SURPLUS RADIO CONVERSION MANUAL

VOLUME No. 1
Third Edition

By

R. C. EVENSON AND O. R. BEACH

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PREFACE

Since the beginning of the "surplus era" a real need has existed for a publication devoted entirely to the conversion information necessary to permit practical use of surplus equipment. The amateur radio operator has had especial need for such a publication. The authors have endeavored to fulfil that need in the following pages by compiling the necessary instructions and diagrams for the practical conversion of a number of the most popular items of surplus equipment.

Theory of circuit operation has not been included in this manual so that conversion data on the largest number of equipments could be included. It has been assumed that those persons interested in a manual of this nature are generally familiar with the operation of electronic equipment. It should be noted that the operation of any radio transmitting equipment, including that described herein, requires the issuance of both an operator's license and a station license by the Federal Communications Commission.

The authors regret that time does not permit them to engage in individual correspondence regarding these or other surplus items, and the publisher has been requested not to forward letters.

We have no information on surplus items other than those in these several Manuals

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SCR-211 FREQUENCY METER SET
(BC-221)

The SCR-211 Frequency Meter Set consists of several minor components and the major component, the BC-221 Frequency meter. It is designed to radiate or measure radio frequencies between 125 kc. and 20,000 kc. This frequency measuring device is a precision instrument and is capable of making frequency measurements to a high degree of accuracy.

It should be noted that no conversion of this unit is required for normal use unless it is desired to use an a-c power supply in the place of the required batteries. If the a-c power supply is desired, reference is made to fig. 3 which is self-explanatory.

Since this article is of a descriptive nature, pertaining to the operation and use of the BC-221, the discussion will be made under the following sections:

(a) General Description
(b) Principles of Operation
(c) General Use of the Instrument

(a) General Description

There are many models of the SCR-211 Frequency Meter Set, which include the SCR-211-A, B, C, D, E, F, J, K, L, M, N, O, P, Q, R, T, AA, AC, AE, AF, AG, AH, AJ, AK, and AL.

Even though many of the models are quite similar, there are numerous minor changes. These changes are too numerous to mention in the scope of this article; however the discussion covers the general operation and characteristics which pertain to all models.

All models of the SCR-211 consist of the following components:

1 ea. Calibration Book, MC-177
1 ea. Crystal Unit, DC-9
Set of vacuum tubes, installed
Set of batteries, 6 ea. BA-2 ("B" Batteries)
4 ea. BA-23 ("A" Batteries)
Headset and Cord (applicable type)

There are two types of cases that enclose the BC-221, the wooden type and the aluminum alloy type. The dimensions of the aluminum case are 12-1/2" high, 10" wide, and 9-1/4" deep; the wooden case is slightly larger.

The self-contained battery compartment is designed to hold 6 BA-2 batteries (22-1/2 volts each) and 4 BA-23 batteries (1-1/2 volts each). This gives the required "B" supply voltage of 135 volts and 6 volts for the "A" supply. (Note: minimum voltages for satisfactory operation are 5.4 volts and 121.5 volts for the "A" and "B" supply respectively.)

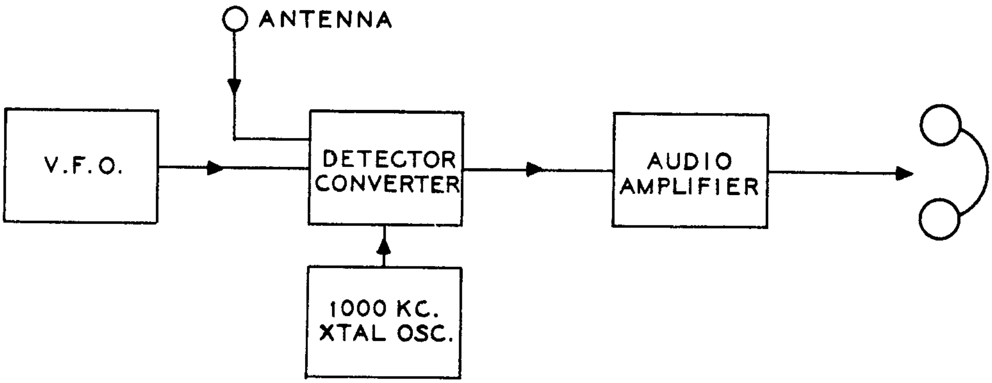
Six different control panel designs appear in the BC-221's varying with the different models and the different manufacturers. This variation is not important since the control labeling and the included unit instructions make the operation self-explanatory.

Each BC-221 unit contains an individually calibrated book, MC-177, permanently attached to the front panel cover.

(b) Principles of Operation

The BC-221 is a heterodyne type of frequency meter employing a 1000 kc. crystal oscillator which furnishes 1000 kc. check points for the variable frequency oscillator. Manual tuning of the variable frequency oscillator is brought out on the control panel with its associated dials.

Two calibration ranges are provided, the 125-250 kc. range and the 2000-4000 kc. range. By use of the 2nd, 4th, and 8th harmonics, the low frequency range covers 250 to 2000 kc. By use of the 2nd, 4th, and 5th harmonics, the high frequency range covers 4000 to 20,000 kc.



With reference to the block diagram of the BC-221, the output of the v.f.o. is heterodyned with the incoming signal from the antenna. After detection the beat frequency is amplified by the audio amplifier and its output connected to headphones.

When the beat frequency reaches the audible range it is heard in the headphones and the final tuning adjustment is made with the v.f.o. to produce a "zero-beat". This indicates the incoming frequency and the dial reading is taken.

The above description of operation refers to an incoming signal such as checking a transmitter. Since the BC-221 also radiates its v.f.o. signal, receiver calibration and checks are made similarly by the "zero-beat" method as heard in the receiver output.

From the following factors: mechanical shocks, locking action of dial, warming up, change of load at antenna, 10 per cent change in battery voltage, error in calibration, and error in crystal frequency, the maximum error should not exceed .034 per cent at 4000 kc. Normally the errors tend to cancel each other so that the normal error should not exceed .02 per cent.

(c) General Use of the Instrument

Reading the frequency meter dial consists of three individual steps. The first two digits are read on the hundreds dial (drum dial). From the large circular dial, labeled "units", the second two digits are read. The vernier scale (located on circular dial) provides the fractional digit in the conventional manner. Thus the following example reading can be obtained: 45 87 . 5. This dial reading is then checked in the calibration book to obtain the frequency of the signal being measured.

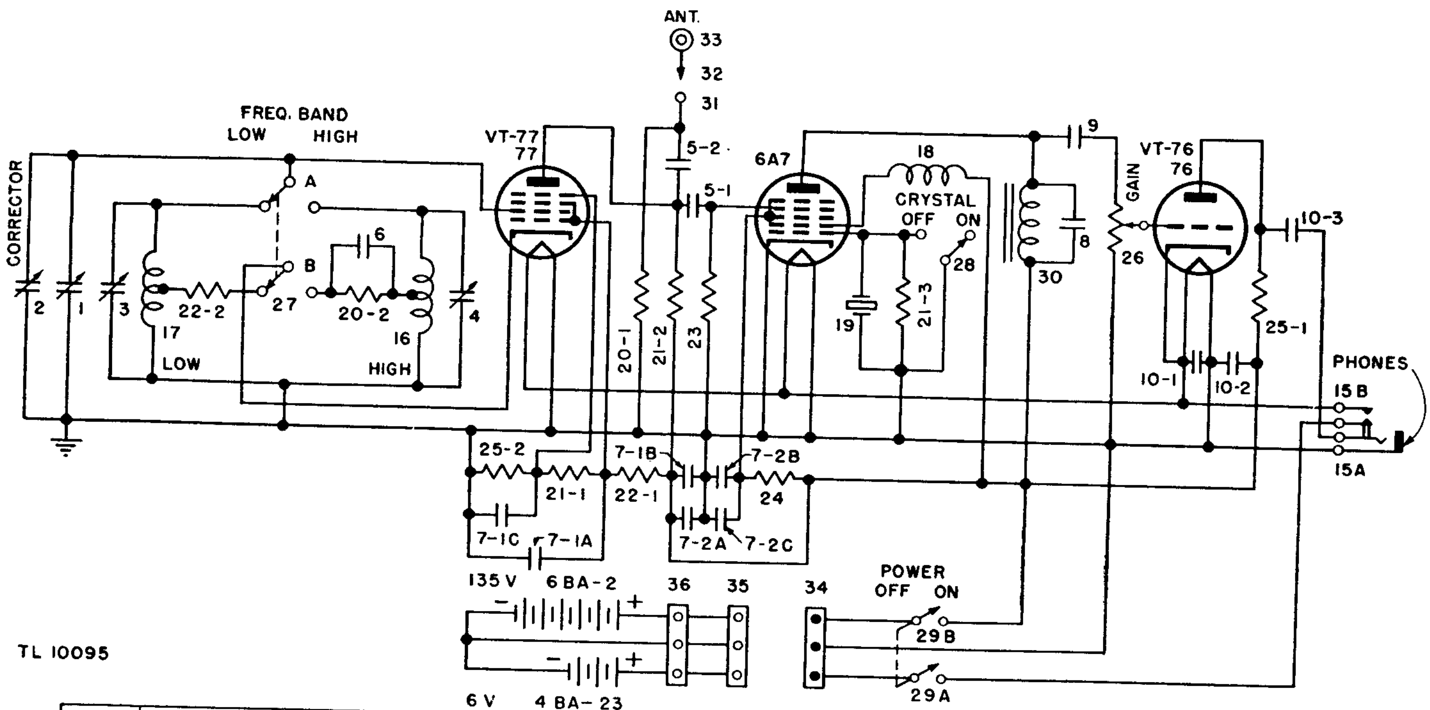
For transmitter frequency measurements, a 2-foot piece of rigid copper wire is adequate for the frequency meter antenna. The antenna should be only in reasonable proximity to the transmitter output. Care should be exercised to avoid allowing excess r-f to enter the frequency meter which can cause permanent damage.

In making frequency checks or dial calibrations with a receiver, the frequency meter antenna lead should be only loosely coupled to the receiver input. This can be close proximity or the wrapping of the respective leads.

At no time should the frequency meter be directly connected for frequency measurement purposes.

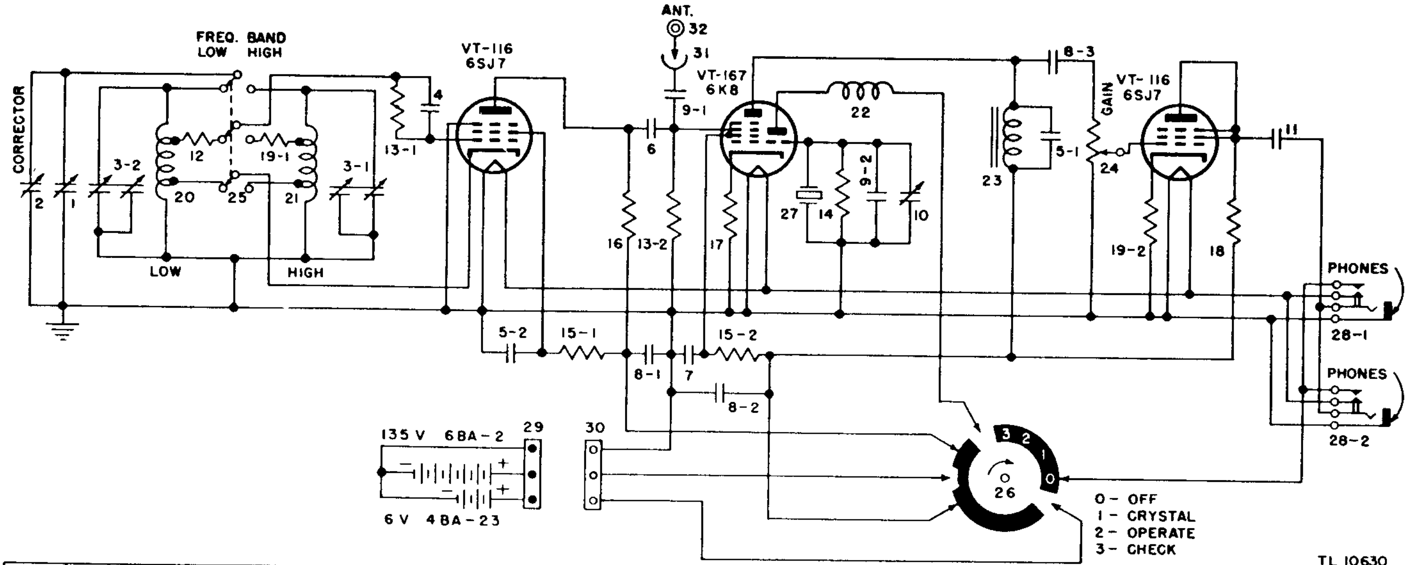
In all models of the BC-221, high impedance headphones should be used for optimum performance. The earlier models specified the P-18 and the P-20 headphones while the later models specified the HS-30.

A point worthy of mention is that in certain measurements where visual observation of the "zero-beat" is desired, an output meter with an appropriate impedance matching device can be used in place of the headphones.



REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION
1	150 μμf	7-1C	0.1 μf	15B	FIL. SWITCH	23	1 MEGOHM	31	ANT. PLUG
2	2 μμf	7-2A	0.1 μf	16	HIGH FREQ. COIL	24	30,000 OHM	32	CONTACT SPRING
3	10 μμf	7-2B	0.1 μf	17	LOW FREQ. COIL	25-1&2	15,000 OHM	33	BINDING POST
4	10 μμf	7-2C	0.1 μf	18	1.7 MILLIHY	26	0.5 MEGOHM	34	POWER PLUGS
5-1&2	10 μμf	8	.001 μf	19	CRYSTAL	27	SWITCH	35	POWER JACKS
6	250 μμf	9	.02 μf	20-1&2	5,000 OHM	28	SWITCH	36	BATTERY TERM
7-1A	0.1 μf	10-1,2,3	0.5 μf	21-1,2,3	50,000 OHM	29	SWITCH		
7-1B	0.1 μf	15A	JACK	22-1&2	10,000 OHM	30	450 HENRYS		

FIG 1 *Frequency Meters BC-221-C and BC-221-D, schematic diagram.*



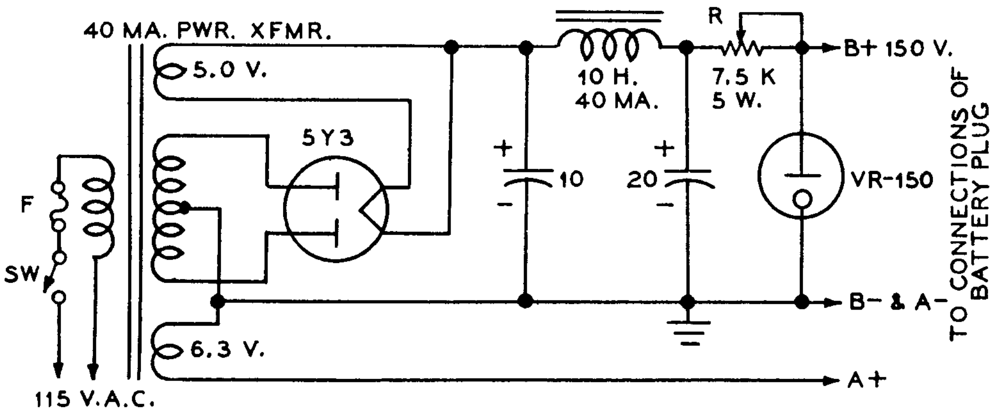
REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION
1	220 μμf	8-1,2,3	.05 μf	15-1&2	8,750 OHM	22	735 MICROHY	29	POWER PLUGS
2	1 μμf	• 9-1&2	12 μμf	16	50,000 OHM	23	300 HENRYS	30	POWER JACKS
3-1&2	25+4 μμf	10	12 μμf	17	75 OHM	24	1 MEGOHM	31	ANT. CLIP
4	100 μμf	11	2 μf	18	12,500 OHM	25	SWITCH	32	BINDING POST
5-1&2	.002 μf	12	4,500 OHM	19-1&2	350 OHM	25	SWITCH		
6	50 μμf	13-1&2	150,000 OHM	20	6.5 MILLIHY	27	CRYSTAL		
7	.001 μf	14	1 MEGOHM	21	25 MICROHY	28-1&2	JACKS		

• REF. NO. 9-2 IS 6μμf

FIG 2 *Frequency Meter BC-221-Q, schematic diagram.*

REGULATED POWER SUPPLY FOR THE BC-221

Figure 3 shows an easily constructed voltage-regulated power supply for operation of the BC-221 frequency meter. The series resistor R should be adjusted, with the BC-221 serving as a load for the power supply, until the current from the cathode terminal of the VR-150 to ground is approximately 15 ma.

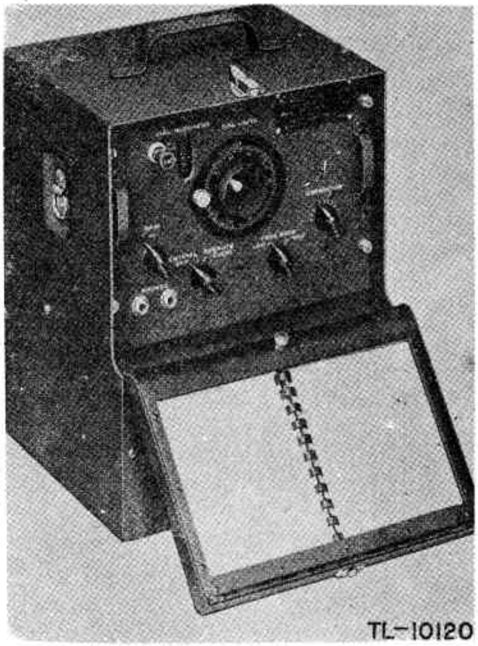


The existing "OFF, CRYSTAL, OPERATE, CHECK" switch is removed from the "A" (+) battery circuit. The positive "A" heater lead from the power plug is connected directly to the ungrounded side of the filament buss.

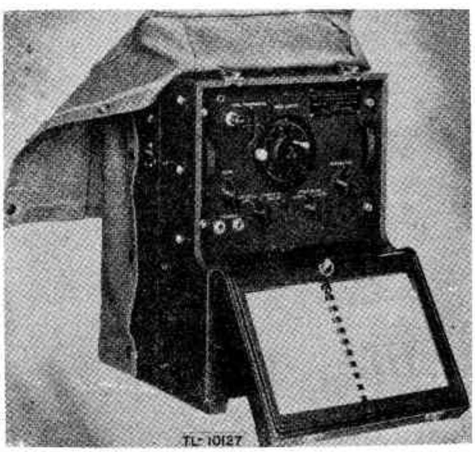
In earlier models of the BC-221 such as the BC-221C, fig. 1, the cathode of the amplifier tube may be connected directly to the filament which provided its bias. In such cases it is necessary to break this connection and run the cathode to ground through a proper value cathode resistor. If this is not done excessive hum will result in the frequency meter output.

On certain models such as the BC-221Q, fig. 2, the "B" (+) lead may be left intact with the original switch. This arrangement in conjunction with the power "OFF-ON" switch permits warm-up of the unit without signal radiation.

The switch for the new power supply (Sw) may be located on the frequency meter cabinet or chassis as desired.



Frequency Meter BC-221-(&), in metal cabinet.



Frequency Meter BC-221-(&), in wooden cabinet.

CONVERTING THE BC-342 RECEIVER

Though the BC-342 Signal Corps short-wave receiver has not appeared in quantity on the surplus market, the BC-312 has been widely available. Either is considered an ideal piece of equipment that can be readily modified and used very nicely as a communications receiver. Either can be made to perform comparably with receivers that sell on the current market for three and four times the price.

The BC-342 is designed to operate on 115 volts ac, 50 or 60 cycles. The direct current version of the BC-342 is the BC-312 (12 volts, dc). Since the major part of the BC-312's conversion is identical to that of the BC-342, only a small part will be devoted to it under a separate title with general reference directed to this article.

Among the most recent models of the BC-342 and BC-312 appearing on the market are the "M" and "N" models. Since the later models are not greatly different from the earlier models, the converting procedure can apply to all of them without regard to the slight variations. The most apparent variation is the omission of the Crystal Filter on the later models of the BC-312.

As is immediately apparent, these Signal Corps receivers were built for service rather than for beauty. Even though it is not as pretty as the modern communications receiver, the ham can be reasonably assured that this receiver is one of the most rugged, both mechanically and electrically, that has ever been built. It has relatively high sensitivity and good stability. Its frequency range is 1500 to 18000 kc. thereby not covering the broadcast band or the 10-meter band. Converters for the high-frequency bands work nicely with this receiver, since direct coaxial coupling to the antenna input is provided on the front panel of the receiver.

The BC-342 has the following tube line-up with the respective functions:

2 ea	6K7	(VT-86)	1st & 2nd RF amplifiers
	6C5	(VT-65)	RF oscillator
	6L7	(VT-87)	1st Detector
2 ea	6K7	(VT-86)	1st & 2nd IF amplifiers
	6R7	(VT-88)	2nd Detector, AVC, 1st Audio amp.
	6C5	(VT-65)	CW Oscillator
	6F6	(VT-66)	Audio output amplifier
	5W4	(VT-97)	Rectifier

The r.f. oscillator stage has been well stabilized, making the drift and dial calibration quite accurate. The frequency coverage of the receiver is accomplished in six bands, with directly calibrated, fast and slow vernier knobs. Since the military requirements were not those generally required for ham use, the following modifications and refinements will be covered:

(a) Modification for the RF Stages
(b) Modifying the Crystal Filter
(c) Backlash Improvement in the Tuning Mechanism

(d) Reducing the Audio Hum Level
(e) Connection for the "send-receive" Switch
(f) Improvement for the Audio Section
(g) Additional Circuit Refinements
(h) Optional Refinements and Suggestions

(a) Modification for the R.F. Stages

Since the r-f stages are operated with a higher than rated grid bias and lower than rated screen voltage, the receivers have a noticably lower signal to noise ratio than is expected in good communication receivers. Increasing the gain of the r-f stages materially improves this condition.

The existing cathode resistors of the 1st and 2nd r-f stages, R_1 and R_7, are 500 ohms. These should be reduced to 250 ohms. The screen resistors, R_3 in the 1st r-f stage and R_9 in the 2nd r-f stage, should be reduced from the original value of 40,000 ohms to 20,000 ohms. These changes give a grid bias of about -3 volts relative to the cathode and a screen voltage of approximately 130 volts. Another recommended feature is the removal of the 1st r-f stage from the manual r-f gain control permitting this stage to operate at maximum gain when using the MVC. This change provides optimum signal-to-noise ratio when the manually controlled gain is reduced to the desired listening level.

To make the above alterations it is necessary to remove the shield plate at the rear of the chassis behind the mixer and the r-f amplifier tubes. The screen resistors are located underneath the plate on the mounting strip and are identified from the schematic diagram as R_3 and R_9. An easy way of making the change is to shunt the existing 40,000-ohm resistors with similar and equal resistors thus giving a value of 20,000 ohms.

The existing cathode resistors are located at the sockets of the tubes requiring the removal of the tube mounting plate. Substitute 250-ohm, 1/2-watt resistor for R_1, soldered between the cathode pin and pin No. 1 (ground). R_7 is replaced with a 250-ohm resistor between the same points as the original resistor.

The increase in gain from the above changes should show a definite peak noise by tuning the trimmer on the 1st r-f stage with the antenna disconnected.

(b) Modifying the Crystal Filter

The crystal filter, which is electrically located just before the 1st i-f stage, is a crystal tuned bridge circuit intended to give greatly increased selectivity. Since the military version seriously reduces the signal level, its operation is not considered up to the requirements to warrant its use; however, the following modification will give radical improvement.

As it is, switching the filter in and out changes the shunting capacitance across the secondary of the i-f transformer to such an extent that the stage is considerably detuned, thus reducing the sensitivity. To avoid this radical change in capacitance at the switching point, which is done by a switch on the capacitor shaft, the switching point should be changed mechanically to close when the phasing capacitor is at minimum capacitance.

The best method of doing this is to force the switch blade around 180 degrees on its collar. Since all switches are not conducive to this treatment without breaking it may be necessary to solder the blade to the collar in its new position. After this change is made and functioning properly it is necessary to readjust the alignment of the i-f transformer secondary in which the crystal filter operates. This adjustment is made at the top of the first detector transformer. It is preferable to align it on noise with the crystal switch out. Now the signal strength should be the same with the filter out, or peaked on the noise when it is in. The crystal selectivity is not too great but considered good for ordinary operation.

A refinement frequently made to make the crystal filter tuning less critical, is to reduce the capacitance of the variable phasing capacitor. This is done by removing (breaking) approximately half of the stator plates from the capacitor. Since it is not necessary to remove the filter assembly for this operation, it is an easy refinement to add.

(c) Backlash Improvement in the Tuning Mechanism

Generally backlash is not considered as being too bad in these receivers. However, it is always the general desire to minimize this condition. The largest part of the backlash occurs between the worm gear and its mating gear on the capacitor shaft. To tighten the mesh of these two gears is a major operation generally not recommended since it requires considerable dismantling of the mechanical tuning assembly. However, in most cases improvement can be obtained by reducing the amount of end play on the worm-gear shaft. This is done by increasing the spring tension on the worm. To do this, loosen the collar, pressing it lightly against the spring, and retighten it in its new position.

(d) Reducing the Audio Hum Level

Frequently a relatively high hum level is present in these receivers. It is generally due to insufficient power supply filtering and use of the output stage for headphone reception.

If insufficient filtering in the power supply is apparent, it is recommended that midget 8 mfd. filter capacitors be shunted across the existing filter capacitors C89 and C90 in the power supply section.

Modification of the audio section as discussed under section (f) of this article will give definite improvement in the hum level for headphone reception.

(e) Connection for the "send-receive" Switch

The "send-receive" switch does not operate the receiver since it is connected into the external plug on the front of the receiver. To make it operate in the normal fashion, it is necessary to remove the leads from the switch and connect one terminal of the switch to the chassis (ground). Disconnect the high-voltage center-tap lead from the negative terminal of the filter capacitor in the power supply and connect this lead to the other side of the "send-receive" switch. This lead is brown in color and long enough to reach the switch through the grommet in the power supply case. The "send-receive" switch should be kept in the center tap lead so as to keep it in the low-potential side of the "B" circuit thus avoiding high voltage at the switch and also eliminating switch "pops" that occur when switching in the high-potential side.

(f) Improvement for the Audio Section

Since this set is capable of supplying adequate audio volume for headphones at the output of the first audio amplifier stage, it is advisable to shift the lower phone jack connection to the output of the first audio stage. This stage is the triode section of the 6R7. Hum and noise which may normally be picked up by the additional audio output stage is reduced considerably.

This change can be accomplished by connecting the lower jack, at the right side of the front panel and labeled 2nd audio phones, to the grid (pin No. 5) of the output tube, the 6F6. In some models this modification will not be necessary since one of the jacks is already connected in the first audio output and labeled accordingly.

To improve further the above modification, it may be preferred to replace the existing jack with an open-circuiting type jack which opens the grid circuit to the output tube when the headphones plug is inserted. This is normal practice in most communication receivers since it removes the speaker output when the headphones are used. If the speaker is not connected, the open-circuiting jack removes the possibility of very high voltages that may be developed at the plate of the output tube with large signals when the circuit is not loaded. These voltages can easily be high enough to arc between the electrodes in the output tube or break down the insulation in the output transformer.

Transformer T_1 is an audio interstage transformer that is used in some models for headphones output from the first audio amplifier. In other models, the transformer is connected to the external plug on the front panel and serves no purpose in the normal operation of the set.

Since the output transformer, T_2, has an output impedance of approximately 3000 ohms, it is not considered practical for normal use. It is generally desired to replace this transformer with a standard output transformer matching the 6F6 to the desired voice coil impedance. This works out nicely with a 6 or 8 inch PM speaker. When changing output transformers, it is possible to select the physical size which can be squeezed into the original position of T_2. The secondary leads can be brought out as before to the speaker jack with the jack labeled accordingly.

If the changing of output transformers is not desired, the existing output of transformer T_2 can be fed directly into another output transformer having a primary impedance of 3000 or 4000 ohms when connected to the speaker voice coil. This method has been used satisfactorily and will eliminate the work in changing transformers.

Additional refinements considered advisable, especially if more audio volume is desired, are changing the following circuit components in the audio section of the receiver.

Replace the 6R7 detector first audio tube with the high mu 6Q7. This is an easy change since the socket connections are the same and only the cathode resistor, R_{28}, must be altered for the proper bias. This is easily done by shunting the existing resistor, R_{28}, with a 300-ohm, 1/2 watt resistor.

The diode filter resistor, R_{49}, is a relatively high value, being 0.5 megohms. Considerable increase in volume can be obtained by reducing this value to normal proportions. This can be conveniently done by shunting the existing resistor with a 100K 1/2-watt resistor.

It will also be noted that the grid resistor, R_{33}, of the output stage is considerably lower than normally used. This resistor should be increased from the existing 50K to 250K.

The above changes will give much increased audio volume which will be more than adequate for speaker and headphone operation.

(g) Additional Circuit Refinements

Noise Limiter:

To bring your receiver up into the top class of communication receivers, the addition of the suggested noise-limiter circuit will be well worth while. This is a series-type limiter using the 6H6 diode with an IN-OUT switch. The schematic diagram should be self-explanatory as shown in fig. 1.

If desired, the entire limiter, tube and all, can be encased in an old i-f transformer can. This will give a professional appearance to the installation, and the assembly may be easily mounted inside the receiver on the chassis.

"S" Meter:

Since many hams do not consider the communication receiver complete without a signal-strength meter, the circuit shown in fig. 1 is recommended. This circuit is standard and considered quite satisfactory.

It is generally considered inconvenient to mount even a small meter on the front panel of the receiver. This is true because of limited space and the thickness of the panel which makes cutting of the hole rather difficult. In most cases, the meter is mounted externally on a bracket to the receiver case.

Separate R.F. Gain Control:

An optional feature that is sometimes desired, is separate and individual r-f and a-f gain controls that are not switched in and out with the AVC switch, SW-12.

This control, as in the military version, consists of the tandem potentiometers, R-34 and R-35. To separate them it is necessary to disconnect one, preferably the a-f, R-34, and add an additional 500K potentiometer to the panel for the new a-f gain control. After this is done, the

MODIFIED AUDIO SECTION OF BC-342 & BC-312

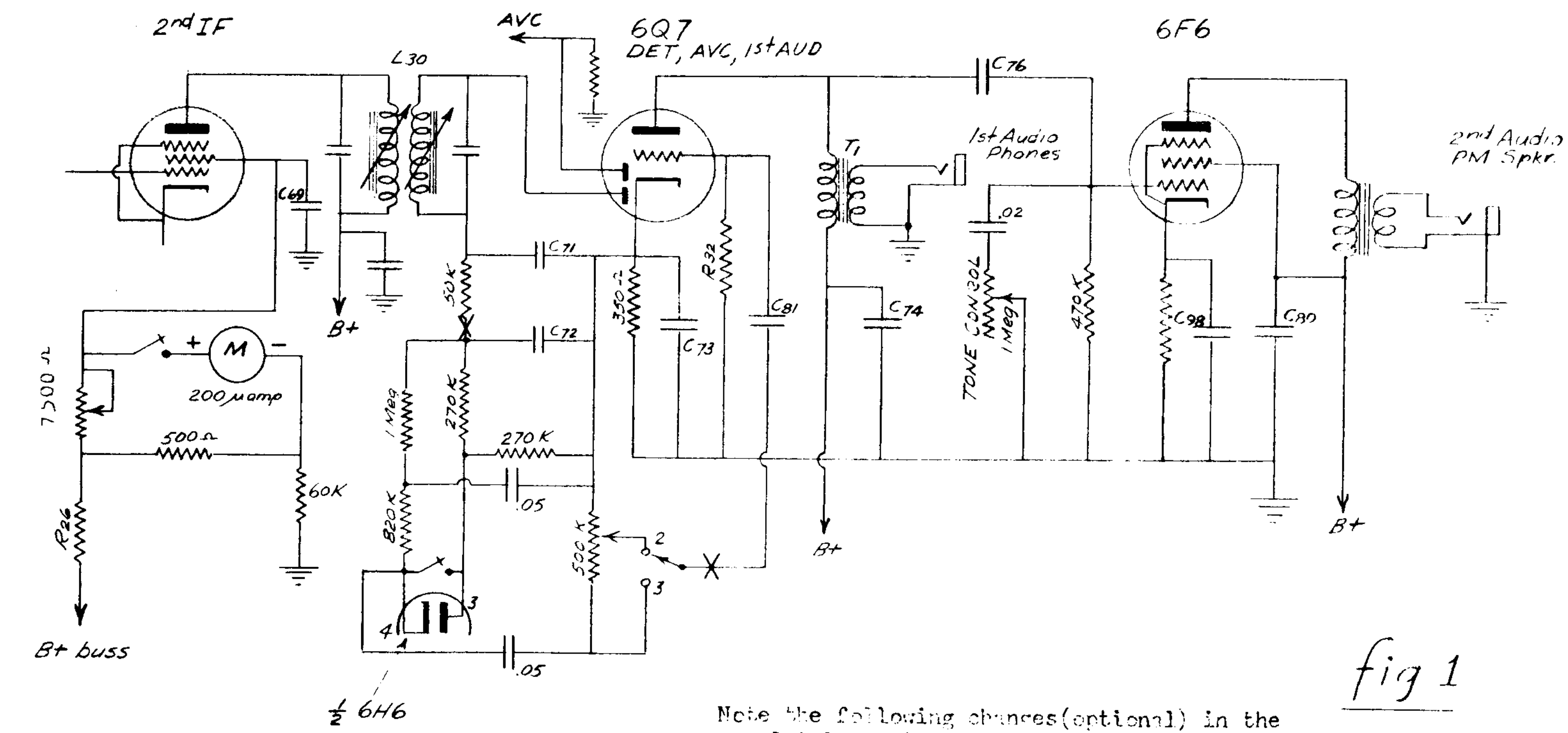


fig 1

NOTE- R25 replaced by S-Meter circuit resistor of 60KΩ. This value is adjusted for meter full scale sensitivity.

Note the following changes(optional) in the completely modified audio section.

1. Output transformer, Plate to Voice Coil
2. 6Q7 for 1st Audio Stage
3. Added "S"-Meter Circuit
4. Added Noise Limiter Circuit (between X's)
5. Tone Control Circuit
6. All indicated condenser and resistor values represent changed values.

leads to the two controls should be reconnected to by-pass switch, SW-12. With this change, the switch in the 2nd and 3rd position only controls the AVC circuit, being either ON or OFF.

Tone Control:

Occasionally a tone control is desired for listening ease and can be added to the receiver. This is quite convenient especially if the receiver does not have the crystal phasing control which is physically replaced with the dial light rheostat on the panel. Since the rheostat is useless in most cases, it can readily be replaced with any other desired control or in this case, the tone control.

A simple type of tone control circuit is shown in Fig. 1.

(h) Optional Refinements and Suggestions:

Among the many personal touches that may be added to the BC-342 and BC-312 for appearance and ease of operation, the following may prove to be ådvantageous or possibly stimulate new ideas:

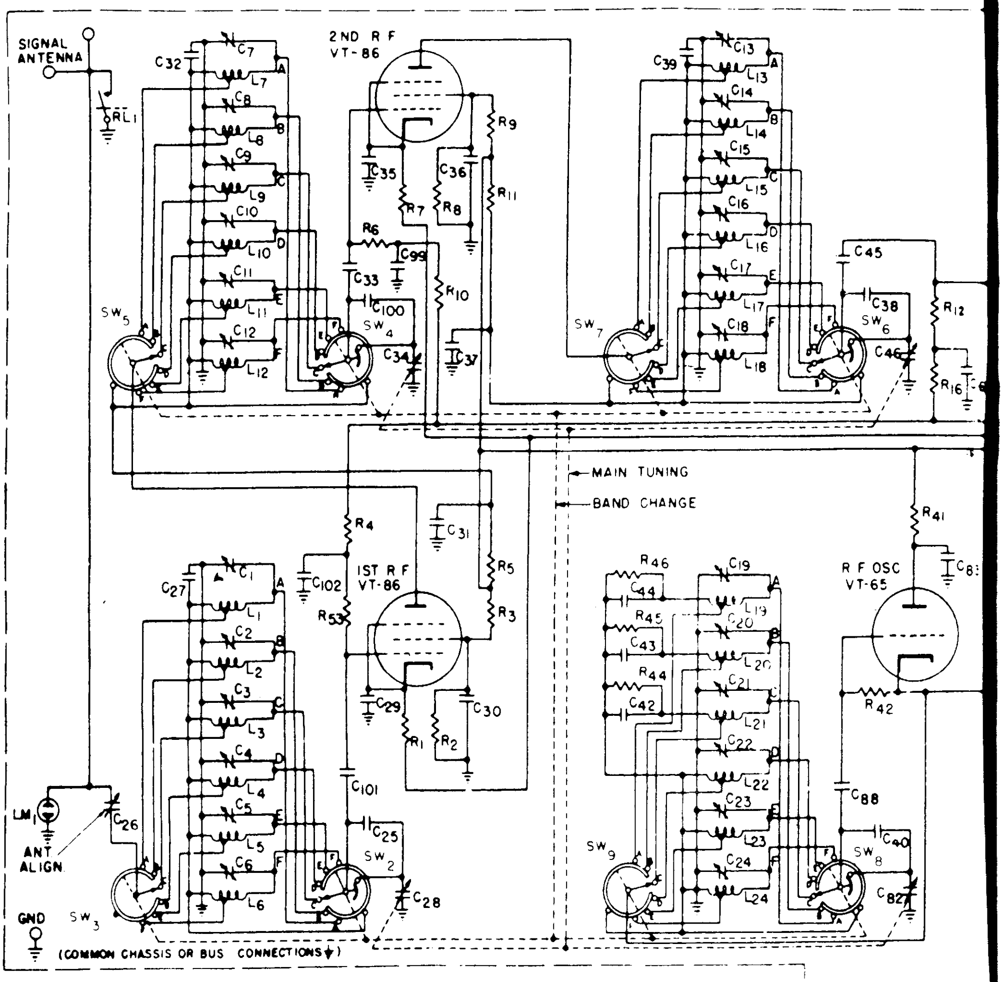
The external plug, SO-1, located on the front panel was intended for use with other associated equipment of which the receiver was a component part. Ordinarily there is no particular need for this plug and it can be removed from the panel. The remaining hole can be plugged or used for added controls. The leads to plug SO-1 should be removed at convenient points in the receiver.

The small vernier tuning knob (1/4" shaft) can be replaced with a larger and more attractive knob which will facilitate fine tuning.

Rubber grommets, inserted in the slide fastener holes on bottom of the receiver case, will serve as a partial shock mount and will eliminate the possibility of sliding or scratching.

The unused jacks on the front panel can also be put to use as desired, such as a phono or audio input to the audio amplifier section. There may be other uses for the jacks that will apply the individual's particular needs.

As will be apparent to the average ham, a number of the above suggestions for conversion of the BC-342 or the BC-312 are optional and will be up to the personal requirements of the individual concerned. With the above conversions this receiver can be made very suitable for ham use with its performance comparable to the high priced communication receivers.



Radio Receiver BC-342-M
Schematic Diagram

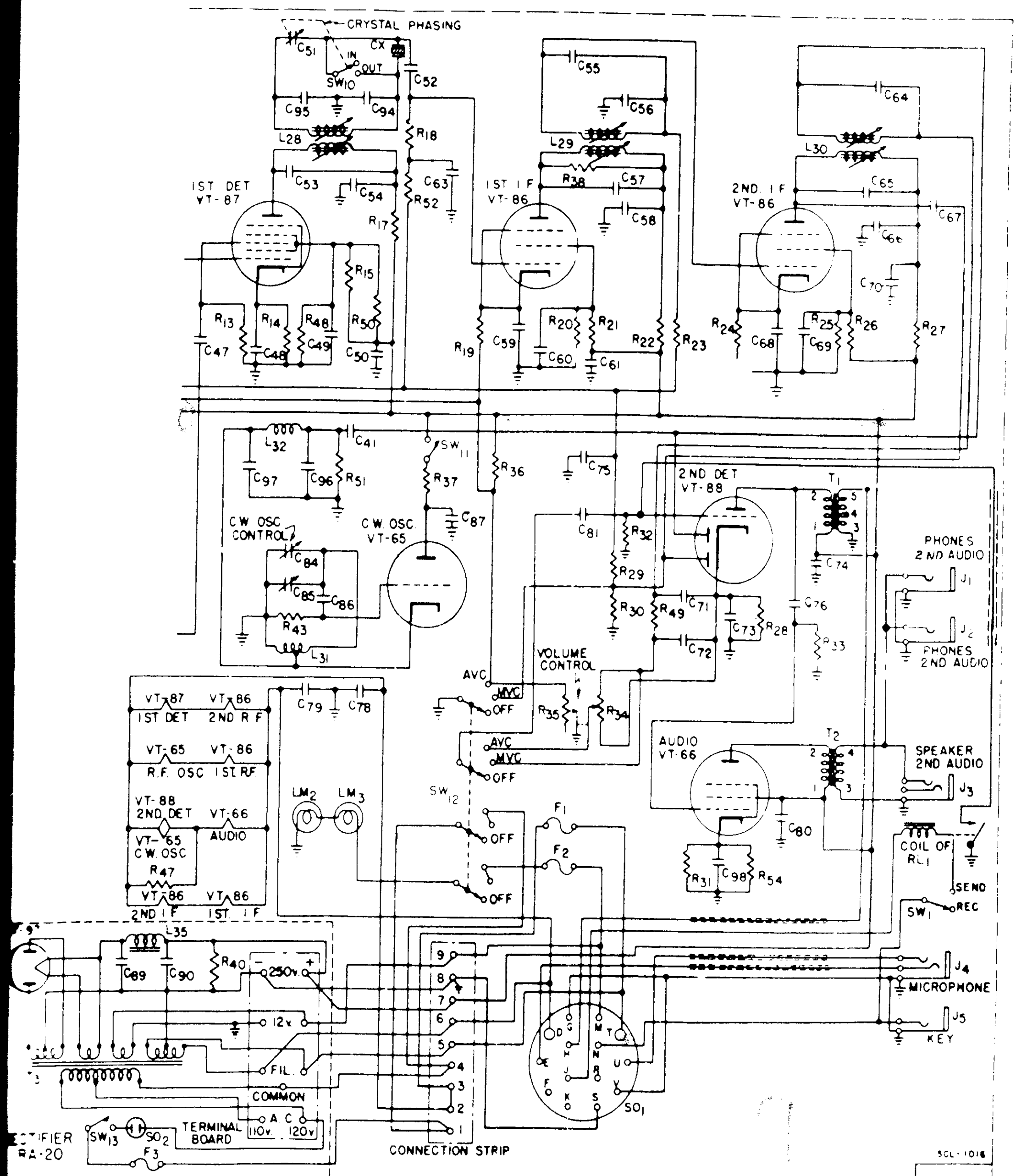


FIG 2

RADIO RECEIVER BC-342-M
SCHEMATIC DIAGRAM

CONVERTING THE BC-312 RECEIVER

This conversion directly supplements the conversion of the BC-342 receiver since the BC-312 is identical to the BC-342 with the exception that it is the direct current version designed to operate from battery power.

Again it should be noted that the different models of this receiver, as indicated by the alphabetical letter, have minor differences. The BC-312A has a thermostatically controlled heater in the oscillator compartment and a noise balancing network in the antenna circuit. The noise balancing network was retained in the "C" model but omitted in later models. Models A, C, D, E, F, and G, all have the crystal filter, but in later models some were supplied with and some without. This was generally dependent on the manufacturer that made them. On models made after the "G", some sets were designed to operate on 24-28 volts and were designated by the letter "X" after the alphabetical letter. However, most of the BC-312 receivers were designed to operate on 12 volts d.c. at approximately 7 amperes.

If it is desired to operate the set on direct current, connections may be made directly into the socket on the front panel with the 12 volt connections made as indicated on the schematic diagram, Fig. 4. For this operation it is also necessary to ground lug No. 8 on the terminal strip located near the front right corner of the chassis.

This article applies to the conversion of the BC-312 for a-c operation. Other conversion data for the receiver is covered in the conversion of the BC-342.

After inspection of the BC-312, it will be apparent that the dynamotor must be replaced with a conventional power supply and that the series-parallel wiring of the tube heaters must be revamped if 6-volt heater operation is desired. An alternate method, which eliminates the difficult rewiring of the heater circuit, is to leave the wiring as is and operate the heaters on slightly less than 12 volts a.c. This is accomplished by using the 6X5 rectifier with the 5 and 6 volt windings connected in series thus supplying approximately 11.3 volts a.c.

The least difficult method of adding the new power supply is to make it an external unit to the receiver. However, this makes for a more bulky arrangement with connecting leads between the power supply and the receiver. With careful selection of parts and a little extra time devoted to the job, the new power supply can be contained in the dynamotor case and thereby kept inside the receiver as is done in the BC-342.

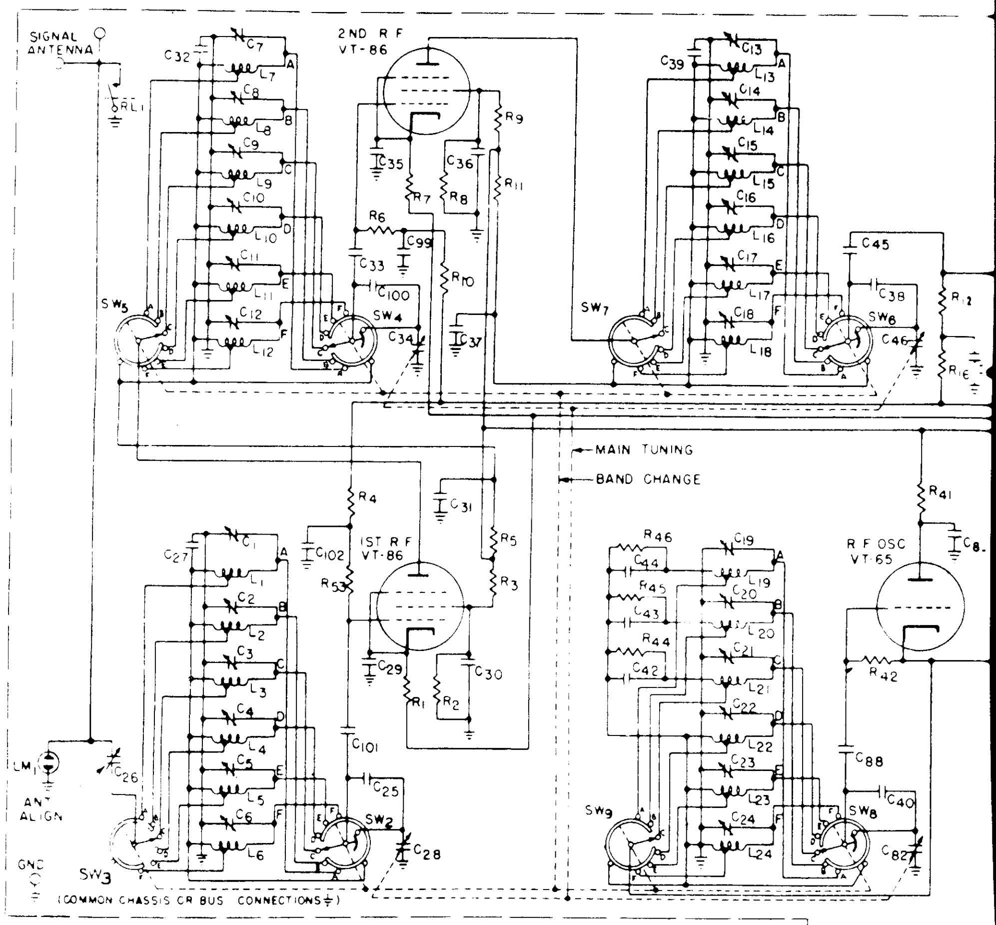
A point worthy of mention is that there have been a few of the BC-342 power supplies, the RA-20, on the surplus market. These are a fortunate find for the BC-312. The RA-20 power supply can be directly interchanged with the dynamotor assembly.

In constructing the new power supply unit, a selected 90-ma. power transformer with both the 5 and 6 volt windings can be fitted with a filter choke, a 16-16 mfd. filter capacitor, bleeder resistor, and the rectifier, 5Y3GT, in the old dynamotor case. This will cause a rather crowded condition but is well worth while if it is desired to have the power supply inside the receiver.

Both the 6-volt and the 12-volt heater version of the recommended power supply, with parts list and connection diagram, are shown in Fig. 3.

It will be noted that the existing OFF-ON switch, SW-12, and the fuse on the front panel are incorporated in the 115-volt circuit of the new power supply. The dial lights are connected directly across the heater circuit at any convenient point in the set. These leads should be twisted and kept away from the grid and plate circuits as much as possible.

For other circuit refinements and modifications, refer to "Conversion of the BC-342."



Radio Receiver BC-312-M
Schematic Diagram

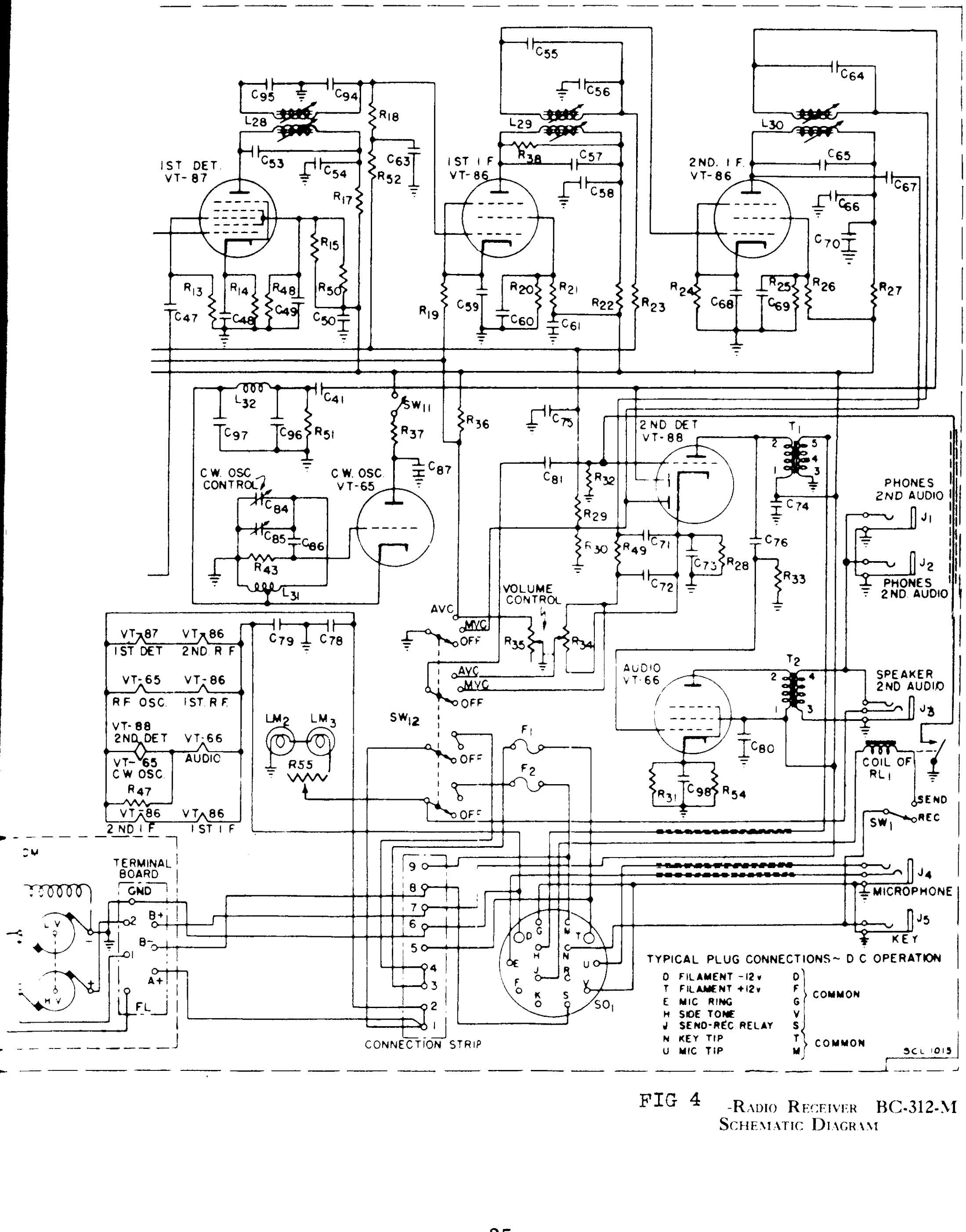


FIG 4 -RADIO RECEIVER BC-312-M SCHEMATIC DIAGRAM

POWER SUPPLY FOR BC-312 RECEIVER

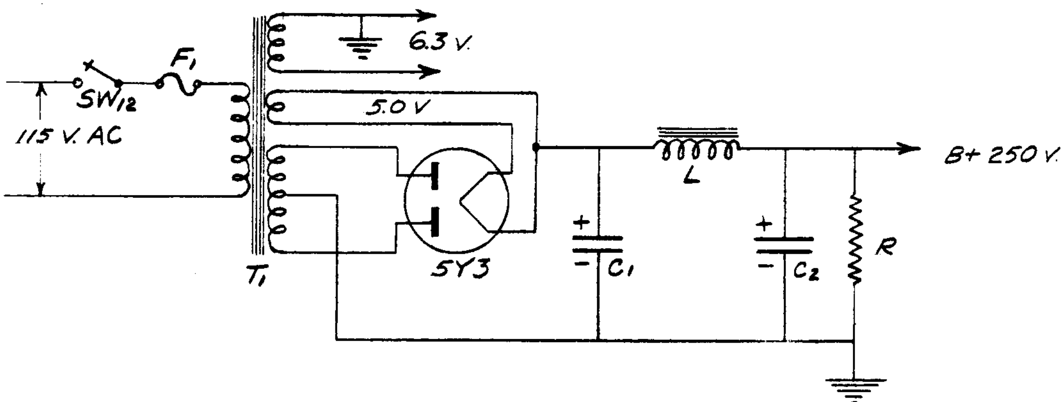
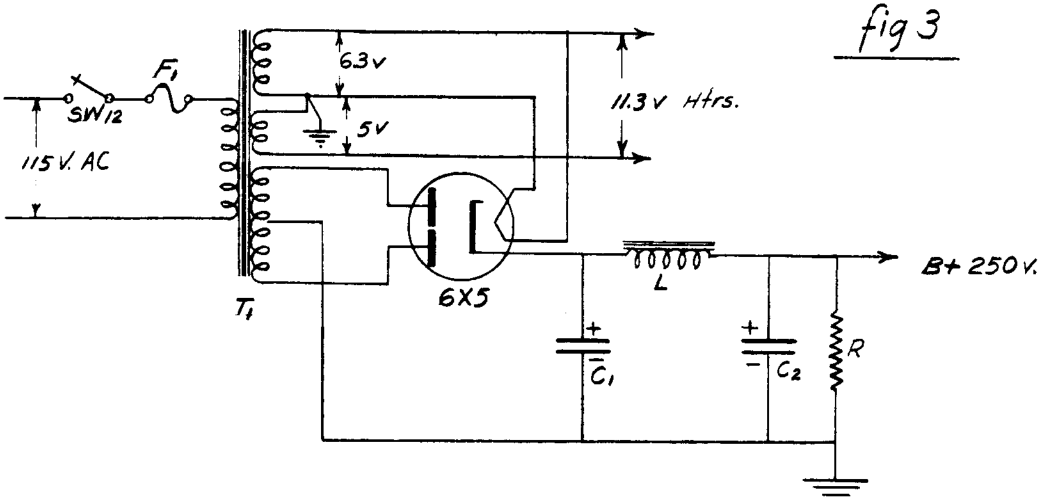
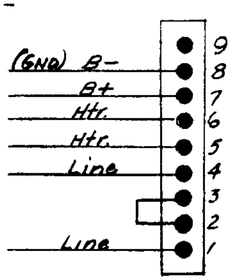


fig 3



PARTS LIST	
T_1	Power X'former, 300-CT-300 V/90 MA, 6.3 V., 5 V.
L	Filter Choke 15H, 90 MA
C_{1-2}	Condenser, Filter 16-16 MFD, 450 V.
R	Resistor, 50,000 Ω, 5 WATT
SW_{12}	Switch, MVC-AVC in Receiver
F_1	Fuse on Receiver Panel, 2 Amp.



COMPONENT PARTS LIST FOR BC312 RECEIVER

CAPACITORS

C1	CA-289	3-25 uuf.
C2	CA-291	6-100 uuf.
C3	CA-291	6-100 uuf.
C4	CA-290	4-50 uuf.
C5	CA-290	4-50 uuf.
C6	CA-290	4-50 uuf.
C7	CA-289	3-25 uuf.
C8	CA-291	6-100 uuf.
C9	CA-291	6-100 uuf.
C10	CA-290	4-50 uuf.
C11	CA-290	4-50 uuf.
C12	CA-290	4-50 uuf.
C13	CA-289	3-25 uuf.
C14	CA-291	6-100 uuf.
C15	CA-291	6-100 uuf.
C16	CA-290	4-50 uuf.
C17	CA-290	4-50 uuf.
C18	CA-290	4-50 uuf.
C19	CA-289	3-25 uuf.
C20	CA-291	6-100 uuf.
C21	CA-291	6-100 uuf.
C22	CA-290	4-50 uuf.
C23	CA-290	4-50 uuf.
C24	CA-290	4-50 uuf.
C25	CA-294	125 uuf.
C26	CA-293	10-210 uuf.
C27	CA-284	.05 uf.
C28	CA-292	13-226 uuf.
C29		.05 uf.
C30	CA-195	.05 uf.
C31		.05 uf.
C32	CA-284	.05 uf.
C33	CA-266	100 uuf.
C34	CA-292	13-226 uuf.
C35		.05 uf.
C36	CA-195	.05 uf.
C37		.05 uf.
C38	CA-294	125 uuf.
C39	CA-284	.05 uf.
C40	CA-294	125 uuf.
C41	CA-278	5 uuf.
C42	CA-300	3000 uuf.
C43	CA-297	1600 uuf.
C44	CA-299	750 uuf.
C45	CA-266	100 uuf.
C46	CA-292	13-226 uuf.
C47	CA-266	100 uuf.
C48		.05 uf.
C49	CA-195	.05 uf.
C50		.05 uf.
C51	CA-323	4-50 uuf.
C52	CA-266	100 uuf.
C53	CA-296	400 uuf.
C54	CA-281	.01 uf.
C55	CA-295	50 uuf.
C56	CA-281	.01 uf.
C57	CA-295	50 uf.
C58	CA-281	.01 uf.
C59		.05 uf.
C60	CA-302	.05 uf.
C61		.05 uf.
C62	CA-284	.05 uf.
C63	CA-281	.01 uf.
C64	CA-295	50 uuf.
C65	CA-295	50 uuf.
C66	CA-281	.01 uf.
C67	CA-279	10 uuf.
C68		.05 uf.
C69	CA-301	.05 uf.
C70		.05 uf.
C71	CA-218	150 uuf.
C72	CA-193	500 uuf.
C73		.05 uf.
C74	CA-301	.05 uf.
C75		.05 uf.
C76	CA-281	.01 uf.
C77	CA-295	50 uuf.
C78		0.1 uf.
C79	CA-276	0.1 uf.
C80		0.1 uf.
C81	CA-281	.01 uf.
C82	CA-292	13-226 uuf.
C83	CA-277	0.1 uf.
C84	CA-280	1-10 uuf.
C85	CA-253	4-75 uuf.
C86	CA-266	100 uuf.
C87	CA-284	.05 uf.
C88	CA-266	100 uuf.
C89	CA-211	.002 uf.
C90	CA-211	.002 uf.
C91	CA-295	50 uuf.
C92	CA-295	50 uuf.
C93	CA-295	50 uuf.
C94	CA-298	800 uuf.
C95	CA-298	800 uuf.
C96	CA-286	75 uuf.
C97	CA-286	75 uuf.
C98	CA-275	4 uf.
C99	CA-284	.05 uf.
C100	CA-294	125 uuf.
C101	CA-266	100 uuf.
C102	CA-284	.05 uf.

