ALIGN THE CIRCUITS OF THE RECEIVER UNLESS THE SENSITIVITY (MEASURED WITH NEW, AVERAGE TUBES INSTALLED) IS FOUND TO BE WORSE THAN FIVE MICROVOLTS.

(b) **Intermediate-Frequency Amplifier**—For a standard output (0.5 milliampere through 10,000 ohms) the approximate input required at each stage of the intermediate-frequency amplifier is as follows:

Stage	Tube Symbol	Signal Frequency	Input Microvolts
1st I-F:		450 kc	
First Stage	V301		40
Second Stage	V302		40
50 kc Converter	V303 to V305	450 kc 50 kc	60 25
Isolation Amplifier	V307 to V309	50 kc	180
2nd I-F:		50 kc	
First Stage	V312		2,600
Second Stage	V311		41,000
Third Stage	V310		680,000

The sensitivity of the intermediate-frequency amplifier varies somewhat with the band-pass filter used. When a ten kilocycle filter is employed the sensitivity is approximately 30 microvolts and when a one kilocycle filter is used the sensitivity is approximately 150 microvolts. The values shown in the preceding tabulation are for a four kilocycle filter.

(c) **Frequency Converter Stage**—After setting the i-f amplifier at a known fixed gain, and using an input sufficient to give standard output, connect the signal generator to the converter grid through a small capacitor (about 0.001 mmf) and connect the converter grid back to the high side of its normally tuned input circuit through a resistance of approximately 0.5 megohms. The i-f input circuit should then be carefully tuned and the signal reduced again to obtain standard output. The conversion gain is the ratio of the value of the signal required on the i-f amplifier to that required on the converter. A signal level of about 60,000 microvolts may be used. The signal level is not important so long as overloading does not occur. However, measurements made at reduced gain at this value (60,000 microvolts) may be used directly in obtaining r-f sensitivity.

Measurements should be made in each of the three bands at the following frequencies: The first band at 3 mc, 4.5 mc and 6 mc; the second band at 6 mc, 9 mc, and 12 mc; and the third band at 12 mc, 18 mc and 24 mc. The values of conversion gain will vary but values between 1 and 2 are normal.

(d) **R-F Unit** (See Section II)—Measurements to obtain r-f gain are made using fixed, known i-f amplifier gain on the same frequencies used to obtain converter gain. Maximum r-f gain and antenna coupling are used. The signal generator is connected to the antenna coupling coil through the dummy antenna (described on page 15) for this test. The signal necessary to obtain standard output is again obtained. The overall r-f gain may be computed by dividing the microvolts input to the overall receiver, necessary to obtain standard output, into the microvolts input to r-f converter necessary to obtain this same standard output. The range of overall gain which may be expected is given on Page 1, Section III. The stage-by-stage gain in this unit varies somewhat with frequency. Average values between six and ten may be expected.

(e) **Overall Image-Signal**—This measurement is made as in the paragraph immediately preceding, excepting that the image frequency is used for the test frequency and the signal generator is connected to the antenna coupling coil through 62.5 ohms in each input lead. Below 20 mc, the ratio of the image input signal in microvolts, to obtain standard output, should be greater than 10,000 to 1.

Selectivity: Selectivity characteristics of the units may be obtained as follows:

(a) **I-F Unit**—The overall selectivity characteristic of the i-f amplifier is substantially rectangular, flat-topped to ±0.5 db from the midband point and essentially centered. The 1-kc band is adjusted to be centered ±0.2 kc and the other bands to ±0.5 kc. The nominal band width is measured between the points on either side of resonance where the diode output current is 1 db below the midband value. Typical i-f selectivity curves are shown in Figure 1, Section IV.

The i-f input selectivity provides for an i-f image-signal ratio of at least 10,000 to 1. The tuned input circuit to the diode driver stage has a band width sufficient to provide approximately uniform input-output linearity throughout the pass band.

(b) **Cross-Talk Selectivity Characteristics (RCA Method)**—These characteristics indicate the amount of cross-talk interference with a desired unmodulated signal, caused by an undesired signal on an adjacent frequency. In making this test, the r-f gain should be fixed (not AGC and set at maximum, while the i-f gain should be adjusted to produce normal output on the desired signal.

Two signal generators of low impedance termination are connected to the receiver input with 125 ohms in each input lead. With one generator turned off the other is set to the desired test frequency and adjusted to give an input of 20 microvolts at the generator. Using maximum r-f gain, but with no modulation, the signal is tuned in and the i-f gain adjusted to give normal diode output. The other signal generator is then turned on and at each of several undesired frequencies covering a wide range on either side of the desired frequency the r-f unmodulated input voltages required to cause a decrease in diode current to 0.27 milliampere are recorded. This corresponds to 30 per cent modulation of the desired carrier by an undesired carrier frequency. Observations should be made at least every 100 kc up to 400 kc above and below the desired signal frequency.

For a given standard test frequency and for the several standard input voltages, cross-talk interference curves are plotted, having as abscissas the frequency difference in kilocycles between the interfering signal and the desired signal, and having as ordinates the observed interference-test inputs in microvolts. Here the strength of the interfering signal plotted has been obtained by taking one-half of the value as measured above, to make it relatively comparable to the desired signal. The frequency scale of abscissas should be uniformly divided, whereas the microvolt scale of ordinates should be logarithmically divided and should increase in the upward direction on the page. A typical curve at 18 mc is illustrated in Figure 10.

Fidelity—This measurement is made at the audio-frequency amplifier output terminals with the band-pass selectivity switch adjusted for the widest pass band. Apply an r-f signal at a mid-band frequency, modulated 30 per cent., to the receiver input. Hold the percentage modulation constant and vary the frequency of the applied signal within the desired limits, measuring the a-c at the audio-frequency amplifier output terminals. It is preferable that a vacuum tube voltmeter having a d-c blocking condenser be used for making this measurement.

Since the fidelity is essentially determined by the characteristics of the i-f band-pass filters it is possible to determine the fidelity that may be expected by reference to the curves shown in Figure 2, Section IV. Average frequency-response curves for all band-pass filters are shown in Figure 1, Section IV.

Hum—Hum measurement is made with reference to a 100% modulated r-f input of from 10 to 30 microvolts. An arbitrary output level should be established by applying a modulated r-f signal of this order to the receiver input, while measuring the output by means of a frequency analyzer or vacuum tube voltmeter connected across the diode output through a d-c blocking condenser. If the modulation is then removed, the residual hum, as measured across the diode output should be 50 db or more below the modulated level previously obtained.

