INSTRUCTION BOOK

Radiomarine®

SSB-1 Mark IIA Single Sideband Transmitter-Receiver

RADIO CORPORATION of AMERICA

COMMUNICATION PRODUCTS DEPARTMENT

RADIOMARINE MARKETING

CAMDEN, N. J.

See List of Service Ports on Back Cover

IB-30691

KFT

INSTRUCTION BOOK

SSB-1 Mark IIA
Single Sideband
Transmitter-Receiver

RADIO CORPORATION OF AMERICA
COMMUNICATIONS PRODUCTS DEPARTMENT
RADIOMARINE MARKETING
CAMDEN, NEW JERSEY

PRINTED IN U.S.A.
WA 610

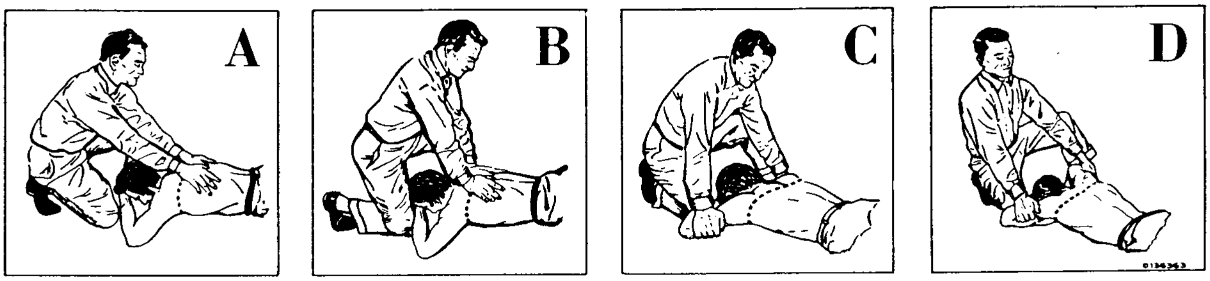
IB-30691

WARNING

ELECTRICAL OR MECHANICAL SERVICING OF THIS EQUIPMENT SHOULD BE ATTEMPTED ONLY BY QUALIFIED TECHNICAL PERSONNEL AUTHORIZED FOR SUCH WORK. OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF VOLTAGES WHICH MAY BE DANGEROUS TO LIFE.

FIRST AID IN CASE OF ELECTRIC SHOCK

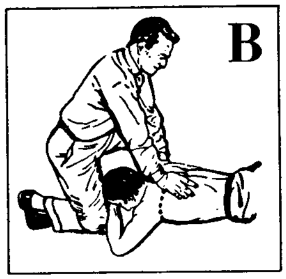
1. PROTECT YOURSELF with dry insulating material.
2. BREAK THE CIRCUIT by opening the power switch or by pulling the victim free of the live conductor. DON'T TOUCH THE VICTIM WITH YOUR BARE HANDS until the circuit is broken.
3. START ARTIFICIAL RESPIRATION IMMEDIATELY, SECONDS COUNT. Do not wait to look for help, to loosen clothing, to warm the victim, or to apply stimulants.



4. LAY VICTIM ON HIS STOMACH, preferably with head downhill.
5. CHECK MOUTH FOR OBSTRUCTIONS, remove foreign objects, pull tongue forward.
6. PLACE VICTIM'S FOREHEAD on his crossed hands, face down.
7. KNEEL AT VICTIM'S HEAD on either knee. See (A)
8. PLACE HANDS, fingers spread with thumbs about two inches apart, heels of hands below line connecting armpits. See (A)
9. WITH ELBOWS STRAIGHT, ROCK FORWARD slowly until arms are vertical. See (B) Do not apply more than 35 pounds pressure.
10. ROCK BACK SLOWLY to release pressure.
11. GRASP VICTIM'S ARMS just above elbows and continue backward. See (C)
12. LIFT ARMS until tension is felt. See (D)
13. LOWER ARMS to complete the cycle.
14. AFTER TWO SECONDS, START AGAIN with step 6.
15. REPEAT THE CYCLE 12 to 15 times per minute.
16. WHILE ARTIFICIAL RESPIRATION IS CONTINUED, HAVE SOMEONE ELSE:
    (a) Loosen the victim's clothing. (b) Summon medical aid.
    (c) Keep the victim warm.
17. DON'T GIVE UP. Continue without interruption until the victim is breathing without help or is certainly dead.
    Four hours or more may be required.
18. REMAIN IN POSITION after victim revives. Be ready to resume artificial respiration if necessary.
19. DO NOT GIVE LIQUIDS WHILE VICTIM IS UNCONSCIOUS.

PRIMEROS AUXILIOS EN CASOS DE ELECTROCUCION

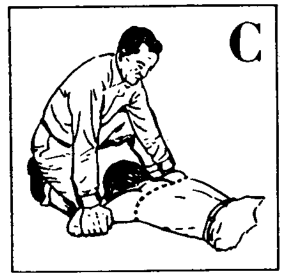
1. PROTEJASE con material aislante seco.
2. CORTE EL CIRCUITO abriendo el interruptor o separando a las víctima del conductor "vivo". NO LA TOQUE CON LAS MANOS DESNUDAS hasta que no se haya cortado el circuito.
3. APLIQUELE RESPIRACION ARTIFICIAL IMMEDIATAMENTE, LOS SEGUNDOS CUENTAN. No se demore buscando ayuda o aflojando la ropa, abrigando o aplicando estimulantes a la víctima.

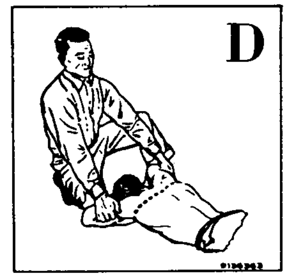


4. COLOQUE LA VICTIMA BOCA ABAJO, preferiblemente con la cabeza más baja que los pies.
5. QUITELE TODA OBSTRUCCION o cuerpo extraño de la boca, tírele la lengua hacia afuera.
6. COLOQUELE LA FRENTE sobre las manos cruzadas.
7. APOYESE SOBRE UNA RODILLA frente a la cabeza de la víctima (ver la figura A).
8. COLOQUELE LAS PALMAS DE LAS MANOS sobre la espalda, a la altura de la línea de las axilas, con los dedos separados y los pulgares cinco centímetros de distancia entre sí (ver la figura A).
9. EXTIENDA LOS BRAZOS Y MUEVA EL CUERPO LENTAMENTE HACIA ADELANTE, hasta que queden los brazos verticales (ver la figura B). No ejerza presión superior a 35 libras (15 kilogramos).
10. MUEVA EL CUERPO LENTAMENTE HACIA ATRAS, para aflojar la presión.
11. TOME LOS BRAZOS DE LA VICTIMA por encima de los codos y continúe el movimiento hacia atrás (ver la figura C).
12. LEVANTE LOS BRAZOS DE LA VICTIMA hasta que se sienta tensión (ver la figura D).
13. BAJELE LOS BRAZOS, para completar el ciclo.
14. DESPUES DE DOS SEGUNDOS, COMIENCE NUEVAMENTE con el paso 6.
15. REPITA EL CICLO 12 ó 15 veces por minuto.
16. MIENTRAS CONTINUA CON LA RESPIRACION ARTIFICIAL PIDA A ALGUIEN QUE:
    a) Afloje la ropa de la víctima
    b) Llame a un médico
    c) Conserve a la víctima abrigada
17. PERSISTA. Continúe sin interrupción hasta que la víctima respire espontáneamente, o hasta que se constate que ha muerto. A veces pueden necesitarse hasta cuatro horas, o más, para revivir a un electrocutado.
18. PERMANEZCA EN POSICION aún después de revivida la víctima. Esté listo para reanudar la respiración artificial si fuera necesario.
19. NO SUMINISTRE LIQUIDOS A LA VICTIMA MIENTRAS ESTE INCONSCIENTE.

SOINS DE PREMIERE URGENCE EN CAS D'ELECTROCUTION

1. SE PROTEGER au moyen d'une matière isolante sèche.
2. COUPER LE COURANT, soit en ouvrant l'interrupteur, soit en dégageant le sujet du conducteur en charge. NE PAS TOUCHER LE SUJET AVEC LES MAINS NUES tant que le courant n'est pas coupé.
3. PRATIQUER IMMEDIATEMENT LA RESPIRATION ARTIFICIELLE, LES SECONDES COMPTENT. Commencer aussitôt, avant même de chercher de l'aide, avant de desserrer les vêtements du sujet, de le réchauffer ou de lui administrer des stimulants.





4. COUCHER LE SUJET A PLAT VENTRE, de préférence avec la tête plus basse que les pieds.
5. DEGAGER LA BOUCHE DE TOUTE OBSTRUCTION ou de tous corps étrangers; tirer la langue vers l'avant.
6. PLACER LE FRONT DU SUJET sur ses mains croisées.
7. S'AGENOUILLER A LA TETE DU SUJET, sur l'un des deux genoux. (Voir A.)
8. POSER LES MAINS, les paumes en dessous de la ligne des aisselles, les doigts écartés et les pouces à cinq centimètres environ l'un de l'autre. (Voir A.)
9. LES BRAS TENDUS, PIVOTER lentement EN AVANT jusqu'à ce que les bras soient à la verticale. (Voir B.) Ne pas exercer une pression de plus de 15 kg.
10. REVENIR LENTEMENT EN ARRIERE pour relâcher la pression.
11. SAISIR LES BRAS DU SUJET juste au dessus des coudes et continuer le mouvement en arrière. (Voir C.)
12. SOULEVER LES BRAS jusqu'à ce qu'une tension se manifeste. (Voir D.)
13. ABAISSER LES BRAS pour compléter le cycle.
14. APRES UNE PAUSE DE DEUX SECONDES, RECOMMENCER comme décrit à l'alinéa 6.
15. RECOMMENCER à raison de 12 à 15 cycles par minute.
16. PENDANT QUE LA RESPIRATION ARTIFICIELLE CONTINUE, DEMANDER A UN AIDE:
    a) De desserrer les vêtements du sujet,
    b) D'appeler un médecin,
    c) De réchauffer le sujet.
17. NE PAS PERDRE COURAGE. Continuer sans interruption jusqu'à ce que le sujet respire sans aide ou que la mort soit constatée.
    Il peut être nécessaire de continuer la respiration artificielle pendant quatre heures ou plus.
18. RESTER EN POSITION après réanimation, afin d'être prêt à reprendre la respiration artificielle en cas de nécessité.
19. N'ADMINISTRER AUCUN LIQUIDE PENDANT QUE LE SUJET EST INCONSCIENT.

TABLE OF CONTENTS

TABLE OF CONTENTS (C ntinued)

LIST OF TABLES

LIST OF ILLUSTRATIONS

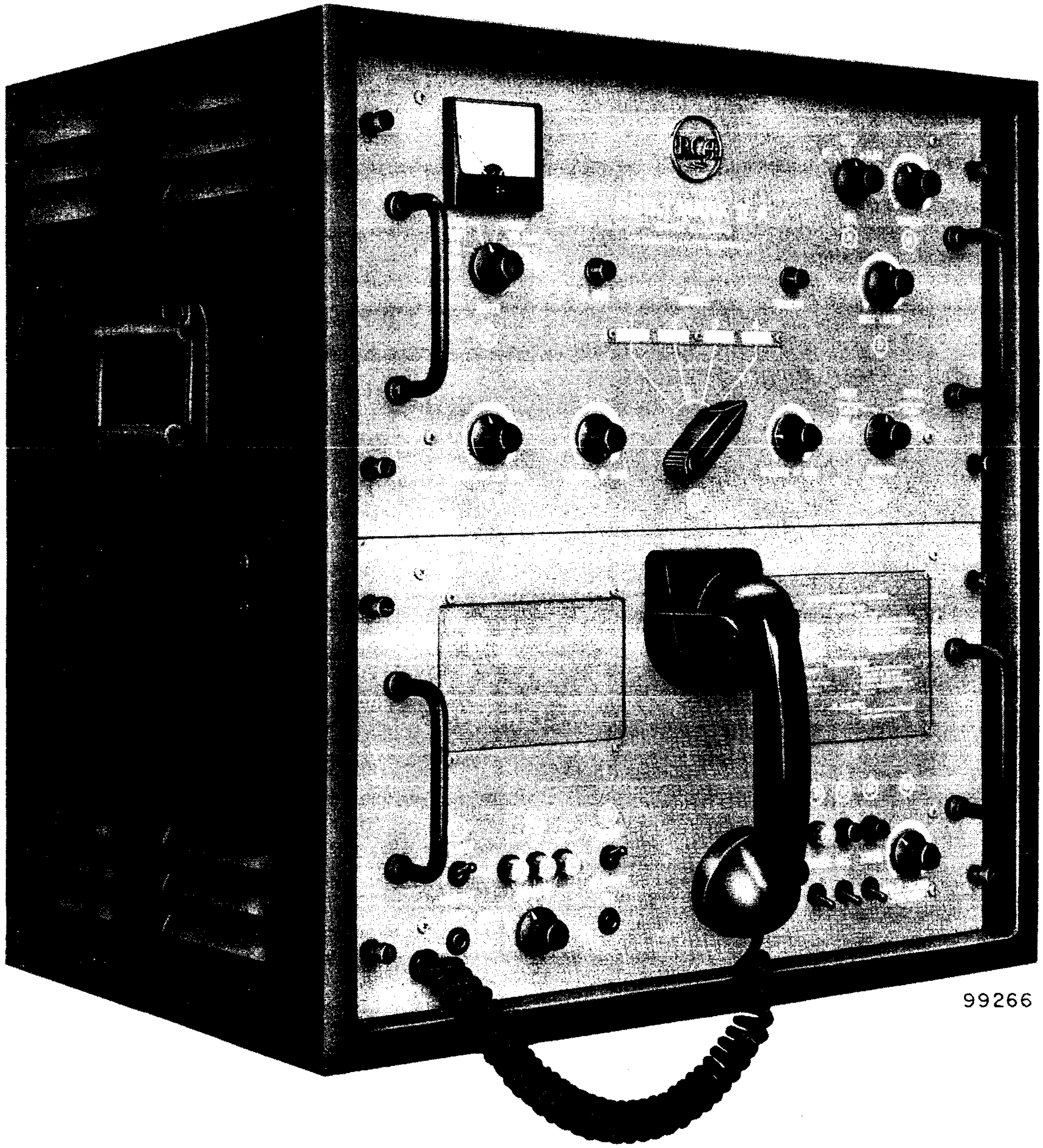


Figure 1. RCA SSB-1 Mark IIA Singl Sideband Communication Equipment

SINGLE SIDEBAND RADIO COMMUNICATION EQUIPMENT
RCA Type SSB-1 Mark IIA MI-555480
SECTION I. GENERAL DESCRIPTION
TECHNICAL SUMMARY

General

Channels .... Four
Type of Operation .... Simplex
("Push-to-Talk" or "Voice Control" Telephone, or Telegraph)
Frequency Range:
Channels 1 and 2 .... 3.0–6.7 mc
Channels 3 and 4 .... 6.7–15.0 mc
Antenna Required .... Resistance: 10–80 ohms
Capacitance: 200 uuf (min.) Single wire, not to exceed 1/4 wavelength at highest channel frequency.
Coaxial Termination .... 50–75 ohms
Crystals Required .... 1–250 kc*
Type CR-46/U*; 1—1150 kc Type CR-27/U*; 1—1650 kc Type CR-27/U*; 4—Type CR-27/U (one per channel) 4400 kc to 16400 kc‡.

NOTE: Channel crystals must be 1400 kc higher in frequency than the desired operating frequency. The same crystal serves both transmitter and receiver.

* These crystals are supplied with the equipment.

‡ These crystals are not supplied with the equipment and must be ordered separately. Specify operating frequencies when ordering.

Emission

Phone .... Single Sideband Suppressed Carrier; Single Sideband Full Carrier (Upper or Lower Sideband)
Telegraph .... A1, Single Sideband Keyed Tone, Audio Frequency Shift Teleprinter
Keying Speed .... 30 Words Per Minute—manual (break-in) operation; 60 Words Per Minute—teleprinter operation

Transmitter

Power Output .... 100 watts
Frequency Stability .... ±0.0002%
Transmitted Sideband .... Selective, Upper or Lower
Unwanted Sideband Suppression .... −50 db min.
Carrier Suppression .... −50 db min.
Harmonic Suppression .... −50 db min.
Audio Input:
a. Single Button Carbon Microphone from Local Handset or from up to 3 Remote Positions.
b. −6 dbm in 600 ohm Line for Full Transmitter Output.
Audio Fidelity .... ±2 db, 300–3000 cps
Amount of Speech Clipping .... 20 db
Transmitted Sideband Distortion .... Single tone, full power output, no clipping, 2.5% at 1000 cps
Tow-Tone Test:
3rd Order Distortion Products .... −30 db min.
Voice Controlled Transmission

Receiver

Sensitivity .... Better than 1 microvolt for 50 milliwatts output for 6 db signal-to-noise ratio.
Selectivity .... Determined by mechanical filter characteristics: 3.25 kc nominal bandwidth for 6 db attenuation; 6.5 kc bandwidth max. for 60 db atten.
Audio Fidelity .... ±3 db, 300–3000 cps
Audio Output .... a. 1 watt maximum in speaker
b. 0.5 watt maximum in 600 ohm line
Audio Distortion .... 2.5% (1000 cps at 50 milliwatts output)
Automatic Gain Control .... Selective—Off/Fast/Slow (delay)
Noise Limiter .... Adjustable
Squelch .... Adjustable
Image Rejection .... −50 db min.
Test Meter .... IPA Grid Drive, PA Plate Current, High Voltage, Low Voltage (Receiver and Transmitter)
Power Requirements .... 115/230 volts ±10%, 50/60 cycles, single phase
Power Load:
Standby .... 35 watts
Receiver .... 135 watts
Receiver and Transmitter:
No signal, Power on .... 255 watts
Full output .... 430 watts

TECHNICAL SUMMARY (C ntinued)

Fus s

1—Type 3AG	4 amp. 125 v
1—Type 3AG	2 amp. 125 v, time lag
1—Type 3AG	1.5 amp. 125 v, time lag
1—Type 3AG	0.5 amp. 250 v
1—Type 3AG	0.25 amp. 250 v

Lamps

8	Neon Glow Lamp—0.04 watts

Germanium Diodes

3	RCA type 1N34A

Tube Complement

Power Supply:

1V1	RCA 5R4GY	+750 v Full Wave Rectifier
1V2	RCA 5R4GY	+750 v Full Wave Rectifier
1V3	RCA 5R4GY	+200 v Full Wave Rectifier
1V4	RCA OA3/VR75	−75 v Bias Regulator
1V5	RCA OD3/VR150	+150 v Regulator
1V6	RCA 12AT7	Tone Oscillator
1V7	RCA 12AT7	Cathode Follower/Mike Amplifier
1V8	RCA 6AK6	Receiver AF Output Amplifier
1V9	RCA 6AK6	Line AF Output Amplifier

Transmitter-Receiver:

2V1	RCA 6146	Power Amplifier
2V2	RCA 6146	Power Amplifier
2V3	RCA 6BA6	Modulation Indicator Amplifier
2V4	RCA 6CL6	Intermediate Power Amplifier
2V5	RCA 12AT7	3rd Balanced Amplifier
2V6	RCA 12AT7	2nd Balanced Amplifier
2V7	RCA 12AT7	1st Balanced Amplifier
2V8	RCA 6CL6	4.4 mc–16.4 mc Crystal Oscillator
2V9	RCA 6BE6	1650/1150 kc Crystal Oscillator
2V10	RCA 6BE6	250 kc Crystal Oscillator
2V11	RCA 6BA6	RF Amplifier
2V12	RCA 6BE6	1st Mixer
2V13	RCA 6BE6	2nd Mixer
2V14	RCA 6BA6	1st IF Amplifier
2V15	RCA 6BA6	AGC Amplifier
2V16	RCA 6BA6	2nd IF Amplifier
2V17	RCA 6AL5	Demodulator/AGC Noise Limiter
2V18	RCA 6AL5	AGC Diode/Squelch Diode
2V19	RCA 12AX7	AF Amplifier/Squelch Triode
2V20	RCA 6AL5	Noise Limiter Diode

Speech Clipper/Voice Control:

3V1	RCA 6U8	AF Amplifier/Cathode Follower
3V2	RCA 6AL5	Diode Clipper
3V3	RCA 12AT7	AF Amplifier/Rectifier
3V4	RCA 12AU7	DC Amplifier/Relay Amplifier

Mechanical

Height	23″
Width	23⅜″
Depth	19″
Weight	155 lbs.

Equipm nt Supplied

SSB-1 Mark IIA complete with operating tubes, and Instruction Book.

TECHNICAL SUMMARY (C ntinued)

Access ry Equipment Available on Special Order

Remote Desk Set	MI-555474
AAT-100 Automatic Antenna Tuner	MI-22774
Spare Parts Kit	MI-555475
Interlock Modification Kit	MI-555473
Selective Ringer	MI-555047-A
Selective Caller	MI-625993

Shipping Information

Net Weight	155 lbs.—70.45 kilos.
Legal Weight	166 lbs.—75.45 kilos.
Gross Weight, Carton Packed	181.0 lbs.—82.27 kilos.
Gross Cube, Carton Packed	10.1 cu. ft.
Gross Weight, Overpacked	220 lbs.—100 kilos.
Gross Cube, Overpacked	14 cu. ft.

NOTE: Carton packing is standard waterproof tri-wall pack suitable for air and most export shipment. Overpack includes wooden case, if desired for under deck shipment.

INTRODUCTION

The RCA Type SSB-1 Mark IIA 100 watt Single Sideband Transmitter-Receiver is two-way radio-communication equipment designed for operation on any of four preselected frequencies between 3 and 15 megacycles. It permits maximum utilization of the congested high frequency spectrum using a nominal bandwidth of 3 kc. Small, compact and easy to install, the SSB-1 Mark IIA is more efficient, more economical to operate than AM equipment of equal effectiveness.

The 100 watt peak envelope power output of the Mark IIA and its highly selective, sensitive receiver, meet the needs of communication services which require more than moderate power and yet must retain simplicity of operation.

The flexibility of the Mark IIA equipment permits its use in services such as simplex telephone systems; simplex telegraph or teleprinter systems; duplex telephone systems; duplex telegraph or teleprinter systems; and compatible operation with conventional double sideband AM systems. Four preselected frequencies in the 3 to 15 megacycle range of the equipment, with optional upper or lower sideband operation at each frequency (with or without carrier), provide a total of 8 usable channels.

Any number of stations may operate on one working frequency or network by sharing time. Transmitting and receiving are on the same frequency, the transmitter working only when the "press-to-talk" button on the handset is operated or automatically by speaking into the handset when "Voice Control" operation is desired. When the button is not pressed, the receiver is ready to receive any other station that may want to talk. Four available frequencies permit any station to be used on several networks, possibly using different frequencies for day and night operation.

Outstanding frequency stability ($\pm 0.0002\%$) is achieved by the use of 1° centigrade crystal ovens for the high frequency crystals and source regulation of the plate voltage for the crystal-controlled frequency determining oscillator.

Ease of operation is assured by placing all operating controls and indicators on the front panel of the unit. Each control is coded to correspond with an operating instruction chart on the front panel. This simple approach assures correct and efficient operation of the Mark IIA by non-technical personnel.

The SSB-1 Mark IIA can be used for teleprinter operation. The keyed tone output of the receiver is fed to external tone-signal conversion equipment which in turn feeds direct current to the teleprinter. "On-line" two-way teleprinter operation can be used through the Mark IIA by simply adding the necessary teleprinting equipment and accessories. The teleprinter itself does the switching, from transmit to receive, automatically.

Provisions are incorporated for operation of the Mark IIA from any one of three remote telephone-type desk sets. The unit may be keyed from any of these remote locations by push-to-talk, or voice keying. In addition, full signalling and intercom facilities are incorporated to permit the local operator to call and talk to any of the remote sites without transmitting the conversation. The remote desk sets (when used) are connected by a 7 wire cable (not supplied) to terminals accessible through the back of the cabinet.

A speech clipper/voice control unit is supplied as standard equipment. During transmission, the speech clipper limits high-level audio signals, thus permitting a higher average transmitted speech power. Voice control allows automatic control (keying) of the transmitter; that is, when speaking into the handset, the transmitter is automatically turned on and kept on while the speaking continues. When the speaking ends the unit restores itself to the receive condition.

Other features include: a built-in speech clipper, providing 20 db of clipping; AGC in the receiver to keep the output at a constant level; an adjustable squelch circuit to permit noiseless stand-by operation; an adjustable noise limiter for suppression of extraneous impulse noise; separate RF and AF gain controls for optimum flexibility in obtaining the best signal to noise ratio; and two separate audio outputs, one of which is terminated for direct connection to a standard 600 ohm line.

The control circuits include: remote channel indication or operation of accessory units; a front panel meter for monitoring various voltages and currents and to indicate level of modulation, and provisions for selective ringing.

The SSB-1 Mark IIA is contained in a single cabinet 22⅜ inches wide and 19 inches deep. It consists of two units: the transmitter/receiver, constructed on a single chassis occupying the upper half of the cabinet; and a power supply unit, including audio and control circuits, which provides all operating and control voltages direct from the power mains, in the lower section of the cabinet.

The equipment operates from either a 115 volt or a 230 volt, 50 to 60 cycle single phase power source and requires approximately 430 watts for full power output.

The receiver stability is controlled by close tolerance crystal oscillators, thereby providing distortion-free reception without a "speech clarifier" or fine tuning control being necessary.

Selective sideband (with or without carrier) is provided for in the transmitter-receiver. With this feature, it is possible to have two networks on the same frequency, one using upper sideband and the other using lower sideband. Both networks may operate simultaneously without interference with each other. An SSB-1 Mark IIA can also be operated in any standard AM system by setting the Sideband switch to the Full Carrier position.

Basic Principles of Single Sideband Suppressed Carrier Communicati n

In a conventional amplitude-modulated transmitter the radiated signal includes a carrier, an upper sideband and a lower sideband. All of the intelligence is contained in the sidebands; none in the carrier. The carrier is transmitted primarily for use at the receiver for demodulation and automatic gain control.

If a carrier of the proper frequency is generated at the receiver and inserted at the demodulator in the receiver, no carrier need be transmitted. Furthermore, since both sidebands contain the same information it is redundant and wasteful to transmit two identical channels when one alone is sufficient. Only one sideband need be transmitted to convey all of the useful information.

A conventional amplitude-modulated transmitter, modulated 100%, uses approximately 50% of the output power in the carrier and the remaining 50% of the output power divided equally between the two sidebands. Thus, since the usable information is in just one sideband, only 25% of the available power is used to convey the information. In addition, the spectrum space occupied is twice as much as is necessary.

For example: to transmit a 3 kc. audio signal with a sideband power of 100 watts would require a 6 kc. bandwidth and a 400-watt AM transmitter. Figure 2 compares the power output of a conventional AM transmitter rated at 100 watts, and the power output of a single sideband suppressed carrier transmitter rated at 100 watts peak envelope power.

The RCA single sideband suppressed carrier transmitter eliminates the carrier and one sideband, thus requiring only one-half the spectrum space of the AM transmitter. To transmit a 3 kc. audio signal, only a 3 kc. bandwidth is required.

In receiving a single sideband suppressed carrier signal, since only half the AM signal bandwidth is required, noise is reduced by one-half (3 db.), and interference within the range of the eliminated sideband is also eliminated. The probability of random interference in the desired sideband is also reduced by one-half.

Since all the power is transmitted in one sideband, a power gain of 4 (6 db.) results for the wanted sideband. Including the 3 db. of noise elimination

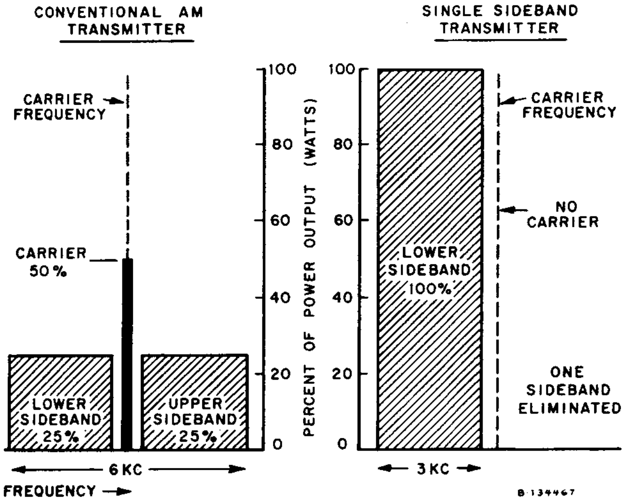


Figure 2. Comparison of AM and SSB Relative Power Output

due to reducing the receiver bandwidth requirement by one-half, a system improvement in signal-to-noise ratio of 9 db. is realized. Thus, the SSB system compared with an AM system of the same rating as shown in figure 2 represents a power advantage of 8. In addition, speech clipping in the single sideband transmitter adds to the effective power gain. It can be stated then, that a single sideband suppressed carrier transmitter having a peak envelope power of 100 watts, is equivalent in effectiveness to an AM system using a transmitted power of 800 watts.

Generating a Single Sideband Signal

A single sideband signal can be produced by introducing low-level audio and a low-frequency R-F signal into a balanced modulator circuit. However, when such a single sideband signal is generated at a low frequency, frequency multiplying circuits are not used to raise the signal to the desired transmission frequency because the original modulation would not be preserved. As a result heterodyning (the mixing of two or more frequencies to produce a third frequency), must be used to raise the low-level, low-frequency signal to the desired output frequency.

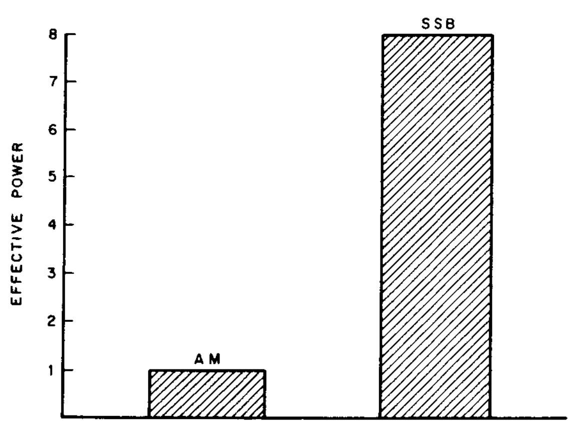


Figure 3. AM vs. SSB Syst m Effective P wer Output

When a low frequency R-F carrier voltage (f_o) and an audio frequency voltage (f_a) are properly combined in a balanced modulator, as shown in figure 4, the output contains frequency components which include the sum of the two original frequencies ($f_o + f_a$) and the difference between the two original frequencies ($f_o - f_a$). The pure carrier (f_o) is cancelled and does not appear as such in the output circuit.

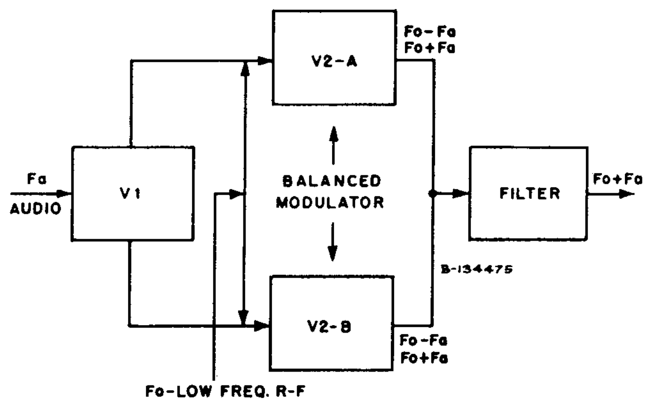


Figure 4. Generating a Single Sideband Suppressed Carrier Signal

After mixing, either the sum (upper sideband, $f_o + f_a$), or the difference (lower sideband, $f_o - f_a$) component can be extracted from the composite signal by using suitable filters which pass the desired sideband and eliminate the other.

After this sideband selection, an additional series of balanced modulators and heterodyning oscillators repeat the above process until the signal has been heterodyned up to the output frequency desired.

Advantages of SSB Suppressed Carrier Communication

RCA single sideband suppressed carrier communication is superior to conventional amplitude-modulated communication in several respects:

(a) The radio-frequency spectrum is more efficiently utilized because a reduced carrier and a single sideband are transmitted in one-half the bandwidth required by the carrier and both sidebands of conventional AM equipment; the required bandwidth is even less when the carrier is completely suppressed and only a single sideband is transmitted.

(b) The power required to transmit a single sideband signal is only about one-eighth of the power required to transmit a conventional AM signal of equivalent system effectiveness. In addition, power is radiated only when modulation is present. This greatly decreases average power drain.

(c) The narrower bandwidths of SSB transmission and reception provide a 3 db improvement in signal-to-noise ratio and minimize the possibilities of interference. The effects of selective fading and phase distortion are also greatly reduced.

(d) Reception is improved by the reduction of steady heterodyne beats from adjacent stations. These heterodyne whistles are most prevalent on AM transmissions as a result of carrier interference.

(e) A greater degree of privacy is inherent with SSB since ordinary home-type short wave receivers capable of receiving conventional AM do not respond to SSB.

SECTION II. CIRCUIT DESCRIPTION

1. GENERAL

When a single-sideband signal is generated at a low frequency, frequency multiplying circuits cannot be used to raise the signal to the desired frequency of transmission; they would not preserve the original modulation. Heterodyning or frequency mixing, methods are used instead.

When two frequencies are mixed together, the resultant output contains a frequency component which is the sum of the original two frequencies (upper sideband) and a component which is the difference of the original two frequencies (lower sideband). Either the sum or the difference component can be extracted from the composite signal by using suitable filters.

The SSB-1 Mark IIA uses three crystal oscillators to heterodyne the original modulating signal up to the transmitter output frequency. The same three oscillators operate with the receiving circuits to heterodyne the received RF down to the original modulating signal. By the use of conventional balanced modulators in the heterodyning process, the crystal oscillator frequencies, and hence, the carrier frequency also, are suppressed.

2. SUPPRESSED CARRIER TRANSMISSION

The intelligence to be transmitted may be either a voice or telegraph signal. A voice signal would be applied from the microphone to the microphone amplifier; a telegraph signal is applied by keying the tone oscillator which feeds the microphone amplifier.