CX CRYSTAL DC-6
DM DYNAMOTOR DM-17-A
F1 FUSE FU-21
F2 FUSE FU-21
J1 JACK JK-34 (1st AUDIO)
J2 JACK JK-34 (2nd AUDIO)
J3 JACK JK-33 (SPEAKER)
J4 JACK JK-33 (MICROPHONE)
J5 JACK JK-34 (KEY)

COILS

L1
L2
L3 1st R.F. COILS
L4
L5
L6
L7
L8
L9 2nd R.F. COILS
L10
L11
L12
L13
L14
L15 1st DET. COILS
L16
L17
L18
L19
L20
L21 OSC. COILS
L22
L23
L24
L25
L26 IGN. SUPP. COILS
L27
L28 TRANSFORMER C-202
L29 TRANSFORMER C-203
L30 TRANSFORMER C-204
L31 BEAT OSC.
L32 FILTER COIL
LM1 NEON LAMP
LM2 LAMP LM-27
LM3 LAMP LM-27

RESISTORS

R1	RS-164	500 ohms 1 watt
R2	RS-169	60,000 ohms 1/2 watt
R3	RS-149	40,000 ohms 1/2 watt
R4	RS-172	100,000 ohms 1/3 watt
R5	RS-167	1,000 ohms 1/3 watt
R6	RS-173	2 MEG. 1/3 watt
R7	RS-164	500 ohms 1 watt
R8	RS-169	60,000 ohms 1/2 watt
R9	RS-149	40,000 ohms 1/2 watt
R10	RS-172	100,000 ohms 1/3 watt
R11	RS-167	1,000 ohms 1/3 watt
R12	RS-173	2 MEG. 1/3 watt
R13	RS-168	50,000 ohms 1/3 watt
R14	RS-166	350 ohms 1 watt
R15	RS-140	30,000 ohms 1/2 watt
R16	RS-172	100,000 ohms 1/3 watt
R17	RS-125	1,000 ohms 1/2 watt
R18	RS-172	100,000 ohms 1/3 watt
R19	RS-164	500 ohms 1 watt
R20	RS-163	60,000 ohms 1 watt
R21	RS-149	40,000 ohms 1/2 watt
R22	RS-125	1,000 ohms 1/2 watt
R23	RS-150	100,000 ohms 1/2 watt
R24	RS-164	500 ohms 1 watt
R25	RS-163	60,000 ohms 1 watt
R26	RS-149	40,000 ohms 1/2 watt
R27	RS-125	1,000 ohms 1/2 watt
R28	RS-171	750 ohms 1 watt
R29	RS-162	.25 MEG. 1/2 watt
R30	RS-161	1 MEG. 1/3 watt
R31	RS-165	1,000 ohms 1 watt
R32	RS-162	250,000 ohms 1/2 watt
R33	RS-131	50,000 ohms 1/2 watt
R34	POTENTIOMETER	0-500,000 ohms
R35	RS-174	0-50,000 ohms
R36	RS-150	100,000 ohms 1/2 watt
R37	RS-150	100,000 ohms 1/2 watt
R38	RS-178	12 ohms 15 watts
R39	RS-178	12 ohms 15 watts
R40	RS-178	12 ohms 15 watts
R41	RS-139	30,000 ohms 1 watt
R42	RS-140	30,000 ohms 1/2 watt
R43	RS-148	200,000 ohms 1/2 watt
R44	RS-127	3,000 ohms 1/2 watt
R45	RS-128	5,000 ohms 1/2 watt
R46	RS-177	7,500 ohms 1/2 watt
R47	RS-176	60 ohms 1/2 watt
R48	RS-169	60,000 ohms 1/2 watt
R49	RS-133	500,000 ohms 1/2 watt
R50	RS-140	30,000 ohms 1/2 watt
R51	RS-129	10,000 ohms 1/2 watt
R52	RS-175	10,000 ohms 1/3 watt
R53	RS-173	2 MEG. 1/3 watt

RL1 RELAY BK-13
SO1 SOCKET SO-94
SW1 SWITCH SW-131
SW2
SW3 1st R.F. SW.
SW4
SW5 2nd R.F. SW.
SW6
SW7 1st DET. (MIXER) SW.
SW8
SW9 OSC. SW.
SW10 CRYSTAL SW.
SW11 BEAT OSC. SW.
SW12 SWITCH SW-119
SW13 SWITCH SW-131
T1 TRANSFORMER C-205
T2 TRANSFORMER C-160

CONVERTING THE BC-348 RECEIVER

Introduction:

The BC-348 series of receivers was manufactured for the Armed Forces and was designed to operate from a 28-volt d-c supply. As these sets were used in aircraft, they are extremely compact and much smaller than their equivalent in present commercial cummunications receivers. The following conversion data will cover the changes necessary to adapt the unit to 115-volt a-c operation. Various circuit improvements will also be elaborated on as applicable to amateur radio use.

Many models of the BC-348 were built but, with the exception of the BC-348J, Q and N, they are electrically and mechanically similar. It is of special note that the B minus of the 348Q is not grounded. The BC-224 series is identical except for the heater circuits.

The receiver covers the frequency range of 1500 to 18,000 kc. and 200 to 500 kc. by means of a directly-calibrated vernier dial. It will be noted that the 10-meter amateur band as well as the standard broadcast band is neatly skipped. Converters will be necessary if these bands are desired.

The receiver has two r-f stages and three i-f stages. The intermediate frequency is 915 kc. A crystal filter is included in the circuit also.

The tube line up is as follows:

1st RF	6K7
2nd RF	6K7
RF Osc.	6C5
1st Det.	6J7
1st IF	6K7
2nd IF and CW Osc.	6F7
3rd IF and 2nd Det.	6B8
Audio	41

It is assumed that the reader would not attempt this conversion without enough technical knowledge to make unnecessary the tedious "wire by wire" descriptions generally encountered and, with the suggestions and conversions given here, satisfactory results should be easily obtained. It is important to bear in mind that, due to the numerous models, and circuit differences, common sense will be required in many of the operations as exact component symbols and wire movements have been eliminated in this article.

The following sections of the conversion procedure will be covered in detail:

(a) Power supply
(b) Filament circuit
(c) Speaker matching
(d) Operation
(e) Additional audio stage
(f) Noise silencer
(g) General notes

(a) Power Supply:

As the receiver was designed for operation from a 28-volt d-c source, it will be necessary to build a 115-volt a-c supply.

Since an external speaker and matching transformer will be required, and in order to keep heat out of the receiver compartment, it is advised that the power supply be built into the speaker cabinet along with the speaker matching transformer, and connections be brought out through a cable and plug system.

It should be possible to obtain, on the surplus market, the plug for power connections that was intended for use with the receiver. But if not, the present socket can be replaced with a standard octal tube socket by removing the present socket and filing the retaining bracket to take the octal tube socket.

The circuit shown in Fig. 1 will work nicely and, by referring to the plug connections given at the end of this article, the connecting cable can be made up.

(b) Filaments:

For 6.3-volt a-c operation, it will be necessary to rewire all tube filaments in parallel and to remove the balancing resistor which was used in the d-c system. Fortunately, all tubes are of the 6.3-volt type and no substitutions are required. The fixed and variable dimming controls associated with the pilot lamp circuit should be removed as this feature is not essential.

Fig. 2 is self-explanatory for the filament conversion, and careful examination will show the few actual wire changes necessary. The 6.3-volt lead should be brought out to pin 3 or pin 4 of the power plug. (These two terminals originally were the 28-volt input connections.)

(c) Speaker Matching:

The output of the receiver was originally designed for headphone operation and consisted of two output connections, for 500 ohms or 4500 ohms, depending upon the tap used on the output transformer. As most permanent magnet dynamic speakers are around 8 ohms, a matching transformer will be required to match one of the original outputs to the speaker. This transformer can be mounted in the speaker cabinet as discussed in the paragraph dealing with the power supply. An alternative is the replacement of the original output transformer with one designed to match the output tube to a PM dynamic speaker. However, the former is to be preferred as it does not necessitate circuit changes.

(d) Operation:

After completion of the previous steps, the receiver will function by merely applying power and connecting together terminals 2 and 6 of the output plug. Terminal 2 is the B plus connection and 6 is the screen-grid lead to the i-f's. These two terminals provide a very simple method of adding an "S" meter to the set. Examination of Fig. 3 will show that this circuit can be inserted between terminals 2 and 6 with no other circuit changes being required. The meter can be mounted in the upper right hand corner of the front panel, providing a very small one is used. The adjustable pot should be of the screwdriver adjusting type and also mounted on the front panel for zero setting the "S" meter. Calibration of the meter in "S" units or in "DB's" will be necessary. This addition is not necessary for operation but will add considerably to the versatility of the receiver for amateur use.

(e) Additional Audio Stage:

The audio gain of the receiver is not quite adequate, and an additional stage is required for satisfactory results. Fig. 4 is a proven circuit consisting of a 6J5 tube in a simple resistance coupled stage to be inserted directly ahead of the 41 power amplifier. With this additional stage the gain will be sufficient.

It is suggested that this added stage be built onto the small removable chassis upon which the dynamotor was originally mounted. The terminal strip on the chassis can be used to bring out all necessary connections and will make a neat and compact unit.

(f) Noise Silencer:

On the higher frequency band of the receiver, and especially if higher frequency converters are to be used, the noise problem becomes one of importance. A shunt-type noise silencer circuit employing a small 1N34 crystal is shown in Fig. 3A. This circuit can be added easily to the receiver schematic. Addition of any noise silencer circuit will normally cause some distortion in the output and therefore should be used only when ignition noise, fluorescent lighting, etc. gives trouble. If properly connected, the silencer should have very little effect on the receiver gain when connected in the circuit and no effect when out of the circuit.

Difficulty may be encountered in using the added audio stage in conjunction with the noise silencer due to the common cathode resistor on the second detector and third i-f stages. This may be remedied by removing the wire between the two cathodes and shorting out "R105".

Note: In 348E, M and P this is not possible as the two stages are in the same tube.

(g) General Notes:

If desired, the audio and RF gain controls, which are originally on a common shaft, may be separated, especially for CW use. This will necessitate disconnecting one of the controls and running the leads to an added control of the same value but mounted elsewhere on the front panel.

The antenna and ground connections may be extended to the rear of the set and terminals added for convenience.

The AVC-OFF-MVC switch has several contacts which were originally used in the 28-volt d-c circuit and which are now useless. These contacts may be used as a standby switch breaking the B minus lead when the switch is in the OFF position and applying it again when in AVC or MVC positions. Careful circuit tracing will be necessary here in order not to disconnect the wrong wires on the switch. An alternative is the use of a simple SPST toggle switch mounted on the front panel and wired in accordance with Fig. 1.

Connections to the output plug (original) are as follows:

1- Output (phones or speaker)
2- B plus
3- 28 volts plus
4- 28 volts plus
5- Output
6- Screen grid voltage to IF
7- Ground (B minus, filament common)

BC-348 POWER SUPPLY & FILAMENT CIRCUIT

fig 1

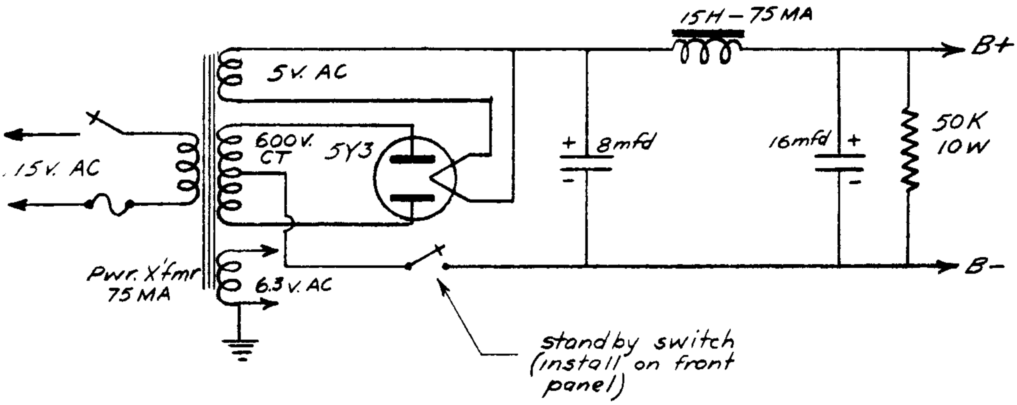
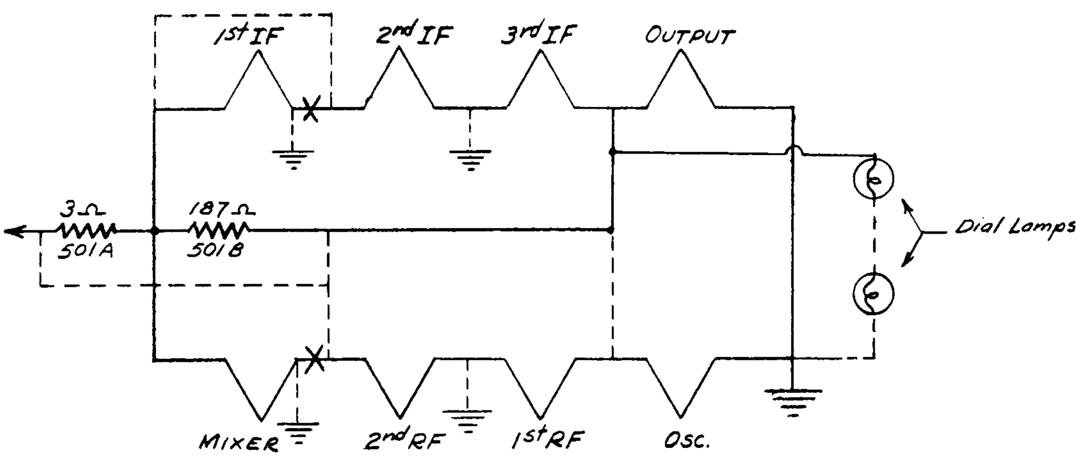


fig 2



Solid lines — Original Circuit
Dotted lines — Added Circuit (modification)
X — Places to break original circuit
NOTE: Osc. can need not be opened.

S-METER CIRCUIT

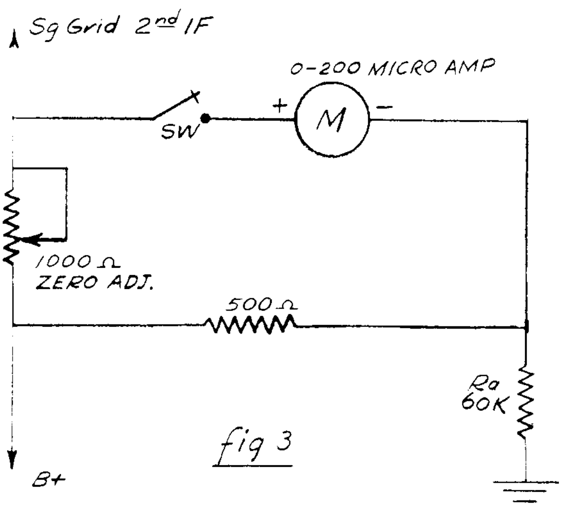


fig 3

NOTE: B+ connection & screen lead to IF Amp are terminals 2 & 6 respectively on the power plug. These connections are normally strapped for operation but the S-Meter can be inserted instead.

For desired swing of meter adjust value of Ra. This value will vary with the sensitivity of the meter movement used.

SERIES TYPE NOISE SILENCER

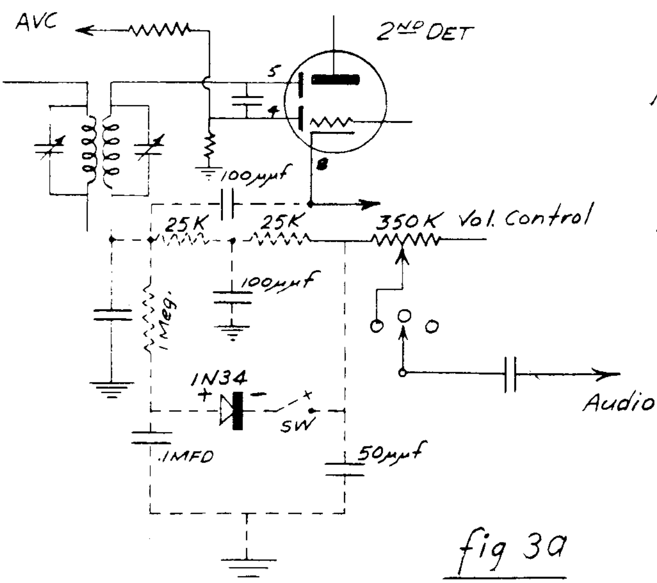


fig 3a

NOTE: Remove lead from rear pot (the one to 4th IF) and add the dotted line components in series with this lead and the pot. Switch should be located on front panel of receiver

ADDED AUDIO STAGE FOR BC-348

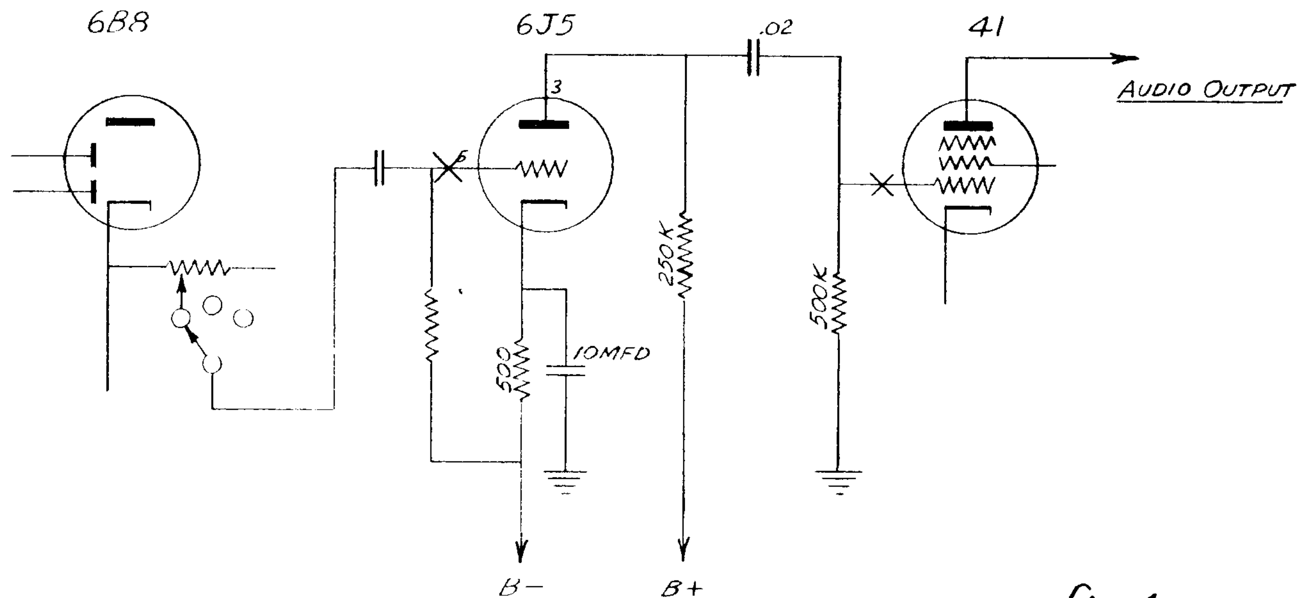
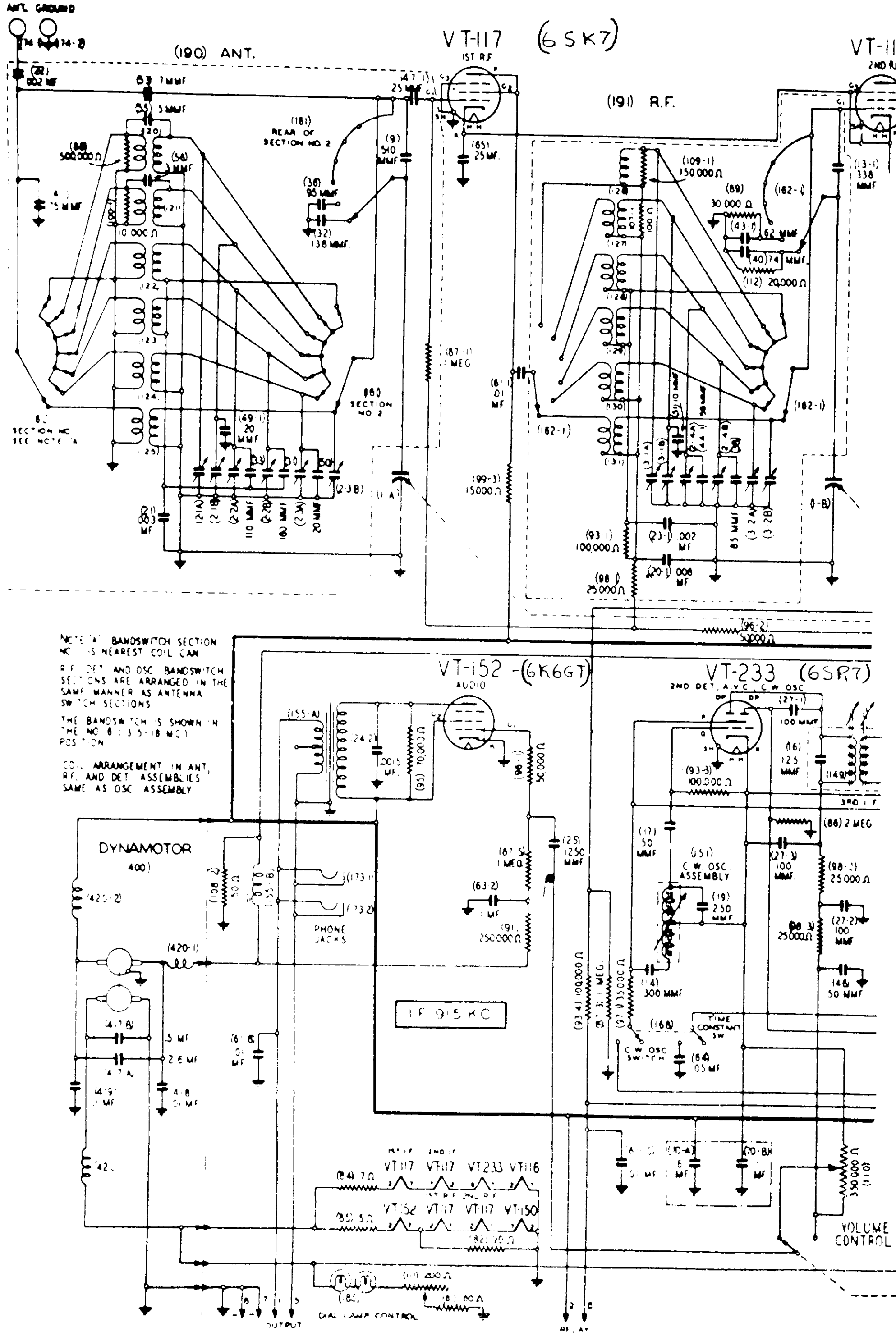


fig 4

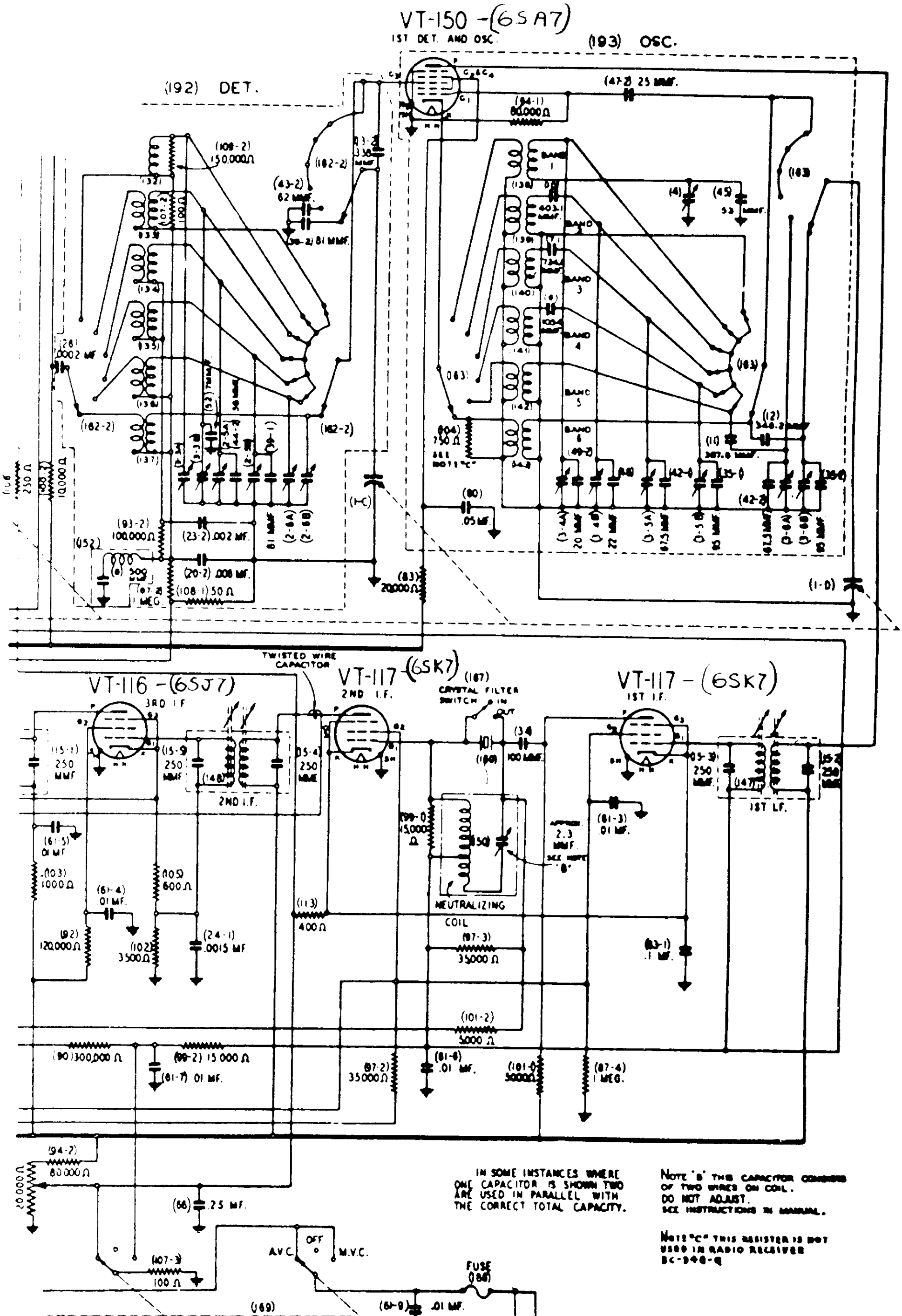
NOTES:

Cathode not grounded in models where B- is not normally grounded.

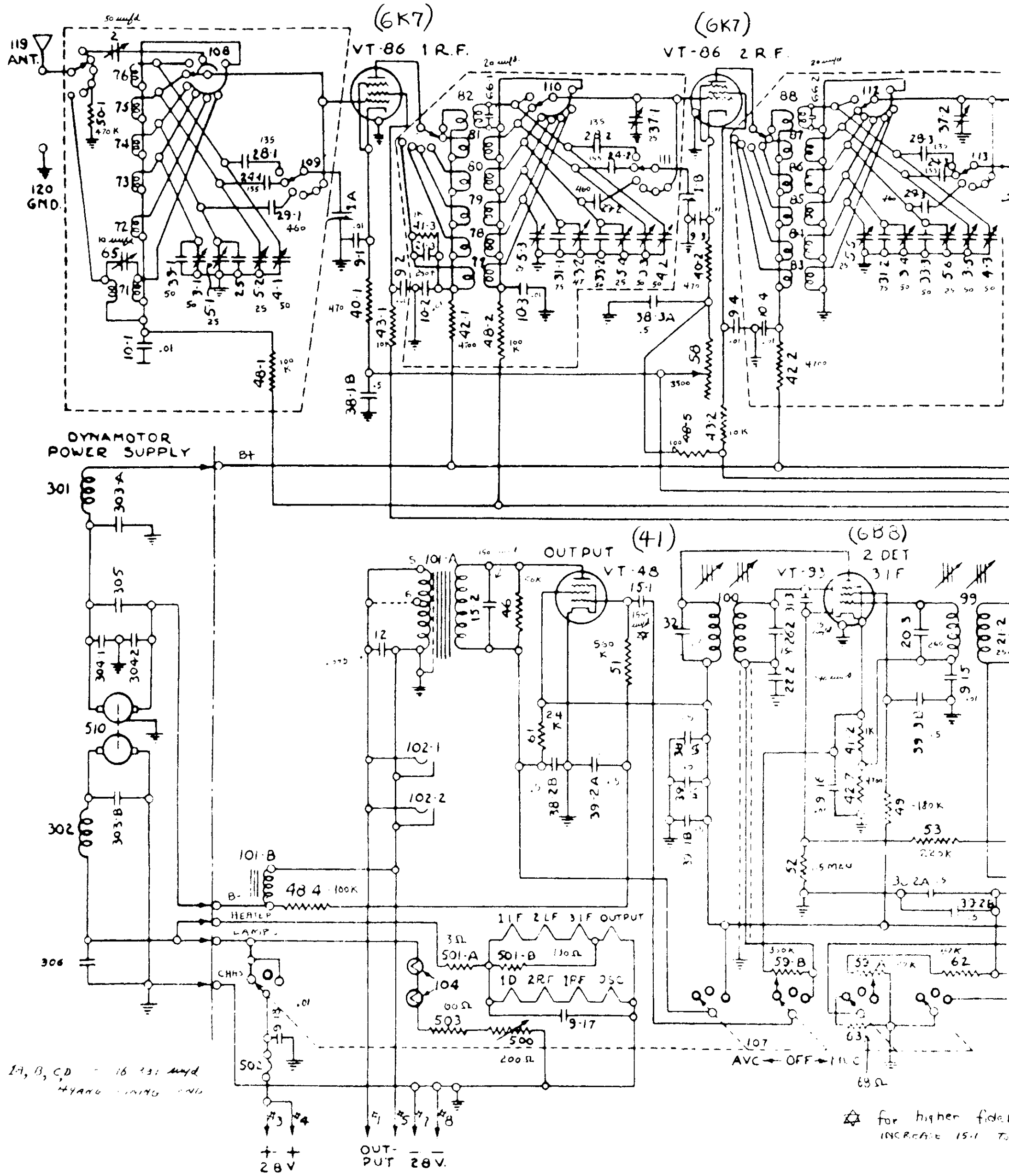
New stage is inserted between points indicated by X's



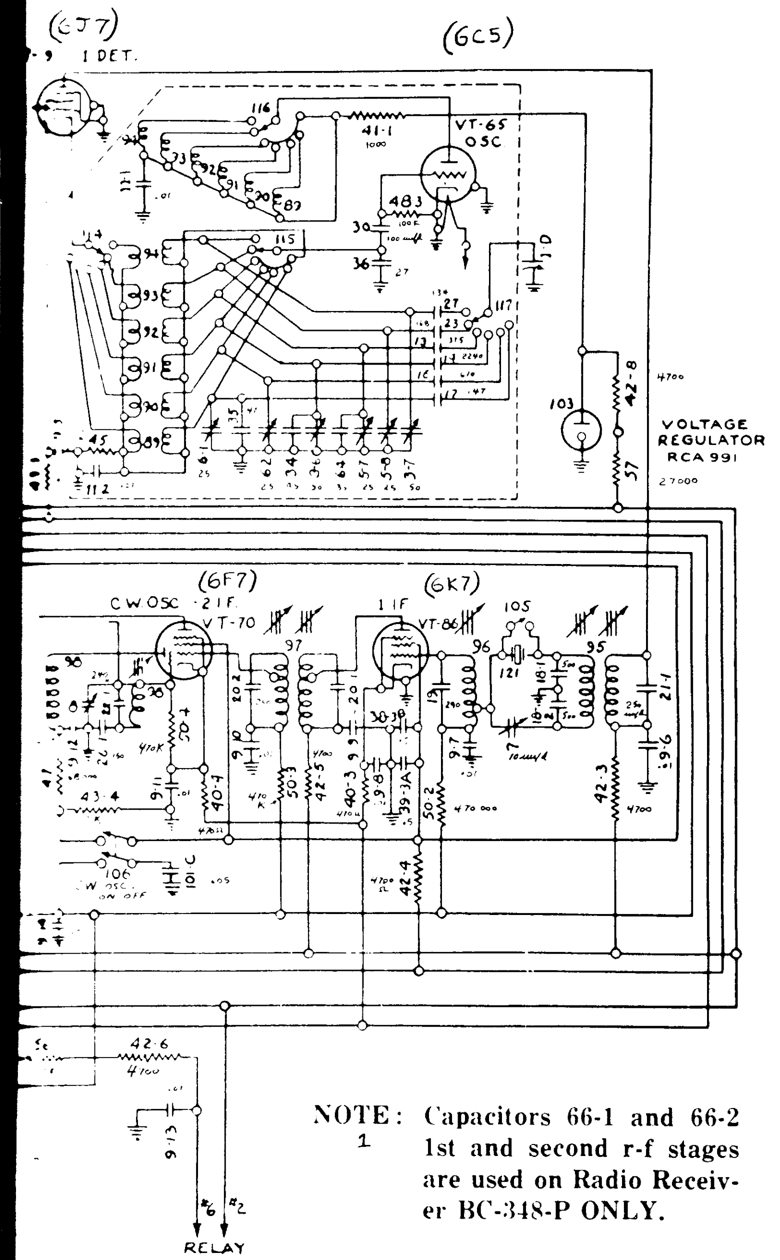
SCHEMATIC DIAGRAM FOR BC-348J,
and will apply to N, and Q models.



SCHEMATIC DIAGRAM FOR BC-348J,
and will apply to N, and Q models.



SCHEMATIC DIAGRAM
FOR BC-348E,M,P,
(and will apply to,
C,K,L,R,H,).



NOTE: 1 Capacitors 66-1 and 66-2 1st and second r-f stages are used on Radio Receiver BC-348-P ONLY.

Note 2 These contacts are normally shorted for recieve operation. They should be opened for transmit.

SCHEMATIC DIAGRAM
FOR BC-348E,M,P,
(and will apply to,
C,K,L,R,H,).

CONVERSIONS FOR THE BC-412 OSCILLOSCOPE

The BC-412 radar oscilloscope was a component of the first mass-produced ground radar set, the SCR-268. This unit is easily recognizable by its rounded-top case and its excessive weight. Its approximate dimensions are 13 x 20 x 27 inches.

In addition to the 5-inch CRT, the BC-412 scope consists of 12 tubes which make up its associated video amplifiers, sweep circuits, and the high and low voltage power supplies. It operates from 115 volts a.c., at 50 or 60 cycles.

The outstanding feature of this radar scope unit is its two power supplies, the high-voltage CRT supply and the low-voltage 150-ma. supply. With these power supplies and the conversions described herein, the BC-412 can be made over into a laboratory test oscilloscope or a well performing television receiver.

This article attempts to briefly outline the conversion procedure for the television receiver and the laboratory oscilloscope with reference to the before and after schematic diagrams. It is assumed that anyone undertaking either of these conversions, will have a general working knowledge of this type equipment.

A WORD OF CAUTION: Always be extremely careful when working with circuits connected with the high voltage supply! Operating voltages are of several thousand volts and warrant the use of well insulated tools. Always turn off the power and short-circuit the high voltage condensers (with a well insulated tool) before attempting work or adjustments on this unit. Remember the old phrase, "Death is so permanent."

TELEVISION RECEIVER CONVERSION

Before any work toward conversion is begun, it is desirable to discard the heavy case and base which eventually can be replaced with a lighter and more attractive one.

After noting the HV and LV power supplies and their respective components, it is necessary to strip the entire chassis of its wiring and components with the exception of the two mentioned power supplies. The high voltage wiring (ignition cable) should be saved for use in the converted high voltage circuits. It will be found that a number of the removed parts can be used in the new circuits.

In this conversion, it is recommended that the RF/Oscillator section, the Video section, and the Audio section be constructed and used on separate chassis which are mounted on the main scope chassis. This method affords a much easier conversion as well as accessibility for maintenance or future changes.

(a) Power Supplies

The low voltage power supply is modified by merely reconnecting its components as shown in fig. 3. It will be noted that the filter section utilizes both chokes (44-1 & 44-2) and two of the dual 8-mfd. filter capacitors (12-3 & 12-4). The d-c supply voltage under loaded conditions should not exceed 300 volts.

The high-voltage supply is reconnected so that its output voltage is positive with respect to ground. Also slight changes are made in the filter section in order to obtain the correct voltages for the 5-inch CRT (5BP4). For this circuit arrangement refer to the schematic diagram, fig. 4.

By modifying the high-voltage filter, sufficient voltage may be obtained to operate a 7-inch CRT such as the 7EP4 or 7JP4. This involves increasing the value of the first filter capacitor and reducing the value of the series filter resistance. For this condition refer to the schematic diagram in fig. 3.

Should a slightly higher voltage be desired, it can be obtained by utilizing the potential voltage of the low voltage supply. This is frequently done in commercial sets and is accomplished by connecting the low potential side of the HV transformer secondary (grounded side) to the high potential side of the LV, d-c supply. This arrangement adds the low supply voltage to the CRT supply voltage.

(b) CRT Circuits

The CRT circuits include the vertical oscillator, vertical amplifier, horizontal oscillator, horizontal amplifier, synchronizing amplifier and the CRT controls. The five mentioned stages are grouped in the location shown in fig. 2, and occupy the former tube sockets on the main scope chassis.

Controls for the CRT circuits, which require least adjustment during normal operation are brought out on the side of the chassis on a separate panel. These controls include Height, Width, Vertical Position, Horizontal Position, and Focus. Due to the high voltages involved and the fact that the ordinary potentiometers are not designed to operate in these ranges, the panel must be of the insulated type. Bakelite or similar material should be used with insulated couplings or shafts to the HV controls.

Location and layout of the above controls are shown in fig. 2.

(c) RF & Oscillator Section

This section consists of the mixer (first detector) and the R-F oscillator with their respective components.

It is necessary to construct this section on a completely separate chassis. The layout of parts is critical to the extent of maintaining as short leads as possible. The control shafts are located to coincide with the panel layout as shown in fig. 2.

For simplicity and ease of operation, a two-section tuning selector switch is used in conjunction with mica trimmer capacitors to tune the RF mixer input and HF oscillator. These capacitors are pretuned to the desired frequencies and are then switched in or out of the circuit with the tuning selector switch. To provide optimum tuning, a fine tuning control is employed which separately tunes the oscillator in the band-spread method. This is accomplished with a variable capacitor of approximately

3-30 mmfd. which is brought out to the front panel through an insulated shaft or coupling. During the alignment of the RF/oscillator section, the fine-tuning variable capacitor should be set approximately to its mid-capacitance position.

The coils for the RF/oscillator section are made in accordance with the following data:

L-1, (ant. coil) - 2 turns, No. 18 enamel, 3/4-inch diameter, with grounded center-tap; loosely coupled to the mixer coil.

(mixer coil) - Approximately 3 turns, No. 14 enamel, 3/4-inch diameter.

L-2, (osc. coil) - 3 turns, No. 14 enamel, 3/4-inch diameter, with cathode tap approximately 1 turn from the grounded end of coil.

The above coils are self-supporting, air-wound, and mounted as close to their connection points and as rigidly as possible. Sufficient coupling between the oscillator and mixer coil is obtained from their close proximity.

In order to bring the coils to the proper tuning range, they may have to be compressed or expanded in order to lower or raise their tuning frequency. The normal spacing of turns will be approximately 1/8 inch.

Even though the RF/oscillator chassis includes the mixer IF transformer and the tuned "sound trap", essentially they are IF components and are discussed under section (d).

For the general layout of components and location of the RF/oscillator chassis, refer to fig. 2.

(d) Video IF Section

To avoid the tedious construction work for the video IF coils, effort should be made to obtain an IF amplifier strip that has the approximate band pass, frequency, and amplification. There are a number of such strips available on the surplus market which can be tuned within the 12 to 27 Mc. range.

One of the preferable IF amplifier strips consists of 5 stages using WE-717's with a frequency of 19 Mc. Since four stages of this strip offer sufficient amplification, the 5th stage is replaced with the 2nd detector/clipper (6H6). The video amplifier stage is also added to the chassis to complete the video section.

Should a satisfactory IF amplifier strip not be available, other coils, such as the 20-Mc. IF, slug-tuned coils, from the BC-404 Receiver (component of the SCR-270 & 271) can be used. These coils will function well in the stagger-tuned video amplifier.

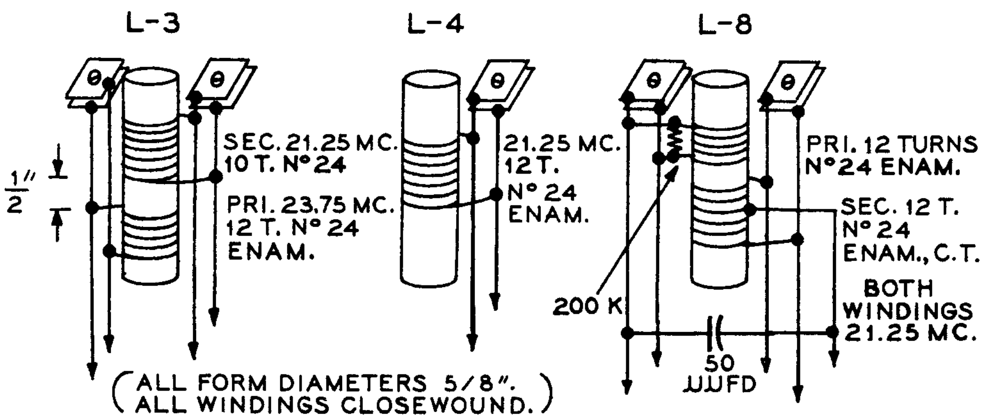
The mixer IF transformer consists of two tuned windings. The primary is tuned to the approximate midpoint between the audio and video IF frequencies, while the secondary is tuned to the audio IF frequency.

Should coils of the above description not be available, they can be made from old IF transformers from the data given below.

Alignment frequencies for single-tuned coils, as described above, in order to obtain the required video band pass (3.5 to 4.0 Mc.) are given in section (f).

The contrast control, in the cathode circuit of the second IF stage, varies the video IF gain. It is physically mounted underneath the main chassis directly below the second IF stage. An extended shaft is used to control the rheostat from the front panel in the position shown in the panel layout.

Peaking coils used in conjunction with the video amplifier, (La & Lb) consist of 50 turns of No. 32 wire, wound in approximately 1/2 inch length on 500K, 2-watt resistors.



(e) Audio Section

This section consists of an IF amplifier stage, operating approximately 4.5 Mc. below the video IF, an FM audio detector, first and second audio amplifier stages, and the associated speaker.

The signal input to the audio chassis is taken from the mixer output IF transformer, L-3. The inter-connecting lead between the secondary of L-3 and the grid of the audio IF amplifier should be as short as possible.

A conventional discriminator circuit is used for the audio detector with the double-tuned IF transformer tuned to the audio IF frequency. If the discriminator IF transformer is not readily available, it can be made from an old IF transformer from the winding data given above.

A 6-inch PM speaker is used with the conventional plate-to-voice-coil output transformer, and is mounted to the audio chassis as shown in fig. 2. The speaker grill consists of symmetrically drilled, 1/4-inch holes, in the side of the main chassis at the speaker location.

(f) Adjustments for Operation

After the power supply and CRT circuits are completed, they can be checked for proper operation. These circuits must function properly before further tests can be made.

Normal operation of the CRT circuits is indicated when a rectangular pattern, formed by the vertical and horizontal sweep, can be adjusted to its proper size, position, intensity, and focus on the CRT screen. Improper position, size, intensity, and focus indicates improper voltage on the element concerned in the CRT.

So as to obtain proper alignment, of the video IF amplifier, a signal generator should be used. This is essential to stagger the peaking of the different stages for the proper video band pass. The band pass should be between 3.5 and 4.0 Mc. Each stage is peaked to the following frequency:

L-3 (primary)	23.75 Mc.
(secondary)	21.25 Mc.
L-4 (sound trap)	21.25 Mc.
L-5, 1st IF	25.75 Mc.
L-6, 2nd IF	25.00 Mc.
L-7, 3rd IF	23.75 Mc.
L-8 (sound dis.)	21.25 Mc.

It should be noted that other video IF's can be used in the 12 to 30 Mc. range, with alignment similar to that given above. Occasionally interference problems may be encountered from other transmitted signals. Such an example can be a strong or local 10-Meter amateur signal coming through an IF amplifier operating in the 28 to 30 Mc. range.

This effect can be reduced considerably with the addition of a tuned RF stage ahead of the first detector, or a tuned trap circuit to reject the undesired frequency.

Alignment of the audio section is simply accomplished by peaking the discriminator, IF transformer to the audio IF which is 4.5 Mc. below the video IF. Final adjustment may be made audibly for the best output.

After aligning the video IF section, the RF and oscillator circuits are tuned to the desired channels by means of the mica trimmers for each position of the tuning selector switch. In order to utilize the full range of fine tuning capacitor, it should be set to its mid-position when aligning the RF & oscillator circuits. The above alignment can be done by visually observing the CRT screen for optimum picture.

A conventional folded dipole antenna with its associated reflector element is recommended and as shown in fig. 1. The antenna should be as high as practical in an unobstructed area. Direction for the antenna is best determined experimentally by rotating it in the horizontal plane for maximum signal. Frequently the final position will be a compromise for the several television stations in the locality.

For additional receiver circuit information, the schematic diagram, fig. 4, reprinted from the August '47 issue of the Radio News magazine, has been included.

LABORATORY TEST OSCILLOSCOPE

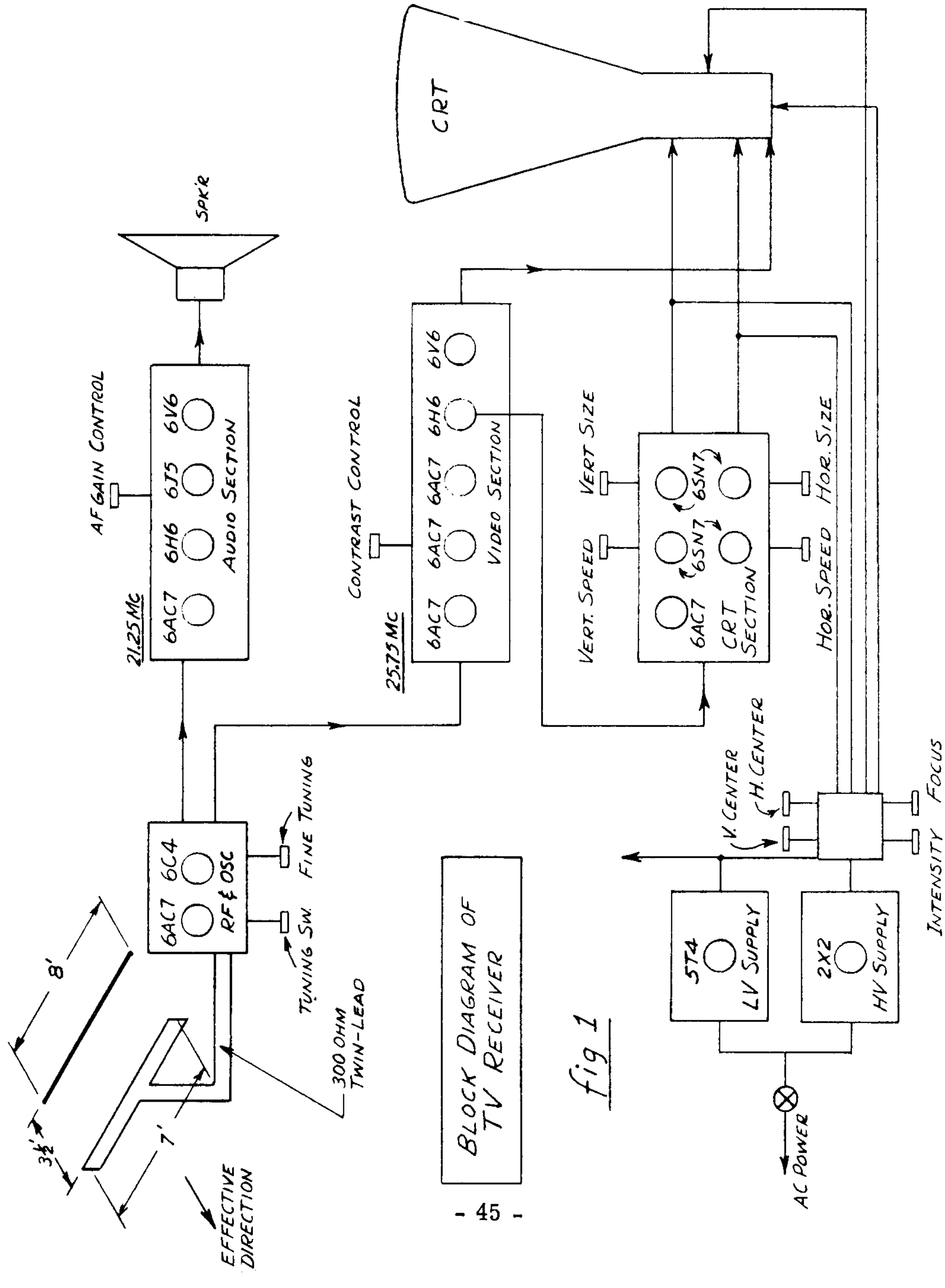
After the BC-412 chassis is stripped of everything except the two power supplies, the laboratory test oscilloscope can be built from the schematic diagram as shown in fig. 5.

This is a proven circuit which follows the conventional form, and offers a high sensitivity with a flat response from 20 to 20,000 cps.

For test scope use, the 5BP1, with which the BC-412's are usually equipped, is satisfactory.

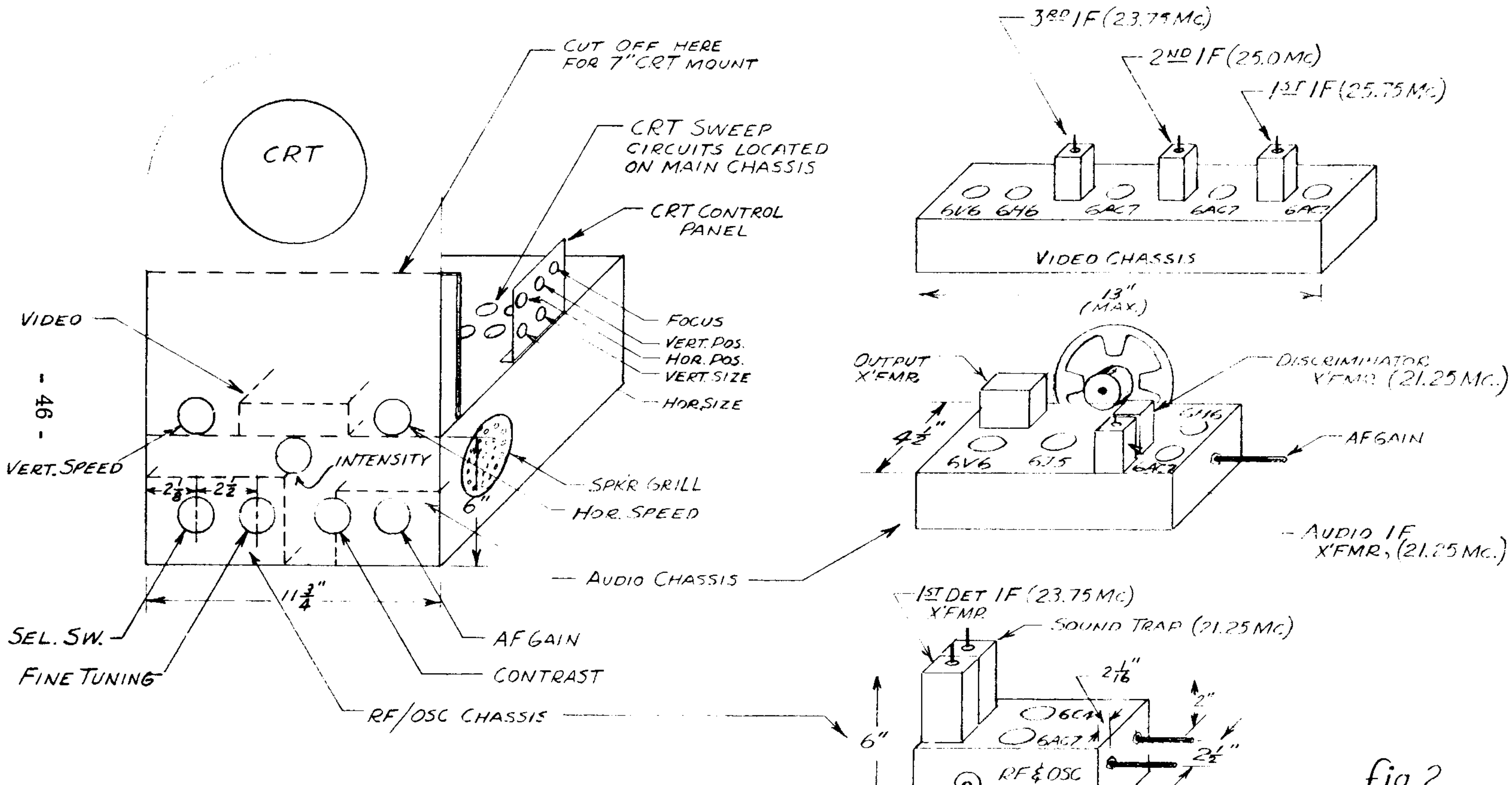
In order to obtain sufficient over-lap of the coarse frequency adjustment, it may be necessary to select capacitor values for the proper sweep frequency range.

The bulky and heavy case is discarded for a lighter and more attractive one which will add to the appearance of the completed test instrument.



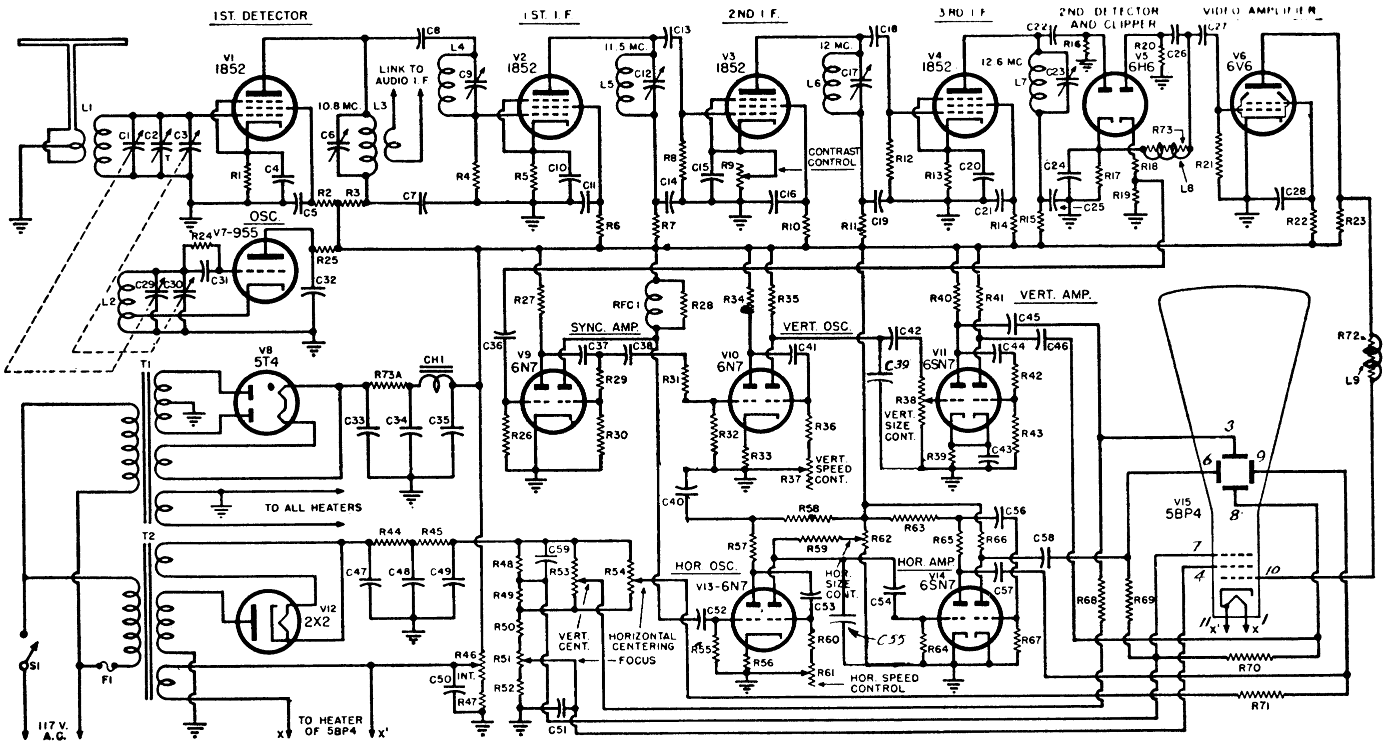
BLOCK DIAGRAM OF TV RECEIVER

fig 1



CHASSIS LAYOUT FOR TV RECEIVER

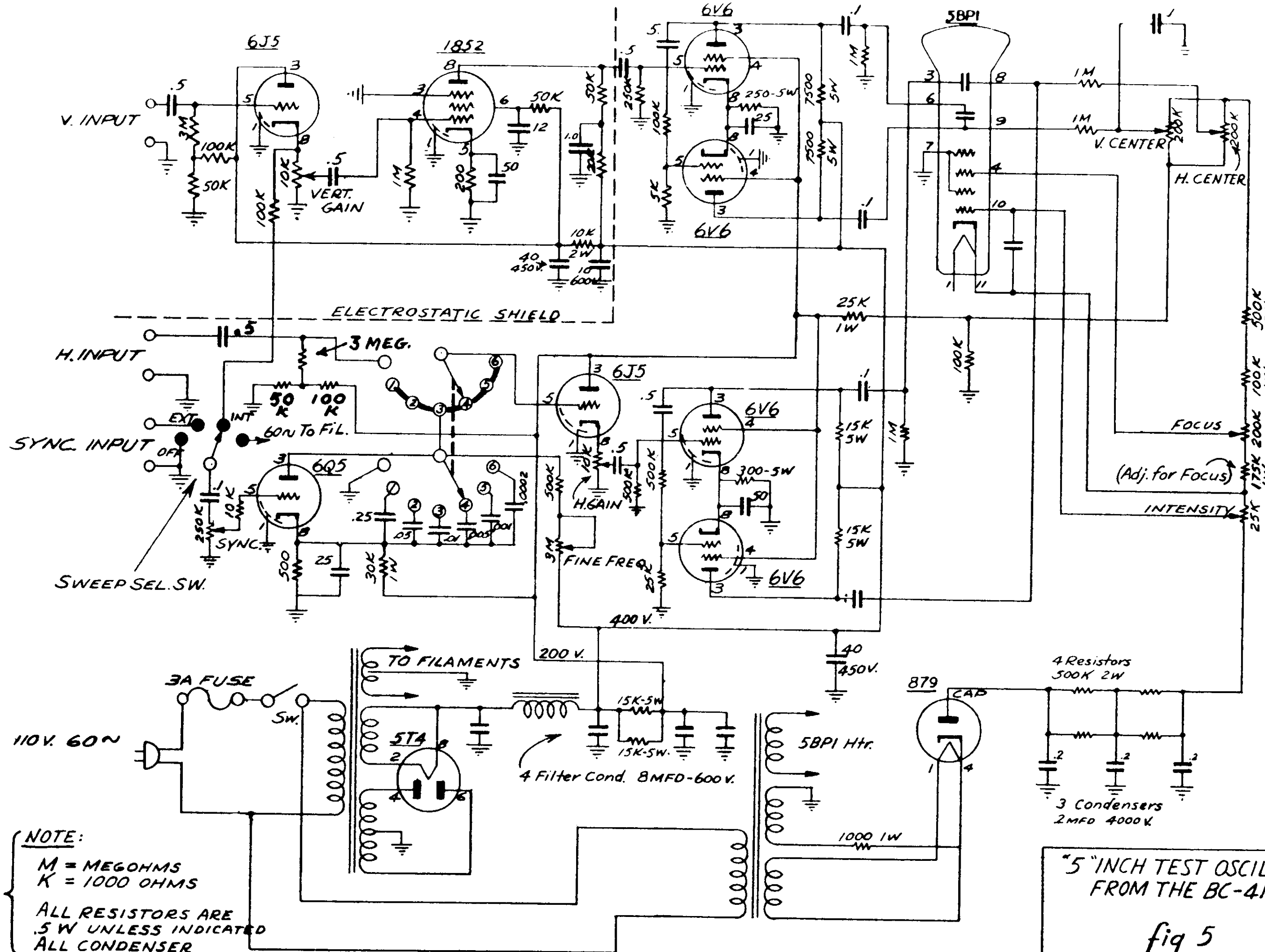
fig 2



R_1, R_{33}, R_{55}—500 ohm, ½ w. res.
R_2, R_6, R_{10}, R_{14}, R_{22}, R_{47}—100,000 ohm, ½ w. res.
R_3, R_7, R_{11}, R_{15}—1000 ohm, ½ w. res.
R_4, R_8, R_{12}, R_{16}—2500 ohm, ½ w. res.
R_5, R_{13}—200 ohm, ½ w. res.
R_9—50,000 ohm pot. with sw.
R_{17}, R_{39}—4000 ohm, ½ w. res.
R_{18}—5000 ohm, ½ w. res.
R_{19}, R_{28}, R_{56}, R_{63}—2000 ohm, ½ w. res.
R_{20}, R_{32}, R_{67}, R_{69}, R_{71}—1 megohm, ½ w. res.
R_{21}, R_{34}, R_{35}, R_{36}, R_{40}, R_{41}, R_{45}, R_{50}, R_{59}—500,000 ohm, ½ w. res.
R_{23}—5000 ohm, 10 w. res.
R_{24}, R_{25}, R_{31}—20,000 ohm, ½ w. res.
R_{26}, R_{30}, R_{42}, R_{64}, R_{68}, R_{70}—2 megohm, ½ w. res.
R_{27}, R_{29}, R_{60}—10,000 ohm, ½ w. res.
R_{37}, R_{62}—500,000 ohm pot.
R_{38}—2 megohm pot.
R_{43}—60,000 ohm, ½ w. res.
R_{44}, R_{57}, R_{58}, R_{65}, R_{66}—50,000 ohm, ½ w. res.
R_{46}, R_{61}—100,000 ohm pot.
R_{48}, R_{49}, R_{52}—200,000 ohm, ½ w. res.
R_{51}, R_{53}, R_{54}—200,000 ohm pot.
R_{72}, R_{73}—.5 megohm 2 w. res. (See coil table)
R_{73A}—300 ohm, 50 w. res.
C_1, C_{29}—50 μμfd. variable cond.
C_2—2-plate trimmer (Comp. type)
C_3, C_{30}—10 μμfd. trimmer (Fine tuning cond.)
C_4, C_5, C_8, C_{10}, C_{11}, C_{13}, C_{15}, C_{16}, C_{18}, C_{20}, C_{21}, C_{22}, C_{32}, C_{41}, C_{54}—.01 μfd., 600 v. cond.
C_6, C_9, C_{12}, C_{17}, C_{23}—See text
C_7, C_{14}, C_{19}, C_{25}, C_{56}—.006 μfd., 600 v. cond.
C_{24}—25 μμfd. mica cond.
C_{26}, C_{27}, C_{28}, C_{36}, C_{37}, C_{38}, C_{39}, C_{40}, C_{42}, C_{43}, C_{44}, C_{50}, C_{51}, C_{59}—.1 μfd., 600 v. cond.
C_{31}—100 μμfd. temp. compensated cond.
C_{33}, C_{34}, C_{35}—8 μfd., 450 v. elec. cond.
C_{45}, C_{46}—.01 μfd., 2500 v. cond.
C_{47}, C_{48}, C_{49}—.1 μfd., 4000 v. cond.
C_{52}—100 μμfd. mica cond.
C_{53}, C_{55}—.001 μfd., 600 v. cond.
C_{57}, C_{58}—.002 μfd., 2500 v. cond.
L_1, L_2, L_3, L_4, L_5, L_6, L_7, L_8, L_9—See coil table
RFC_1—2½ mh. r.f. choke
S_1—S.p.s.t. sw. on R_9
F_1—110 v., 1 amp. fuse
CH_1—8 hy., 150 ma. filter choke
T_1—Power trans. 375-0-375 v. @ 150 ma.; 5 v. @ 2 amps.; 6.3 v. @ 8.5 amps.
T_2—Power trans. 2500 v. @ 10 ma.; 2.5 v. @ 1.75 amps.; 6.3 v. @ .6 amp.