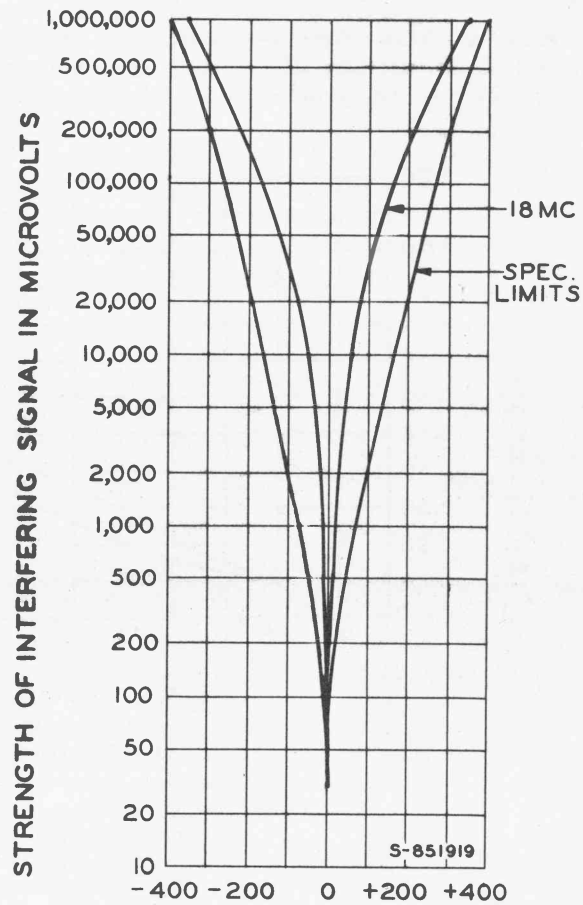


Figure 10—Two-Signal Selectivity Characteristics (S-851919—Sub. 0)

It is suggested that after preliminary hum measurements have been made the position of the plug on the input power supply line cord be reversed and that the hum measurements be then repeated. The plug should be left in the position at which the hum has a minimum value.

Automatic Gain Control—Information on AGC performance is given in the paragraphs which follow:

Regulation—Using maximum fixed r-f gain, and the audio-frequency amplifier unit for AGC, the i-f gain (AGC on) should be so adjusted that with no signal applied to the receiver input the rectified output of the diode will be 0.1 milliampere. A reference signal level of 10 microvolts should then be applied at the receiver input. The diode output current should then not vary more than 2.8 db for a further increase of 40 db in r-f signal level, or more than 3.4 db for an increase of 60 db over the initial 10-microvolt reference signal level. Figure 11 illustrates the AGC characteristics curve for a typical receiver taken at 18 mc using a 4-kc band-pass filter.

Impaired AGC Action—Partial loss of the control action of the AGC system is sometimes experienced and may be caused by leakage anywhere in the system. The easiest and best way to check and locate such trouble is to tune in a signal on one receiver that is acting normally and then switch the suspected receiver on to the diversity combination with the normal one. If AGC action is impaired thereby, the controlled tubes and the "AGC-FIXED" switch on the suspected receiver should be checked. Time-constant capacitors, wiring, and by-pass capacitors in the controlled circuit should be similarly checked. This method of checking the circuit by its own action is the only one that can be used successfully to locate trouble in the AGC system.

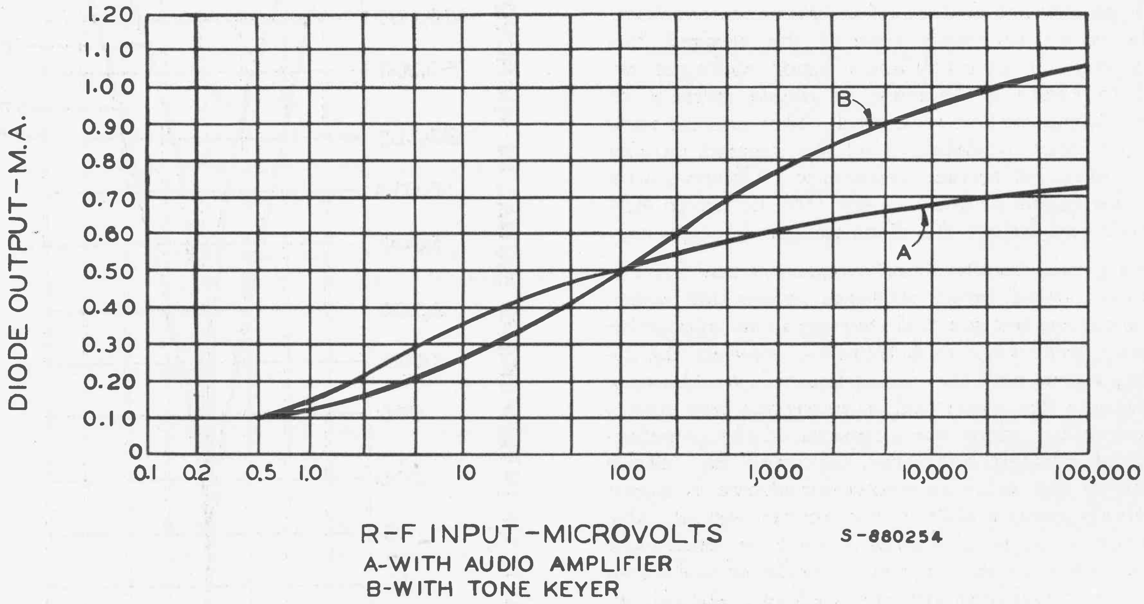


Figure 11—Automatic Gain Control (AGC) Regulation (S-880254—Sub. 0)