In the discussion which follows, it will be assumed that the modulating signal is a 1 kc tone from the tone oscillator, with the understanding that the discussion is equally valid for a voice signal. Refer to the block diagram, Figure 5.

a. The tone oscillator, 1V6A, (one half of a type 12AT7 dual triode) is a phaseshift oscillator operating at 1000 cps. One contact of keying relay 1K1, in the cathode circuit of 1V6A keys the oscillator. When 1K1 is energized by pressing the telegraph key, another contact of the relay energizes the transmit-receive relay, 2K1, which connect the antenna to the transmitter. Relay 2K1 is held energized (transmit position) by a resistance-capacitance delay circuit bridging the "key-off" time as long as normal keying is continued. This keying system provides "break-in" type switching between receiver and transmitter on telegraph operation, and thus requires no manual switching.

b. Audio output from the keyed tone oscillator or voice current from the microphone of handset 1HS1 (with "push-to-talk" button depressed) is fed to the microphone amplifier which consists of two stages, an AF voltage amplifier, 1V6B, (one half of a 12AT7 dual triode) and a cathode follower, 1V7A, (also one half of a 12AT7 tube).

c. Assume that a 1 kc test tone is applied either through the microphone of handset 1HS1 or by the tone oscillator through the microphone amplifier to the speech clipper. The speech clipper is a plug-in unit consisting of an AF amplifier, 3V1A (the pentode section of a 6U8A triode-pentode) a clipper tube, 3V2, (a 6AL5 dual-diode) and a cathode follower, 3V1B, (the triode section of the 6U8A). The speech clipper limits the peaks of a varying amplitude voice signal so that the average intelligence signal level can be kept high. When a tone is applied the speech clipper functions only as a buffer amplifier.

d. The 1 kc tone is applied to the grids of 2V7 (a 12AT7 dual-triode), the first balanced modulator stage in opposite phase through AF transformer 2T2

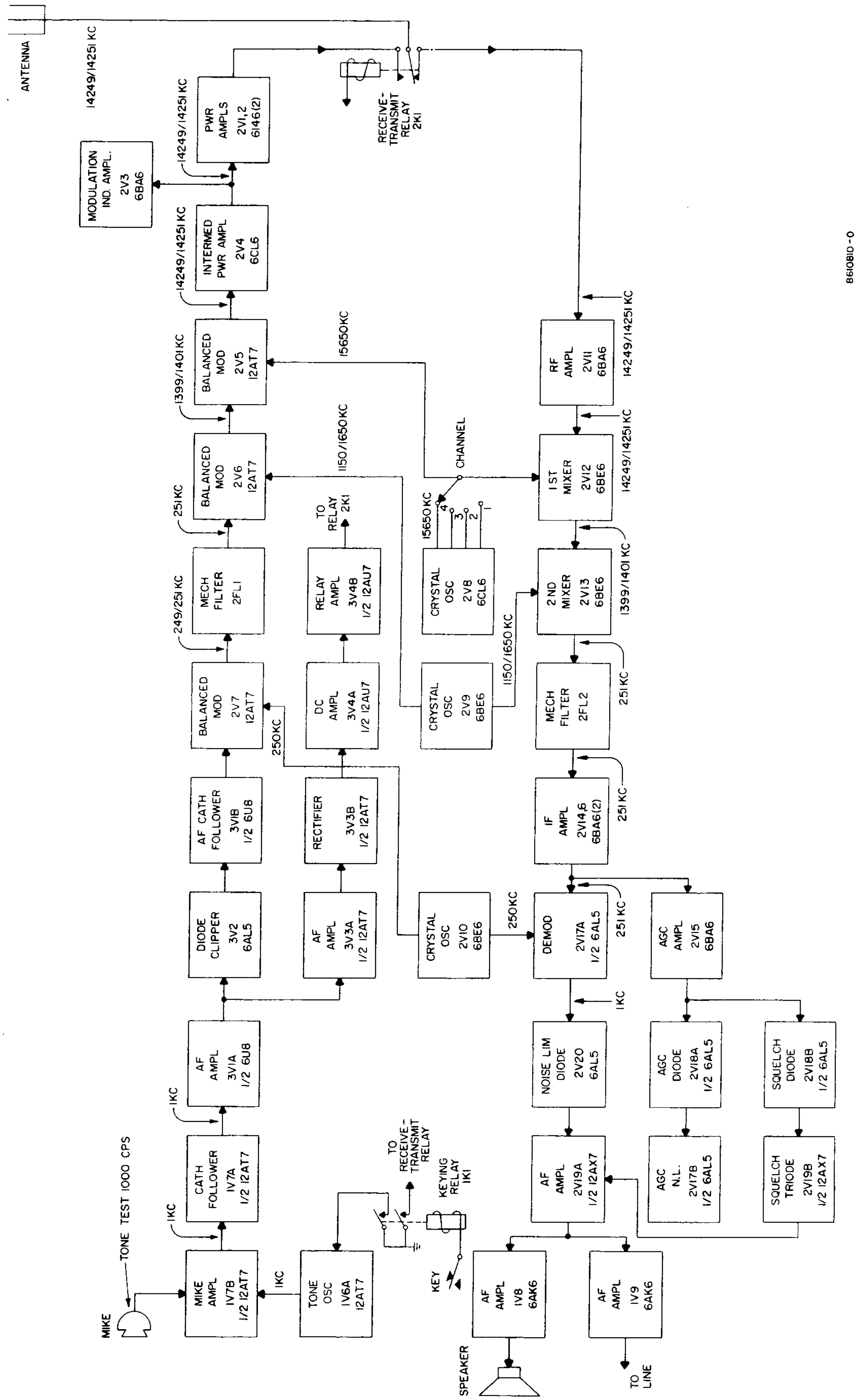


Figure 5. SSB-1 Mark IIA Transmitt r-R c iv r, Bl ck Diagram

and TRANSMITTER GAIN control 2R36A and B (a dual potentiometer with sections in series and center grounded). At the same time a 250 kc signal is fed from crystal oscillator 2V10 to both 2V7 grids in phase. These phase relationships result in the 250 kc signal cancelling out in the series-connected output of the circuit and the generation of the sum and difference frequencies, 251 kc and 249 kc. Potentiometer 2R27 and trimmer capacitor 2C43 are adjusted to balance the output circuit of 2V7 to achieve a high order of cancellation of the 250 kc signal.

e. The resultant 249 and 251 kc signals are applied to a mechanical filter, 2FL1, an electro-mechanical filter designed to pass a band of frequencies in the 250 kc range with excellent rejection of frequencies outside of the desired pass-band. The filter contains a special nickel-alloy rod resonant in the 250 kc range. Accurately processed ferrite rods and electrical coils are attached to both ends of the resonator to couple and transform electrical energy into mechanical energy. The entire assembly, shown in Figure 6, weighs only seven ounces and is housed in a metal case filled with an inert gas and hermetically sealed. No adjustments are required in the filter unit.

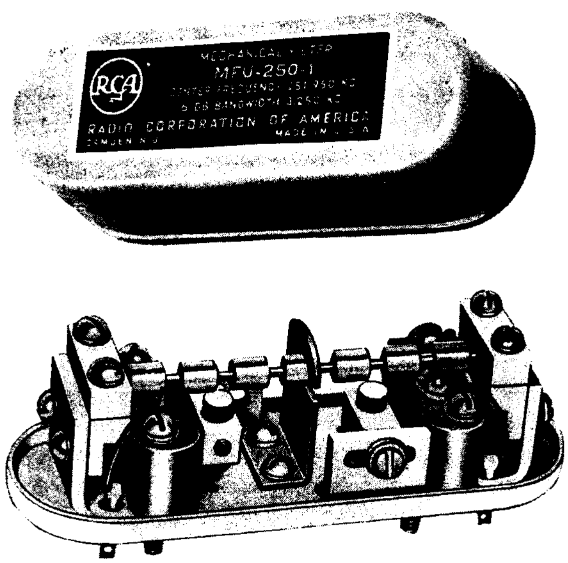


Figure 6. RCA Type MFU-250-1 Mechanical Filter Unit

The materials used for the metal resonator and ferrite rods are carefully selected and processed to produce filter elements that will have little frequency variation with temperature change. To achieve the excellent bandpass characteristics of this filter, such resonators and couples require exacting workmanship. The degree of selectivity of the filter is dependent proportionately upon the number of tuned elements of the resonator, while the width of the passband is a design function of the mechanical coupler between the tuned elements.

The response of the RCA type MFU-250-1 filter used in this equipment is shown in Figure 7.

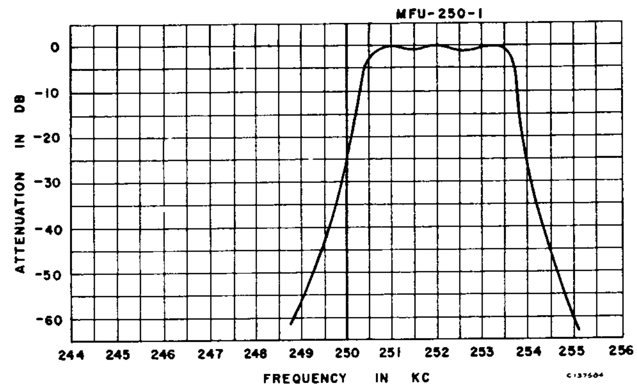


Figure 7. Response of Mechanical Filter 2FL1

It can be seen from the graph that all frequencies outside the passband of the 250 kc filter are rejected, while the frequencies inside this passband are limited to a bandwidth of approximately 3.25 kc at the 6 db points. The filter rejects the 249 kc lower sideband and passes only the 251 kc upper sideband information.

At this point in the transmitter (the output terminals of 2FL1) the single sideband signal is present for the first time. The succeeding stages of the transmitter heterodyne this signal to the desired output frequency and amplify it to the desired power level.

f. The 251 kc signal (upper sideband) is then applied in opposite phase to the grids of the 2nd balanced modulator, 2V6, (another 12AT7 dual-triode) along with the application, in parallel, of a 1150 kc signal from crystal oscillator 2V9. This second balanced modulator operates in a manner similar to the first one, eliminating the 1150 kc and generating sum and difference frequencies of 1401 kc and 899 kc. These two frequencies are applied to tuned RF transformer 2T1 which passes the 1401 kc signal but eliminates the 899 kc. Output circuit balance is achieved by the use of 2R16 and 2C34.

g. The 1401 kc (upper sideband) signal is then applied to the 3rd balanced modulator, 2V5 (another 12AT7) along with the output of crystal oscillator 2V8, the frequency of which depends upon the channel crystal selected. Assume that the highest frequency channel is being used and that its crystal produces an output of 15,650 kc (for a nominal carrier frequency of 14,250 kc). The 1401 kc and 15,650 kc signals, mixed in the balanced modulator, produce sideband frequencies of 17,051 and 14,249 kc, the 15,650 kc signal being balanced out in the same manner as explained for the previous balanced modulators. Pretuned inductance and capacitance circuits, selected by sections of the CHANNEL switch, 2S1, pass the lower sideband signal, 14,249 kc, but eliminate the 17,051 kc.

h. The single sideband signal (14249 kc) is then fed through the intermediate power amplifier and power amplifier stages at output frequency. The IPA stage, 2V4, uses a 6CL6 pentode in a conventional Class A power amplifier circuit having a pretuned inductance-capacitance network in the plate circuit as selected by sections of the CHANNEL switch, 2S1. The signal is then applied to the grids of the power amplifier, 2V1 and 2V2 (type 6146 tetrodes in parallel) in a Class AB_1 linear-amplifier circuit. The plate circuit of the parallel power amplifiers is inductance-capacitance pretuned to the output frequency using tapped coil 2L2 and variable capacitors as selected by the CHANNEL switch, 2S1. The output signal is fed through a contact of the antenna transfer relay, 2K1, and antenna loading coil 2L1 to the antenna terminal, 2E4.

i. The modulator indicator amplifier 2V3, (a 6BA6 pentode operating off the grid circuit of the power amplifiers) with PA Grid indicator 2DS1 lamp in its plate circuit, gives a flash indication on the lamp when the plate current of 2V3 increases due to modulation peaks. This occurs just below the point where the power amplifier grids go positive. Necessary adjustment is made using TRANSMITTER GAIN control 2R36 (see paragraph d above).

j. The three crystal oscillator; 250 kc, 1150/1650 kc and the four-channel oscillator, are of the electron-coupled type with crystals connected between screen and grid, output being taken from the plate circuit. Each oscillator supplies mixing frequency for both the transmitter balanced modulator and the receiver mixer stages. All crystals, except the 250 kc crystal, are mounted in dual crystal ovens of the plug-in type. The oven heaters are fed 6.3 v ac from transformer 1T4.

The 250 kc oscillator, 2V10, uses a 6BE6 pentagrid tube and the 250 kc crystal, 2Y7, is mounted in socket 2XY7.

The 1150/1650 kc oscillator, 2V9, also uses a 6BE6 pentagrid tube and the 1150 kc crystal (2Y5) is mounted in oven 2E3 as is the 1650 K crystal (2Y6).

The channel frequency oscillator (2V8) uses a 6CL6 power pentode and any one of four crystals (2Y1 to 2Y4) as selected by CHANNEL selector 2S1. Diodes 2CR1 and 2CR2 keep the output voltage of 2V8 at a constant amplitude over the entire frequency range.

3. TRANSMISSION WITH CARRIER

When it is desired to radiate the carrier as well as one sideband, the sideband switch, 2S4 is turned to Full Carrier. This reinserts the 250 kc carrier signal after filter 2FL1 at the input of the second balanced modulator, 2V6, along with the 251 kc sideband signal passed by the filter. Both of these signals are then heterodyned up to the final output frequency, maintaining the frequency difference between the carrier and sideband the same as in the original signal. Again assume an output of 15,650 kc from the channel crystal oscillator (2V8). The radiated signal would then be composed of a 14,250 kc carrier and the lower sideband (14,249 kc) produced by the 1 kc tone. This composite signal can be detected by any standard AM receiver which can be tuned to this frequency.

4. RECEPTION

Single sideband suppressed carrier reception requires techniques somewhat different from conventional AM methods.

One of the foremost considerations is that of extreme selectivity since only one sideband at any given carrier frequency is processed to extract the transmitted intelligence.

In developing a single sideband suppressed carrier signal for transmission, the original modulating frequency must be raised to the desired output frequency by the process of heterodyning. (Frequency multiplying circuits are not used because they would destroy the original modulation.)

In heterodyning, signal mixing in a properly designed circuit produces the desired modulation by the sum and difference method. If two signals are introduced into such a mixing circuit, the output of the circuit contains both the sum of and the difference between the two signals. As an example: If a 100 kc signal and a 1000 kc signal were introduced into a mixer dircuit, the output would include signals at 900 kc (the *difference* between 1000 kc and 100 kc) and 1100 kc (the *sum* of 1000 kc and 100 kc).

If the output of this mixer is fed through sharp bandpass filters, constructed with the proper circuit constants, either the sum or the difference signal can be selected or rejected. This is possible because these tuned circuits are normally sensitive to only a restricted range of frequencies. Using these filters in the low frequency circuits rather than at the high frequencies is more practical because at the higher frequencies circuit components become extremely critical and comparatively unstable. It is therefore more difficult to obtain sharp selectivity at high frequencies. Conversely, at the lower frequencies (below 300 kc) it becomes practical to employ extremely sharp filters. In fact, the sideband filter used in the Mark IIA (designed to 250 kc) has a bandpass characteristic which accepts signals over a range of only 3.25 kc and rejects any signals outside of this 3.25 kc passband.

Since the single sideband suppressed carrier signal is developed by heterodyning the signal upward to the frequency of transmission, in the receiver, this process must be reversed and the received signal heterodyned *downwards*. When heterodyning "down" it is always necessary to process the difference signals in order to obtain the original low modulating frequencies.

Essentially then, the Mark IIA receiver heterodynes the received signals down to 250 kc where a mechanically resonant tuned circuit (the bandpass filter) processes the resultant signal to remove all but the desired sideband.

a. The operation of the receiving section is essentially the reverse of the transmitter operation. Again assume that the intelligence signal is a 1 kc tone and that the frequency of the crystal oscillator 2V8 is 15,650 kc. The frequency of the received single sideband signal would therefore be 14,249 kc (15,650 kc minus 1400 kc minus 1 kc), the same as for the transmitter as explained above.

b. The signal (14,249 kc) from the antenna is fed through a contact of antenna-transfer relay 2K1 and the tuned rf transformer, as selected by CHANNEL switch 2S1 for the proper channel, to the RF amplifier (2V11, a 6BA6 pentode) where it is amplified and fed to the first mixer, tuned by the proper rf inductor selected by the CHANNEL switch. RECEIVER RF GAIN control 2R68 controls the bias on the 1st mixer tube and the 2nd mixer tube, thus controlling the gain of the receiver.

c. In the first mixer (2V12, a 6BE6 pentagrid converter), the single sideband signal (14,249 kc) is mixed with the channel crystal frequency (15,650 kc) from the crystal oscillator 2V8 with the CHANNEL switch (2S1) selecting the proper crystal. The output of 2V12 thus contains the sum and difference frequency components (28,899 kc and 1401 kc respectively). IF interstage transformer 2T3, peaked at 1400 kc, passes the 1401 kc but rejects the 28,899 kc signal.

d. The resultant signal (1401 kc) is fed into the second mixer (2V13, another 6BE6 converter) where it is mixed with the 1150 kc output of crystal oscillator 2V9 to produce sum and difference frequencies, (2551 kc and 251 kc). The resultant signals are fed to mechanical filter 2FL2, peaked for the upper sideband and identical to 2FL1 used in the transmitter. The difference frequency (251 kc) is passed but the sum frequency (2551 kc) is attenuated by the filter.

e. The single sideband signal (251 kc) is then amplified in two stages of conventional i.f. amplification using two 6BA6 pentodes (2V14 and 2V15). I.F. interstage transformers 2T4 and 2T6 are of the double-tuned, adjustable-core type. The primary and secondary of 2T4 and 2T6 are peaked at 250 kc.

f. The output signal (251 kc) from 2T6 is fed to the demodulator tube, 2V17A, one half of a 6AL5, along with 250 kc output from the crystal oscillator (2V10). Mixing of the two frequencies in 2V17A produces sum and difference frequencies (501 kc and 1 kc respectively). The output circuit of the demodulator bypasses the higher frequencies to ground through a capacitor. Thus the sum frequency (501 kc) is bypassed to ground and the difference frequency remains. This difference frequency (1 kc in this case) represents the original intelligence signal (test tone).

g. The intelligence signal (1 kc) is then fed to the noise limiter diode, 2V20. From there is passes to the AF amplifier, 2V19A, which is controlled by the squelch triode, 2V19B.

h. The final AF amplifier stages 1V8 and 1V9 (each one is a 6AK6 power pentode) supply audio output. Amplifier 1V8 supplies audio through transformer 1T7 to handset 1HS1 and speaker 1LS1 when the SPEAKER-HANDSET switch, 1S5, is in SPEAKER position. A telephone headset may also be plugged into PHONES jack 1J4 for monitoring purposes. The LOCAL-REMOTE switch allows selection of either the local handset or any one of up to three remote desk sets.

Amplifier 1V9 supplies audio output through transformer 1T6 to the 600 ohm line, terminals 8, 9 and 10 of terminal board 1TB4.

AGC Amplifier and Diode

The AGC amplifier tube, 6BA6 (2V15), amplifies the 250 kc IF signal appearing at the grid of 2V16. This stage of amplification is necessary to obtain a sufficiently high voltage level at the AGC diode 2V18A. In addition, the AGC amplifier output feeds the Squelch diode. 2T5 is a 250 kc IF transformer with its primary and secondary tuned to 250 kc. This transformer is the plate load impedance for the AGC amplifier tube.

The AGC diode (2V18A) is coupled to the AGC amplifier through transformer 2T5. This diode rectifies the IF signal and produces a negative voltage proportional to the strength of the received signal. The negative AGC voltage is then filtered and applied simultaneously to the grids of the RF amplifier, 1st and 2nd mixer stages and the 1st IF amplifier to control the overall receiver gain.

The AGC switch, located on the front panel, permits selection of either of two time constants—FAST or SLOW. SLOW AGC action is used for single side band reception and FAST action for AM reception. Since there is no carrier present in single sideband signals, there will not be a signal present constantly at the plate of the AGC diode. However, the long time constant consisting of a 1 mf capacitor (2C123) and a 10 meg resistor (2R97) is used on SLOW AGC and thus maintains the bias level between modulation intervals. The short time constant of 1 mf capacitor (2C123) and the 1 meg resistor (2R98) is used on FAST AGC. When 2S5 is switched to OFF, the AGC voltage is shorted to ground and the RF and IF stages will have maximum gain, limited only by the position of the squelch control.

An external source of AGC voltage may be connected to the rear of the receiver, at terminal board 2TB3, if control of this function is desired from another point.

N ise Limiter

The noise limiter used in the Mark IIA is the series type of limiter, its action being controlled by the position of the NOISE LIMITER control, 2R103. When the control is turned counter-clockwise there is no limiting action as the diode (2V20) is based for maximum conduction. As the control is advanced in a clockwise direction, the cathode bias is reduced and limiting action takes place. When noise pulses exceed the bias as set by the NOISE LIMITER control (2R103), the noise limiter diode ceases to conduct and thus limits the noise pulses.

Squelch Circuit

The purpose of a squelch circuit is to silence the receiver when there is no information being received. This allows the operator to have the receiver volume control turned "up", ready to receive transmissions, without hearing annoying background noise.

When the squelch triode (2V19B) is conducting heavily the AF amplifier (2V19A) is "cut off" (squelched) and there is no audio output. The position of the SQUELCH control (2R106) determines the amount of conduction of the squelch triode (2V19B). An incoming signal causes the squelch diode (2V18B) to conduct producing a negative voltage which is applied to the grid of the squelch triode (2V19B). When the rectified bias from the squelch diode exceeds the squelch control bias, the squelch triode will be cut off allowing the AF amplifier (2V19A) to conduct and amplify the audio information being received.

Automatic Voice Operation

The Speech Clipper/Voice Control unit contains all of the necessary circuits to actuate the keying relay of the SSB-1 Mark IIA, causing the transmitter to go "on the air" whenever a sound is received in the microphone of the handset. This unit, designed specifically for the Mark IIA, provides a versatility and convenience of operation approaching the simplicity of common telephone usage. It not only relieves the operator from the use of the push-to-talk button, but also relieves the operator from the necessity of monitoring transmissions and switching from transmit to receive when transmissions originate at a remote land-line telephone.

The Speech Clipper/Voice Control unit is easily installed. It is simply plugged into an octal socket provided on the power supply chassis of the Mark IIA. The octal socket, 1J1, provides all power and operating signals for the tubes used in the unit. A schematic diagram of the unit is shown in Figure 36.

The sensitivity of the voice-operated relay may be adjusted by the VOICE SENSITIVITY control, 1R9, located on the Mark IIA front panel. When the sensitivity control is turned clockwise, the audio level to the unit is increased causing the voice-operated relay to respond to a lower level of speech.

An adjustment is provided on the voice control unit to control the sensitivity of relay 3K1. A 10K ohm adjustable resistor, 3R20, can be varied to change the resting current of relay 3K1 and relay amplifier 3V4B.

When the Speech Clipper/Voice Control accessory unit is installed in the octal receptacle 1J1 and switch 1S7 is in the VOICE CONTROL position, the automatic voice control circuits enable the voice or audio signal to actuate relay 2K1. (SPEAKER-HANDSET switch must be in the HANDSET position.) When the contacts of relay 3K1 close, the keying relay, 2K1, changes from the receive to the transmit position.

Figure 30 shows the connections to the Speech Clipper/Voice Control receptacle. Audio, from the speech clipper, 3V1A, is applied to the voice control circuits through 1R9, a 0.5 megohm potentiometer. The voice sensitivity control, 1R9, varies the audio level at which relay 3K1 will actuate.

Automatic voice control operation may be accomplished from the local position or from any remote deskset position. In addition, automatic control is possible using an audio signal from the 600-ohm line input.

To adjust the Speech Clipper/Voice Control unit for proper operation, proceed as follows:

Rotate potentiometer 3R20 until relay 3K1 is activated, and then back off the adjustment until the relay just falls out. With the MANUAL CONTROL/ VOICE CONTROL/INTERCOM switch R (1S7) in the VOICE CONTROL position, adjust VOICE SENSITIVITY W (1R9) clockwise until the transmitter is turned on when speaking into the handset. (SPEAKER/HANDSET switch must be in the HANDSET position.)

Meter Circuits

The SSB-1 Mark IIA features a front panel meter which permits monitoring of the IPA Grid Drive, the PA Plate Current, the High Voltage and the Low Voltage, (Receiver and Transmitter).

Each of these conditions may be checked by turning the meter switch knob to the function desired. The meter switch, 2S3, is a 4-position rotary switch mounted on the front panel of the transmitter-receiver unit.

Switch position #1 connects the meter, 2M1, between the input grid of the intermediate power amplifier, 2V4, and ground. 2CR3 rectifies a small portion of the output of 2V5. This is fed through 2M1 to provide an indication of the output of the 3rd Balanced Modulator.

Switch position #2 places the meter in the PA plate circuit to read the combined plate current of 2V1 and 2V2. Switch position #3 places the meter from the PA plate circuit to ground, where it reads the plate voltage of the PA stage. Position #4 places the meter from the low voltage power supply to ground causing it to read the +B voltage of the receiver normally, and to indicate the +B voltage of the transmitter when the press-to-talk switch is operated.

Selective Caller

The RCA type MI-625993 Selective Calling Unit is intended to originate the calling signal required to operate the RCA type 27A Selective Ringer. The Calling Unit is a two-tone generator designed to transmit coded signals by means of a dial telephone over the SSB-1 Mark IIA Transmitter.

Referring to Figure 8, an oscillator consisting of half of V101, transformer T101, capacitors C101 through C106 and other associated components generates either a 600 cycle or 1500 cycle tone, depending on the position of the impulse contacts of telephone dial N101. These tones are fed to the other half of V101, connected as a cathode follower. R105 is used

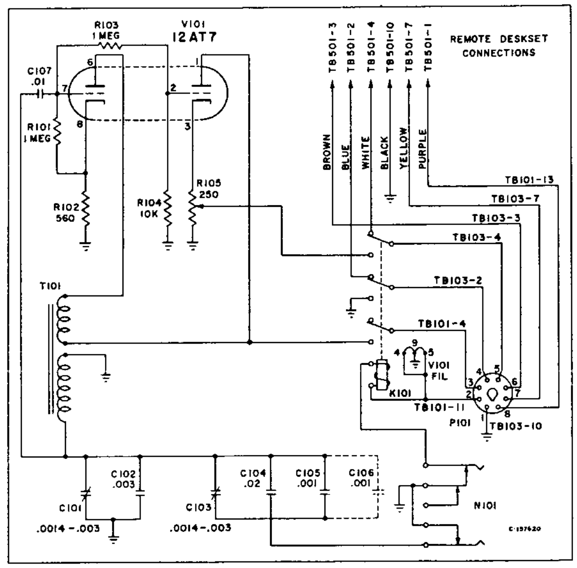


Figure 8. Selective Caller, Schematic Diagram

as an output level control and the tones go from it to the input of the SSB-1 Mark IIA microphone amplifier.

Since the Calling Unit may be used either at the SSB-1 Mark IIA or at a Remote Deskset location, relay K101 is provided to effect the necessary transfer of connections when it is used with a remote deskset. In the normal condition, K101 is not activated and the remote deskset is connected through to the proper terminals on 1TB3 of the Mark IIA. When telephone dial N101 is moved off normal to make a call, K101 is activated. This connects plate voltage to V101, actuates Transmit-Receive relay 2K1 of in the Mark IIA and transfers the input of the Mark IIA microphone amplifier from the remote deskset to the output of the Calling Unit, causing the two-tone calling signal to be transmitted.

Installation

If the Calling Unit is used with a remote deskset, the six wire cable coming from the rear of the unit is connected to 5TB1 on the deskset, as shown in Figure 8, and the eight wire cable supplied with J101 must be lengthened or replaced by an eight wire cable required to reach from the Mark IIA to the remote deskset location. Connections from this cable to 1TB2 and 1TB3 of the Mark IIA are also shown in Figure 8. The length of this cable from the Mark IIA to the remote deskset location should not be more than 250 feet, and the wires in the cable should be #20 AWG or heavier.

If the Calling Unit is used at the Mark IIA, the eight wire cable supplied with it is connected to 1TB2 and 1TB3 as shown in Figure 8, and the lugs of the six wire cable are taped up, since this cable is not required.

After all connections have been made, the Mark IIA transmitter is put "on the air" and the Transmitter Gain Control is adjusted for flashing of the PA Grid Indicator as described in this instruction book. The output level control of the Calling Unit is then advanced until the PA Grid Indicator flashes on both tones when a number is dialed. It is important that both tones shall cause flashing, since the the 600 cycle tone is normally about 3 db lower than the 1500 cycle tone and it is necessary to advance the output level control until the speech clipper of the Mark IIA equalizes them. The transmitted tones may be monitored by means of headphones plugged into the "PHONES" jack of the Mark IIA.

Operation

When the Calling Unit is used with a remote deskset, the POWER, RECEIVER and TRANSMITTER power switches are turned on and the Local-Remote switch is turned to Remote #1 position. (Assuming that the interconnecting cable is connected to the group of terminals on 1TB3 assigned to "Remote Deskset No. 1".) The handset may be on or off its cradle, but the "Press-to-talk" button should not be depressed while dialing. When dialing, a short pause should follow the first digit (always a "1") to permit all Selective Ringers in the network to be restored to normal. The telephone dial should always be permitted to return to normal at its own speed, it should not be forced back at a higher rate. After a desired number has been dialed and an answer received from the called station, operation proceeds in a normal manner.

TABLE 1. TUBE SOCKET VOLTAGES, SELECTIVE CALLER

Pin Number	*Voltage*
1	+210
2	−.1
3	+5.4
4	6.3 AC
5	6.3 AC
6	+210
7	−9.5(1) −4.0(2)
8	+4
9	0

(1) With 1500 cycle tone
(2) With 600 cycle tone

All measurements made with vacuum tube voltmeter. Lower resistance meter will cause wide variation in measurements on pins 2, 7 and 8.

When the Calling Unit is used at the Mark IIA, all power switches are turned on and the Local-Remote switch is turned to Remote #1 position for dialing. After dialing is completed, the Local-Remote switch is turned to "Local" and operation proceeds in a normal manner. The same precautions on dialing procedure apply in this case as in the previous one.

Maintenance

The selective calling system may become inoperative either because of no tone output from the Calling Unit or because one or both tones are badly off frequency. In the first case normal servicing procedures are in order. Voltages at the various tube pins, as listed in Table 1, are a good indication of tube performance and the contacts of K101 and N101 should be checked for proper contact. In the second case, some accurate source of audio frequencies is required to recalibrate the two tones. The 1500 cycle tone is adjusted first by means of C101 and then the 600 cycle tone is adjusted by means of C103.

RCA Selective Ringer MI-55047-A

The communications equipment uses the Selective Ringer MI-555047-A as a ringing unit in a two-tone audio-frequency selective signal system. The selector set performs the local function of closing a bell/ circuit when actuated by the proper sequence of audio frequency signals. These signals consist of pulses of 600 and 1500 cycle modulation which are alternated at a rate of 4 to 5½ cycles per second. The selector set may be preset to respond to a code system having a total of 23, 25, 27 or 29. This permits greater flexibility with code combinations which number in the thousands. The use of an individual code, similar to a telephone number, enables any one of a group of stations operating on the same channel frequency to be signaled.

The calling signal, consisting of groups of 600 and 1500 cycle pulses, is impressed across a tuned circuit consisting of inductances L-101 and L-102 connected in series, as shown in Figure 9. The 600 cycle pulses are rectified by the full-wave rectifier made up of four germanium crystals (Y-101 through Y-104 inclusive) arranged in a bridge circuit. The rectified current flows through winding 4-7 of the polarized relay K-101. The 1500 cycle pulses are rectified by a similar bridge rectifier (Y-105 through Y-108 inclusive) and the resulting current flows through winding 3-8 of the same relay. The currents in these two windings have opposite effects upon the operation of the relay armature.

Winding 2-9 of relay K-101 is a polarized winding connected to the armature which reverses the direction of the current through the winding when the armature transfers. The effect of this connection is to hold the armature against the last made contact until the next pulse, of opposite polarity, is impressed

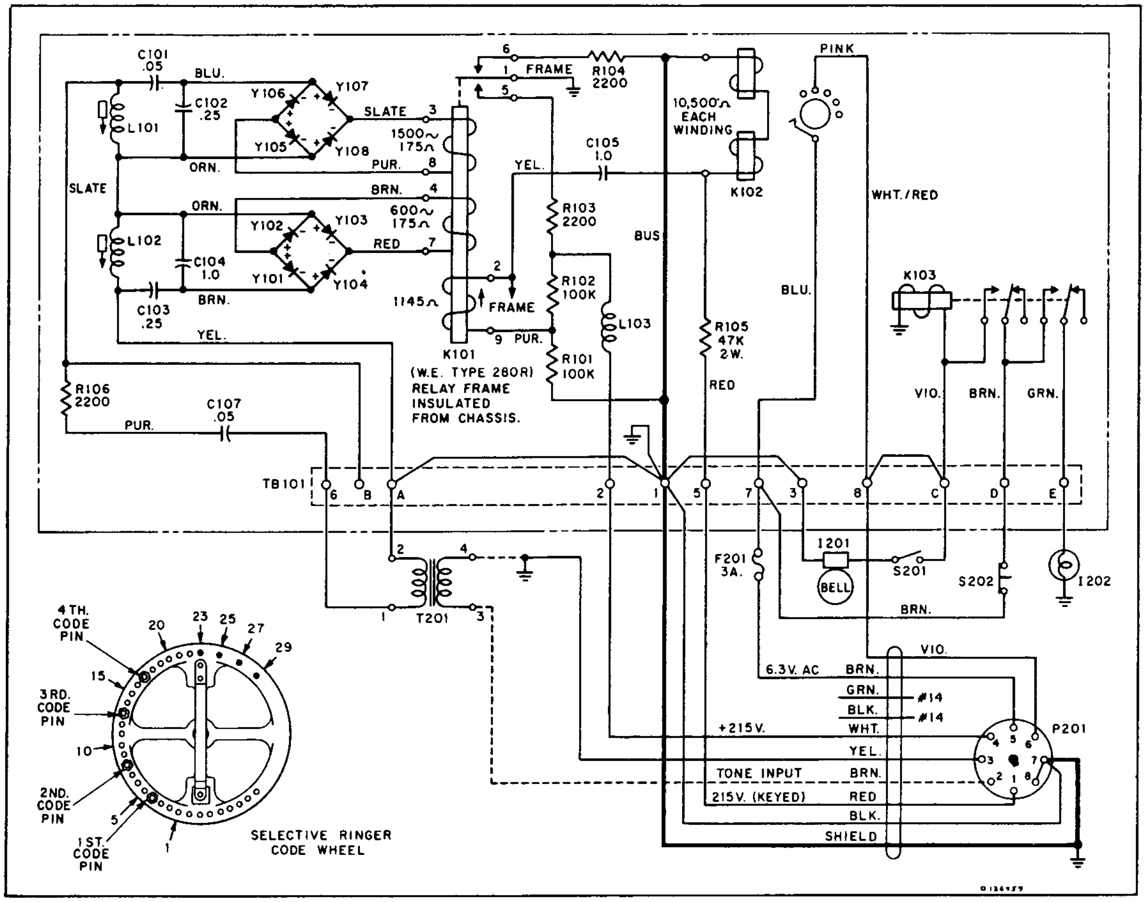


Figure 9. Selective Ringer and Code Wheel, Schematic Diagram

upon the relay. The voltage for operating this winding is obtained from voltage divider R-101 and R-102.

Capacitor C-105 is alternately charged and discharged through the windings of the selector K-102 when the relay K-101 is operated by the calling signals. After the final pulse of the proper 23, 25, 27 or 29 pulse calling code is received, the code wheel contact spring will engage the first, second, third or fourth ringing terminal on the bridge of the selector. The two contacts, connected to 7 and 8 on the terminal strip, are used to energize the bell. Refer to Figure 9.

The ringing circuit will be opened when a restoring voltage is applied at 5 on the terminal strip. This voltage (obtained from the transmitter plate supply) advances the selector code wheel one additional position, thereby opening the code wheel contacts when the transmitter is turned on.

The audio frequency input required to operate the Selective Unit is approximately 25 volts at 600 and 1500 cycles, measured with a 1000 ohm per volt AC voltmeter, between terminals A and B on the terminal strip. The input impedance is approximately 15,000 ohms.

The voltage for operating the selector and providing biasing current for relay K-101 is obtained from the receiver "B" supply.