Reprinted from the August 1947 issue RADIO NEWS

fig 4

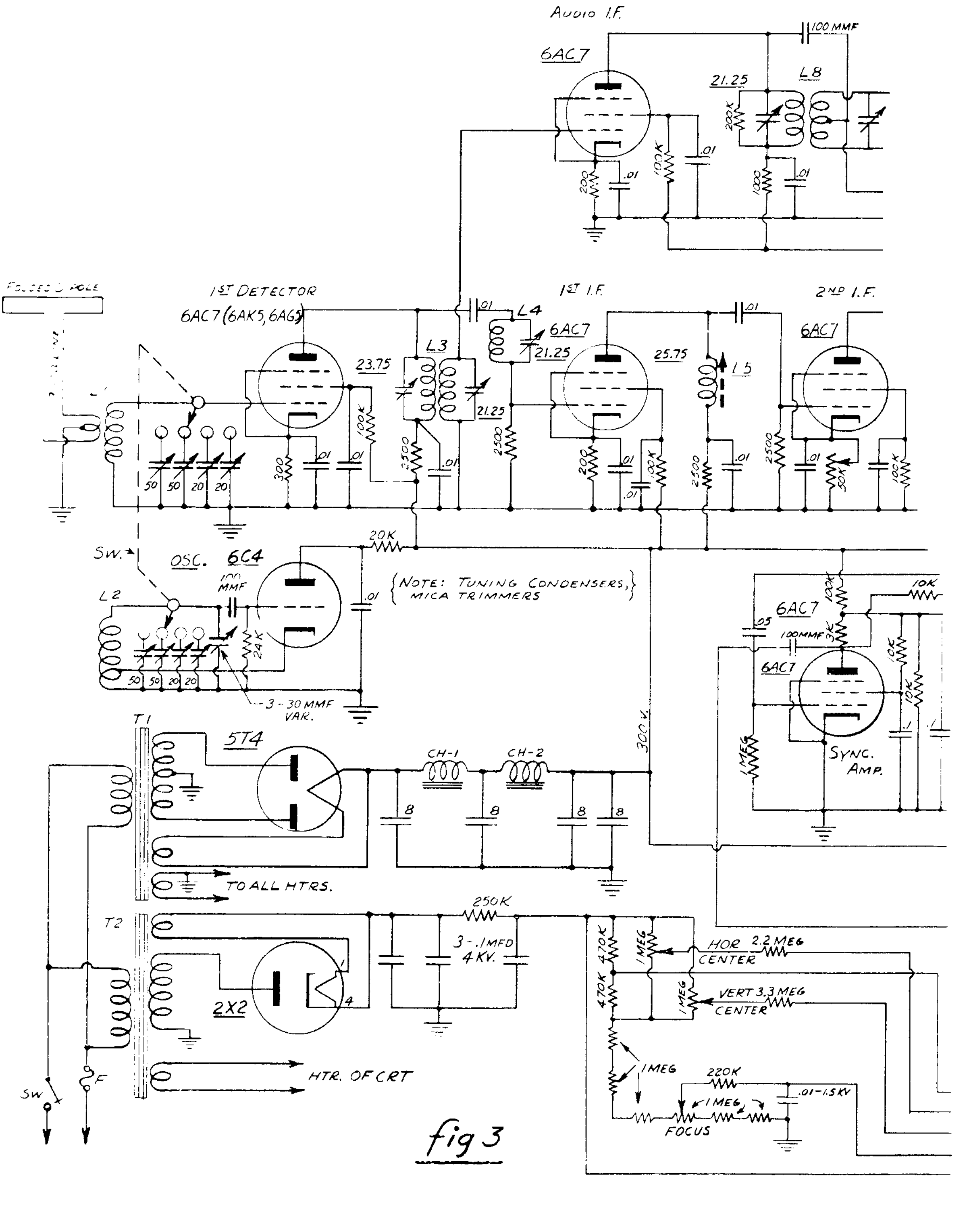


NOTE:
M = MEGOHMS
K = 1000 OHMS
ALL RESISTORS ARE .5 W UNLESS INDICATED
ALL CONDENSER VALUES IN M.F.D

"5" INCH TEST OSCILLOSCOPE FROM THE BC-412

fig 5

Courtesy Bardwell & McAlister, Inc., Hollywood, Calif.



Audio I.F.
6AC7
100 MMF
21.25
L8
200K
100K
.01
200
1000
1st DETECTOR
6AC7 (6AK5, 6AG5)
23.75
L3
.01
L4
6AC7
21.25
1st I.F.
25.75
L5
2nd I.F.
6AC7
100K
2500
300
50
50
20
20
200
10K
50K
SW.
OSC. 6C4
100 MMF
L2
24K
20K
(NOTE: TUNING CONDENSERS, MICA TRIMMERS)
3-30 MMF VAR.
6AC7
.05
100 MMF
3K
1 MEG
SYNC. AMP.
T1
5T4
CH-1
CH-2
8
300 V.
TO ALL HTRS.
T2
250K
3-.1 MFD 4 KV.
2X2
470K
1 MEG
HOR CENTER
2.2 MEG
VERT CENTER
3.3 MEG
220K
.01-1.5 KV
FOCUS
SW
F
HTR. OF CRT

fig 3

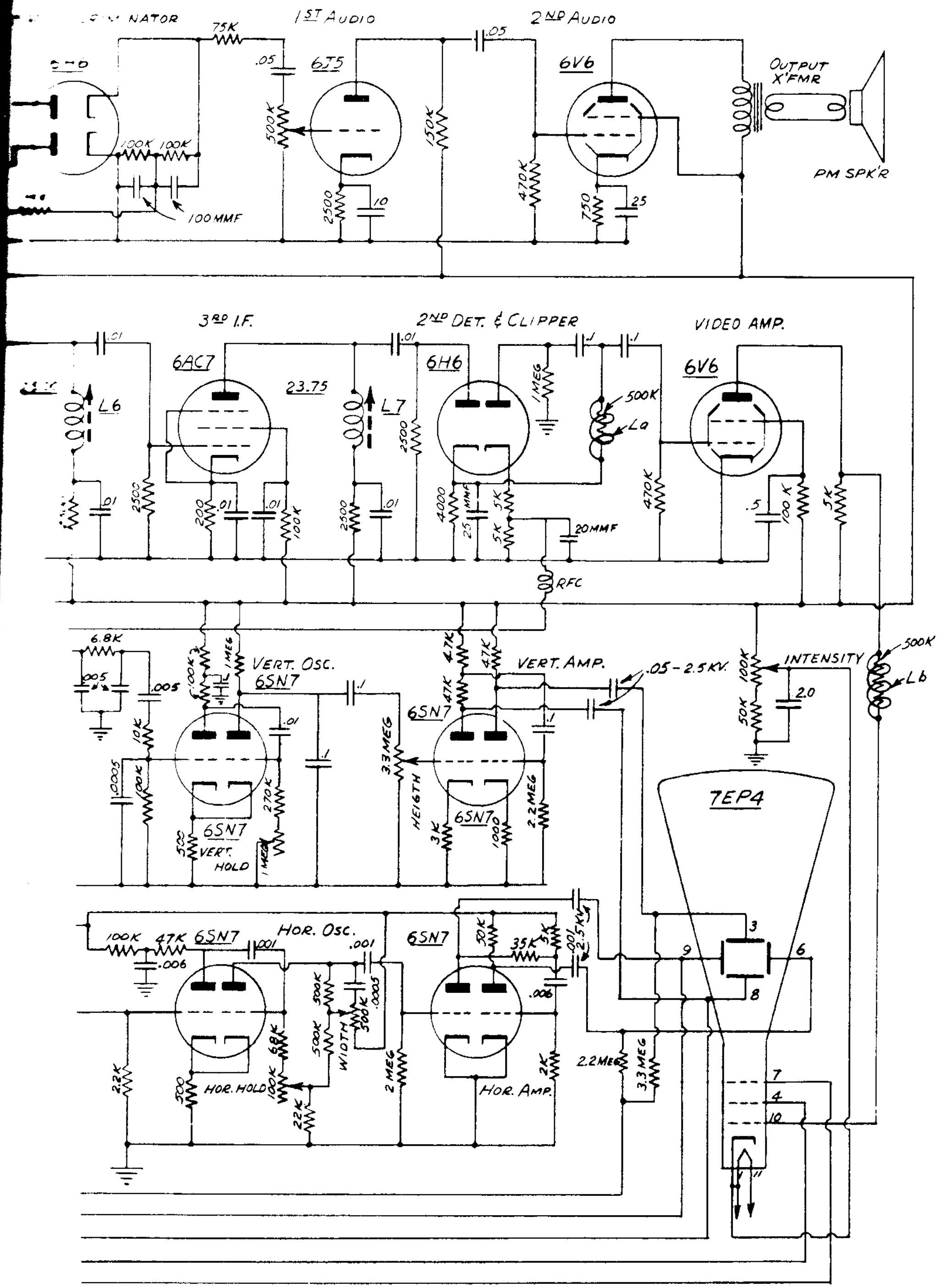

NATOR
1ST AUDIO
2ND AUDIO
75K
.05
6J5
.05
6V6
OUTPUT X'FMR
500K
150K
100K
100K
470K
100MMF
2500
10
750
25
PM SPK'R
3RD I.F.
2ND DET. & CLIPPER
VIDEO AMP.
.01
6AC7
.01
6H6
.1
.1
6V6
L6
23.75
L7
1 MEG
500K
La
2500
2500
200
.01
.01
100K
2500
.01
4000
25 MMF
5K
5K
470K
.5
100K
5K
20MMF
RFC
6.8K
.005
.005
100K
1 MEG
VERT. OSC.
6SN7
.1
VERT. AMP.
.05 - 2.5 KV.
INTENSITY
100K
500K
Lb
47K
47K
47K
6SN7
.1
2.0
50K
10K
.01
.0005
100K
270K
3.3 MEG
HEIGTH
2.2 MEG
7EP4
6SN7
6SN7
500
VERT. HOLD
1 MEG
3K
1000
HOR. OSC.
100K
47K
6SN7
.001
.006
.001
6SN7
50K
35K
5K
.001
2.5 KV
3
9
6
8
500K
.0005
500K
300K
.006
500K
WIDTH
68K
2 MEG
2K
2.2 MEG
3.3 MEG
2.2K
500
HOR. HOLD
100K
22K
HOR. AMP.
7
4
10
11

fig 3

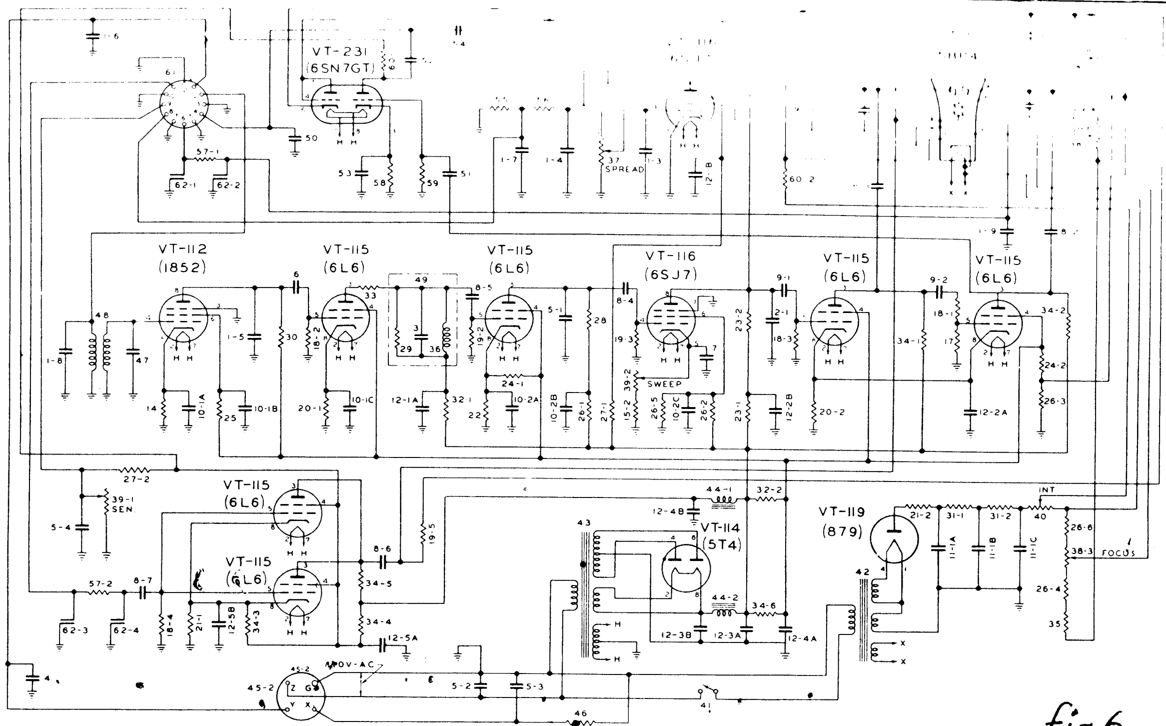


fig 6

APPARATUS LEGEND FOR OSCILLOSCOPE BC-412-A MODIFIED

PART Nº	QTY REQD	DESCRIPTION	MANUFACTURERS TYPE OR CATALOG Nº AS SPECIFIED BELOW OR EQUAL	ASSEMBLED AS DWG Nº	ITEM
1	9	CAPACITOR 100 MMF 500 VOLTS	AEROVOX CORP TYPE 1468	ES-D-8811	51
2	1	CAPACITOR 50 MMF 500 VOLTS	AEROVOX CORP TYPE 1468	ES-D-8816	27
3	1	CAPACITOR 350 MMF 500 VOLTS	AEROVOX CORP TYPE 1467	ES-D-8811	52
4	1	CAPACITOR .001 MFD 500 VOLTS	AEROVOX CORP TYPE 1467	ES-D-8821	9
5	4	CAPACITOR .005 MFD 500 VOLTS	AEROVOX CORP TYPE 1467	ES-D-8811	50
6	1	CAPACITOR .01 MFD 500 VOLTS	SOLAR MFG CORP TYPE MP	ES-D-8811	49
7	1	CAPACITOR .1 MFD 500 VOLTS	AEROVOX CORP TYPE 1468	ES-D-8811	48
8	7	CAPACITOR 1 MFD 600 VOLTS DC SEALDTITE	SOLAR MFG CORP TYPE XTIM	ES-D-8811	54
9	2	CAPACITOR .5 MFD 600 VOLTS DC SEALDTITE	SOLAR MFG CORP TYPE XTIM	ES-D-8811	47
10	1	CAPACITOR A 1 MFD 400 VOLTS DC; B 1 MFD 400 VOLTS DC; C 1 MFD 400 VOLTS DC	CORNELL DUBILIER ELECTRIC CORP TYPE PC 1845	ES-D-8811	46
11	1	CAPACITOR A 2 MFD 4000 VOLTS DC; B 2 MFD 4000 VOLTS DC; C 2 MFD 4000 VOLTS DC	TOBE DEUTSCHMANN CORP TYPE SC 510M-6	ES-D-8811	45
12	5	CAPACITOR A 8 MFD 600 VOLTS DC SURGEPROOF; B 8 MFD 600 VOLTS DC FILTERMITE	TOBE DEUTSCHMANN CORP TYPE PT SC 2	ES-D-8811	53
13	0	REPLACED IN CONVERSION	INTERNATIONAL RESISTANCE CO	ES-D-8811	44
14	1	RESISTOR 250 OHMS 1/2 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	61
15	0	REPLACED IN CONVERSION	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	76
15-a	1	RESISTOR 500 OHMS 1/2 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	75
16	0	ELIMINATED IN CONVERSION	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	75
17	1	RESISTOR 50 000 OHMS 1/2 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	74
18	4	RESISTOR 100 000 OHMS 1/2 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	73
19	5	RESISTOR 1 MEGOHM 1/2 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1/2	ES-D-8811	72
20	2	RESISTOR 500 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	71
21	2	RESISTOR 1000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	70
22	1	RESISTOR 15 000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	69
23	2	RESISTOR 20 000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	68
24	2	RESISTOR 40 000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	67
25	1	RESISTOR 50 000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	66
26	6	RESISTOR 100 000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	65
27	2	RESISTOR 500 000 OHMS 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8816-11	64-24
28	1	RESISTOR 1 MEGOHM 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8811	63
29	1	RESISTOR 7500 OHMS ±5% 1 WATT	INTERNATIONAL RESISTANCE CO TYPE BT-1	ES-D-8821	8
30	1	RESISTOR 20 000 OHMS 2 WATTS	INTERNATIONAL RESISTANCE CO TYPE BT-2	ES-D-8811	60
31	2	RESISTOR 250 000 OHMS 2 WATTS	INTERNATIONAL RESISTANCE CO TYPE BT-2	ES-D-8811	59
32	2	RESISTOR 5 000 OHMS 10 WATTS	INTERNATIONAL RESISTANCE CO TYPE AB	ES-D-8811	58
33	1	RESISTOR 7 500 OHMS 10 WATTS	INTERNATIONAL RESISTANCE CO TYPE AB	ES-D-8811	57
34	6	RESISTOR 15 000 OHMS 10 WATTS	INTERNATIONAL RESISTANCE CO TYPE AB	ES-D-8811	56
35	1	RESISTOR 500 000 OHMS 5 WATTS	CONTINENTAL CARBON CO TYPE H5	ES-D-8816	23
36	1	INDUCTION COIL	AS PER ES-D 8821	ES-D-8[illegible]	5
37	1	POTENTIOMETER 500 OHMS SHAFT SHALL BE 1/4" LONG	INTERNATIONAL RESISTANCE CO TYPE 11-103	ES-D-8811	39
38	3	POTENTIOMETER 200000 OHMS SHAFT SHALL BE 1/4" LONG	INTERNATIONAL RESISTANCE CO TYPE 11-129	ES-D-8816	14
39	2	POTENTIOMETER 75 000 OHMS SHAFT SHALL BE 1/4" LONG	INTERNATIONAL RESISTANCE CO TYPE 14-125	ES-D-8811	38
40	1	POTENTIOMETER 25000 OHMS SHAFT SHALL BE 1/4" LONG	INTERNATIONAL RESISTANCE CO TYPE 11-120	ES-D-8816	15
41	1	SAFETY SWITCH	ARROW HART & HEGEMAN CO TYPE 3392	ES-D-8816	16
42	1	TRANSFORMER	KENYON TRANSFORMER CO TYPE S-13336	ES-D-8811	30
43	1	TRANSFORMER	THORDARSON ELECTRIC MFG CO TYPE 92-R-21	ES-D-8811	31
44	2	CHOKES 15 HENRIES	THORDARSON ELECTRIC MFG CO TYPE 74-C-29	ES-D-8811	32
45-1	0	ELIMINATED IN CONVERSION	RUSSEL & STOLL CO TYPE 8141	ES-D-8811	36
45-2	1	SOCKET 4 PRONG FEMALE EVERLOCK	RUSSEL & STOLL CO TYPE 8141	ES-D-8811	35
46	1	RESISTOR 300 OHMS 50 WATTS	INTERNATIONAL RESISTANCE CO TYPE EP	ES-D-8811	55
47	1	CAPACITOR MICA .007 MFD 500 VOLTS	AEROVOX CORP TYPE 1467	ES-D-8822	3
48	1	INPUT TRANSFORMER 212 MH	AS PER ES D 882[illegible]	ES-D-8811	28
49	1	INDUCTION COIL ASSEMBLY	AS PER ES D 882[illegible]	ES-D-8811	27
50	1	CAPACITOR 250 MMF	SOLAR MFG CORP		2
51	1	CAPACITOR 25 MMF	SOLAR MFG CORP	C-202-322	26
52	1	CAPACITOR .01 MFD 400 VOLTS	MICAMOLD	C-202-322	25
53	1	CAPACITOR .1 MFD 400 VOLTS	MICAMOLD	C-202-322	24
54	1	CAPACITOR .005 MFD 5000 VOLTS	SOLAR MFG CORP TYPE XS	C-202-322	[illegible]
55	1	RESISTOR 75 OHMS 1 WATT	ALLEN BRADLEY TYPE GB		6
56	1	RESISTOR 470 OHMS 1 WATT	ALLEN BRADLEY TYPE GB		5
57	2	RESISTOR 1000 OHMS 1 WATT	ALLEN BRADLEY TYPE GB		3
58	1	RESISTOR 2 200 OHMS 1 WATT	ALLEN BRADLEY TYPE GB	C-202-322	23
59	1	RESISTOR 10 000 OHMS 1 WATT	ALLEN BRADLEY TYPE GB	C-202-322	2[illegible]
60	2	RESISTOR 100 000 OHMS 1 WATT	ALLEN BRADLEY TYPE GB	C-202-322	2[illegible]
61	1	12 PRONG MALE CONNECTOR	AMERICAN PHENOLIC CORP TYPE AN-3102-24-684S	B-201-315	10
62		SPARK PLATE	AS PER A-2D 1283	B-201-315	7

BC-645 CONVERSION FOR 420-MC. OPERATION

Although the BC-645 originally was designed for use by the armed forces an airborne IFF equipment, the equipment may be converted to form a complete transmitter and receiver for the 420-Mc. band. The unit originally operated in the frequency range between 470 and 495 Mc. and transmitted either a pulse signal or a c-w signal modulated by a 30-kc. wave. The unit acted as a transpondor when it emitted pulse signals; that is to say that the pulse emissions of the transmitter were triggered by incoming pulse signals which had been detected by the receiver.

The overall dimensions of the BC-645 are 10-1/2" by 13-1/2" by 4-1/2", with the weight of the unit being about 25 pounds. Power for both the transmitter and the receiver were supplied by a PE-101 dynamotor which operated from either a 12-volt or a 24-volt d-c source.

This article describes the BC-645 and its conversion in the following sections with references to the included diagrams:

(a) General Description and Operation
(b) Transmitter Conversion
(c) Receiver Conversion
(d) Mechanical Modifications
(e) Power Supply
(f) Operation of the Converted Unit

(a) General Description and Operation:

The transmitter section includes the following tubes with their respective functions:

WE-316A	(VT-15)	Self-excited power oscillator
6F6	(VT-13)	Pulse modulator
6F6	(VT-14)	30kc. oscillator/modulator
7F7	(VT-12)	Pulse amplifier

The WE-316A is a self-excited power oscillator using a tuned-line tank circuit which determines its frequency. Its output is coupled to the antenna plug through a variable pick-up loop and a short section of rigid coaxial line. Two separate 6F6 modulators are used. One is used as a pulse modulator which is driven by the 7F7 pulse amplifiers. The other 6F6 is a 30kc. oscillator and modulates the power oscillator when brought into the circuit by relay No. 6.

The superhet receiver and its associated output circuits consist of 11 tubes. Tuned lines are employed in the antenna input and the hf oscillator circuits. Acorn type, 955 tubes are used for the hf oscillator and the first detector with the first detector functioning as a diode with an injector grid.

The IF amplifier consists of three stages operating at 40 Mc. and uses 7H7 type tubes in all three stages.

The second detector output, after being amplified by the three video stages, is divided, half of which is used to pulse modulate the transmitter through the pulse amplifiers. The other half operates the sequence relays through appropriate timing multivibrator circuits.

Before beginning the circuit conversion of this unit, it is suggested that all excess components be removed from the chassis. This is essential because of the limited space in the unit; also, removal of these parts will result in a neater looking conversion.

The unused components that should be removed include the following:

(1) All relays except relay #1
(2) All potentiometers
(3) Two-position switch at front of case
(4) 30-kc. oscillator coil (used with VT-14)
(5) Resistor/capacitor terminal boards (the two located on each side of the center divider on underside of chassis)

(b) Transmitter Conversion:

In order to lower the tuning of the self-excited power oscillator to the 420-450 Mc. band, it is necessary electrically to lengthen the tuning line. This is accomplished by adding a circular type neutralizing capacitor across the open end of the line. The removal of relay #2 provides space for the added capacitor. By this method of lowering the tuning to the 420-450 Mc. band, the increase in equivalent physical length would approximate 1/2 inch.

The remainder of the transmitter conversion consists of revamping the modulator for voice modulation.

In order to obtain 100 per cent modulation of the WE-316A, it is necessary to use both 6F6's (VT-13 & VT-14) operating in parallel. These stages are driven from the two-stage speech amplifier, 7F7 VT-12, converted as shown in Fig. 2. Sufficient gain is provided by the speech amplifier for crystal or dynamic microphone use.

It will be noted from the converted diagram that the two parallel Heising modulators require a heavier modulating choke than was used in the existing circuit.

Relay #1 is used as the send-receive relay and is actuated from the microphone circuit. This relay operates from 12 volts at approximately 3 ma.

(c) Receiver Conversion:

Since the antenna circuit will tune down to the 420-450 Mc. band, no alteration is required; however, the hf oscillator line must be physically lengthened to tune down to this range. This is accomplished by soldering a 1/2 inch extension to the end of the line (the end away from the oscillator tube.) The shorting bar is then moved to the new end of the tuning line.

No other changes are required in the RF and oscillator sections of the receiver.

Even though the IF amplifier section will operate satisfactorily as is without bias (other than the AVC), better performance can be obtained by adding cathode resistors to ground with their respective by-pass capacitors. This providing of cathode bias for the IF stages gives a better signal-to-noise ratio. For the above alteration, refer to the circuit diagram in fig. 2.

The existing audio section requires considerable modification to adapt it for A2 or A3 reception.

Beginning at the second detector, the 7E6 (VT-6) stage is changed to function as the second detector, AVC, and the first audio amplifier in the conventional manner. If more audio gain is desired, the 7E6 may be replaced with a higher mu (triode section) equivalent, such as the 7B6. The only circuit alteration required for this change is the substitution of the proper value cathode resistor.

An AF gain control is added in the grid circuit of the first audio stage as shown in fig. 2.

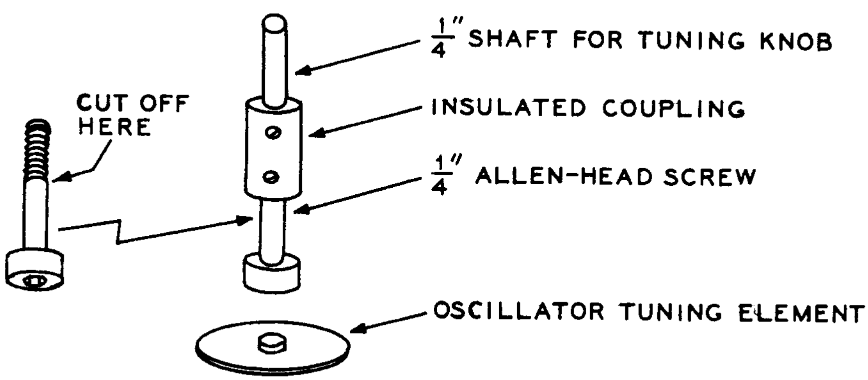
For the audio output stage a 7C5 tube is added with an appropriate plate-to-voice-coil output transformer. This stage is RC coupled from the first audio stage in the normal manner, and replaces the former 7F7 (VT-9) tube. Due to its height the added 7C5 must occupy the location of the former relay #3. Required socket connections and added components are shown in fig. 2.

In adding the 7C5 output tube, it will be noted that its complementary series tube, VT-8, in the 12-volt heater circuit is shunted with a 40-ohm 2-watt resistor to provide the proper heater current for the 7C5.

(d) Mechanical Modifications:

As previously mentioned, all excess circuit components should be removed for the ease of conversion. This becomes apparent when in some cases special long soldering iron tips have been recommended for working in these close quarters. It should also be noted that the IF coils are quite fragile and extreme care should be exercised to avoid damaging them.

To provide an external oscillator tuning control, the following approach is quite simple and eliminates a special "hex-nut" alignment tool:



It is suggested that the existing antenna connectors be replaced with standard coaxial fittings. This is advisable since the mating plugs for the present connectors are difficult to obtain and are also quite expensive.

To add the final touch to the converted BC-645, a front panel arrangement should be made to carry the controls, jacks, power plug, and any other refinements that may be desired.

The panel can be made of 1/16-inch aluminum with the receiver gain control and speaker jack on the left side and the transmitter mike gain control and mike jack on the right. The power plug can be mounted in the center of the panel.

(e) Power Supply:

The power requirements for the converted BC-645 are 400 volts d.c. at 165 ma., and 12 volts at approximately 2.4 amperes.

The a-c power supply shown in fig. 3 is designed to fill the above requirements and should be self explanatory. It should be noted that the 12 volt d-c source required for relay #1 is obtained from a tap on the bleeder resistor. This relay may be operated from a 12-volt battery with a current drain of approximately 3 ma.

Should the BC-645 be desired for mobile operation, the regular dynamotor PE-101 can be used as shown in the plug connections diagram in fig. 4.

For 6-volt operation, revision of the filament circuit is required. It should be noted that this is a rather difficult job and may also cause instability in the IF amplifiers.

(f) Operation of the Converted Unit:

The transmitter is simply tuned by the capacitor located at the end of its tuned-line tank circuit. A 6-volt (blue bead) pilot lamp makes a good resonance indicator and will burn from 1/2 to full brilliance when brought in contact with the antenna or the center lead of the coax cable.

Before operation the receiver tubes should be checked for their proper "B" voltage. The voltage on the acorn tubes (955's) should be 200 to 250 volts with approximately 250 volts on the other tubes. The series dropping resistor in the plate voltage supply lead may have to be changed for the above voltages.

A tuning reaction between the oscillator and antenna circuits will be apparent when tuning the receiver. Simultaneous tuning of the two circuits, rechecking the antenna tuning after each change in oscillator tuning provides the best adjustment.

Both receiver and transmitter are designed for a 50-ohm load. RG-8/U coaxial cable which is available on the surplus market meets the above requirements.

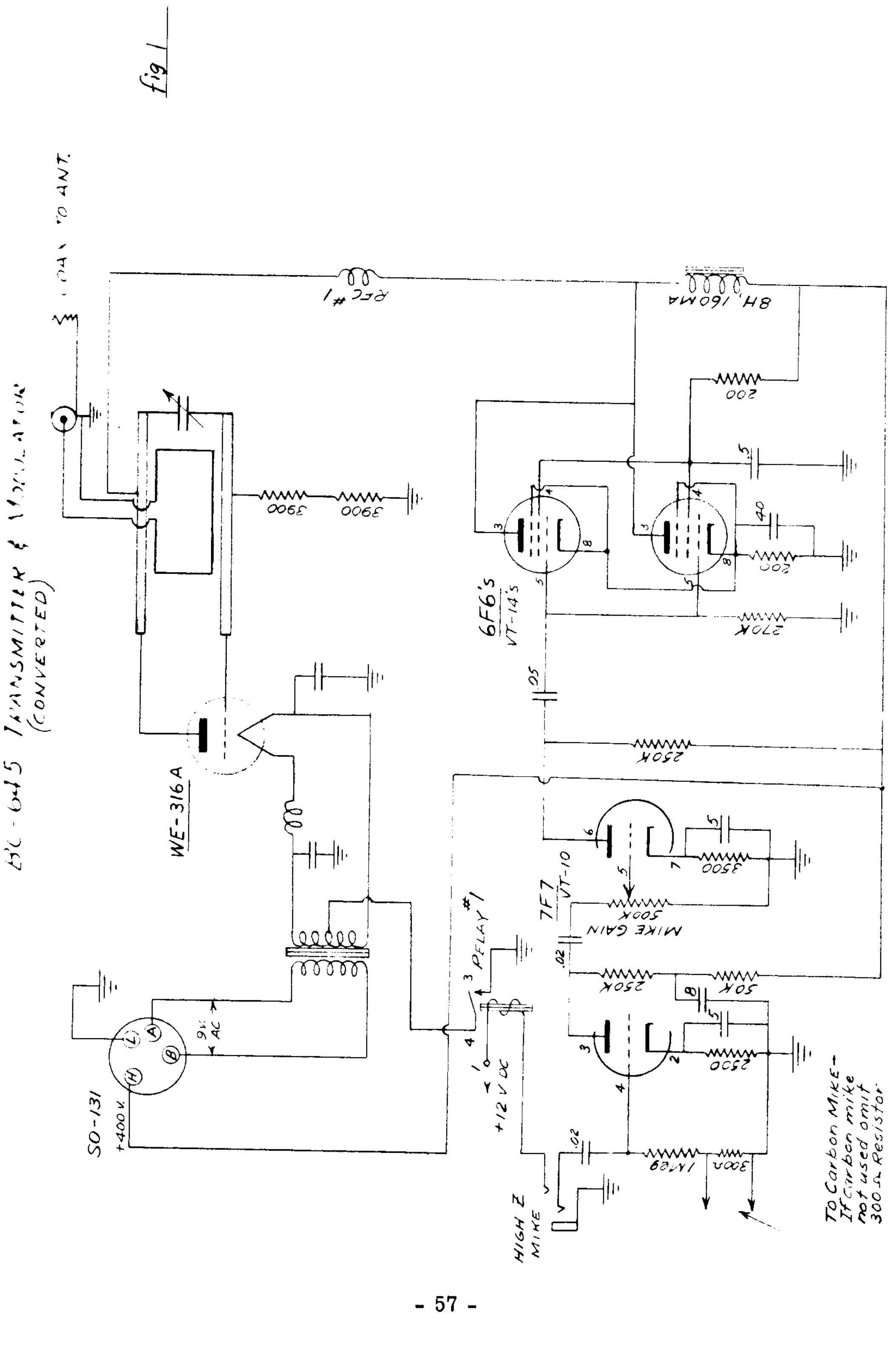
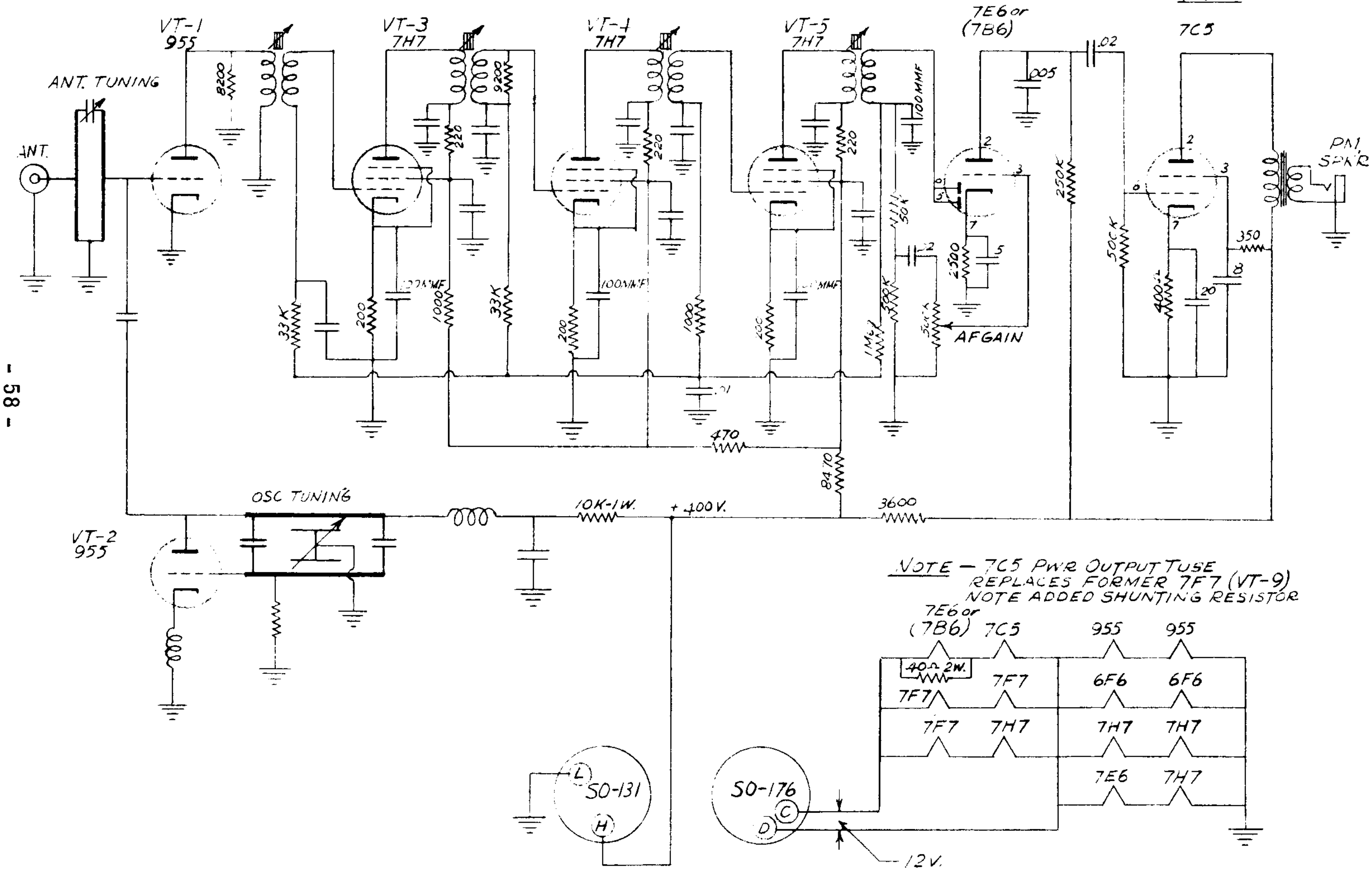


fig 1
(CONVERTED)
TO ANT.
RFC #1
8H, 160MA
WE-316A
3900
3900
200
.5
40
200
270K
6F6's
VT-14's
.05
250K
7F7
VT-10
3500
500K
MIKE GAIN
.02
250K
50K
8
5
2500
1MEG
300Ω
RELAY #1
+12 V DC
9V. AC
SO-131
+400V.
HIGH Z MIKE
TO Carbon Mike-
If carbon mike
not used omit
300 Ω Resistor

CONVERTED BC-645 RECEIVER

fig 2



AC Power Supply For The BC-645

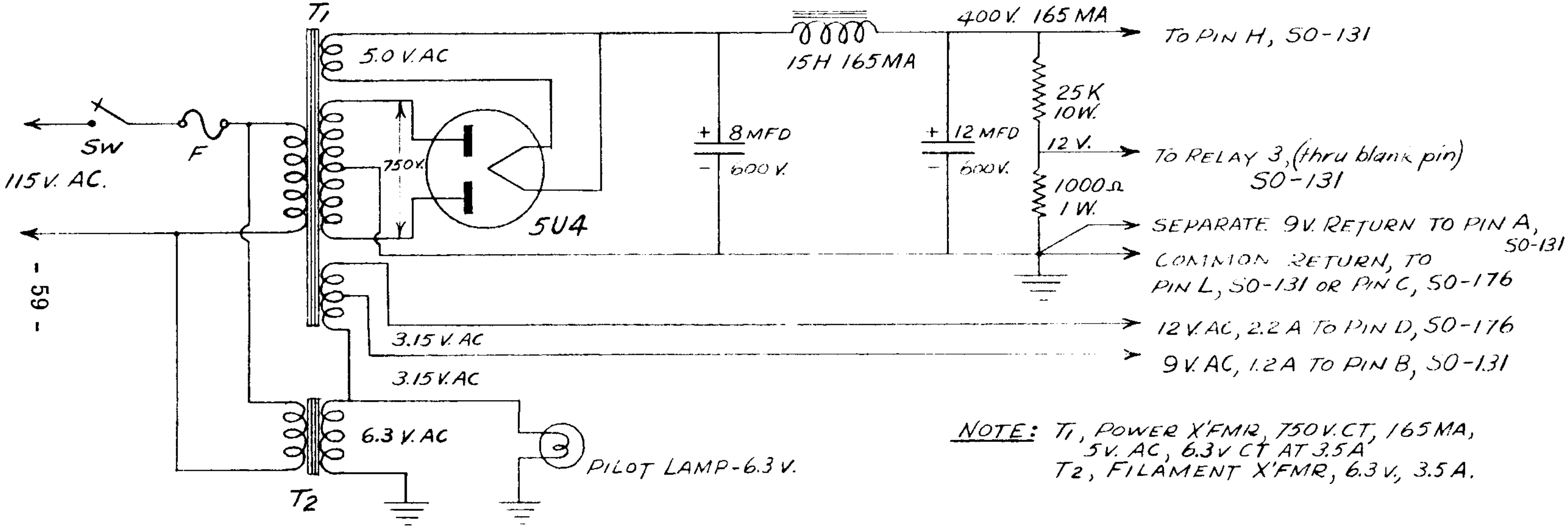
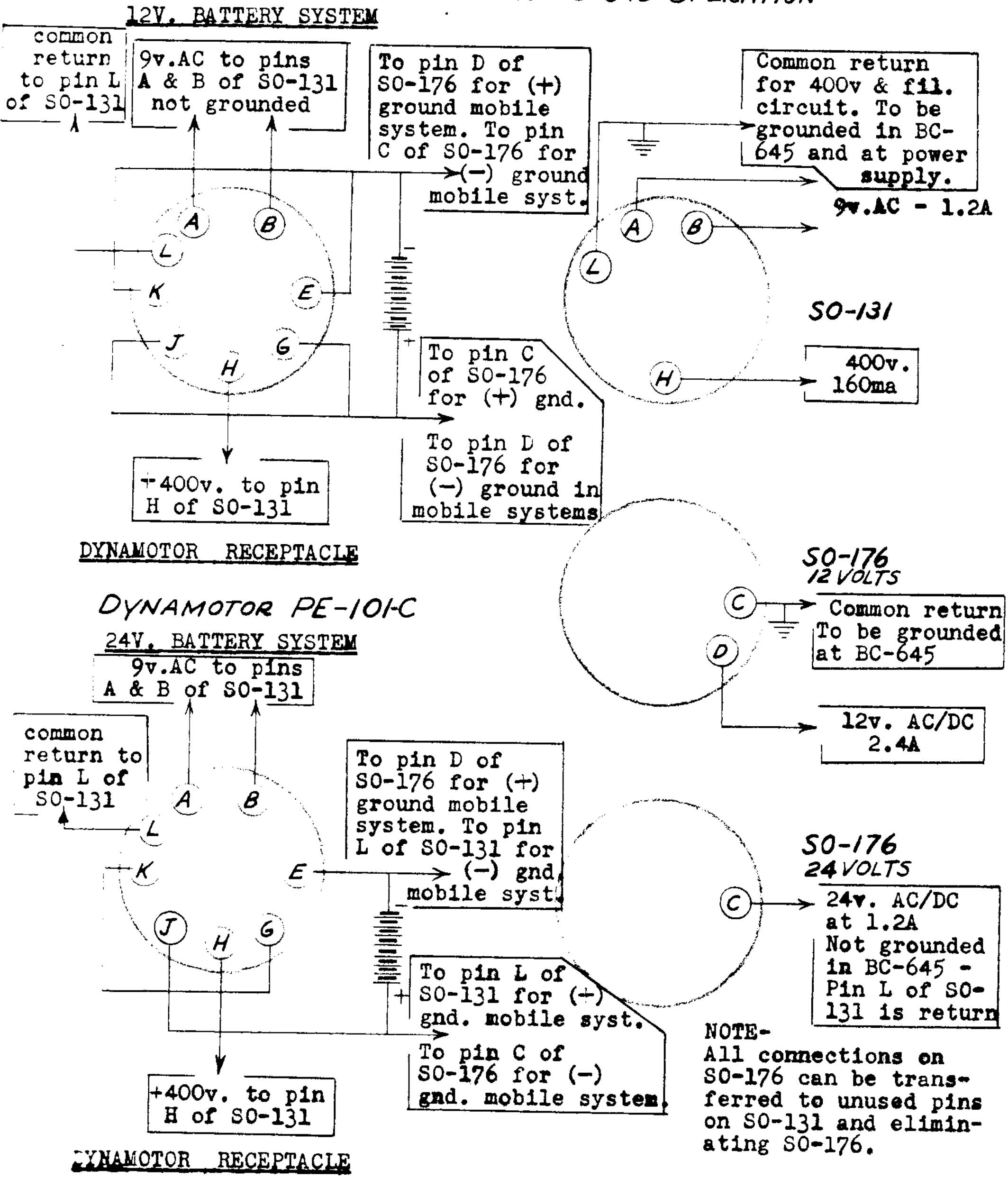


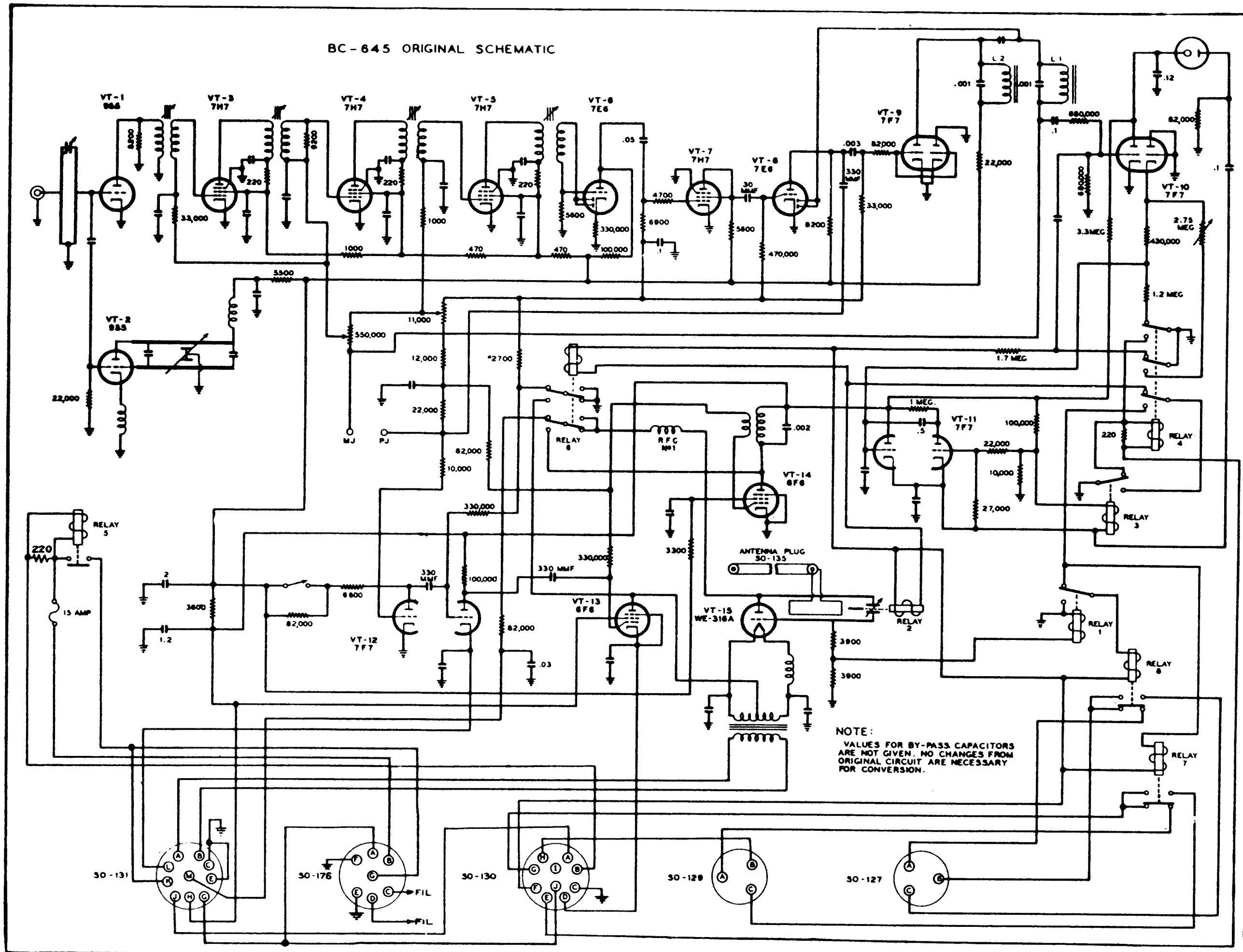
fig 3

SOCKET CONNECTIONS FOR BC-645 OPERATION



NOTE-
All connections on SO-176 can be transferred to unused pins on SO-131 and eliminating SO-176.

fig 4



Courtesy Belmont Radio Corporation

FIG 5

BC-946-B RECEIVER - CONVERSION FOR USE ON 6 VOLTS D.C. (AUTO RADIO)

Introduction:

The BC-946-B receiver is one designed for use in Army aircraft and is of all aluminum construction. It weighs about 6 pounds and is approximately 5" x 8" x 12" in size.

The unit incorporates a 6-tube superhet circuit covering the frequency range of 520 kc. to 1500 kc. by means of a directly calibrated vernier dial. The unit is designed to operate from a 28-volt d-c dynamotor, but the instructions herein will explain how it can be easily adapted for 6-volt battery operation. The receiver's excellent shielding makes it a natural for mobile use.

The conversion data as covered in this article will cover a typical auto installation in use at present by the author in conjunction with a 10-meter converter.

Conversion Instructions:

In order that he may have the general picture in mind, it is suggested that the reader briefly scan this entire article before commencing work on the receiver.

The following steps will be covered in detail:

(a) Removal of present CW oscillator stage
(b) Addition of first a-f stage in place of c-w Osc.
(c) Rewiring filaments for 6 volts
(d) Replacing output transformer
(e) Moving antenna post
(f) Addition of vibrator power supply or dynamotor
(g) Installation using FT-220-A rack
(h) Selectivity adjustments
(i) Noise limiter circuit

(a) Removal of Present CW Oscillator Stage:

Remove all wires to terminals 6 and 2 of the 12SR7 tube, and all wires to terminal 5 of the 12A6 tube. This operation makes the following component parts useless and they should be removed to give space: R14, C26, L12, L13, C27, C28, R15, C25, R18, R19, R20, R16, R17, C29. (It will be necessary to refer to the circuit diagram in order to locate and remove these parts.)

(b) Addition of First A-F Stage In Place Of C-W Oscillator:

The triode section of the 12SR7 tube is now free after the above change, and a stage of resistance-coupled amplification can be substituted. The diagram (Fig. 2) will clearly show the manner in which this is added. It will be noted that an audio volume control is included in the revision. The control is physically mounted on the front panel in place of the present plug. The plug wiring is removed completely and discarded except for the wire labeled "Gain control line" on the circuit diagram. (Front plug is J1.) This wire is removed and connected to ground.

This is the RF gain control line. Originally an external control was used to control the gain. However, in this modification an AF gain control is used and the RF gain control line is connected to ground, leaving the RF gain wide open as is normal in broadcast receivers.

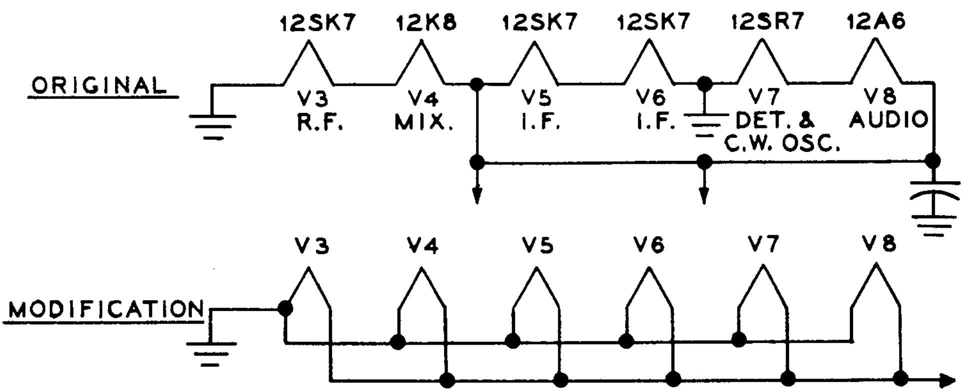
A dural plate is made to just fit in place of the plug, and the AF gain control (500,000 ohms) is mounted in the center of the plate.

It will also be noted that a noise silencer circuit is included in the circuit. This can be built as an individual unit if desired and mounted in a small can alongside the receiver, or it can be built directly into the set, depending upon whether the reader desires to use the silencer for other purposes at some future date.

(c) Rewiring Filament For 6 Volts:

This step might have been accomplished first, but the removal of the CW osc circuit allows more room for rewiring the filaments.

Rewire all tubes in parallel as in the diagram below. Attention to the original filament circuit as given will readily show the few wires necessary to be moved.



It will be necessary to replace the 12-volt tubes with their 6-volt equivalents as follows: replace 12SK7 with 6SK7, 12K8 with 6K8, 12SR7 with 6SR7 or 6SQ7, and replace the 12A6 with either a 6K6, 6V6, or 6F6.

(d) Replacement of the Output Transformer:

The present output transformer should be replaced with a unit which will match the chosen output tube to the voice coil of a PM dynamic speaker. If a very small transformer of the replacement type is obtained it may be installed in the place of the original transformer. The output lead (one side is grounded) is run directly to the rear plug in accordance with the general diagram of figure 3.

(e) Moving of Antenna Post:

It is advisable to remove the present antenna post and replace it with a standard bayonet receptacle as used on most auto radios. In addition, it is suggested that this receptacle be installed on the side of the receiver instead of in front for convenience.

(f) Addition of Vibrator Power Supply or Dynamotor:

Any standard 6-volt vibrator power supply that will give approximately 160 to 250 volts at 40 ma. can be used on this receiver. The supply can be mounted on the space where the former dynamotor was installed. It can be a commercial ready-built unit such as a Mallory Vibrapack, or a standard circuit built and mounted on the rear of the chassis.

A very easily obtained power supply for this unit can be created by using a 12-volt dynamotor such as is used in the BC-312 receiver. This dynamotor will run from 6 volts d.c. and put out sufficient voltage with no conversion.

It will be necessary to remove the former dynamotor plug on top of the chassis. Remove the plug and all wires except the B plus connection which should be removed and connected to the B plus of the power supply used.

(g) Installation Using FT 220 A Rack:

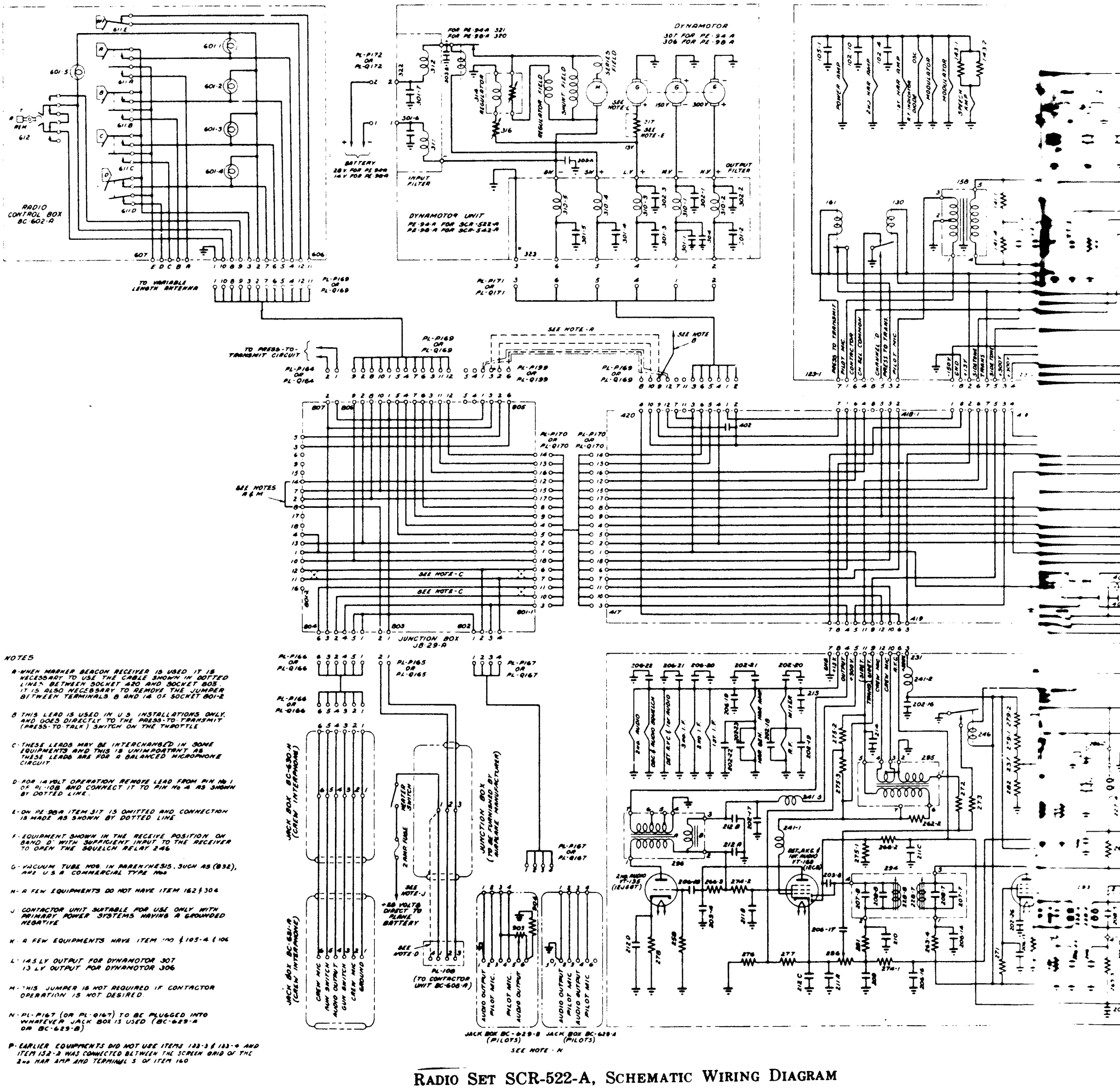
In the author's installation, the FT 220 A rack was purchased for less than $1 and one section sawed off to take the receiver. (The rack is made for 3 receivers.) The rack is mounted under the dash of the car and allows the receiver to slip in and out quite easily. The fuse mounted on the rear of the rack was used for the A voltage fuse, and the toggle switch on front was rewired for a standby switch in the B plus lead as shown in figure 3.

(h) Selectivity Adjustments:

The selectivity of the receiver is quite high for broadcast reception. If desired, the tuning can be broadened by increasing the coupling of the IF transformers. This can be done by pushing down, all the way, the small fibre rod protruding from the IF cans.

(i) Noise Limiter Circuit:

The noise silencer circuit shown in figure 2 has proven to be very effective. The neon-tube peak limiter across the output transformer is then not needed.

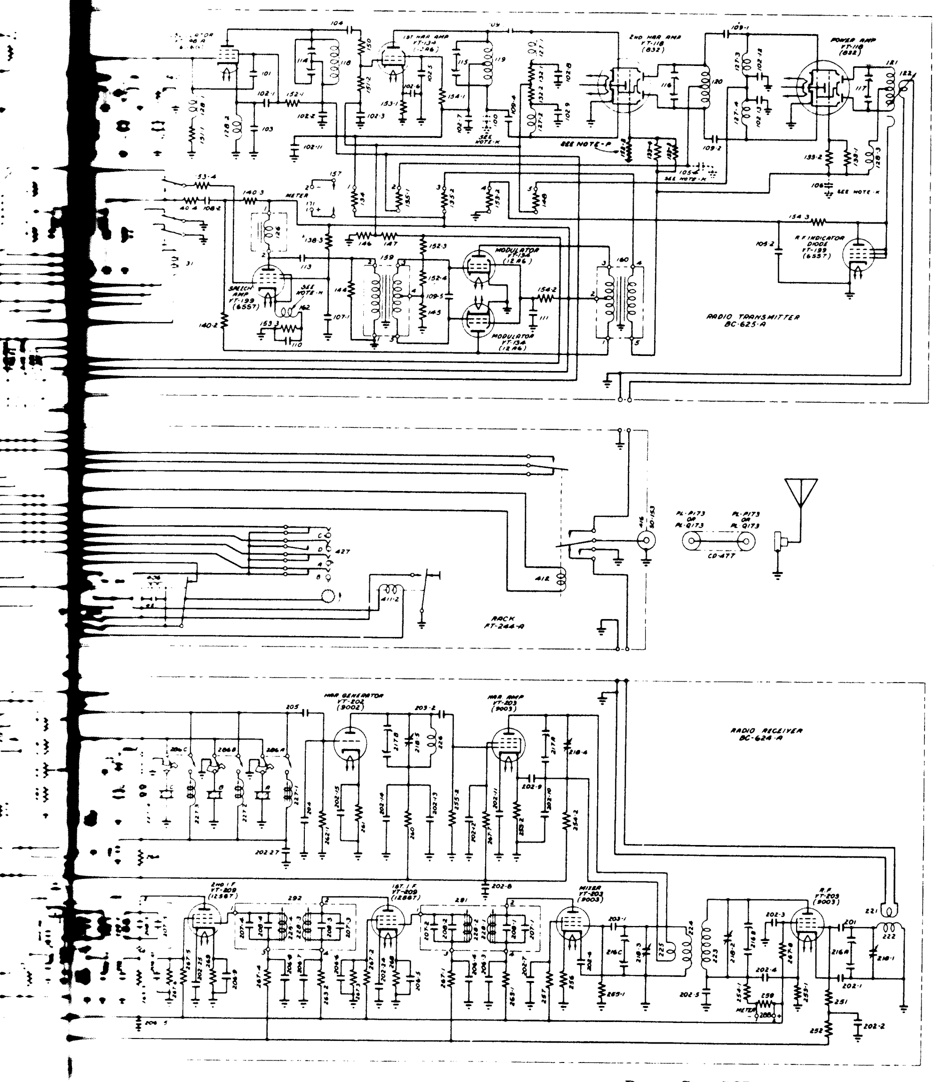


RADIO SET SCR-522-A, SCHEMATIC WIRING DIAGRAM

REVISED 4 SEPTEMBER 1943
181–182

FIG 4

For text, see page 90;
also 97, 82.