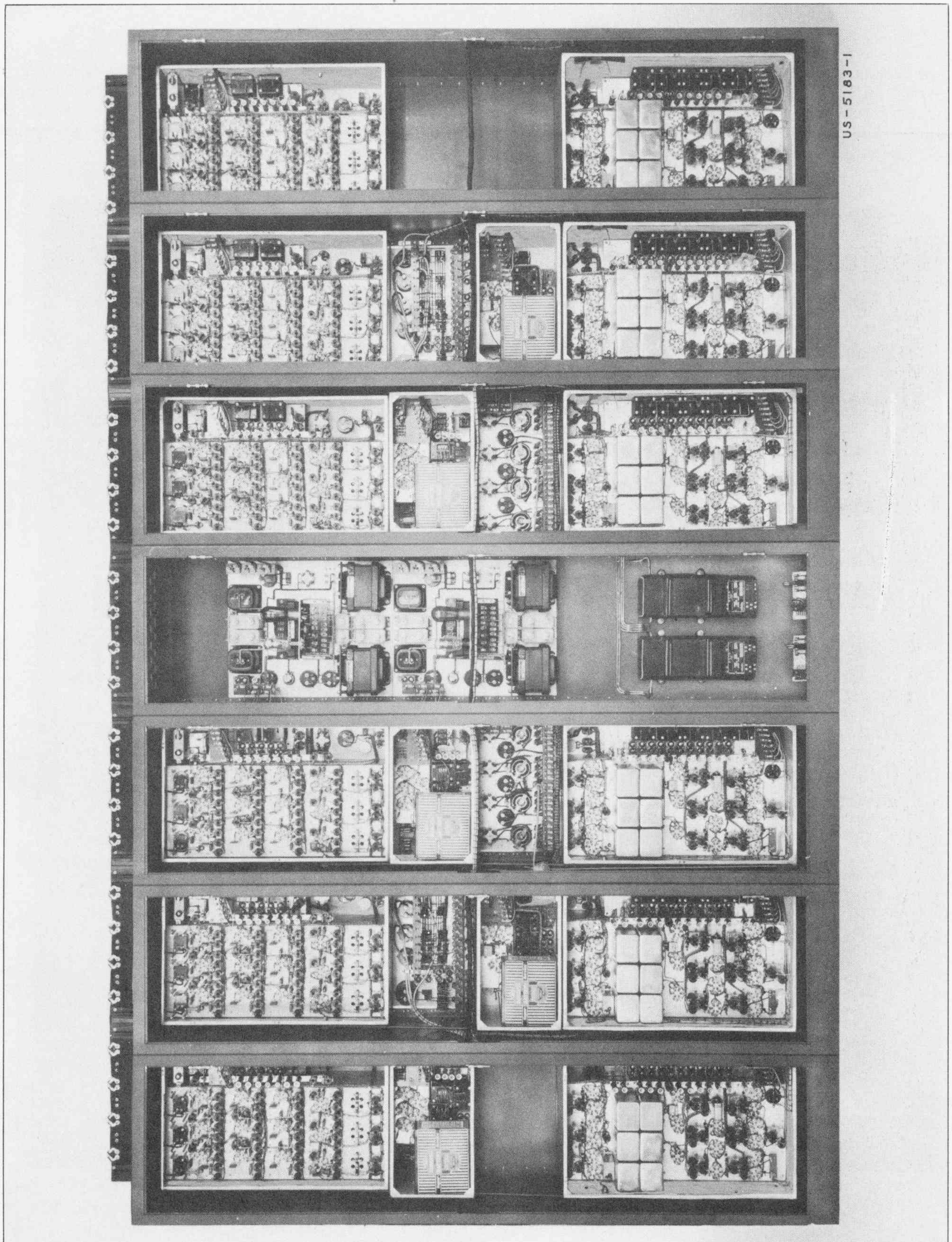


Figure 12—Model RBP-1 Diversity Radio Receiving Equipment (Rear View, Doors and Covers Removed, Access Panels Open)

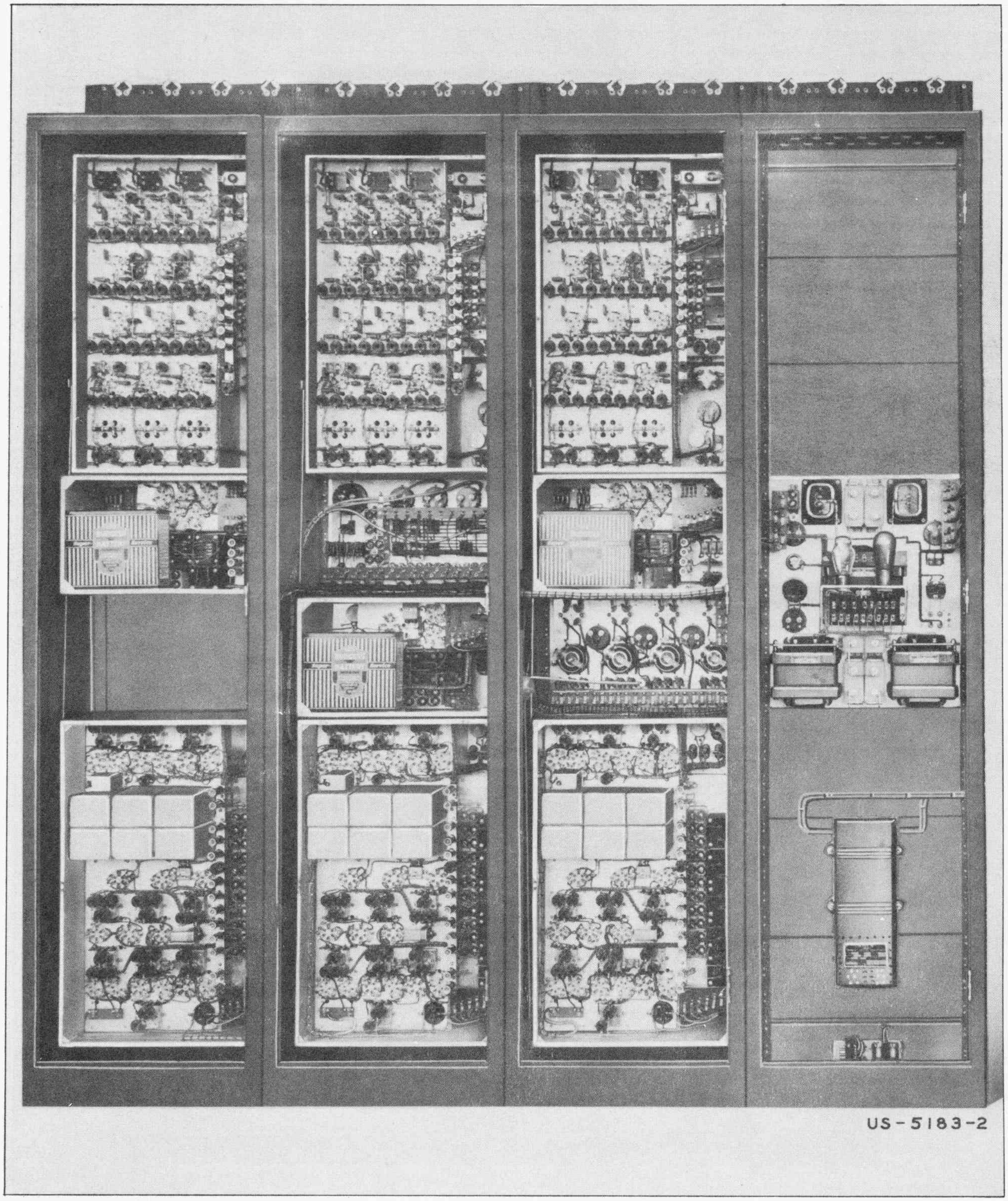


Figure 13—Model RCP Diversity Radio Receiving Equipment (Rear View, Doors and Covers Removed, Access Panels Open)