The selector relay K-102 may be set to a predetermined code by properly locating the four adjustable code pins in holes around the rim of the code wheel. The selector responds to a preset code (zero on the dial being 10 pulses). The digit "1" is always dialed first to insure that all selectors are restored to normal before the station code is dialed.

Installation

The Selective Ringer (MI-555047-A) should be installed in a vertical position close enough to the equipment with which it is to be operated, in order that the cable will reach the terminal connection of the communications equipment. The octal plug of the Ringer is plugged into the octal socket (1J2) of the Mark IIA. The code wheel of the Ringer is set to the desired code number combination in accordance with Figure 9 and Adjustment Procedure of Selector Relay K-102.

Operation

The radiotelephone equipment receiver is turned ON and the Channel Switch turned to the channel on which calls are expected. To eliminate background noise, the Speaker-Handset switch is placed in the "Handset" position and, if noise from the handset receiver is objectionable, the Local-Remote switch may be turned to Remote #1 position. The Receiver Gain Control should be slightly advanced beyond the position used for normal reception. When the number set up on the code wheel is called, the alarm bell will ring if the Bell Disconnect Switch is in the "ON" position and the Call Indicator Lamp will light. The transmitter of the equipment is turned ON and, if the Local-Remote switch was in the Remote #1 position, it is turned to "Local". Pressing the "Press-to-talk" button of the handset will reset the Ringer code wheel to normal, after which pressing the "Reset" button on the Ringer will extinguish the Call Indicator Lamp and disconnect the bell circuit. The call is then answered in the usual manner.

Maintenance

Relay K-101 and selector K-102 have been properly adjusted at the factory and no attempt should be made to adjust them (other than changing the code) unless it is definitely known that they are causing trouble. Contacts may be slightly tarnished and should be polished with a burnishing tool. Abrasives must not be used.

Polarized Relay K-101: The correct adjustment for satisfactory operation of the polarized relay is as follows:

1. The armature should not touch the inside of the winding spool.

2. The contacts should line up so that the point of each contact falls wholly within the boundary of the opposing contact.

3. Contact and pole-piece clamping screws should be sufficiently tight to hold any adjusted position.

4. The total contact travel should be between 0.002 and 0.005.

5. The clearance between the stop pins on the armature and either pole-piece, with the armature against the opposite pole-piece should be a maximum of 0.018 inch.

6. The pole-piece should be free from dirt or metal chips.

7. The relay should be free from magnetic bias. That is, with the power off and no input from the receiver, the armature should not tend to remain against one contact in preference to the other.

8. The relay should operate in either direction on a current of 0.0018 ampere through winding 2-9. The resistance of winding 2-9 is 1145 ohms.

Adjustment Procedure for Polar Relay K-101

1. K-101 is a polarized relay with three windings. Windings 3-8 and 4-7 have the same number of turns and a resistance of 175 ohms each. The third winding 2-9 has a resistance of 1145 ohms. For proper operation the relay requires careful adjustment of the armature, pole-pieces and contacts.

2. The chatterless armature consists of a solid portion and a flexible portion, with the contacts mounted on the latter. These flexible contact springs are mounted on the solid portion of the armature at one end and rest against each other at the other end. The requirement for this armature is that the flexible springs rest against each other in line with the solid armature. Here a pressure of 20 to 50 grams is measured on one spring at the contact with the other spring. When the contacts and pole-pieces are backed off so the armature is free from any effects of the magnetic circuit, it should take a position about in the center of the opening through which it passed in the winding spool. The flexible contacts should also align concentrically with the stationary contacts. If the armature requires adjustment because of failure to satisfy these requirements, the relay cover must be removed in order to make available the armature mounting screws at the terminal end of the winding spool, opposite the contacts.

3. After the armature has been adjusted for position, one of the contacts is adjusted until it just touches the contact of the armature and then backed off the required amount (one-twelfth of a turn of the contact screw or about one-third of the distance between hole centers in the head of the contact screw is equal to about .002 inch). Then the same adjustment is applied to the other contact. With this adjustment, the armature should be about half-way between the two contacts in its normal position and have a total contact travel of .002 to .005 of an inch.

4. The magnetic air-gap is adjusted by turning in the pole-piece screws gradually and equally until the armature, when moved by hand, will just stick to each contact. Before making the exact balance, tighten the pole-piece locking screws enough to hold the pole-piece screws firmly. Otherwise the balance obtained will be very unstable. After magnetic balance has been obtained, a check should be made with the non-magnetic thickness gauge of the total magnetic air-gap. The total air-gap between either pole-piece and the armature stop pin with the armature touching the other pole-piece should be maximum of .018 inch. It is desirable to keep this gap as close to this maximum as possible and still meet the electrical requirements. If the electrical requirements cannot be met with the maximum gap, move the pole-pieces

closer together and re-establish magnetic balance before again checking the electrical requirements.

5. The requirements on the polar relay are that it must transfer on successive current reversals of .0017 ampere in either winding 3-8 or 4-7 on the relay. The third winding may be used, which is connected between 2 and 9. The relay should transfer on current reversals of .0018 ampere in this winding.

Adjustment Procedure of Selector Relay K-102

1. The selector should not require any adjustment except to change the adjustable code pins in setting up a new code for the unit.

2. The following instructions cover the method of changing the code setting of the selector to agree with the assigned code number.

3. The first digit of the code is always 1 and is used as a clearing pulse to restore the code wheels of all of the selectors to normal position. This operation is necessary in case the selector has been stepped to an off normal position previous to the reception of the calling signal.

4. The second digit determines the location of the first adjustable code pin, which is placed in the hole in the code wheel having the same number as the second digit.

5. The third digit determines the location of the second adjustable code pin, which is placed in the hole in the code wheel having the same number as the sum or the second and third digits.

6. The proper locations for the third and fourth code pins are determined in the manner outlined above. The sum of the digits of the code is always 23 and the bell contact is made on the 23rd pulse. A fixed code pin is located in position 23 to hold the code wheel in the ringing position until the selector code wheel is impulsed to the 2nd, (25th pulse) 3rd, (27th pulse) or 4th, (25th pulse) permanent pin or restored to normal by the operation of the handset.

7. DO NOT REMOVE THE CODE WHEEL OR LOOSEN THE SET SCREWS. To change the location of the adjustable code pins, unscrew the nuts on the top of the adjustable code pins, remove the pins, place them in the proper holes, and tighten the nuts.

8. DO NOT REMOVE THE CODE WHEEL OR LOOSEN THE SET SCREWS WHEN CLEANING AND OILING THE SELECTOR. Periodic cleaning and oiling of the selector relay is required. First, clean all the bearings with a small lettering brush carrying enough cleaning fluid to dissolve any old oil or other matter. Then lubricate the bearings by applying a high quality light mineral oil sparingly.

9. The following parts should also be cleaned as specified above, but in this case these parts are not to be oiled:

(a) The four contact points of the contact bridge.

(b) The contact of the code wheel spring.

(c) The code wheel spring at the point where it lies on the mode wheel.

(d) The four permanent code pins on the code wheel.

(e) The cup-shaped portion of the holding spring which contacts the code pins.

Selective Filter Circuits and Germanium Crystal Diode Rectifier

In order to check the operation of the filter circuits and rectifiers, the following tests can be made with a DC voltmeter having a resistance of at least 1000 ohms per volt:

1. With a source transmitting a 1500 cycle modulation, the DC voltage, measured across winding 3-8 of relay K-101, must be 0.8 volt or more (terminal 3 is positive) and across winding 4-7 not more than one-fifth as much.

2. For 600 cycle modulation, winding 4-7 must be 0.8 volt or more (terminal 8 is positive) and across winding 3-8 not more than one-fifth as much.

The voltage for operating the selector and providing biasing current for relay K-101 is obtained from the receiver "B" supply.

The selector relay K-102 may be set to a predetermined code by properly locating the four adjustable code pins in holes around the rim of the code wheel. The selector responds to a five-digit code whose sum is 23 (zero on the dial being 10 pulses). The digit "1" is always dialed first to insure that all selectors are restored to normal before the station code is dialed.

5. POWER AND CONTROL CIRCUITS.

a. When the input power is 230 volts AC, it is applied through step-down transformer 1T5. 115 volts is applied directly to the power supply circuit without the use of 1T5. Refer to Figure 37.

b. Turning POWER switch 1S1 on, energizes transformer 1T4 which applies power to the crystal oven heaters; makes power available at RECEIVER switch 1S2 and lights the POWER indicator 1DS3.

c. Turning RECEIVER switch 1S2 on, energizes transformer 1T3, makes power available at TRANSMITTER SWITCH 1S3 and lights RECEIVER indicator 1DS2. One secondary winding of 1T3 furnishes filament power for the three crystal oscillators and all of the receiver tubes. Another secondary furnishes filament power for the Low-Voltage Rectifier tube 1V3. The third secondary of 1T3 is center-tapped and furnishes plate power to the 5R4GY full-wave LV rectifier tube 1V3 which supplies filtered dc at +200 volts for receiver and transmitter tube plates (low level stages) and +150 volts to the crystal oscillator plates. The +150 volt supply is regulated by 1V5 (an OD3/VR150 tube). The +200 volt supply is switched between transmitter and receiver by contacts of antenna transfer relay 2K1. The bias supply is obtained from a tap-off on the LV Supply using regulator tube 1V4 (an OA3/VR-75) and is adjustable by BIAS ADJ potentiometer 1R7. The bias voltage is applied to the grids of 1V1, 1V2, and 1V3. The negative voltage is also used to operate the antenna transfer relay (2K1).

d. Turning TRANSMITTER switch, 1S3 on, energizes transformers 1T1 and 1T2 and lights the TRANSMITTER lamp 1DS1. 1T1 supplies filament power for all of the transmitter tubes. 1T2 supplies plate voltage for the HV rectifiers 1V1 and 1V2 (type 5R4GY) connected in a full-wave center tap circuit with plates in parallel, to supply +750 volts dc through a single-section choke input filter to the plates of power amplifiers 2V1 and 2V2.

e. The connections to the switches are such that when the POWER switch is off the entire equipment is de-energized, regardless of the positions of the other switches. When the RECEIVER switch is off, the transmitter circuits are also de-energized, regardless of the position of the TRANSMITTER switch. Also, jumpers inside voltage regulator tubes 1V4 and 1V5 are connected in series with the RECEIVER and TRANSMITTER switches, so that if either tube is removed from its socket, no power can be applied to any circuit except the oven heaters.

f. When antenna transfer relay 2K1 is de-energized its contacts connect the antenna to the receiver input and plate voltage to the receiver tubes. When it is energized its contacts connect the transmitter output to the antenna and plate voltage to the transmitter tubes. Energizing the relay is accomplished by operating the push-to-talk switch on the handset or deskset or by setting switch 1S4 to the TELEGRAPH position and operating a telegraph key inserted in the KEY jack 1J3.

g. LOCAL-REMOTE switch 1S6 selects the local handset or any one of the remote desksets. It switches the microphone circuit, the received audio signal, the push-to-talk control circuit, and (for the remote desksets) the power for the indicator lamp which denotes the selected remote station.

SECTION III. INSTALLATION

1. LOCATION AND MOUNTING

The Type SSB-1 Mark IIA communication equipment may be mounted on a desk or a table top, or at any site affording a mounting area of 23⅜ inches wide by 19 inches deep. A minimum clearance of 12½ inches is required at the top of the cabinet to permit the raising of the cabinet top panel; a minimum clearance of 6 inches is required at the rear of the cabinet to permit antenna and ground connections. Figure 10 shows the outline dimensions of the equipment.

When locating the SSB-1 Mark IIA equipment provide sufficient space for the removal of the chassis from the cabinet for inspection or servicing. It is also important to have free circulation of air around the equipment. Installations in closets or other confined areas should be avoided.

Other considerations when locating communications equipment are: convenience to AC power; routing of antenna and ground wires; the location of associated equipment; the proximity of interfering structures.

2. ANTENNA SYSTEM

Satisfactory operation of a transmitter depends largely on the proper choice and location of an antenna. A single-wire antenna installed at the highest practical location above ground is easy to construct and works well with the Mark IIA Transmitter.

The length of an antenna of this type should be one-quarter of a wave-length at the highest channel frequency. The following chart and Figure 11 show the length of wire necessary for a given frequency. The length of wire indicated in the chart is the overall length of the antenna measured from the antenna standoff terminal to the far end of the wire.

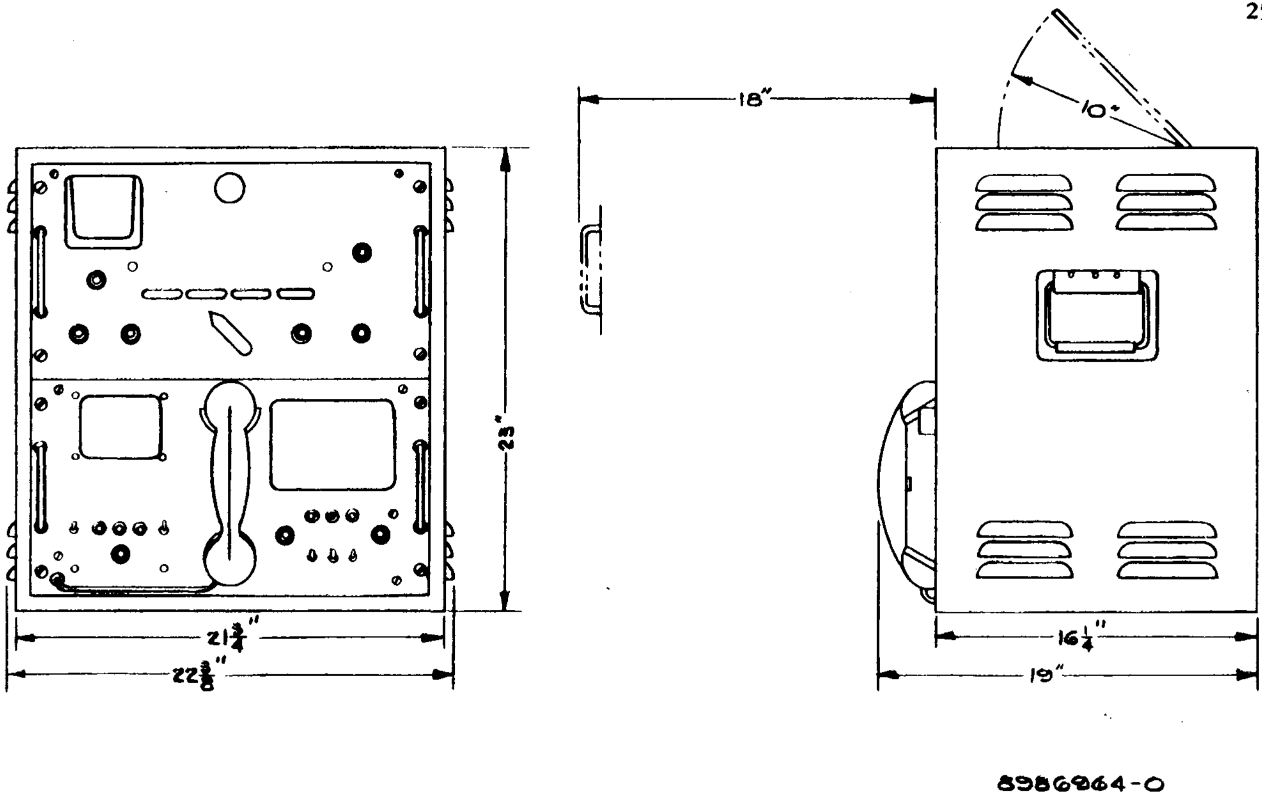


Figure 10. SSB-1 Mark IIA, Outline Dimensions

Highest Transmitted Frequency (MC)	*Length of Antenna (ft.)*
3	78.0
4	58.5
5	46.8
6	39.0
7	33.4
8	29.3
9	26.0
10	23.4
11	21.3
12	19.5
13	18.0
14	16.7
15	15.6

As an example, for 14,250 kc carrier the length of antenna would be approximately 16.4 feet. If difficulty is experienced in loading the antenna on the highest frequency channel, the antenna should be shortened slightly 1 or 2 feet at a time, until proper loading is obtained.

When four channel frequencies are used, the highest frequency will determine the length of the antenna. Then, when the Mark IIA is operated on one of the lower frequencies the antenna will be capacitive and the antenna loading coil in the unit will resonate the antenna. In this way, the antenna can be tuned to any frequency within the range of the equipment.

Dipole antennas are also recommended for use with the Mark IIA transmitter and receiver. Half-wave dipoles may be cut to length from the following formula:

$$\text{length (feet)} = \frac{468}{\text{frequency (mcs)}}$$

The half-wave dipole antenna consists of a wire (#14 or #12 AWG copper) cut to length from the formula given above and supported at each end by glass or ceramic insulators.

Half-way between the two insulators the wire is cut and another insulator is inserted. In effect, two antennas, each one-quarter wavelength long, are created. Each conductor of a balanced transmission line (two wire, or coaxial twin-lead) is connected to each side of the center insulator, thus one conductor of the transmission line is connected to one-half of the dipole, and the other conductor is connected to the other half of the dipole. This type of antenna is for a specific frequency however, not multiple frequency use.

Another type of unbalanced transmission line connection is the end-fed connection. This type of connection is similar to balanced feed except that the antenna is fed at one end instead of the center. The leads of the transmission line are separated by an insulator and connected to the extreme end of the antenna. The supporting insulator for the antenna should be connected as shown in Figure 12b. When

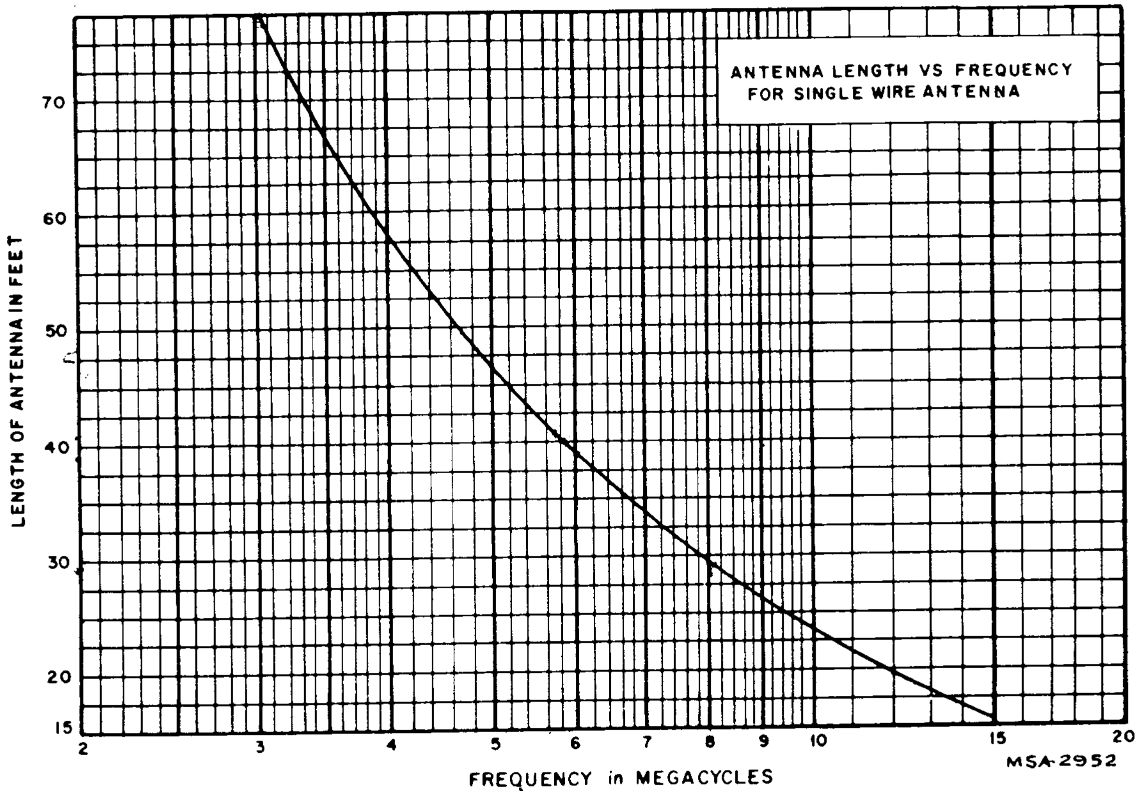
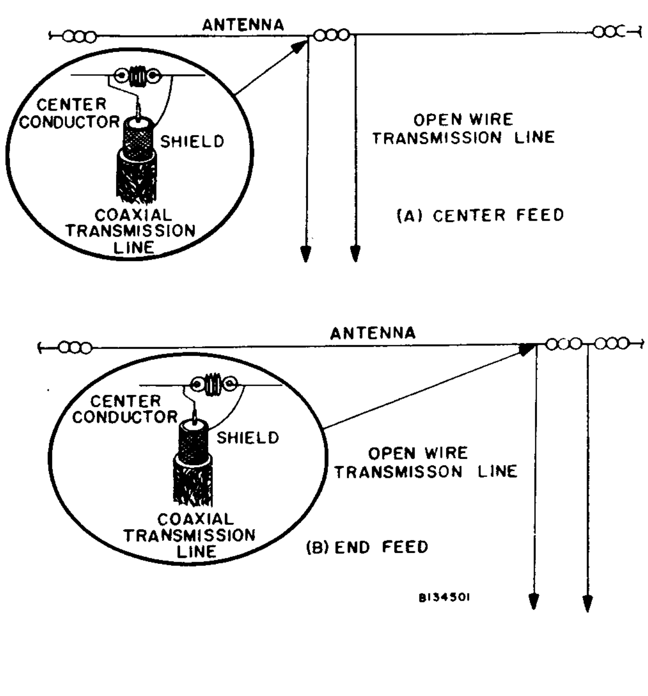


Figure 11. Antenna Length vs. Frequency, Single Wire Antenna



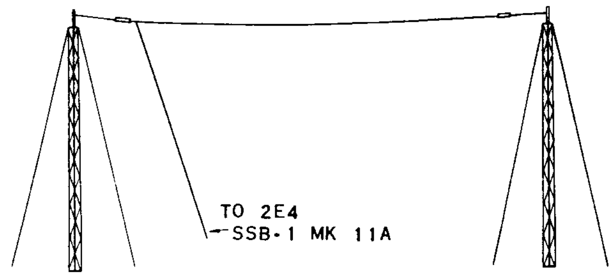
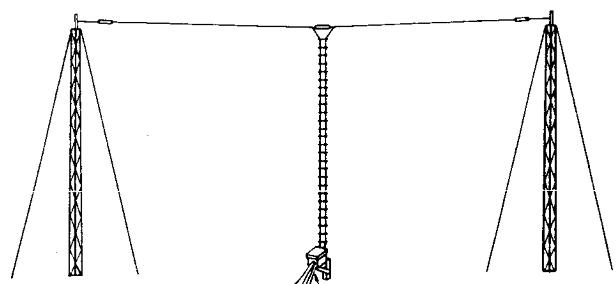
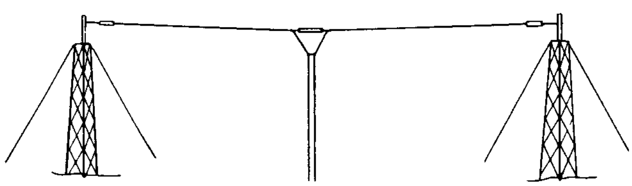
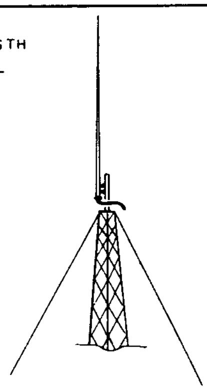
Figur 12. End-fed and C nter-f d Antennas

coaxial shielded transmission line is used with these antennas the shield and conductor are connected as shown in Figure 12. This is also a single frequency type of antenna.

When using a single frequency antenna that is cut for an optimum frequency, the coaxial jack 2J1 should be used for maximum efficiency, and a quarter wave antenna can also be used for the other channels by connecting a single wire to 2E4.

Other antenna systems are shown in Figure 13. Of special interest is the multiband antenna. Multiband operation is possible through the use of the RCA AAT-100 Automatic Antenna Tuner. This is connected to the dipole by 450-ohm open-wire transmission line. The AAT-100 Automatic Antenna Tuner is an automatic matching device that will provide a constant impedance match between the output of the SSB-1 Mark IIA transmitter and a 78-foot dipole antenna. The tuner is connected to the SSB-1 Mark IIA by RG-8/U coaxial cable to 2J1 and a 5 wire control cable connected to 2TB1. (The coaxial cable and 5 wire control cable are not supplied.)

When the AAT-100 is used selection of any one of four pre-tuned channels in the frequency range of 3 to 15 megacycles is automatically accomplished through channel switch section 2S1J in the SSB-1 Mark IIA.

ANTENNA TYPE	LENGTH	TRANSMISSION LINE	CONNECTIONS TO SSB-1 MK 11A
¼ WAVELENGTH SINGLE WIRE 	3500 kc (CHAN 1) 66¾ FT. 7500 kc (CHAN. 3) 31¼ FT. 15500 kc (CHAN 4) 17¼ FT.	(PART OF ANT.)	TERM 2E4
MULTI-BAND 	78 FEET [AS SUPPLIED WITH RCA AAT-100 AUTOMATIC ANTENNA TUNER.]	450 OHM OPEN WIRE (SUPPLIED)	COAXIAL FITTING 2J1
HALF-WAVE DIPOLE 	3500 kc. (CHAN. 1) 133¾ FT. 7500 kc (CHAN. 3) 62½ FT. 13500 kc (CHAN. 4) 34½ FT.	72 OHM TWIN LEAD OR 72 OHM COAXIAL	TERM. 2E4 AND GROUND COAXIAL FITTING 2J1
¼ WAVELENGTH VERTICAL 	13500 kc. (CHAN. 4) 17¼ FT. 15000 kc. (CHAN. 4) 15½ FT.	50 OHM COAXIAL	COAXIAL FITTING 2J1

Figur 13. Typ s f Ant nnas Used with the SSB-1 Mark IIA

3. GROUND CONNECTION

A connection should be made from the ground terminal at the rear of the transmitter-receiver chassis to a good ground (earth) with a heavy flexible copper wire or copper strap. A good outdoor ground may be made by driving a 6-foot length of 1-inch pipe into moist earth. If it is impractical to make an outdoor ground, a secure connection to a cold-water pipe will suffice. If possible, connection to the pipe should be made at the point where the water pipe enters the earth.

All ground wires should be made as short and direct as practical. A long ground wire may have a detuning effect and require a shortening of the antenna.

4. POWER SOURCE

Primary power for the SSB-1 Mark IIA may be either 115 volts or 230 volts ac, single phase, 50 to 60 cycles. Internal connections at 1TB1 located on the bottom side of the power supply chassis, must be checked to ensure proper transformer connections for the power source employed. Use rubber covered two-conductor cable, No. 14 AWG or larger. The connections are listed below and are shown in Figure 37.

Power Source	*Line Connections at Terminal Board 1TB1*
115 v ac, 50/60 cps	Terminals 1 and 2
230 v ac, 50/60 cps	Terminals 3 and 4

5. REMOTE TELEPHONE CONNECTIONS

Connections for up to three remote telephones are provided at terminal board 1TB3 on the power supply chassis. Connect each remote telephone board 5TB1 to terminal board 1TB3, mating terminals bearing identical numbers. These connections are shown in Figure 37. For connection of each remote deskset use a 7 conductor shielded cable, No. 24 AWG for up to 300 feet, or larger for greater distances.

6. TUBES

Refer to Figure 25 for the location of all tubes, and to the Technical Summary which lists the tube complement of both chassis. Make certain that each tube is firmly seated in its socket, with the tube shields in place.

7. CRYSTALS

The equipment uses three crystals for the fixed frequency oscillators and one to four crystals for the "channel frequency" oscillator. The 250 kc crystal (2Y7 type CR-46/U) is mounted in 2XY7 socket. The 1150 kc crystal (2Y5 type CR-27/U), and the 1650 kc crystal (2Y6 type CR-27/U) are mounted in crystal oven 2E3. These crystals are supplied with the equipment. The channel frequency crystals (2Y1 to 2Y4, type CR-27/U) are not furnished with the equipment unless specified by special order.

When ordering or installing channel frequency crystals the correct crystal frequency is determined as follows: Add 1400 kc to the desired nominal carrier frequency. Thus, if the nominal carrier frequency desired is 14,250 kc the channel crystal frequency is determined by adding 14,250 kc and 1400 kc which equals 15,650 kc.

NOTE: The audio frequency of the modulation or tone frequency is not involved in determining the crystal frequency: only the carrier or assigned channel frequency is used.

Figure 15 shows the location of the crystal ovens and crystals on the chassis. The rear oven, 2E2, contains crystals for channels 1 and 2 (2Y4 and 2Y3) in the frequency range of 4400 kc to 8100 kc. The front oven, 2E1, contains the crystals for channels 3 and 4 (2Y2 and 2Y1) in the frequency range of 8100 kc to 16,400 kc.

NOTE: For convenience in operation, the crystals should be placed in order of frequency ascension from the rear to the front of the chassis: i.e., the lowest in channel 1 position, the next higher in channel 2, etc.

Install channel crystals as follows:

a. Withdraw the crystal oven from its socket (2E1 for channel 4 for 15,650 kc, as an example).

b. Loosen the screws securing the oven cover to the oven base and remove the cover.

c. Insert channel crystal in proper socket (front position no. 2 in 2E1 for the 15,650 kc).

d. Replace the oven cover and mark the appropriate crystal frequency on the top of the cover. Reinsert the oven into its socket.

e. Install crystals for other channels, as required, in a similar manner.

f. At the front panel of the equipment, above the CHANNEL selector, write the nominal carrier frequencies of the channels (crystal frequencies minus 1400 kc) in the blanks provided below the corresponding channel numbers.

After the channel frequency crystals have been installed, as described under CRYSTALS, check to make sure that all tubes are firmly seated in their sockets; all tube shields are in place; the cap connections to the power amplifier tubes are secure; taps on the plate tank coil (2L2) and the antenna loading coil (2L1) are not shorting to each other or to other turns of the coils; and that a secure ground connection is made to the chassis.

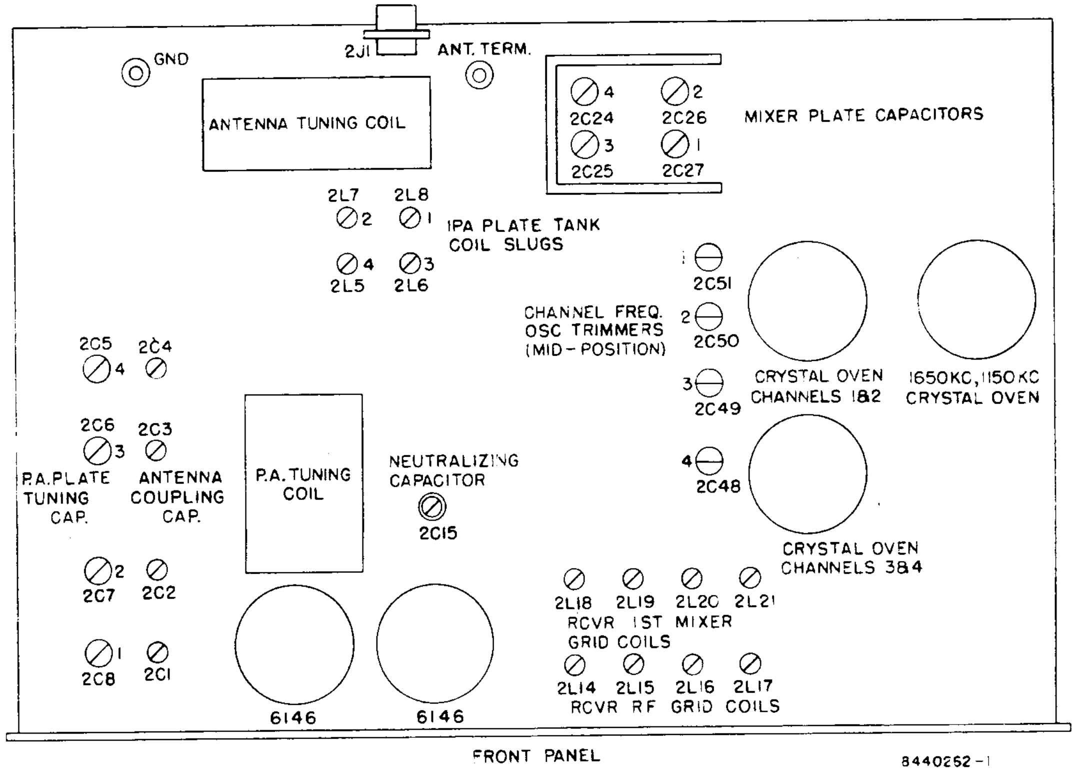
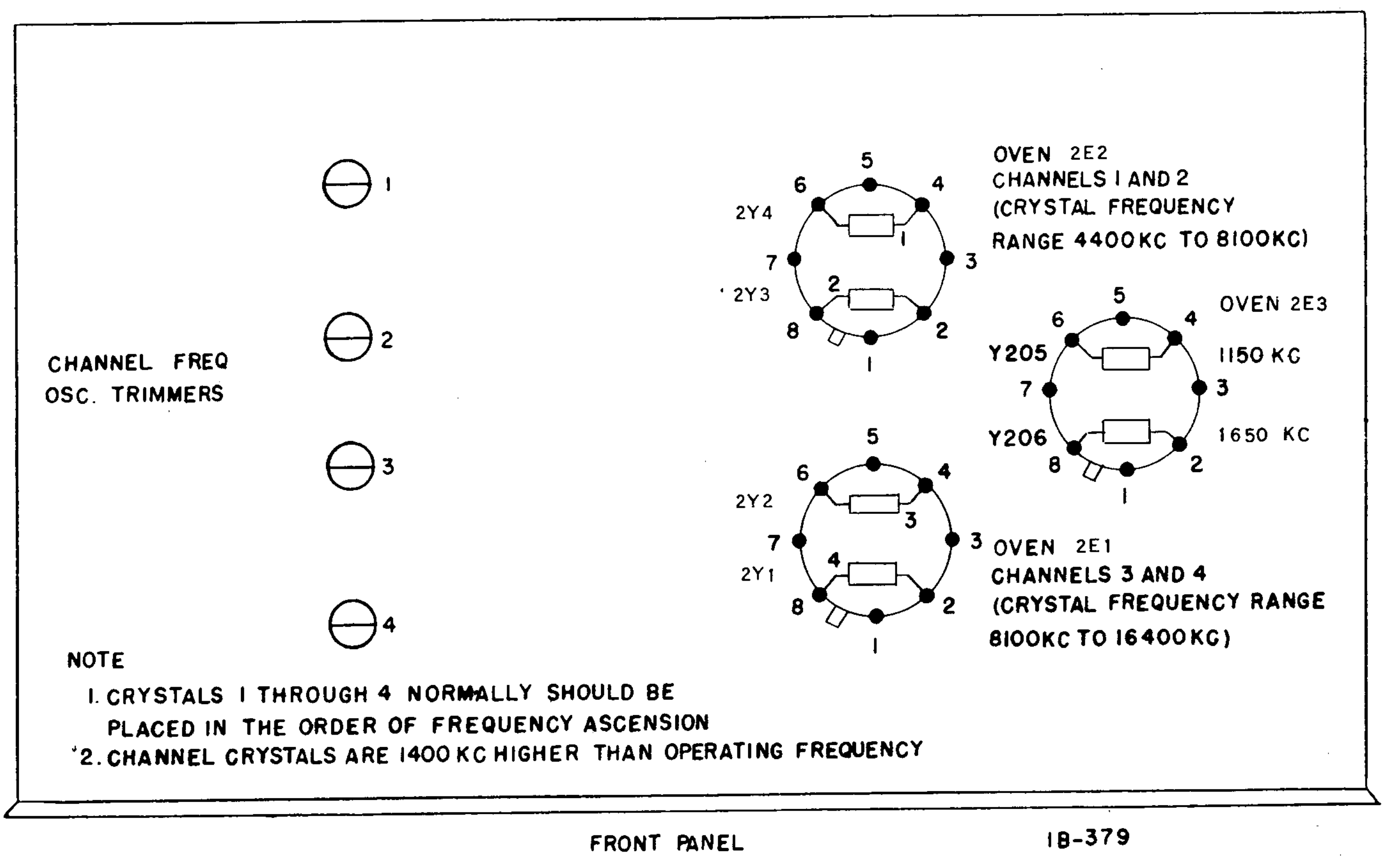


Figure 14. Location of Channel Alignment Components, Transmitter-Receiver Chassis



Figur 15. Crystal Ovens, Top View, C ver Rem ved

When tuning the transmitter, a dummy load or a suitable antenna, as described in the preceding paragraphs, should be connected to the appropriate antenna terminals on the TRANSMITTER/RECEIVER chassis. The transmitter should not be operated without a suitable "load" connected to the antenna terminals because, during the tuning procedure, excessively high voltages and/or currents may be developed in the power amplifier output circuits and may cause damage to the equipment.