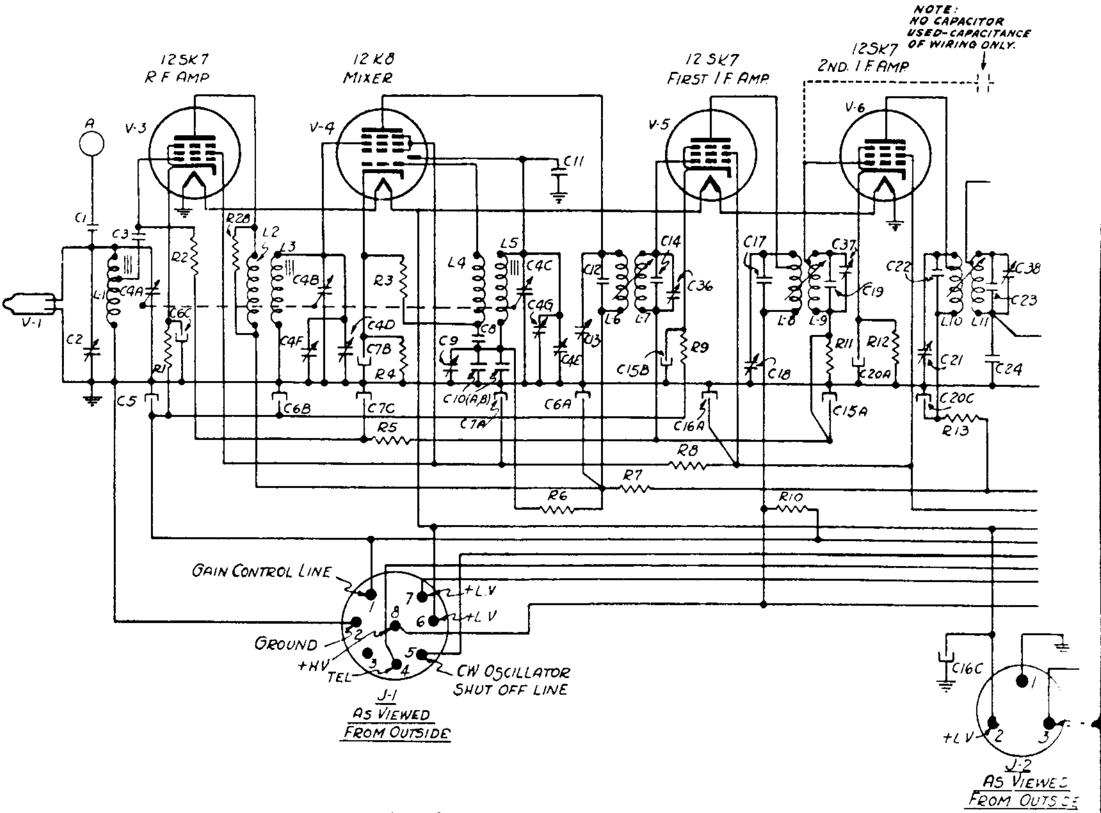


RADIO SET SCR-522-A, SCHEMATIC WIRING DIAGRAM

REVISED 4 SEPTEMBER 1943
181–182

FIG 4

For text, see page 90;
also 97, 82.



CIRCUITS IN RF COIL SET, IF COUPLING UNITS, CW OSCILLATOR, & OUTPUT TRANSFORMER
THE TERMINAL NUMBERS ON THESE UNITS AGREE WITH THOSE SHOWN AT THE
CORRESPONDING LOCATIONS ON THE WIRING DIAGRAM

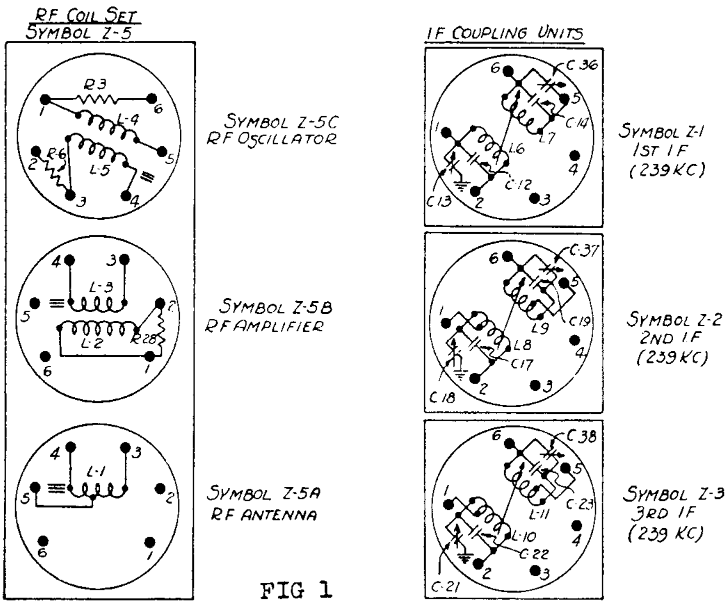
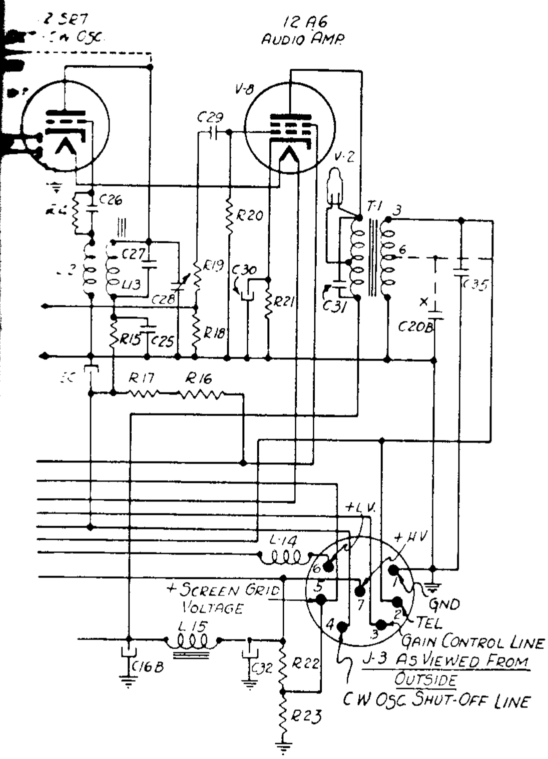


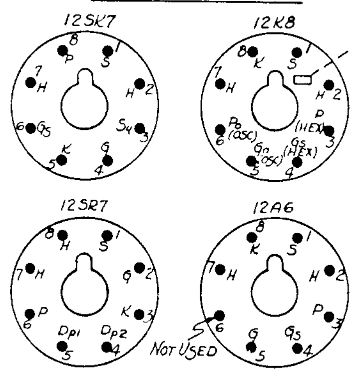
FIG 1

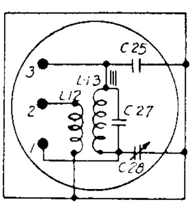
Radio Receiver BC-946-B — Schematic Wiring Diagram



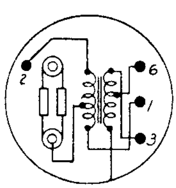
CAPACITANCES		INDUCTANCES		RESISTANCES	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	OHMS
C-1	11 MMF	L-1	ANT. INPUT	R-1	620
C-2	15 MMF	L-2, L-3	RF AMP	R-2	2,000,000
C-3	100 MMF	L-4, L-5	RF OSC	R-3	51,000
C-4(A TO G)	GANG(346 MMF)	L-6, L-7	IN FIRST IF	R-4	620
C-5	3 MFD	L-8, L-9	IN 2ND IF	R-5	150,000
C-6(A,B,C)	.05/05/05 MFD.	L-10, L-11	IN 3RD IF	R-6	300,000
C-7(A,B,C)	05/05/05 MFD	L-12, L-13	CW OSC	R-7	200
C-8	200 MMF	L-14	RF CHOKE	R-8	200
C-9	40 MMF		112 MICRO-	R-9	620
C-10 (AB)	670MMF TOTAL		HENRIES	R-10	360,000
C-11	3 MMF	L-15	AF CHOKE	R-11	100,000
C-12	180 MMF		3 HENRIES	R-12	510
C-13	17 MMF			R-13	200
C-14	180 MMF			R-14	100,000
C-15(A,B,C)	05/.05/05 MFD			R-15	20,000
C-16(A,B,C)	.22/.22/.22 MFD			R-16	100,000
C-17	180 MMF			R-17	100,000
C-18	17 MMF			R-18	510,000
C-19	180 MMF			R-19	100,000
C-20(A,B,C)	05/.01/.05 MFD			R-20	2,000,000
C-21	17 MMF			R-21	1500
C-22	180 MMF			R-22	7000
C-23	180 MMF			R-23	7000
C-24	200 MMF			R-28	51,000
C-25	.001 MFD				
C-26	100 MMF				
C-27	335 MMF				
C-28	34 MMF				
C-29	.006 MFD				
C-30	15 MFD				
C-31	.001 MFD				
C-32	5 MFD				
C-33	WIRING CAPACITANCE LESS THAN 2 MMF				
C-35	750 MMFD (SEE NOTE ④ BELOW)				
C-36	17 MMF				
C-37	17 MMF				
C-38	17 MMF				

TUBE SOCKET TERMINALS
AS VIEWED FROM BOTTOM





SYMBOL Z-4
CW OSCILLATOR
(239 KC)



SYMBOL T-1
OUTPUT TRANSFORMER

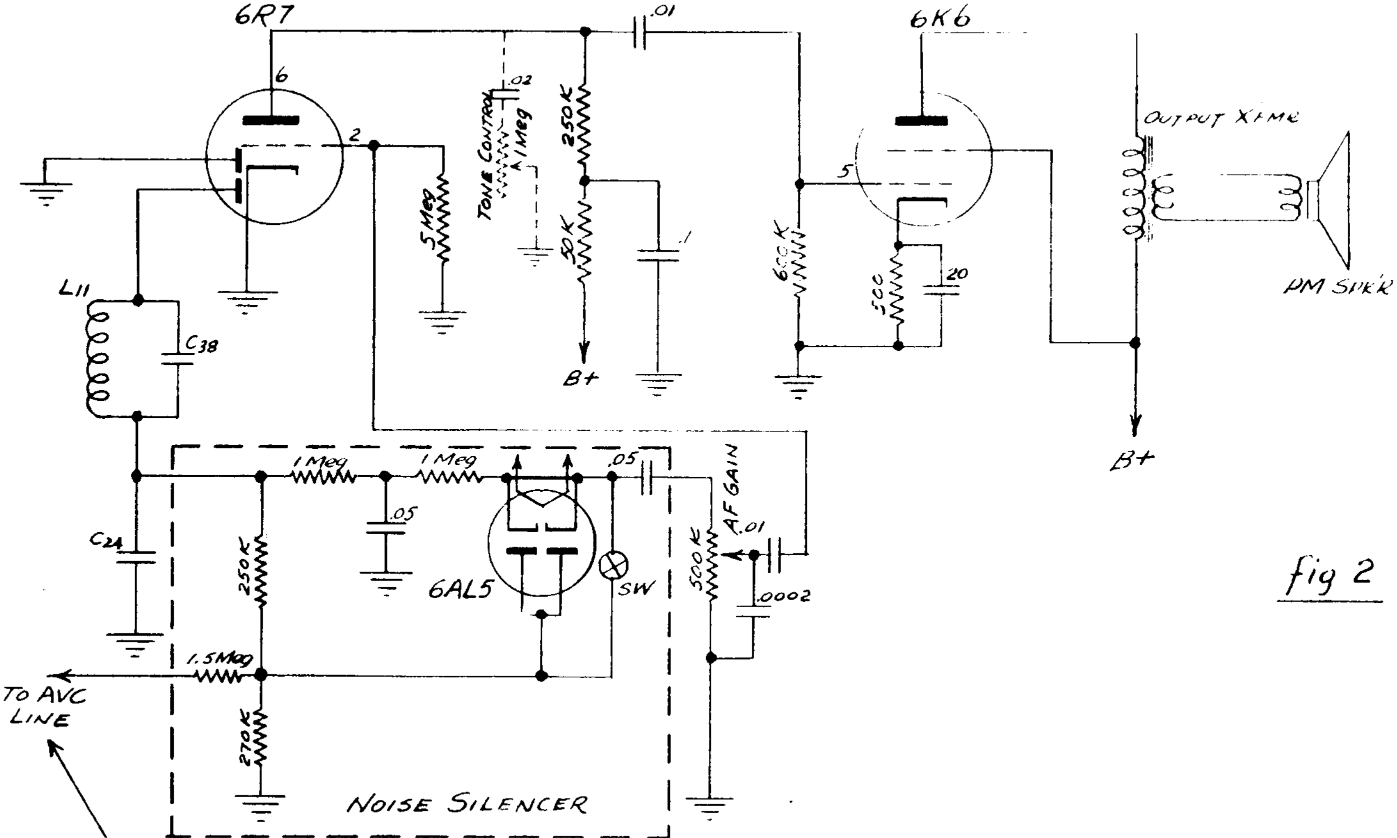
TUBE TERMINAL CODE

S = SHELL	G_S = SCREEN GRID
H = HEATER	G_S(HEX) = SCREEN GRID, HEXODE SECTION
K = CATHODE	G_O(OSC) = CONTROL GRID, OSC SECTION
S_u = SUPPRESSOR GRID	P = PLATE
D_{P1} = FIRST DIODE PLATE	P(HEX) = PLATE, HEXODE SECTION
D_{P2} = SECOND DIODE PLATE	P_O(OSC) = PLATE, OSC. SECTION
G = CONTROL GRID	G(HEX) = CONTROL GRID, (HEXODE SECTION

④
C35 & TERMINAL 3 TO BE USED FOR 4000 OHM OUTPUT
C20B & TERMINAL 6 TO BE USED FOR 300 OHM OUTPUT

Radio Receiver BC-946-B — Schematic Wiring Diagram

MODIFIED AUDIO SECTION OF BC-946-B



NOTE: Remove R11 from original circuit and connect AVC to ungrounded side of C15A

fig 2

NOTES - Noise Silencer Circuit Added.
1st Audio Stage Replaces Original CW Oscillator.
Tone Control, optional — (dotted circuit)

CONNECTION DIAGRAM FOR BC-946B RECEIVER USING THE FT-220A RACK (TYPICAL AUTO INSTALLATION)

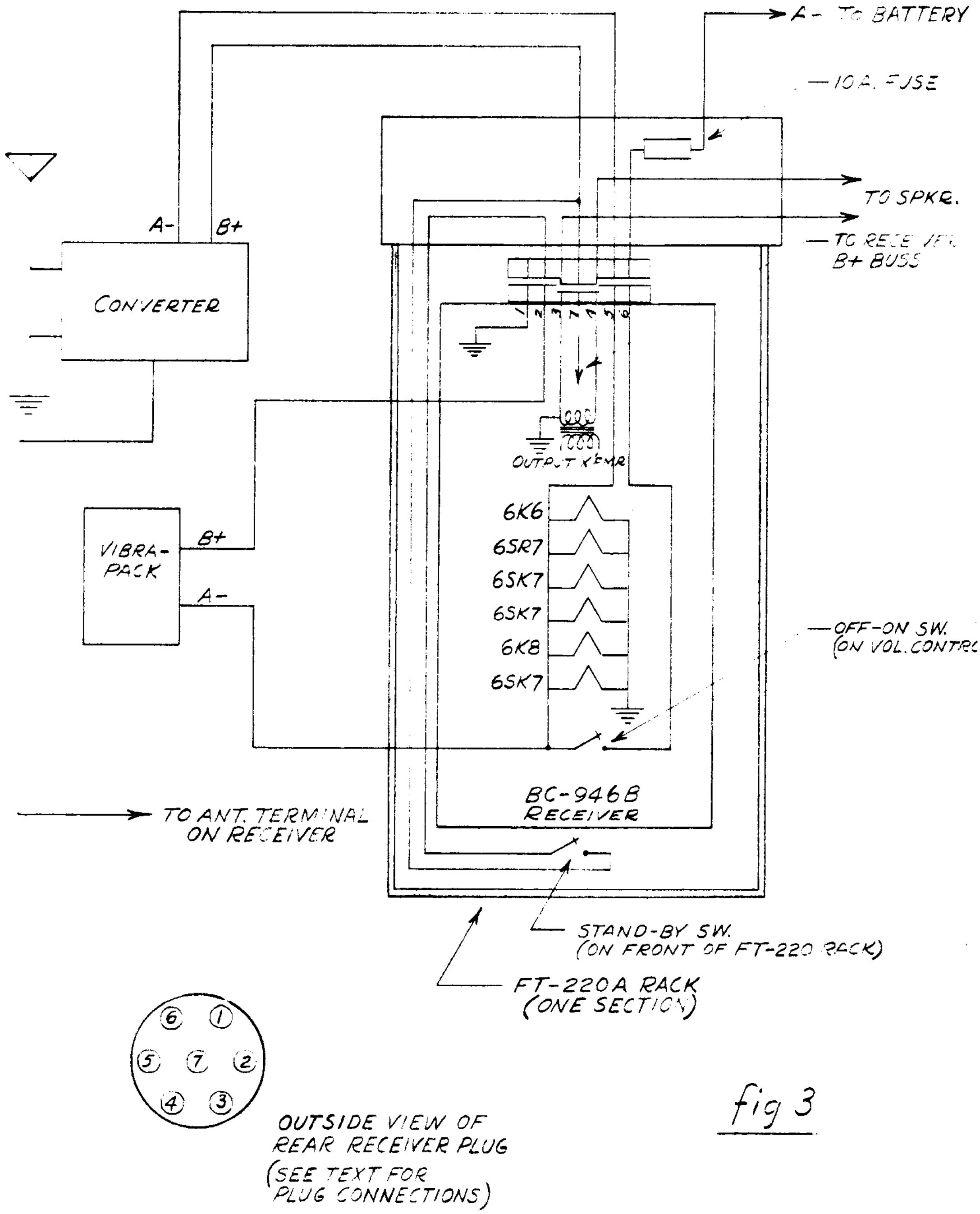
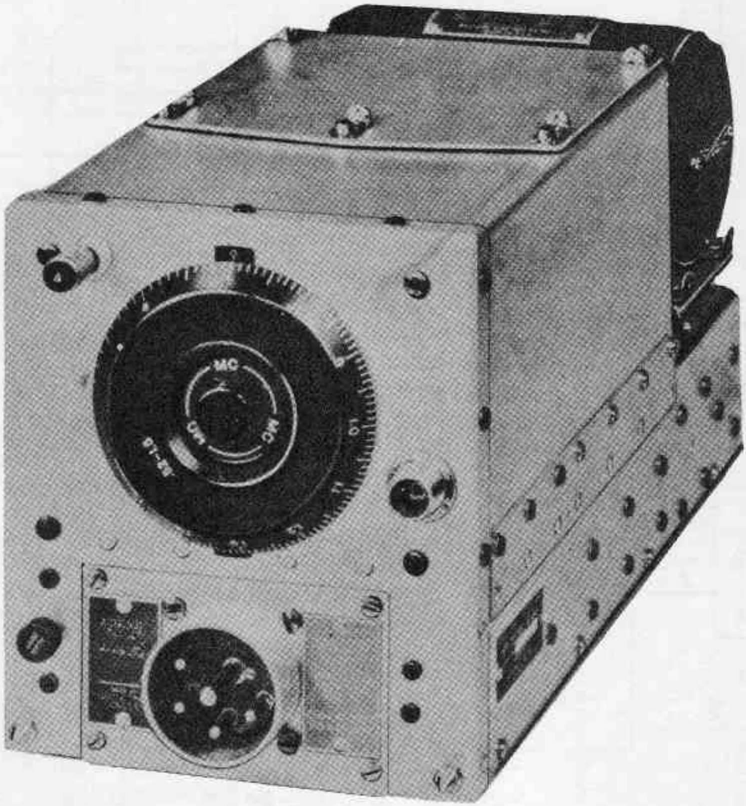


fig 3



BC-946B RECEIVER(Before conversion)

Typical of Command Set type Receivers

CONVERTING THE SCR-274N COMMAND SET RECEIVERS
(BC-453 Series)

"Q-5'er" CONVERSION | 10-METER CONVERSION

Introduction:

The SCR-274N series of command-set receivers includes the BC-453, BC-454, and the BC-455. Almost identical counterparts to these three are available in the ARC-5 command-set series.

The BC-453 (and its ARC-5 equivalent) is quite effective and justifiably popular as a "sharp-channel" i-f system to follow a conventional communications receiver. Either the BC-454 or the BC-455 may be used intact as a communications receiver, but it will be found that the receivers are excessively broad in selectivity due to the high value of intermediate frequency which is employed. However, due to this relatively high i.f. either of the latter types of receiver may be converted for image-free operation on the 10-meter band by revamping the r-f coil assembly and the main tuning capacitor. In addition, several changes are required in the audio circuit. These changes are similar to those suggested previously for the BC-946B conversion.

(a) General Description:

The command-set receivers, designed for aircraft use, are light, very compact, and totally shielded in an aluminum case. Each is a 6-tube superheterodyne with one r-f stage, two i-f stages, mixer, detector, beat oscillator and audio. All are designed to operate from a 28-volt d-c source, with a dynamotor supplying the plate voltage.

The units of this series are substantially identical with the exception of the main tuning capacitor, and the r-f and i-f coils which are plug-in units. Frequency coverages and intermediate frequencies are as follows:

Unit	Frequency Coverage	Intermediate Frequency
BC-453	190 to 550 kc.	85 kc.
BC-454	3 to 6 Mc.	1415 kc.
BC-455	6 to 9.1 Mc.	2830 kc.

(b) Ten-Meter Conversion--Modifying the R-F Coil Assembly:

This modification involves rewinding of the coils in the plug-in coil assembly to obtain coverage of the 28-Mc. band. Modification of the tuning capacitors to obtain bandspread operation is discussed in a later paragraph.

L 1 (Ant. coil) - Remove the existing winding and rewind with 6 turns of #18 enameled wire, space wound the full length of the coil form.

L 2 (RF mixer coil) - Remove the existing "honey-comb" coil with the exception of the last layer. This will leave approximately 9 turns for L 2.

L 3 (RF mixer coil) - Remove the existing winding and rewind with 5 turns of #18 enameled wire, spacing the winding evenly the full length of the coil form.
L 4 (Osc. coil) - No alteration is necessary on this coil.
L 5 (Osc. coil) - Remove the existing winding and rewind with 5 turns of #18 enameled wire, close spaced. L 5 should be between 1/8 and 3/16 inch from L 4.

(c) Modify ing the Tuning Capacitor:

In order to provide sufficient spread of the 10-meter band, it is necessary to reduce the capacitance of each section of the tuning capacitor. This is accomplished by removing all the rotor plates except the two end ones in each section. Care should be taken so as not to damage the remaining plates.

With two rotor plates in each section, the band spread for 27 to 30 Mc. will be approximately 3.5 to 4.7 on the calibrated dial. Using only one rotor plate per section, the 27 to 30 Mc. band will cover approximately the entire dial of the receiver.

To facilitate alignment of the receiver after modification, drill necessary holes (1/4") to expose the trimmer capacitor adjustment screws with the shields in place. Since the added cppacitance of the shields tends to detune the circuit, it is preferable to align the receiver with the coil shields in place.

It should be noted that the oscillator frequency must be tuned above the incoming frequency to obtain tracking over the entire dial.

(d) Changes in the Audio Circuit:

Unless the BFO (V-7 stage) is specifically desired, it should be converted to a first audio amplifier. This additional stage gives sufficient increase in audio gain for satisfactory speaker operation.

Even though some conversions use the existing RF gain control method (approximately 20K. variable between cathode and ground), it is generally preferred to have the RF gain remain maximum and use the conventional AF gain control. This is a convenient addition, especially if stage V-7 is changed to the first audio amplifier as mentioned above and as shown in Fig. 1. When the AF gain control is used, the cathode buss lead (labeled "gain control line") to pin #1 of J-1 is connected directly to ground.

With reference to Fig. 1 it will be noted that the 12A6 (V-8) is used as the output stage, R-C coupled to the first audio stage through the AF gain control. A conventional plate to voice-coil output transformer replaces the existing output transformer T1. The output transformer used must match the speaker voice-coil impedance to the required plate load impedance of the 12A6; this is approximately 7500 ohms. The existing output transformer, T1, is designed for a load impedance of either 300 ohms or 4000 ohms. These outputs were used for headphone reception.

V2 is a neon type, peak-limiting device and should be removed unless specifically desired.

For headphone reception with the above modification of the audio circuit, and open-circuiting type jack should be used at the plate output of the first audio amplifier. This jack is inserted between the coupling capacitor, C-29, and the grid of the 12A6.

(e) AVC Circuit:

For optimum signal to noise performance, the RF stage should operate at maximum gain. This requires removing the AVC voltage from this stage. To do this, disconnect R2 from the AVC line and ground at some convenient point. (R2 is V3 grid resistor.)

Due to the high gain of the RF and IF sections of this set, some AVC action is obtained from the existing circuit. (Diode action of control grid of second IF amplifier.) If more AVC is desired, it can be obtained from the unused diode plate of V-7 (12SR7) in the conventional manner. For this change refer to Fig. 1.

In using the diode section of V-7 for the AVC, it is necessary to remove R11 from the V-6 grid circuit. Refer to Fig. 1 for the added AVC components to V-7.

(f) Power Supply:

The most convenient AC power supply to use with these receivers is the one shown in Fig. 2. By using the cathode type rectifier (6X5), the 5 and 6.3 volt windings are used in series which gives approximately 12 volts for filament supply. This permits the use of the existing tubes with just minor changes in the filament circuit as shown in Fig. 2.

Correct polarity (phasing) of the two filament windings should be observed to obtain the proper additive voltage.

(g) Mechanical Modifications:

To complete the receiver conversion, the following mechanical modifications should be made:

The added controls, OFF-ON switch, volume control, and headphone jack should be brought out in the front panel. This is accomplished by removing all of the hardware of the J-1 plug assembly located on the front panel. An aluminum plate is mounted over the opening left by the J-1 plug and serves as a panel mount for the controls.

When removing J-1, all connecting leads can be removed from the set except the one labeled "gain control line" which is connected to pin #1. This lead is grounded as stated above in section (d).

With a bit of ingenuity and patience, the power supply can be located on the receiver chassis in the former dynamotor position. However, if the power supply is constructed as a separate component, the J-3 position can be used as the connecting plug.

All leads can be removed from J-2; lead to pin #2 is the filament lead and is connected to the new filament source.

It is apparent that the several components connected to J-3 are not needed for AC operation and can be removed to provide more space for the modifications and additional parts as were the BFO components of the V-7 stage.

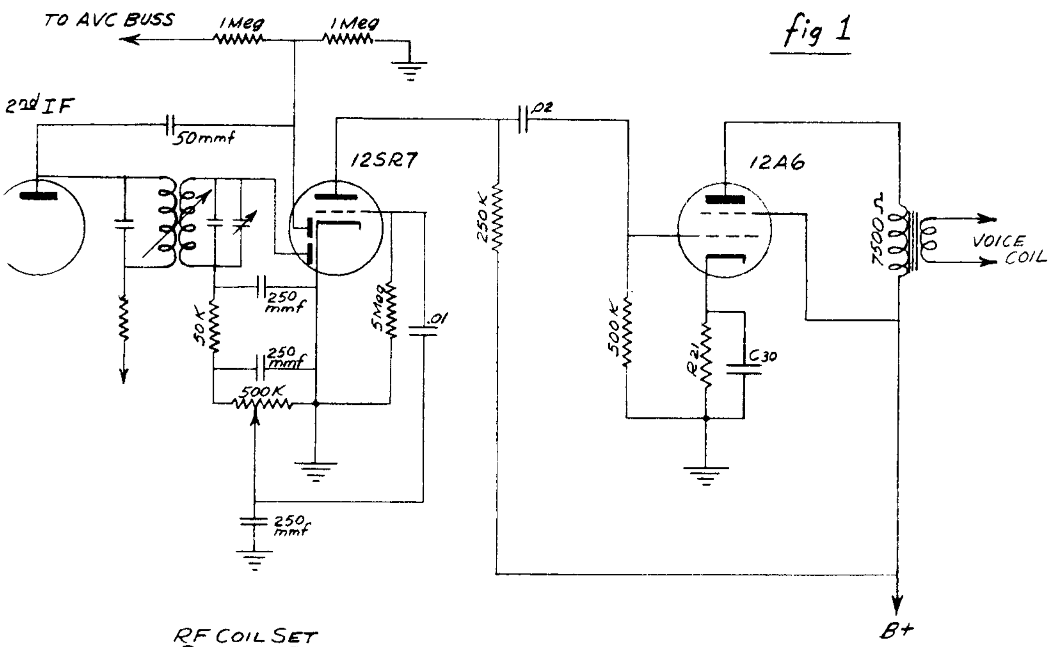
NOTE: For schematic diagram refer to Fig. 1 of the BC 946.

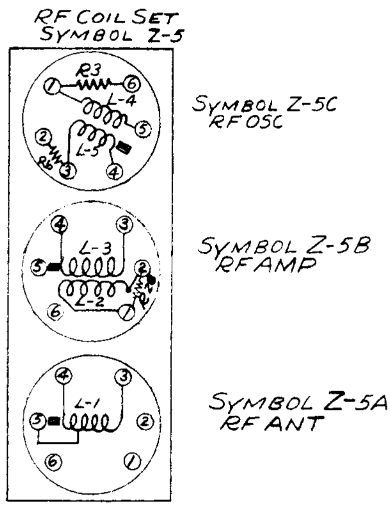
(h) Use of the BC-453A as a "Q-5'er":

The BC-453A command receiver operates with an i.f. of 85 kc., which permits it to have an unusually sharp response characteristic. The normal method of using this receiver as a "Q-5'er" is to convert the audio system and the power supply as just described, and then to couple a shielded wire with a probe on the end into the communications receiver in the region of the last i-f stage. The BC-453 will operate, without modification, as a sharp i-f channel for any receiver having an intermediate frequency from 190 to 550 kc. Greatest selectivity will be obtained with the fiber rods which protrude from the center of the top of each of the i-f transformers pulled out as far as they will go for each of the three transformers. This degree of selectivity, which may be too much for comfortable listening to a phone contact, may be reduced by stagger tuning the i-f transformers slightly, or by pushing down one or more of the fiber rods.

The BC-453A may be operated in conjunction with a BC-348 as a sharp channel either by making modifications in the r-f coil assembly of the BC-453A or by using a frequency-converter stage. It is possible to remove turns from the coils in the r-f assembly until the front end of the receiver will tune to the 915-kc. i.f. of the BC-348. The alternative method of using the BC-453A in conjunction with the BC-348 is to use an outboard mixer stage between the output of the BC-348 and the input of the BC-453A. This mixer stage should accept the 915 kc. signal from the BC-348 and convert it, using conventional broadcast receiver components, to a frequency in the vicinity of 456 kc. for feeding to the input of the BC-453A. A 6SA7 tube is ideally suited to performing the frequency conversion which is required.

Audio Section for Converted SCR-274N (BC-453A) Series Receiver





NOTE: Should Noise Limiter Circuit be desired refer to conversion of BC-946, page 57

For original schematic diagram refer to BC-946, page 58

POWER SUPPLY FOR SCR-274 N RECEIVERS

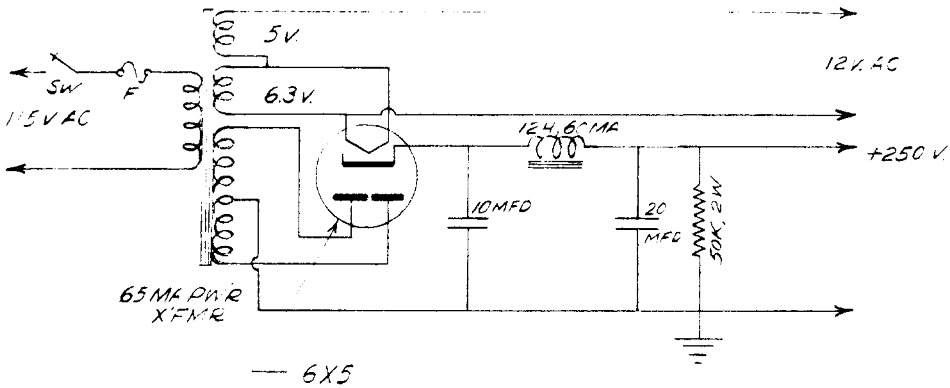
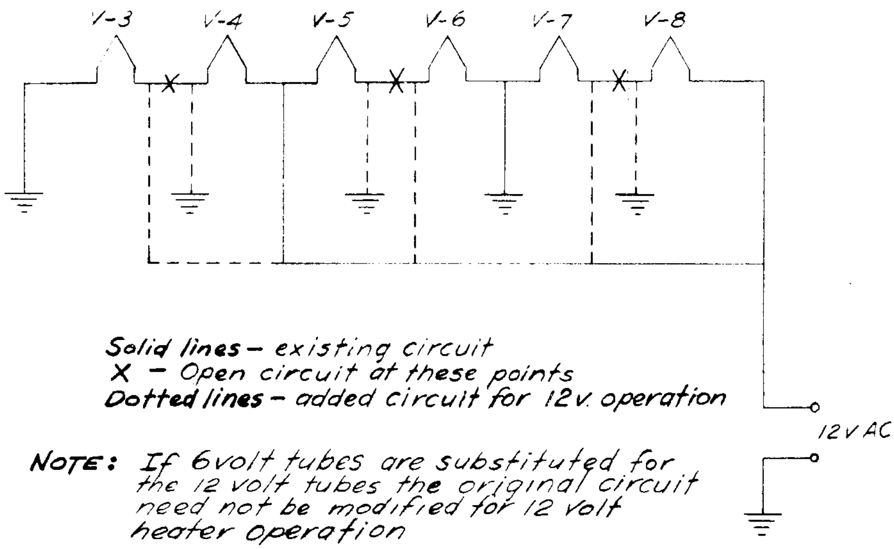


fig 2

FILAMENT CIRCUIT



Solid lines – existing circuit
X – Open circuit at these points
Dotted lines – added circuit for 12v. operation

NOTE: If 6 volt tubes are substituted for the 12 volt tubes the original circuit need not be modified for 12 volt heater operation

CONVERTING THE BC-457A TRANSMITTER SERIES (SCR-274N) FOR USE AS VFO

Introduction:

This series of transmitters was designed for use in Army aircraft and, for all practical purposes, the following data will also be applicable to the Navy version (ARC-5 Series).

Frequency coverage of units:

BC	457A	4 to 5.3 Mc.	(Crystal check point at 4600 kc.)
"	458A	5.3 to 7 Mc.	(" " " " 6200 ")
"	459A	7 to 9.1 Mc.	(" " " " 8000 ")
"	696A	3 to 4.0 Mc.	(" " " " 3500 ")

The circuit schematic included as part of this article is for the BC 458A, but it is typical of all the models including the Navy ARC-5 series.

The output frequency is governed by the directly calibrated tuning dial and has nothing to do with the crystal in the unit. This crystal is merely used as a check on dial calibration and can be changed to any frequency desired, providing the pin connections are observed on the crystal.

The tuning eye (1629) originally obtained part of it's operating bias from the 24-volt DC source, and, in order to allow this tube to function normally with AC on the filaments, remove resistors R-70 and R-77 from V-53. Replace R-77 with a 2000 or 2500-ohm 1-watt resistor. The tuning eye will now function nicely. To calibrate the unit, set the dial to frequency of the crystal in the unit and insert a screwdriver in the opening under the slide in front of the 1629 compartment. Adjust this trimmer (Osc trimmer) for maximum shadow on the 1629 tuning eye. Clockwise rotation lowers the frequency.

Connections to the unit will be greatly simplified if a rack is purchased which was designed to hold this size unit, and if not used intact, the plug can be removed and used to make power connections. Otherwise the power leads will have to be soldered directly to the terminals of the plug on the rear of the unit.

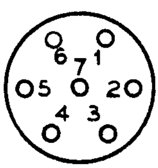
To Convert For Use As VFO:

1. Jam the bottom relay closed (K53) or short out the associated contacts. (This relay was used as a keying relay and applied plate voltage to the Osc while at the same time shorting out R75.)
2. Solder the top relay (K54) to the antenna post. This relay originally grounded out the antenna when the transmitter was not in use.
3. Connect 24 volts AC (1 amp), to terminals 1 and 6 of the plug for filament voltage. (If desired, the filaments may be easily rewired for 12 volts by referring to the schematic.)

4. Connect approximately 300 volts to terminals 1 and 7 for the Power Amplifier plate voltage (1625's). (Terminal 1 is ground.)
5. Connect approximately 200 volts to terminals 1 and 4 for the Power Amplifier Screen voltage.
6. Connect 180 to 200 volts to terminals 1 and 3 for the Osc plate voltage. (For stable operation this should be from a regulated supply.)
7. Couple the output of the unit thru a coaxial cable or twisted pair to your transmitter's v.f.o. input.
8. If trouble is experienced with oscillations, it may be wise to remove the antenna tuning coil L52 completely from the unit. If this is done, the secondary of T54 can be brought out to the original antenna post and to an added one, allowing a balanced (ungrounded) line to your transmitter.
9. It may also be desirable to add a midget phone jack in the lower left hand corner of the unit and wire in series with the 1625 cathode circuit. A milliammeter may then be plugged into this jack to read plate current of the 1625's.

NOTE: All terminal designations given above are for BC-457A series, the plug connections, of which are shown immediately below. For the ARC-5 series, refer to the alternative plug-connection diagram below.

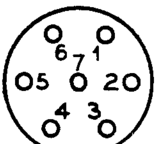
PLUG CONNECTIONS AFTER MODIFICATION FOR V.F.O. (BC 457A SERIES)



FACING REAR OF TRANSMITTER

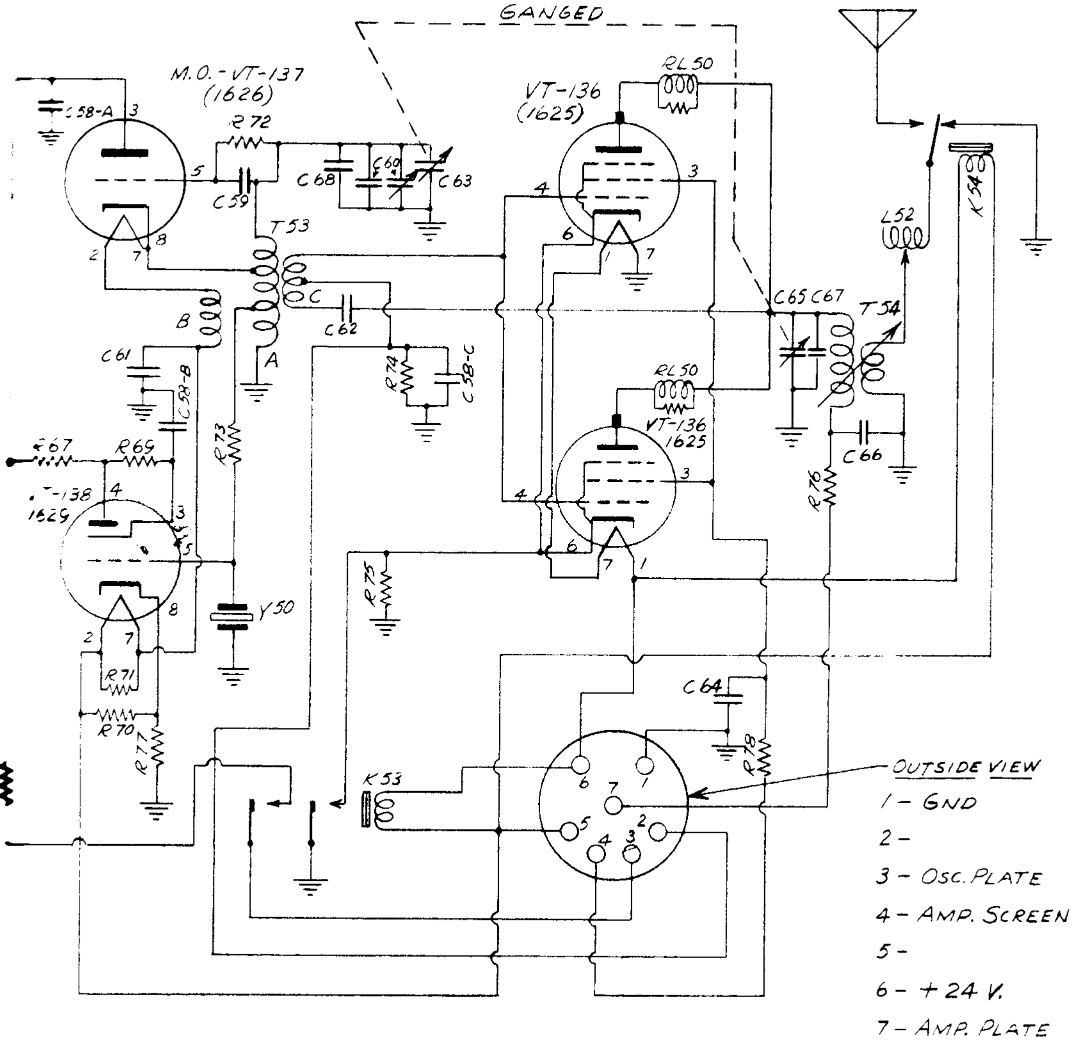
1. 24 VOLTS AC
2. NOT USED
3. OSC. PLATE VOLTAGE (1626)
4. PA SCREEN VOLTAGE (1625)
5. NOT USED
6. 24 VOLTS AC
7. PA HIGH VOLTAGE (1625'S)

PLUG CONNECTIONS AFTER MODIFICATION FOR V.F.O. (ARC-5 SERIES)



1. NOT USED
2. OSC. PLATE VOLTAGE
3. NOT USED
4. 24 VOLTS (GND)
5. 24 VOLTS
6. PA SCREEN VOLTAGE
7. PA HIGH VOLTAGE

SCHEMATIC OF BC-458A (5.3 - 7 Mcs)



C58A,C58B,C58C - .05 uf
C59 - .00018 uf
C60 - Master Osc. padding
C61 - .006 uf
C62 - Fixed Neutralizing
C63 - Master Osc. tuning
C64 - .002 uf
C65 - P.A. tuning
C66 - .01 uf
C67 - P.A. padding
C68 - 3.0 uuf
C69 - 50 uuf
K53 - Xmttr Selector Relay
K54 - Xmttr Output Relay

L52 - Ant. Loading Coil
R67,R72,R75, - 51,000 ohms
R68,R76, - 20 ohms
R69 - 1 Megohm
R70 - 1000 ohms
R71 - 126 ohms
R73,R74, - 15,000 ohms
R77 - 390 ohms
R78 - 51 ohms
RL-50 - Parasitic Suppressors
T53 - Oscillator Coils
T54 - Amplifier Coils
Y50 - Crystal Unit

CONVERTING THE SCR-522
(Transmitter-Receiver)

A popular piece of v.h.f. radio equipment that has been quite common on the surplus market is the SCR-522 (also SCR-542) communication transmitter-receiver. In the military service it was generally known as the v.h.f. communication set used in the larger aircraft for inter-aircraft and air-ground communication. The ground version of the SCR-522 included several additional components such as a power unit, antenna, and antenna mast.

Power requirements for the SCR-522 are 28 volts d.c., at 11.5 amperes (maximum), with the PE-94A dynamotor furnishing the required "B" supply. Identical to the SCR-522, the SCR-542 operates from 14 volts dc., at 23 amperes, and uses the PE-98A dynamotor.

This set, consisting of an automatically-tuned, four-channel, crystal-controlled transmitter-receiver, operates in the range of 100 to 156 Mc. The frequency channels are determined by the four sets of crystals used. This frequency range covers many of the important services including airport control, police, railroad, air navigation aids, facsimile, urban telephone, and of course the 144 to 148 Mc. amateur band.

The complete SCR-522 Radio Set consists of the following components:

Transmitter	BC-625
Receiver	BC-624
Dynamotor Unit	PE-94A
Rack	FT-224
Case	CS-80
Control Box	BC-602
Jack Boxes (for crew interphone)	BC-629, BC-630, and BC-631

The conversion of the SCR-522 for amateur use involves the two basic components, the transmitter, BC-625, and the receiver, BC-624. These will be discussed separately since it is generally preferable to use them as separate units for stationary operation. For mobile operation, the units may be replaced in their original case and operated from the original dynamotor, PE-94A.

Transmitter, BC-625:

The conversion and modification of the BC-625 is discussed under the following section headings:

(a) General Description and Operation
(b) Circuit Changes
(c) Power Supply
(d) Mechanical Modifications

(a) General Description and Operation:

This transmitter with only slight modification makes an excellent low-power transmitter for either stationary or mobile use. With the recommended power supply, it will deliver 12 to 15 watts to the antenna; or it may be successfully used to drive a large power amplifier on 144 Mc. where higher power is desired.

The transmitter tube complement consists of seven tubes, three of which comprise the modulator, and four in the RF section.

Beginning with the RF section, VT-198A (6G6-G) is a modified Pierce crystal oscillator which doubles its frequency in the plate circuit. For operation in the 144-148 Mc. range, it is necessary to use a crystal frequency in the range of 8.0 to 8.255 Mc.; the power amplifier output is the 18th harmonic of the crystal frequency.

The plate output of the crystal oscillator, which is at 16 Mc., is tripled in the next stage to 48 Mc. This stage is the VT-134 (12A6) and drives the third stage, VT-118 (832), which also is a tripler. This brings the frequency up to the final frequency of 144 Mc. The output of the second tripler is coupled into the final with the hair-pin type of tank tuned with a split-stator butterfly capacitor. The final power amplifier VT-118 (832) operates as a straight amplifier and is coupled to the antenna through a variable swinging link.

It will be noted upon inspection that all coils are of the silver-plated type. Another point worthy of mention, is that the antenna loading can be anything between 20 and 500 ohms. However, it will be most convenient to use 52 ohm coaxial cable which matches the receiver input impedance and which also is the most readily available on the surplus market.

In some models of the SCR-522, a VT-199 (6SS7) stage is used as an RF indicator. This stage is connected as a diode and coupled with a pick-up loop into the final tank circuit.

The modulator section of the transmitter consists of a speech amplifier, VT-199 (6SS7), which is driven by a carbon mike through the input transformer 158. This stage also acts as an audio oscillator when tone modulation is used. The speech amplifier in turn drives the push-pull modulators, VT-134's (12A6's), which modulate the plate and screen of the final RF amplifier and the screen of the driver stage through the modulation transformer 160.

(b) Circuit Changes:

Voice modulation with the existing modulator is accomplished with a single or double button carbon mike through input transformer 158. If a single button mike is used, only half of the transformer primary is used with the center-tap grounded as shown in fig. 1. If a crystal mike is considered, it will be necessary to add an additional pre-amplifier to the modulator input. This can be a conventional voltage amplifier using a high mu triode with a 12-volt heater such as the 12F5. An alternative approach is using the unnecessary RF indicator stage VT-199 (6SS7) rewired in the conventional manner as the pre-amplifier stage.

The T-17, which is readily available on the surplus market, will operate very satisfactorily with the transmitter as a carbon mike.

If modulated c-w operation is desired, in addition to voice, it can be easily obtained by keying the cathode circuit of the speech amplifier, 6SS7

(VT-199), when it operates as an audio oscillator. This is conveniently done by inserting a normally-closed-circuit keying jack in the cathode circuit as shown in fig. 1. It is also necessary to install a double-throw single-pole switch in the grid circuit of the 6SS7. This switch changes the operation of the normal speech amplifier to an audio oscillator, thus giving the audio tone necessary for ICW. This switch as shown in fig. 1 merely replaces the grid circuit contacts that formerly existed on relay No. 131.

Since the mechanical tuning arrangement is removed from the transmitter and discarded as discussed in section (d), it is necessary to provide a crystal selector switch in order to utilize the different crystals. This is accomplished by a four-position single-pole switch as shown in fig. 1. The switch is physically located on the front panel as shown in the panel layout, fig. 2.

To facilitate tuning and operation, it is necessary to meter the plate and grid circuits in the conventional manner. This was accomplished by a switching arrangement and metering leads which were brought out to jacks for a separate external meter. As shown in fig. 2, a O-1 d-c milliammeter can be mounted on the panel with the metering leads run directly to the meter. The selector switch shaft is then extended and controlled from the panel.

Since metering is practically a necessity for tuning up a transmitter, the added meter is a worth-while addition that will complete and dress-up the appearance of the converted transmitter.

After the BC-625 is converted and connected to the power supply, described in section (c), it can be tuned up on the 144 Mc band in the conventional manner. The following chart gives the resonant conditions of the different stages, using the O-1 milliammeter in the respective circuit positions as selected by the metering selector switch:

Sw. Pos.	Circuit	Normal Meter Reading	Actual Current (ma)	Full Scale Represents
No. 1	1st freq. mult. plate	0.4	40	50
No. 2	2nd freq. mult. plate	0.5	50	100
No. 3	PA plate *	0.6 - 0.7	60-70	100
No. 4	Not used **			
No. 5	PA grid	0.5 - 1.0	1.0 - 2.0	2
No. 6	OFF (open position)			

* Adjust antenna loading.

** Used on some models in conjunction with RF indicator, full scale represents 1 ma.

The above data are the approximate values that can be expected when using a plate supply of 300 volts at approximately 260 ma. This represents approximately 20 watts input to the final which under normal conditions should give about 12 watts to the antenna.

(c) Power Supply:

The power supply required to operate the BC-625 has to supply 12 volts at 2.4 amperes for the heaters, and to supply a plate load of 260 ma. at 300 volts. A fixed negative bias of 150 volts is also required.

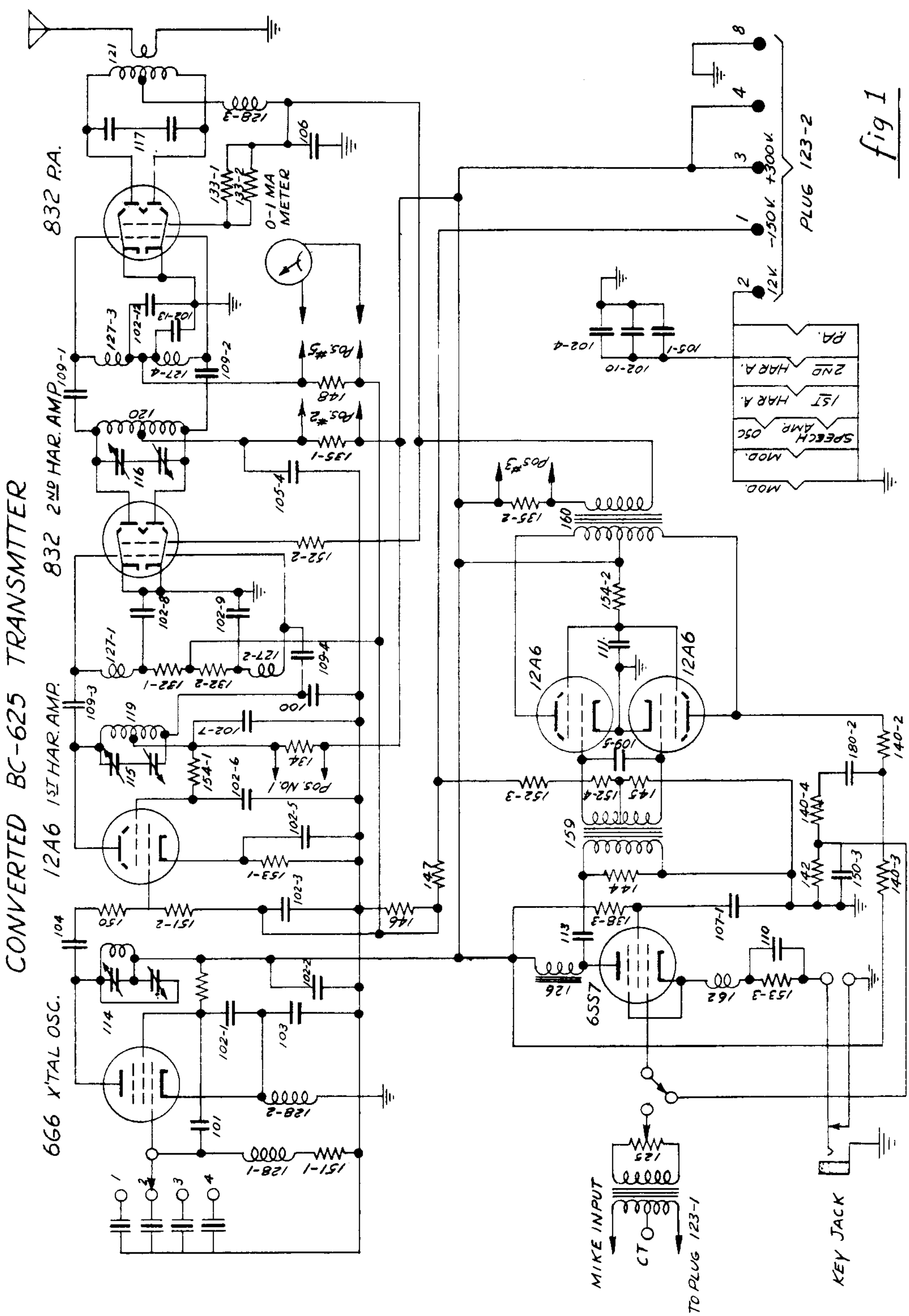
The easiest method for obtaining the bias voltage is from the bleeder which is tapped at ground thus giving the required bias voltage below ground potential. If this method is not convenient, the bias may be obtained from a battery source since the current drain is very low.

A power supply designed to meet the above requirements is shown complete in fig. 3, and should be self-explanatory. It will be noted that the recommended rectifier tube operates very near its upper limit; however for normal transmitter use, it will operate very satisfactorily.

(d) Mechanical Modifications:

The mechanical modifications primarily pertain to the added panel with its associated controls as shown in fig. 2. In order to add the necessary tuning controls, it is necessary to disconnect the tuning capacitor shafts from the ratchet tuning mechanism. It is not necessary to remove the ratchet assembly itself since the shaft extensions extend through this assembly.

The panel used is of standard relay rack dimensions and is mounted to the transmitter chassis with 3 inch brackets. It carries all of the designated controls as well as the O-1 milliammeter.


CONVERTED BC-625 TRANSMITTER
6G6 X'TAL OSC.
12A6 1ST HAR. AMP.
832 2ND HAR. AMP.
832 P.A.
0-1 MA METER
12A6
12A6
6SS7
PLUG 123-2
12V.
-150V.
+300V.
MOD.
SPEECH AMP. OSC.
1ST HAR. A.
2ND HAR. A.
P.A.
MIKE INPUT
CT
TO PLUG 123-1
KEY JACK
fig 1

BC-625 PANEL LAYOUT

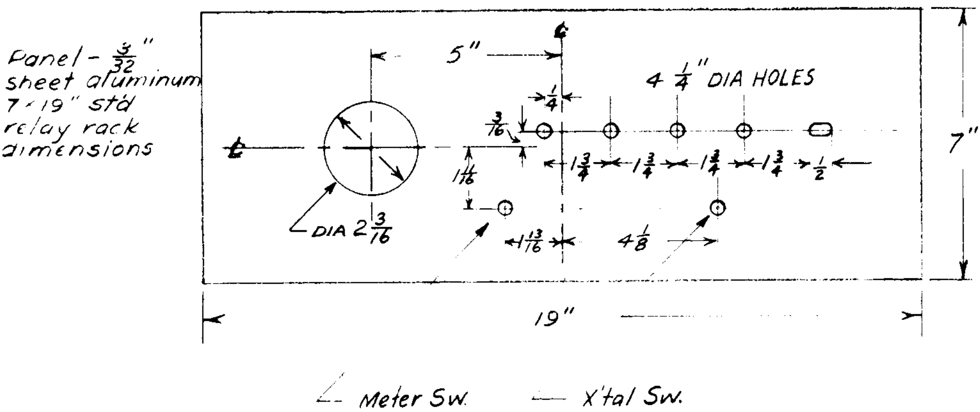
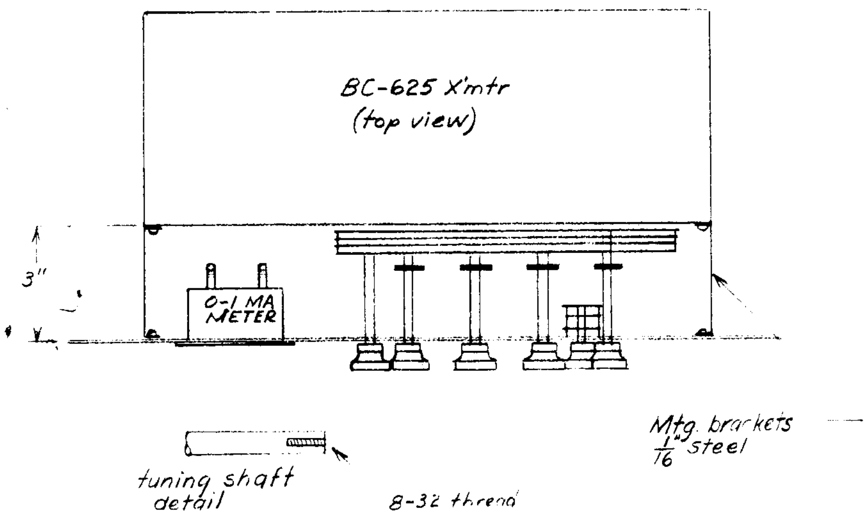
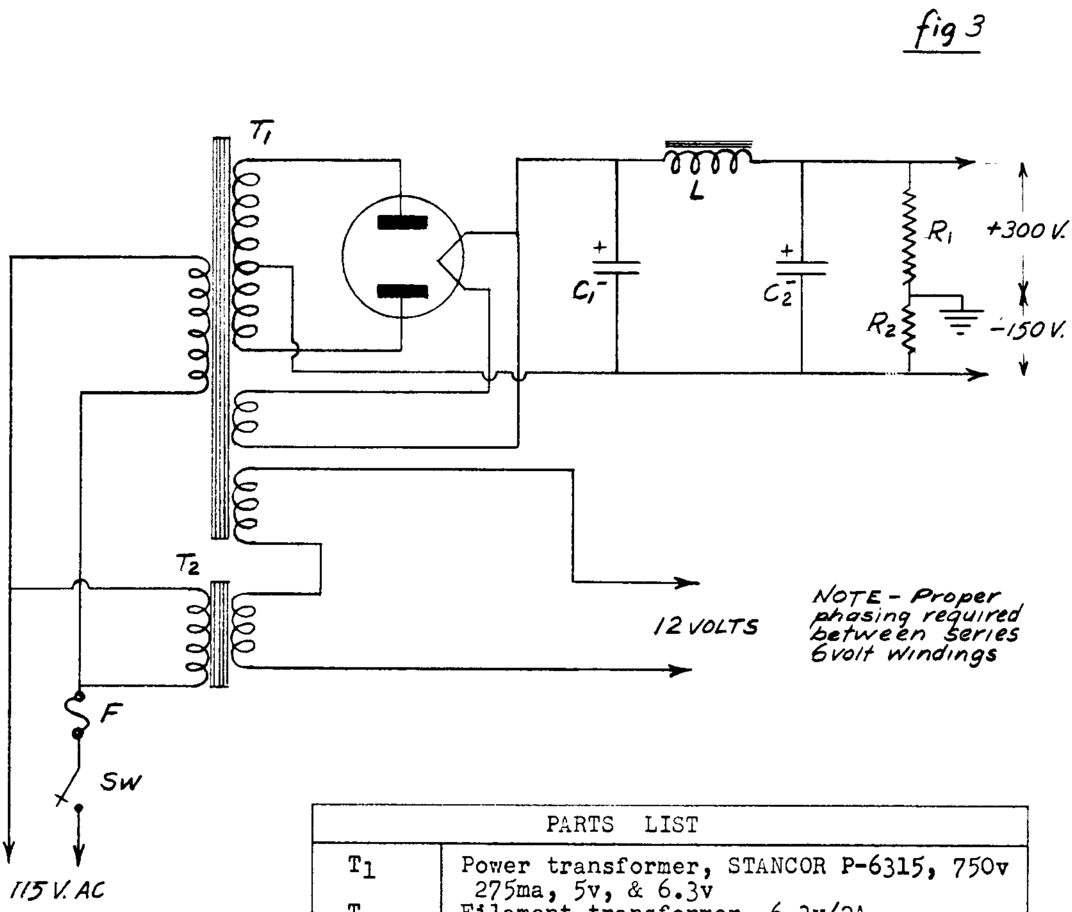


fig 2



POWER SUPPLY FOR BC-625



PARTS LIST	
T_1	Power transformer, STANCOR P-6315, 750v 275ma, 5v, & 6.3v
T_2	Filament transformer, 6.3v/2A
Rect.	5Z3 or 5U4
L	Filter Choke, 10 h., 250 ma.
C_1	Filter Condenser, 8 mfd, 600 v.
C_2	Filter Condenser, 16 mfd, 600 v.
R_1	Resistor, 35,000 ohms, 10 watt.
R_2	Resistor, 750 ohms, 5 watt.
F	Fuse, 2 amp.
Sw	Switch, toggle

Receiver, BC-624:

As the receiver component of the SCR-522, the BC-624 lends itself nicely to conversion for the two meter enthusiasts.

From the general description it becomes apparent that there is more required in converting the BC-624 than its companion component, the BC-625 transmitter. Even though the conversion appears difficult, it is generally considered a rather easy and interesting one to the average ham.

It will also be apparent that some of the described refinements are optional and not essential for putting the set into operation. However, in most instances, these optional features are incorporated as well as a number of the personal touches. This is not out of line in doing justice to a well designed receiver such as the BC-624 which will perform with best of them.

The following topics of conversion will be discussed in detail with references to the schematic diagrams and drawings:

(a) General Description and Operation
(b) The HF Oscillator Circuit
(c) Revamping the Second Detector and Adding the Noise Limiter
(d) The First Audio and Addition of the "S"-Meter
(e) Adding the Second Audio, Power Amplifier Stage
(f) Power Supply for the BC-624
(g) Tuning Mechanism
(h) Mechanical Modifications and Panel Layout
(i) Performance Information

(a) General Description and Operation

This receiver is a 10-tube superhet with an intermediate frequency of 12 Mc. In its military form it is a 4-channel receiver which has a preset tuning arrangement and a crystal-controlled high-frequency oscillator.

The three principal models of the BC-624 are the BC-624A, the BC-624AM, and the BC-624C. The "A" model is the earlier model with the "AM" being the modified "A" model. This modification was the military improvement and consisted of an additional tube (12H6) installed under the chassis which functioned as a noise limiter and delayed AVC. The latest model is the "C", which incorporates several modifications over the earlier sets. These changes consist of an added "squelch" circuit and an extra audio stage.

From the above information, it is apparent that the later models are the preferable ones since the addition of the noise limiter and AVC is an important improvement toward the receiver's operation. This modification was later made by the Army on almost all of the earlier sets.

The existing tube line-up with their respective functions are as follows:

9003 (VT-203) First RF Amplifier
9003 (VT-203) Mixer (first detector)
12AH7GT (VT-207) Crystal Osc. and Audio Squelch

9002	(VT-202)	Harmonic Generator
9003	(VT-203)	Harmonic Amplifier
12SG7	(VT-209)	First IF Amplifier
12SG7	(VT-209)	Second IF Amplifier
12SG7	(VT-209)	Third IF Amplifier
12C8	(VT-169)	Second Det., AVC, and First Audio
12J5	(VT-135)	Second Audio Amplifier

(b) The HF Oscillator Circuit:

The existing crystal oscillator operates on four preset crystal frequencies in the range of 8.0 to 8.7 Mc. The harmonic generator selects the desired harmonic, (11th to the 18th) while the harmonic amplifier amplifies the relatively weak harmonic frequency to usable strength for the mixer stage.