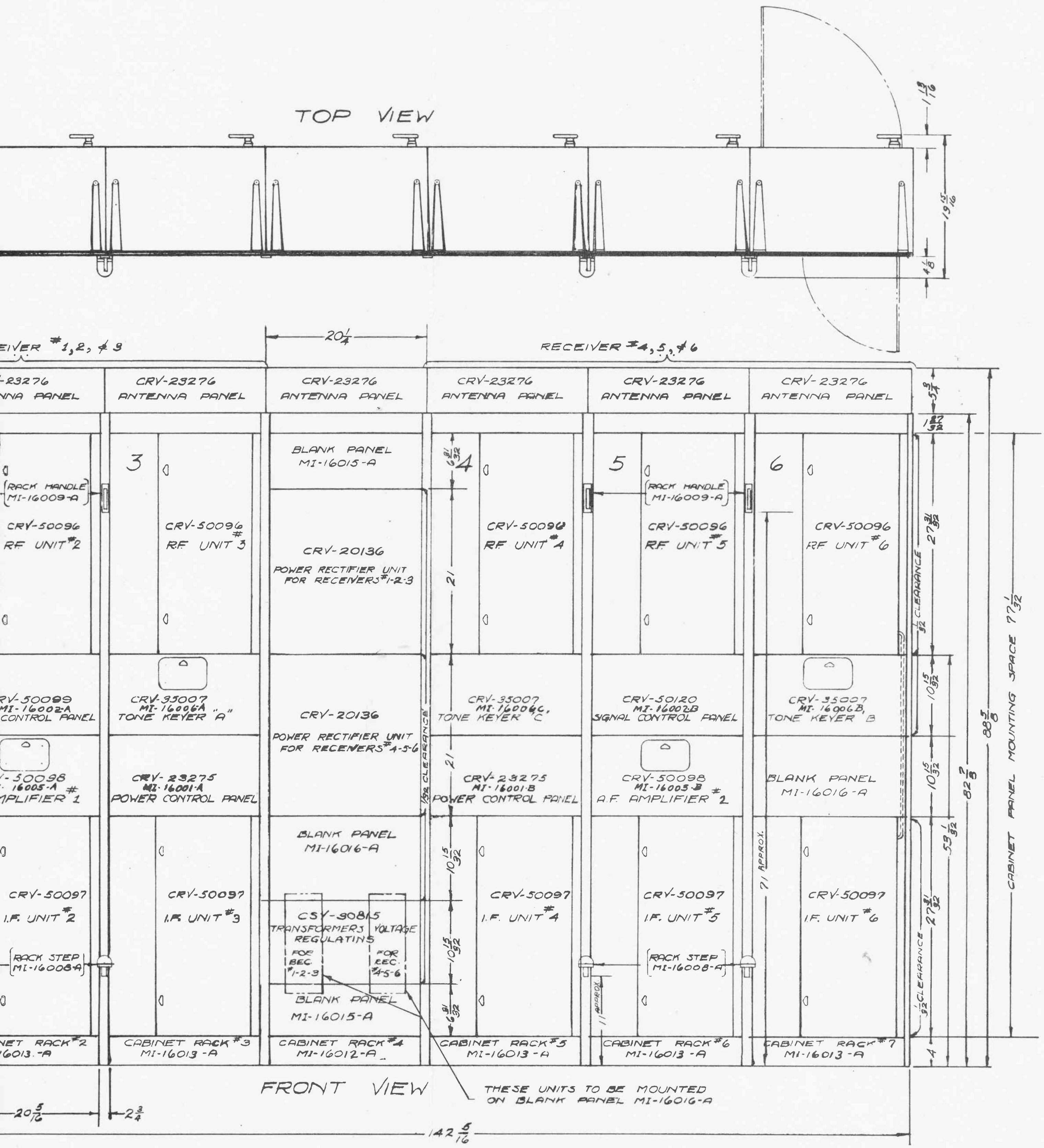
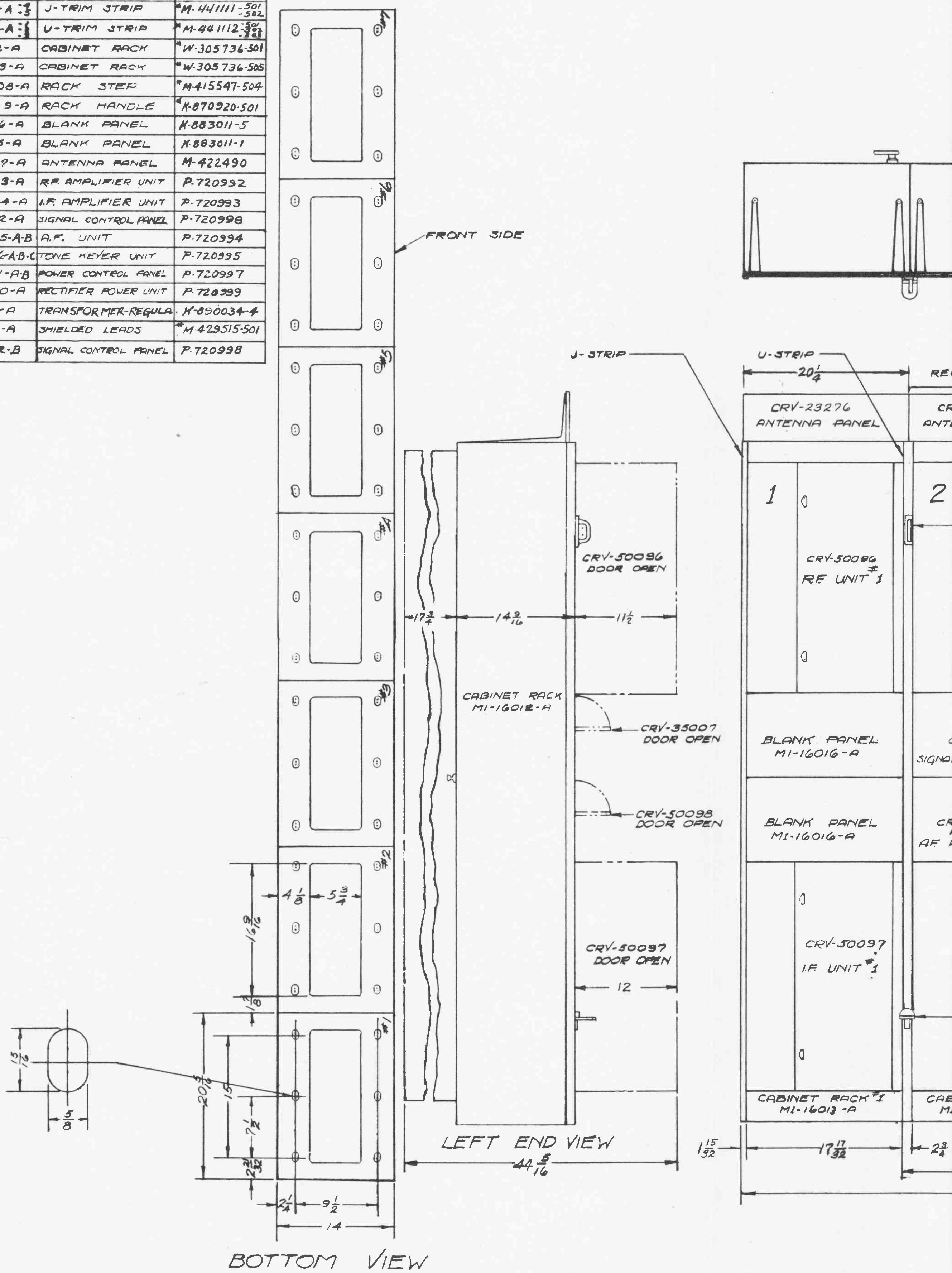


Figure 14—Model RBP-1 Diversity Radio Receiving Equipment (Outline, T-621183—Sub. 1)

QTY.	BUREAU DESIGNATION	RCA DESIGNATION	DESCRIPTION	ASSEMBLY* OR OUTLINE
2		MI-16014-A -4 -5	J-TRIM STRIP	*M-441111 -501 -502
6		MI-16014-A -1 -2 -3	U-TRIM STRIP	*M-441112 -501 -502 -503
1		MI-16012-A	CABINET RACK	*W-305736-501
6		MI-16013-A	CABINET RACK	*W-305736-505
4		MI-16008-A	RACK STEP	*M-415547-504
4		MI-16009-A	RACK HANDLE	*K-870920-501
5		MI-16016-A	BLANK PANEL	K-883011-5
2		MI-16015-A	BLANK PANEL	K-883011-1
7	CRV-23276	MI-16007-A	ANTENNA PANEL	M-422490
6	CRV-50096	MI-16003-A	R.F. AMPLIFIER UNIT	P.720992
6	CRV-50097	MI-16004-A	I.F. AMPLIFIER UNIT	P-720993
1	CRV-50099	MI-16002-A	SIGNAL CONTROL PANEL	P-720998
2	CRV-50098	MI-16005-A-B	A.F. UNIT	P-720994
3	CRV-35007	MI-16006-A-B-C	TONE KEYER UNIT	P-720995
2	CRV-23275	MI-16001-A-B	POWER CONTROL PANEL	P-720997
2	CRV-20136	MI-16000-A	RECTIFIER POWER UNIT	P-720999
2	CSY-30815	MI-16011-A	TRANSFORMER-REGULA.	K-890034-4
6		MI-16010-A	SHIELDED LEADS	*M-429515-501
1	CRV-50120	MI-16002-B	SIGNAL CONTROL PANEL	P-720998