A "dummy load" is preferred during initial tuning adjustments. This type of load prevents unwanted radiation from interfering with other communications. A suitable dummy load consists of a non-inductive resistor having a wattage rating equivalent to the power output of the transmitter. A 50-ohm 100 watt resistor is recommended for the SSB-1 Mark IIA. The dummy load is connected with a short length of wire (six inches) to a male coaxial connector and should be connected to 2J1, the 50-ohm output terminal of the power amplifier. If a suitable dummy load is not available, an ordinary 150-watt light-bulb connected in the same manner as above may be used instead.

Illumination of the light-bulb when the transmitter is tuned indicates that RF power is present in the PA output circuits. The comparative brilliance of the bulb indicates, *roughly*, the power output.

8. TRANSMITTER CHANNEL ALIGNMENT

All components mentioned in the following procedures may be located by referring to Figure 14.

> *CAUTION: High voltages are present in this equipment. Exercise caution when performing the alignment procedures. Before applying power, make certain that the equipment has been properly grounded.*

a. Set CHANNEL FREQ OSC TRIMMERS 1 (2C51), 2 (2C50), 3 (2C49), and 4 (2C48) midway between their fully clockwise and counterclockwise limits. (Screwdriver slots parallel to front panel, as shown in Figure 14.)

b. From a fully counterclockwise position, rotate IPA PLATE TANK COIL SLUG 1 (2L8) the number of turns required to tune to the desired output frequency of channel 1. The number of required turns relative to the desired frequency is given below and is shown graphically in Figure 17.

APPROXIMATE SLUG POSITIONS OF
IPA PLATE TANK COILS

Frequency	*Number of Turns from Minimum Inductance*
CHANNELS 1 or 2	
3000 KC	31
4000 KC	23
5000 KC	19
6000 KC	16
6700 KC	13
CHANNELS 3 or 4	
6700 KC	29
8000 KC	25
9500 KC	21½
11000 KC	19
13000 KC	16
15000 KC	13

c. Place tap 1 (leads are marked with channel number) of P.A. TUNING COIL (2L2) at the number of turns from the cold end (the end closer to ANTENNA TUNING COIL) required to tune to the desired output frequency of channel 1. The required number of turns relative to the desired frequency is given below and shown graphically in Figure 16.

APPROXIMATE TAP POSITION OF
THE PLATE TANK COIL 2L2

Frequency	*Number of Turns from Cold End of Coil*
CHANNELS 1 or 2	
3.0–3.2 MC	2½
3.2–3.4 MC	3½
3.4–3.6 MC	4½
3.6–4.0 MC	5½
4.0–4.4 MC	6½
4.4–4.8 MC	7½
4.8–5.2 MC	8½
5.2–5.6 MC	9½
5.6–6.3 MC	10½
6.3–6.7 MC	11½
CHANNELS 3 or 4	
6.7–7.1 MC	8½
7.1–8.0 MC	9½
8.0–9.2 MC	10½
9.2–10.7 MC	11½
10.7–13.0 MC	12½
13.0–15.0 MC	13½

Thus as 14,250 kc carrier, the number of turns would be 13½.

d. Rotate ANTENNA COUPLING CAP 1 (2C1) for maximum capacitance (fully counterclockwise).

e. Set tap 1 of ANTENNA TUNING COIL (2L1) on the turn closest to the ANT TERM post.

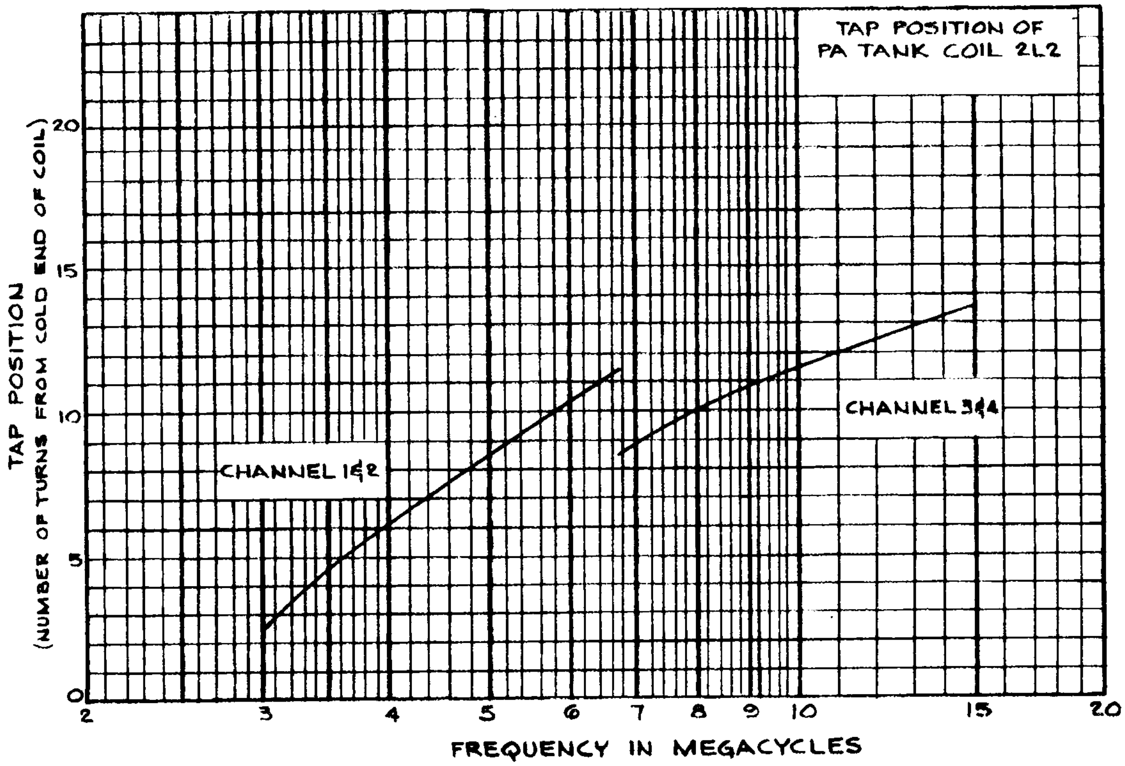
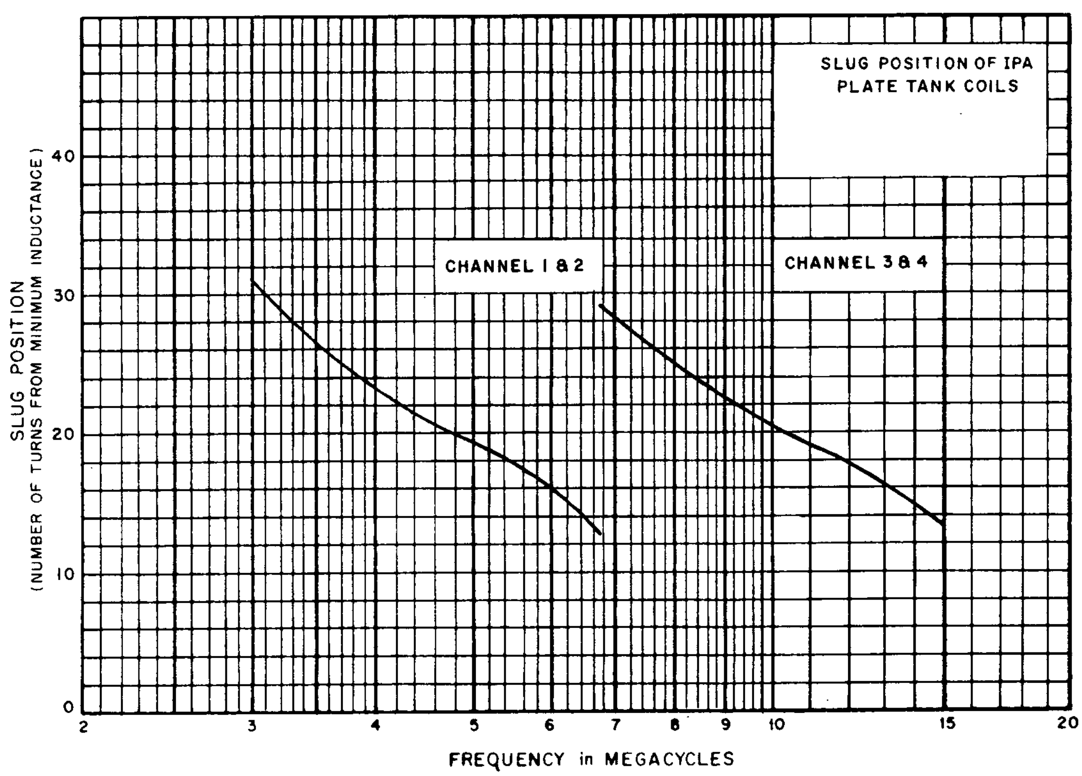


Figure 16. Tap Positions of Plate Tank Coil 2L2



Figur 17. Slug P sitions of IPA Plat Tank C ils

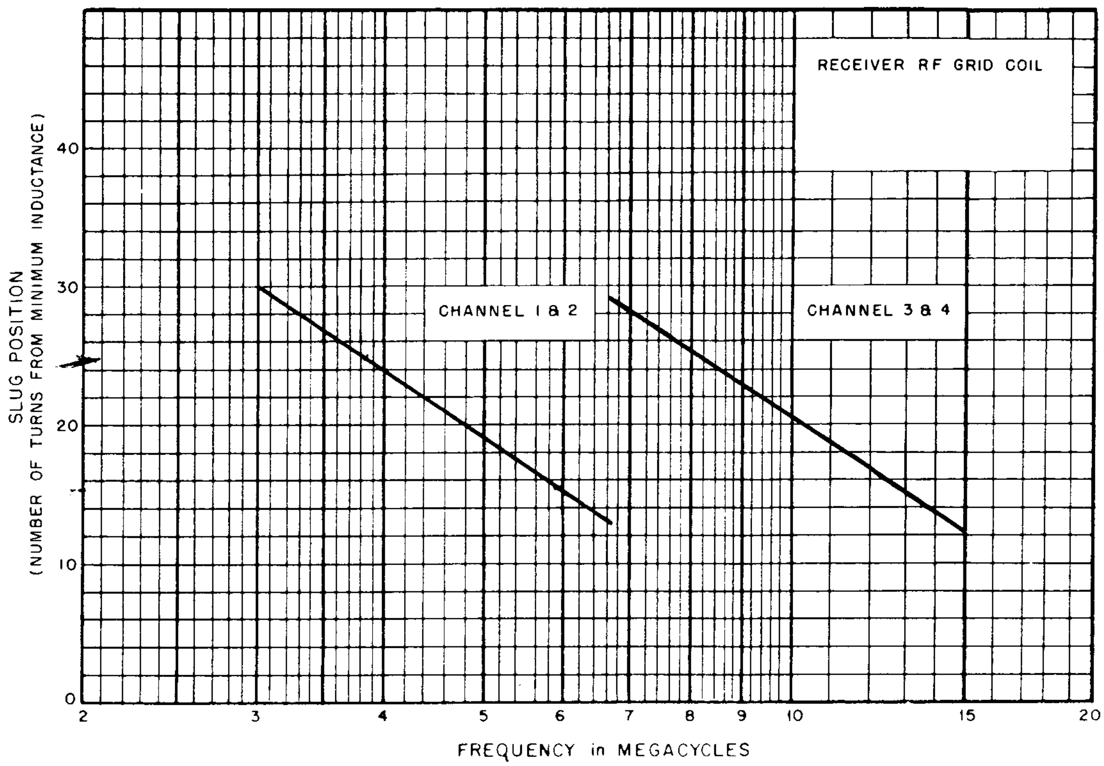
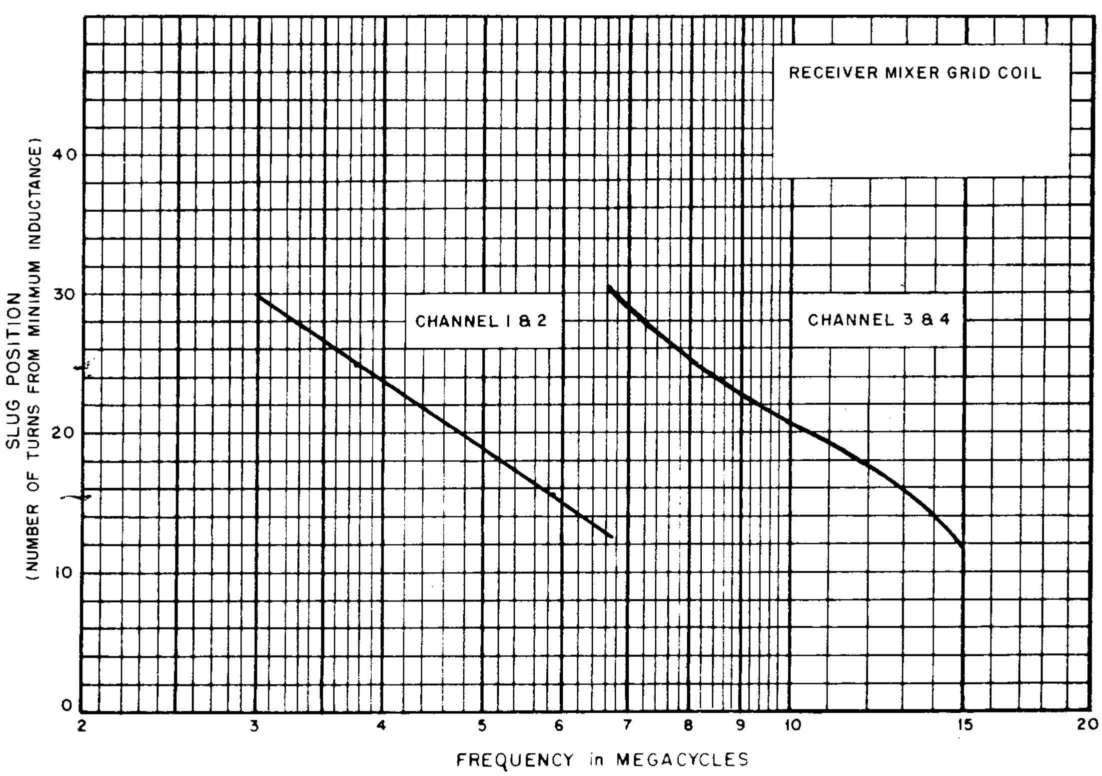


Figure 18. Slug Positions of Receiver RF Coils



Figur 19. Slug Positi ns of Receiver Mixer Grid Coils

f. Repeat steps b through e above, for channels 2, 3 and 4.

g. Remove the antenna connection from the ANT TERM binding post.

h. Insert a key into the front panel KEY jack.

i. Adjust the front panel controls as follows:

TELEGRAPH-PHONE switch to TELEGRAPH.
SIDEBAND switch to SUPPRESSED.
TRANSMITTER GAIN control to 0.
CHANNEL SELECTOR to 1.
METER switch to PA PLATE CURRENT.

j. Turn POWER, RECEIVER and TRANSMITTER switches on. Allow the equipment a 30 second warm-up interval. Press the telegraph key. The PA plate current should read between 58 and 62 ma. If it is not between these limits, adjust power supply chassis control 1R7 (located on top of chassis) for a PA plate current of 60 ma. Retighten the locking nut on 1R7.

NOTE: For the remainder of this procedure, as tuning adjustments are made, make certain that the meter does not read more than 90 ma with the antenna disconnected. Decrease the current as necessary by lowering the setting of the TRANSMITTER GAIN control. Use an insulated screwdriver for all adjustments.

k. Set METER switch to IPA GRID EXCITATION. With the key depressed and the TRANSMITTER GAIN control set at midposition, adjust 3rd BAL MOD PLATE CAPACITOR 1 (2C27) for maximum deflection of the meter. To be sure of tuning to the desired output frequency and not to the oscillator frequency, back off on the TRANSMITTER GAIN control. If the meter deflection decreases, the mixer is tuned for the desired frequency. If the meter deflection does not decrease as the TRANSMITTER GAIN is lowered, the mixer is tuned to the HF oscillator frequency. Turn BAL MOD PLATE CAPACITOR 1 (2C27) to a lower frequency (increased capacity) until another maximum in meter deflection is noted.

l. Set METER switch to PA PLATE CURRENT. Adjust IPA PLATE TANK COIL 1 (2L8) for maximum deflection of the meter (PA Plate). If the meter exceeds 90 ma, lower the TRANSMITTER GAIN control setting.

m. Adjust PA PLATE TUNING CAP 1 (2C8) for a dip in PA plate current. The current should dip to approximately 65 ma or lower.

n. Turn off the TRANSMITTER switch. Reconnect the antenna. Turn on the TRANSMITTER switch. Set the TRANSMITTER GAIN control to 0.

o. Press the telegraph key and place the Sideband switch to Full Carrier. Note the PA plate current.

p. Set Sideband switch to Suppressed Carrier. Change tap 1 of ANTENNA TUNING COIL, 2L1, one turn at a time, away from the antenna end of the coil. After each turn, reset the Sideband switch to Full Carrier, press telegraph key and note the plate current. Continue this procedure until a peak plate current is reached. The antenna circuit is now properly tuned to the desired frequency. Readjust P.A. PLATE TUNING CAP 1 (2C8) for a dip in the plate current. Only a slight variation of the capacitor should be required if the antenna circuit has been properly resonated.

NOTE: If unable to note any rise in PA plate current as the antenna coil tap is changed, increase coupling to the antenna circuit by rotating ANTENNA COUPLING CAP 1 (2C1) clockwise one or two turns, retune PA PLATE TUNING CAP 1 (2C8) for dip in plate current and repeat procedure as in paragraphs o and p.

q. Place the sideband switch to Suppressed Carrier and depress the key. Increase TRANSMITTER GAIN until PA Grid indicator lights. Full load conditions exist when the indicator lights coincident with a milliammeter indication of 190 ma.

r. If the PA Grid indicator lights coincidentally with a plate current indication below 15 ma, an undercoupled condition exists. Adjust ANTENNA COUPLING CAP 1 (2C1) clockwise in small increments. After each increment, dip the plate current by adjusting the P.A. PLATE TUNING CAP 1 (2C8), and raise the TRANSMITTER GAIN control until a full-load condition exists.

s. If the PA Grid indicator lights coincidentally with a plate current indication above 200 ma (step q above), an overcoupled condition exists. Adjust ANTENNA COUPLING CAP 1 (2C1) counterclockwise in small increments. After each increment, dip the plate current by adjusting P.A. PLATE TUNING CAP 1 (2C8) and adjust the TRANSMITTER GAIN control until a full-load condition exists.

t. If a full-load condition cannot be obtained, vary P.A. PLATE TUNING COIL (2L2), tap 1. Change the tap position one or two turns and repeat the procedures of steps n through t, above.

u. Tune channels 2, 3 and 4 using the respective circuit elements and following the procedures of steps i through t, above. If difficulty is experienced in loading the highest frequency channel refer to paragraph 2 above.

9. RECEIVER CHANNEL ALIGNMENT

Components are numbered 1 through 4, corresponding to their respective channels. All components may be located by referring to Figure 14.

a. Turn off all power and make the following preliminary adjustment. From a fully counterclockwise position, adjust REC RF GRID COIL 1 (2L17) to the desired frequency of channel 1. The number of turns relative to the desired frequency is listed below and shown graphically in Figure 18.

APPROXIMATE SLUG POSITION OF RECEIVER RF COILS

Frequencies	*Number of Turns*
CHANNELS 1 or 2	
3000 KC	30
4000 KC	24
5000 KC	19
6000 KC	15
6700 KC	13
CHANNELS 3 or 4	
6700 KC	29
8000 KC	25
9500 KC	22
11000 KC	19
13000 KC	15
15000 KC	12

Thus at 14,250 kc carrier, the number of turns would be 11.

b. Adjust REC. 1st MIXER GRID COIL 1 (2L21) from a fully counterclockwise position. Turn the slug the number of turns required to tune to the desired frequency of channel 1, as indicated below or as shown in Figure 19.

APPROXIMATE SLUG POSITION OF RECEIVER MIXER GRID COILS

Frequencies	*Number of Turns*
CHANNELS 1 or 2	
3000 KC	30
4000 KC	23½
5000 KC	19
6000 KC	15
6700 KC	12½
CHANNELS 3 or 4	
6700 KC	30
8000 KC	25
9500 KC	21½
11000 KC	19
13000 KC	15½
15000 KC	12

Thus at 14,250 kc carrier, the slug position would be 14.5 turns from minimum inductance.

c. Turn on the POWER and RECEIVER switches; set CHANNEL selector to 1, SPEAKER-HANDSET switch to SPEAKER and TELEGRAPH-PHONE switch to PHONE; and turn the RF GAIN control full clockwise, AGC—off, Squelch and Noise Limiter maximum CCW, and AF Gain to maximum.

d. Adjust the REC RF GRID COIL 1 (2L7) for maximum noise response of the SSB-1 Mark IIA speaker.

e. Adjust the REC. 1st MIXER GRID COIL 1 (2L21) for maximum noise response of the speaker.

f. Align the receiver for channels 2, 3 and 4 by using the respective circuit tuning elements for each channel and following the procedures of steps a through e above.

10. TELEPRINTER CONNECTIONS

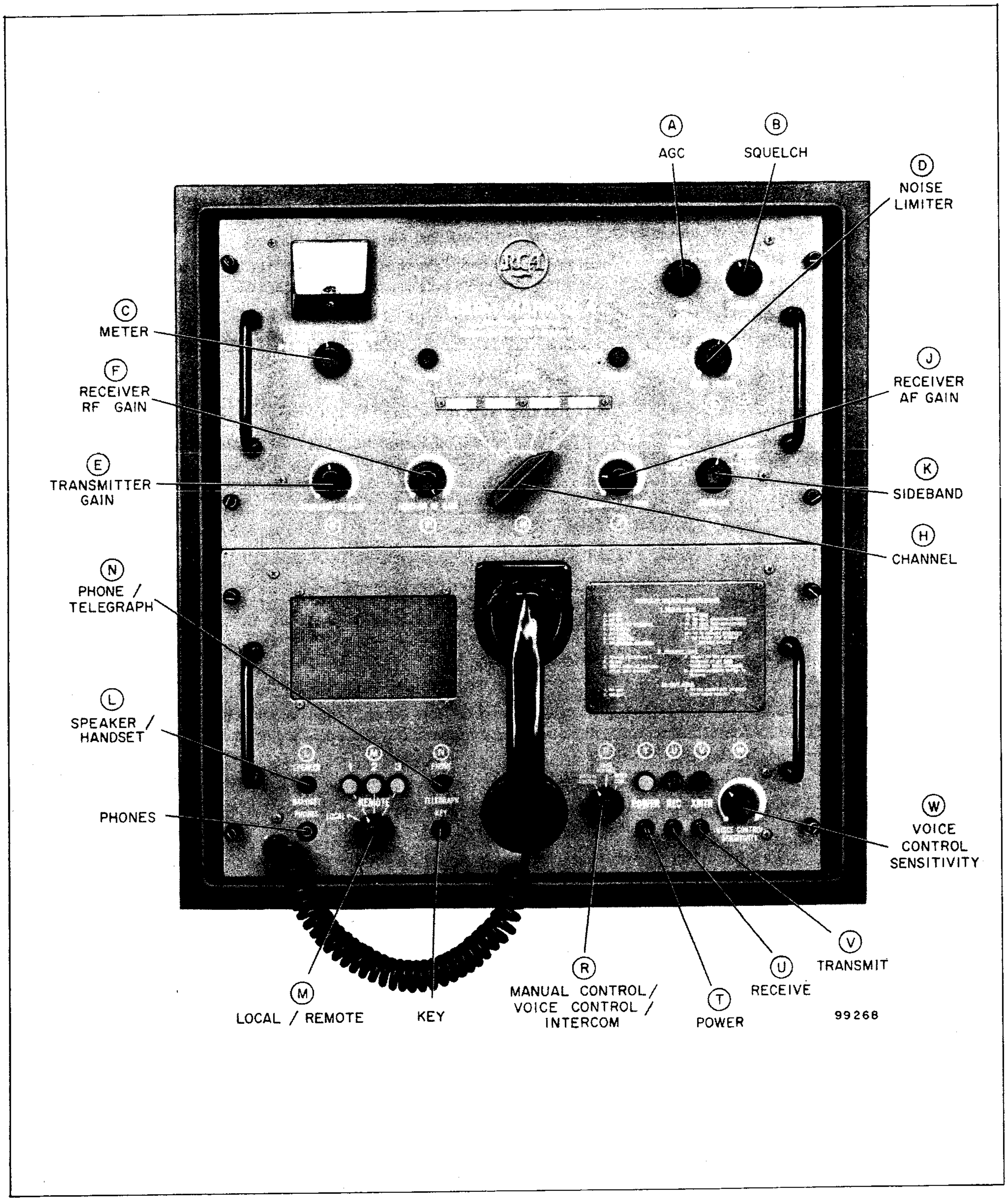
When external teleprinter and tone converter equipment is to be used, connect this equipment to terminal board 1TB4 on the rear apron of the SSB-1 Mark IIA power supply chassis, as shown in Figure 37. With this connection, the tone oscillator in the SSB-1 Mark IIA is keyed externally and the added switch operates the internal antenna transfer relay to switch between receiver and transmitter operation.

11. OPERATIONAL CHECKS

Using the operational procedures of Section IV, check that the equipment is operating properly on each channel. Establish contact with another station of the network. During reception, adjust the respective CHANNEL FREQ. OSC. TRIMMERS 1, 2, 3 and 4 (2C51, 2C50, 2C49 and 2C48, respectively) for clearest reception. This procedure also adjusts the transmitted signal for clearest reception at the distant station.

TABLE 2 — FUNCTIONS OF CONTROLS AND INDICATORS

Designation	*Type of Control*	*Function*
TRANSMITTER-RECEIVER UNIT		
Ⓐ AGC-OFF, FAST, SLOW	Rotary Switch (3 positions)	Selects FAST or SLOW AGC response or AGC "OFF"
Ⓑ SQUELCH	Potentiometer	Quiets receiver during stand-by operation.
Ⓒ METER	Rotary Switch	Permits front panel meter to be used in various functions.
Ⓓ NOISE LIMITER	Potentiometer	Reduces random noise from handset or speaker.
Ⓔ TRANSMITTER GAIN	Potentiometer	Adjusts gain of transmitter. Normally set while talking for occasional flashing of PA GRID panel lamp.
Ⓕ RECEIVER RF GAIN	Potentiometer	Adjusts RF gain of receiver. Normally set for maximum when AGC is on Fast or Slow. Adjusts output level of receiver when AGC is on Off.
Ⓗ CHANNEL 1-2-3-4	Rotary Switch (4 positions)	Selects predetermined operating frequency of transmitter and receiver. Frequencies are as marked.
Ⓙ RECEIVER AF GAIN	Potentiometer	Adjusts AF gain of receiver. Normally set for maximum when AGC is on Off. Adjusts output level of receiver when AGC is on Fast or Slow.
PA GRID	Neon Lamp (red)	Indicates degree of modulation.
TRANSMIT	Neon Lamp (red)	Indicates transmitter is on.
Ⓚ SIDEBAND: *Upper:* FULL CARRIER, SUPPRESSED CARRIER *Lower:* SUPPRESSED CARRIER, FULL CARRIER	Rotary Switch	Selects desired sideband, with or without carrier.
POWER SUPPLY UNIT		
Ⓛ SPEAKER-HANDSET	Toggle Switch (2 positions)	Selects either handset or speaker for receiver output.
Ⓜ LOCAL-REMOTE	Rotary Switch (4 positions)	Selects operation from either local handset or up to three remote (extension) desk sets.
REMOTE INDICATORS 1-2-3	Neon Lamps (white)	Remote lamp lights when respective extension is used.
Ⓝ PHONE-TELEGRAPH	Toggle Switch	On telegraph, CW telegraph or tone SSB Transmission may be used. On phone, telephone signals only are used.
Ⓡ MANUAL CONTROL-VOICE CONTROL-INTERCOM	Rotary Switch (3 position)	Selects desired mode of operational control.
Ⓣ POWER	Toggle Switch	In ON position, line power is brought into power supply. 6.3 V AC is applied to crystal ovens.
POWER	Neon Lamp (white)	Indicates application of line power to power supply.
Ⓤ REC	Toggle Switch (2 positions)	Applies operating voltages to receiver.
REC	Neon Lamp (amber)	Indicates receiver power supply is energized.
Ⓥ XMTR	Toggle Switch (2 positions)	Applies operating voltages to transmitter.
XMTR	Neon Lamp (red)	Indicates Transmitter power supply is energized.
Ⓦ VOICE CONTROL SENSITIVITY	Potentiometer	Sets the audio level to control transmit/receiver functions automatically by voice.
PHONES	Telephone Jack	Provides local monitoring facilities for remote operation (listen only).
KEY	Telephone Jack	Provides connection for external telegraph key.



Figur 20. SSB-1 Mark IIA, Front Pan l Contr ls

SECTION IV. OPERATION

1. CONTROLS AND INDICATORS

All indicators and operating controls of the SSB-1 Mark IIA are located on the front panels of the equipment. Controls and their associated indicators are keyed by the encircled letters to the step-by-step operating instruction chart on the front panel. These controls and indicators are illustrated in Figure 20 and are listed, with their functions, in Table 2. Study this information before operating the equipment.

2. PUSH-TO-TALK (SIMPLEX) RADIO TELEPHONE OPERATION

Push-to-talk operation, commonly referred to as "SIMPLEX" operation, may be performed by the local operator or by an operator at any one of the three remote locations where remote desksets are installed. This permits any operator to communicate with another station merely by depressing the button on the handset handle and speaking into the microphone. To receive, the button is released. This automatically places the receiver in operation.

Operation of a simplex radio telephone station using an SSB-1 Mark IIA with up to three remote desksets such as shown in Figure 21 is as follows:

a. TO RECEIVE VOICE.

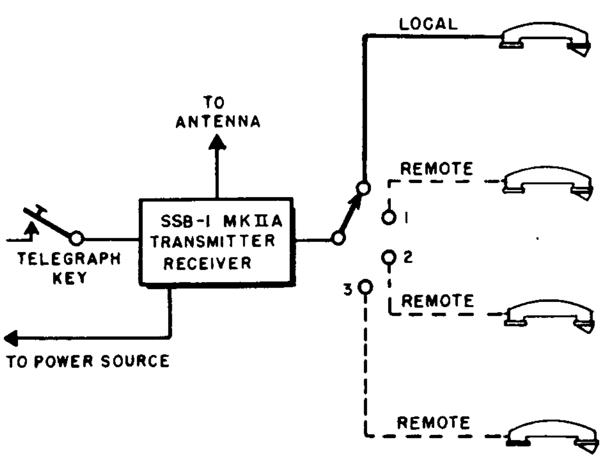
(1) Turn POWER switch (T) on.

(2) Turn RECEIVER switch (U) on.

(3) Turn CHANNEL selector (H) to the desired channel.

(4) Turn TELEGRAPH-PHONE switch (N) to PHONE position.

(5) Set LOCAL-REMOTE selector (M) to LOCAL position.



Figur 21. Simpl x Radi Telephone Station

(6) Set SPEAKER-HANDSET switch (L) to SPEAKER position.

(7) Set switch (R) to MANUAL CONTROL.

(8) Set AGC selector switch (A) to SLOW. The AGC switch positions are used as follows:

OFF—CW
FAST—AM
SLOW—SSB

(9) Turn SQUELCH control (B) full counterclockwise. The SQUELCH control is adjusted to reduce the background noise when no signal is being received. For reception of weak signals the SQUELCH control should be turned fully counterclockwise to effect minimum SQUELCH and enable the station to be heard.

(10) Turn NOISE LIMITER control (D) full counterclockwise. If impulse type noise is objectionable, advance the NOISE LIMITER control in a clockwise direction until the noise is eliminated or reduced to a suitable level.

(11) Turn RECEIVER RF GAIN control (F) fully clockwise. The RECEIVER RF GAIN control is turned fully clockwise for AM and SSB operation.

(12) Set SIDEBAND selector switch (K) to desired sideband.

(13) Adjust RECEIVER AF GAIN (J) for desired speaker volume.

b. TO TRANSMIT VOICE—SSB.

(1) Follow procedure "a" above.

(2) Turn XMTR switch (V) on.

(3) Set SIDEBAND selector switch (K) to UPPER or LOWER, Suppressed Carrier.

(4) Press handset button and speak into the handset.

(5) Adjust the TRANSMITTER GAIN control (E) for occasional flashing of the PA GRID indicator while speaking.

(6) Release the handset button to receive.

c. TO TRANSMIT VOICE—AM.

(1) Follow procedure "a" above.

(2) Turn the LOCAL-REMOTE switch (M) to Local.

(3) Set SIDEBAND selector switch (K) to UPPER or LOWER SIDEBAND, FULL CARRIER.

(4) Press handset button and speak into the handset.

(5) Adjust the TRANSMITTER GAIN control (E) for occasional flashing of the PA GRID indicator while speaking.
(6) Release the handset button to receive.

d. OPERATION FROM REMOTE SITE.
(1) Follow procedure "a" above.
(2) Turn the LOCAL-REMOTE switch (M) to the number of the extension to be used.
(3) The lamp on the extension desk will light indicating at the remote location that the extension is now connected to the communication system.
(4) Pick up the extension telephone, operate the push-to-talk switch when speaking, and release it when listening. In other respects it is used like an ordinary telephone.
(5) At the equipment site the appropriate REMOTE lamp will light when the extension telephone is lifted from its cradle and go out when it is replaced. The system may be monitored by plugging a headset into the PHONE jack. This circuit monitors both transmitted and received signals. The received signal only may be monitored on the speaker by turning switch (L) to SPEAKER.

e. To shut down the equipment.
(1) Turn XMTR switch (V) off.
(2) Turn RECEIVE switch (U) off.
(3) Leave POWER switch (T) on, except for an extended shutdown period.

3. SIMPLEX NETWORK OPERATION

Any number of stations may operate on one working frequency by sharing time. Transmitting and receiving are on the same frequency, the transmitter working only when the "press-to-talk" button on the handset is operated. When the button is not pressed, the receiver is ready to receive any other station that may want to talk. The four available frequencies permit any station to be used on several networks, possibly using different frequencies for day and night operation.