To obtain continuous coverage of the band, it is obvious that the oscillator must be changed from the crystal controlled type to the variable tuned type. This is accomplished by eliminating the existing crystal oscillator stage and converting the harmonic generator to the variable-tuned HF oscillator. This becomes an easy matter since the harmonic generator tuning capacitor, 217B now becomes the new oscillator tuning capacitor.

All four crystal circuits and the former oscillator circuit are eliminated in this change and can be removed to provide additional space. The circuit modification is self-explanatory from the before and after circuit diagrams in fig. 4* and fig. 5 respectively.

For the required mechanical tuning arrangement of the oscillator, refer to section (g).

(c) Revamping the Second Detector and Adding the Noise Limiter:

As mentioned before, the later models of the BC-624 have the modification that incorporates the 12H6 (duo-diode) as the Second detector and the noise limiter. This stage is mounted on a bracket under the chassis. To add this modification to the earlier models, should it be necessary, it should be noted that the 12H6 replaces the original 12C8 tube. From the modified schematic diagram, one half of the 12H6 serves as the detector and also furnishes AVC voltage in the conventional manner. The other half of the duo-diode serves as the noise limiter with its respective circuit and may be manually switched in or out. This stage should be wired as per the modified circuit as shown in fig. 5.

(d) The First Audio and Addition of the "S"-Meter:

The former 12C8 tube location is used for the 12AH7, dual triode, one section of which serves as the first audio amplifier. This stage is coupled to the second detector output in the conventional manner through a .5-meg. volume control.

An optional feature which is frequently added to facilitate tuning and to estimate signal strength, is the "S"-Meter. The circuit includes a 0-1 milliampere meter which can be attractively added to the panel of the

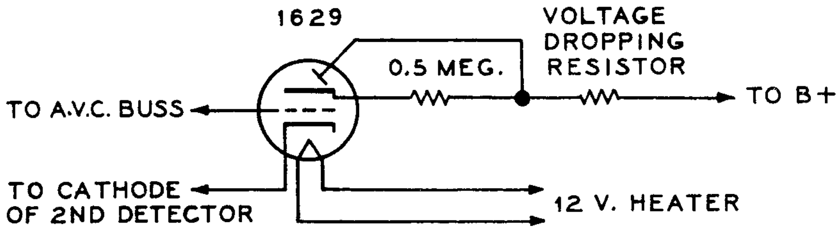
*For Fig. 4 - see pg. 66.

receiver as shown in the panel layout. This "S"-Meter differs from the more conventional type since it utilizes the AVC voltage for its operation. The AVC voltage controls the meter bridge circuit through the triode amplifier, 12AH7 (second section). For manual adjustment of the meter deflection, a 0.25-meg. potentiometer in the 12AH7's grid circuit is used to obtain the proper amount of the AVC voltage. A switch is provided in this circuit for switching the "S"-Meter in or out as desired.

Another version of the above described "S"-Meter circuit incorporates the tuning-eye instead of the 0-1 millampere meter and the meter bridge circuit. This is primarily a tuning indicator and involves fewer parts and less expense if parts have to be purchased.

The 12-volt version of the 6E5 (magic eye tube) is the 1629 (VT-138) and is readily obtainable on the surplus market. It can be conveniently mounted at the rear of the receiver panel projecting through the panel in the approximate location shown for the meter in fig. 6.

Operation of the tuning-eye is directly controlled by the AVC voltage; however, due to the relatively low AVC voltage, the circuit shown below is recommended for optimum operation.



(e) Adding the Second Audio, Power Amplifier Stage:

In order to obtain sufficient audio volume for speaker operation, the power output stage, 12A6, is added with the conventional plate-to-voice-coil output transformer. In the later models this stage would replace the existing second audio stage, (12J5). In the earlier models this stage can be located in place of the squelch transformer 295. The "squelch" circuit is generally not considered practical and is completely removed from the receiver to make room for added modifications.

The audio power amplifier is coupled to the first audio amplifier (12AH7) in the normal R-C manner. Output transformer, 296, intended for headphone use (50, 300, and 4000 ohms) is replaced with a conventional plate-to-voice-coil output transformer. The impedance match for the 12A6 from the PM speaker voice coil should be approximately 7500 ohms.

It may be desired to add a closed circuit jack in the grid circuit of the power amplifier, 12A6, for headphone operation. Both jacks, first audio phones and second audio speaker, can be brought out to the panel of the receiver as shown in the panel layout.

(f) Power Supply for the BC-624:

The power requirements for this receiver are a plate potential of 300 volts at 60 ma., and a 12-volt heater supply at approximately 1.7 amperes. A power supply for these requirements can be conveniently constructed as shown in fig. 5. A 70-ma. power transformer is used with the 5 and 6 volt windings connected in series, and using the 6X5 (cathode type) rectifier. Polarity of the two filament windings must be observed in order to avoid phase cancellation. This can be determined by experiment so as to obtain the correct additive voltage. The conventional filter is used with a stand-by switch placed in the center tap lead for use with the transmitter.

Even though it is possible to build the power supply inside the receiver with careful layout of parts, it is considered preferable to keep it as a separate component with a connecting cable and plug to the receiver. If desired, the power supply OFF-ON switch may be located on the receiver panel with the leads brought out to the above mentioned power supply connecting plug.

(g) Tuning Mechanism:

The manual tuning capacitor controls of the converted receiver involve the two-ganged capacitor which tunes the oscillator and the harmonic amplifier, and the three-ganged, RF amplifier grid, the RF amplifier plate, and Mixer grid tuning capacitor.

The original preset ratchet selector and tuning mechanism is not particularly adaptable for ham operation and should be completely removed from the receiver chassis. This then makes available both shafts of the above mentioned tuning capacitors.

Due to the highly compressed 2-Meter band, as appearing on the capacitor shafts, it is quite necessary to use considerable mechanical reduction for manual tuning. This is particularly true for the oscillator tuning, since the band appears in a very narrow sector of its 90 degree rotation.

For the three-ganged capacitor, the National velvet vernier dial, such as found in the surplus BC-375 tuning units, is quite satisfactory. This type of dial is quite compact and easy to use, being well appearing on the receiver panel.

Due to the very narrow section in the oscillator tuning, it is apparent that even the National vernier dial is not sufficient reduction to afford practical tuning or dial calibration. For this problem there has appeared a variety of tuning arrangements that include both the electrical band spread method as well as the various mechanical methods.

The electrical method is probably the most desirable but does involve considerable effort for installation. This is generally accomplished by using a separate two-ganged condenser having only two or three plates per section, and connecting it in parallel with the existing condenser.

Of the different mechanical reduction arrangements, this one as described below, is probably the most straight forward and fool-proof. It consists of the national, type "A", vernier dial used in conjunction with a belt (dial cord) driven reduction. The dial cord and pulley arrangement is supported between a frame-work consisting of two metal plates. This assembly is mounted directly on the receiver chassis, positioned to couple the drum to the oscillator capacitor shaft and to locate the tuning knob in a symmetrical position on the panel. The drawing in fig. 2 shows this assembly in detail.

The described tuning assembly gives very satisfactory and smooth tuning reduction. This reduction will be such that the 144-Mc. band will be approximately 50 divisions on the 100 division vernier dial. Parts for the dial cord and pulley arrangement are easily made or readily available.

(h) Mechanical Modifications and Panel Layout:

After the removal of the slider-ratchet tuning mechanism from the front of the receiver, brackets are made to support the panel approximately 3 inches from the front of the receiver. The 3-inch space between the panel and chassis is ample for the tuning reduction assembly and all of the other controls.

If all the modifications listed herein are contemplated, the front panel will carry the two National dials, the "S"-Meter or tuning indicator, volume control, AVC switch, send-receive switch, "S"-Meter" switch (if used) noise limiter switch, and the power OFF-ON switch.

(i) Performance Information:

As was originally true in the military version of the BC-624, the converted receiver should have a signal sensitivity of approximately 3 microvolts for an audio signal to noise ratio of 10 db.

The receiver input is designed to operate from a 50-ohm antenna circuit. Should higher impedance lines be used, it will be necessary to increase the number of turns on the antenna coupling coil. The increase of turns is small, being approximately 2-1/2 turns (total) required for a 600-ohm line.

Should a balanced antenna input be desired, the grounded side of the coupling coil should be lifted.

It will be found that the modified high-frequency oscillator can be tuned either 12 Mc above or below the incoming signal. After becoming experienced with the tuning characteristics of the receiver, the operator should be able to use the preferable frequency (above or below) without difficulty.

An interesting note in connection with the exceptional oscillator tuning range is, that by squeezing the RF and mixer coils slightly, the receiver will tune down to the 88-108 Mc. FM band. By utilizing the above and below tuning of the oscillator, as mentioned above, the FM band can be covered without sacrificing any of the 144-Mc. band, thus a total coverage from 88 to 148 Mc. Since the IF band pass is approximately 150kc., it can be made to operate nicely on FM by incorporating a limiter and discriminator circuit.

From the above information, the 2-meter enthusiast should be able to have, at a very nominal cost, a smooth operating and attractive receiver. The performance of this unit will be found to compare favorably with the best receivers of this type.

BC-624 (converted)

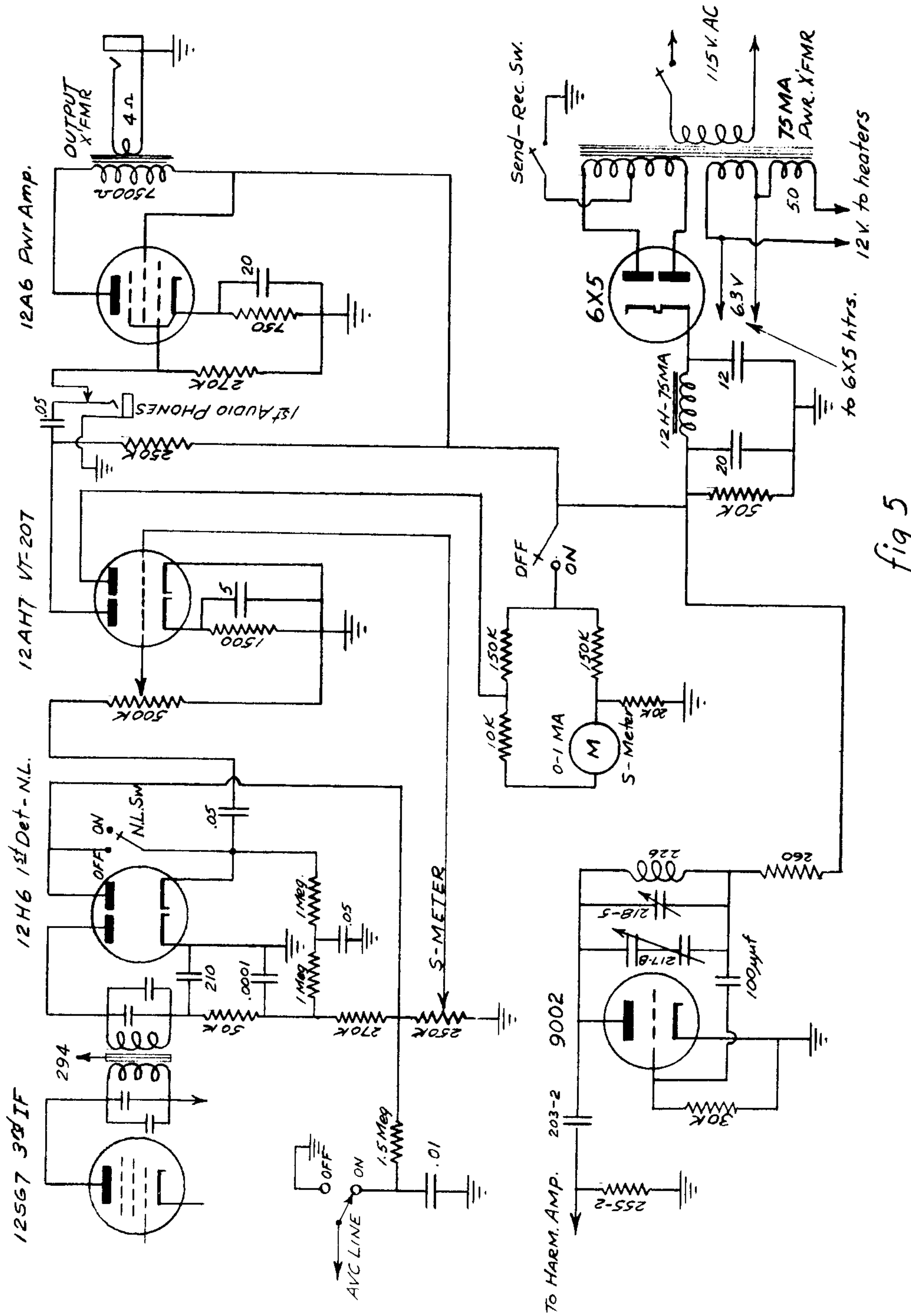


fig 5

PANEL & MECHANICAL LAYOUT FOR BC-624

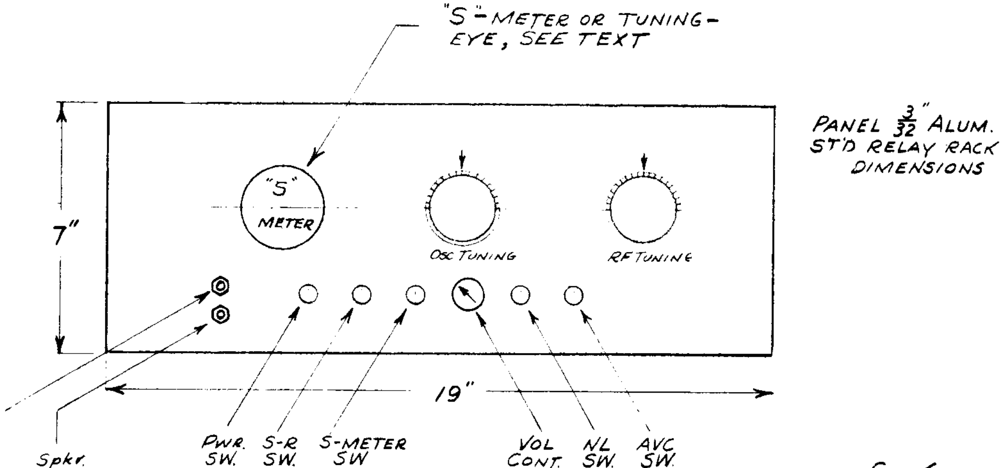
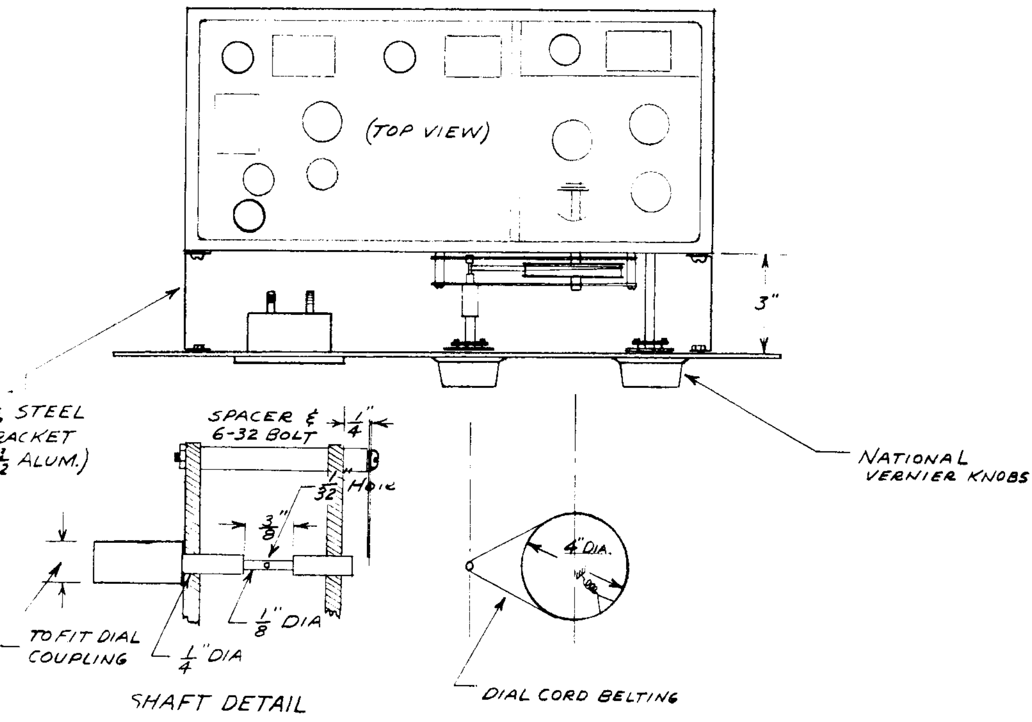
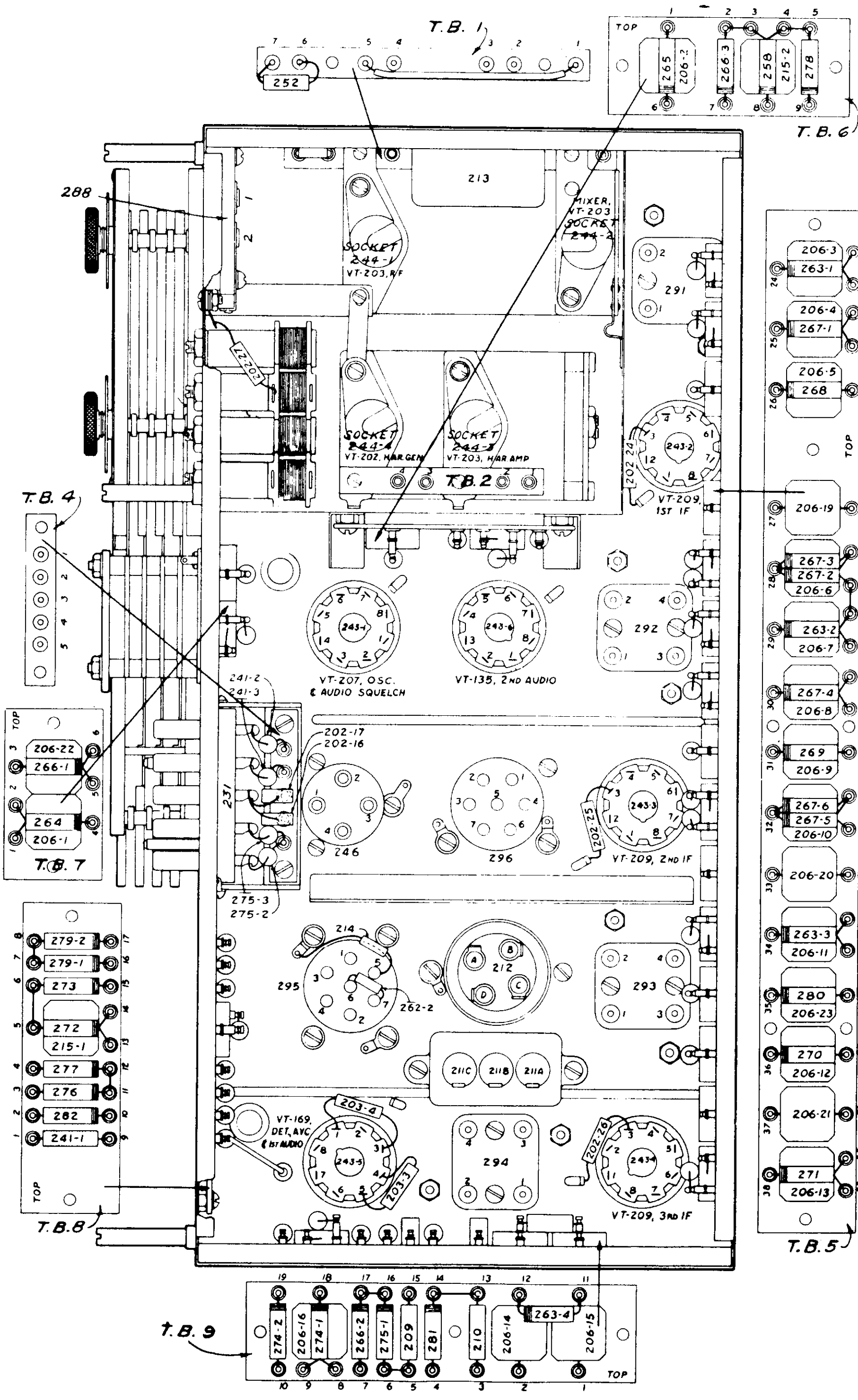
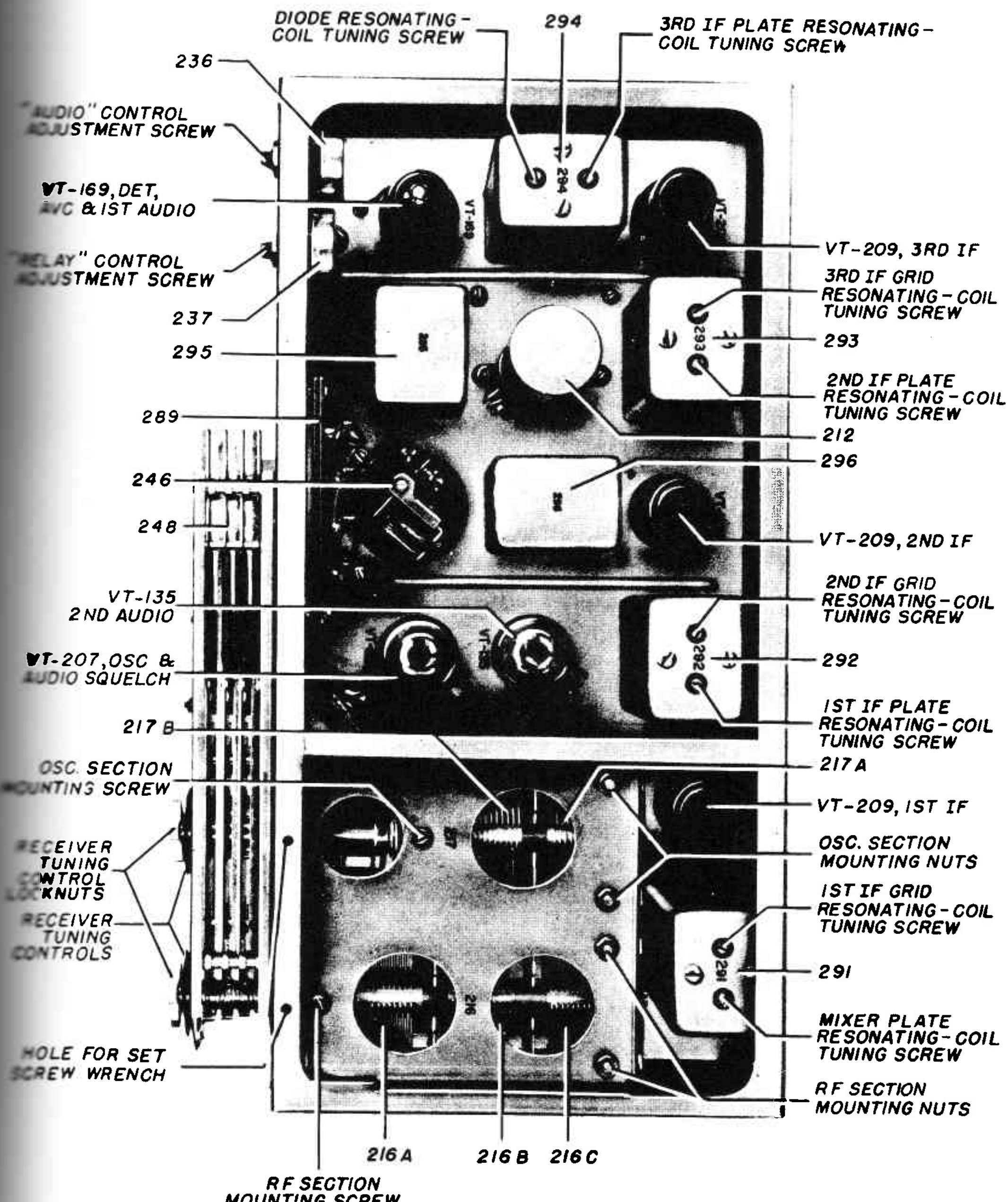


fig 6





RECEIVER CONTINUITY TEST DIAGRAM



RADIO RECEIVER BC-624-A, REAR VIEW

CONVERTING THE TBY TRANSCEIVER FOR CRYSTAL CONTROLLED OPERATION ON THE 10 AND 6 METER AMATEUR BANDS

Introduction:

The model TBY transmitter receiver was designed for the US Navy's landing operations. It is an ultra-portable unit, weighing less than 50 pounds complete and comes equipped with a canvas carrying case that may be strapped to the back if desired.

The unit is excellent for mobile or portable operation and has a nominal power output of 1/2 watt.

The frequency range is from 28 to 80 Mc. and, as originally used, was continuously variable over this range. However, the frequency stability, along with the fact that the tuning dials are not calibrated directly in frequency, makes it necessary to convert the unit to a crystal-controlled circuit.

The unit was built to operate from either a special battery pack or a combination vibrator-storage battery pack which clips onto the bottom of the Transmitter/Receiver unit. The special pack of batteries is not available (at least not with fresh batteries) leaving the vibrator pack for practical use. This supply consists of a 4-volt leak proof storage battery and a vibrator unit supplying 2.35, 3.3, 4.2, 8.6, and 158 volts. The storage battery will last about 15 hours and can be recharged from any standard 6 volt charger or from a car battery.

Upon purchase of the unit, the following accessories should be obtained:

1. Combination vibrator-storage battery pack
2. Whip Antenna (9 ft)
3. Mike and Phones plus cables

The original tube line up is as follows:

	(2)	958A's	--	PP self excited oscillator
Transmitter	(1)	30	--	Tone generator
	(1)	1E7	--	PP modulators
	(1)	959	--	RF stage
Receiver	(1)	958A	--	Super Regenerative Detector
	(1)	30	--	1st audio (Same tube acts as tone generator in xmtr.)
	(1)	1E7	--	PP audio (Same tube acts as modulator in xmttr.)

Crystal Calibrator (1) 30

Spare tubes usually come with the set, and a complete set of accessories will come in handy if available.

Conversion Procedure:

The actual conversion is quite simple. Only one change need be made in the circuit, but two additional tubes must be added as a crystal controlled oscillator and buffer. The one change necessary is that of lifting the grid leads of the two push-pull 958A tubes in the transmitter circuit from the turret coil assembly and running these leads out to the added stages.

The added stage consists of a 1S4 crystal oscillator and a 958A buffer. To provide space for these circuits, the tube type 30 (directly behind the meter) is removed. This tube originally acted as a crystal calibrator and will not be needed now.

The 1S4 crystal stage can be built on a small piece of bakelite and mounted in the space made available by removing the 30 tube. The 958A buffer can be mounted on an insulated plate alongside the detector shield can. The smallest components possible should be used, as space is at a premium, but the construction can be accomplished by careful planning and a little ingenuity.

The circuits in Fig. 1 and 2 are self-explanatory, and only the dotted components need be added. The crystal for the oscillator should be in the range of 7125-7425 kc. for the 10-meter phone band, and in the range 8333 -9000 kc. for the 6-meter band.

The complete schematic is also included with this article for information.

The coil data is as follows (per Fig. 2):

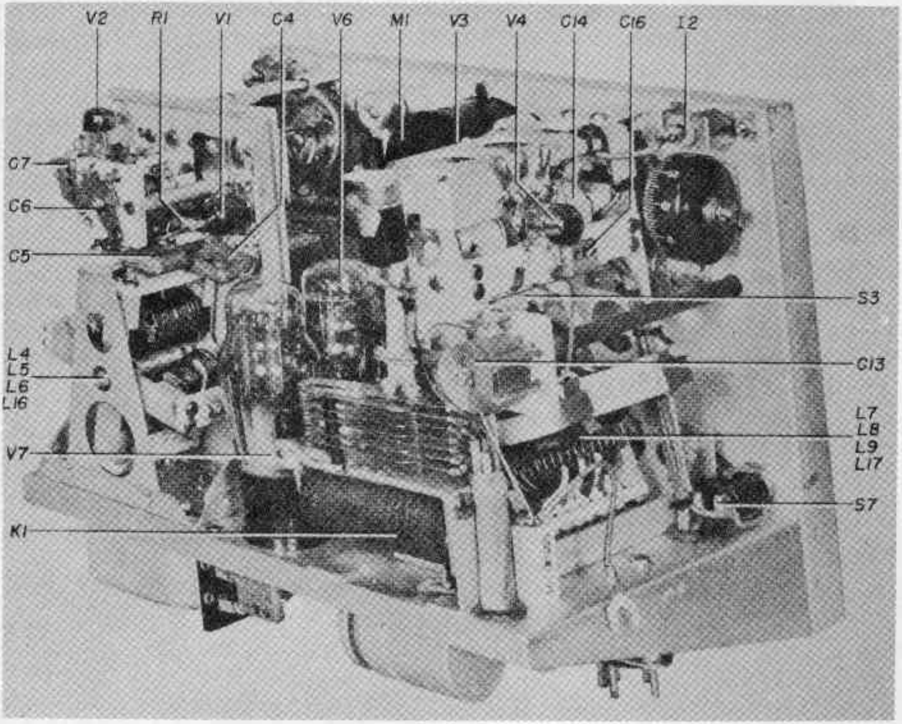
L1 (28 Mc.)	--	14 turns of #16 enameled 5/8" inside diameter, air wd.
L1 (50 Mc.)	--	6 turns of #16 enameled 5/8" inside diameter 1" long
L2	--	14 turns #16 enameled, close wound on 1" form
L3, L4	--	8 turns each of #20 DCC and the two wound side by side on 1" form.

Note: C6 need not be touched after initial adjustment (not critical).

Operation:

The meter indicates either filament voltage or plate current, depending upon the switch position. Originally, the unit was designed so that both these readings were normal when the meter read mid-scale. However, with the additional stages (1S4 and 958A) the readings will be higher than midscale and should read about 3/4 scale on plate current. Adjust the volume of the receiver to mid position and advance the regeneration control until a definite rushing or hissing sound is heard. Adjust the REC ANT tuning to resonance and when a signal is heard, readjust the REGN control to a point just above where the rushing sound starts. The transmitter is tuned as any conventional one, and now that the OSC is crystal controlled, a pronounced dip in plate current will indicate resonance on the meter. This should occur about 3/4 up the meter scale.

Although the power output is low, this unit will surprise you and is well worth the cost.


V2
R1
V1
C4
V6
M1
V3
V4
C14
C16
I2
C7
C6
C5
S3
C13
L4
L5
L6
L16
L7
L8
L9
L17
V7
S7
K1

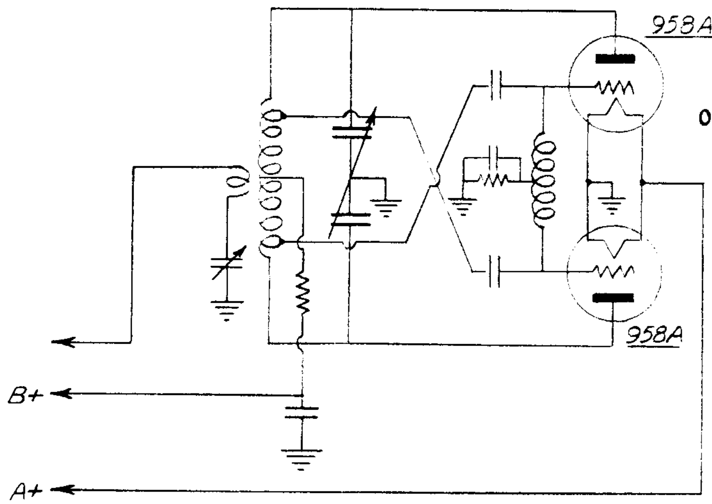


fig 1

ORIGINAL TRANSMITTER SECTION

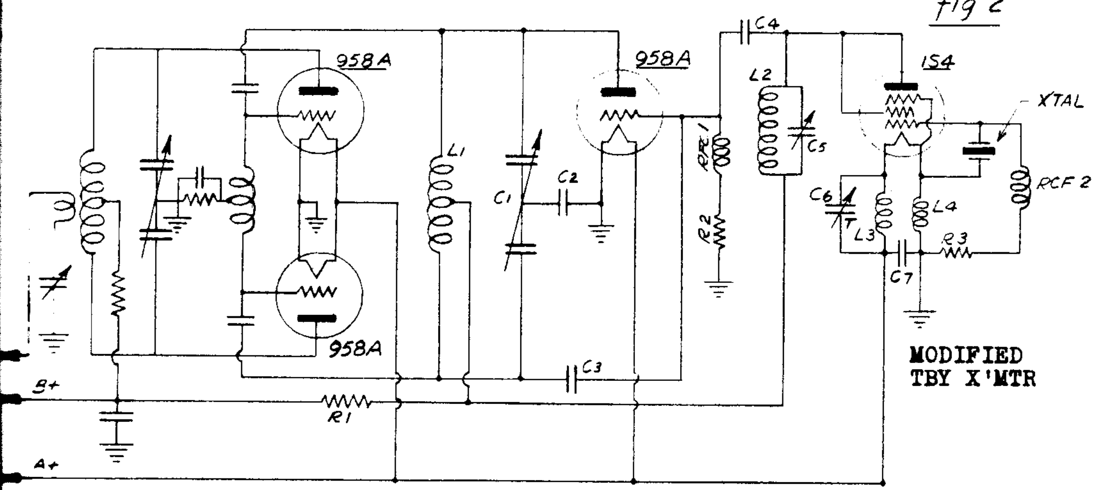
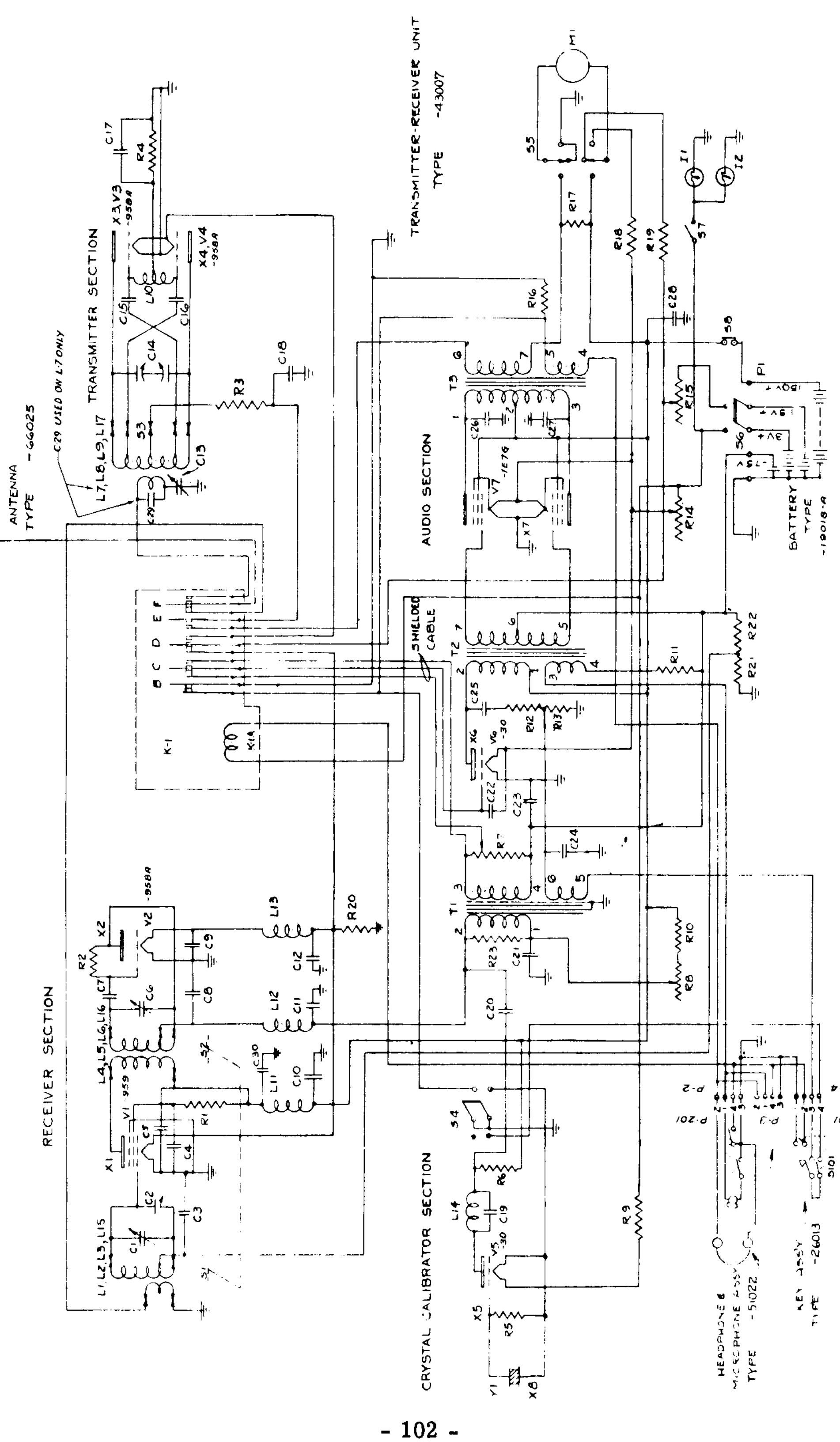


fig 2

MODIFIED TBY X'MTR

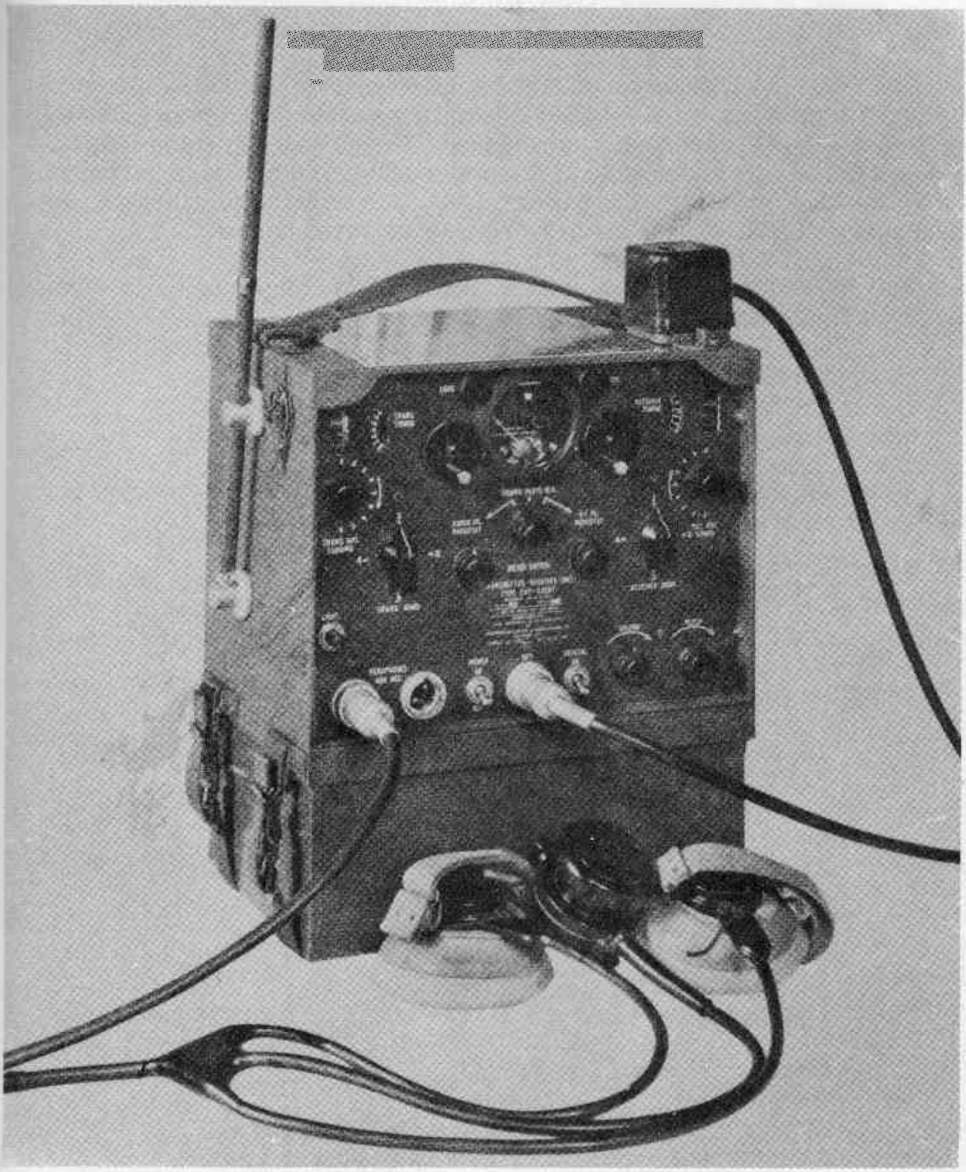
PARTS LIST FOR ADDED STAGES

R-1 - 10,000 ohm, ½ w
R-2 - 150,000 ohm, ½ w
R-3 - 100,000 ohm, ½ w
C-1 - 25 mmfd (each sec) variable
C-2 - .002 mfd, mica
C-3 - 2 mmfd, mica
C-4, C-7 - .001 midget mica
C-5 - 100 mmfd, midget var.
C-6 - 100 mmfd, trimmer
L-1, L-2, L-3, L-4 See text
RFC-1, RFC-2 - 2.5 mh. RF chokes
Crystal - See Text



TBY SCHEMATIC

FIG 3



TBY TRANSCEIVER

PE-103A DYNAMOTOR

The PE-103A Dynamotor will deliver 160 ma. at 500 volts from either a 6 or 12 volt battery. The battery drain when used on a 6-volt battery is approximately 22 amps and when used on a 12-volt battery is approximately 11 amps. (This assumes that the full load of 160 ma. is being drawn.) Under no-load conditions the battery drain is approximately 5 amps. Actually the unit will deliver much more than its rated current.

The lower housing of the unit contains filter components and circuit breakers for overload protection as follows:

Right	40 Amps	(Dynamo primary overload)
Center	.22 Amps	(High-voltage overload)
Left	7.5 Amps	(Control and filament overload)

A switch located on top of the housing under a protective cap can be set for either 6 or 12 volt operation.

When used on a 6-volt battery, the green-white wire from the rotary switch "3-S-1" should be removed to prevent a small drain when the unit is not in operation. (This lead is in a relay circuit for the 12-volt section.)

The pin connections are as follows:

1- Not used.
2- Not used.
3- Negative 6 volts through relay.
4- Start coil.
5- Common, positive 6 volts and negative 500 volts.
6- Not used.
7- Negative 6 volts.
8- Positive 500 volts.

For typical operation using a 6-volt battery with positive gnd:

Connect terminal 5 to ground.
Turn switch on top to 6-volt position.
Start dynamo by connecting terminal 4 to ground.
A minus will appear at terminal 3 (A plus is ground).
B plus will appear at terminal 8 (B minus is ground).

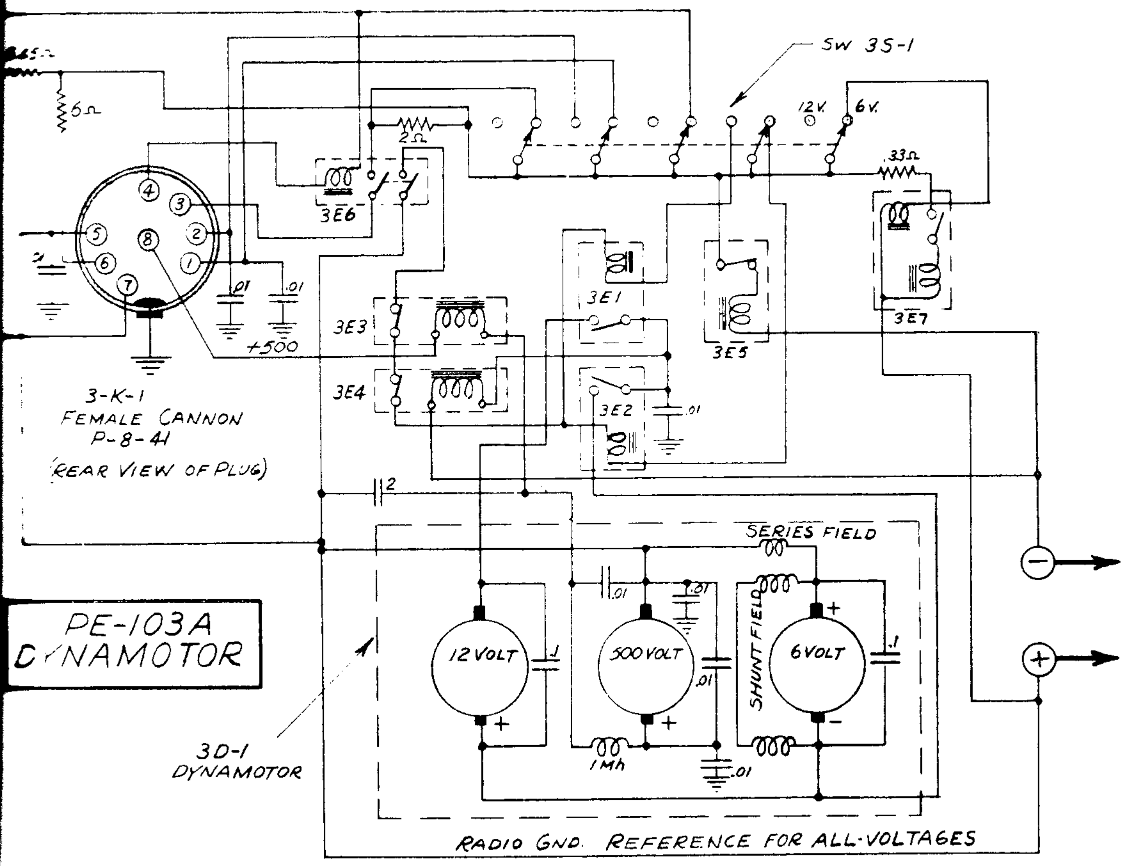
Connections for 255 volts at 80 ma:

By connecting the armature for 12 volts and actually running it on 6 volts, and running the six-volt field directly from the battery, the no-load current is 3 amps. This will give an output of 255 volts at 80 ma., but under loaded conditions the drain is only about 7 amps. This provides excellent efficiency and by throwing the 12v-6v switch, power may be stepped up.

General Notes On Dynamotors:

Dynamotors intended for 12 volts can be operated at 6 volts by connecting the field coils in parallel instead of in series (watch polarity). Under these conditions the output voltage will be cut in half.

Parallel connection for the field coils of 24 volt dynamotors will normally allow operation from 6 volts but with only a quarter of the normal output voltage.



CONVERTING THE 1068A OR 1161A RECEIVER TO 144-148 MC. (2 METERS)

Introduction:

These receivers were designed originally for the US Army and were used as IFF receivers in conjunction with the SCR268-271 series of Radar equipment.

The receiver comes complete in an olive-drab steel case which is approximately 16" x 16" x 10" and weighs about 75 lbs. It contains a built in 110-volt AC power supply and covers the range of 155 to 200 Mc. before conversion.

The IF transformers are normally stagger tuned with the center on 11 Mc., and have a band width of approximately 4 Mc.

The unit contains 14 tubes, used as follows:

6SH7	1st RF Amp.	-no VT No.
6SH7	2nd RF Amp.	-no VT No.
9006	1st Det. (Mod)	-no VT No.
6J5	Osc.	- VT 94
6AC7	1st IF Amp.	-VT 112
6AC7	2nd IF Amp.	-VT 112
6AC7	3rd IF Amp.	-VT 112
6AB7	4th IF Amp.	-VT 176
6AB7	5th IF Amp.	-VT 176
6H6	2nd Det.	-VT 90
6SH7	Video Amp.	-no VT No.
6SN7	Output Amp.	-VT 231
6E5G	Tuning Indicator	-VT 215
5U4G	Rectifier	-VT 244

Conversion Instructions:

The conversion will be discussed under the following headings:

(a) Preliminary Steps
(b) RF Modifications
(c) AF Modifications
(d) IF Modifications
(e) General notes

(a) Preliminary Steps:

The first step necessary in converting the unit for 2 meter operation, is to replace the 3 connectors (123-124-125) on the rear of the chassis with more suitable ones. Connector 123 can be replaced with a female coaxial chassis plug, 124 with any standard AC connector, such as an Amphenol 61-M-10, and 125 can be replaced with a standard phone jack (for the loudspeaker).

The spare-fuse holder and automatic pilot-lamp switch should be removed from the front panel. The wires from the pilot lamps which were removed from the automatic pilot-lamp switch are soldered together and should be connected to the heater circuit. The B plus lead to the tuning indicator tube which was also removed from the switch is soldered to the lead coming from the tuning eye tube.

(b) RF Modifications:

The two RF stages and first detector must be changed to tune the 144-148 Mc. range. This is done by decreasing the spacing between turns on the 3 coils concerned (do not change the oscillator coil). This will increase the inductance and should be sufficient. However, if necessary, small 10-mmfd. trimmers can be shunted across the 3 coils. Be careful so as to not damage the coil windings, and don't allow the turns to touch and short out.

If band-spread tuning is desired on the 2-meter band, a small 2-plate midget variable capacitor may be mounted beneath the chassis near the oscillator coil. The shaft for this capacitor is inserted in the hole provided by removal of the automatic pilot-lamp switch.

(c) AF Modifications:

Replace resistor 67-2 (video amplifier grid resistor) with a 500,000 ohm pot. (arm of pot. goes to grid of the video amplifier). This will allow control of the audio gain. This pot. can be mounted in one of the holes in the front panel. The pot. should be of the type with a switch on the back which is used as the AC switch in place of the present one, which can now be used as a standby switch by placing it in series with the center tap of the HV power transformer winding.

(d) IF Modifications:

A 5000-ohm wire-wound pot. (used as a rheostat) is installed in a spare hole and used as an IF gain control. The center arm is grounded and one side is connected to the "B" wire on plug 125 (see diagram).

(e) General Notes:

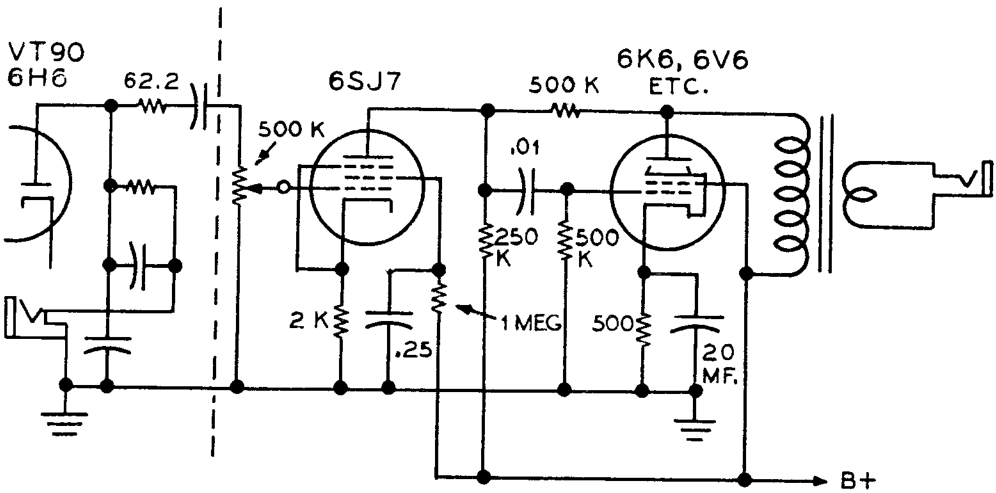
The RF gain can be increased by replacing the RF tubes with the WE717 type and also by replacing the loading resistors across the IF transformer windings (secondary) with 100,000 ohm resistors. This will narrow the IF band pass and increase the gain.

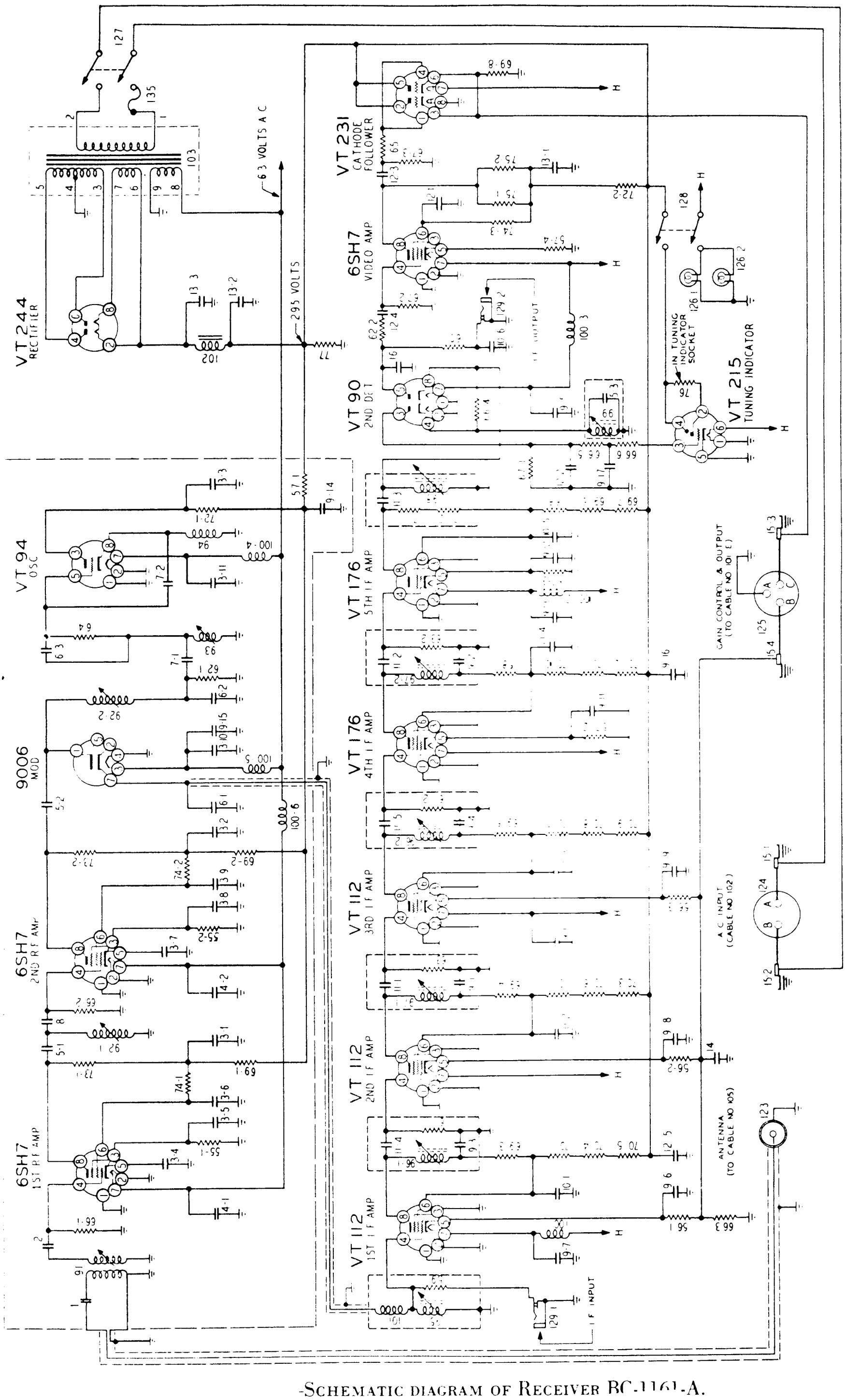
In addition, an S meter (0-1 ma.) can be connected to the phone jack marked "IF amp. out" and calibrated in S units.

The receiver is aligned in the usual manner and can be done on a good local signal.

If the audio gain is not adequate, it may be advisable to replace the 6SN7 output stage with another consisting of a 6SJ7 and 6V6 or 6K6.

Diagram of audio modification. The 6SH7 and 6SN7 (VT231) are eliminated and this circuit inserted in their place.





-Schematic diagram of Receiver BC-1161-A.

BC-1161A RECEIVER(Before conversion)

ADF	Navy receiver, 15 to 1750 kc., in 6 bands, 8 tubes - (3) 6D6, (2) 76, (2) 6C6, (1) 41.
AM-26/21C	Interphone Amplifier containing (2) 12J5, (2) 12A6 tubes, designed for use from 28-volt DC dynamotor.
APA-10	Pan-Oscillo Receiver: is 115vAC operated and contains panoramic adapter with IF of 405-505 kc., 4.75 to 5.75 Mc., and 29 to 31 Mc.
APN-1	Altimeter: 418-462 Mc. Transmitter and Receiver which measures 3 to 4000 feet altitude, weighs 25 lbs. and is 18" x 9" x 7". Designed to operate from 28 volts DC and contains the following tubes: (4) 12SH7, (3) 12SJ7, (2) 12H6, (1) VR 150, (2) 955, (2) 9004.
APN-4	Radar Oscilloscope containing 25 tubes, 18" x 9" x 12", and weighs 50 lbs.
R65/APN-9	Loran Indicator and Receiver containing 35 tubes and 3" scope. 110 volts, 400 cycles.
APQ-9	VHF Radar.
RT34/APS-13	Transmitter and Receiver containing following tubes: (5) 6J6, (9) 6AG5, (1) VR 150, (2) 2D21. 410-420 Mc. 30 Mc. IF Freq.
APS-15	Radar set, 45 tubes, 3 meters, four 115 volt 400 cycle supplies, multivibrators, 5" and 2" scopes.
APT-5	Transmitter - 1500 Mc., uses 115VAC filaments, no plate supply included. (2) 6AC7, (1) 6L6, (2) 829, (1) 931A, (1) 522, (1) 6AG7.
ARB	Navy 4-band receiver, 195 to 9 Mc., uses (1) 12SA7, (4) 12SF7, (1) 12A6, weighs 28 lbs., and is 6" x 7" x 15".
ARC-4	Transmitter and Receiver using 4 crystal channels, in 140 Mc. range for 24 or 12 volt DC operation. Transmitter has 7 tubes. Receiver has 13 tubes.

ARC-5	Navy aircraft equipment:		
	Receivers: 190 to 550 kc. 1.5 to 3 Mc. 3 to 6 Mc. 6 to 9.1 Mc.	Transmitters 500 to 800 kc. 800 to 1300 kc. 1.3 to 2.1 Mc. 3 to 4 Mc. 4 to 5.3 Mc. 5.3 to 7 Mc. 7 to 9.1 Mc. 100 to 156 Mc.	Modulator is MD-7/ARC5 2-1625's

ARC-429 — 2 band receiver, 201 to 400 Kcs and 2500 to 4700 Kcs (aircraft).

ARC-429A — 2 band receiver, 201 to 400 Kcs and 4150 to 7700 Kcs (aircraft).

R-89/ARN-5A — Glide Path Receiver
11 tube superhet on 332 to 335 Mcs
fixed tuning
Glide path receiver
(7) 6AG5
(1) 12SR7
(2) 12SN7
(1) 28D7

Crystal frequencies are:
332.6 Mcs
333.8 "
335.0 "

weighs 12 lbs.
size 13" x 5" x 6"

R-5/ARN-7 — Radio Compass Receiver - covers 200 to 1750 Kcs in 3 bands with 17 tubes.

ART-13, or ATC — Collins Auto tune transmitter: 2 to 18.1 Mcs in 11 channels, weighing 70 lbs. and is 23" x 13" x 11" 150 watts voice, cw or mcw. Uses 813 in final and 811's in PP modulator. v.f.o. and crystal calibrator.

ASB — Radar equipment, 515 Mc.

ATD — Aircraft transmitter - 540 to 9050 Kcs CW or Phone requires 380 volts and 1000 volts DC.

RF osc - 6L6	6SL7 speech	PP 6L6 mod.
RF amp - 814	6L6 driver	Designed for dyna-
Weight 75 lbs.	size 11" x 12" x 21"	motor operation

AVT-112A — Aircraft transmitter - 2500 to 6500 Kcs Phone, operates from 6, 12, or 24 volt source. Has 6 tubes and weighs 6 lbs.

B-19	Mark II Transmitter and receiver covering 40 to 80 meter bands.
BC-191	Same as 375E transmitter except operates on 12 or 14 volts.
BC-221	Frequency meter: Up to 125th harmonic. Basic frequency is 125 to 250 Kcs and 2000 to 4000 Kcs. Better than .005% accurate.
BC-222	Receiver/Transmitter. 28-38 Mcs and 38-52 Mcs. Similar to BC-322.
BC-223AX	Transmitter, covering medium frequencies. Uses 801 Osc, 801 Pa (2) 46 Mod, (1) 46 SP amp. 10 to 30 watts output on tone, voice or CW 4 crystal frequencies and master oscillator on switch. 3 coils, TU 17A 2000 to 3000 Kcs " 18 3000 to 4500 Kcs " 25 3500 to 5250 Kcs Black wrinkle case with 2 separate cases for spare coils.
BC-224	Receiver, 200 to 500 Kcs and 1500 to 18,000 Kcs. Operates from 14 volt dynamotor (identical with BC-348 except for input voltage).
BC-306A	Antenna tuning unit for BC-375 transmitter. Operates from 150 to 800 Kcs.
BC-312	Receiver - 1500 to 18,000 Kcs. Uses 9 tubes with 2 RF stages. (4) 6K7, (1) 6L7, (2) 6C5, (1) 6R7, (1) 6F6.
BC-314	Same as BC-312 except covers 150-1500 Kcs.
BC-322	Receiver/Transmitter 52-65 Mcs.
BC-342	Same as BC-312 except will operate on 115 VAC.
BC-344	Similar to BC-312 except covers 150 to 1500 Kcs and is 115 VAC operated.
BC-348	Receiver - 1500 to 18,000 Kcs and 200 to 500 Kcs. Automatic noise compensator (neon). Output 300 or 4000 ohms. Crystal filter, AVC-MVC-BFO. 1st RF 6K7 2nd RF 6K7 RF Osc 6C5 1st Det 6J7 1st IF 6K7 2nd IF & CW Osc 6F7

	3rd IF & 2nd Det 6B8 Audio 41 Operates from 28 volts DC
BC-357J	Beacon Receiver for 75 Mcs.
BC-375	Transmitter - 150 watts output, 200 to 12000 Kcs (less BC), 211 Osc, 211 RF amp, 10 Speech amp, (2) 211 PP modulators, 5 tuning units as follows: TU 5B 1500 to 3000 Kcs " 6B 3000 to 4500 " " 7B 4500 to 6200 " " 8B 6200 to 7700 " " 10B 10,000 to 12,500 Kcs
BC-403	Radar oscilloscope, 5" scope 115 volt 60 cycles operation, component of SCR-270 and 271.
BC-404	Radar receiver for SCR-270 and 271, 102 to 110 Mcs, 12 tubes, operates from 115 volts 60 cycles.
BC-406	Receiver from SCR-268 unit covering 201 to 210 Mcs, with 15 tubes and 115 VAC operated.
BC-412	Oscilloscope from SCR-268 radar.
BC-450A	Control box for 453A type receivers.
BC-453A	Army aircraft receiver: This is merely one of a group in this series. The receivers are of all aluminum construction weighing about 6 lbs. and are approximately 5" x 8" x 12". Power required is 250 volts at 50 ma and 25.2 volts at .45 A. Receivers have hi and low impedance output (300 or 4000 ohms) and are for voice, mcw or cw. Tubes contained are (3) 12SK7 (1) 12SR7 (1) 12A6 (1) 12K8 BC-453A covers 190 to 550 Kcs 454A covers 3 to 6 Mcs 455A covers 6 to 9.1 Mcs The 274N command set consists of 3 receivers, 2 transmitters, 4 dynamotors, 1 modulator, 2 control boxes, and ant coupling and total of 26 tubes. Receivers cover 190 to 550 Kcs, 3 to 6 Mcs and 6 to 9.1 Mcs. Transmitters cover 3-4 Mcs and 4 to 5.3 Mcs.