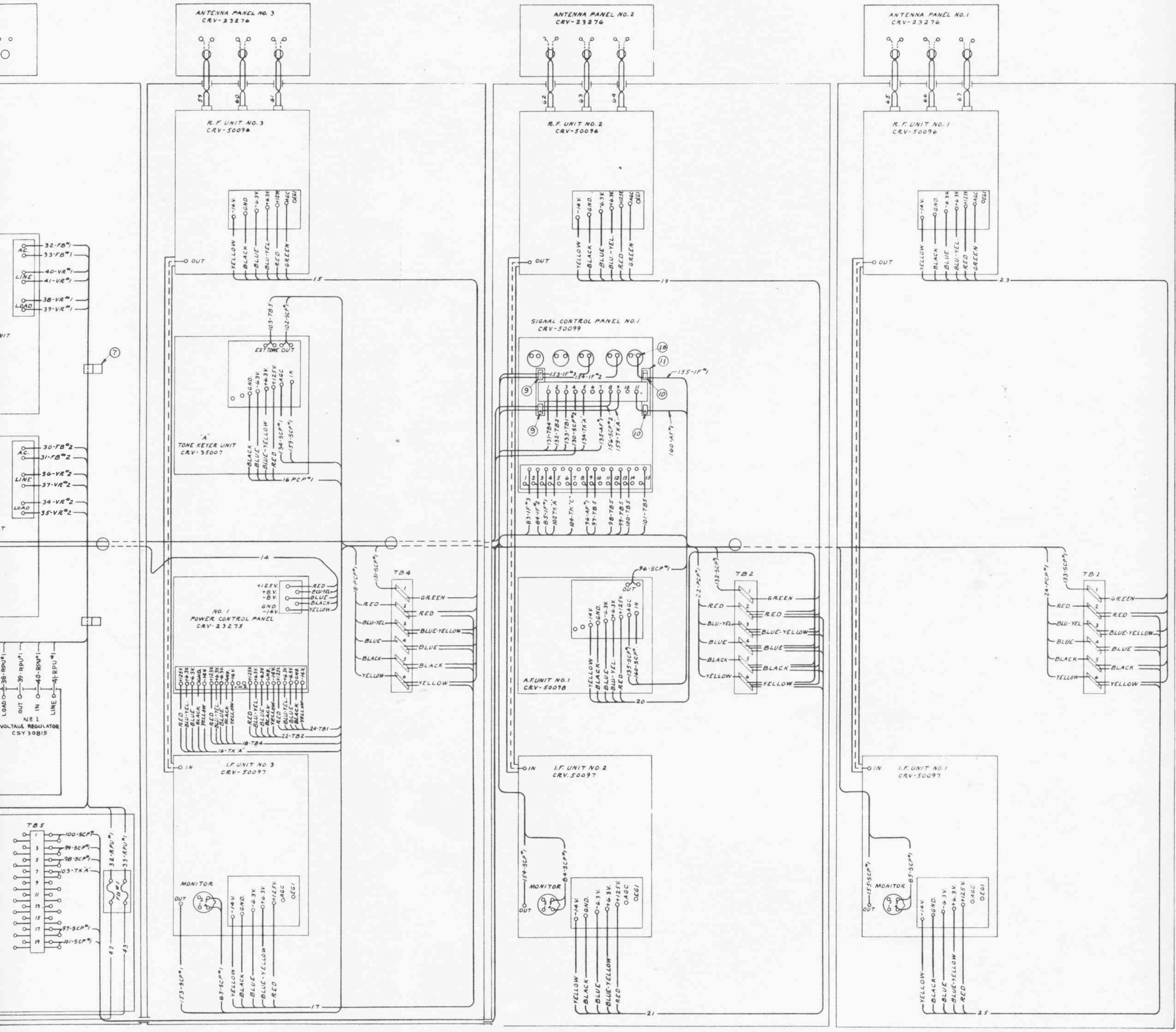
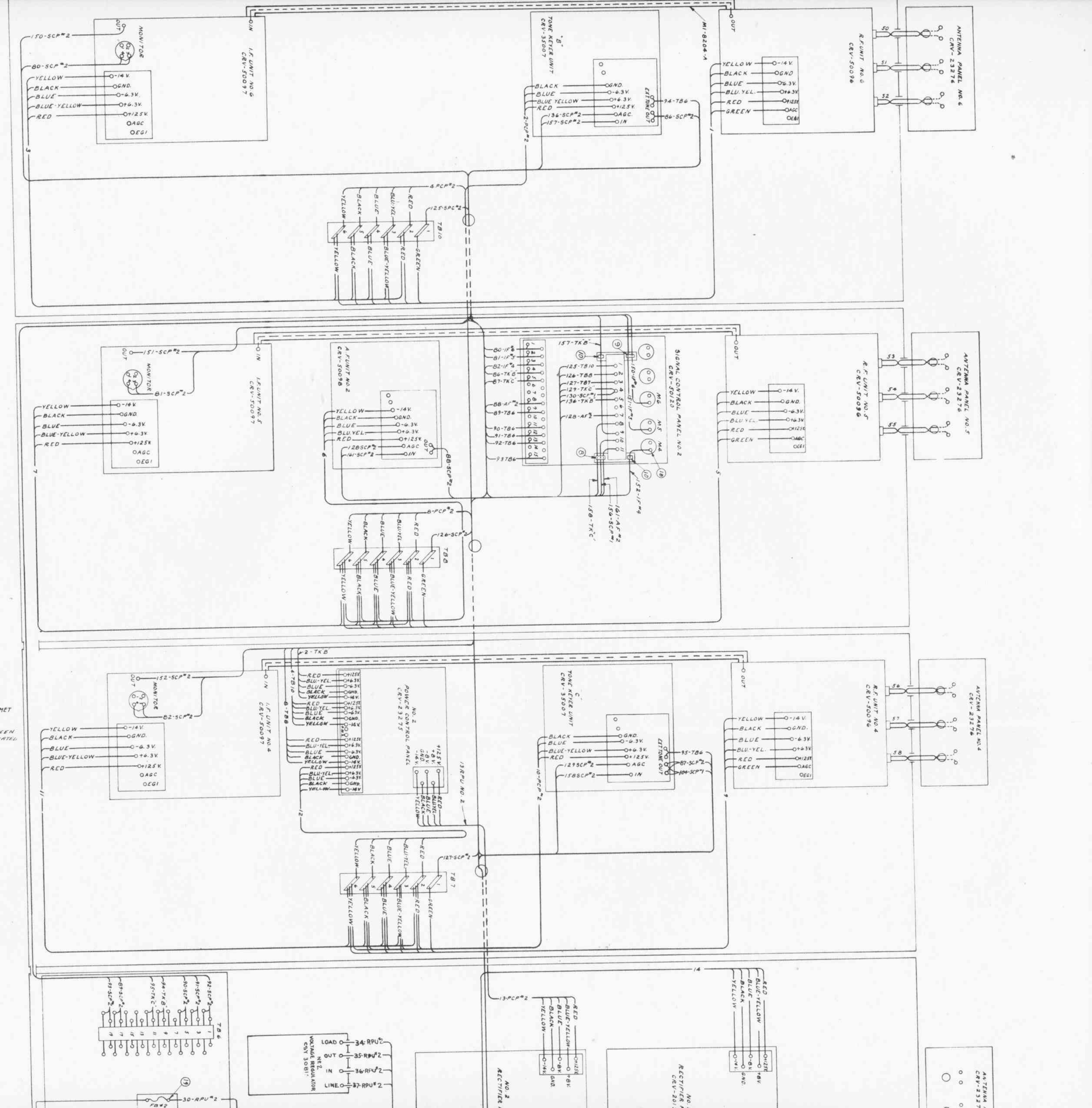