4. TELEGRAPH AND TELEPRINTER OPERATION

Operation of the SSB-1 Mark IIA for telegraph use is as follows:

a. TELEGRAPH OPERATION.
(1) Turn POWER switch (T) ON.
(2) Turn RECEIVER switch (U) ON.
(3) Turn CHANNEL selector (H) to the desired channel.
(4) Turn TELEGRAPH-PHONE switch (N) to TELEGRAPH position.

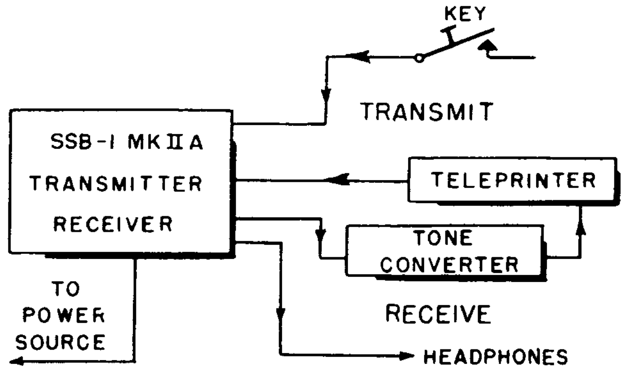


Figure 22. Telegraph and Teleprinter Operation

(5) Set LOCAL-REMOTE selector (M) to LOCAL position.
(6) Set SPEAKER-HANDSET switch (L) to SPEAKER position.
(7) Set switch (R) to MANUAL CONTROL.
(8) Set AGC selector switch (A) to OFF.
(9) Turn SQUELCH control (B) full COUNTERCLOCKWISE.
(10) Turn NOISE LIMITER control (D) full counterclockwise.
(11) Turn RECEIVER AF GAIN full clockwise.
(12) Set SIDEBAND selector switch (K) to desired sideband.
(13) Adjust RECEIVER RF GAIN for desired speaker volume.
(14) Turn switch (N) to TELEGRAPH position.
(15) Plug telegraph key into the KEY jack and transmit code. While transmitting, adjust the TRANSMITTER GAIN control (E) to obtain intermittent flashing of the PA GRID indicator lamp. Break-in operation is a feature of the SSB-1 Mark IIA, i.e., pressing the telegraph key automatically switches the unit from receive to transmit. A delay circuit holds the unit in the transmit condition during fast keying. A slight pause will allow the break-in relay to switch to the receive condition.
(16) To receive, plug a headset into the PHONES jack, or if desired, use the speaker by setting switch (L) to SPEAKER.
(17) To transmit again, just operate the key.

b. *Teleprinter Operation.*

The SSB-1 Mark IIA can also be used for teleprinting. The keyed tone is received by a system with necessary tone signal conversion equipment to feed direct current to the teleprinter. "On-line" two-way teleprinter operation can be used through the SSB-1 Mark IIA by simply adding the necessary teleprinting equipment and accessories. The teleprinter itself does the switching, from transmit to receive, automatically, Teleprinter keying speeds being in the order of 60 words per minute, the break-in feature of the SSB-1 Mark IIA cannot be used. The teleprinter is connected to 1TB4. The keying lead keys only the tone oscillator, the transmit-receive relay being operated by an external switch.

5. INTERCOM OPERATION

The INTERCOM function provides two-way communication between the local operator and any of the remote locations. The equipment is operated as outlined below when INTERCOM operation is desired.

Calls originated by the Local Operator.

(1) Turn POWER switch Ⓣ ON.
(2) Turn RECEIVER switch Ⓤ ON.
(3) Turn XMTR switch Ⓥ ON.
(4) Turn CHANNEL selector Ⓗ to the desired channel.
(5) Turn switch Ⓡ to INTERCOM position.
(6) Select the location, using the LOCAL-REMOTE switch Ⓜ, with which communication is desired. This will light the amber light on the handset of the remote location selected.
(7) When the remote location handset is removed from its cradle the white lamp at the local position will light for the location selected.
(8) Normal telephone communication can be carried on between the local and remote stations. It is not necessary to use the P/T buttons for INTERCOM COMMUNICATION. Also, during intercom operation the receiver continues to function allowing the operator to hear a call on the channel he is tuned to.

6. RADIO FREQUENCY PROPAGATION

Reliable radio communications over long distances depend on many factors. Two that are most important are the choice of frequency and the choice of either day-time or night-time transmission. These are a prime consideration since propagation of energy at

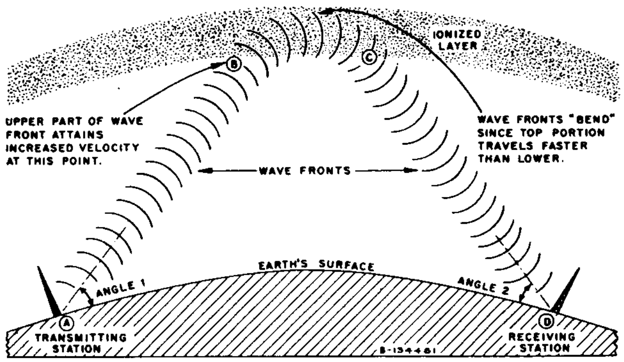


Figure 23. Reflection of Radio Wav s from a Layer of Ionized Gas

radio frequencies within the frequency range of the SSB-1 Mark IIA Transmitter/Receiver will vary considerably, depending upon the variable position and composition of ionized layers of gases which exist between 30 and 250 miles above the earth.

These layers of gases (usually designated D, E, F_1, F_2) are in a state of ionization for several reasons. Ionization of these gases is produced by electromagnetic radiation (including ultraviolet light), X-rays, gamma rays and cosmic rays. Ions are also produced by the impact of high speed particles in molecules or atoms of a gas. The predominate cause of ionization in the upper atmosphere appears to be ultraviolet light from the sun.

Ionization is an important consideration in understanding radio propagation since, under certain conditions, ionized gases will either *attenuate, reflect,* or *pass* electromagnetic radio waves. For reliable communications it is necessary to transmit radio signals of the proper frequency and at the proper time of day so that these signals will be *reflected* by the ionosphere to the required receiving point.

To understand the reflection process, see Figure 23. Radio waves being transmitted from point "A" leave the transmitter at angle 1. The transmitted wave fronts continue in a straight line upward from the transmitter until they reach the reflecting layer of ionized gas. It is a recognized phenomenon that electromagnetic radio energy moves faster through a gas, the greater the ionization of this gas. Refer again to Figure 23.

When the upper part of each wave front enters the ionosphere at point "B", it travels faster than the lower part. Since the upper part of the wave front is now traveling at an *increased* velocity and the lower part is traveling at its original speed (which is lower than the now increased velocity of the upper part of the wave front) the entire series of wave fronts wheel about similar to a column of soldiers obeying the

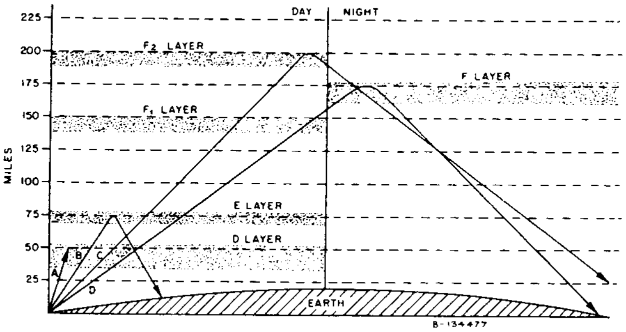


Figure 24. Relative Positions of Ionized Layers

command "Column Right!" The bending process continues until the new direction of the wave fronts causes them to pass from the iohosphere at point "C". The wave fronts then continue unobstructed in a straight line to point "D" and communication is established.

When the proper time of day is chosen and the proper frequency used, the reflection of radio signals in the manner just described gives maximum propagation of the transmitted signals.

NOTE: Refer to Figure 23. This shows that both the height and the degree of ionization of the reflecting layer can cause the radio signal to be reflected at points other than the required point "D".

Figure 24 shows the relative positions of the four most common ionized layers during the daylight hours. Notice that during the night-time hours the D and E layers disappear; and the F_1 and F_2 layers merge to form a signal reflecting ionized belt.

In addition to day and night changes there are other regular and irregular variations in the upper atmosphere, or ionosphere, which effect radio transmission. One of the foremost is the change caused by sunspot activity.

The exact nature of sunspots is not known but they are thought to be solar storms in the hot gases which make up the visible surface of the sun. Although sunspots themselves appear dark, they produce radiation having very high energy content. These outbursts of radiation reach the earth and cause striking changes in the ionization of the ionosphere.

During high sunspot activity, ionization of the F_1 and F_2 layers increases. Because of the greater ionization higher radio frequencies can be reflected by these layers and therefore may be utilized for long range communications. Maximum sunspot periods occurs every eleven years, the most rcent maximum period being 1958-1959.

A similar variation of ionization can also be expected as the relative position of the sun with respect to the earth moves from one hemisphere to the other. During the winter months, ionization of F_2 layer is greatest; during the summer months ionization of the other layers is greatest. This means in winter there is less absorption of signals in the lower portion of the 3 to 15 mc band by the D layer and a greater reflection of the high frequencies by the F_2 layers.

Because of the many predictable and unpredictable characteristics and variations of the ionosphere its effect on radio signals of different frequencies varies greatly. This means the proper choice of operating frequencies is *extremely important* to reliable radio communications. The following general statements may be made concerning propagation in the 3 to 15 mc region, however for a more detailed analysis refer to the notes at the end of this discussion.

Propagation in the 3 to 4 mc Region

These frequencies will be most useful for night rather than day-time communications. During the day the D layer tends to absorb frequencies in this range. After sundown, however, as the D layer disappears reliable communications may be obtained over distances of several hundred kilometers. During the summer months and particularly during the daylight hours, these are very high atmospheric noises present on these frequencies. This high noise level further reduces the effectiveness of these frequencies for daylight operation. This adverse noise condition is present all year in semi-tropical and tropical areas.

Propagation in the 7 to 8 mc Region

Since these frequencies are subject to less absorption by the D layer they are more effective for daylight communications. After sundown they have characteristics similar to frequencies in the 3 to 4 mc band. Generally, summer noise is less of a problem in this band. Noise may be a problem however, in tropical zones.

Propagation in the 12 to 15 mc Region

These frequencies are particularly useful during the daylight hours for communications over many hundreds of miles. During high sunspot activity these frequencies may be used to many advantages. After sundown the effectiveness of these frequencies is somewhat reduced.

NOTE: Though specific mention has been made only to limited bands of frequencies, these are the specific frequencies whose performance can be best described. Frequencies falling between the areas described may have characteristics of both the frequencies above and below. For example, 5 mc might under some conditions be useful for daytime transmission but would certainly be better at night. 6 mc would exhibit better daytime characteristics but would also improve at night, etc.

The above discussion of the capabilities of different frequencies is necessarily brief. A further and more complete study of the problems involved is recommended for anyone operating a communications system. The Central Radio Propagation Laboratory of the National Bureau of Standards, Washington, D. C., U.S.A., publishes charts which predict ionospheric conditions 3 months in advance. With these charts and by following instructions contained in U. S. Department of Commerce, National Bureau of Standards Circular 462, "Ionospheric Radio Propagation", it is possible to choose with considerable accuracy the best operating frequency for a given time, path length, and geographical location. The prediction charts are in the form of a publication called "GRPL-D Basic Radio Propagation Predictions".

This publication is available on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., U.S.A. Copies of Circular 462 may be obtained from that office at $1.25 each, U. S. currency.

Fading

One additional, relatively uncontrollable factor, will effect reliable communications. This is the phenomenon known as "FADING". The term fading refers to rapid changes in the strength of received radio signals which vary with time because of fluctuations in the ionosphere. Fading may take place with a duration of minutes, seconds, or even fractions of a second. In general, fading is more rapid on high frequencies than on low frequencies. There are many types of fading but only three need be considered in this discussion; Selective Fading, Absorption Fading, and Skip Fading.

S lective Fading

Selective Fading may be caused by many factors, however only its effect is important. In selective fading, some frequencies fade, while others are propagated. In conventional AM transmission, it is quite common to experience fading of either of the sidebands or the carrier, or both the carrier and one sideband simultaneously. Such fading in addition to causing variations in received signal intensity can create distortion of AM radio telephone signals. This type of fading is minimized by the RCA SSB-1 Mark IIA since only one sideband is transmitted at any given time and the carrier is suppressed.

Abs rpti n Fading

As the name implies, absorption fading is caused by variations in the amount of energy absorbed from the radio wave by the ionosphere. This type of fading is in general much longer than selective fading since ionospheric absorption changes very slowly. There is a similar type of fading which might be referred to as Absorption Fading which is caused by absorption of radio signals by physical objects rather than the ionosphere.

This type of fading may be caused in a mobile receiver when the vehicle passes under a bridge or near a metal structure. In this case the signal is absorbed by the nearby structure. When there are nearby objects such as wires, fences, bridges, oil tanks, steel buildings, etc., which can cause these effects, extreme care must be exercised in selecting a proper location for receiving antenna.

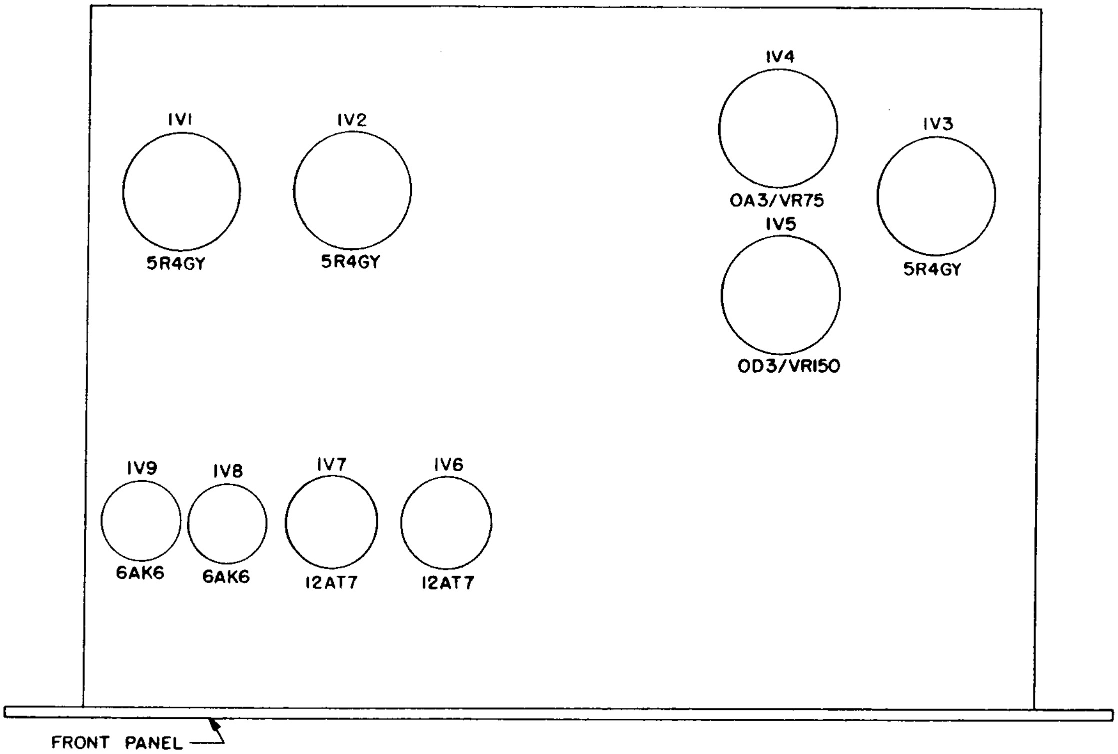
Skip Fading

Skip fading is caused by reflected radio waves alternately skipping and returning to earth. Near sunrise and sunset, when the ionization is changing, the frequencies in use may be rapidly reflected to different points on the surface of the earth. When the ionosphere changes to a point that the reflected signals move out past the receiving station (called "going into skip"), the intensity of the received signals at the receiving station may drop by a factor of 100 or more and momentarily increase again just as abruptly. This type of fading may take place many times before steady transmission is established. It is a good indication that propagation conditions are changing and either the day-time or night-time frequency should be established.

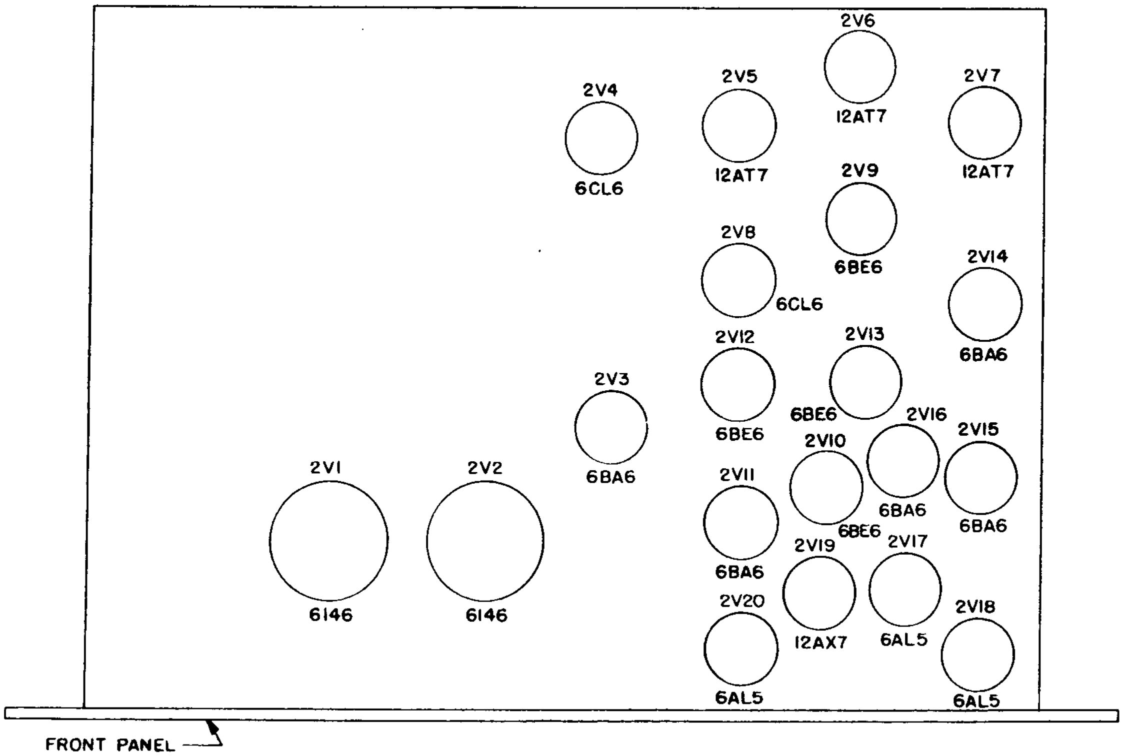
All fading is minimized in the SSB-1 Mark IIA through the use of automatic gain control in the receiver. This circuit automatically increases the gain of the receiver when the received signal decreases in intensity. Conversely, it lowers the gain of the receiver when the intensity of the received signal increases. This tends to keep audio output constant during such periods.

7. SHUTTING DOWN

When shutting down for short periods of time, turn the TRANSMITTER and RECEIVER switches off. If the shutdown is to be for more than a few hours, turn off the POWER switch also.



POWER SUPPLY CHASSIS



TRANSMITTER-RECEIVER CHASSIS

Figure 25. Tub L cati n Diagram

SECTION V. MAINTENANCE

1. GENERAL

The SSB-1 Mark IIA receiver should maintain correct alignment for a reasonably long period of time. Readjustment of tuned transformers and coils is not normally necessary unless they have been misaligned. Refer to the alignment procedure when alignment becomes necessary.

The only necessary routine maintenance is a periodic cleaning of the chassis and an inspection of the connections to the terminal boards on the rear of the chassis. All connections should be kept clean and tight. Arrange all wires and cables in an orderly manner to prevent the possibility of arc-over or shorts. Replace any wires that show signs of cracking or deterioration.

Knob Removal

The knobs on the front panel may be removed, when necessary, by loosening the set screws on the sides of the knobs. Use a #8 Allen set-screw wrench. There are two set screws on each knob except the CHANNEL knob which has only one.

Trouble Shooting

80% of all breakdown or faulty operation of radio communication equipment may usually be attributed to defective vacuum tubes. Since a defect in a tube is very often a filament "burn-out", visual inspection is advisable before servicing. A reliable tube tester may be required when checking for weak tubes. However, the substitution of tubes with good tubes is a faster method for finding defective tubes and restoring operation quickly.

Test equipment for trouble shooting need not be extensive. A vacuum tube voltmeter (with R-F probe), a signal generator with audio modulation and an oscilloscope will serve for all servicing. Equipment for alignment purposes is listed under CHECKING AND ALIGNMENT.

One of the first steps in troubleshooting is to make a careful visual inspection of all components under the chassis. Look for signs of burning or overheating of components. Also check for loose connections and poorly soldered joints.

If there is no physical evidence to indicate the location of the failure, and it is evident that the power supply is supplying B-plus and filament voltages, the next step is to isolate the trouble.

Signal tracing is the best method for quickly isolating trouble in a receiver. To do this, inject an audio signal at the grid of the audio amplifier tubes. If the audio signal can be heard from the speaker, the audio circuits are functioning. In a similar manner, a modulated R-F signal may be applied to various points in the R-F amplifier and detector circuits. After determining which circuit is causing the loss of signal, a voltmeter will generally indicate the defective component.

Voltages and resistance charts for measurements at tube sockets are shown in Tables 3, 4 and 5. Measurements are given using both the RCA WV-98A Senior "VoltOhmyst" (VTVM) and the Simpson model 260 voltohmmeter. Measurements in high-frequency communications equipment should always be made with a high impedance meter. Low impedance instruments tend to "load down" high-frequency circuits and may give erroneous indications which can cause improper operation and subsequent damage to the equipment.

All adjustments and all tubes are accessible by merely loosening the four thumb-bolts at the corners of each of the two units, grasping the handles and gently pulling the units forward. Care should be taken when withdrawing the units to make sure that all cable and wire connections at the terminal boards at the rear of the chassis have sufficient slack so that excessive strain or unwanted disconnections do not occur.

Chassis Removal

Both chassis of the SSB-1 Mark IIA equipment may be completely removed from the cabinet when necessary.

To accomplish this, first remove all wires and cables from the rear of the chassis to be removed. Next, loosen the large thumb screw near each corner of the front panel sufficiently to release the chassis from the cabinet.

Pull the chassis out on its rollers as far as it will go.

Place hands under each side of the chassis at the front. Lift up the front part of the chassis as far as possible, then pull the chassis up and out causing the chassis rollers to roll up and over the stops on the chassis slide.

2. VACUUM TUBES

Breakdown or faulty operation of radio communication equipment may usually be attributed to defective vacuum tubes. Locate the chassis in which faulty operation occurs, by use of the trouble shooting procedure given below, and attempt to locate the tube that is defective. If it is impossible to localize the defective stage, change all tubes, one at a time, and either check in a tube tester or substitute a new tube. The tube complement is listed in the Technical Summary of Section I, tube locations are shown in Figure 25.

3. TROUBLE SHOOTING

In the event of equipment breakdown, it is first necessary to sectionalize the trouble to either the power supply chassis, which includes power supply and audio circuits, or the transmitter-receiver chassis, which includes the oscillator, transmitter and receiver circuits. Secondly, it is necessary to localize the trouble to a particular stage. The following procedure not only will assist in locating the trouble source but will also act as an overall check of optimum system performance after repairs have been made.

a. TEST EQUIPMENT—The following test equipment is required to check and align the SSB-1 Mark IIA.

(1) Vacuum Tube Voltmeter with R.F. probe.
(2) Calibrated Signal Generator.
(3) Oscilloscope.
(4) Calibrated Audio Ooscillator.
(5) Dummy Antenna: Any 100 watt noninductive resistor with a resistance between 10 and 80 ohms in series with a transmitting type mica capacitor of at least 300 uuf.

b. TEST PROCEDURE — Performance of these tests presupposes that the technician is familiar with the operating procedures given in Section IV. Follow the step-by-step procedure, checking that panel lamps light, an audio response is obtained at the receiver output and the PA Grid indicator indicates modulation of the transmitted output.

c. TROUBLE SHOOTING INFORMATION — The following photographs and charts are included in this book to facilitate the localization of a trouble source within the equipment.

Figure 25. Tube Location Diagram
Figure 26. Power Supply, Top View
Figure 27. Power Supply, Bottom View
Figure 29. Remote Desk Set
Figure 30. Transmitter-Receiver, Top View
Figure 31. Transmitter-Receiver, Bottom View
Figure 37. Power Supply Schematic
Figure 38. Transmitter-Receiver Schematic
Tables 3 & 4. Tube Socket Voltages

d. OPERATIONAL AND VOLTAGE CHECK— Perform a complete check of the equipment under various operating conditions. The receiver may be checked using transmission from another single-sideband station or using an accurately calibrated signal generator adjusted to a frequency in the sideband range for the channel being checked. The transmitter may be checked using either a single-sideband receiver or an AM receiver with a beat-frequency oscillator to listen to the signal. Note any faulty operation or improper signal and proceed to find the trouble and correct it before making final adjustments.

4. CHECKING AND ALIGNMENT

The following alignment procedure describes the tuning and adjustment procedures of all circuits of the SSB-1 Mark IIA. Normally a complete realignment of the Mark IIA would not be necessary unless tests proved an absolute need for it. If a defective part, such as an IF transformer is replaced, only that part of the circuit affected by the replacement would be realigned.

Power Supply

CAUTION: Make sure that the power is off before making the following adjustments.

Connect an ohmmeter between 1TB2, terminal 2, and the chassis. Set the low voltage power supply bleeder resistor 1R3 to 1500 ohms. Disconnect the ohmmeter and turn on the POWER and RECEIVER switches. The voltage across 470 ohm resistor, 1R4, should be approximately 17.5 volts and VR tubes 1V4 and 1V5 should ignite within 10 seconds. If the voltage across 1R4 is not approximately 17.5 volts, adjust bleeder resistor 1R3. Turn on power switch (T) (1S1) on the Power Supply. Maintain the line voltage at 115 volts during the tests as follows:

250 kc Oscillator Adjustment

1. Turn on the Receiver switch (U) (1S2).

2. Connect a frequency counter between test point 2TP3 and the chassis. The frequency of the signal at 2TP3 shall be adjusted to 250 kc at ± 1.0 cps, using capacitor 2C72. Disconnect the frequency counter from 2TP3.

3. Using a VTVM, measure the AC voltage at 2TP3. The voltage shall be 3 ± 0.5 volts. Disconnect the VTVM from 2TP3.

1150 kc, 1650 kc, Oscillator Adjustment

1. Connect the VTVM (set for AC volts) between 2TP2 and the chassis. A reading of 3 ± 1.5 volts should be obtained with Sideband Switch (K) on Lower and Upper. Disconnect the VTVM from 2TP2.

2. Connect the frequency counter between test point 2TP2 and the chassis.

3. With Sideband switch (K) set to Lower adjust capacitor 2C69 for 1150 kc ± 1 kc.

4. With Sideband switch (K) set to Upper adjust capacitor 2C68 for 1650 kc ±1 kc.

Channel Selector Oscillator Adjustments

1. Connect the VTVM between test point 2TP1 and the chassis. A voltage reading of between 0.8 and 1.2 volts should be obtained for each of the four channels. Disconnect the VTVM.

2. Connect the frequency counter between 2TP1 and the chassis. Adjust the frequency counter between 2TP1 and the chassis. Adjust the frequency of the oscillator, using capacitors 2C51, 2C50, 2C49 and 2C48 (for channels 1 to 4 respectively) to within ±10 cps of the nominal crystal frequency. Disconnect the frequency counter from 2TP1.

Receiver Alignment

1. Set the Receiver AF Gain control (J) (2R107) to its maximum clockwise position. Set the Speaker-Handset switch (L) (1S5) to Handset. Set the Squelch control (B) and the Noise Control (D) counter-clockwise and the AGC switch (A) to OFF.

2. Connect the AC voltmeter between test point 1TP1 and the chassis (power supply chassis).

3. Apply a CW signal of 251.9 kc between 2TP5 and the chassis. Adjust the signal generator output level to provide 0.5 volts as indicated by the AC voltmeter.

4. Adjust the bottom cores of transformers 2T4 and 2T6 for maximum output reading on the AC voltmeter. Reduce the output level of the signal generator as necessary to maintain the output level at 0.5 volts.

5. Adjust the top cores of transformers 2T6, 2T4 and capacitors 2C96 and 2C100 for maximum output, reducing the signal level when necessary as explained above.

6. Set the signal generator to 251.5 kc. With the VTVM connected to 2TB3-AGC, and the AGC control (A) in the FAST position, peak transformer 2T5 for maximum output.

7. Carefully tune the signal generator through the frequency range of 250.3 kc to 253.2 kc. Retune the generator to the frequency at which the AC voltmeter reads the highest output. Adjust the signal generator output level for 0.5 volts as indicated on the AC voltmeter. Maintaining the signal generator output level constant, again tune the generator through 250.3 kc to 253.2 kc, while observing the output readings. The output level should not decrease more than 3.0 db peak to valley within the range. If the receiver does not meet this requirement, readjust capacitor 2C100 and repeat this step from the beginning.

8. Tune the signal generator to 251.5 kc. Adjust the signal generator output level for a reading of 0.5 volts on the AC voltmeter. The signal generator output level should not exceed 60 microvolts.

9. Adjust the signal generator to 249.0 kc. Adjust the generator output level to 0.5 volts as indicated by the AC voltmeter. The generator output level should be at least 60 db (1000 X) higher than in step 8.

Receiver Bandpass Filter Response

1. With the test equipment still connected as for the preceding steps, adjust the signal generator to 250.3 kc and the generator output level so that approximately 0.5 volts is obtained on the AC voltmeter.

2. Carefully tune the signal generator (output level held constant) toward 253 kc. Select the highest peak at approximately 251.5 kc and adjust the signal generator for a convenient reading on the db scale (approximately 0.5 volt).

3. Maintaining the signal generator output level constant, carefully tune the generator *lower* in frequency to that frequency which results in a 6.0 db loss in output level. The generator should be tuned to 250.4 kc ±100 cps at this point.

4. Carefully tune the signal generator higher in frequency to 253 kc. The output level, as indicated by the AC voltmeter, should not be more than 6.0 db below reference level at any frequency between the frequency obtained in step 3 above 253 kc.

5. Continue tuning the signal generator higher in frequency until the output level is 6.0 db below reference level.

6. The total bandpass between the 6.0 db points should be 3.250 kc ±150 cps. (Frequency obtained in step 3 above subtracted from the frequency obtained in step 5 above.) Disconnect the signal generator from test point 2TP5.

Transformer 2T3 Alignment

1. Connect the signal generator between test point 2TP4 and the chassis. Set the RF Gain control (F) to the maximum clockwise position.

2. Adjust the generator frequency to 1401 kc and adjust the level to provide an output of 0.5 volts on the AC voltmeter still connected to test point 1TP1.

3. Tune the top and bottom cores of transformer 2T3 for maximum voltmeter reading, reducing the generator output level as necessary to obtain 0.5 volt output. The signal level required should not exceed 20 microvolts for 0.5 volts output. Disconnect the signal generator from 2TP4.

Receiver R.F. Alignment

1. Connect the output of the signal generator between the relay side of the antenna coil (2L1) and the chassis. (The AC voltmeter is still connected between 1TP1 and the chassis; Receiver Gain control is in the maximum clockwise position; the Speaker-Handset switch is in the Handset position.)

2. Set the channel selector switch to the channel #1 position.

3. Adjust the signal generator to the channel 1 frequency. Adjust the signal generator output level to obtain 0.5 volts output on the AC voltmeter.

4. Adjust the cores of 2L21 and 2L17 for maximum voltmeter reading, reducing the generator output level as necessary to obtain 0.5 volts output at 1TP1.

5. Reduce the signal generator output to zero. Adjust the RF Gain control for 0.16 volts noise output as indicated by the AC voltmeter. Increase the signal generator output level until 0.5 volts output is obtained on the voltmeter. The generator output level should not exceed 1.0 microvolts.

6. Set the Channel Selector switch to the #2 position. Repeat steps 1 to 5 with the signal generator tuned to the channel 2 frequency, adjusting 2L20 and 2L16 (step 4).

7. Set the Channel Selector switch to the #3 position. Repeat tests as in steps 1 to 5 with the signal generator tuned to the channel 3 frequency, adjusting 2L19 and 2L15 (in step 4).

8. Set the Channel Selector switch to the #4 position. Repeat test as in steps 1 to 5 with the signal generator tuned to the channel 4 frequency, adjusting 2L18 and 2L14 (step 4).

9. Check upper sideband sensitivities of channels 1, 2, 3 and 4.

Receiver Power Output

With the test equipment still connected as in the preceding tests set the Channel Selector switch to the #1 position. Set the Receiver Gain control to the maximum clockwise position. Tune the signal generator to the channel 1 frequency. Beginning with the generator output controls adjusted for zero output, increase the output level until a receiver output of 1.8 volts is obtained, as indicated by the AC voltmeter. (1.8 volts across 5 ohms—1 watt.) The signal input to the receiver should not exceed 2.0 microvolts. Disconnect test equipment connections to the receiver.

Squelch

1. Set AGC switch Ⓐ to OFF; turn Receiver RF Gain Ⓕ to maximum clockwise position.

2. Adjust the signal generator to the channel frequency at 10 microvolts.

3. Adjust the Squelch control Ⓑ to just pass the signal.

4. A 5 microvolt signal should be −30 db below reference output.

5. Set AGC switch Ⓐ to FAST.

6. Adjust the Squelch control to pass 10 microvolts.

7. A 1 microvolt signal should be −30 db minimum below reference output.

AGC

1. Set the AGC switch Ⓐ to FAST; RF Gain control Ⓕ to maximum clockwise position.

2. Adjust audio output level to 0.5 volts.

3. The RF variation between 10 and 10,000 microvolts should produce no greater than 10 db change in audio level.

Fidelity

1. Connect the audio oscillator to 2V20, pin 2 and ground.

2. Vary the oscillator frequency between 300 and 3000 cycles, maintaining a constant input level.

3. Check that the output does not vary more than ±3 db over the frequency range.

Transmitter Adjustments

1. Set meter switch Ⓒ to the PA PLATE CURRENT position.

2. Connect a telegraph key to the key jack (on the power supply panel).

3. Turn the Transmitter Gain control Ⓔ to the maximum counterclockwise position. Set the Phone/Telegraph switch Ⓝ to the Phone position.

4. Connect an audio oscillator to terminals 14 and 15 of 1TB2 (power supply chassis) set to 1900 cps, output at maximum, and set the Transmitter switch Ⓥ to the ON position. With the telegraph key closed, adjust potentiometer 1R7 (power supply chassis) for 55–60 ma on the meter. Turn off Transmitter switch Ⓥ. Open the telegraph key.

5. From a fully counterclockwise position, rotate IPA Plate Tank Coil Slug 1 (2L8) the number of turns required to tune to the desired output frequency of channel 1. The number of required turns relative to the desired frequency is given in Section III, par. 8 b, and is also shown in graphical form in Figure 17.

6. Place tap 1 of the PA Tuning Coil (2L2) at the number of turns from the cold end (end closer to the Antenna Tuning Coil) required to tune to the desired output frequency of channel 1. The required number of turns relative to the desired frequency is given in Section III, par. 8 c, and is also shown graphically in Figure 16.