BC-454A See data on BC-453A.

BC-455A See data on BC-453A.

BC-456A Is modulator unit for BC-457A Series transmitters.

BC-457A Series Transmitters are designed for use with BC-453A Series receivers in Army aircraft and are similar in appearance but slightly larger. Rated output is 30-40 watts. Have directly calibrated vernier dial and contain the following tubes:

(2) 1625 PA
(1) 1626 Osc
(1) 1629 Tuning Indicator
All units have crystal for check on calibration.

BC-457A	4 to 5.3 Mcs	(Crystal	4600 Kcs)
BC-458A	5.3 to 7 Mcs	("	6200 Kcs)
BC-459A	7 to 9.1 Mcs	("	8000 Kcs)
BC-696	3 to 4 Mcs	("	3500 Kcs)

BC-458A See BC-457A.

BC-459A See BC-457A.

BC-603 10 channel FM receiver using push buttons or manual 20 to 30 Mcs, Superhet, BFO, 12 volt operation. 10 tube.

BC-604 10 channel FM transmitter push button or manual 20 to 30 Mcs using 1625 final with 20 watts output for 12 volt operation. 8 tubes.

BC-620A Transmitter and Receiver covering 20 to 27.9 Mcs Crystal controlled FM with 13 tubes.

(4) 1LN5	(4) 1299
(1) 1LC6	(1) 1294
(1) 1LH4	
(2) 1291	Weighs 38 lbs.

BC-624 Receiver component of SCR-522, 10 tube superhet.

BC-645 Transmitter and Receiver (IFF).
435 to 500 Mcs with 15 tubes.
400 volts at 135 ma required plus 9 volts at 1.2 Amp AC.

(4) 7F7	(2) 955
(4) 7H7	(1) 316A
(2) 7E6	
(2) 6F6	Weighs 25 lbs.

BC-653A	Transmitter - 100 watts CW, 22 watts phone. 2 to 4.5 Mcs 807 buffer (2) 1613 MO and Mod (2) 814 Final
BC-654A	Transmitter and Receiver. 3800 to 5800 Kcs Calibration every 10 Kcs 200 Kcs crystal for check points Power output is 12 watts voice or 25 watts CW 7 tube superhet receiver using (3) 1N5, (1) 1A7, (2) 3Q5, (1) 1H5 6 tube transmitter uses (2) 307A in final Requires 1.5 volts, 45 volts, 90 volts for receiver Requires 1.5 volts, 6 volts, 51 volts, 84 volts, and 500 volts for transmitter. Operates from PE 103A dynamotor.
BC-659	Transmitter and Receiver. FM voice only 27 to 38.9 Mcs Crystal controlled 2 watt output battery operated
BC-684/683	Transmitter and Receiver. FM units Receiver uses 9 tubes in 10 channels (push buttons) Transmitter uses 8 tubes in 10 channels (" ") 35 watt output 27 to 38.9 Mcs
BC-696	See BC-457A.
BC-701	VHF receiver, 170 to 180 Mcs. IF freq. is 30.5 Mcs, 11 tubes, self contained power supply.
BC-704A	Radar indicator unit, part of SCR-521. (4) 6AC7 (1) 5BP1 (3) 6H6
BC-728	Push button receiver. 2-5 Mcs 2 or 6 volts 6 tubes
BC-733D	Localizer Receiver. Blind landing equipment with 6 Crystal frequencies. 108 to 120 Mcs with 10 tubes.

	(3) 717A 12SQ7 12A6	(2) 12SG7 12AH7 (2) 12SR7
BC-788	Receiver. 420 to 450 Mc. 6 IF stages using 6AG5's 30 Mcs broad band width	
BC-929	Army radar oscilloscope, 110 volts, 400 cycle.	
BC-939	Antenna tuning unit for BC-610 transmitter.	
BC-946B	See BC-453A receivers - covers 520 to 1500 Kcs.	
BC-947A	UHF transmitter. 3000 Mcs 115 volt AC operation with blower	
BC-966A	IFF, approximately 2 meters, 14 tubes, 350 volt dynamotor with 12 volt input.	
BC-1023A	Marker Beacon Receiver. 75 Mcs using 6S07, 6U6G, 6SC7, 12SH7 12 or 24 volt DC operation	
BC-1068A	Receiver (see BC-1161A).	
BC-1072A	Transmitter: 115 volt AC operation 150 to 200 Mcs 11 tubes	
BC-1161A	Receiver used with 1072A transmitter. 115 volt AC operation with 14 tubes 10" x 16" x 15" 1- 6SN7 Cathode follower 1- 6H6 2nd Det. 2- 6SH7 1st and 2nd RF 1- 6SH7 Video amp 3- 6AC7 1st, 2nd and 3rd IF 2- 6AB7 4th, 5th IF 1- 9006 Mod. 1- 6J5 Osc. 1- 5U4G Rect. 1- 6E5 tuning ind. Component of RC 150 IFF Same as BC-1068A	IF Band Pass is 4 Mc

BC-1206C	Setchell Carlson Beacon Receiver: (2) 25L6, 6SK7, 6SF7, 6SA7, 6K7 195 or 420 Kcs Weighs 4 lbs., 4" x 4" x 6-5/8"
BC-1267	Transmitter and receiver, 154 to 186 Mcs. 1 KW pulse oscillator superhet circuit, 2 RF stages, and 5 stagger tuned IF's
BD-77Km	Dynamotor, input 14 volts DC, output 1000 volts at 350 ma. Used with BC-191.
C-1	Auto Pilot Amplifier. For radio controlled models etc. (3) 7F7 Amps. (3) 7N7 Signal discriminators (1) 7Y4 Rectifier
CCT-46077	Transmitter: 2-20 Mcs, 12 Volt input. 30 lbs. Unit of RBM-2 Equipment.
CRV-46151	Aircraft receiver. 4 bands covering 195 to 9,050 Kcs. 6 tube superhet
DAG-33A	Dynamotor, input 18 volts DC, output 450 volts DC at 60 ma.
DM-21	Dynamotor, input 14 volts DC, output 235 volts at 90 ma.
DM-33A	Dynamotor, input 28 volts DC, output 540 volts DC at 250 ma. (Power supply for modulator of SCR-274N series.)
EE-8	Field telephone.
GF-11	Equipment consists of: CW 52063A Transmitter CW 52014 Transmitter base CW 23097 Transmitter control box CW 23098 Extension control box CW 23049 Relay unit CW 47092 Coil set
GO-9	Transmitter with power supply, 200 to 18.100 Kcs, 115 volt, 800 cycles. 803 final, v.f.o., 150 watt.
GP-7	Navy transmitter, 125 watts, 350 to 9050 Kcs with plug-in tuning units.

PC-77	Dynamotor, input 12 volts DC, output 175 volts at 100 ma and 500 volts at 50 ma.
PE-73CM	Dynamotor, input 28 volts, output 1000 volts at 350 ma, used with BC-375.
PE-86	Dynamotor, input 28 volts DC, output 250 volts DC at 60 ma.
PE-101C	Dynamotor, input 12 or 24 volts, output 800 volts at 20 ma and 400 volts at 135 ma, plus 9 volts at 1.1 amps. Used with BC-645.
PE-103A	Dynamotor, 500 volts at 160 ma from either 6 or 12 volts DC.
PE-104	Dynamotor, 90 volts at 50 ma from 6 or 12 volts DC input.
PE-109	Direct current power plant. Gasoline engine driven generator, has 32 volt output at 2000 watts.
PRS-1	Mine detector.
RAK-7	Navy Receiver. 9 tubes, 115 volt AC operation 6 bands 15 Kc to 600 Kc
RA-20	115 v. 60 cycle power supply for BC-312, BC-342.
RA-38	Rectifier, 15 KVA, output is 15 KV at 500 ma, variable, weight 2040 lbs., 63" x 54" x 57".
RA-58A	Hi voltage supply. 500 to 15,000 volt continuously variable at 35 ma for breakdown tests, 115 volt AC operation.
RA-63A	Rectifier, input 115 volts at 60 cycles, output 12 volts at 8 amps.
RA-105	Rectifier, 117 volt, 60 cycles input, output is 2000 volts, 610 v, 415 v, 300 v, 200 v, all DC plus 6.3 volts AC. Weighs 119 lbs. and is 10" x 24" x 19".
RAX-1	Receiver combination. #1- 4 bands from 200 to 1500 Kcs #2- 4 bands from 1500 to 9000 #3- 5 bands from 7 to 27 Mcs Operates from 24 volt dynamotor
RC-150	IFF equipment, used with SCR-270 and 271.

RC-188A	IFF equipment, 157 to 185 Mcs, Transmitter/Receiver indicator, 62 tubes, operates from 110 volts, 60 cycles.
RL-9	Interphone amplifier from 24 volt DC dynamotor.
RT-1248	GE transmitter and receiver. 435 to 500 Mcs 20 watts out 5 tubes using WE 316A final Receiver uses 10 tubes 955 1st Det, 955 Osc, (3) 7H7 IFs, 7E6, 7H7 12 volts required
RU-16/GF-11	Transmitter - Receiver. 3000 to 4525 and 6000 to 9050 Kcs Transmitter 195 to 13,575 KC receiver 12 watt voice or CW 100 lbs. and 13" x 31"
SCR-195	Transceiver Walkie-Talkie. 52.8 to 65.8 Mcs 27 lbs. with knapsack 25 mile range handset and spare parts plus antenna (telescope)
SCR-269F	Radio compass. 17 tube superhet receiver 200 to 1750 Kcs in 3 bands
SCR-274N	Command set composed of 453A series receivers and 457A transmitters (see those listings).
SCR-474	Portable transmitter and receiver, covering 40 and 80 meter bands, 1 volt tubes in receiver. Has 6V6 v.f.o., 6V6 power amp., and 6V6 modulator.
SCR-522	Transmitter and Receiver: 100 to 156 Mcs 12 watts output on voice 4 crystal frequencies antenna is AN-104-B 1/4 wave Transmitter alone is BC-625 Receiver is BC-624 Tubes used: (2) 832, (3) 12A6, (1) 6G6, (2) 6SS7, (1) 12J5, (1) 12C8, (1) 9002, (3) 9003, (1) 12AH7, (3) 12SG7

SCR-536	Walkie Talkie. 1- 1R5 1- 1T4 1- 1S5 2- 3S4
SCR-578	Gibson girl transmitter. Automatic SOS for sea rescue.
SCR-625	Mine detector. Balanced inductance bridge with 1000 cycle osc. 2 tube amplifier 1G6 and 1N5 2 flashlight batteries plus 100 volts B battery weighs 15 lbs.
SPR-2A	Receiver. Superhet 1000 to 3100 Mcs 2C40 UHF osc. 115 VAC operation 15 tubes. Weighs 15 lbs. and is 8" x 10" x 23"
T-17B	Carbon hand mike, 200 ohms single button press to talk.
TA-12	Bendix 100 watt transmitter; v.f.o., par 807 final.
TBW	Transmitter, similar to GO-9. 3-18,100 kc., 150 watts.
TBY	Transmitter/Receiver 28-80 Mcs, Voice and MCW Output 1/2 watt. Portable.
TCS-9	Transmitter and Receiver, 25 watt output. 1500 to 12,000 Kcs 115 Volts AC Crystals or VFO
TU-5B, 6B, etc.	Tuning units for BC-375 Transmitter (see listing of BC-375).
I-152AM	Radio altimeter indicator. 3 each 6AG5, 2X2, 3DP1, operates from 110 volts, 400 cycles.
I-122A	Signal generator, self contained, 115 volts 60 cycle supply, with crystal calibrator, 8-15 Mcs and 150-230 Mcs, with harmonics covers 8 to 308 Mcs.
I-233	Range calibrator. (2) 6SN7, (2) 6L6, (2) 6V6, (1) 6SJ7, (1) 5Y3.
602A-41	Amplifier 2 stage RF amp for UHF.

CROSS INDEX OF ARMY VT NUMBERS AND COMMERCIAL NUMBERS

Tube Listings by VT Numbers

VT Number	Commercial Number	VT Number	Commercial Number	VT Number	Commercial Number
VT-1	WE-203A**	VT-43	845	VT-88	6R7
VT-2	WE-205B	VT-44	32	VT-88A	6R7G
VT-3	**	VT-45	45	VT-88B	6R7GT
VT-4A	**	VT-46	866	VT-89	89
VT-4B	211	VT-46A	866A	VT-90	6H6
VT-4C	JAN 211	VT-47	47	VT-90A	6H6GT
VT-5	WE-215A	VT-48	41	VT-91	6J7
VT-6	212A**	VT-49	39/44	VT-91A	6J7GT
VT-7	WX-12**	VT-50	50	VT-92	6Q7
VT-8	UV-204**	VT-51	841	VT-92A*	6Q7G
VT-10	**	VT-52	45 spec	VT-93	6B8
VT-11	**	VT-53	(VT-42A)	VT-93A	6B8G
VT-12	**	VT-		VT-94	6J5
VT-13	**	VT-54	34	VT-94A	6J5G
VT-14	**	VT-55	865	VT-94B	6J5 spec selec
VT-16	**	VT-56	56	VT-94C	6J5G " "
VT-17	860	VT-57	57	VT-94D	6J5GT
VT-18	**	VT-58	58	VT-95	2A3
VT-19	861	VT-60	850	VT-96	6N7
VT-20	**	VT-62	801,801A	VT-96B	6N7 spec selec
VT-21	**	VT-63	46	VT-97	5W4
VT-22	204A	VT-64	800	VT-98	6U5/6G5
VT-23	**	VT-65	6C5	VT-99	6F8G
VT-24	864	VT-65A	6C5G	VT-100	807
VT-25	10	VT-66	6F6	VT-100A	807 mod
VT-25A	10 spec	VT-66A	6F6G	VT-101	837
VT-26	22	VT-67	30 spec	VT-102	canceled
VT-27	30	VT-68	6B7	VT-103	6SQ7
VT-28	24, 24A	VT-69	6D6	VT-104	12SQ7
VT-29	27	VT-70	6F7	VT-105	6SC7
VT-30	01-A	VT-72	842	VT-106	803
VT-31	31	VT-73	843	VT-107	6V6
VT-32	**	VT-74	5Z4	VT-107A	6V6GT
VT-33	33	VT-75	75	VT-107B	6V6G
VT-34	207	VT-76	76	VT-108	450TH
VT-35	35/51	VT-77	77	VT-109	2051
VT-36	36	VT-78	78	VT-111	5BP4/1802P4
VT-37	37	VT-80	80	VT-112	6AC7/1852
VT-38	38	VT-83	83	VT-114	5T4
VT-39	869	VT-84	84/6Z4	VT-115	6L6
VT-39A	869A	VT-86	6K7	VT-115A	6L6G
VT-40	40	VT-86A	6K7G	VT-116	6SJ7
VT-41	851	VT-86B	6K7GT	VT-116A	6SJ7GT
VT-42	872	VT-87	6L7	VT-116B	6SJ7Y
VT-42A	872A spec	VT-87A	6L7G	VT-117	6SK7

CROSS INDEX OF ARMY VT NUMBERS AND COMMERCIAL NUMBERS

Tube Listings by VT Numbers

VT Number	Commercial Number	VT Number	Commercial Number	VT Number	Commercial Number
VT-117A	6SK7GT	VT-154	814	VT-197A	5Y3GT/G
VT-118	832	VT-155	spec tube	VT-198A	6G6G
VT-119	2X2/879	VT-156	" "	VT-199	6SS7
VT-120	954	VT-157	" "	VT-200	VR-105/30
VT-121	955	VT-158	" "	VT-201	25L6
VT-122	530	VT-159	" "	VT-201C	25L6GT
VT-123	RCA A-5586	VT-160	" "	VT-202	9002
superceded by VT-128		VT-161	12SA7	VT-203	9003
VT-124	1A5GT	VT-162	12SJ7	VT-204	HK24G
VT-125	1C5GT	VT-163	6C8G	VT-205	6ST7
VT-126	6X5	VT-164	1619	VT-206A	5V4G
VT-126A	6X5G	VT-165	1624	VT-207	12AH7GT
VT-126B	6X5GT	VT-166	371A	VT-208	7B8
VT-127	spec tube	VT-167	6K8	VT-209	12SG7
VT-127A	" "	VT-167A	6K8G	VT-210	1S4
VT-128	1630(A5588)	VT-168A	6Y6G	VT-211	6SG7
VT-129	304TL	VT-169	12C8	VT-212	958
VT-130	250TL	VT-170	1E5-GP	VT-213A	6L5G
VT-131	12SK7	VT-171	1R5	VT-214	12H6
VT-132	12K8 spec	VT-171A	1R5(loctal)	VT-215	6E5
VT-133	12SR7	VT-172	1S5	VT-216	816
VT-134	12A6	VT-173	1T4	VT-217	811
VT-135	12J5GT	VT-174	3S4	VT-218	100TH
VT-135A	12J5	VT-175	1613	VT-219	**
VT-136	1625	VT-176	6AB7/1853	VT-220	250TH
VT-137	1626	VT-177	1LH4	VT-221	3Q5GT
VT-138	1629	VT-178	1LC6	VT-222	884
VT-139	VR-150/30	VT-179	1LN5	VT-223	1H5GT
VT-140*	1628	VT-180*	3LF4	VT-224	RK-34
VT-141	531	VT-181	7Z4	VT-225	307A
VT-142	WE-39DY1	VT-182	3B7/1291	VT-226	3EP1/1806P1
VT-143	805	VT-183	1R4/1294	VT-227	7184
VT-144	813	VT-184	VR-90/30	VT-228	8012
VT-145	5Z3	VT-185	3D6/1299	VT-229	6SL7GT
VT-146	1N5GT	VT-186	spec tube	VT-230	350A
VT-147	1A7GT	VT-187	575A	VT-231	6SN7GT
VT-148	1D8GT	VT-188	7E6	VT-232	E-1148
VT-149	3A8GT	VT-189	7F7	VT-233	6SR7
VT-150	6SA7	VT-190	7H7	VT-234	HY-114B
VT-150A	6SA7GT	VT-191	316A	VT-235	HY-615
VT-151	6A8G	VT-192	7A4	VT-236	836
VT-151B	6A8GT	VT-193	7C7	VT-237	957
VT-152	6K6GT	VT-194	7J7	VT-238	956
VT-152A	6K6G	VT-195	1005	VT-239	1LE3
VT-153	12C8 spec	VT-196	6W5G	VT-240	710A

CROSS INDEX OF ARMY VT NUMBERS AND COMMERCIAL NUMBERS

Tube Listings by VT Numbers

VT Number	Commercial Number
VT-241	7E5/1201
VT-243	7C4/1203A
VT-244	5U4G
VT-245	2050
VT-246	918
VT-247	6AG7
VT-248	1808P1
VT-249	1006
VT-250	EF50
VT-251	441
VT-252	923
VT-254	304TH
VT-255	705A
VT-256	ZP486
VT-257	K-7
VT-259	829
VT-260	VR-75/30
VT-264	3Q4
VT-266	1616
VT-267	578
VT-268	12SC7
VT-269	717A
VT-277	417
VT-279	GY-2
VT-280*	C7063
VT-281*	HY-145ZT
VT-282	ZG489
VT-283*	QF-206
VT-284	QF-197
VT-285*	QF-200C
VT-286	832A
VT-287	815
VT-288	12SH7
VT-289	12SL7GT

* Indicates VT number canceled.

** Obsolete.

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SURPLUS RADIO CONVERSION MANUAL

VOLUME No. 2

By

R. C. EVENSON AND O. R. BEACH

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VOLUME II

Second Edition

by

R. C. Evenson and O. R. Beach

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CONVERTING THE ARC-5 AND BC-454 SERIES RECEIVERS FOR OPERATION ON 10 METERS

The ARC-5 and BC-454 "Command Set" series receivers may be converted into 10-meter receivers that are hard to beat. They are especially well adapted for mobile use. One of these receivers can be used in conjunction with the ARC-5 transmitter on 10 meters, as described elsewhere in this manual, to make up a very economical mobile installation.

(a) General Description:

The receivers are very compact, light, and completely enclosed in an aluminum case. The basic circuit is that of a 6-tube superhet designed to obtain its "B" voltage from a 28-volt dynamotor normally clipped onto the rear of the chassis. (For additional data and other uses for these units, see Volume I of this manual.)

All units of the series are nearly identical with the exception of frequency coverage and intermediate frequencies, which are given in the following chart:

Navy	Army	Freq. Coverage	IF Freq.
	BC-453	190-550 kc.	85 kc.
	BC-946B	520-1500 kc.	239 kc.
R26/ARC5	BC-454	3-6 Mc.	1415 kc.
R27/ARC5	BC-455	6-9 Mc.	2830 kc.

The first two receivers listed are not recommended for 10-meter operation due to the low intermediate frequency.

The following instructions are applicable to all models. However, if the ARC-5 series is used special attention should be paid to the following points. The ARC-5 receivers differ from the BC-454 series in that they use a 12SF7 tube at V6 as the second IF and AVC, whereas the command sets use a 12SK7 as second IF and the AVC is taken from the 12SR7 stage. This causes some change in the audio circuit components, due to the different AVC circuits. A diagram (Fig. 3) is given of the ARC-5 after conversion.

(b) Filament Circuit Changes:

As the filaments were originally wired for 28-volt operation (in series parallel) it will be necessary to rewire them for 6-volt operation by placing all tubes in parallel with one side common to ground. The hot filament lead may be brought out on pin 6 of the rear plug. (Wires on this pin were part of the original filament circuit and may be removed.) All extra filament wiring as used in the original 28-volt system should be removed, along with the filament choke L-14.

The present 12-volt tubes should be replaced with their 6-volt equivalents as follows:

Original	Replacement
12SK7	6SK7
12K8	6K8
12SR7	6SR7 or 6SQ7
12A6	6K6, 6V6 or 6F6
ARC-5 Only-12SF7	6SF7

No changes in wiring are necessary when substituting 6-volt tubes.

(c) Removal of Present CW Oscillator Stage:

It is assumed that the CW oscillator will not be desired on 10 meters. Since this stage can be made into an additional stage of audio, all wires to terminals 6 and 2 of the 12SR7 tube and all wires to terminal 5 of the 12A6 should be removed. This operation causes the following component parts to be useless. Hence they may be removed. R14, C26, L12, L13, C27, C28, R15, R18, R19, R20, R16, R17, C29. It will be necessary to refer to the original circuit (pages 8-9) to locate and remove these parts. Once again some confusion may arise if the ARC-5 is being converted, so be careful to remove only the parts associated with the CW oscillator circuit.

(d) Addition of First Audio Stage:

The operation just accomplished causes the triode section of the 12SR7 tube to be free for use as a stage of resistance-coupled amplification. Refer to the circuit of Fig. 2 if the BC-454 series is used and to Fig. 3 if the ARC-5 is used.

The audio volume control included in the revision is mounted on the front panel in place of the original adapter plug, from which all wiring can be removed. However, the wire labeled "Gain Control Line" on the circuit diagram normally went through an external 50,000-ohm pot to ground for control of RF gain. In this conversion it is to be grounded directly to the chassis at some convenient point, allowing the RF gain to run wide open.

It will be noted that a 1N34 crystal-diode noise limiter is included in the circuit. This limiter is especially advisable if the receiver is to be used in an automobile. The noise-silencer switch is mounted in place of C5. (C5 may be used in the plate circuit of V7 after conversion.)

The present output transformer should be replaced, as the original one was designed to match headphones and will not match the ordinary PM speaker. A small universal matching transformer to couple the chosen output tube to a PM speaker should be installed.

(e) Antenna Post Modification:

It is advisable to remove the present antenna post and to replace it with a standard bayonet receptacle as used on most auto radios. For convenience, it is suggested that this receptacle be installed on the side of the receiver instead of on the front.

Note: The above modifications will allow operation on the original frequency of the unit merely by applying heater and plate voltage; however, for 10-meter operation the RF section must be modified further as follows:

(f) RF Components:

Remove the plug-in RF assembly consisting of the 3 coils enclosed in the metal shield cans. Work on one coil at a time. It will be necessary to remove the metal slug in each coil to facilitate rewinding. The slug is replaced when rewinding is finished.

L1 (Ant coil) Remove the existing winding and rewind with 6 turns of No. 18 enameled wire, space wound the full length of the coil form.

L2 (Honeycomb mixer coil) Remove the existing honey-comb coil with the exception of the last layer. This will leave approximately 9 turns for L2. This should be interwound with L3 after L3 has been rewound as in the next step. (Added sensitivity will be gained by interwinding the coils.)

L3 (On same form as L2) Remove the existing winding and rewind with 5 turns of No. 18 enameled wire, space wound the full length of the coil form. (Now interwind L2 with L3.)

L4 (Osc coil - small winding) No alteration necessary.

L5 (Osc coil - on same form as L4) Remove the existing winding and rewind with 5 turns of No. 18 enameled wire close spaced. L5 should be between 1/8" and 3/16" from L4.

In order to provide sufficient spread of the 10-meter band, it is necessary to reduce the capacitance of each section of the tuning condenser. This is accomplished by pulling off all rotor plates with the exception of the slotted one at the end of each section. This can be done with a pair of long nosed pliers without removing the condenser. Using a single plate in each section of the condenser, the band spread should be about 27 to 30 Mcs on the calibrated dial. The original dial plate should be removed by loosening the retaining nut, and replaced with a round piece of lucite or metal on which the 10-meter calibration may be marked.

If not already provided, holes should be drilled in the RF section shield to expose the trimmer condensers with the shield in place. Otherwise, the added capacitance of the shield would detune the circuits.

At this point the receiver is capable of operation providing power is applied. (See following section on power supplies.) The alignment is quite simple. The receiver should operate smoothly over the band. If it does not oscillate, reverse the connections to the oscillator coil winding. If the receiver is sensitive only in spots instead of over the entire range, take a turn at a time off the oscillator coil or coils until the receiver tracks. (The oscillator must be tuned above the incoming frequency to obtain proper tracking.) Normally the oscillator can be made to track properly by adjustment of the oscillator trimmer, but sometimes a turn or so must be taken off the coil to increase its frequency.

If the RF trimmer appears to have no effect, take a turn at a time from the center coil (small wire) until the trimmer gives a definite peak in output.

The oscillator padder should be adjusted for maximum output while the tuning dial is rocked back and forth. The oscillator trimmer may be used to move the 10-meter band into the limits of the dial desired.

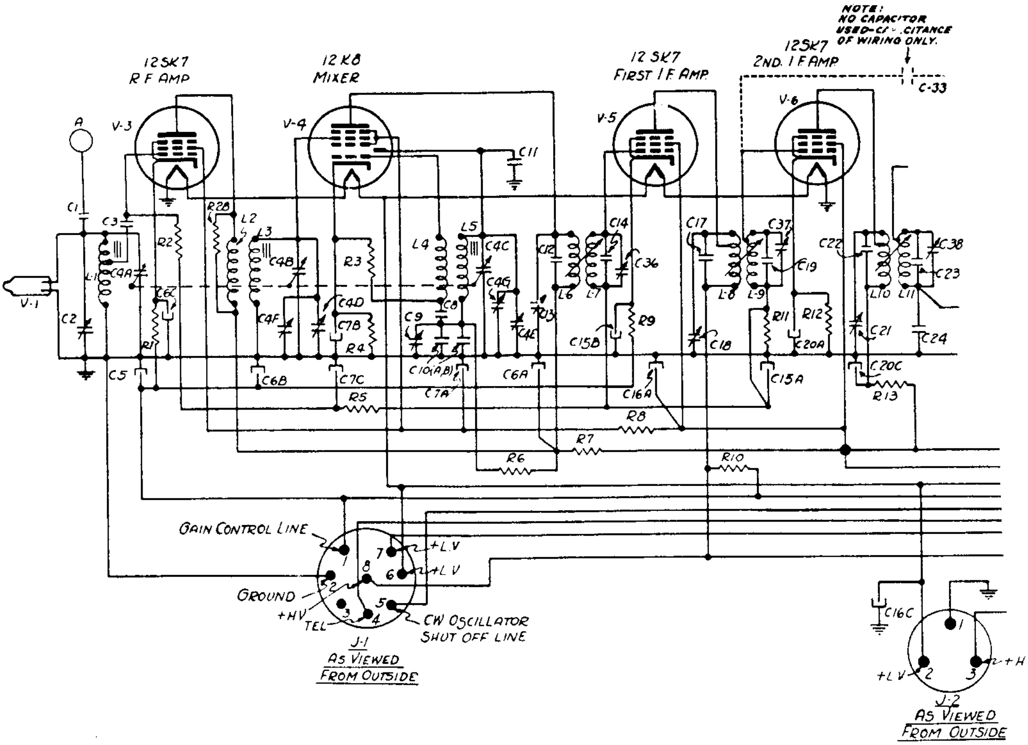
The 2-meg. grid resistor of V3 should be detached from the AVC circuit and grounded to give a better signal/noise ratio.

(g) Power Supplies:

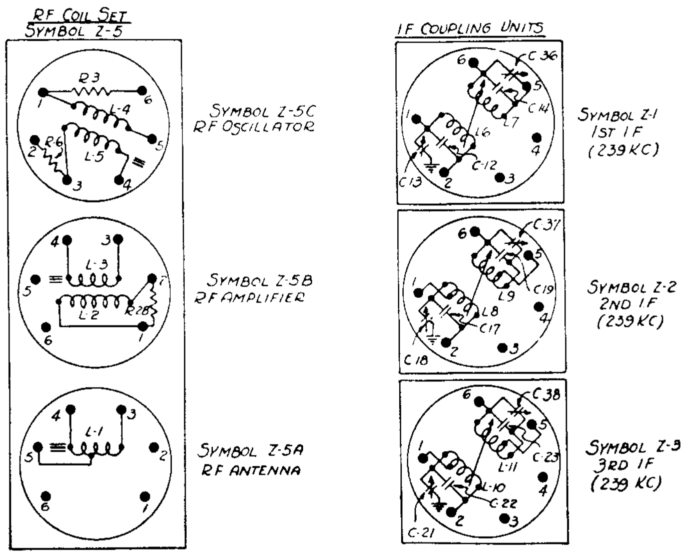
A simple power supply circuit for use with the receiver is shown in Fig. 4. A vibrator supply can be used if mobile operation is desired. Also, for mobile operation the voltages can be taken from the existing broadcast receiver thus eliminating the need for an extra supply. In this case it is necessary to place a switch in the broadcast receiver to remove its load from the power supply when the 10 meter receiver is being used.

(h) Rack Mounting:

For mobile installations, the FT220A rack may be used to mount the receiver, making it an easy matter to take out and repair the set. This rack was designed to take 3 receivers so it will be necessary to saw off one and rewire it to suit the plug connections used on the receiver. The switch on the front of the rack may be used for a standby switch and the fuse block on the rear will be handy for a battery lead fuse.

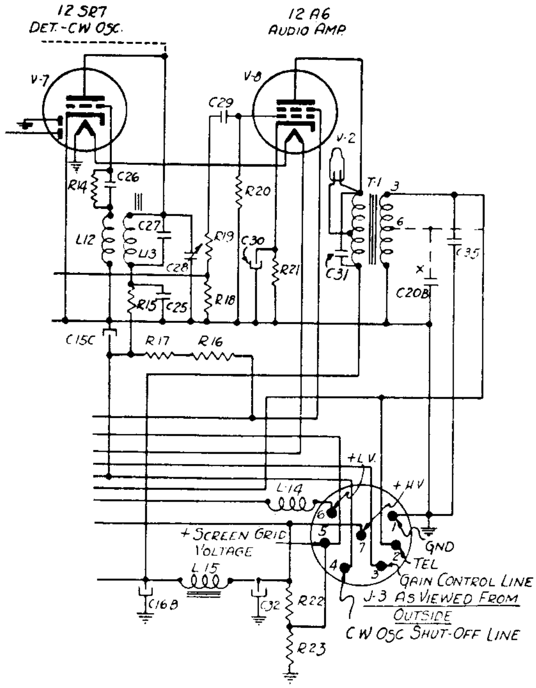


CIRCUITS IN RF COIL SET, IF COUPLING UNITS, CW OSCILLATOR, & OUTPUT TRANSFORMER
THE TERMINAL NUMBERS ON THESE UNITS AGREE WITH THOSE SHOWN AT THE CORRESPONDING LOCATIONS ON THE WIRING DIAGRAM

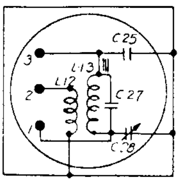


Radio Receiver BC-946-B Schematic Wiring Diagram

Typical also of the BC-454 series and most other "Command Set" type Receivers.

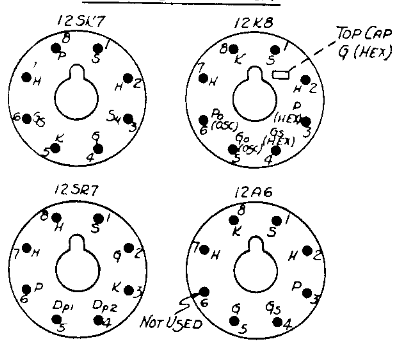


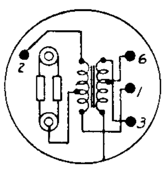
CAPACITANCES		INDUCTANCES		RESISTANCES	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	OHMS
C-1	11 MMF	L-1	ANT. INPUT	R-1	620
C-2	15 MMF	L-2, L-3	RF AMP	R-2	2,000,000
C-3	100 MMF	L-4, L-5	RF OSC	R-3	51,000
C-4 (A TO G)	GANG (346 MMF)	L-6, L-7	IN FIRST IF	R-4	620
C-5	3 MFD	L-8, L-9	IN 2ND IF	R-5	150,000
C-6 (A,B,C)	.05/05/05 MFD.	L-10, L-11	IN 3RD IF	R-6	300,000
C-7 (A,B,C)	05/05/.05 MFD	L-12, L-13	CW OSC	R-7	200
C-8	200 MMF	L-14	RF CHOKE	R-8	200
C-9	40 MMF		112 MICRO-	R-9	620
C-10 (AB)	670 MMF TOTAL		HENRIES	R-10	360,000
C-11	3 MMF	L-15	AF CHOKE	R-11	100,000
C-12	180 MMF		3 HENRIES	R-12	510
C-13	17 MMF			R-13	200
C-14	180 MMF			R-14	100,000
C-15 (A,B,C)	05/.05/05 MFD			R-15	20,000
C-16 (A,B,C)	.22/.22/.22 MFD			R-16	100,000
C-17	180 MMF			R-17	100,000
C-18	17 MMF			R-18	510,000
C-19	180 MMF			R-19	100,000
C-20 (A,B,C)	05/.01/.05 MFD			R-20	2,000,000
C-21	17 MMF			R-21	1500
C-22	180 MMF			R-22	7000
C-23	180 MMF			R-23	7000
C-24	200 MMF			R-28	51,000
C-25	.001 MFD				
C-26	100 MMF				
C-27	335 MMF				
C-28	34 MMF				
C-29	.006 MFD				
C-30	15 MFD				
C-31	.001 MFD				
C-32	5 MFD				
C-33	WIRING CAPACITANCE LESS THAN 2 MMF				
C-35	750 MMFD (SEE NOTE BELOW)				
C-36	17 MMF				
C-37	17 MMF				
C-38	17 MMF				



SYMBOL Z-4
CW OSCILLATOR
(239 KC)

TUBE SOCKET TERMINALS
AS VIEWED FROM BOTTOM





SYMBOL T-1
OUTPUT TRANSFORMER

TUBE TERMINAL CODE

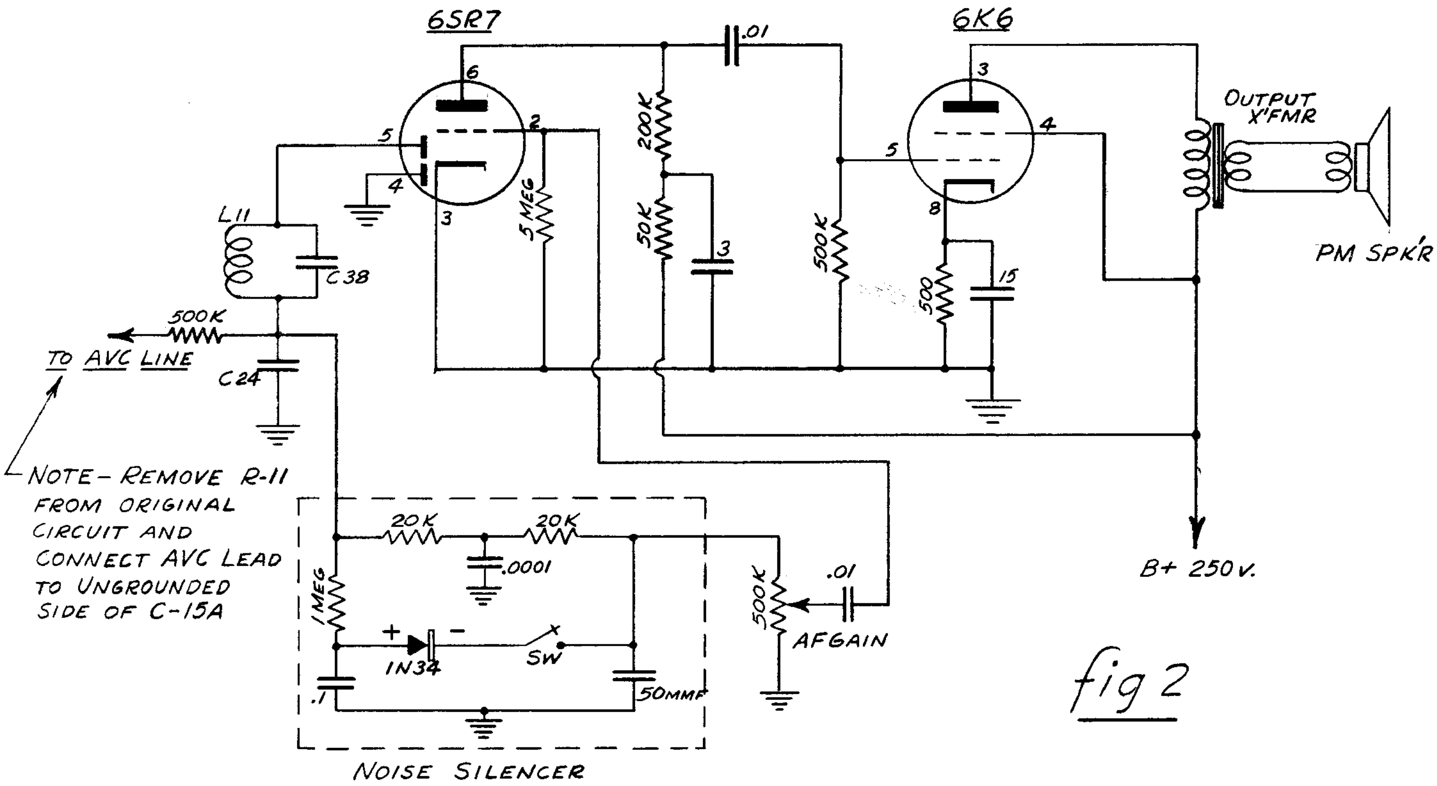
S = SHELL	Gs = SCREEN GRID
H = HEATER	Gs (HEX) = SCREEN GRID, HEXODE SECTION
K = CATHODE	Go (OSC) = CONTROL GRID, OSC SECTION
Su = SUPPRESSOR GRID	P = PLATE
Dp1 = FIRST DIODE PLATE	P (HEX) = PLATE, HEXODE SECTION
Dp2 = SECOND DIODE PLATE	Po (OSC) = PLATE, OSC. SECTION
G = CONTROL GRID	G (HEX) = CONTROL GRID, (HEXODE SECTION)

④
C 35 & TERMINAL 3 TO BE USED FOR 4000 OHM OUTPUT
C 20B & TERMINAL 6 TO BE USED FOR 300 OHM OUTPUT

Radio Receiver BC-946-B Schematic Wiring Diagram

Typical also of the BC-454 series and most other "Command Set" type Receivers.

Modified Audio Section of BC-454 Receiver



NOTE- REMOVE R-11 FROM ORIGINAL CIRCUIT AND CONNECT AVC LEAD TO UNGROUNDED SIDE OF C-15A

fig 2

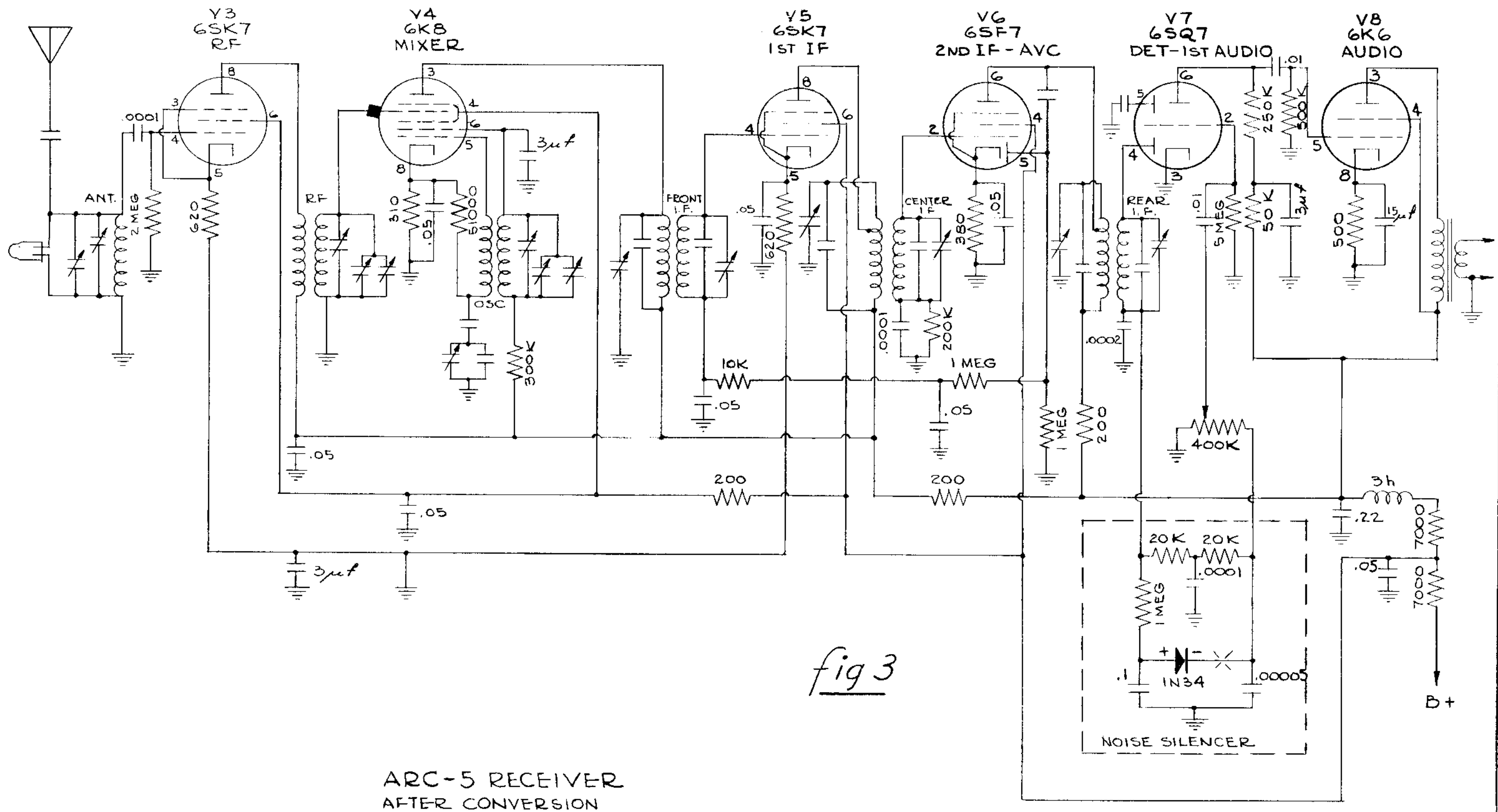


fig 3

ARC-5 RECEIVER
AFTER CONVERSION
TO 10 METERS

Original schematic identical to BC-946-B (page 9) except: V6 is 12SK7, and there is no a.v.c. in the 946-B. I.f. transformers in the various receivers differ according to the list on page 5.

POWER SUPPLY FOR SCR-274N & ARC-5 RECEIVERS

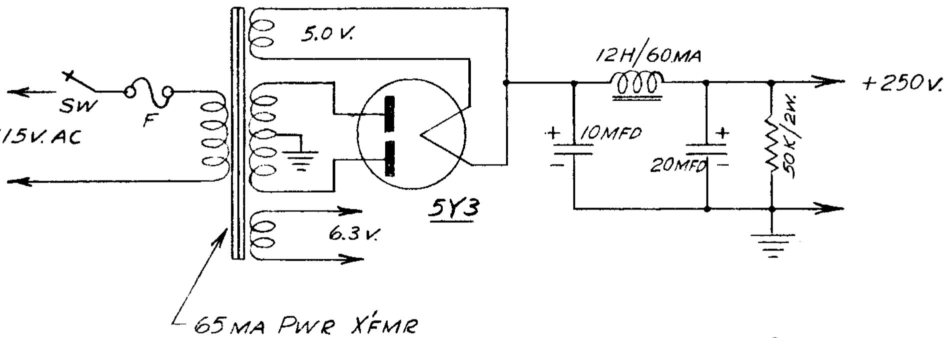
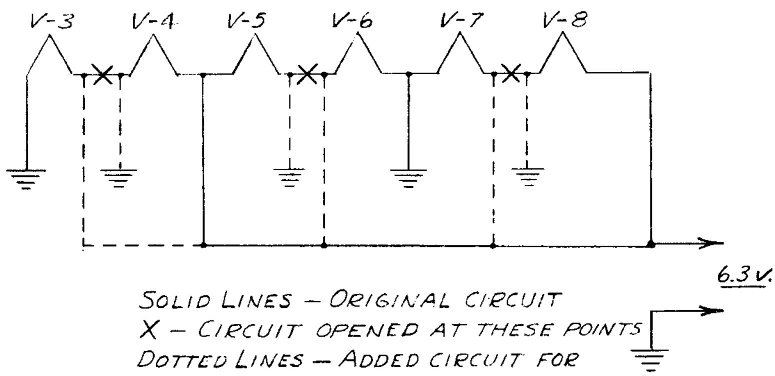


fig 4

FILAMENT CIRCUIT



SOLID LINES — ORIGINAL CIRCUIT
X — CIRCUIT OPENED AT THESE POINTS
DOTTED LINES — ADDED CIRCUIT FOR 6 V. OPERATION.

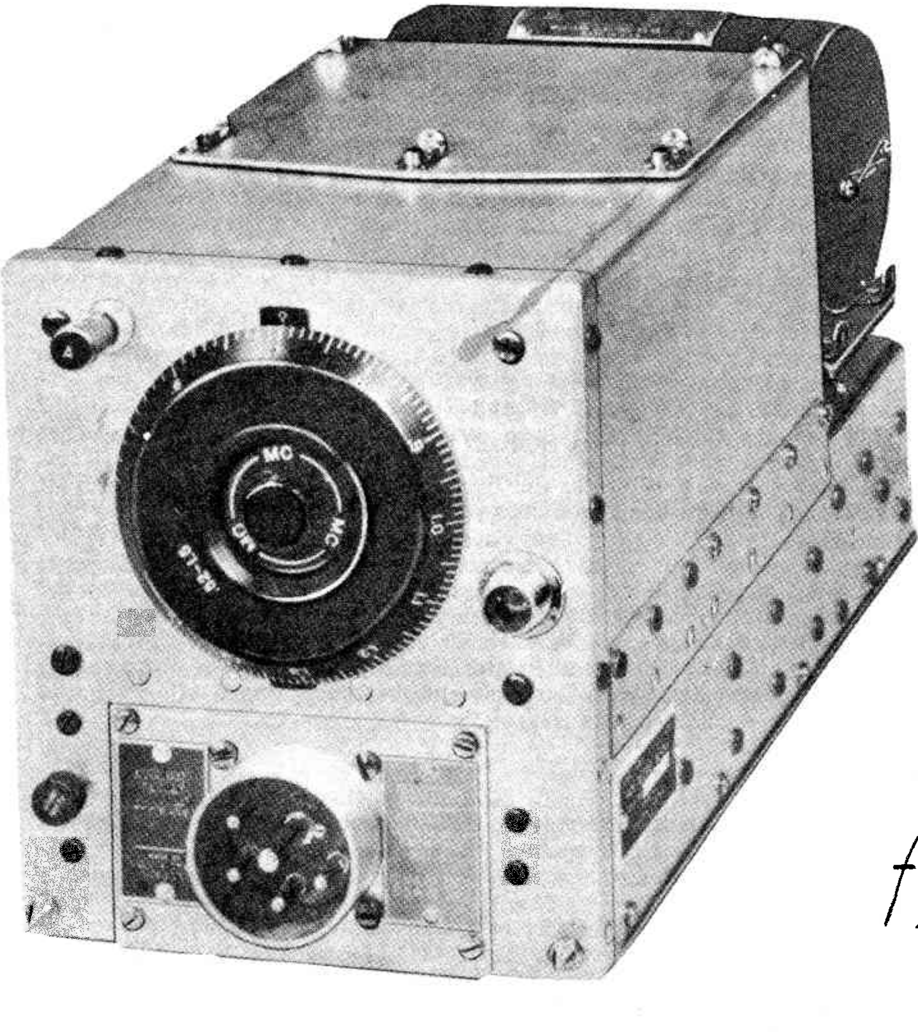


fig 5

BC-946-B RECEIVER (Before Conversion)

Typical of Command Set Type Receivers

APS-13 TRANSMITTER/RECEIVER FOR 420-MC. OPERATION

The AN/APS-13 Transmitter/Receiver is a low-powered airborne radar unit, designed and used as a warning device for rear approaching enemy aircraft. It was commonly referred to as the "Tail-End Charlie" and operated audible indicators when rear approaching aircraft were within operating range of the unit.

The unit is completely enclosed and weighs approximately 12-1/2 pounds. It operated from 28 volts DC, requiring 3.25 amperes, with a self-contained dynamotor supplying the "B" voltage.

Since the APS-13 is designed to operate in the 420-Mc. range, no major revamping of the tuned circuits in the transmitter and receiver sections is required for amateur use. However, the pulse modulator and other components for the radar functions are not used and therefore are modified or removed from the unit.

(a) Description:

Two 6J6's operating in parallel push-pull as a self-excited oscillator form the transmitter section of the APS-13. Tuning of the transmitter is accomplished by a screwdriver control on the front panel which slides a shorting bar along the 1/4-wave plate line. The antenna circuit is coupled to the 1/4-wave line by means of a "hair pin" pick-up loop which is variable by screwdriver adjustment. Coupling of the antenna circuit is also controlled by the variable antenna loading condenser, C-159.

The receiver section consists of the front-end section (6J6 oscillator and 6J6 mixer), 30-Mc. IF, detector and video. The video output controls audible and visual indicators through the two 2D21 thyratrons and associated relay circuits.

Tuning of the receiver "front-end" is accomplished by screwdriver adjustments from the front panel. The tuning arrangement consists of a shorting bar on the oscillator line and mechanical rotation of condenser plates on the mixer line.

Converted for amateur use, the APS-13 includes the original receiver "front-end" and IF section with an added audio section for AM reception. The audio section also serves as a plate modulator for the transmitter. A conventional AC power supply is also included in the modified version.

(b) Removal of Parts:

For AM operation it is obvious that the pulse modulator must be replaced and the receiver modified for audio reception. This eliminates the pulse forming networks and other associated components used for radar operation as listed below:

Dynamotor	D-101
Relay	K-101, with terminal board and associated parts.
RF Transformers	T-108, T-109, T-110, T-111, T-112, T-113, T-114, T-115, & T-116
Condensers	C-157, C-158 (A & B)
Coil	L-111
Tubes & Sockets	V-110, V-111, V-114, V-115, V-116, & V-117, with all small immediately associated parts.
Terminal Boards	E-116 (on back of front panel), with associated parts. E-103 (associated with V-109; leave tube and socket).
Plug	J-101 (on front panel).
Cover Plate	(on front panel) with associated C-115, C-209, L-153, & L-154
Coax Line	(on front panel) temporarily removed
Receiver front-end section	" "
Transmitter section	" "

Removal of the above components leaves primarily only the IF section. Temporary removal of the transmitter and receiver front-end sections becomes apparent in the following mechanical modifications.

(c) Addition of Components and Controls:

From Fig. 1, it is apparent that the center section of the chassis is cut out with a hacksaw and replaced with a new solid section of sheet dural or aluminum. This operation permits better mounting of the added components and improves the appearance of the completed unit. Dimensions of the removed section and new section are given in Fig. 1.

Before replacing the new chassis section, drilling and cutting of mounting holes for the major added components should be done. The location of these components, power supply and so forth, is not critical and can be determined approximately from the photos.

The following controls and components are located on the front panel:

AF Gain Control (in former position of "Regulation Control")
RF Gain Control (provided with shaft extension for control knob)
Speaker Plug (4 prong socket in former position of J-101)
Microphone Jack (to correspond to microphone used, T-17, etc.)
Transmit-Receive Switch (4 pole, 2 position)
Coax Mounting Bracket (remounted to clear receiver controls as shown in photographs)
Receiver Oscillator Tuning Control (adapted for knob)

(d) Receiver Front-End Section:

Before replacing the receiver front-end section, the removal of several parts and reconnection of the heaters is necessary. Parts to be removed include C-143, C-144 and C-145 feed-through type condensers with terminal board E-119 and all immediately associated parts located on the side adjacent to the oscillator tuning line. The yellow lead to the cathode of V-101 is also removed.

The heater circuit for this section is reconnected for 6-volt operation as shown in the converted schematic diagram, Fig. 5. It should be noted that all the RFC's are used.

To facilitate receiver operation, the existing screwdriver oscillator tuning should be modified for a knob control. This is easily accomplished by using a standard 1/4" shaft extension as shown in Fig. 2. If desired, this same treatment may be used for the screwdriver mixer tuning control.

After the receiver front-end section is replaced in its original position on the chassis, it is reconnected as shown in Fig. 5.

(e) Receiver IF Section:

From the converted schematic diagram, Fig. 5, it is apparent that the five 30 Mc. IF stages are left intact and that only slight circuit changes are made. These primarily involve the voltage supply circuits and the RF gain control.

To obtain correct voltages for the screen grid buss and the plates of the IF amplifier stages, dropping resistors are used with by-pass condensers for ample decoupling. If sufficient decoupling is not used, "motorboating" may occur through the power supply from the AF section.

The new RF gain control varies the screen voltage on the first IF stage. The former RF gain control (cathode circuit of fifth IF amplifier) is removed with the cathode resistor, R-132, being run directly to ground.

Unfortunately in most cases, the upper slug adjusting screws of the IF transformers were clipped off at their stagger-tuned settings. This practically eliminates realignment of the stages in order to narrow the existing pass band. However, this is not too objectionable since there is ample gain available. Also, a relatively wide pass band is desirable to compensate for frequency instability of the modulated self-excited oscillators commonly used in the u.h.f. bands.

It should be noted that slight retuning can be accomplished by careful adjustment of the primary slugs (lower ones). Peaking on noise is satisfactory.

(f) Audio Section:

The added audio section consists of 3 stages: the plate detector (6AG5), first audio amplifier (6AG5), and the second audio power amplifier (6V6). This circuit is of conventional design utilizing as many of the original parts as possible. It should be noted that the microphone circuit derives its excitation voltage from the cathode resistor of the 6V6 stage.

The output transformer is of the conventional push-pull to voice-coil type which utilizes half of the primary winding as a secondary for modulating the transmitter. With the "T-R" switch in the transmit position, the speaker voice coil (secondary) circuit is opened, giving a 1:1 impedance ratio to the plates of the transmitter oscillator.

It should be noted that the "T-R" switch disables the receiver section by removing the plate voltage from the IF section during the transmit period. In the transmit position, the mike transformer secondary is switched into the grid circuit of the first audio amplifier. Also the oscillator becomes active when its cathode circuit is completed by the "T-R" switch in the transmit position.

(g) Transmitter Section:

The transmitter section remains virtually unchanged with exception of the removal of R-155 and R-156. As in the receiver section, the heater circuits are reconnected for 6-volt operation with all the RFC's used. After the transmitter is replaced on the chassis in its former position, it is reconnected as shown in Fig. 5.

(h) Power Supply:

Power requirements for the converted APS-13 are 6.3 volts at 4.3 amperes for the heater circuit, and 300 volts DC at approximately 80 ma. for the plate supply.

The power supply shown in Fig. 5 is adequate for the above requirements and can be conveniently placed on the new chassis section as shown in the photographs. The AC power switch may be located at the AF gain control or separately on the front panel as desired.

(i) Adjustments and Operation:

Before attempting adjustment of the receiver and transmitter, all voltages should be checked. Readings should approximate the values shown on the converted schematic diagram.

If the AF and IF sections are functioning, the oscillator "hiss" (noise) should be heard at the speaker output with its level being varied by both the AF and RF gain controls.

With the oscillator tuning set at its approximate mid-position, the mixer can be tuned through resonance with an obvious increase in noise level at the resonant point. Mixer resonance should occur near the open position of its condenser plates. If it is not near this point, the tuning range of the mixer can be shifted by moving the shorting bar on the mixer line. Generally this adjustment is not necessary.

Further adjustment of the receiver tuning must be done with an external signal or ignition noise.

In coupling the receiver input to the antenna, adjustment of padder condenser, C-119 (labeled "B" on panel) and the "hair-pin" coupling loop is necessary. Adjustment of the padder condenser, C-119, is critical for optimum performance.

If the self-excited transmitter is oscillating ("T-R" switch in transmit position), its grid voltage will be approximately -22 volts. This reading is obtained when the oscillator is not loaded.

Loading of the transmitter is adjusted by C-159 and the "hair-pin" coupling loop. Under loaded conditions, the plate current of the oscillator should not exceed 50 ma. Normal readings will be around 45 ma. It should be noted that this type of oscillator may not oscillate when too heavily loaded.

Modulation level is adjusted by the AF gain control in the audio section. In normal operation, the AF gain is left at its proper modulation setting for transmission, with the RF gain being adjusted for the desired receiver output level.

For transmitter adjustment, the ordinary 28-volt dial lamp provides a good indicator for RF output and modulation of the RF output.

After connecting the coax matching section to the receiver and transmitter, it is necessary to make slight tuning readjustments both for the transmitter and receiver. When using the antenna matching section, tuning interaction between the transmitter and receiver requires careful adjustment for optimum operation.

Satisfactory operation can be had by using the converted APS-13 with a multi-element beam fed with 52-ohm coax. For proper matching, a series 1/4-wave line section can be used.

(j) Optional Refinements:

For those who may desire to improve further their converted APS-13, the following suggestions may be of interest:

(1) By carefully locating the added components on the new chassis section, sufficient space can be obtained for mounting a small PM speaker on the inside of the front panel. This necessitates cutting a hole or drilling the front panel for the speaker grill-work. With the speaker mounted internally, the speaker plug can be eliminated.

(2) Higher efficiency in the antenna circuit can be obtained by replacing the existing coaxial matching section with an antenna switching relay. This relay may preferably be of the coaxial type.

(3) For added sensitivity and higher signal noise ratio, an added RF stage can be used ahead of the receiver "front-end". Excellent results can be had by using the light-house tube with coaxial tank circuits.

(4) Better performance can be had by using voltage regulation from a VR-105 (used in the original circuit) for the screen supply voltage of the IF amplifier section.

(5) For optimum transmitter adjustment, metering of the grid and plate circuits is very helpful. Also, at these frequencies a field strength meter is advantageous in tuning antenna systems.