Figure 16—*Model RBP*-1 *Diversity Radio Receiving Equipment* (*Interconnections, W*-305727—*Sub.* 2)



WIRE TABLE

PART NO. SEE K-870926	DESCRIPTION	WIRE & CABLE NO.
1	K-878674-1 6 CONDUCTOR CABLE	1 TO 25 INCL.
2	K-832462-3 TWO COND. SHIELDED 1-BLACK-1-RED	80 TO 104 INCL.
3	P5-5166 TWO COND. TRANSMISSION CABLE	50 TO 67 INCL.
4	P5-496 WIRE .064 DIA. V.C.L.C. 600 V.	30 TO 43 INCL.
5	P5-533-9 GREEN 26/.010 V.C.B.C.	125 TO 136 INCL.
6	MI-20 SHIELDED CABLE LOW CAPACITY	150 TO 161 INCL.

— NOTES —

CODING INSERTED IN WIRES & CABLES INDICATES WIRE NO. & DESTINATION OF WIRE RESPECTIVELY, THUS 1-TB#1 INDICATES CABLE NO. 1 TERMINATES AT TERM. BOARD NO. 1. NUMBER IN CIRCLES REFER TO PART NO. ON WIRING MATERIAL LIST K-874433.

CUT CABLE & WIRES TO REQUIRED LENGTHS, STRIP ENDS 3/8 & TIN.

CUT OUT WIRES NOT USED IN P.1, WRAP ENDS OF CABLE WITH P-15.

CUT, FORM & DRILL P-7 FOR CABLE CLAMPS LOCATE AS REQUIRED.

USE P.16 ON ALL ENDS OF P.2.
USE P-17 ON ALL ENDS OF P.6.

LEAD COVER OF P.4 MUST EXTEND THROUGH GROMMET ON VOLTAGE REGULATOR.

WIRES #42 AND #43 ARE TO BE CONNECTED BETWEEN FB#1 AND FB#2 FOR PROPER PHASING AS INDICATED BY TEST FOR MINIMUM HUM.

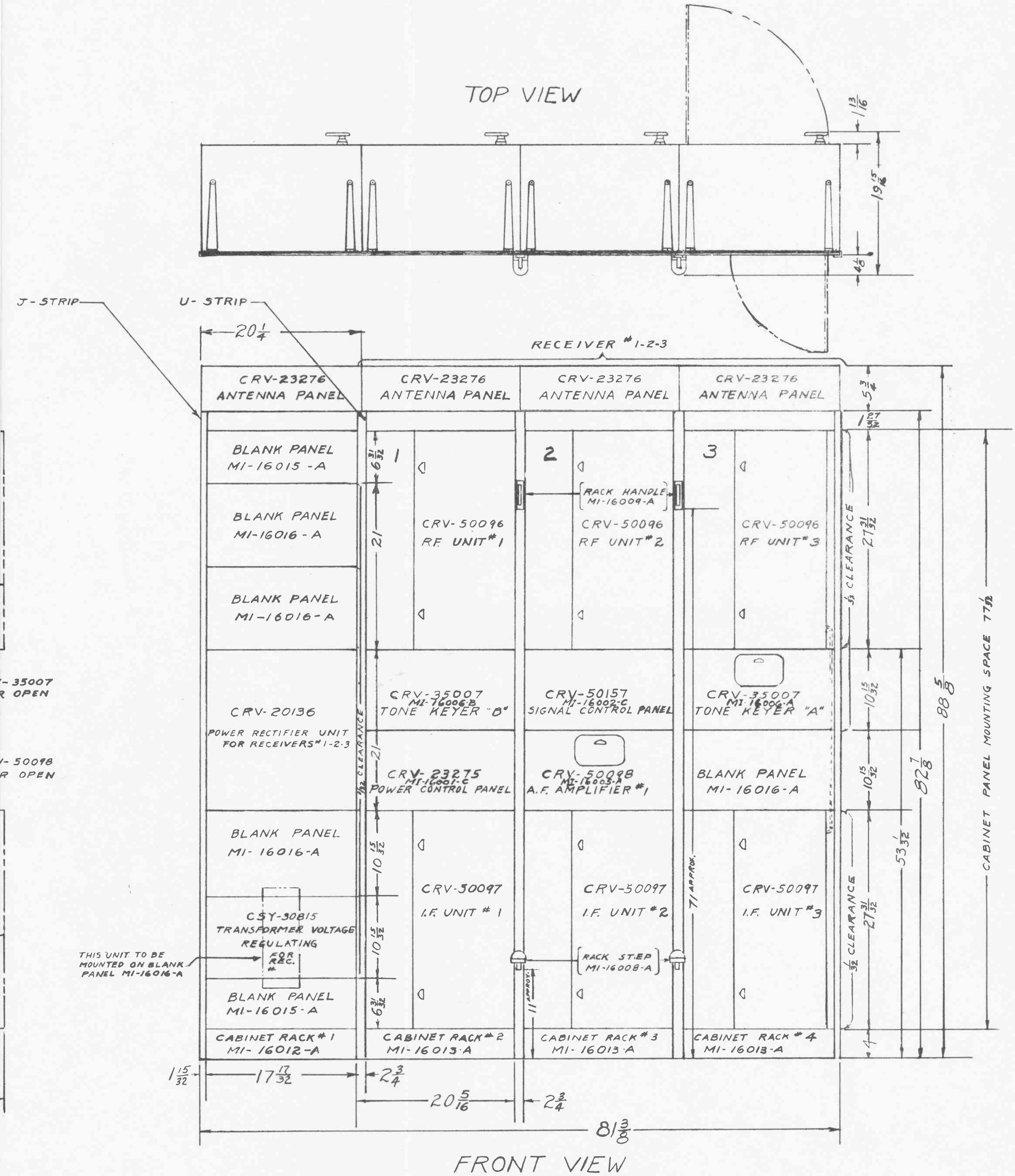
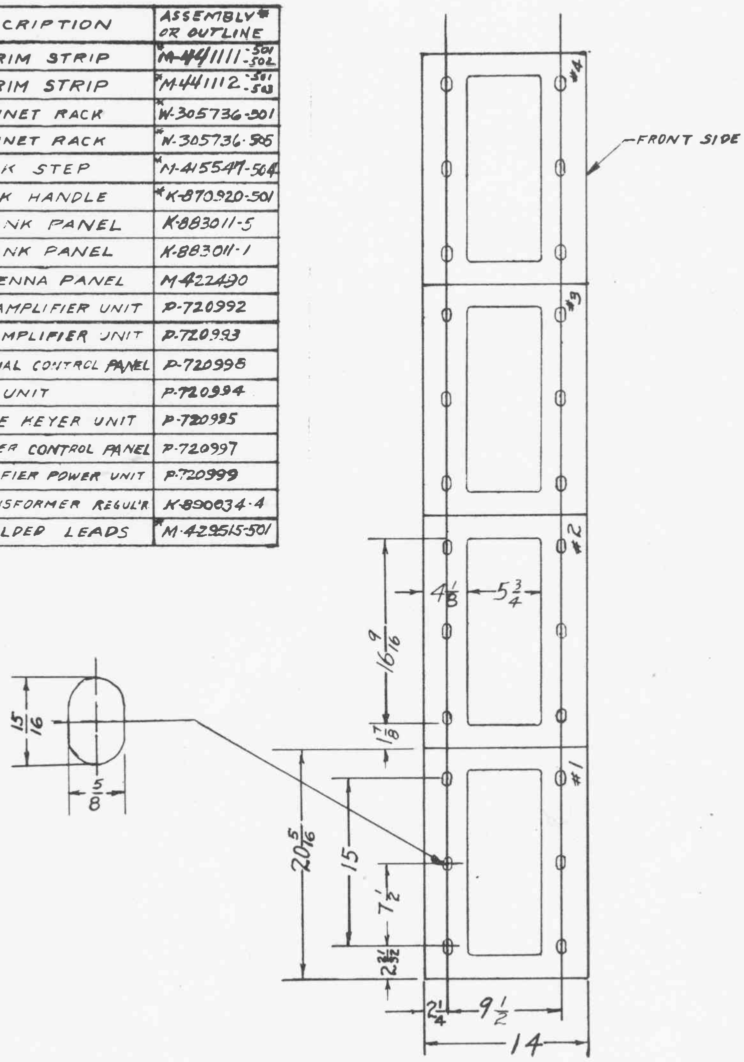
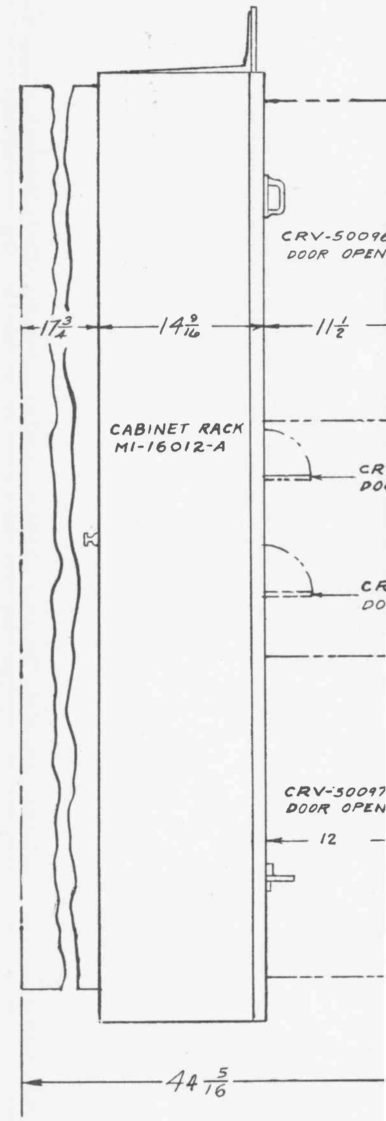