7. Adjust the associated components for channels 2, 3 and 4 by repeating the procedure of 5 and 6 above.

8. Set coupling capacitors 2C1, 2C2, 2C3 and 2C4 for maximum capacitance (fully counterclockwise).

9. Set taps 1, 2, 3 and 4 of antenna tuning coil 2L1 on the turn closest to the antenna terminal post.

10. Set the meter switch (C) to the PA Plate Current position.

11. Set the channel selector switch to the #1 position. Set the Transmitter Gain control (E) to its maximum clockwise position.

12. Turn on the transmitter switch V . Close the telegraph key. Adjust capacitor 2C27 for maximum deflection of the meter. Reduce the transmitter gain as necessary to keep the meter reading below 90 ma. The first indication may be very small. Turn 2L8 for maximum deflection. Repeat the adjustment of 2C27 and 2L8 until maximum deflection of the meter is obtained. Check that the circuit is tuned to the correct frequency by turning the Transmitter Gain control to the maximum counterclockwise position. The meter should read 60 ma.

13. Turn the Transmitter Gain control clockwise until the neon Peak Modulation Indicator lights. Back off the gain control until the neon indicator lamp extinguishes. Reduce the Transmitter Gain as necessary to maintain this condition as the top and bottom cores of transformer 2T1, and 2C27 and 2L8 are retuned for a peak meter reading.

14. Repeat steps 12 and 13 above for Channel Selector positions 2, 3 and 4. Tune 2L7 and 2C26; 2L6 and 2C25; and 2L5 and 2C24, respectively. Do *not* retune transformer 2T1.

15. Turn the Channel Selector switch to the #1 position. Adjust 2C8 for minimum meter reading. Repeat this step for channel 2, 3 and 4, adjusting capacitors 2C7, 2C6 and 2C5 respectively. Release the telegraph key and turn off the transmitter switch.

16. Connect the dummy R.F. load between the Antenna Post (2E4) and the chassis.

17. Turn on the Transmitter switch (V). Close the telegraph key. Turn the Sideband switch to suppressed carrier and change tap #1 of 2L1 one turn at a time. At each turn put SIDEBAND switch to FULL CARRIER and note the plate current reading. Repeat this procedure until a peak value of plate current is obtained. This is the correct tap setting for 2L1. Readjust P.A. PLATE TUNING CAP 1 (2C8) for a dip in plate current. Only a slight variation of the capacitor should be required if the antenna circuit has been properly resonated.

> NOTE: If unable to note any rise in P.A. plate current as the antenna coil tap is changed, increase the coupling to the antenna circuit by rotating ANTENNA COUPLING CAP 1 (2C1) clockwise one or two turns, return P.A. PLATE TUNING CAP 1 (2C8) for a dip in plate current and repeat the procedure in par. 8 p and q of Section III.

18. Set the SIDEBAND switch to suppressed carrier and raise the TRANSMITTER GAIN control setting. Full load conditions are obtained if the P.A. GRID indicator lights coincident with 190–200 ma of plate current.

19. If the P.A. GRID indicator lights coincident with P.A. plate current below 190 ma, turn capacitor 2C1 clockwise in small increments, dipping the plate current with capacitor 2C8 after each change. Raise the TRANSMITTER GAIN setting after each change until full load conditions exist.

20. If the P.A. GRID indicator lights coincident with plate current in excess of 200 ma, turn capacitor 2C1 counterclockwise, dipping the plate current with 2C8, until conditions of full load exist.

21. Align channels 2, 3 and 4 by repeating steps (17) through (20) above, using the proper P.A. tuning and coupling capacitors for each channel.

22. P.A. NEUTRALIZATION — The setting of the P.A. neutralizing capacitor 2C15 will seldom require adjustment. A need for re-neutralization will be apparent if excessive plate dissipation in the P.A. tubes is noted with full output (plate slightly red) or if any oscillatory condition exists, usually at the higher frequencies.

If neutralization adjustment is required, connect a 0–3 amp (or lower) RF ammeter in series with the dummy antenna. Set the panel meter to the P.A. PLATE CURRENT position. With the transmitter controls set as for channel alignments and the CHANNEL switch set for the highest frequency channel, advance the TRANSMITTER GAIN control for approximately 130 ma of P.A. plate current and vary the plate tuning capacitor for that channel through resonance as indicated by the dip in P.A. plate current. Also note the reading of RF ammeter. The dip in plate current should coincide with maximum current, as indicated on the RF ammeter, when the P.A. is properly neutralized. If this is not the case, vary the setting of neutralizing capacitor 2C15 in small increments until plate current dip and maximum output current are coincident. Tighten the locking screws on capacitor 2C15 and recheck the neutralization.

23. Couple an oscilloscope vertical input to the transmitter output circuit using a pick-up coil placed near the transmitter antenna coil.

24. With the TRANSMITTER GAIN control in the maximum counterclockwise position, set the transmitter switch to the ON position. Adjust the 'scope controls for a convenient signal amplitude on the screen. Set the SIDEBAND switch to suppressed position. Depress the key.

25. Set the TRANSMITTER GAIN to the maximum counterclockwise position. With no audio input, adjust 250 kc balance (2C43 and 2R27) and 1150/1650 kc balance (2C34 and 2R16) for minimum output on the 'scope. This adjustment is critical and should be done in steps as there will be interaction between the controls. Adjust the 250 kc balance first and the 1150/1650 kc balance second.

26. Close the telegraph key circuit. Increase the TRANSMITTER GAIN to the setting just below the point at which the indicator neon lights. Using the 'scope attenuators, measure the attenuation required to produce the same amplitude as at the end of step 25 above. At least 50 db will be required. Remove the 'scope pick-up coil from the vicinity of the antenna coil. CAUTION—HIGH VOLTAGE.

Transmitter Bandpass Filter Response

1. Set the Channel Selector switch to the channel #1 position.

2. Set the Transmitter switch to the ON position. Close the telegraph key. Adjust the audio oscillator output level to just below the point which causes the neon indicator to light.

3. Couple the oscilloscope vertical input to the transmitter output circuit using a pick-up coil placed near the transmitter output circuit using a pick-up coil placed near the transmitter antenna coil. Adjust the 'scope vertical gain control for a convenient amount of vertical deflection on the screen.

4. Holding the audio oscillator output level constant, vary the oscillator frequency about the 1900 cps setting. Set the oscillator at the frequency which results in the highest output indication on the scope. Adjust the vertical gain control of the 'scope for a convenient deflection.

5. Vary the frequency of the audio oscillator (holding the output level constant) between 300 and 3000 cps while observing the amount of deflection on the scope. The maximum peak to valley ratio within the range should be 3 db. Adjust capacitors 2C139 and 2C140 if the peak to valley requirement is not met and repeat the procedure beginning with step 4 above.

6. With the oscillator again adjusted to the frequency of the highest peak (approx. 1900 cps) adjust the oscillator lower in frequency until the output level indicated on the 'scope is down 6 db (50%). This point will be reached when the oscillator frequency is 300 $\pm$100 cps.

7. Continue to adjust the audio oscillator higher in frequency until a 6.0 db (50%) drop in output is indicated.

8. The difference between the frequencies obtained in step 6 and step 7 above should be 3250 $\pm$150 cps.

NOTE: If an audio oscillator is not available, temporary field adjustments may be made using the tone oscillator (1000 cps) in the Mark IIA. In this case, adjust 2C139 and 2C140 for a max. response on the 'scope. (Permanent adjustments should be made at earliest opportunity using the proper frequency.)

Carrier Level Adjustment

1. Adjust the audio oscillator frequency to 1000 cps.

2. Determine which channel requires the most audio signal to light the neon indicator. With the transmitter operating on this channel, adjust the TRANSMITTER GAIN control just below the setting at which the neon indicator lights.

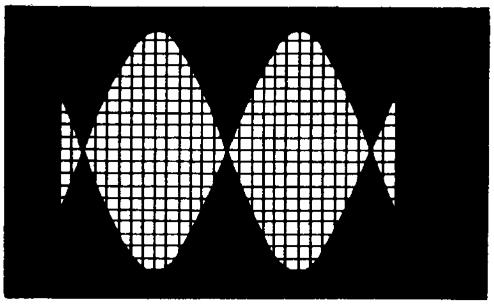
3. Adjust the oscilloscope vertical gain control for a convenient deflection.

4. Turn the TRANSMITTER GAIN to the maximum counterclockwise position.

5. Set the SIDEBAND switch to the FULL CARRIER position. Adjust 2C40 for a deflection of the 'scope of 50% of the amount of deflection in step 3 above.

6. Set the SIDEBAND switch to the SUPPRESSED CARRIER position. Adjust the TRANSMITTER GAIN control for the same amount of deflection on the 'scope as in step 5 above.

7. Set the SIDEBAND switch to the carrier IN position. The amount of deflection should now be twice the deflection of step 5 and should be symetrical about the cross-over (base line). Reset the SIDEBAND switch to the SUPPRESSED carrier position.



Transmitter Maximum Power Output

With the transmitter operating on the same channel as for the "Carrier Level Adjustment" but with the TRANSMITTER GAIN control set to its maximum clockwise position, adjust the audio input (1000 cps) level to the point at which the neon modulation indicator lights. The input level measured between the Transmitter-Receiver chassis 1TB2 terminals 14 and 15 should be less than 1.0 volts rms. (Turn the Transmitter off to read level.) Disconnect the audio oscillator from 1TB2, 14 and 15.

Voice Modulation Test

With the transmitter still operating on the same channel as for the preceding test, voice modulate using the handset microphone. A normal conversational level into the microphone should cause the Modulation Indicator to light on peaks with the TRANSMITTER GAIN control at half rotation or less from extreme counterclockwise setting.

5. ROUTINE MAINTENANCE

The SSB-1 Mark IIA can be maintained at peak performance without the need of frequent service by keeping the equipment clean and free of dust and maintaining adequate inspection schedules. The frequency of these schedules will be determined by the conditions under which the equipment must function. Routine maintenance records should be kept on prepared forms so that a continuous record of performance may be had for reference. Records may then be compared and an evaluation made of the performance of the equipment.

A typical routine maintenance schedule is suggested below. The frequency of performance of maintenance procedures will vary according to operating conditions; for example, cleaning may be required more frequently in extremetly dusty locations.

ROUTINE MAINTENANCE SCHEDULE

DAILY

Make general inspection.
See that all tube and tube shields are firmly seated.
Replace burned-out tubes and lamps.

WEEKLY

Remove all dust and dirt from the equipment.
Check all cables and leads for secure connections and correct lead dress.

MONTHLY

Make performance checks.
Clean all relay contacts.
Test tubes; replace weak tubes.

TABLE 3 — TUBE SOCKET VOLTAGES

Readings taken with 20,000 Ohms/Volt Voltmeter (Simpson 260)

CONDITIONS: All readings are DC and were taken from tube pin to ground, unless otherwise noted.
Squelch - CCW, Noise Limiter - CCW, RF Gain - CW.

Tube Type and Symbol	Pin Numbers								
	1	2	3	4	5	6	7	8	9	Cap
1V1 5R4GY	0	780	0	850 ac	0	850 ac	50 ac	780	-	-
1V2 5R4GY	30 ac	780	40 ac	850 ac	0	850 ac	3 ac	780	-	-
1V3 5R4GY	-30	220	48 ac	375 ac	40 ac	375 ac	-100	220	-	-
1V4 0A3	-90	-75	0	190	G	0	6.3 ac	0	-	-
1V5 OD3	3 ac	0	27 ac	6.3 ac	150	6.3 ac	0	3 ac	-	-
1V6 12AT7	90	0	1	6.3 ac	6.3 ac	0	0	0	G	-
1V7 12AT7	190	30	50	6.3 ac	6.3 ac	60	-0.2	0.5	G	-
1V8 6AK6	0	8.2	6.3 ac	0	185	190	8.2	-	-	-
1V9 6AK6	0	0	6.3 ac	0	190	190	0	-	-	-
2V1* 6146	G	6.3 ac	200	G	-42	G	G	G	-	750
2V2* 6146	G	6.3 ac	200	G	-42	G	G	G	-	750
2V3* 6BA6	-42	G	G	6.3 ac	170	180	G	-	-	-
2V4* 6CL6	5	0	160	G	6.3 ac	160	G	160	0	-
2V5* 12AT7	156	0	2.6	6.3 ac	6.3 ac	155	0	2.6	G	-
2V6* 12AT7	125	0	3.4	6.3 ac	6.3 ac	125	0	3.4	G	-
2V7* 12AT7	120	0	0	6.3 ac	6.3 ac	120	0	0	0	-
2V8 6CL6	G	-4.8	150	6.3 ac	G	25	G	150	-4.8	-
2V9 6BE6	-0.25	G	G	6.3 ac	90	50	40	-	-	-
2V10 6BE6	-1.3	0	G	6.3 ac	120	45	45	-	-	-
2V11 6BA6	0	0.7	G	6.3 ac	125	60	0.7	-	-	-
2V12 6BE6	0	1.8	G	6.3 ac	185	75	0	-	-	-
2V13 6BE6	0	1.3	G	6.3 ac	137	67	0	-	-	-
2V14 6BE6	0	7.5	G	6.3 ac	195	65	3.5	-	-	-
2V15 6BA6	0	1.8	G	6.3 ac	185	80	1.8	-	-	-
2V16 6BA6	0	1.5	G	6.3 ac	190	65	1.5	-	-	-
2V17 6AL5	0	-5.8	G	6.3 ac	G	-	-0.3	-	-	-
2V18 6AL5	90	-0.1	G	6.3 ac	2	-	-90	-	-	-
2V19 12AX7	0	-90	-85	6.3 ac	6.3 ac	150	0	1.3	G	-
2V20 6BE6	-5.2	-5.2	G	6.3 ac	-5.2	-	-5.2	-	-	-

* Key closed, TELEGRAPH-PHONE switch in TELEGRAPH position.

TABLE 4 — TUBE SOCKET VOLTAGES

Readings taken with Vacuum Tube Voltmeter (RCA-WV97A)

CONDITIONS: *All readings are DC and were taken from tube pin to ground, unless otherwise noted.*

Squelch - CCW, Noise Limiter - CCW, RF Gain - CW.

Tube Type and Symbol	*Pin Numbers*									*Cap*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	
1V1 5R4GY	0	780	0	850 ac	0	850 ac	50 ac	780	-	-
1V2 5R4GY	30 ac	780	40 ac	850 ac	0	850 ac	3 ac	780	-	-
1V3 5R4GY	-30	220	48 ac	375 ac	40 ac	375 ac	-100	220	-	-
1V4 0A3	-88	-74	40 ac	190	G	0	0.7	0	-	-
1V5 OD3	2.8 ac	G	43 ac	6.3 ac	150	42 ac	40 ac	3 ac	-	-
1V6 12AT7	180	0.2	1	6.3 ac	6.3 ac	0	0	0	G	-
1V7 12AT7	200	32	48	6.3 ac	6.3 ac	60	-0.8	0.5	G	-
1V8 6AK6	0	8.4	6.3 ac	0	190	200	8.4	-	-	-
1V9 6AK6	0	0	6.3 ac	0	200	200	0	-	-	-
2V1* 6146	G	6.3 ac	190	G	-40	G	G	G	-	750
2V2* 6146	G	6.3 ac	190	G	-40	G	G	G	-	750
2V3* 6BA6	-40	G	G	6.3 ac	170	180	G	-	-	-
2V4* 6CL6	4.8	0	158	G	6.3 ac	160	G	160	0	-
2V5* 12AT7	150	-1.8	3.3	6.3 ac	6.3 ac	150	0.7	3.3	G	-
2V6* 12AT7	120	0	3.8	6.3 ac	120	0	3.8	G	-	-
2V7* 12AT7	120	0	3.7	6.3 ac	6.3 ac	120	0	0	0	-
2V8 6CL6	G	-4.1	150	6.3 ac	G	25	G	150	-4.1	-
2V9 6BE6	-2.2	G	G	6.3 ac	92	46	42	-	-	-
2V10 6BE6	-3.2	0	G	6.3 ac	110	42	44	-	-	-
2V11 6BA6	0	0.6	G	6.3 ac	110	52	0.6	-	-	-
2V12 6BE6	0.48 ac	1.8	G	6.3 ac	195	78	0	-	-	-
2V13 6BE6	0.46 ac	1.4	G	6.3 ac	145	68	0.5 ac	-	-	-
2V14 6BA6	0	3.2	G	6.3 ac	190	63	3.2	-	-	-
2V15 6BA6	0	1.6	G	6.3 ac	180	80	1.6	-	-	-
2V16 6BA6	0	2.8	G	6.3 ac	190	60	2.8	-	-	-
2V17 6AL5	0	-90	G	6.3 ac	G	-	-0.6	-	-	-
2V18 6AL5	-90	-0.1	G	6.3 ac	2	-	-92	-	-	-
2V19 12AX7	0	-90	-85	6.3 ac	6.3 ac	150	0	1.3	G	-
2V20 6BE6	-7.5	-7.5	G	6.3 ac	-7.5	-	-7.6	-	-	-

* Key Closed, TELEGRAPH-PHONE switch in TELEGRAPH position.

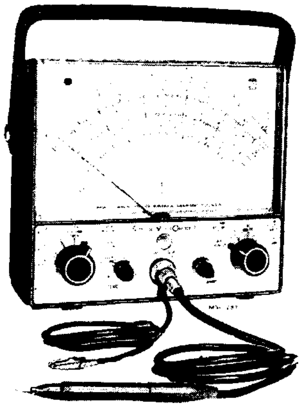
TABLE 5 — TUBE SOCKET RESISTANCES

Readings taken with Simpson 260 Meter

CONDITIONS: All readings were taken from tube pin to ground.

Tube Type and Symbol	Pin Numbers								Cap
	1	2	3	4	5	6	7	8	9	
1V1 5R4GY	∞	30K	∞	100	∞	100	∞	30K	-	-
1V2 5R4GY	∞	30K	∞	100	∞	100	∞	30K	-	-
1V3 5R4GY	7K	10K	∞	1.1K	∞	1.1K	1.1K	10K	-	-
1V4 0A3	1.1K	1.5K	∞	10K	0	25	∞	∞	-	-
1V5 OD3	0	0	∞	0	10K	∞	∞	0	-	-
1V6 12AT7	220K	2 meg	10K	0	0	∞	∞	∞	0	-
1V7 12AT7	10K	500K	7K	0	0	100K	1 meg	400	0	-
1V8 6AK6	40	600	0	0	10K	10K	600	-	-	-
1V9 6AK6	30	600	0	0	10K	10K	600	-	-	-
2V1 6146	0	0	∞	0	10K	0	0	0	-	30K
2V2 6146	0	0	∞	0	10K	0	0	0	-	30K
2V3 6BA6	10K	0	0	0	∞	∞	0	-	-	-
2V4 6CL6	240	0	∞	0	0	∞	0	∞	0	-
2V5 12AT7	∞	250K	1K	0	0	∞	250K	1K	0	-
2V6 12AT7	0	50K	1K	0	∞	∞	50K	1K	0	-
2V7 12AT7	∞	500K	1K	0	0	∞	600K	1.1K	0	-
2V8 6CL6	0	47K	10K	0	0	21K	0	10K	47K	-
2V9 6BE6	1 meg	0	0	0	30K	60K	120K	-	-	-
2V10 6BE6	1 meg	0	0	0	28K	120K	120K	-	-	-
2V11 6BA6	1 meg	100	0	0	20K	55K	100	-	-	-
2V12 6BE6	50K	5K	0	0	12K	30K	400K	-	-	-
2V13 6BE6	50K	5K	0	0	32K	32K	200K	-	-	-
2V14 6BA6	100K	1.6K	0	0	12K	220K	1.6K	-	-	-
2V15 6BA6	40	220	0	0	12K	60K	250	-	-	-
2V16 6BA6	43	1.2K	0	0	18K	25K	1.1K	-	-	-
2V17 6AL5	10K	140K	0	0	0	∞	5 meg	-	-	-
2V18 6AL5	1000	10K	0	0	2K	∞	210K	-	-	-
2V19 12AX7	100K	430K	7K	0	0	150K	620K	4.5K	0	-
2V20 6BE6	500K	210K	0	0	500K	∞	200K	-	-	-

TEST EQUIPMENT



RCA WV-98A Senior "VoltOhmyst"

DC VOLTMETER:
Seven continuous ranges. . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance (including 1 megohm in probe):
All Ranges . . . . . 11 megohms
Sensitivity for the 1.5-volt range . . . . . 7.3 megohms-per-volt
Overall accuracy . . . . . ±3% of full scale

AC VOLTMETER—Fourteen continuous ranges:
Peak-to-peak ranges . . . . . 0 to 4, 14, 42, 140, 420, 1400, 4200 volts
RMS ranges (for sine waves) . . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input resistance and capacitance with WG-299B set to AC-OHMS:
1.5, 5, 15, 50, 150-volt ranges—
0.83 megohm (min.) shunted by 70 mmf
500-volt range . . . . . 1.3 megohms shunted by 60 mmf
1500-volt range . . . . . 1.5 megohms shunted by 60 mmf
Frequency response with WG-299B set to AC-OHMS:
1.5, 5, 15, 50, 150, 500-volt ranges flat from 30 cps to 3 Mc for voltage source having 100-ohm impedance, or lower
Overall accuracy: All ranges . . . . . ±3% of full scale

MAXIMUM INPUT VOLTAGES:
DC voltage (with no ac voltage present) . . . . . 1500 volts
AC voltage (with no dc voltage present):
RMS for sine waves . . . . . 1500 volts
Peak-to-peak for sine waves . . . . . 4200 volts
Peak-to-peak for complex waves . . . . . 2000 volts
Combined ac and dc voltages: Sum of dc and peak ac voltages . . . . . 2000 volts

OHMMETER:
Seven continuous ranges . . . . . 0 to 1000 megohms
Center scale values . . 10, 100, 1000, 10,000 ohms; 0.1, 1, 10 megohms

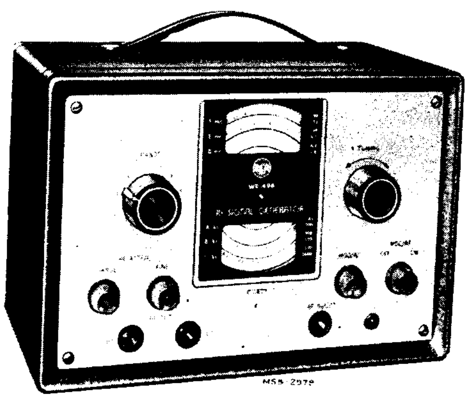
TUBE COMPLEMENT: 1 RCA-6AL5, 1 RCA-12AU7

POWER SUPPLY:
Voltage: 105-125 volts, 50-60 cps
Power Consumption (approx.) . . . . . 5 watts

BATTERY (1.5-volt cell) 1 RCA-VSO36

OVERALL DIMENSIONS . . . . . 6½" high, 7" wide, 3¾" deep

WEIGHT . . . . . 6 lbs. net



RCA WR-49B R-F Signal Generator

RF CHARACTERISTICS:
(Six Ranges):
"A" Range . . . . . 85 kc to 200 kc
"B" Range . . . . . 200 kc to 550 kc
"C" Range . . . . . 550 kc to 1600 kc
"D" Range . . . . . 1.6 mc to 4.8 mc
"E" Range . . . . . 4.7 mc to 14 mc
"F" Range . . . . . 13 mc to 30 mc

MAXIMUM RF OUTPUT VOLTAGES (open circuit value):
(All Ranges):
At RF OUT HI Connector . . . . . at least 0.05 rms volt
AT RF OUT LO Connector . . . . . at least 0.01 rms volt
Accuracy of Dial Calibration . . . . . ±1%
Attenuator Range . . . . . 65 db
Internal Modulating Frequency . . . . . approx. 400 cps
Internal Percentage of Modulation . . . . . adjustable up to 70%
Audio Frequency Output . . . . . at least 8 rms volts across 15,000-ohm load

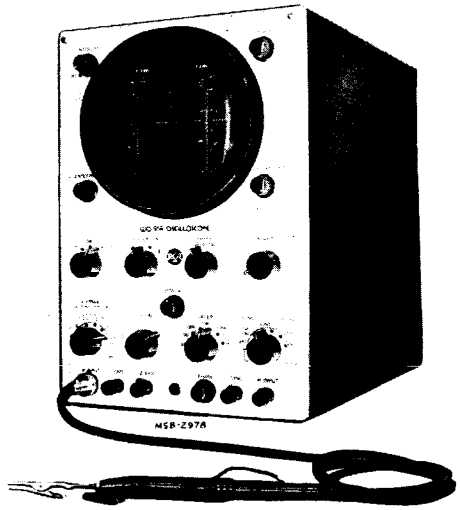
EXTERNAL MODULATION:
Modulating Frequency . . . . . 15 kc max.
Voltage required for 30% modulation using 400 cps . . . . 10 rms volts
Impedance at AF IN/OUT connector (400 cps) . . approx. 16,000 ohms

TUBE COMPLEMENT: 1 RCA-12AU7, 1 RCA-6C4

POWER SUPPLY:
Voltage: 105-125 volts, 50-60 cps
Power Consumption . . . . . 15 watts

WEIGHT: . . . . . 8 lbs. net

DIMENSIONS: . . . . . 7½" high, 10½" wide, 6" deep



RCA WO-91A Oscilloscope

SWEEP OSCILLATOR:
Frequency Range (continuously adjustable) . . . . . 10 cps to 100 kc
Preset Positions . . . . . 30 cps (TV "V"); 7875 cps (TV "H")

Z-AXIS INPUT:
Minimum input voltage for blanking . . . . . 12 rms volts
Frequency response . . . . . 3 cps to 500 kc

RISE TIME (Vertical Amplifier):
4.5 mc Positions . . . . . 0.1 usec
1.5 mc Positions . . . . . 0.5 usec

INPUT RESISTANCE AND CAPACITANCE (Vertical Amplifier):
At V INPUT Connector . . . . . 1 megohm shunted by 40 mmf
With WG-300A probe set to "DIRECT" . . . . . 1 megohm shunted by 75 mmf
With WG-300A probe set to "LOW CAP" . . . . . 10 megohms shunted by 11 mmf
Horizontal Amplifier
(At H INPUT terminal) . . . . . 2.2 megohms shunted by 30 mmf
SYNC Input Terminal . . . . . 0.5 megohm shunted by 35 mmf

FREQUENCY RESPONSE (Reference frequency, 10 kc)
Vertical Amplifier:
Wide-Band Positions (10 cps to 4.5 mc) . . . . . within ±1 db
Narrow Band (High-Sensitivity) Positions
10 cps to 0.5 mc . . . . . within —1 db
10 cps to 1.5 mc . . . . . within —6 db
Horizontal Amplifier (10 cps to 500 kc) . . . . . within —6 db

DEFLECTION SENSITIVITY:	4.5-mc (Wide-Band) Positions		1.5-mc (High-Sensitivity) Positions	
Vertical Amplifier:	rms	p-p	rms	p-p
At V INPUT Connector	0.053	0.15	0.018	0.05 volt/in
With WG-300A set to "DIRECT"	0.053	0.15	0.018	0.05 volt/in
With WG-300A set to "LOW CAP"	0.53	1.5	0.18	0.5 volt/in

Horizontal Amplifier (at H INPUT terminal) . . . . . 0.18 rms volt/in

POWER REQUIREMENTS:
Voltage . . . . . 105-125 volts, 50-60 cps
Average Power Consumption . . . . . 65 watts