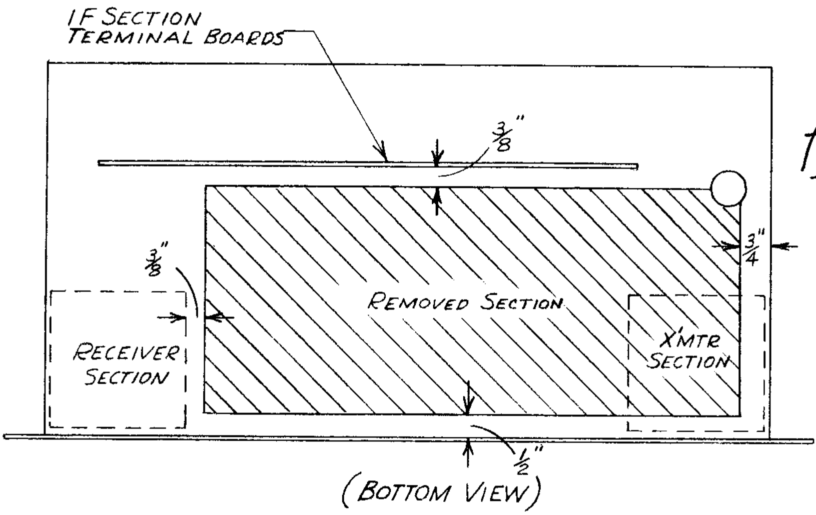
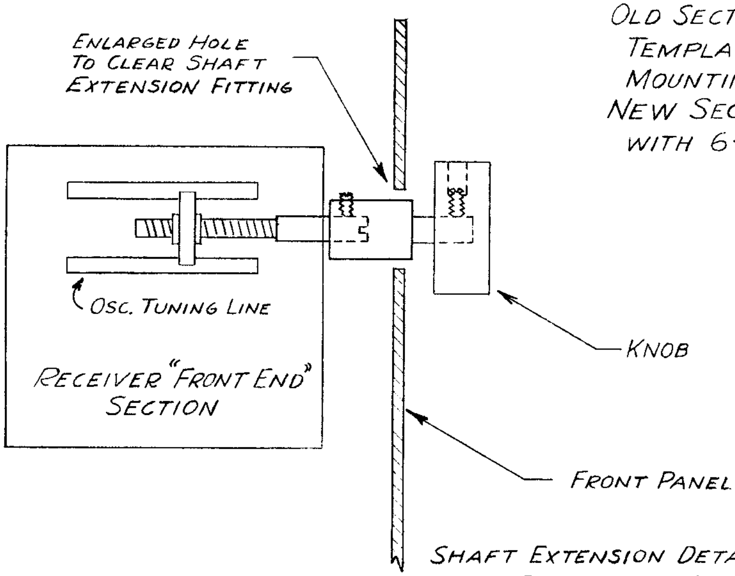


fig 1

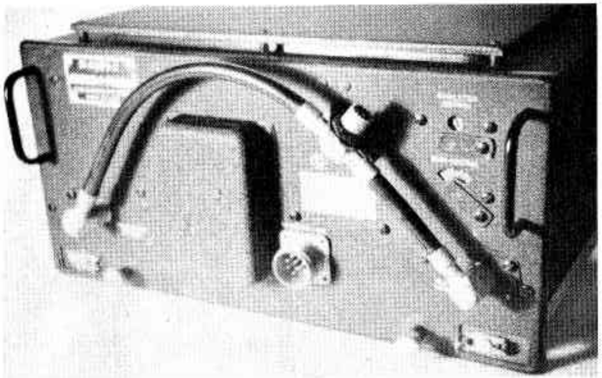
NEW CHASSIS SECTION
$11\frac{3}{8}$" x 5", .040" SO DURAL.
OLD SECTION SERVES AS
TEMPLATE FOR X'MTR
MOUNTING.
NEW SECTION BOLTED IN
WITH 6-32 x $\frac{1}{4}$ SCREWS.

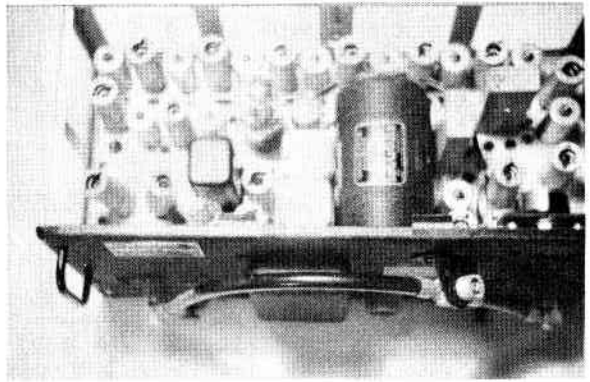


SHAFT EXTENSION DETAIL
FOR RECEIVER H.F.
OSC. TUNING.

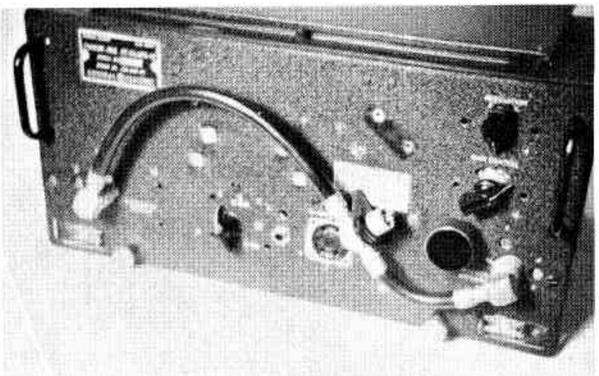
fig 2

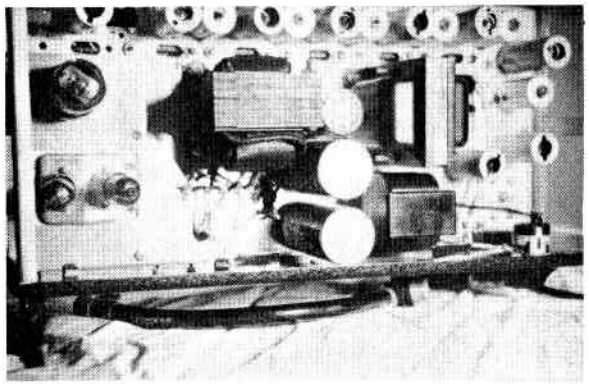
AN/APS-13 PHOTOGRAPHS





(ORIGINAL)





(CONVERTED)

fig 3

APS-13 ORIGINAL SCHEMATIC

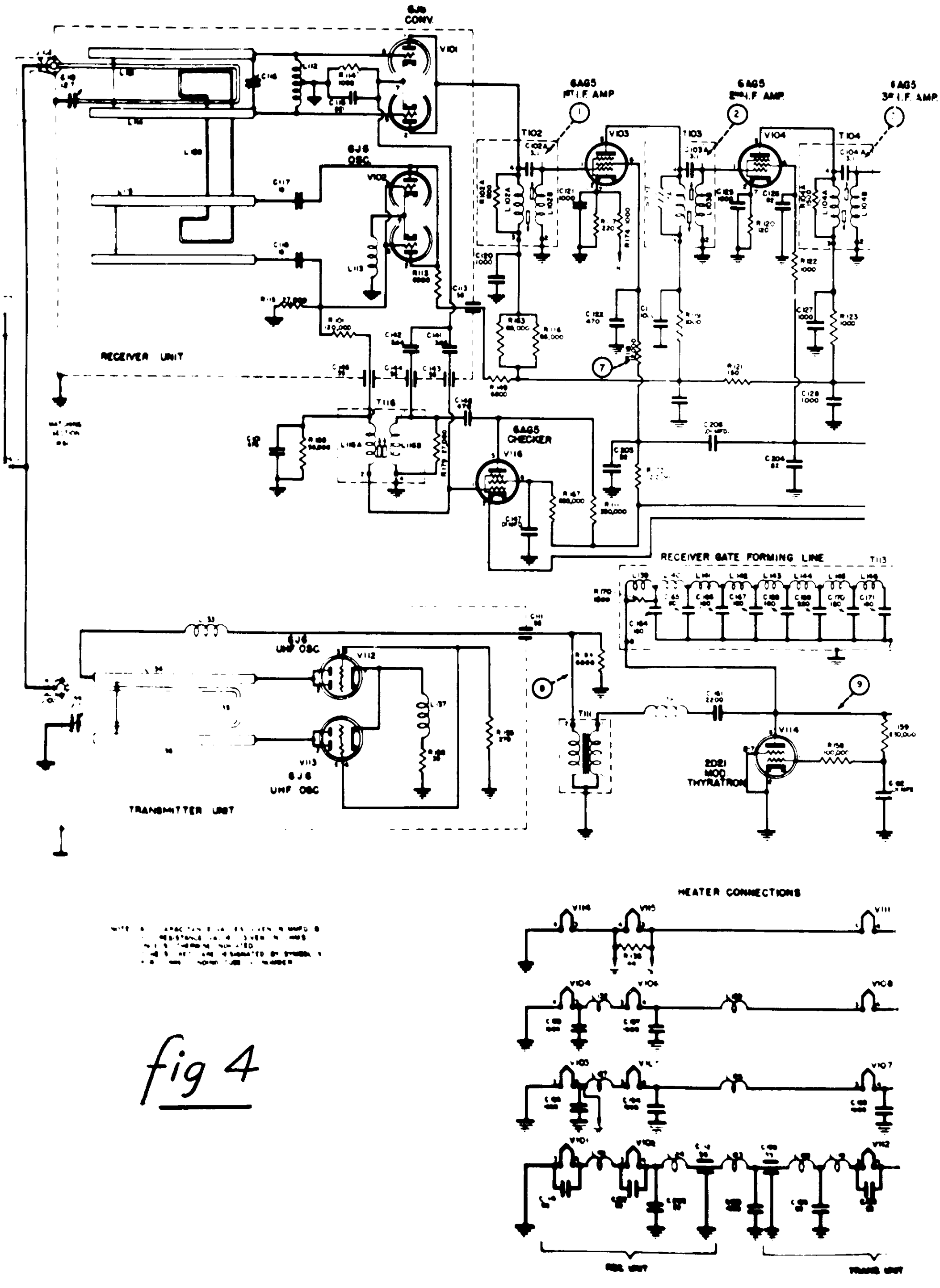
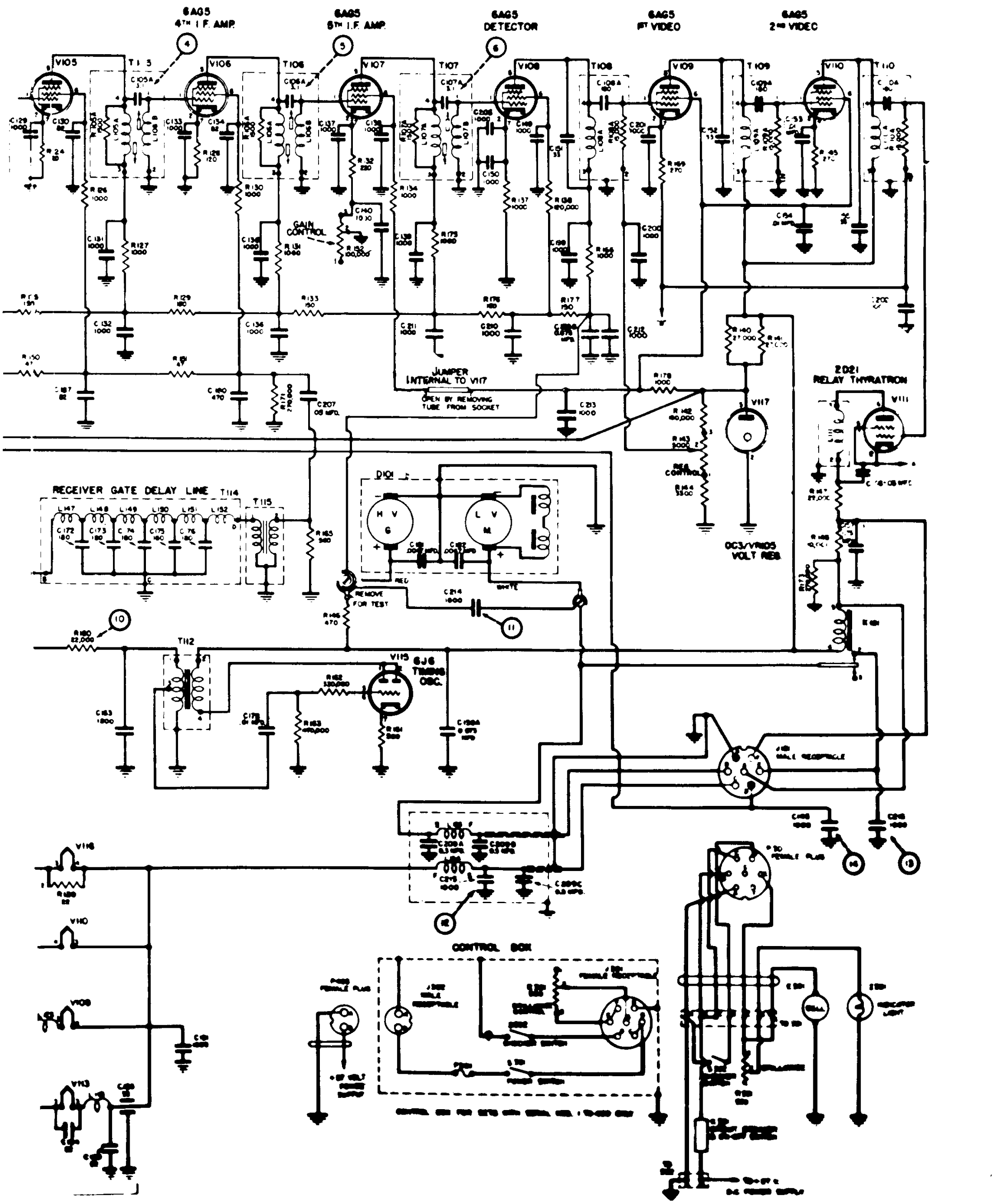
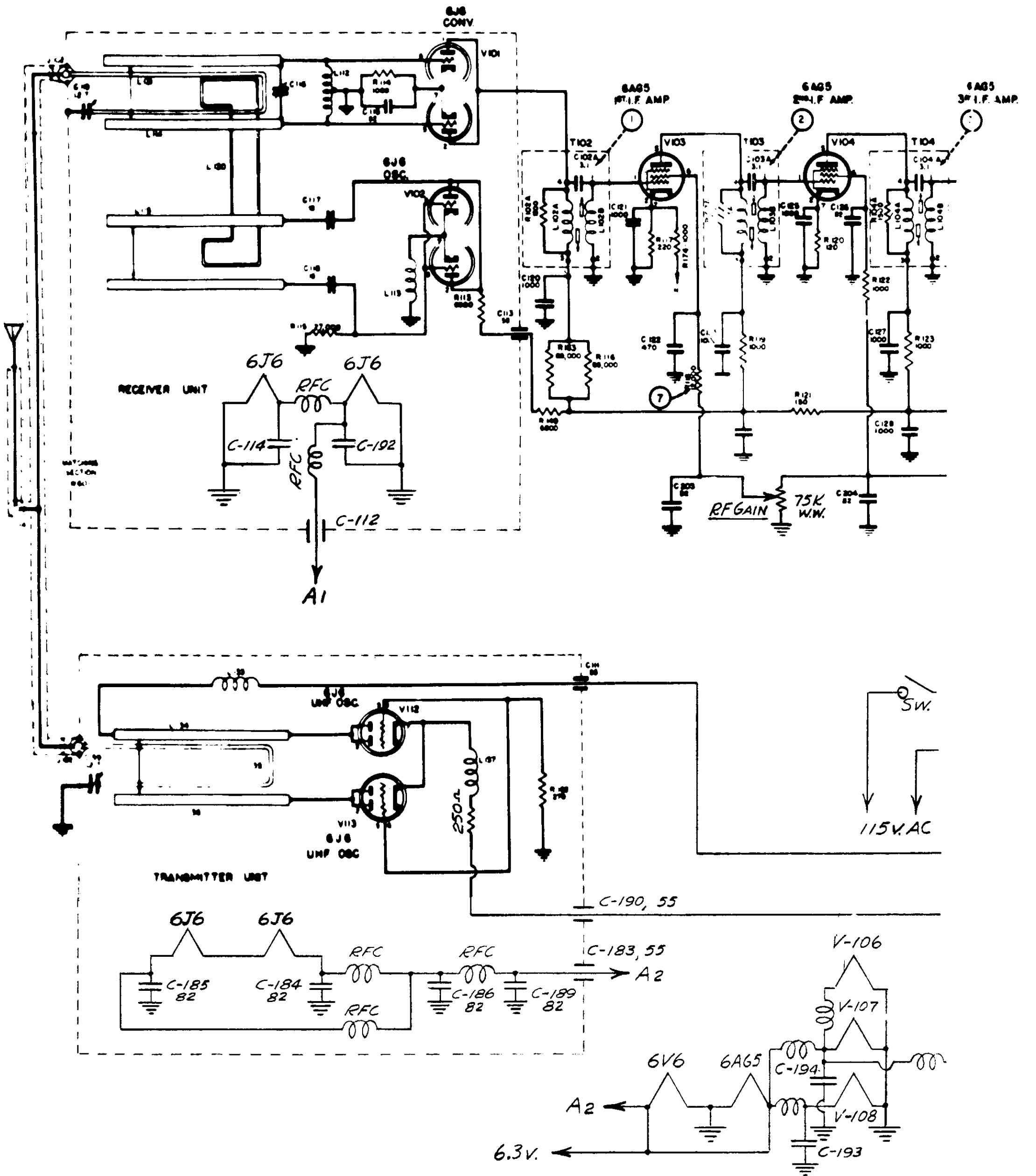


fig 4

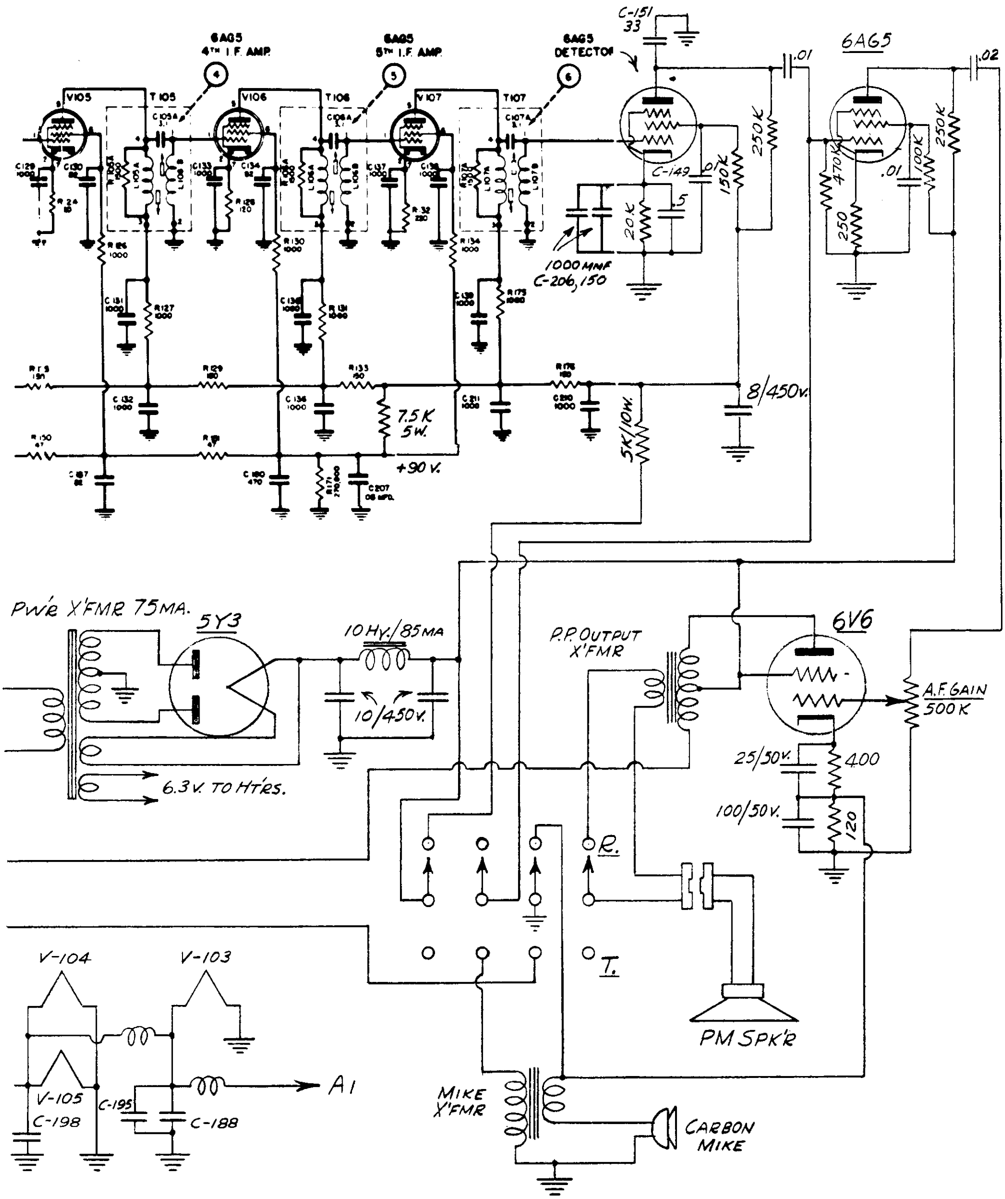
APS-13 ORIGINAL SCHEMATIC



APS-13 SCHEMATIC DIAGRAM (CONVERTED) fig 5



APS-13 SCHEMATIC DIAGRAM (CONVERTED) fig 5



CONVERTING THE ARC-5 OR SCR-274N SERIES TRANSMITTERS FOR 10-METER MOBILE OPERATION

The SCR-274N or ARC-5 series aircraft transmitters, have several good features that justify their modification for 10-meter mobile operation in conjunction with the popular PE-103 dynamotor. This converted transmitter, used in conjunction with the converted 10-meter ARC-5 or BC-454 receiver, also described in this manual, provides the amateur with a satisfactory 28 Mc. mobile rig at a very reasonable cost.

The SCR-274N or ARC-5 series transmitter consists of a stable VFO with a directly calibrated dial driving a pair of parallel 1625's (12-volt 807's). The existing circuit requires 28 volts DC using series-parallel circuits for the 12-volt tubes. The plate voltage supply is obtained from a 28-volt dynamotor located in the separate modulator unit. The circuit also includes a tuning-eye indicator and a plug-in crystal unit for calibration of the VFO.

This conversion deals with the more popular unit, the BC-459, having the fundamental frequency range of 7 to 9.1 Mc. Multiplying by 4, the output frequency becomes 28 to 36.4 Mc which includes the 10-meter band. It becomes apparent that the BC-457, which has a fundamental frequency of 4 to 5.3 Mc, with a frequency multiplication of 6, covers 24 to 31.8 Mc, thus including both the 10 and 11-meter bands. If the BC-457 is used, the only variation required from the conversion described herein is that the stage following the VFO must function as a tripler instead of as a doubler.

(a) Preparation of the Chassis:

From the photographs and the converted circuit it is apparent that all components and associated wiring are removed with the following exceptions: the VFO circuit, coil compartment, and variable condenser C-63 which are left intact; the variable condenser (C-65) which was originally the PA tuning condenser; the mechanical tuning gear and drive arrangement; and the tube sockets.

After stripping the chassis, except for the VFO which is left unaltered, variable condenser C-65 is mechanically uncoupled from the oscillator tuning control shaft. This is accomplished by removing the drive gear from the condenser shaft. The shaft is then extended through a hole in the chassis skirt for an external knob or screwdriver control with a locking device. This condenser becomes part of the PA plate circuit and functions as the antenna loading condenser.

Since a mating plug for the existing J-64 at the rear end of the chassis is not always available, it is replaced with a standard 6-prong tube socket.

Relays K-53 and K-54, along with the antenna connection post, are also removed from the chassis. Relay K-53, which is located on the under side of the chassis, should be saved. After modification it is used for the new antenna switching relay.

(b) Tube Substitution:

For 6-volt operation all the existing 12-volt tubes must be discarded. The 1626 oscillator tube can be directly replaced by a 6J5, its 6-volt equivalent. The metal type is preferred.

The two sub-chassis sockets formerly occupied by the two 1625's are now modified for the 807 (PA) and the 6V6 (second doubler). Due to the different base of the 807, the 7-prong socket holes must be filed out with a small round file to accept the 807 as shown in Fig. 1. Before filing, the spring clips on the bottom of the socket should be removed so as not to damage the contacts. The spring clips are replaced after the pin holes have been modified.

The second sub-chassis socket is modified for mounting the 6V6 octal socket. The spring contacts are removed and discarded by drilling out the rivets. A hole of sufficient diameter is cut in the insulating material to accept a standard ring-mounted octal socket. Care should be exercised to avoid cracking the insulating material.

As shown in Fig. 2, the first doubler (6SK7) occupies the socket of the former calibration indicator (1629). The heater circuit is then wired for parallel operation with one side grounded as shown in the diagram, Fig. 6.

(c) Addition of the Frequency Multiplier Stages:

For conservation of space and ease of operation, permeability tuned coils are used for both doubler stages (14 Mc. & 28 Mc.). These forms are available in all varieties, both surplus and standard manufacture. Since the efficiency of these stages is not of importance and relatively broad tuning is desirable, the distributed circuit capacitance is sufficient for tuning the coils to resonance.

Coil winding data is given in Fig. 4. If forms of different diameter are used, the number of turns should be varied accordingly. The resonant point and harmonic output of the doubler stages can be easily determined with an absorption-type wavemeter. A small neon lamp is also useful for adjusting these stages.

The doubler coils are single-hole mounted to the chassis skirt with the adjustment screw exposed for external adjustment. The first doubler coil is mounted directly under the 6SK7 socket, while the second doubler coil is mounted in the existing hole in the chassis skirt beside the 6V6 socket. The mounting hole was formerly used for the PA padder (C-67) adjustment.

Since the grid leads to both doubler stages are rather long, it is preferable to use shielded cable for both these leads. Low-capacitance mike cable or coax with both ends of the shield grounded should be used.

It should be noted that the first doubler grid is driven from the same point of the VFO that formerly drove the grids of the 1625's. In the first doubler grid circuit, R-74 becomes the grid-leak resistor for the 6SK7; this value should be changed to 100K ohms. Bias for the second doubler is derived both from the grid leak action and from a cathode resistor.

It is important to note the connections to the oscillator coil compartment before removing the original leads. This will eliminate the necessity of removing the oscillator compartment shield to determine the proper connections. Component placement and shortness of leads are important in wiring the two doubler stages as is usual in transmitter design.

(d) Power Amplifier Circuit:

All components, except the antenna loading condenser C-65 and the plate feed RFC are mounted above the chassis. This provides good isolation in addition to convenient mounting and close grouping of components. The PA plate tuning condenser is mounted as near the 807 socket as possible and is controlled by the former antenna loading control shaft and knob. This shaft is modified for coupling to the condenser shaft as shown in the photos. The final tank, (L-3) is mounted vertically beside the PA tuning condenser.

A centralized junction point for the RF leads from the antenna coupling condenser, the final tank, and the antenna loading condenser is made by relocating the porcelain feed-through button as shown in the photograph.

For isolation, the PA feed RFC is located under the chassis with its associated by-pass condenser directly between the end of the antenna loading condenser and the chassis skirt.

(e) Antenna Circuit:

As indicated in the converted schematic diagram, Fig. 6, the PA tank circuit and the antenna loading condenser form a pi-network. With each setting of the loading condenser, the PA tank must be retuned to resonance. Greater loading requires less capacitance in the loading condenser and more capacitance in the PA tuning condenser to maintain resonance.

The original relay K-53 is modified by rewinding it for 6-volt operation and revamping the contacts as shown in Fig. 3. With the relay in its open position (unexcited) the transmitter RF circuit to the antenna is open and the receiver is switched to the antenna. The relay is mounted inside the transmitter front panel in the former position of K-54 without the necessity of drilling new holes. The antenna switching relay is coupled to the pi-network through a .001 mfd. silver-mica condenser.

(f) Metering:

The second doubler grid, PA grid, and the PA plate circuits are metered. Midget closed-circuit jacks are located on the chassis skirt as near to the circuits concerned as possible. The locations should be apparent from the photographs.

If a single meter is used, the proper shunt values must be determined for the circuits concerned. A O-1 ma. meter can be used satisfactorily with approximate shunt values of 15 ohms for Ra and 0.75 ohms for Rb. If accurate readings are desired, shunts must be determined experimentally for the individual O-1 ma. meter used.

(g) Modulator:

The modulator described herein is capable of delivering 12 watts of audio power which will satisfactorily plate modulate 25 to 30 watts input to the power amplifier.

A separate, completely enclosed, chassis is used for the modulator. As shown in the photographs, the chassis from the AM-26 Interphone Amplifier will serve the purpose satisfactorily; however, any chassis of similar size can be used.

The circuit consists of push-pull 6V6's driven by a push-pull connected 6SN7 which in turn is driven by the surplus T-17 single-button carbon microphone. Transformer requirements include a mike to push-pull grids transformer and a modulation transformer such as the UTC S-18. The impedance transformation from the 6V6 plates to the 807 is 9000 to approximately 6000 ohms. The actual impedance of the PA will depend upon the loading of the PA circuit.

To avoid poor voltage regulation and large dissipation in a dropping resistor, the full 500-volt output of the PE-103 dynamotor is applied to the plates of the 6V6's. To permit this high voltage, the cathode bias is increased considerably above that used in normal audio applications. Normal voltages for the screens of the 6V6's and the 6SN7 as well as for the low voltage stages in the transmitter are obtained through dropping resistors as shown in Fig. 6.

One feature to be noted is that the mike excitation is obtained from a tap on the cathode resistor of the 6V6's. This consists of a potentiometer in series with the cathode resistor at the low potential end. The swinger of the potentiometer supplies the excitation voltage for the mike and also serves as a mike gain control. This is an optional arrangement since the mike voltage can also be obtained from the 6-volt automobile battery through an appropriate RC hash filter.

(h) Control Circuits:

Because the transmitter, modulator, and dynamotor are normally located in the trunk or rear section of the automobile, a remote control box is required for operation from the front seat of the car. This control box is usually located at some convenient point on the dash panel and includes a mike jack (for PL-66), a toggle switch (s.p.s.t.) and a pilot lamp.

Since slow-heating cathode-type tubes are used in this version, the heater circuit must be separately controlled from the high-voltage circuit. To avoid damage to the tubes, the heaters should be on approximately 30 seconds before the high voltage from the PE-103 is applied.

From the control circuit diagram, Fig. 7, it is evident that a separate power switch operates the heater circuit and also the pilot lamp circuit in the control box. Closing the "push-to-talk" switch on the hand microphone operates the dynamotor relay circuit and the antenna switching relay.

Even though it is preferable to use a separate relay for the heater circuit, in this instance it can be eliminated if a heavy No. 8 or No. 10 lead of minimum length is used between the modulator and the Remote Control Box. Voltage drop is not appreciable since the current in this circuit only approximates 3 amperes.

The total load drawn from the car battery when operating the transmitter will be approximately 25 amperes. Normal operation and tuning adjustments will not overload the circuit breakers in the PE-103; if they do open, trouble can be expected in the transmitter and modulator circuits. The connection diagram and operation for the control circuits should be self-explanatory from Fig. 7.

(i) Operation:

Preliminary operation and adjustment should be done on the bench with reduced voltage (200 to 250 volts) on the PA. This precaution is obvious since PA bias is derived by the grid-leak action. The lack of RF excitation to the grid of the 807 would result in permanent damage to the tube if high voltage were used. However, the VFO always oscillates, while crystal oscillators often do not.

With low voltage applied to the transmitter, set the oscillator at approximately 7.25 Mc. and adjust the two doublers to their proper harmonic. As previously mentioned, this is easily checked by an absorption-type wave meter. The second and fourth harmonics are 14.5 Mc. and 29 Mc. respectively.

If the doubler stages are resonant at their proper frequency, the final stage can be tuned to 29 Mc. as indicated by the dip in its plate current. For this initial adjustment, the antenna loading condenser should be set at its maximum capacitance (minimum loading). This results in the most pronounced dip in the PA plate current.

The modulator may be separately checked by connecting an ordinary output transformer and PM speaker to the secondary of the modulation transformer. Audible check for distortion and response should be sufficient in this case. The power output can be roughly checked along with the amount of excitation voltage for the mike by measuring the a-c voltage across a 6000-ohm, 10-watt resistor connected across the output of the modulator.

Before replacing the covers on the completed transmitter, the VFO should be recalibrated. This is necessary in order to compensate for the slight electrical differences in the new circuit following the VFO, and for variation between the former 1626 and the 6J5. Recalibrating is a simple operation and is done by setting the VFO dial to 7.50 Mc. and beating its second harmonic with WWV's 15 Mc. signal in your receiver. Zero beat is attained by adjusting the oscillator padder condenser (C-60) accessible through the top of the VFO coil compartment. Generally, the oscillator inductance (slug adjustment, exposed screw on top of VFO coil compartment) need not be changed.

Due to the relatively broad tuning of the multiplier stages and the loaded PA circuit, the transmitter frequency can be shifted considerably by merely tuning the VFO.

When the transmitter is functioning properly, full voltage may be applied to it and the modulator from the PE-103 with the following expected meter readings:

Second Doubler Grid Current	0.6 ma.
PA Grid Current	4 to 5 ma.
PA Plate Current	80 to 90 ma. (normal loading)

When loading the PA to the 1/4-wave (approx. 100 inches) whip antenna or a dummy antenna, the capacitance in the loading condenser is decreased as the loading is increased. As previously mentioned, the final tank circuit must be retuned to resonance for each new setting of the loading condenser. Normal loading for the PA should be between 80 to 90 ma. with the full applied voltage.

(j) Optional Refinements:

For those who may desire additional refinements, the following suggestions may be of interest:

(1) Monitoring Circuit, especially useful for checking the transmitter output can be added with a one-turn pick-up coil at the cold end of the PA tank coil. The output from the circuit shown in Fig. 5 is brought out to the transmitter front panel for high impedance phones.

(2) Resonance Indicator, which consists of a pick-up turn at the cold end of the PA tank coil with a .15 ampere pilot lamp, provides easier adjustment of the PA tuning. The pilot lamp can be located directly behind the plastic window on the transmitter front panel.

(3) Heater Circuit Relay, which avoids the necessity of heavy leads to the remote control box, can be placed in the heater circuit and located on the modulator chassis. This relay can be wired for both local and remote control.

(4) Metering, can be more elaborately done by mounting a 2-inch O-1 ma. meter in the front panel of the transmitter with a rotary switch and circuit as shown in Fig. 5.

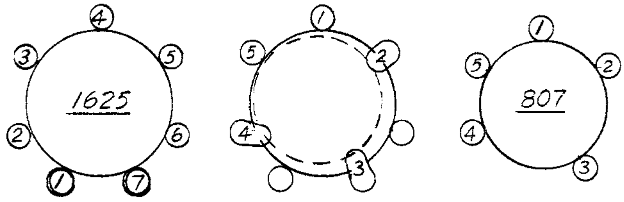
(5) Crystal Microphone, can be added with an extra stage of voltage amplification at the front end of the modulator. This stage should consist of a 6F5, 6J7, or similar tube. The circuit can be located at the remote control box as the preamplifier and must incorporate the conventional mike gain control.

(6) Stabilization of the VFO, can be slightly improved by regulating its plate-supply voltage. This can be accomplished in the conventional manner through the use of VR tubes.

(7) Mounting For the Transmitter, can be facilitated by using its regularly associated FT-226A mounting rack. By using both sections of the rack, both the transmitter and modulator can be mounted. This will also provide convenient removal of the units for adjustment and servicing.

For additional data, refer to Volume I of the "Surplus Radio Conversion Manual", "SCR-274N Transmitter Conversion to VFO."

BOTTOM VIEW OF SOCKET



MED. 7-PIN BASE MODIFIED SOCKET FOR 5-PIN BASE 5-PIN BASE

fig 1

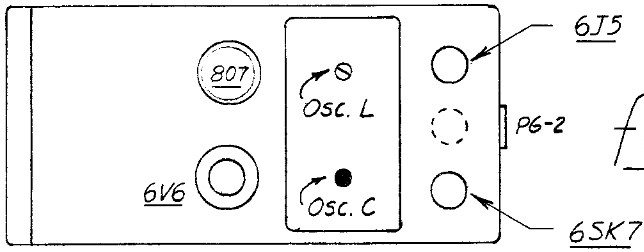


fig 2

TOP VIEW OF CHASSIS

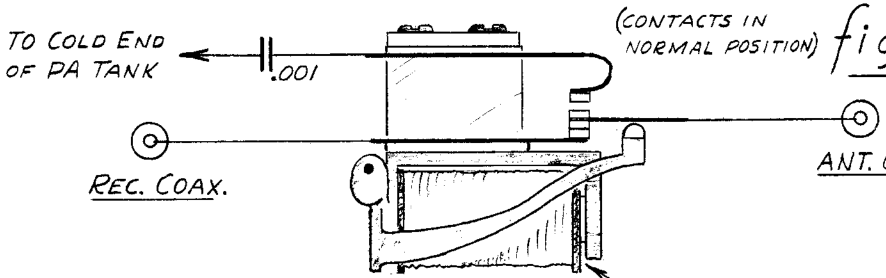


fig 3

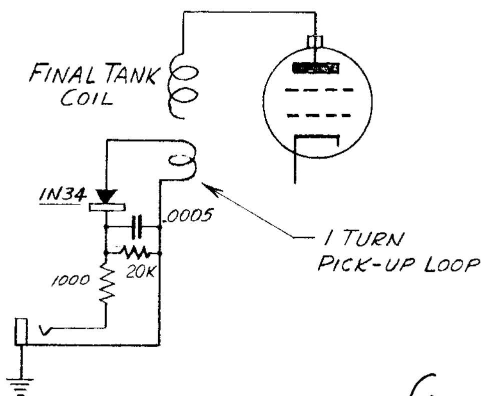
MODIFIED ANTENNA RELAY

COIL IS REWOUND FULL OF #32 ENAMEL FOR 6V. OPERATION.

COIL WINDING DATA

fig 4

L-1	(1st doub. plate)	14Mc	12 turns, #24 enamel, close wound on 5/8" dia. form.
L-2	(2nd doub. plate)	28Mc	7 turns, #20 enamel, space wound on 5/8" dia. form, length 3/8".
L-3	(PA plate)	28Mc	9 turns, #16 tinned, 1-1/4" long on 1" dia. form.
RFC-1	(parasitic choke)		7-1/2 turns, hook-up wire in plate lead, 1/4" dia. 1/2" long.



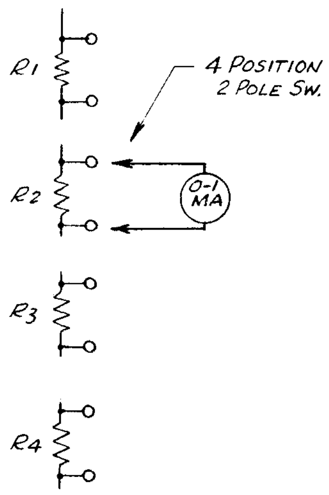


fig 5

VALUES FOR METER SHUNTS DETERMINED FOR CIRCUIT CONCERNED & METER USED.

Control Circuits for Mobile Transmitter

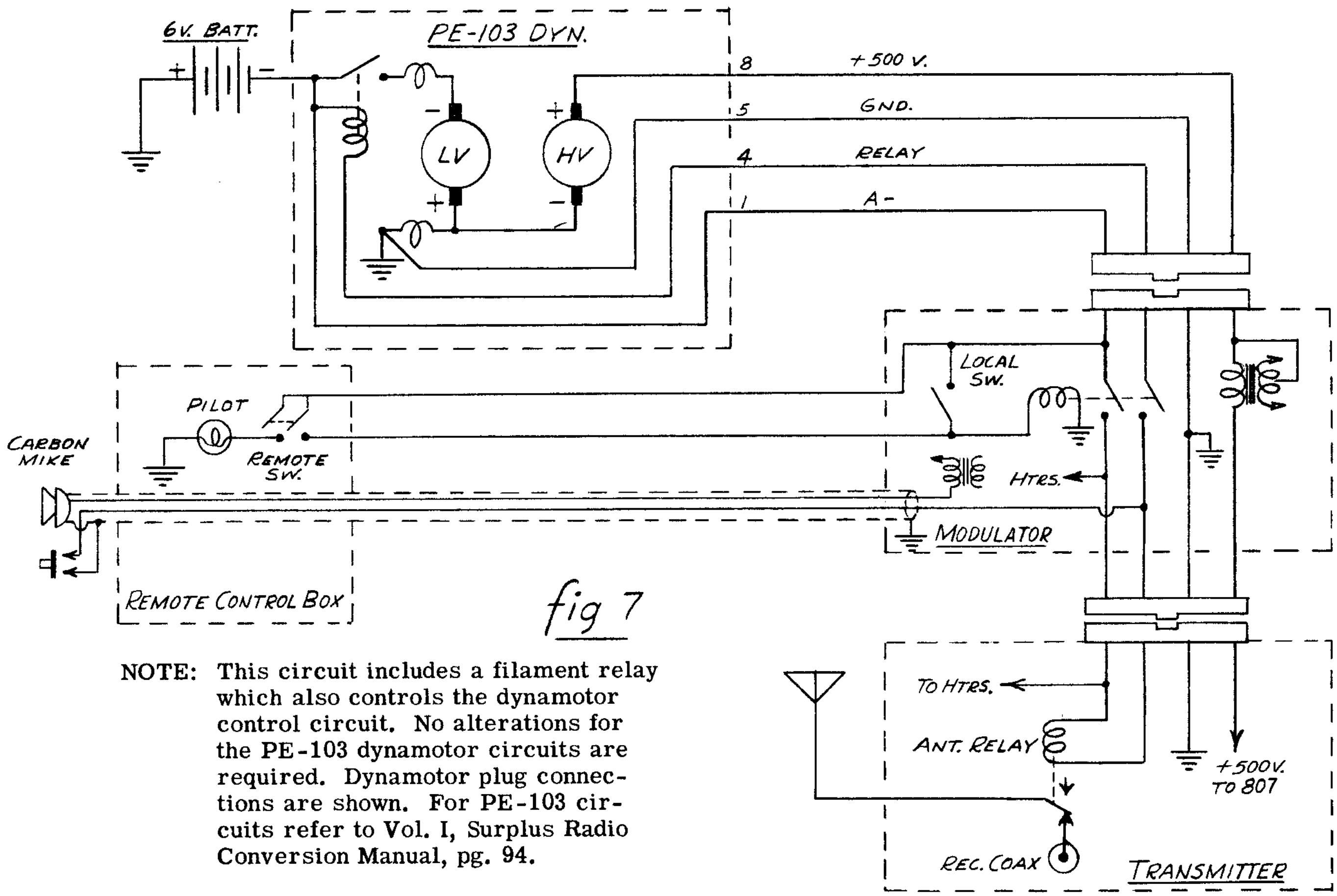
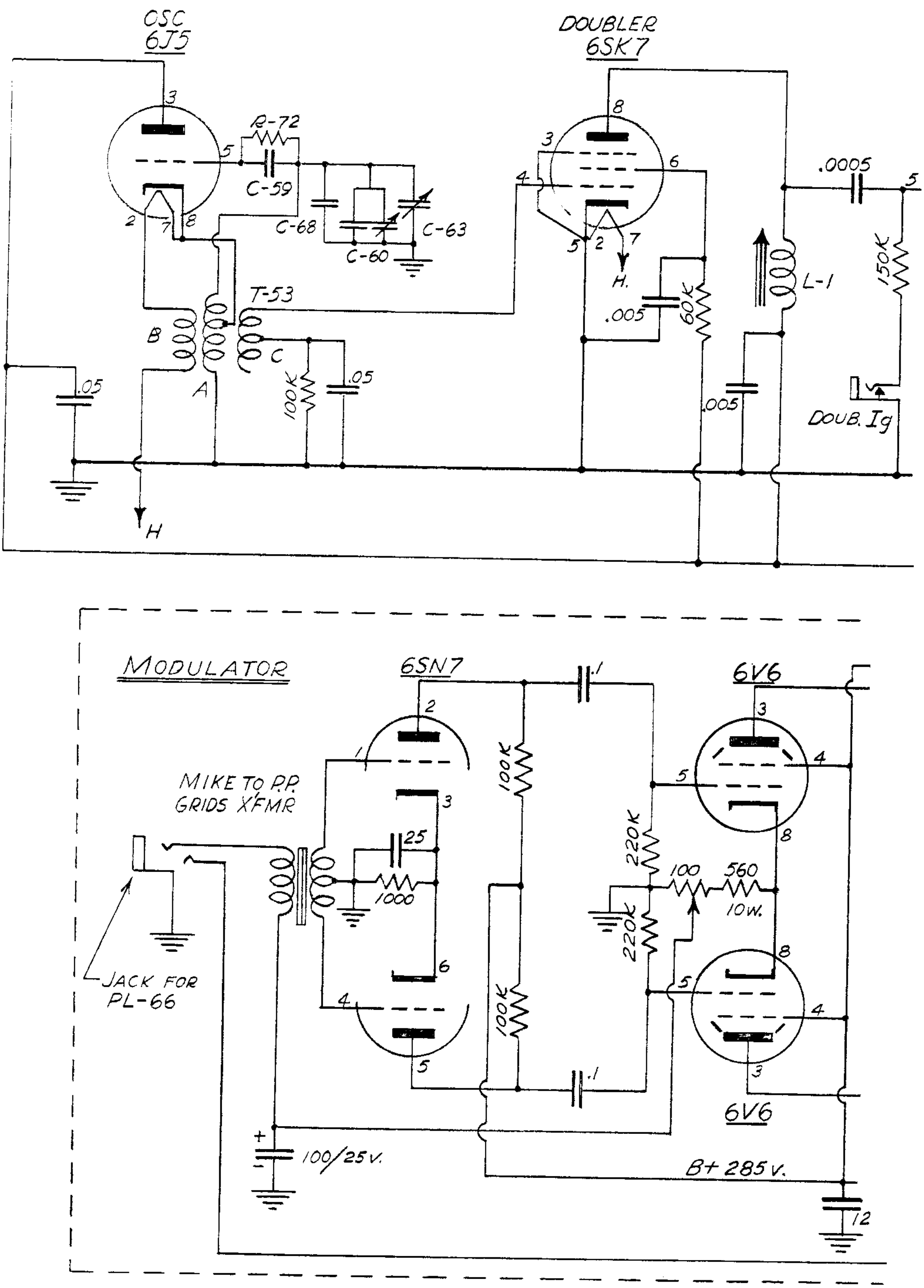


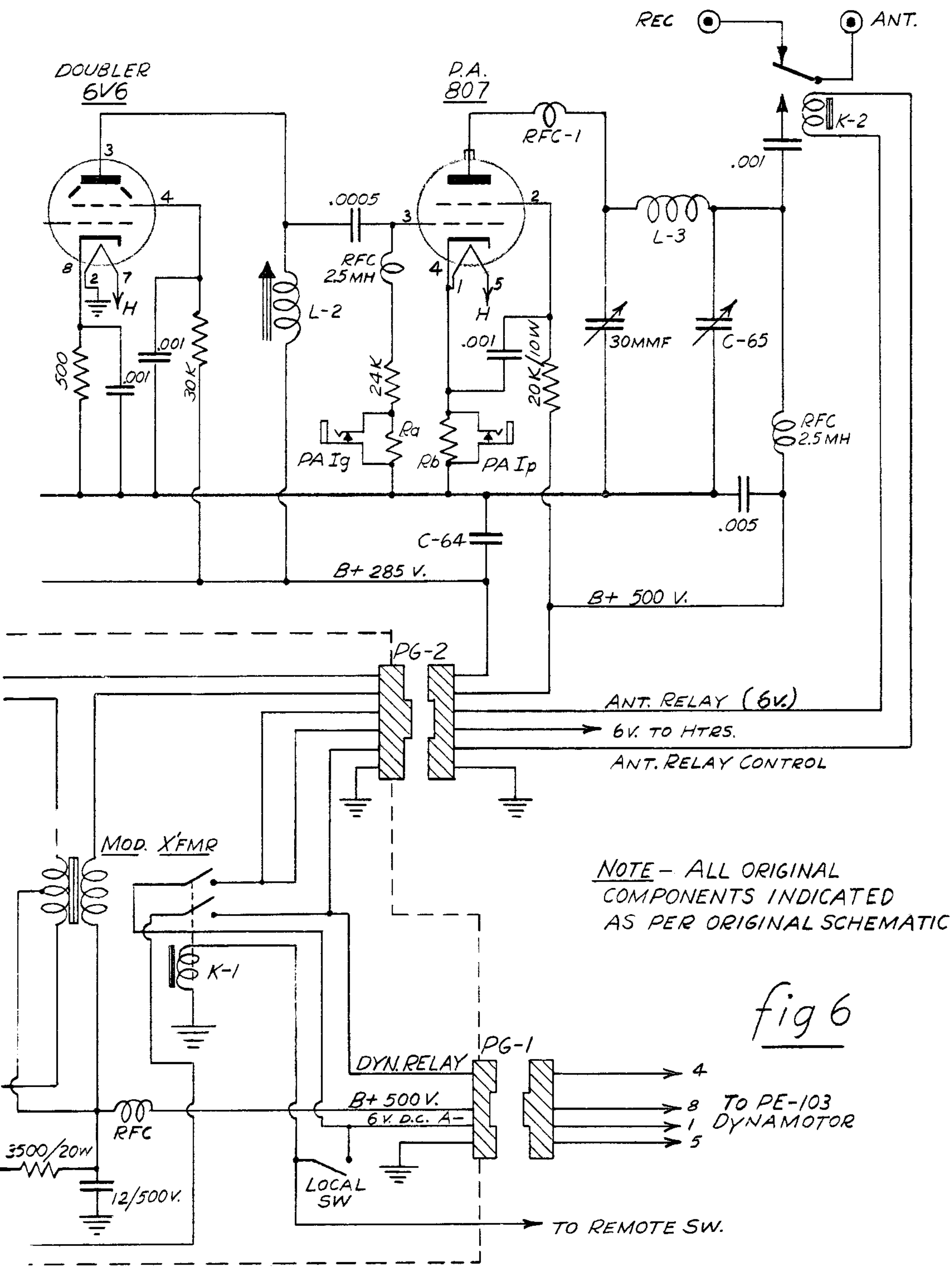
fig 7

NOTE: This circuit includes a filament relay which also controls the dynamotor control circuit. No alterations for the PE-103 dynamotor circuits are required. Dynamotor plug connections are shown. For PE-103 circuits refer to Vol. I, Surplus Radio Conversion Manual, pg. 94.

MODIFIED BC-459 X'MTR & MODULATOR SCHEMATIC



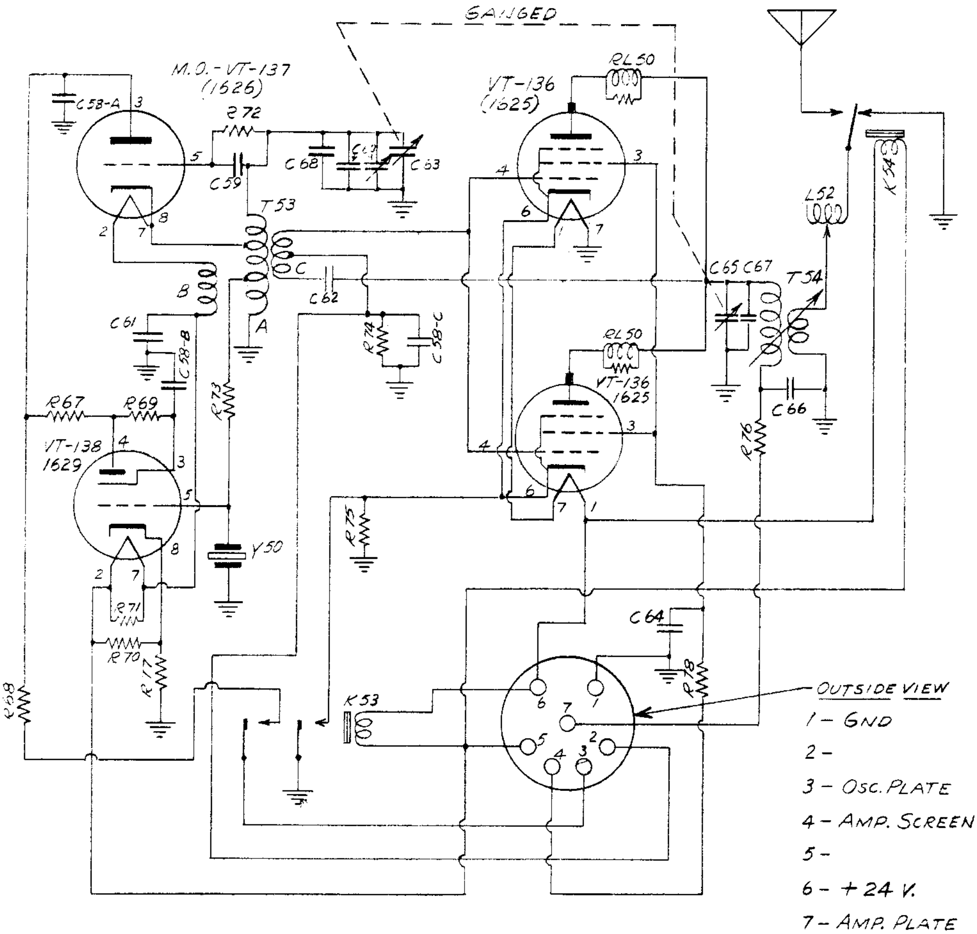
MODIFIED BC-459 X'MTR & MODULATOR SCHEMATIC



NOTE – ALL ORIGINAL COMPONENTS INDICATED AS PER ORIGINAL SCHEMATIC

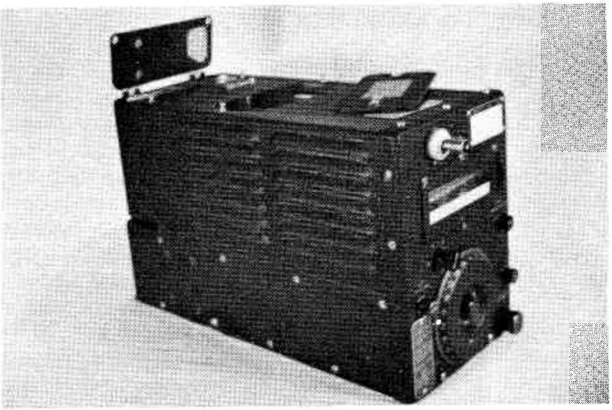
fig 6

SCHEMATIC OF BC-459 TRANSMITTER (7-9.1 Mcs)



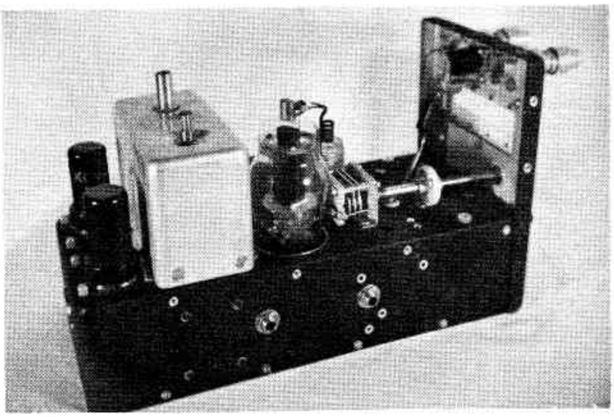
C58A,C58B,C58C - .05 uf	L52 - Ant. Loading Coil
C59 - .00018 uf	R67,R72,R75, - 51,000 ohms
C60 - Master Osc. padding	R68,R76, - 20 ohms
C61 - .006 uf	R69 - 1 Megohm
C62 - Fixed Neutralizing	R70 - 1000 ohms
C63 - Master Osc. tuning	R71 - 126 ohms
C64 - .002 uf	R73,R74, - 15,000 ohms
C65 - P.A. tuning	R77 - 390 ohms
C66 - .01 uf	R78 - 51 ohms
C67 - P.A. padding	RL-50 - Parasitic Suppressors
C68 - 3.0 uuf	T53 - Oscillator Coils
C69 - 50 uuf	T54 - Amplifier Coils
K53 - Xmttr Selector Relay	Y50 - Crystal Unit
K54 - Xmttr Output Relay	

fig 8

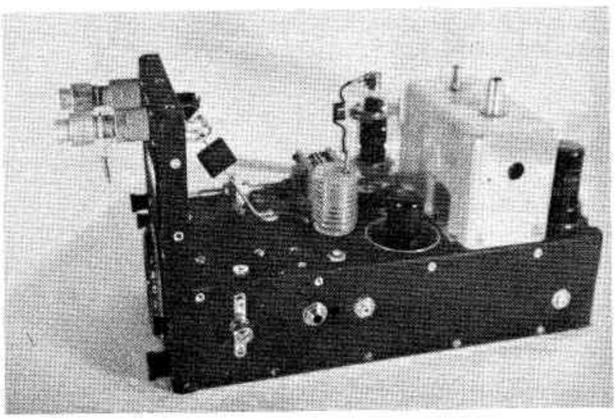


ORIGINAL ARC-5 TRANSMITTER

fig 9



CONVERTED MOBILE TRANSMITTER

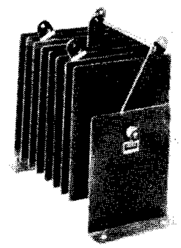


SELENIUM-RECTIFIER POWER UNITS

A majority of the items of electronic equipment available on the surplus market are designed for operation in military aircraft. Hence, these items of equipment have been designed for the types of power supply available aboard such an aircraft. Three types of power supply have been standard; these are: 12-14 volts d.c., 24-28 volts d.c., and 115 volts a.c. at 400 cycles or 800 or 2400 cycles. It is impracticable to attempt to construct a high-frequency a-c supply for the operation of electronic equipment requiring such a source of power. It is better in such cases to construct a completely new power supply for the equipment and to design this power supply for operation from the standard 115-volt 60-cycle line.

Many of the items of surplus equipment are designed in such a manner that certain of the operating features and conveniences are lost when a 12-volt or 24-volt d-c power supply is not available for the unit. Relays, motors, band-changing systems and such conveniences must have a sizeable d-c power supply for their operation in many of the items of equipment. And if a d-c power supply is made available for these sections of the equipment it is often practicable and even less expensive to construct a slightly larger d-c power supply so that the plate-supply dynamotor and the tube heaters also may be operated from the d-c supply.

Typical 28-Volt Medium-Current Selenium Rectifier. (Vickers)



Features of the Selenium-Rectifier Power Supply:

The selenium-rectifier power supply for the production of low-voltage high-current d.c. is a completely reliable and quite satisfactory item of equipment. The efficiency of operation of such power supplies is quite good, running from 75 to 85 per cent at full load on the basis of output to input wattage. Regulation is adequate, running from three to five per cent from half-load to full-load current. The life of the rectifier unit is, for amateur use particularly, substantially unlimited; a standard unit running at rated load with normal cooling will show a loss of only a few per cent in output voltage after a 10,000-hour period of operation. The rectifiers deliver full output as soon as they are turned on and they are completely silent in operation since there are no moving parts.

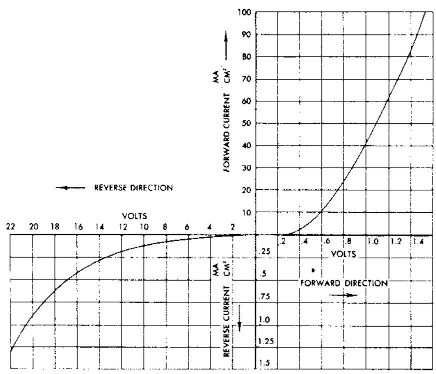


Figure 1 - Forward and reverse current characteristics of a typical selenium-rectifier plate.

Design of Selenium-Rectifier Supplies:

Figure 1 shows the static forward and reverse current characteristics of a typical selenium rectifier plate. It can be seen that current flows much more readily in one direction than in the reverse direction. However, there is a moderate limit to the value of reverse voltage which may be applied to such a rectifier plate. The actual value of the maximum value of reverse r-m-s voltage which may be applied to each plate of a selenium rectifier depends upon the size of the plate and upon the maximum temperature at which the plate will be operated. Under ordinary conditions this maximum permissable reverse voltage varies from something over 20 volts for the small rectifier units used in a.c.-d.c. power supplies down to about 14 volts for the larger of the plates used in low-voltage high-current power supplies.

Figure 2 shows the dynamic voltage drop across each of the plates of each section of a selenium rectifier unit. A half-wave rectifier has only one section, a full-wave rectifier has two sections, and a bridge rectifier of the type used in low-voltage supplies has four sections. Rectifier units designed for an output voltage of 12 to 14 volts have only one rectifier unit for each of the four sections of the bridge rectifier, while units designed for 24 to 28 volts output have either two or three units in series in each of the sections. In the curves of figure 2 the number (1) represents the very smallest rectifier plate while (6) represents a relatively large plate of the type used where several amperes of output current will be required.

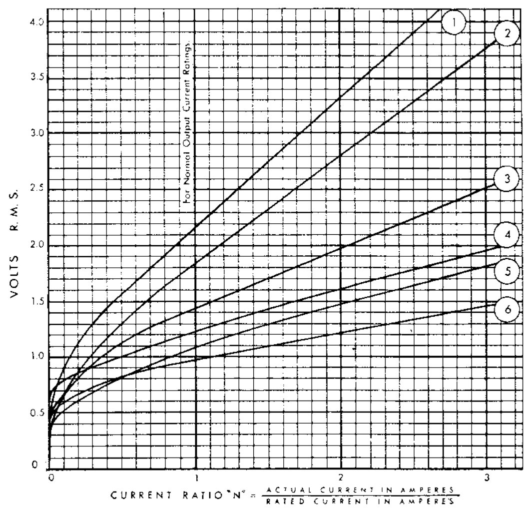


Figure 2 - Dynamic voltage-drop characteristics of six typical selenium-rectifier plates.

From figure 2 it can be seen that a voltage drop of approximately one volt for each plate connected in series in the effective current path within the power supply will be obtained at full load. Referring to the recommended circuit for a selenium-rectifier power supply, figure 3, it can be seen that the number of plates in series in the current path for a bridge rectifier is twice the number of plates in each section of the rectifier. And, with a choke-input power supply, the average output voltage of the rectified wave is 0.9 times the transformer secondary voltage. Hence, with a nominal 28-volt power supply as shown the output voltage will be 0.9 times the transformer secondary voltage minus about 4 volts rectifier drop (assuming two plates per section in the rectifier) minus the resistance drop in the power transformer and the drop in the filter choke.

The power transformer which feeds the rectifier must have a current rating of at least 1.15 times the d-c output current which will be taken from the power supply. This comes about as a result of the fact that the r-m-s value of the alternating current wave which is fed to the rectifier is 1.15 times the average or d-c value of the rectified wave.

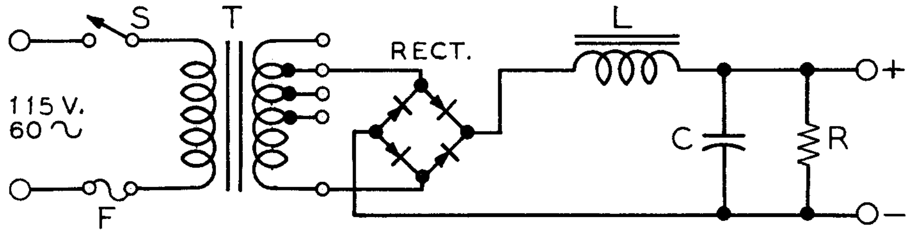


FIGURE 3

TYPICAL VALUES FOR A 28-VOLT, 10-AMPERE SUPPLY.

S - A.C. LINE SWITCH.
F - 5-AMPERE FUSE.
T - TAPPED 35, 36, 37, AND 38 VOLTS AT 12 A.
L - 0.025 HENRY, 10 AMPERES.
C - 2000 μFD., 50 VOLTS.
R - 30 OHMS, 50-WATT BLEEDER RESISTOR.
RECT. - 10-AMPERE, 28-VOLT SELENIUM BRIDGE RECTIFIER.