Figure 15—Model RCP Diversity Radio Receiving Equipment (Outline, T-621140—Sub. 2)

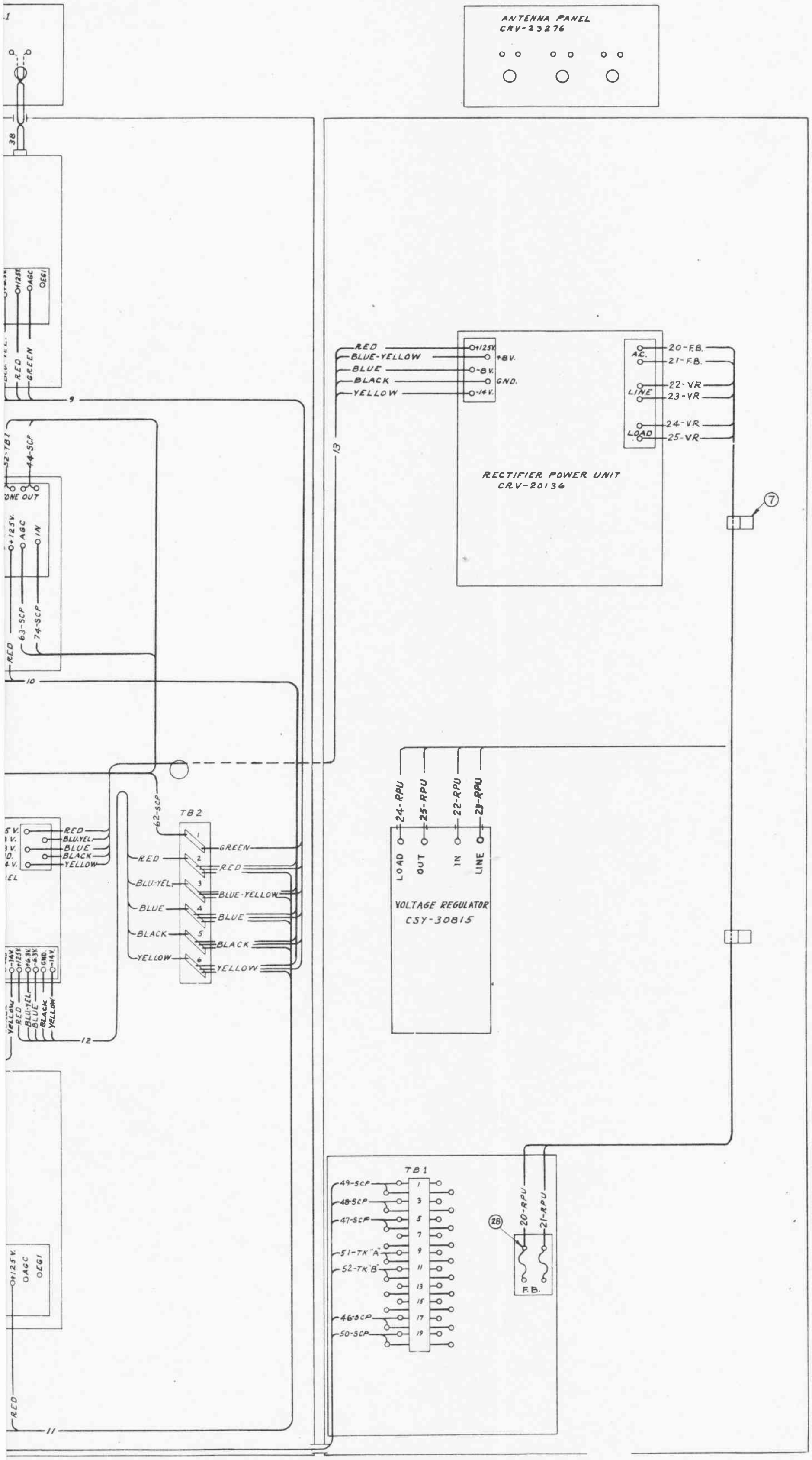
QTY.	BUREAU DESIGNATION	R.C.A. DESIGNATION	DESCRIPTION	ASSEMBLY* OR OUTLINE
2		MI-16014-B-3/-4	J-TRIM STRIP	M-441111-501/-502
3		MI-16014-B-1/-2	U-TRIM STRIP	*M-441112-501/-503
1		MI-16012-A	CABINET RACK	*W-305736-501
3		MI-16013-A	CABINET RACK	*W-305736-505
2		MI-16008-A	RACK STEP	*M-415547-504
2		MI-16009-A	RACK HANDLE	*K-870920-501
5		MI-16016-A	BLANK PANEL	K-883011-5
2		MI-16015-A	BLANK PANEL	K-883011-1
4	CRV-23276	MI-16007-A	ANTENNA PANEL	M-422490
3	CRV-50096	MI-16003-A	R.F. AMPLIFIER UNIT	P-720992
3	CRV-50097	MI-16004-A	I.F. AMPLIFIER UNIT	P-720993
1	CRV-50157	MI-16002-C	SIGNAL CONTROL PANEL	P-720998
1	CRV-50098	MI-16005-A	A.F. UNIT	P-720994
2	CRV-35007	MI-16006-A-B	TONE KEYER UNIT	P-720995
1	CRV-23275	MI-16001-C	POWER CONTROL PANEL	P-720997
1	CRV-20136	MI-16000-A	RECTIFIER POWER UNIT	P-720999
1	CSY-30815	MI-16011-A	TRANSFORMER REGUL'R	K-890034-4
3		MI-16010-A	SHIELDED LEADS	*M-429515-501