TUBE COMPLEMENT: 1 RCA-6AN8, 2 RCA-6J6, 1 RCA-12AT7, 1 RCA-12AU7, 1 RCA-12AX7, 1 RCA-563-GT, 1 RCA-1V2, 1 RCA-5UP1

DIMENSIONS: . . . . . 13½" high, 9" wide, 16½" deep

WEIGHT: . . . . . 30 lbs. net

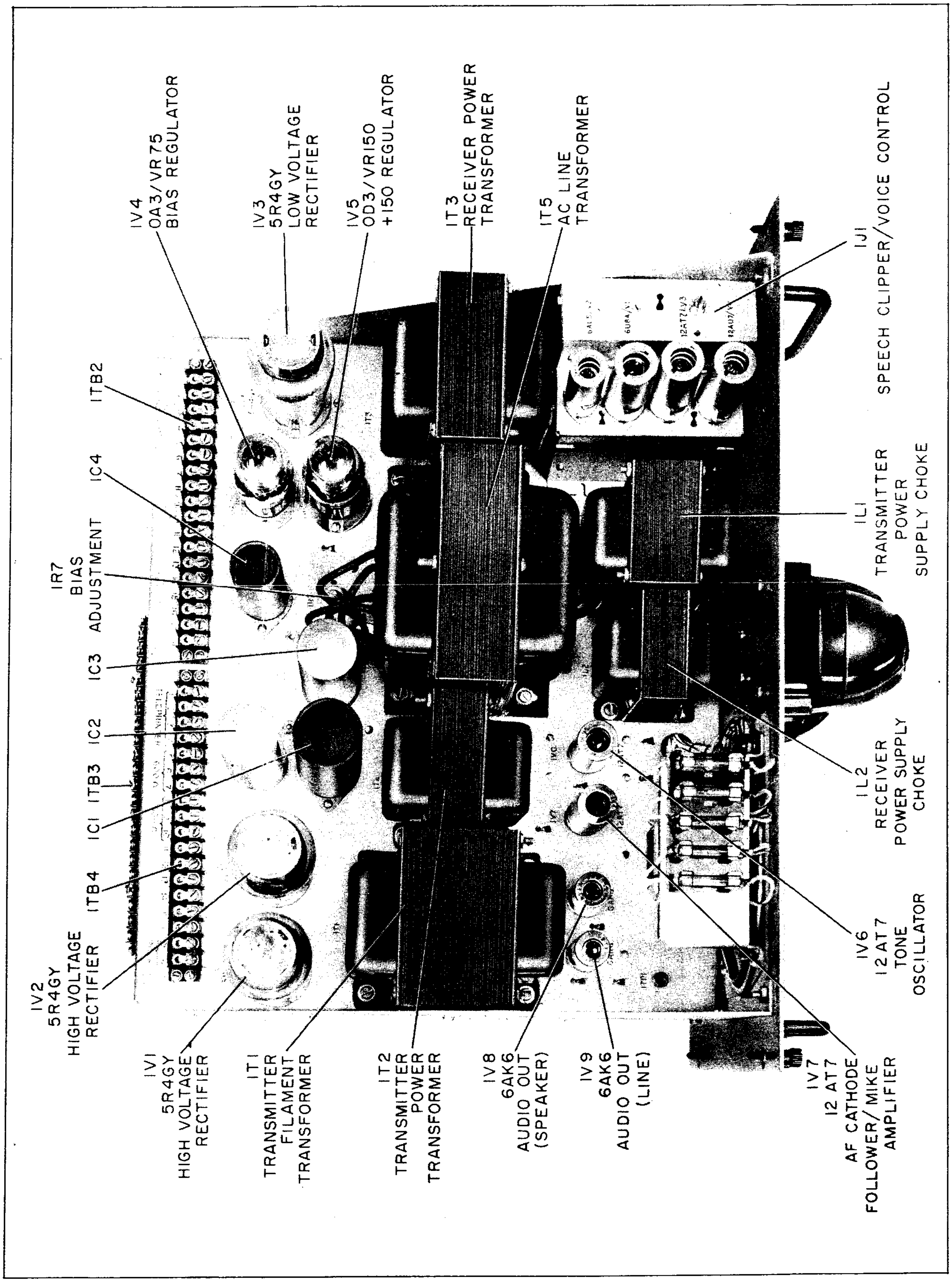


Figure 26. Pow r Supply, T p View

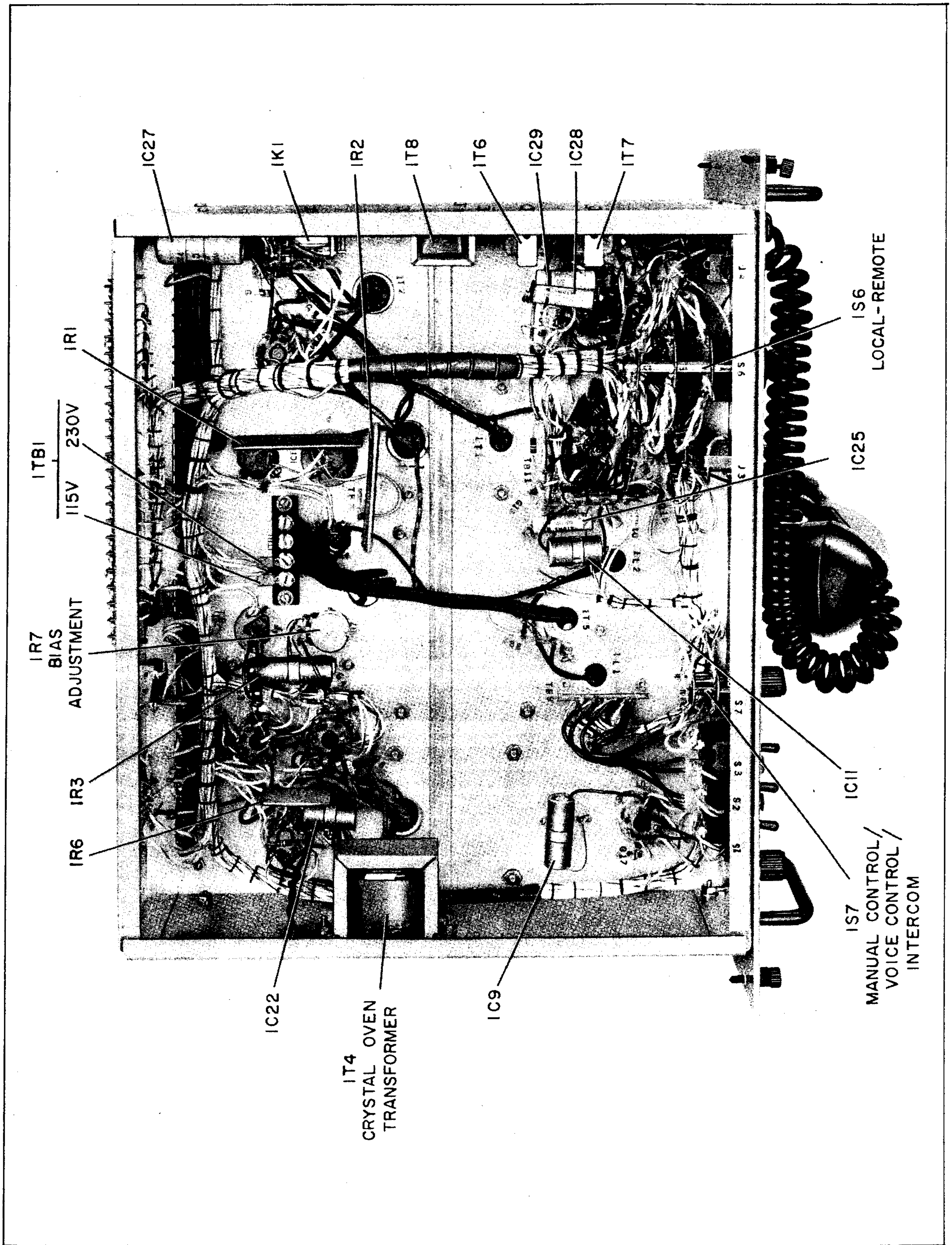


Figure 27. Power Supply, Bottom View

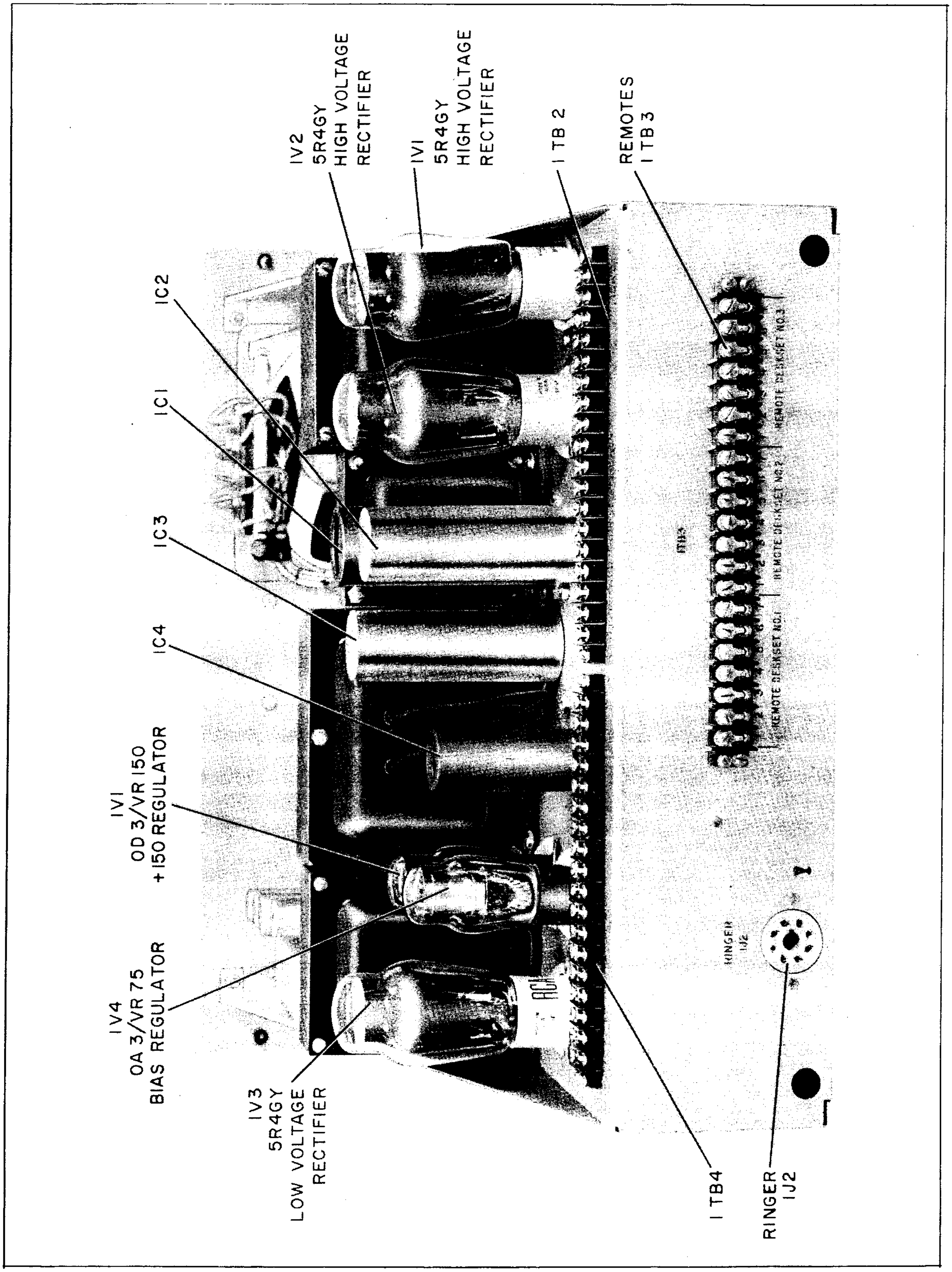
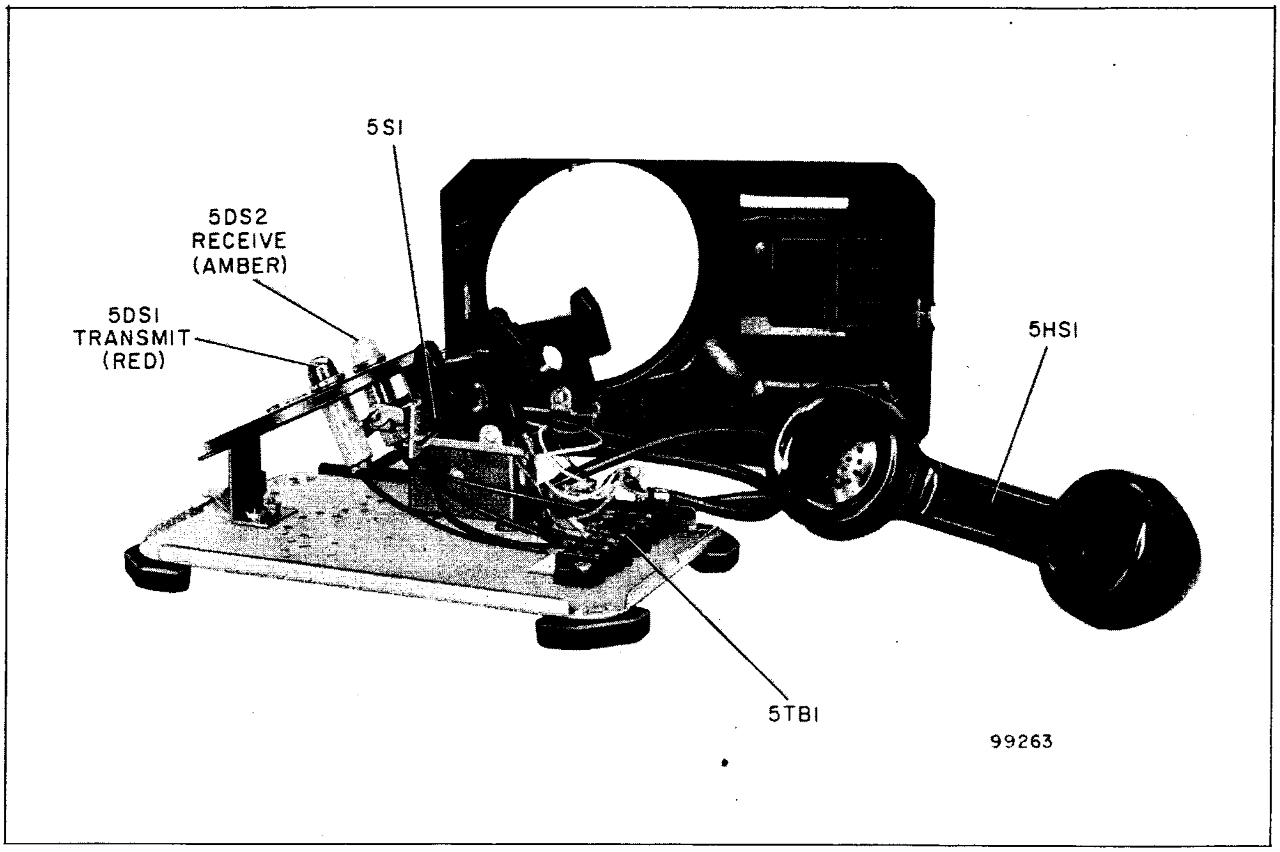


Figure 28. Pow r Supply, Rear View



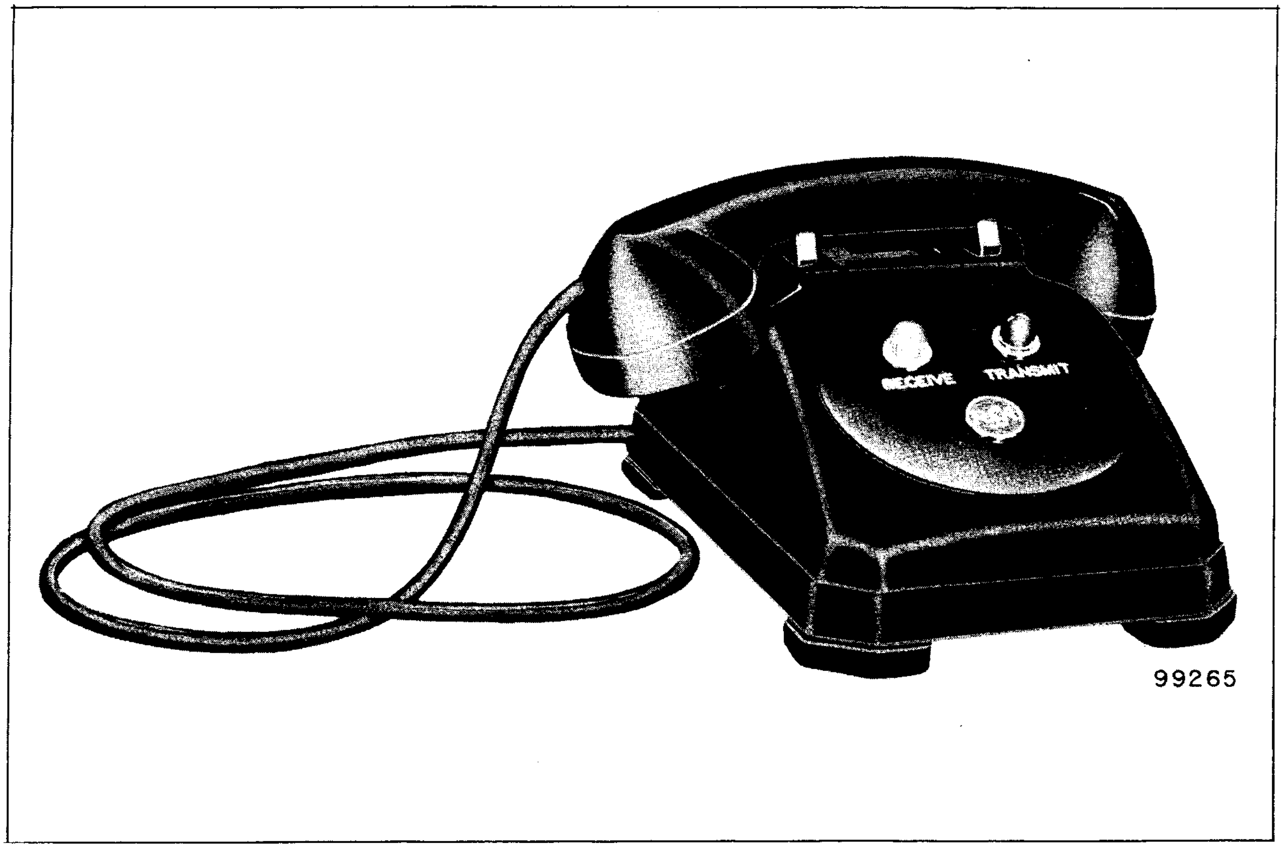


Figure 29. Remote Desk Set

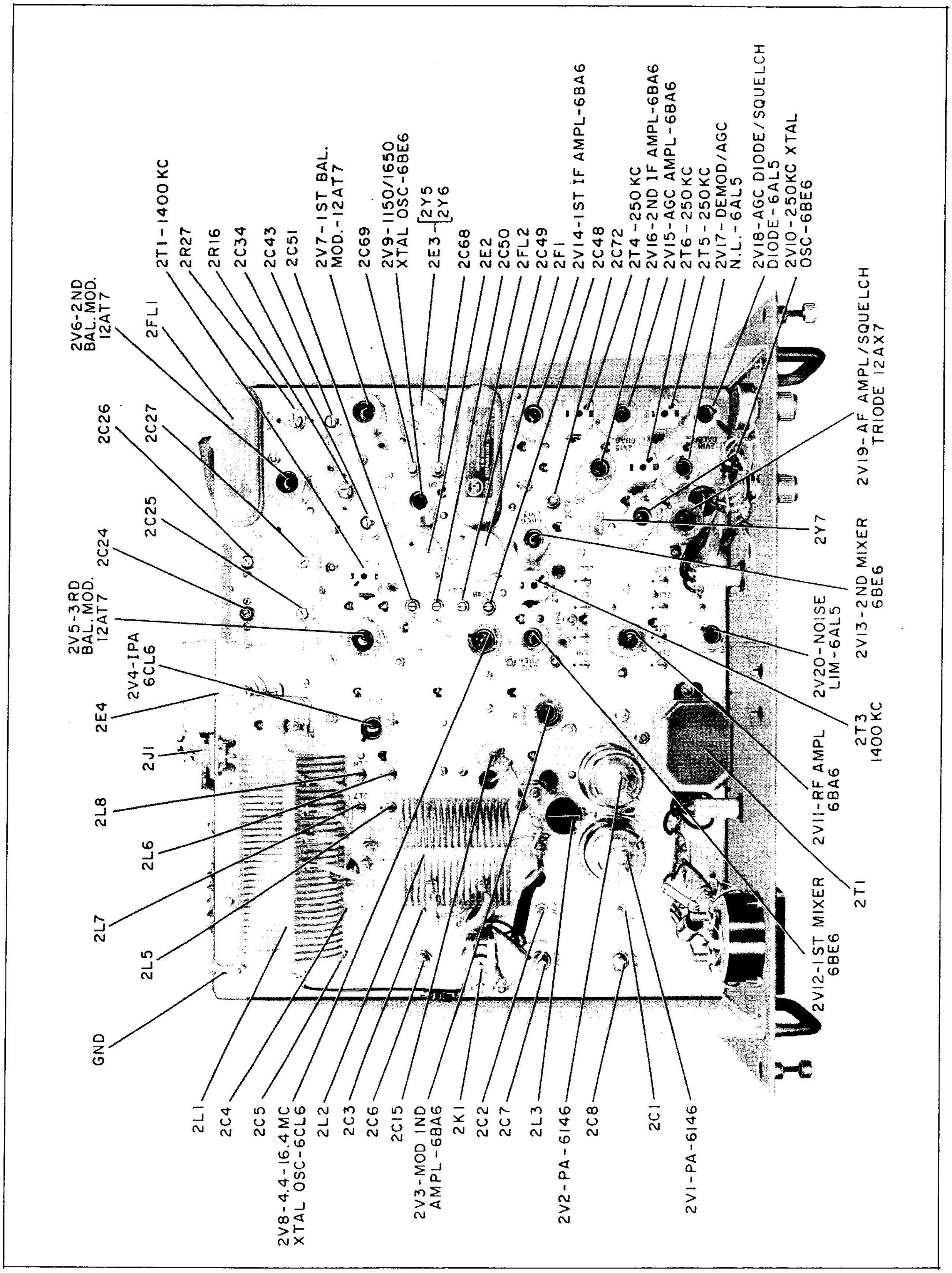


Figure 30. Transmitter-Receiver, Top View

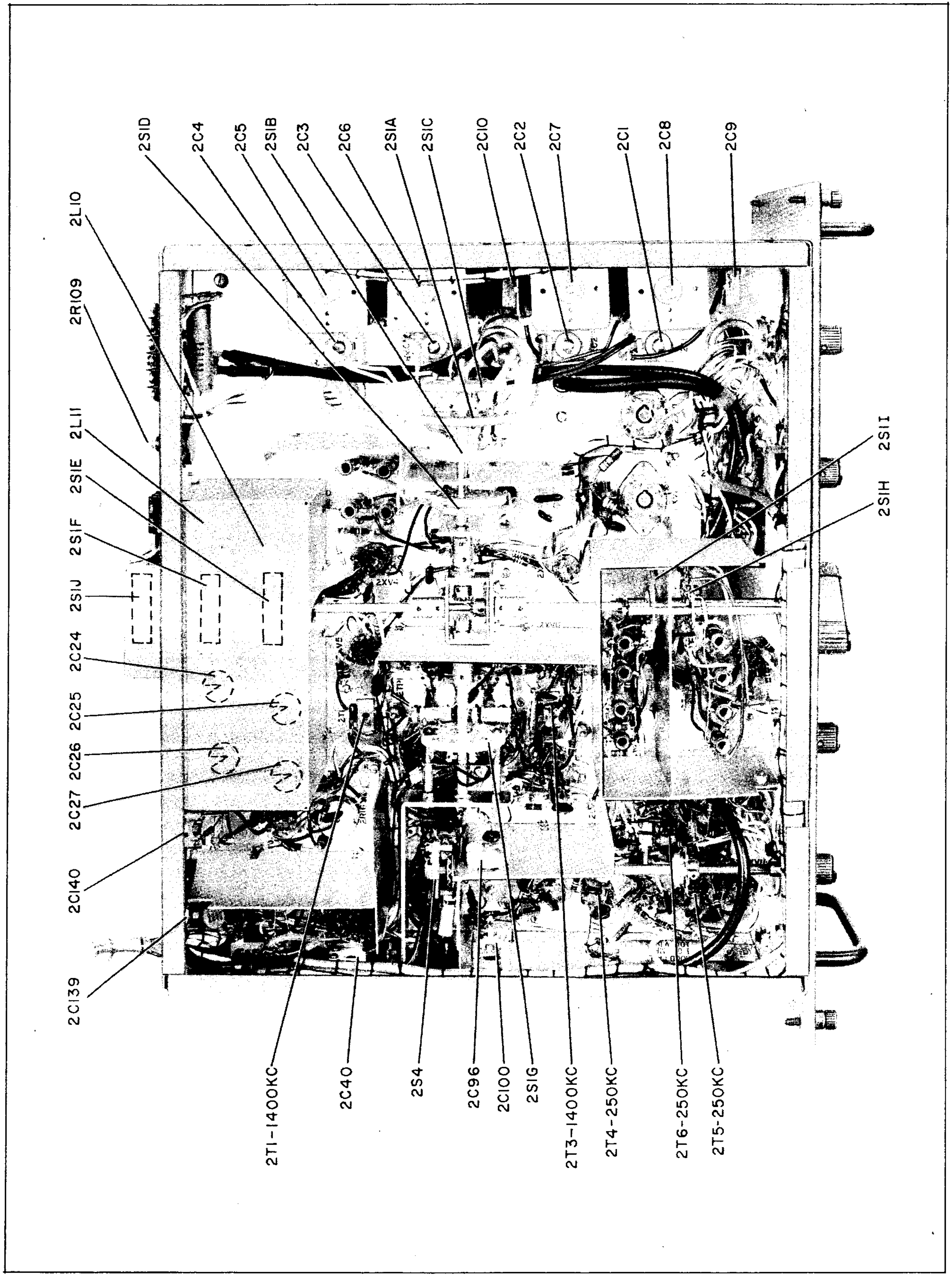


Figure 31. Transmitter-Receiver, B ttom View

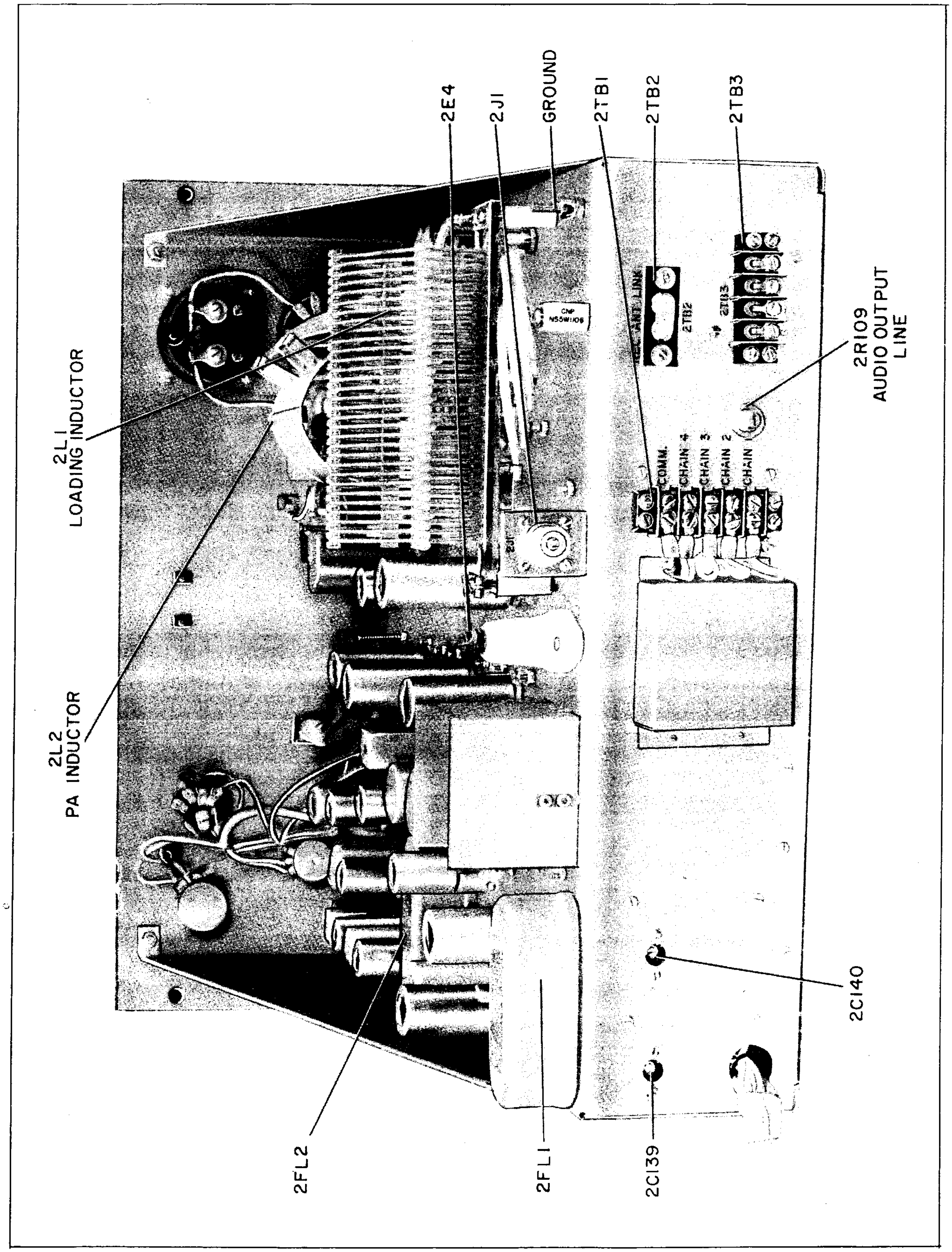
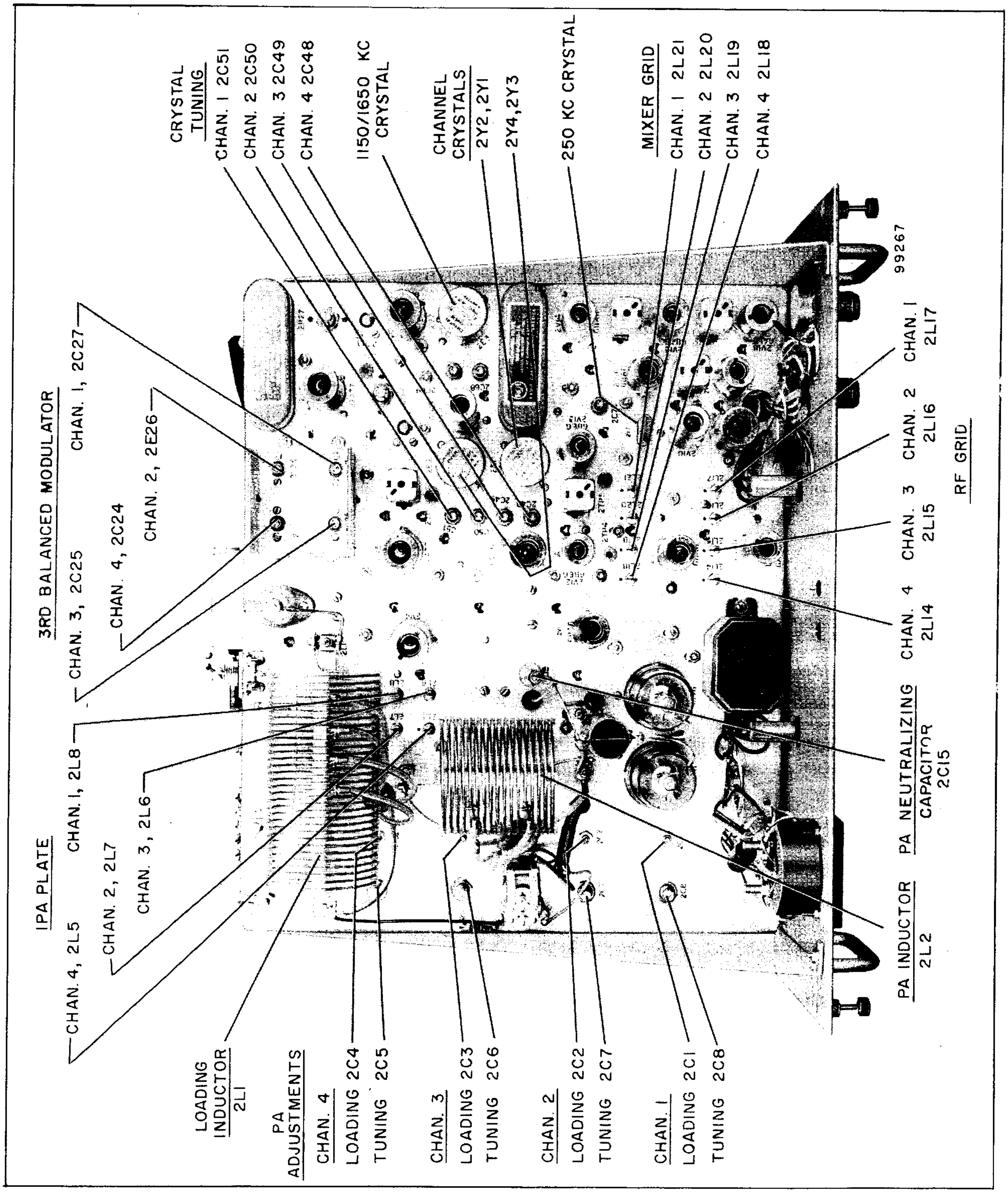
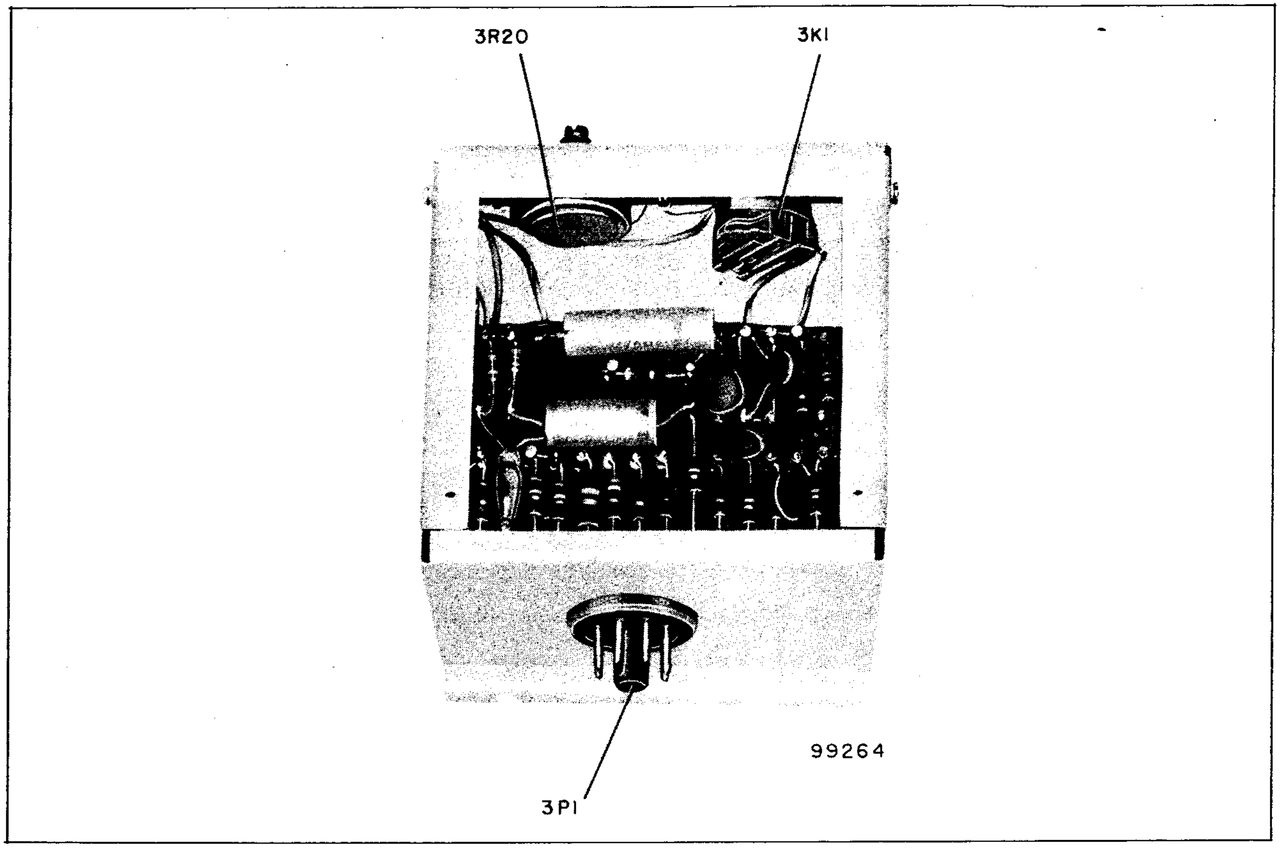


Figure 32. Transmitter-Receiver, Rear View



Figur 33. Transmitter-R c iver, T p View, Tuning Adjustments



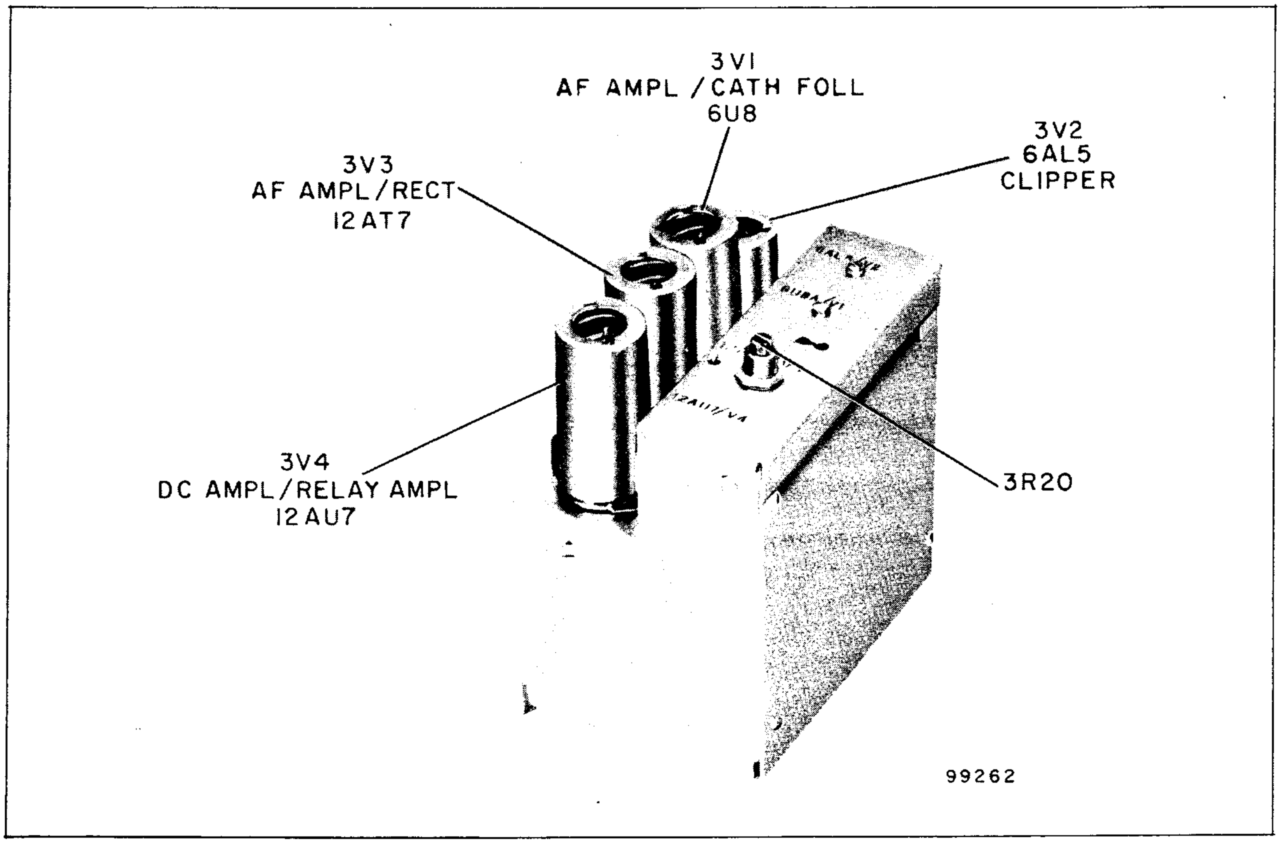


Figure 34. Sp ech Clipper/Voice Control

LIST OF PARTS
SSB-1 Mk IIA
TRANSMITTER-RECEIVER, MI-555478

Symbol	*Drawing No.*	*Description*
		CAPACITORS:
2C1,2C2	1219816-515	Variable: 1400-3055 μμf, 250 v
2C3,2C4	1219816-1007	Variable: 340-1070 μμf, 500 v
2C5 to 2C8	8956280-14	Variable: 12-250 μμf, 1500 v
2C9,2C10	728645-109	100 μμf, 2500 v
2C11,2C12	8956280-20	1000 μμf, 1500 v
2C13,2C14	8811182-5	0.01 μf, 450 v
2C15	1216366-1	Variable: .75-4 μμf
2C16	990491-147	1000 μμf, 500 v
2C17	8811182-5	0.01 μf, 450 v
2C18	990786-283	0.47 μf, 200 v
2C19	990490-207	22 μμf, 500 v
2C21 to 2C23	8811182-5	0.01 μf, 450 v
2C24 to 2C27	8956280-12	Variable: 6.7-140 μμf, 600 v
2C28,2C29	8811182-5	0.01 μf, 450 v
2C30,2C31	990490-107	22 μμf, 500 v
2C32	990490-244	750 μμf, 300 v
2C33	990490-107	22 μμf, 500 v
2C34	984003-7	4.5-25 μμf
2C35,2C36	8811182-5	0.01 μf, 450 v
2C37	990490-135	330 μμf, 500 v
2C38	990490-244	750 μμf, 300 v
2C39	990490-135	330 μμf, 500 v
2C40	984003-8	2.5 13 μμf
2C41	990490-107	22 μμf, 500 v
2C42	990490-336	360 μμf, 500 v
2C43	984003-7	4.5-25 μμf
2C44,2C45	8811182-5	0.01 μf, 450 v
2C46,2C47	990490-123	100 μμf, 500 v
2C48,to 2C51	469700-4	Variable: 2.6-13.3 μμf
2C52,2C53	990786-275	0.1 μf, 200 v
2C54,2C55	990490-240	510 μμf, 300 v
2C56,2C57	990491-149	1200 μμf, 500 v
2C58	8811182-5	0.01 μf, 450 v
2C59	990491-147	1000 μμf, 500 v
2C60	990489-1	5 μμf, 500 v
2C61,2C62	8811182-5	0.01 μf, 450 v
2C63	990489-1	5 μμf, 500 v
2C64	8811182-5	0.01 μf, 450 v
2C65	990491-147	1000 μμf, 500 v
2C66	990490-139	470 μμf, 300 v
2C67	8811182-5	0.01 μf, 450 v
2C68,2C69	469700-4	Variable: 2.6-13.3 μμf
2C70	990491-147	1000 μμf, 500 v
2C71	8811182-5	0.01 μf, 450 v
2C72	469700-4	Variable: 2.6-13.3 μμf
2C73,2C74	8811182-5	0.01 μf, 450 v
2C75	990490-215	47 μμf, 500 v
2C76	990490-123	100 μμf, 500 v
2C77	990490-218	62 μμf, 500 v
2C78 to 2C81	8811182-5	0.01 μf, 450 v
2C82	990490-123	100 μμf, 500 v
2C83	990490-215	47 μμf, 500 v
2C84 to 2C87	8811182-5	0.01 μf, 450 v
2C88	990489-102	10 μμf, 500 v
2C89	8811182-5	0.01 μf, 450 v
2C90	990489-102	10 μμf, 500 v
2C91	8811182-5	0.01 μf, 450 v
2C92	990786-271	0.047 μf, 200 v
2C93 to 2C95	8811182-5	0.01 μf, 450 v
2C96	258851-7	Variable: 20-125 μμf
2C97	990490-336	360 μμf, 500 v
2C98	8811182-5	0.01 μf, 450 v
2C99	990490-336	360 μμf, 500 v

Symbol	Drawing No.	Description
2C100	258851-7	Variable: 20-125 μμf
2C101 to 2C104	8811182-5	0.01 μf, 450 v
2C105, 2C106	990489-102	10 μμf, 500 v
2C107	990786-275	0.1 μf, 200 v
2C108, 2C109	990489-102	10 μμf, 500 v
2C110	8811182-5	0.01 μf, 450 v
2C111	990786-71	0.047 μf, 50 v
2C112 to 2C115	8811182-5	0.01 μf, 450 v
2C116	990489-102	10 μμf, 500 v
2C117	8811182-5	0.01 μf, 450 v
2C118	990489-102	10 μμf, 500 v
2C119	990490-139	470 μμf, 300 v
2C120	990490-123	100 μμf, 500 v
2C121	990490-135	330 μμf, 500 v
2C122, 2C123	990786-187	1.0 μf, 100 v
2C124 to 2C126	8811182-5	0.01 μf, 450 v
2C127	990786-275	0.1 μf, 200 v
2C128	8811182-5	0.01 μf, 450 v
2C129	990490-131	220 μμf, 500 v
2C130	990490-107	22 μμf, 500 v
2C131, 2C132	8811182-5	0.01 μf, 450 v
2C133	8811182-2	1000 μμf, 500 v
2C134, 2C135	990490-123	100 μμf, 500 v
2C136	990489-102	10 μμf, 500 v
2C137, 2C138	990786-275	0.1 μf, 200 v
2C139, 2C140	258851-7	Variable: 20-125 μμf
2C141	8811182-5	0.01 μf, 450 v
2C142	8956280-20	1000 μμf, 1500 v
2C143	8811182-5	0.01 μf, 450 v
2CR1 to 2CR3		Crystal: diode, 1N34A
2DS1, 2DS2	1216716-1	Pilot light: neon, red
2E1 to 2E3	8977231-1	Oven: crystal
2E4	1216616-1	Insulator
2E5	426772-3	Insulator: steatite
2FL1, 2FL2	MI-33500A	Filter: mechanical
2J1	255223-2	Connector
2K1	8956280-38	Relay
2L1	1216617-2	R.F. Inductor: 22 μh
2L2	1216617-1	R.F. Inductor: 12 μh
2L3	1216373-501	R.F. Choke: 155 μh
2L4	8886161-14	R.F. Choke: 1 mh
2L5, 2L6	1239611-1	R.F. Inductor: 1.30-10 μh
2L7, 2L8	1239611-2	R.F. Inductor: 6.8-55 μh
2L9	8886161-11	R.F. Choke: 0.5 mh
2L10	1216618-1	R.F. Inductor: 24 μh w/1.2 μh link
2L11	1216618-2	R.F. Inductor: 5.2 μh w/.5 μh link
2L12	8886161-14	R.F. Choke: 1 mh
2L13	T-1569-17	Coil: 1.24 μh
2L14, 2L15	1239611-1A	R.F. Inductor: 1.3-10 μh
2L16, 2L17	1239611-2A	R.F. Inductor: 6.8-55 μh
2L18, 2L19	1239611-1	R.F. Inductor: 1.3-10 μh
2L20, 2L21	1239611-2	R.F. Inductor: 6.8-55 μh
2M1	1216722-1	Meter: 200 μa

Symbol	Drawing No.	Description
		RESISTORS:
		Fixed, Composition - Unless Otherwise Specified
2R1	90496-82	47,000 ohm ±10%, 1 w
2R2, 2R3	867970-329	Wire wound, 4.3 ohm ±10%
2R4	1216621-2	Wire wound, 0.80 ohm ±10%,
2R5, 2R6	82283-62	1000 ohm ±10%,
2R7	82283-79	27,000 ohm ±10%
2R8	82283-80	33,000 ohm ±10%
2R9	82283-54	220 ohm ±10%
2R10	82283-74	10,000 ohm ±10%
2R11	82283-156	750 ohm ±5%
2R12	82283 74	10,000 ohm ±10%
2R13	82283-62	1000 ohm ±10%
2R14, 2R15	82283-94	470,000 ohm ±10%
2R16	8956280-29	Variable, 50,000 ohm
2R17	82283-74	10,000 ohm ±10%
2R18	82283-62	1000 ohm ±10%
2R19, 2R20		Not Used
2R21, 2R22	82283-82	47,000 ohm ±10%
2R23, 2R24	82283-86	100,000 ohm ±10%
2R25, 2R26	82283-76	15,000 ohm ±10%
2R27	8956280-31	Variable, 20,000 ohm
2R28, 2R29	82283-76	15,000 ohm ±10%
2R30	82283-74	10,000 ohm ±10%
2R31	82283-62	1000 ohm ±10%
2R32, 2R33	82283-88	150,000 ohm ±10%
2R34, 2R35	82283-98	1 meg ±10%
2R36	8956280-32	Variable, (A) 100,000 ohm (B) 100,000 ohm
2R37, 2R38	82283-78	22,000 ohm ±10%
2R39, 2R40	82283-82	47,000 ohm ±10%
2R41	82283-63	1200 ohm ±10%
2R42, 2R43	99126-78	22,000 ohm ±10%, 2 w
2R44	99126-76	15,000 ohm ±10%, 2 w
2R45	82283-53	180 ohm ±10%
2R46	82283-81	39,000 ohm ±10%
2R47	82283-73	8200 ohm ±10%
2R48	82283-75	12,000 ohm ±10%
2R49	82283-86	100,000 ohm ±10%
2R50	82283-98	1 meg ±10%
2R51	82283-86	100,000 ±10%
2R52	82283-73	8200 ohm ±10%
2R53	82283-98	1 meg ±10%
2R54	82283-86	100,000 ohm ±10%
2R55	82283-74	10,000 ohm ±10%
2R56	82283-55	270 ohm ±10%
2R57	82283-98	1 meg ±10%
2R58	82283-86	100,000 ohm ±10%
2R59	82283-50	100 ohm ±10%
2R60	90496-80	33,000 ohm ±10%, 1 w
2R61	82283-82	47,000 ohm ±10%
2R62	90496-74	10,000 ohm ±10%, 1 w
2R63	82283-82	47,000 ohm ±10%
2R64, 2R65	82283-86	100,000 ohm ±10%
2R66	82283-82	47,000 ohm ±10%
2R67	82283-54	220 ohm ±10%
2R68	8956280-30	Variable, 5000 ohm, 2 w
2R69	82283-78	22,000 ohm ±10%
2R70	82283-86	100,000 ohm ±10%
2R71	82283-66	2200 ohm ±10%
2R72	82283-86	100,000 ohm ±10%
2R73	82283-82	47,000 ohm ±10%
2R74	82283-53	180 ohm ±10%
2R75, 2R76	82283-78	22,000 ohm ±10%

Symbol	Drawing No.	Description
2R77	82283-66	2200 ohm ±10%
2R78, 2R79	82283-86	100,000 ohm ±10%
2R80	82283-80	33,000 ohm ±10%
2R81	822283-64	1500 ohm ±10%
2R82	82283-90	220,000 ohm ±10%
2R83, 2R84	82283-66	2200 ohm ±10%
2R85	82283-86	100,000 ohm ±10%
2R86	82283-54	220 ohm ±10%
2R87	82283-82	47,000 ohm ±10%
2R88	82283-66	2200 ohm ±10%
2R89	82283-88	150,000 ohm ±10%
2R90	82283-62	1000 ohm ±10%
2R91	82283-90	220,000 ohm ±10%
2R92	82283-66	2200 ohm ±10%
2R93	82283-78	22,000 ohm ±10%
2R94	82283-87	120,000 ohm ±10%
2R95	82283-86	100,000 ohm ±10%
2R96	82283-106	4.7 meg ±10%
2R97	82283-110	10 meg ±10%
2R98	82283-98	1 meg ±10%
2R99	82283-90	220,000 ohm ±10%
2R100	82283-94	470,000 ohm ±10%
2R101	82283-90	220,000 ohm ±10%
2R102	82283-94	470,000 ohm ±10%
2R103	737801-34	Variable, 500,000 ohm
2R104	82283-72	6800 ohm ±10%
2R105	82283-86	100,000 ohm ±10%
2R106	737814-13	Variable, 25,000 ohm
2R107	737801-34	Variable, 500,000 ohm
2R108	82283-90	220,000 ohm ±10%
2R109	737829-26	Variable, 500,000 ohm
2R110	82283-88	150,000 ohm ±10%
2R111	82283-70	4700 ohm ±10%
2R112	82283-86	100,000 ohm ±10%
2R113	82283-90	220,000 ohm ±10%
2R114	82283-74	10,000 ohm ±10%
2R115	82283-90	220,000 ohm ±10%
2R116	82283-78	22,000 ohm ±10%
2R117	82283-88	150,000 ohm ±10%
2R118	1216620-2	12.5 meg ±1%, 2 w
2R119	1216620-1	1.25 meg ±1%
2S1	1215015-1	Switch: (A)(B)(C)(D), 4 pos. rotary
2S1	1214336-1	Switch: (E)(F) 4 pos. rotary
2S1	1214337-1	Switch: (G) 4 pos. rotary
2S1	1215016-1	Switch: (H)(I) 4 pos. rotary
2S1	1215701-1	Switch: (J) 4 pos. rotary
2S2		Not Used
2S3	1233608-1	Switch: DP4T, rotary
2S4	1233607-1	Switch: 4 pos rotary
2S5	1216612-1	Switch: SP3T rotary
2T1	1249258-11	Transformer: IF, 1500 kc
2T2	1243615-1	Transformer: AF, 16.1 kc
2T3	1249258-11	Transformer: IF, 1500 kc
2T4 to 2T6	1249258-6	Transformer: IF, 262 kc
2TB1	430764-4	Terminal board: 5 term.
2TB2	86927-20	Terminal board: link term.
2TB3	441607-3	Terminal board: 4 term.
2TP1 to 2TP5	8825493-2	Tip jack: red

Symbol	Drawing No.	Description
		TUBES:
2V1, 2V2		6146
2V3		6BA6
2V4		6CL6
2V5 to 2V7		12AT7
2V8		6CL6
2V9, 2V10		6BE6
2V11		6BA6
2V12, 2V13		6BE6
2V14 to 2V16		6BA6
2V17, 2V18		6AL5
2V19		12AX7
2V20		6AL5
		SOCKETS:
2XE1 to 2XE3	99391-2	Octal
2XV1, 2XV2	99391-2	Octal
2XV3	737867-17	7 pin min.
2XV4 to 2XV8	737870-17	9 pin min.
2XV9 to 2XV18	737867-17	7 pin min.
2XV19	737870-17	9 pin min.
2XV20	737867-17	7 pin min.
2XY7	8885952-3	Crystal
2Y1, 2Y2		Crystal: CR-27 U, 8.1-16.4 mc
2Y3, 2Y4		Crystal: CR-27U, 4.4-8.1 mc
2Y5		Crystal: CR-27 U, 1150 kc
2Y6		Crystal: CR-27 U, 1650 kc
2Y7		Crystal: CR-46 U, 250 kc
SSB-1 Mk IIA POWER SUPPLY, MI-555477		
		CAPACITORS:
1C1	442900-99	Electrolytic: 125 μf, 450 v
1C2, 1C3	442900-97	Electrolytic: 125 μf, 450 v
1C4	458557-3	Electrolytic: 100 μf, 150 v
1C5 thru 1C8	8811182-5	.01 μf, 450 v
1C9	442901-163	Electrolytic: 10 μf, 250 v
1C10	990491-155	2200 μμf, 500 v
1C11	442901-156	Electrolytic: 10 μf, 150 v
1C12	8811182-5	.01 μf, 450 v
1C13 thru 1C15	990490-137	390 μμf, 500 v
1C16, 1C17	8811182-5	.01 μf, 450 v
1C18	990490-135	330 μμf, 500 v
1C19	990490-109	27 μμf, 500 v
1C20, 1C21	1219583-1	.01 μf, 500 v
1C22	442901-156	Electrolytic: 10 μf, 150 v
1C23, 1C24	990491-147	1000 μμf, 500 v
1C25	8946094-19	25 μf, 25 v
1C26	990786-275	0.1 μf, 200 v
1C27	442901-161	Electrolytic, 50 μf, 150 v
1C28, 1C29	8946094-19	25 μf, 25 v
1C30, 1C31	8811182-5	.01 μf, 500 v
1DS1	1216716-1	Pilot light: neon, red.
1DS2	1216716-2	Pilot light: neon, amber
1DS3 thru 1DS6	1216716-3	Pilot light: neon, white
1F1	990141-13	Fuse: 4 amp. 125 v
1F2	990141-7	Fuse: 0.5 amp. 250 v
1F3	990441-210	Fuse: 1.5 amp (TL) 125 v

Symbol	*Drawing No.*	*Description*
1F4	990141-211	Fuse: 2.0 amp. (TL) 125 v
1F5	990141-5	Fuse: 0.25 amp. 250 v
1HS1	755445-4	Handset assembly
1J1, 1J2	99391-2	Socket, octal
1J3	8887792-2	Jack, key
1J4	8887792-2	Jack, phone
1K1	8956280-39	Relay
1L1	1233606-1	Inductor: 2-12 H, 25-250 ma
1L2	1233604-1	Inductor: 7 H, 140 ma
1L3, 1L4	8886161-14	RF Choke: 1 mh
1LS1	460292-1	Speaker: PM, 4 x 6 in., 3.2 ohm
		RESISTORS:
		Fixed, Composition - Unless Otherwise Specified
1R1, 1R2	1219580-481	Wirewound: 15,000 ohm ±10%, 20 w
1R3	427491-23	Variable, comp., 2000 ohm, 25 w
1R4	99126-58	470 ohm ±10%, 2 w
1R5	90496-86	100,000 ohm ±10%, 1 w
1R6	1219580-152	Wirewound, 910 ohm ±10%, 5 w
1R7	8956280-29	Variable, comp., 50,000 ohm, ½ w
1R8	90496-62	1000 ohm ±10%, 1 w
1R9	737801-34	Variable, comp., 500,000 ohm
1R10	82283-74	10,000 ohm, ±10%
1R11	90496-90	220,000 ohm ±10%, 1 w
1R12	82283-66	2200 ohm ±10%
1R13 thru 1R15	82283-94	470,000 ohm ±10%
1R16	82283-98	1 meg ±10%
1R17	82283-104	3.3 meg ±10%
1R18	90496-180	7500 ohm ±5%, 1 w
1R19	82283-94	470,000 ohm ±10%
1R20	90496-86	100,000 ohm ±10%, 1 w
1R21	82283-56	330 ohm ±10%
1R22	82283-98	1 meg ±10%
1R23	82283-74	10,000 ohm ±10%
1R24	82283-79	27,000 ohm ±10%
1R25	82283-62	1000 ohm ±10%
1R26	90496-50	100 ohm ±10%, 1 w
1R27	82283-88	150,000 ohm ±10%
1R28	82283-58	470 ohm ±10%
1R29	1219580-104	Wirewound, 5 ohm ±10%, 5 w
1R30 thru 1R33	82283-88	150,000 ohm ±10%
1R34	99126-58	470 ohm ±10%, 2 w
1R35	82283-98	1 meg ±10%
1R36	82283-59	560 ohm ±10%
1R37	82283-98	1 meg ±10%
1R38	82283-59	560 ohm ±10%
1R39	82283-57	390 ohm ±10%
1R40	82283-82	47,000 ohm ±10%
1S1	449663-6	Switch: toggle, DPST
1S2, 1S3	449663-2	Switch: toggle, SPST
1S4, 1S5	449663-8	Swmtch: toggle, DPDT
1S6	1233611-1	Switch: rotary
1S7	1233613-1	Switch: rotary
1T1	1233605-1	Transformer: power
1T2	1233601-1	Transformer: power
1T3	1233602-1	Transformer: power
1T4	1233603-1	Transformer: power
1T5	1233610-1	Transformer: power
1T6	8436763-1	Transformer: audio, 600 ohm out
1T7	8436762-1	Transformer: audio, 3.2 ohm out

Symbol	Drawing No.	Description
1T8	8436763-1	Transformer: audio, 600 ohm out
1TB1	8893711-4	Terminal board: 4 terminals
1TB2	441607-17	Terminal board: 18 terminals
1TB3	441607-20	Terminal board: 21 terminals
1TB4	441607-17	Terminal board: 18 terminals
1TP1	8825493-2	Tip jack: red
1V1		5R4GY Tube
1V2		5R4GY Tube
1V3		5R4GY Tube
1V4		OA3/VR75 Tube
1V5		OD3/VR150 Tube
1V6		12AT7 Tube
1V7		12AT7 Tube
1V8		6AK6 Tube
1V9		6AK6 Tube
1XV1 thru 1XV5	99391-2	Socket: tube, octal
1XV6, 1XV7	737870-17	Socket: 9 pin miniature
1XV8, 1XV9	737867-17	Socket: 7 pin miniature
	SPEECH CLIPPER/VOICE CONTROL ASSEMBLY MI-555476	
3C1	8811182-5	Capacitor: .01 μf, 450 v
3C2	8811182-2	Capacitor: .001 μf, 500 v
3C3, 3C4	8811182-5	Capacitor: .01 μf, 450 v
3C5	8946094-19	Capacitor: 25 μf, 25 v
3C6	990786-375	Capacitor: 0.1 μf, 400 v
3C7	990786-271	Capacitor: .047 μf, 200 v
3DS1	872291-4	Lamp: neon, NE-2
3K1	1219630-1	Relay
3P1	143637-501	Plug: octal
		RESISTORS: *Fixed, Composition - Unless Otherwise Specified*
3R1	82283-154	620 ohm ±5%
3R2	82283-62	1000 ohm ±10%
3R3	82283-90	220,000 ohm ±10%
3R4	82283-98	1 meg ±10%
3R5, 3R6	82283-86	100,000 ohm ±10%
3R7	82283-91	270,000 ohm ±10%
3R8	82283-97	820,000 ohm ±10%
3R9	82283-88	150,000 ohm ±10%
3R10	82283-98	1 meg ±10%
3R11	82283-58	470 ohm ±10%
3R12	82283-69	3900 ohm ±10%
3R13	82283-80	33,000 ohm ±10%
3R14	82283-90	220,000 ohm ±10%
3R15	82283-106	4.7 meg ±10%
3R16 thru 3R18	82283-94	470,000 ohm ±10%
3R19	90496-86	100,000 ohm ±10%, 1 w
3R20	737801-44	Variable, comp., 10,000 ohm
3V1		6U8A Tube
3V2		6AL5 Tube
3V3		12AT7 Tube
3V4		12AU7 Tube
3XV1	727870-17	Socket: 9 pin miniature
3XV2	737867-17	Socket: 7 pin miniature
3XV3, 3XV4	737870-17	Socket: 9 pin miniature

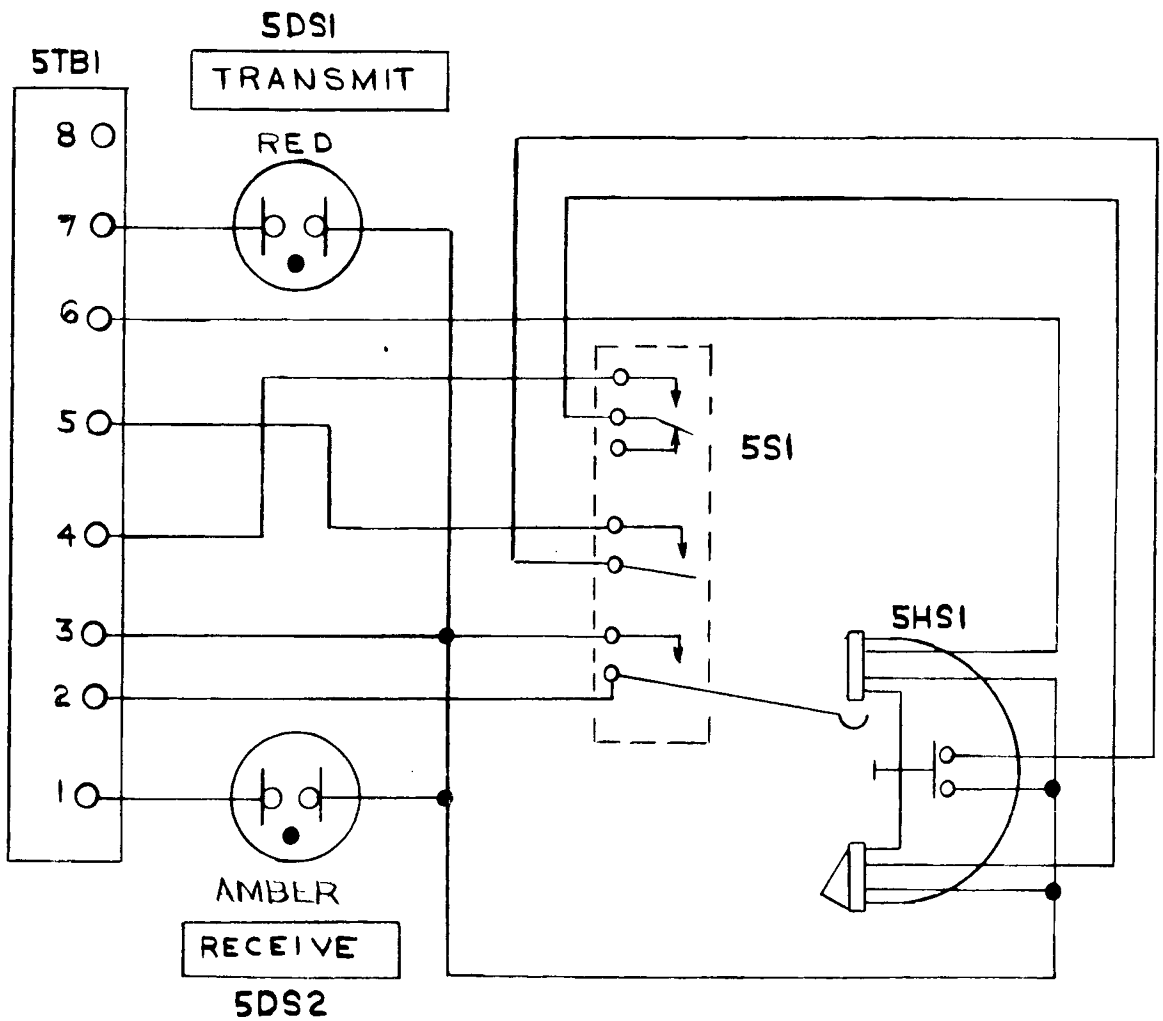


Figure 35. Remot Desk S t, Schematic Diagram (1241899)

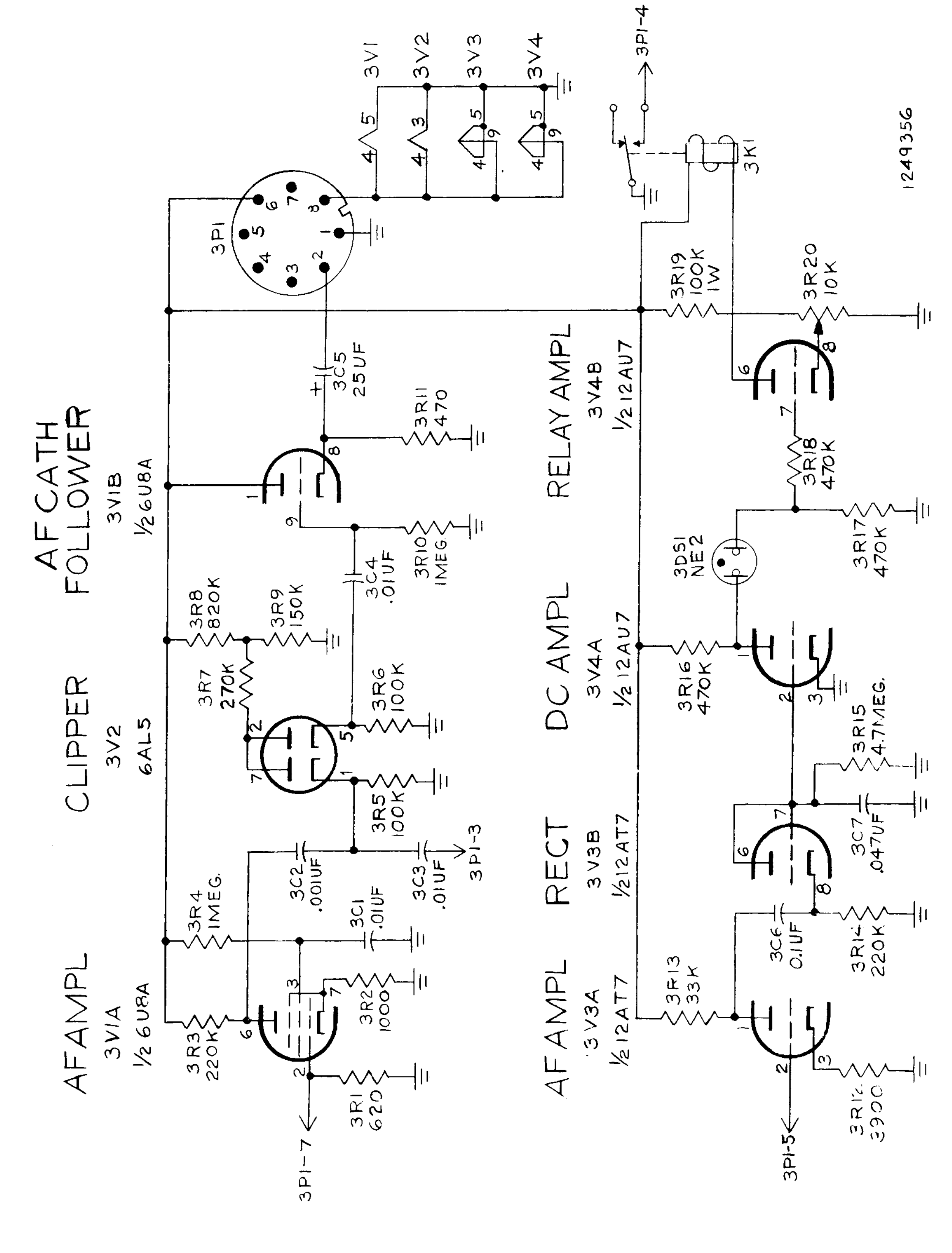
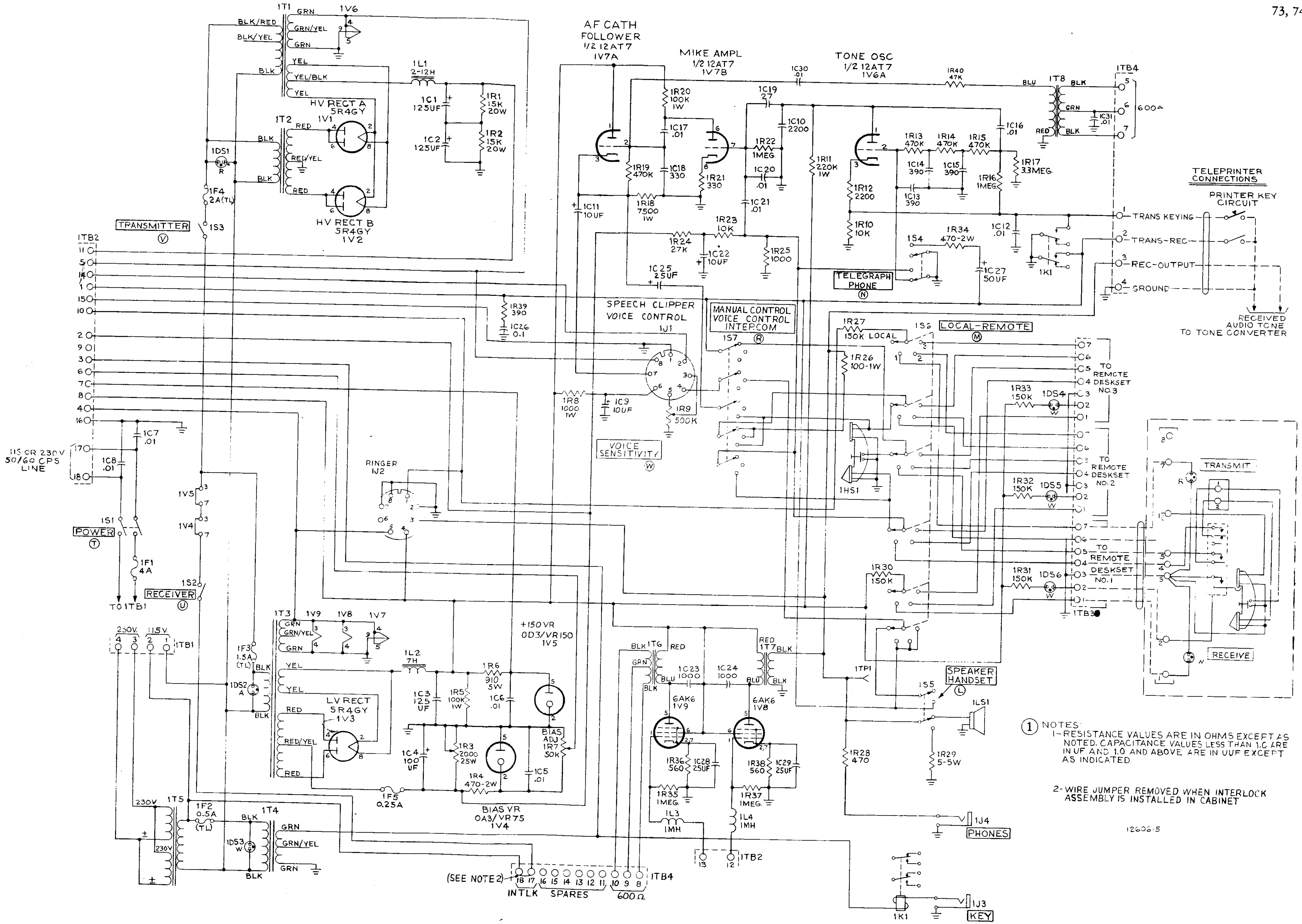


Figure 36. Sp ech Clipper/Voic Control, Schematic Diagram (1249356)



① NOTES:
1- RESISTANCE VALUES ARE IN OHMS EXCEPT AS NOTED. CAPACITANCE VALUES LESS THAN 1.0 ARE IN UF AND 1.0 AND ABOVE ARE IN UUF EXCEPT AS INDICATED.

2- WIRE JUMPER REMOVED WHEN INTERLOCK ASSEMBLY IS INSTALLED IN CABINET

Figure 37. Power Supply, Schematic Diagram (1260615)

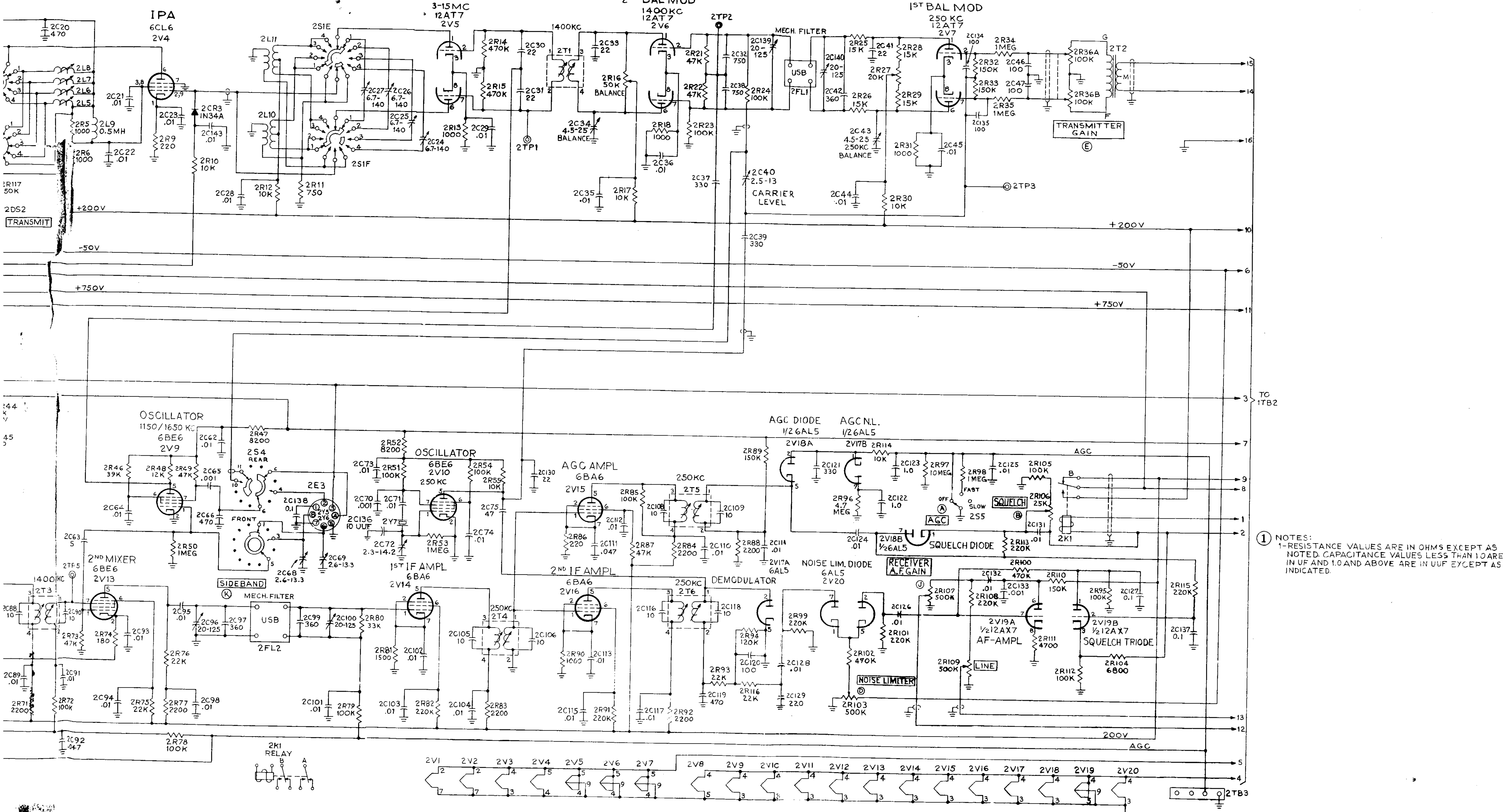


Figure 38. Transmitter-Receiver, Schematic Diagram (1260620)

OULD
RIZED
SE OF

free of the
until the

o not wait

D

forward.

nds below

l. See (B)

ELSE:

ithout help

spiration if