BOTTOM VIEW



LEFT END VIEW



WIRE TABLE		
PART NO. SEE K-878675	DESCRIPTION	WIRE & CABLE NO.
1	K-878674-1 6 CONDUCTOR CABLE	1 TO 13 INCL.
2	K-832462-3 TWO COND. SHIELDED 1-BLACK-1-RED	40 TO 52 INCL.
3	PS-5166 TWO COND. TRANSMISSION CABLE	30 TO 38 INCL.
4	PS-496 WIRE .064 DIA. V.C.L.C. 600 V.	20 TO 25 INCL.
5	PS-533-9 GREEN 26/.010 V.C.B.C.	60 TO 65 INCL.
6	MI-20 SHIELDED CABLE LOW CAPACITY	70 TO 75 INCL.

— NOTES —

CODING INSERTED IN WIRES & CABLES INDICATES WIRE NO. & DESTINATION OF WIRE RESPECTIVELY, THUS 1-TB#4 INDICATES CABLE NO. 1 TERMINATES AT TERM. BOARD NO. 4. NUMBER IN CIRCLES REFER TO PART NO. ON WIRING MATERIAL LIST

CUT CABLE & WIRES TO REQUIRED LENGTHS, STRIP ENDS 3/8 & TIN.

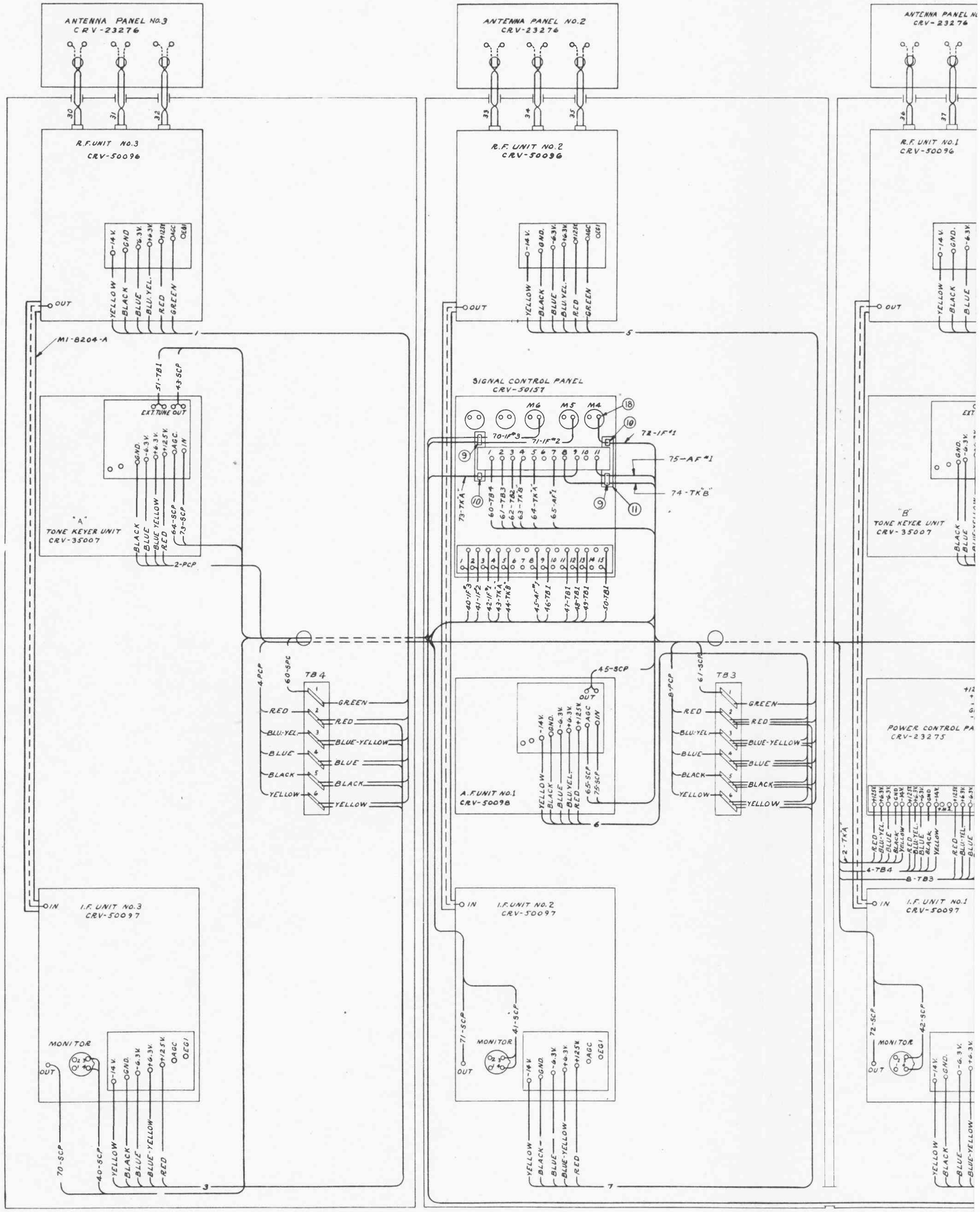
CUT OUT WIRES NOT USED IN P 1, WRAP ENDS OF CABLE WITH P-15

CUT, FORM & DRILL P-7 FOR CABLE CLAMPS LOCATE AS REQUIRED.

USE P-16 ON ALL ENDS OF P2.
USE P-17 ON ALL ENDS OF P6.

LEAD COVER OF P-4 MUST EXTEND THROUGH GROMMETS ON VOLTAGE REGULATOR.

Figure 17—Model RCP Diversity Radio Receiving Equipment (Interconnections, W-305725—Sub. 1)


ANTENNA PANEL NO.3
CRV-23276
R.F. UNIT NO.3
CRV-50096
MI-8204-A
"A"
TONE KEYER UNIT
CRV-35007
EXT. TUNE OUT
TB4
I.F. UNIT NO.3
CRV-50097
MONITOR
ANTENNA PANEL NO.2
CRV-23276
R.F. UNIT NO.2
CRV-50096
SIGNAL CONTROL PANEL
CRV-50157
M6
M5
M4
A.F. UNIT NO.1
CRV-50098
TB3
I.F. UNIT NO.2
CRV-50097
R.F. UNIT NO.1
CRV-50096
"B"
TONE KEYER UNIT
CRV-35007
POWER CONTROL PA
CRV-23275
I.F. UNIT NO.1
CRV-50097
YELLOW
BLACK
BLUE
BLU-YEL.
RED
GREEN
BLUE-YELLOW