The use of a choke-input filter for the output of the selenium rectifier in a high-current power supply is to be preferred over the use of a filter capacitor directly across the output of the rectifier. With a capacitor-input filter across the output of the rectifier (in such cases a single capacitor is usually the only filter) the d-c output voltage will be somewhat higher, but the regulation will be much poorer and the r-m-s current through the rectifier will be approximately 1.2 times the d-c current being taken from the supply. With a choke-input power supply the d-c output voltage is as stated in the paragraph above, the regulation is good, and the r-m-s current through the rectifier is only 0.8 times the d-c output current of the power supply.

Filter chokes for low-voltage high-current power supplies are not so easily available as rectifiers. But a relatively small amount of inductance is required of such a choke. The minimum value of inductance required is determined through the use of the same formula as used in determining the value of the input choke for a conventional mercury-vapor-rectifier high-voltage power supply. $L = R_L/1000$. In this case R_L represents the smallest value of load resistance which will ever be used across the output of the power supply. If the power supply will sometimes be allowed to run without external load, R_L is the value of the bleeder resistor which will be used. However, if the power supply always will be operated with full load, R_L is equal to the output voltage of the power supply divided by the load current in amperes. The inductance required in a 10-ampere power supply will be found to be in the region of 10 millihenries, depending upon the voltage and upon the minimum current which will be drawn. In most cases it will be found that the choke required by the formula stated above will be about the same in physical size as the choke which normally would be used in a conventional high-voltage power supply with the same power output rating.

The filter capacitor should have a capacitance of 100 to 5000 mfd. depending upon the load being placed upon the power supply and upon the degree of filtering required. However, in many cases and with many items of equipment neither a filter choke nor a filter capacitor will be required. In the power supplies for these items of equipment it is necessary only to connect the output of the rectifier to the input terminals of the equipment. In fact, if it is desired to get by with the bare minimum in the power supply it will be wise to attempt this procedure with the power supply for the equipment in question. If excessive hum or unsatisfactory operation is obtained the filter choke and capacitor may then be added.

The selenium rectifier should be mounted in such a manner that free air circulation is allowed. The rectifier plates are required to dissipate a moderate amount of heat by their operation. The units are designed in such a manner that normal convection currents of air flowing between the plates will accomplish the cooling. Under no conditions should the temperature of any of the plates in the selenium rectifier be permitted to exceed 75° Centigrade. If this temperature is exceeded, rapid deterioration of the plates may be expected. Selenium-rectifier stacks are designed in such a manner that under full load with an ambient (or inside-the housing) temperature of 35° C. the maximum safe operating temperature of the rectifier unit will not be exceeded.

THE ARC-5 VHF TRANSMITTER/RECEIVER

Most "surplus hounds" are well familiar with the popular ARC-5 series transmitters and receivers, but the VHF units of that series are not so well known. The ARC-5 VHF consists of the T-23/ARC-5 Transmitter and the R-28/ARC-5 Receiver, neither of which resembles the lower frequency ARC-5 units which are so common on the surplus market.

This article does not cover the actual conversion procedure, but merely gives information to assist the reader in converting the units as may seem necessary.

The transmitter and receiver are of the crystal-controlled variety, each using four crystals. Both can be set to operate on four channels throughout the range of 100-156 Mc. The units are designed exclusively for phone operation and also are intended only for operation from a remotely-controlled, push-button box.

The modulator (type MD-7/ARC-5) is a separate unit including a 28-volt DC dynamotor which furnishes voltages for the transmitter mounted on the same chassis. The 28-volt dynamotor which supplies voltages for the receiver is located on the rear of the receiver chassis.

The primary power requirements for operation are as follows:

Receiver only	28 volts DC at 2.0 amperes
Xmttr and Modulator (standby)	" " " " 2.7 "
Xmttr and Modulator (transmitting)	" " " " 9.5 "
Receiver, Xmttr and Modulator:	
(standby)	" " " " 4.7 "
(transmitting)	" " " "11.5 "
(channel switching)	" " " " 6.9 "

Transmitter:

The T-23/ARC-5 transmitter weighs 12.3 lbs. and is 15-3/16 inches by 8-9/16 inches by 5-29/64 inches in physical size. It is normally plugged into a type MT-69/ARC-5 mounting rack. For original schematic see Fig. 1, pages 44-45.

The power output is from 6 to 10 watts into a 50-ohm antenna on any one of four frequencies within the following channels:

A - 100-124 Mcs
B - 122-146 "
C - 122-146 "
D - 132-156 "

The crystal frequency to be used for each channel is determined by the following formula:

$$\text{Crystal Frequency equals } \frac{\text{Carrier Frequency}}{18}$$

The Transmitter tube line up is as follows:

V301 (1625) Crystal controlled harmonic oscillator
V302 (1625) 1st harmonic generator
V303 (832A) 2nd harmonic generator
V304 (832A) Final PA

The power amplifier is plate and screen modulated by the separate MD-7/ARC-5 modulator and power unit.

Transmitter Tuning:

To tune the transmitter, allow the turret mechanism to come to rest on the channel desired and connect an external milliammeter from the terminals of J307 (on front of transmitter), to ground, according to the circuit being tuned. The tuning controls are labeled on Fig. 4 for easy reference. The following currents are normal:

Oscillator grid current	0.7 to 1.2 ma
1st harm. gen. grid	1.5 to 5.4 ma
2nd harm. gen. grid	1.5 to 5.4 ma
RF amplifier grid	1.2 to 4.8 ma
Plate voltage, final	550 volts

A listing is made here of relay functions in order to simplify the schematic diagrams.

K304	Controls motor
K301	Antenna relay
K302	Plate and screen voltage
K303	Modulator Screen and key control
K305	Aux. plate and screen voltage
K306	Modulator plate and voltage regulator interlock.

Receiver:

The R28/ARC-5 Receiver weighs 14.5 lbs. and is 14 by 7-5/32 by 4-7/8 inches in physical size. It is normally plugged into a type FT-220A mounting rack.

The circuit is a 10-tube superhet with no provision for BFO, as only voice reception is intended. The receiver will function on only four frequencies in the following channels, depending upon the crystals used:

A- 100-124 Mcs.
B- 122-146 "
C- 122-146 "
D- 132-156 "

For schematic diagrams see center spread, page 65.

The crystal frequency is determined by the following formula:

$$\text{Crystal Frequency equals } \frac{\text{Carrier Frequency - 6.9 Mc.}}{24}$$

The Intermediate Frequency is 6.9 Mc. and the aüdio output impedance is 300 ohms, unless the BC-942A equalizer is used, which causes the output to be 4000 ohms.

The tube line up of the Receiver is as follows:

V101	(717A)	RF amplifier
V102	(717A)	Mixer
V103	(12SH7)	1st IF
V104	(12SH7)	2nd IF
V105	(12SL7)	Det-AVC-squelch
V106	(12SL7)	1st AF and squelch amp.
V107	(12A6)	2nd AF
V108	(12SH7)	RF osc - 4th harmonic generator
V109	(717A)	Tripler - 12th harmonic generator
V110	(717A)	Doubler - 24th harmonic generator

For information, the plug connections on the receiver are as follows:

Rear plug (J102)

1- Ground
2- Audio output (hi or low)
3- MVC gain control lead
4- AVC-MVC control lead
5- Blank
6- 28 volts (in)
7- "B" plus (out)

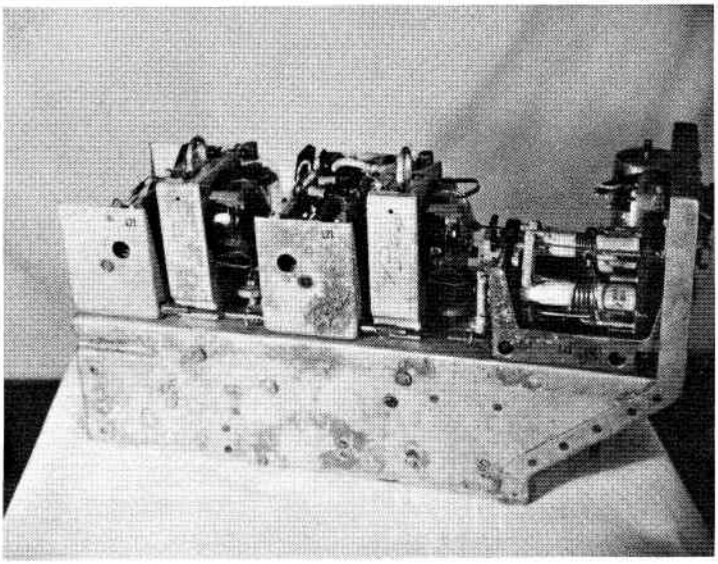
Front plug (J103)

1- Channel A control
2- Channel B control
3- Ground
4- Channel C control
5- Channel D control
6- Blank

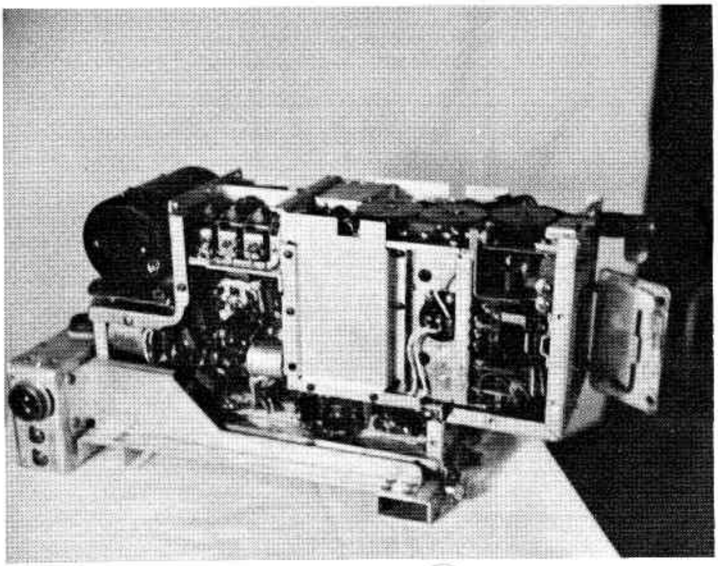
To operate the receiver alone, short terminals 1 and 6 of the rear plug to start the dynamotor, and place a 50,000-ohm pot. to ground from terminal 3 to function as an RF gain control.

A schematic drawing of the FT-220A Rack is given in Fig. 5, page 46.

For diagram of interconnections, see center spread, page 66.



ARC-5 VHF TRANSMITTER (Cover Off)



ARC-5 VHF RECEIVER (Cover Off)

FIG. 6

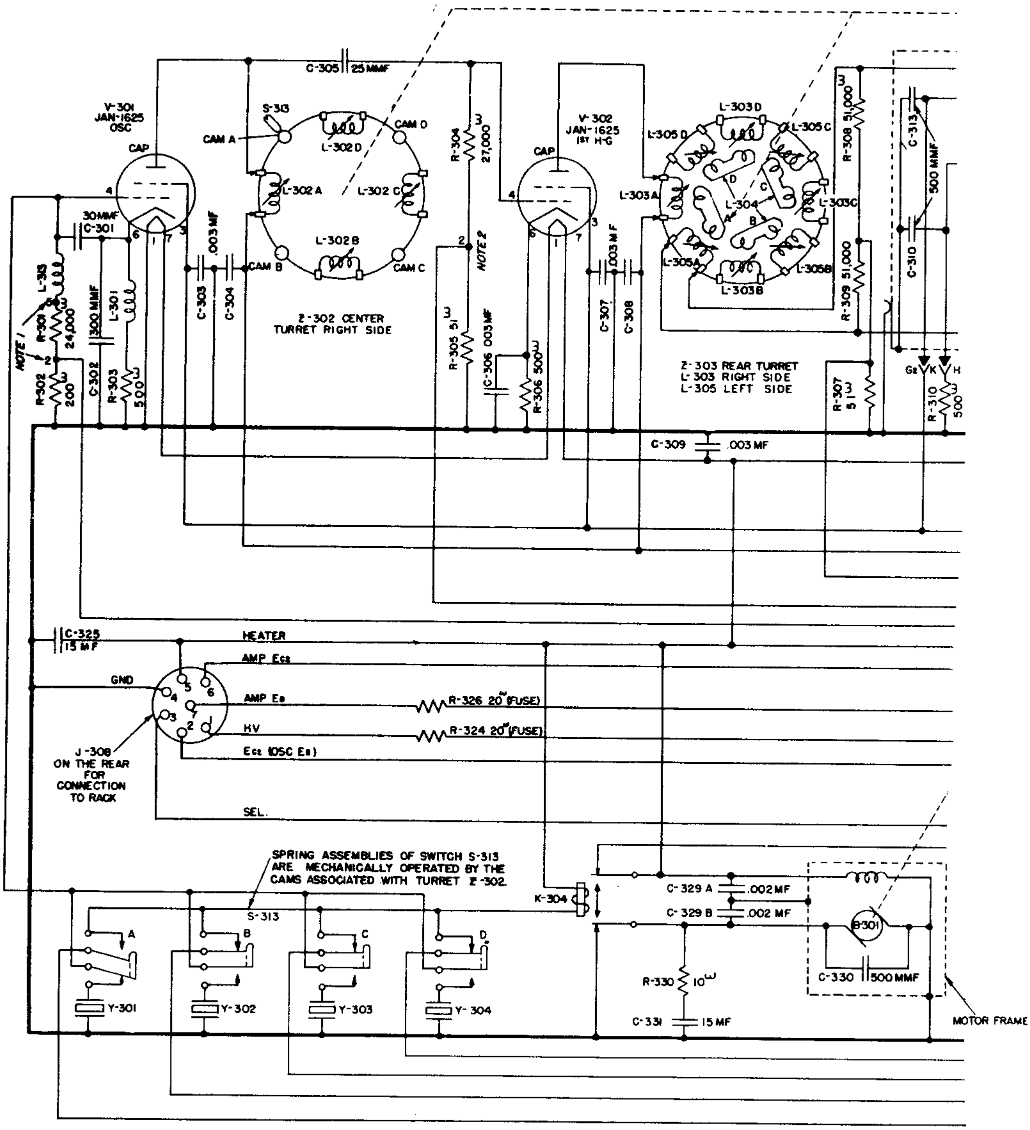


FIG. 1 - ARC-5 VHF TRANSMITTER (Original Schematic)

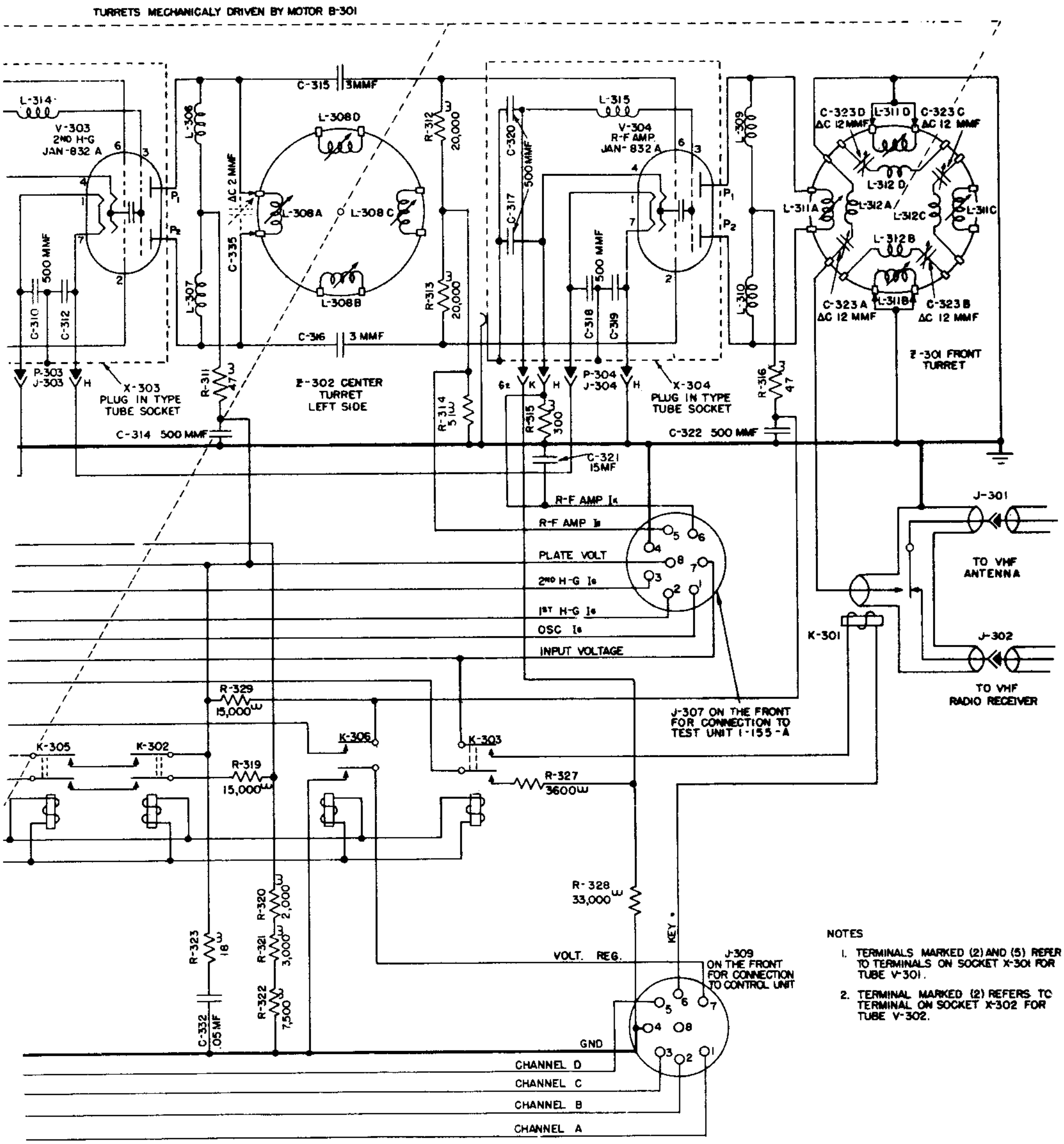


FIG. 1 - ARC-5 VHF TRANSMITTER (Original Schematic)

For ARC-5 VHF Receiver, see page 65.

ARC-5 VHF Transmitter Tuning

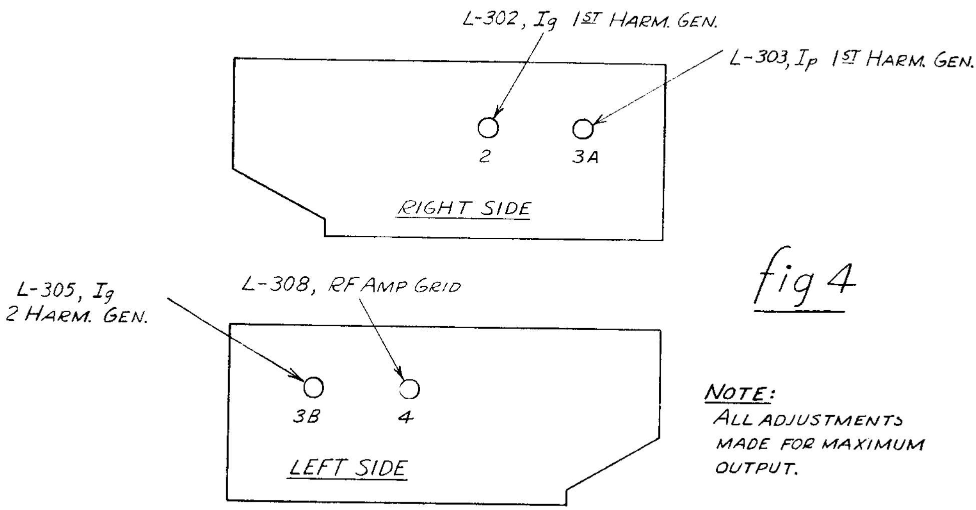
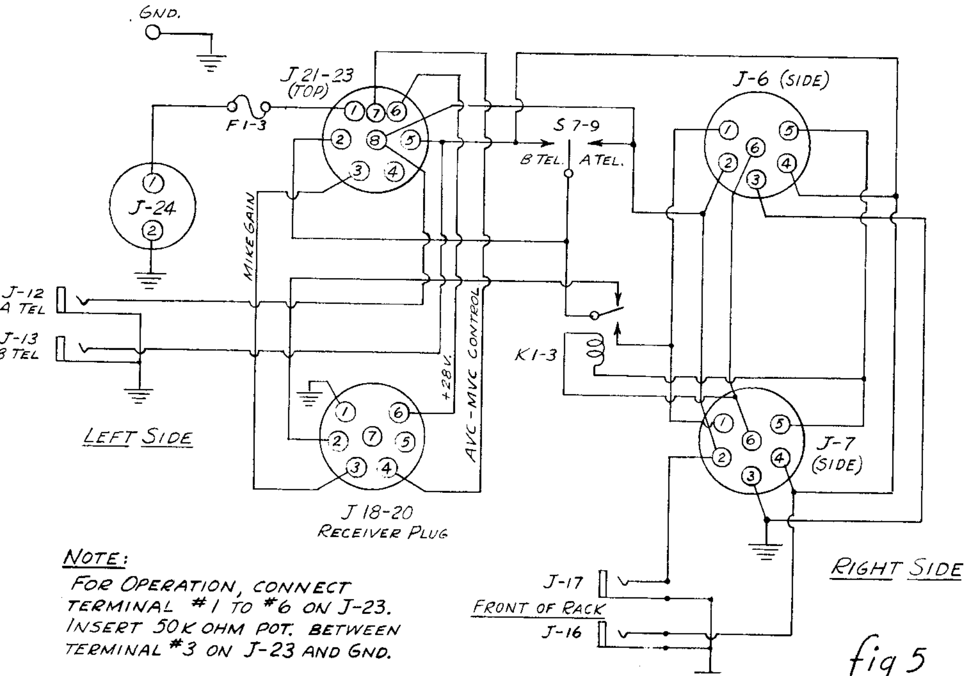


fig 4

NOTE:
ALL ADJUSTMENTS MADE FOR MAXIMUM OUTPUT.

FT-220A Mounting Rack Schematic



NOTE:
FOR OPERATION, CONNECT TERMINAL #1 TO #6 ON J-23. INSERT 50K OHM POT. BETWEEN TERMINAL #3 ON J-23 AND GND.

fig 5

CONVERSION OF THE GO-9 TRANSMITTER
(Also applicable to TBW series)

The model GO-9 Aircraft transmitter was manufactured for the United States Navy and used primarily in the larger Naval aircraft for CW and MCW transmission with a nominal power output of 100 watts. The complete unit is quite adaptable to amateur use as it covers directly the 20, 40 and 80 meter bands.

It is to be noted here that another popular surplus transmitter, the "TBW", is quite similar to the GO-9. The TBW is also Naval equipment, being designed for advance-base installations. The general appearance is somewhat different, but the same three-section construction is used. Two major differences exist between the models: First, the TBW intermediate frequency section covers a slightly different range (350 to 1000kc.); second, the TBW incorporates an 843 tube as a class A suppressor-grid modulator.

The high-frequency section of the TBW is identical to that of the GO-9 in regard to the basic circuit, and the power unit is similar. The instructions to follow may be generally used for the TBW, but as this conversion data pertains primarily to the GO-9 transmitter, certain sections will not apply to the TBW. Particular attention should be paid to the difference in terminal connection numbers in relation to the power supply section. Naturally, since the TBW has its original modulator, the one described for the GO-9 will not be necessary.

The assembly consists of three aluminum frames fastened together with snap catches and guide pins to operate as a single unit. All of the necessary connections between units are made by contact brushes and contacts.

The three units and their specifications pertaining to the GO-9 and TBW follow:

		GO-9	TBW
IF Transmitter		Type CAY 52192	Type CAY 52238
Size:	Height	33 31/32 inches	33 1/4 inches
	Width	10 1/2 inches	13 5/8 inches
	Depth	16 3/8 inches	17 1/4 inches
	Weight	44 lbs.	76.5 lbs.
	Frequency	300-600 kc.	350-1000 kc.
HF Transmitter		Type CAY 52193	Type CAY 52239
Size:	Height	33 31/32 inches	33 1/4 inches
	Width	10 1/2 inches	13 5/8 inches
	Depth	16 3/8 inches	17 1/4 inches
	Weight	47.5 lbs.	84 lbs.
	Frequency	3000-18,000 kc.	3000-18,000 kc.
Rectifier Unit		Type CAY 20103	Type CAY 20084 (includes Modulator)
Size:	Height	33 31/32 inches	33 1/4 inches
	Width	7 3/8 inches	10 7/16 inches
	Depth	16 3/8 inches	17 1/4 inches
	Weight	40.5 lbs.	71 lbs.

Tube Line Up (Same for both GO-9 and TBW with exception of an additional 843 modulator in TBW.)

IF Transmitter
1 type 801 Master Oscillator
1 type 807 IF Amplifier
1 type 803 Power Amplifier

"10-METER" SECTION FOR THE GO-9

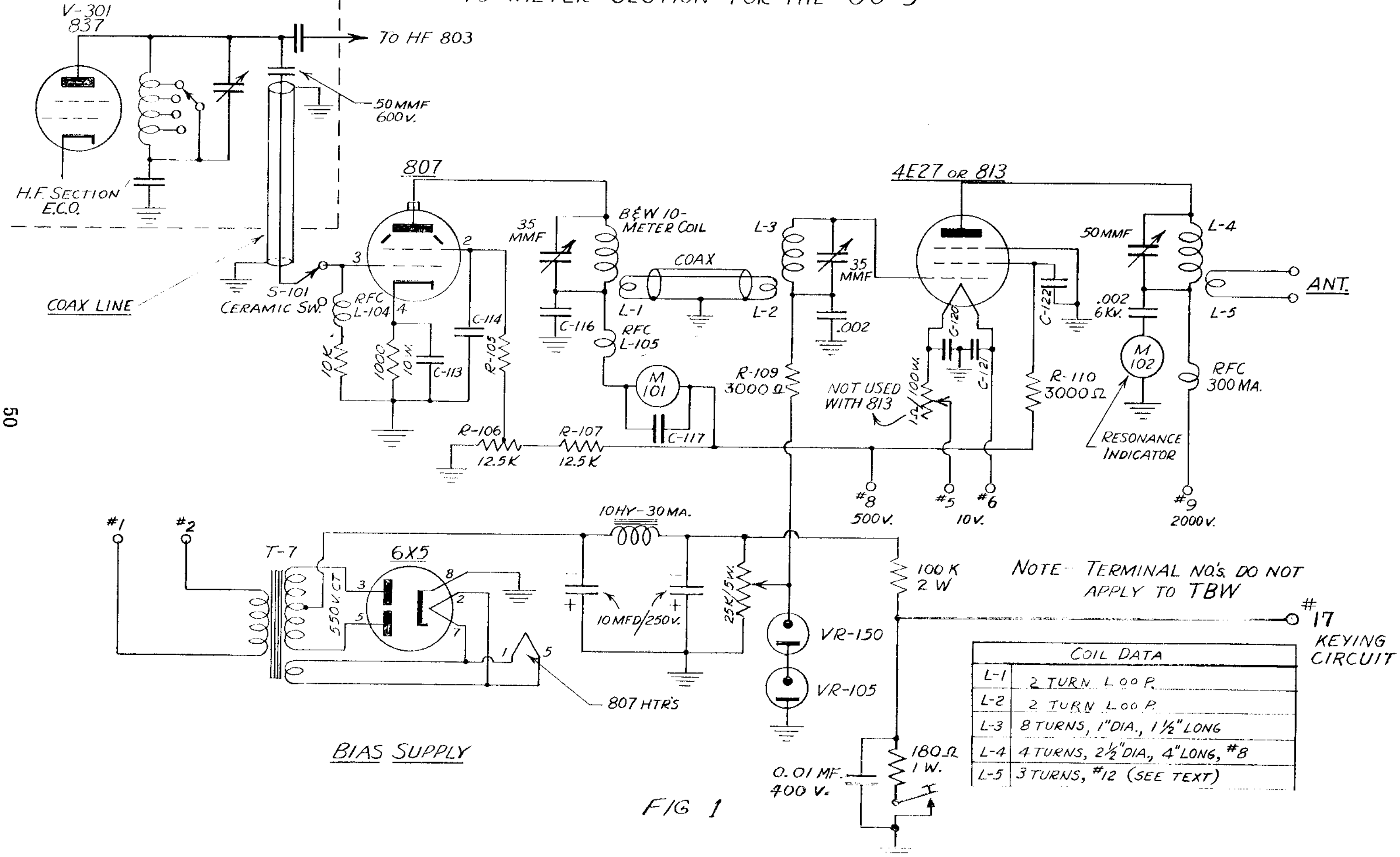
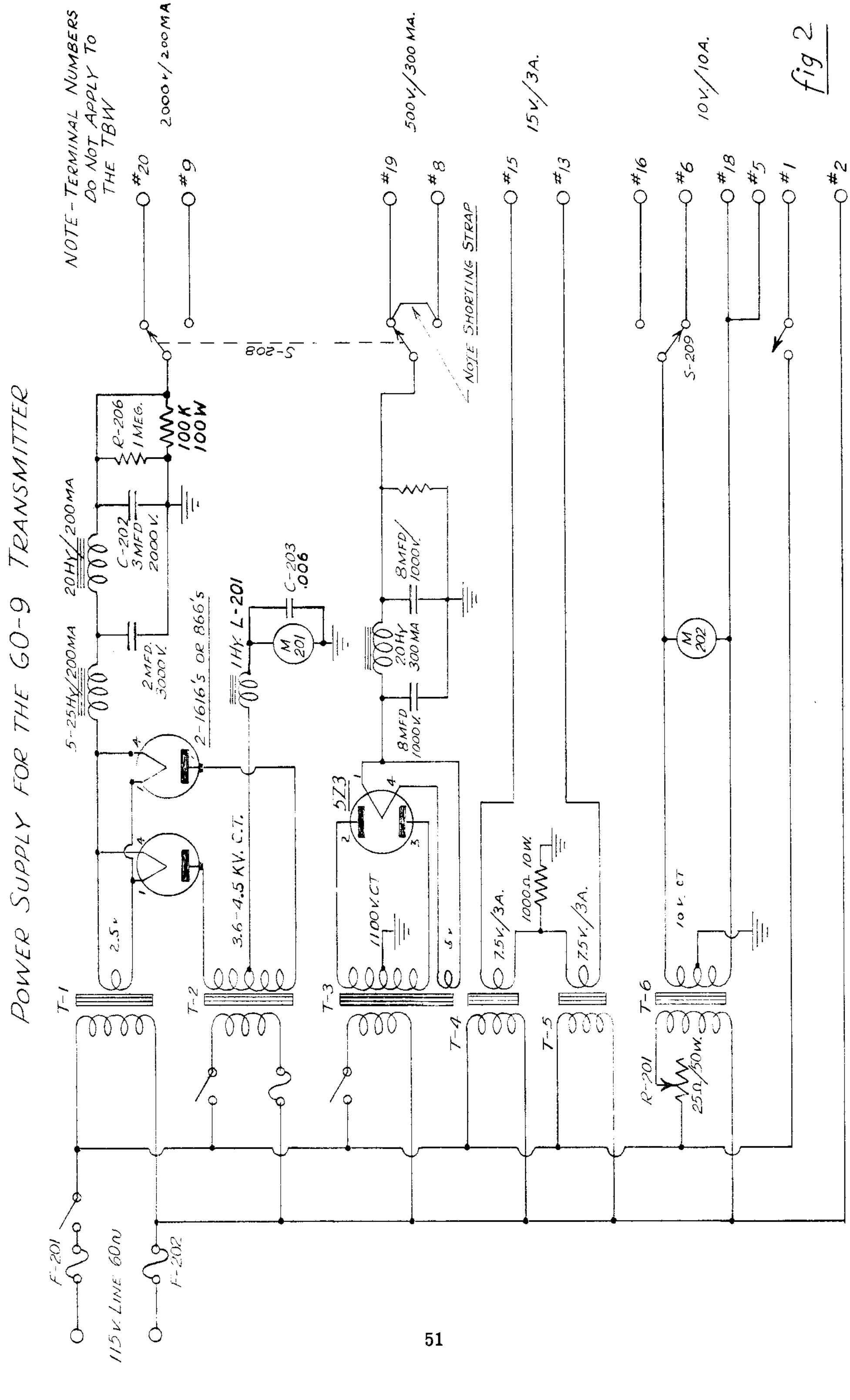
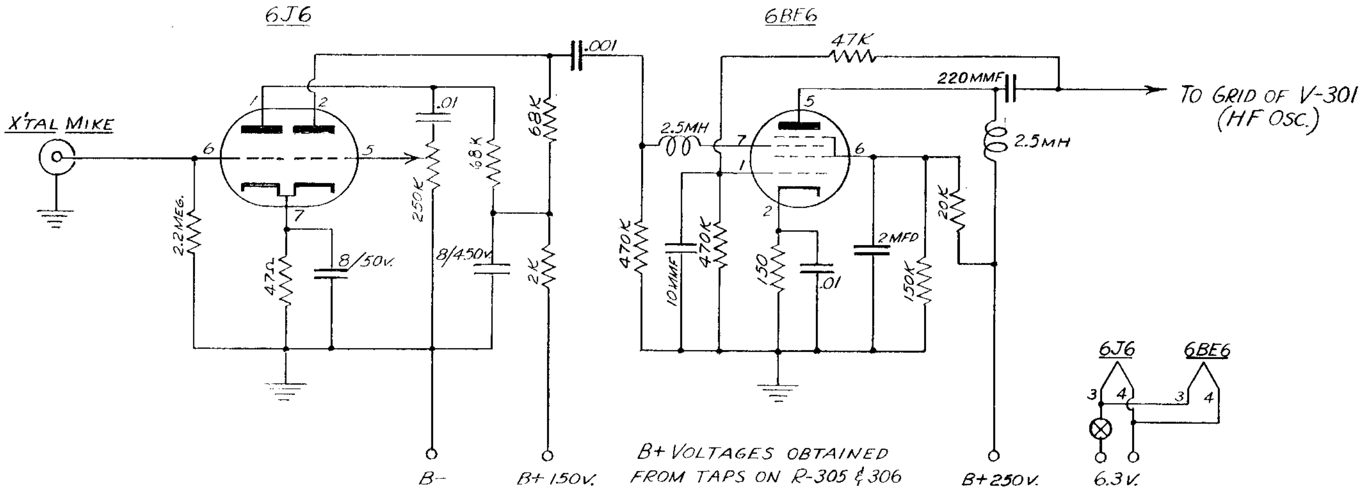


FIG 1


POWER SUPPLY FOR THE GO-9 TRANSMITTER
NOTE - TERMINAL NUMBERS DO NOT APPLY TO THE TBW
2000V/200MA
500V./300 MA.
15V./3A.
10V./10A.
fig 2
#20
#9
#19
#8
#15
#13
#16
#6
#18
#5
#1
#2
S-208
S-209
NOTE SHORTING STRAP
R-206 1 MEG.
100K 100W
20HY/200MA
C-202 3 MFD 2000V.
5-25HY/200MA
2 MFD. 3000V.
2-1616's OR 866's
1HY. L-201
C-203 .006
M 201
8MFD/1000V.
20HY 300MA
8MFD 1000V.
5Z3
M 202
2.5V
3.6-4.5 KV. C.T.
1100V CT
5V
7.5V./3A.
1000Ω 10W.
10V. CT
T-1
T-2
T-3
T-4
T-5
T-6
R-201 25Ω/50W.
F-201
F-202
115V. LINE 60~

NBFM REACTANCE MODULATOR FOR THE GO-9



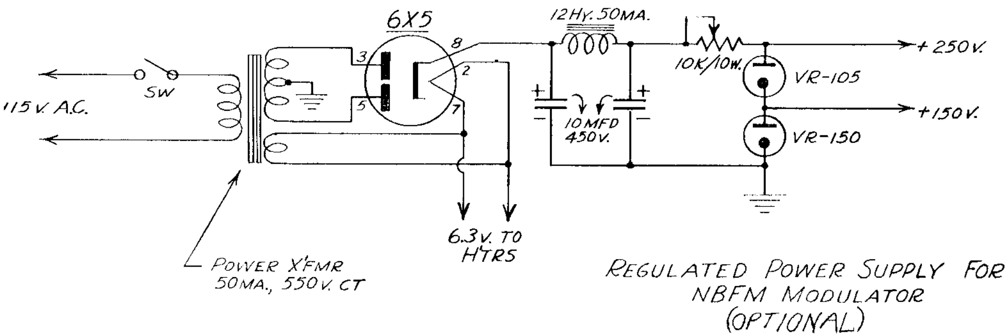
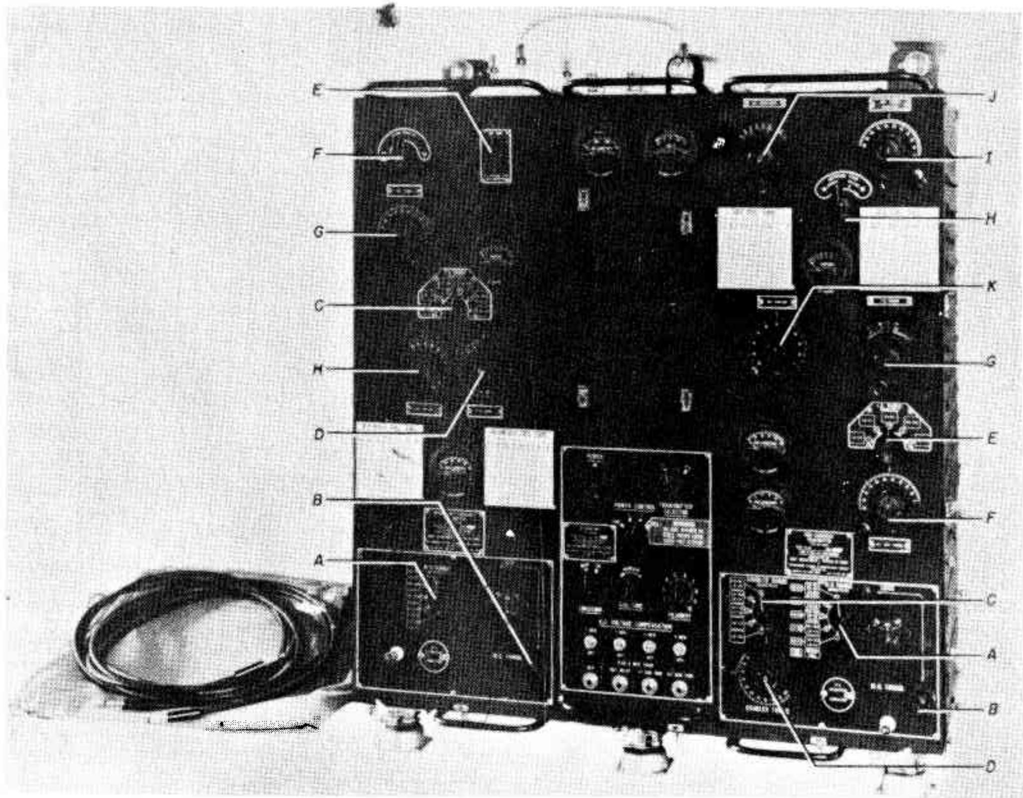


fig 3

Courtesy QST Magazine
February Issue 1948



GO-9 TRANSMITTER

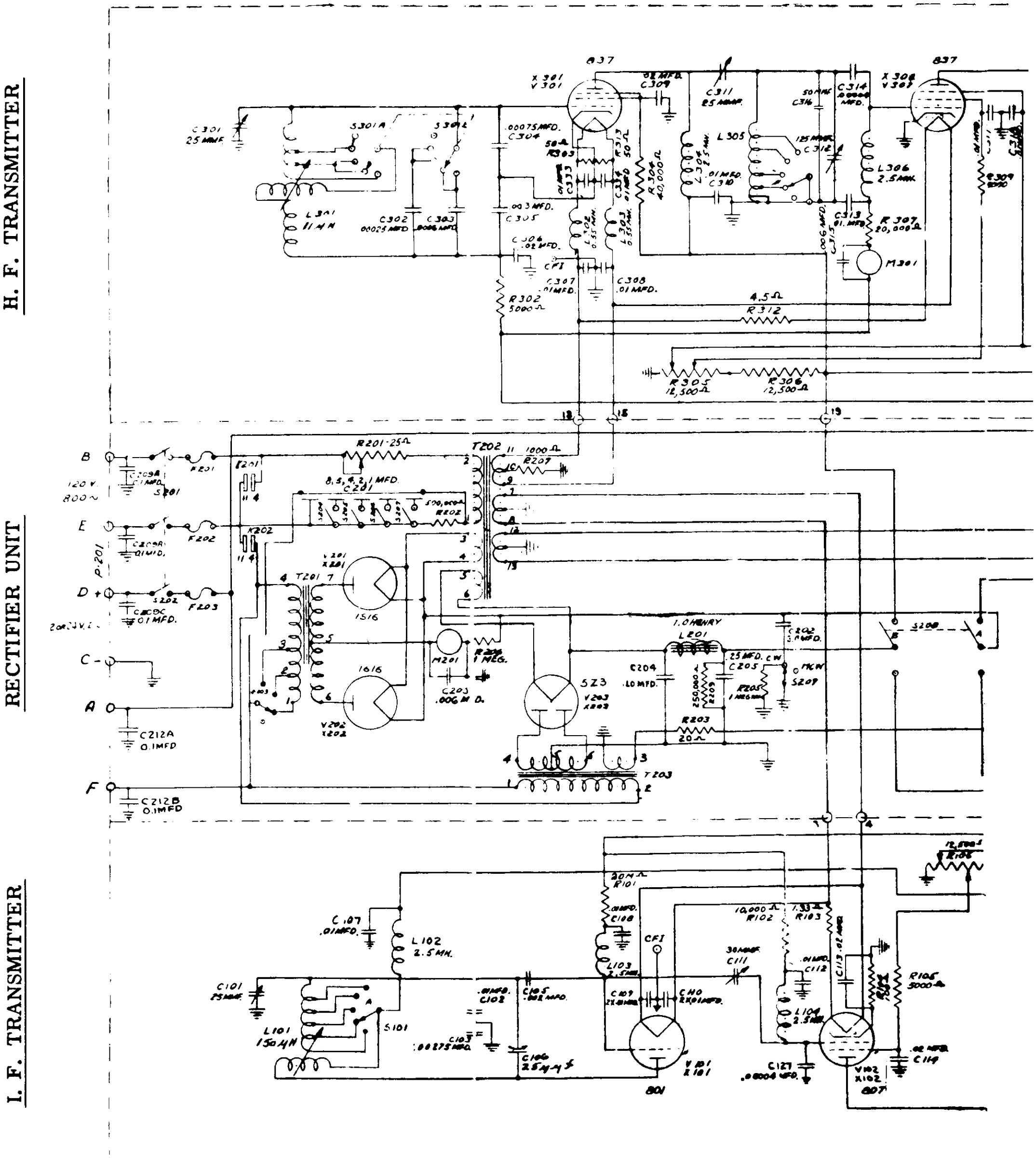


Fig. 4 - ORIGINAL SCHEMATIC OF GO-9 TRANSMITTER

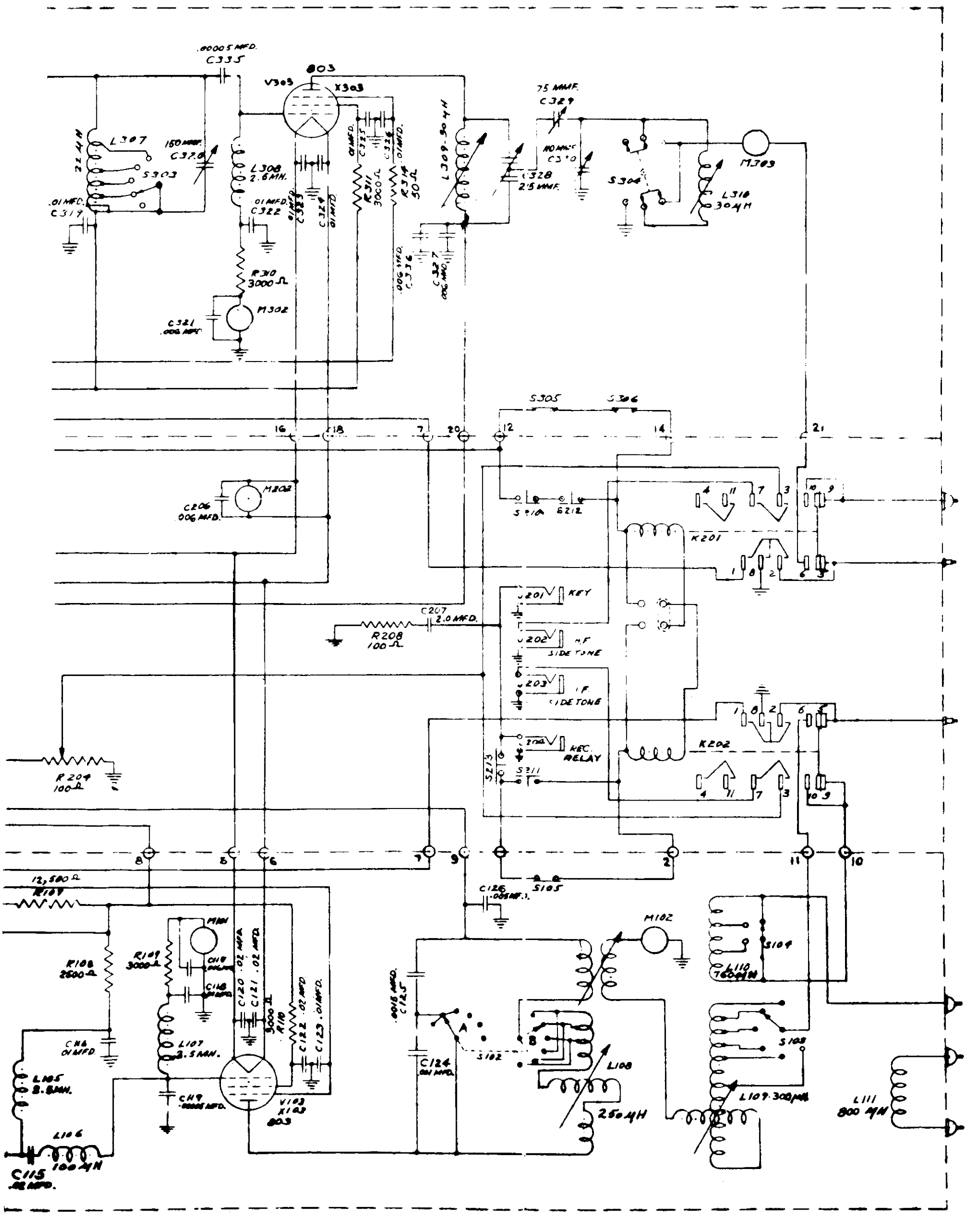


Fig. 4 - ORIGINAL SCHEMATIC OF GO-9 TRANSMITTER

THE BC-357 MARKER-BEACON RECEIVER

Marker-beacon receivers, particularly the BC-357, have appeared in large quantity and at very moderate cost on the surplus market. The BC-357 is of little value in its original form to the average experimenter. However, its small size, and several of the components in the unit, make for easy conversion to a capacity-operated relay. This type of relay, which is caused to operate by the immediate presence of any large object, has many uses which may include the control provision for the opening of garage doors, turning on of lights or ringing of bells as an intruder protection, counting of personnel, and similar applications.

The original circuit of the receiver consisted essentially of a two-tube, tuned r-f, reflex-type receiver with its rectified output used to operate an extremely sensitive relay. The receiver is completely enclosed in an aluminum case with dimensions of 3-1/2 inches in width, 5-1/2 inches in height, and 6 inches in depth. The most valuable components of the unit are the sensitive relay and the housing. The relay will close with a current of 0.4 ma. and will open again when the current falls to 0.2 ma. The contacts are capable of carrying up to 500 ma. at low voltage without deterioration. The housing alone is excellently suited for use as a container for receivers, converters, or other items of mobile equipment.

Conversion to a Capacity-Operated Relay:

A simple Hartley oscillator is used with the sensitive relay in the plate circuit of a 6J5 tube. The circuit is self-rectifying to permit the use of the 115-volt a-c line voltage as plate supply potential. Before adding the new circuit the chassis is stripped of all components except for the relay, one tube socket, and the lower tuning condenser. The completed circuit includes a well insulated lead brought out from the grid of the oscillator. This lead should not exceed 5 or 6 feet in length and may be terminated at the existing jack on the front panel. The oscillator coil, as shown in figure 2, can be for any frequency below about 500 kc.

The operating principle is as follows: When the circuit is oscillating a relatively high bias is developed at the grid of the tube. With the high bias, which results from grid-leak action, very little plate current flows and the relay does not close. However, when the grid circuit is loaded by an external capacitance the r-f grid voltage is decreased, resulting in lowered grid bias which increases the plate current and closes the relay.

Final adjustment of the converted unit will include adjustment of the tension-spring of the relay. This spring must be adjusted to locate the operating point of the relay in the center of the tube characteristic. The unit is capable of slight r-f radiation since the external lead is coupled directly to the grid of the oscillator. However, if a frequency well below 500 kc. is used this radiation will be so small that it will not be perceptible even in a nearby receiver. A BC-348 receiver may be used to check the installation to insure that oscillator radiation is not taking place. Positive tests should be made to insure against violation of FCC regulations concerning such devices.

BC-357 Marker Beacon Receiver

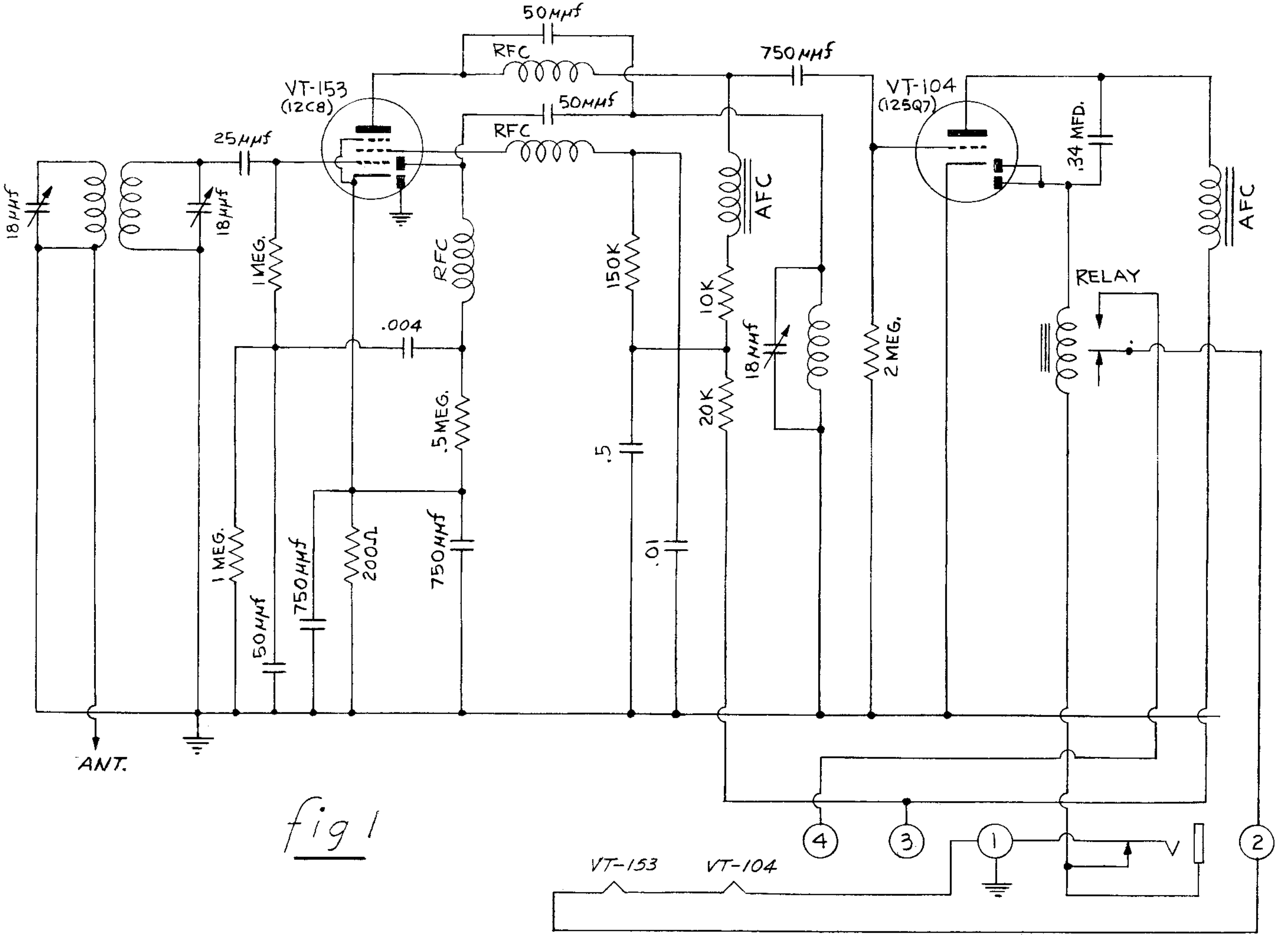


fig 1

CAPACITY OPERATED RELAY CIRCUIT

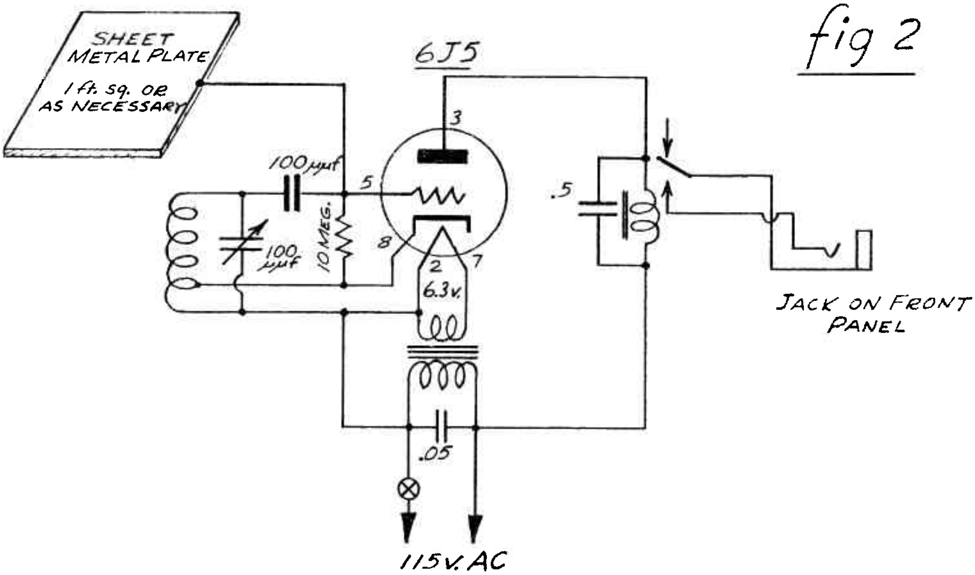
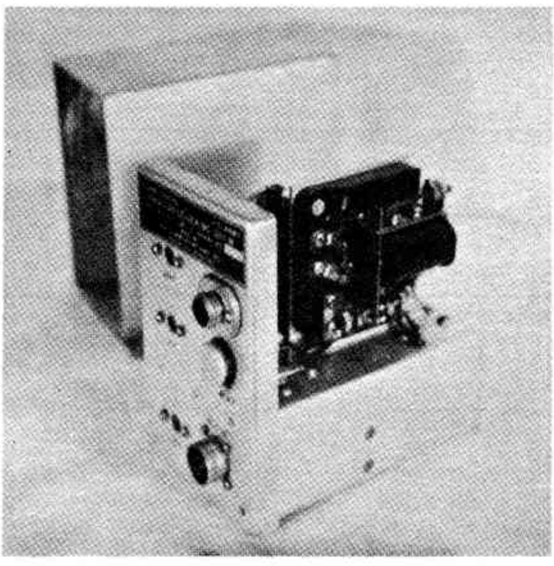


fig 2

ORIGINAL BC-357 RECEIVER



HIGH-FIDELITY TUNER
FROM THE BC-946B RECEIVER

The BC-946B aircraft receiver, or its Navy equivalent, in the ARC-5 series, lends itself readily for conversion to a high-fidelity broadcast tuner. This receiver is identical to the SCR-274 series except that its frequency range is 520 to 1500 kc. with an intermediate frequency of 239 kc. For schematic, see pages 8-9, and 11.

Typical of aircraft equipment, this receiver was designed to operate from 28 volts, DC. The 12-volt heaters were wired in series-parallel while the high voltage was supplied by a dynamotor mounted on the rear of the chassis. The original tube line-up is as follows:

12SK7	1st RF amp
12K8	1st Detector (mixer)
12SK7	1st IF amp
12SK7	2nd IF amp
12SR7	2nd Detector, CW osc.
12A6	2nd Audio amp (output)

(a) Preparation of Chassis for Added Circuits:

After removing the bottom plate from the chassis, the three plug assemblies (J-1, front; J-3, rear; and J-2, dynamotor) with their respective wiring and hardware should be removed and discarded. This is done with the following exceptions:

(1) The "gain control line" (green lead) from the cathode bus to pin No. 1 of J-1, should be grounded to a convenient point on the chassis.
(2) R-22 and R-23, the tapped bleeder resistor across the plate supply which furnishes the screen voltage (approx. 100 volts) from the tap, is left intact.
(3) C-32 is then rewired as the screen voltage by-pass from the tap on the bleeder.

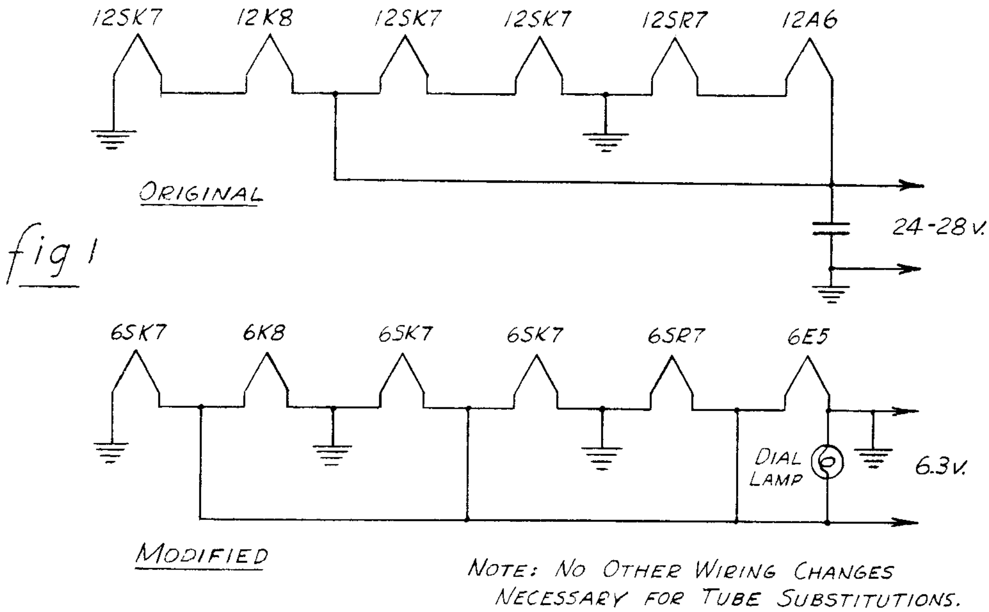
All other components associated with the plugs and the audio section and the CW oscillator are completely stripped from the chassis. These include the following: L-15, L-14, C-16, L-12 and 13 (and components inside can), C-26, R-14, C-29, R-19, R-18, R-21, V-2, C-31, C-35, and T-1.

The output transformer, T-1, has a high-impedance secondary (4000 and 300 ohms) intended for headphone use and is not usable with conventional speakers.

(b) Modification of the Heater Circuit for 6-Volt Operation:

Since broadcast tuners are normally used in conjunction with a separate audio amplifier which supplies the heater and plate voltages for the tuner, 6-volt heater operation is recommended. This necessitates changes in the heater wiring as shown in Fig. 1 and the substitution of 6-volt equivalents for the existing tubes. In the tuner version, the audio output stage, (12A6), is not used and therefore no substitution is required. However, this socket affords tie points for connection of the 6E5 tuning-eye assembly. The leads are run through the center hole of the socket with the connections made underneath the chassis.

If the audio amplifier is added to the chassis as mentioned in section (i), a 6V6 output tube is substituted for the former 12A6. The heaters of the 6E5 are merely paralleled at some convenient point in the heater circuit.



(c) AVC Circuit Modification:

In the original circuit, the AVC voltage was derived from the diode action of the second IF amplifier grid. For better performance this is changed as shown in Fig. 6 using the second diode plate of the 6SR7. This change requires removing R-11 from the grid circuit of the second IF amplifier and connecting the AVC lead to the AVC bus at the junction of C-15A.

The tuning indicator (6E5) is operated from the AVC voltage in the conventional manner as shown in Fig. 6.

(d) Audio Section:

The audio modification as shown in Fig. 7 includes the conventional volume control in the grid circuit of the 6SR7. The audio output from the triode section of the 6SR7 is brought out through the rear of the chassis with about 30 inches of shielded microphone cable. A standard microphone cable connector provides a good shielded connection to the amplifier used. The circuit components shown in Fig. 6 give audio response from approximately 30 to 10,000 cps.

(e) Power Connections:

Power connections for the tuner (6 volts and plate voltage) are brought out on the rear end of the chassis through a conventional socket. Unless a specific plug is required, the ordinary octal tube socket can be used in the former position of the J-3 plug. At this plug the "B" minus lead is grounded to the chassis as well as to one side of the heater supply voltage. It should be noted that these grounded connections must correspond to those of the power supply and amplifier used. A grounded center tap on the heater transformer at the power supply cannot be used unless the tuner heater circuit is rewired with an ungrounded system. If the heater supply is center-tapped, generally the center tap can be lifted and one side of the 6-volt circuit grounded instead.

(f) Adjustments for Operation:

After the converted tuner is operable, IF alignment and coupling adjustments should be made to obtain the broad band-pass necessary for high-fidelity reception. This phase of the conversion is the key feature for high-fidelity performance. The higher audio frequency response is primarily determined by the band-pass of the IF amplifier which in this case should approach 20 kc.

The best IF amplifier alignment can be obtained only by the scope and wobbulator method where adjustment can be made with a visual pattern of the IF amplifier response. Most of the larger radio service shops have this type of equipment.

This method of alignment results in a symmetrical waveform as produced by the three tuned stages and the proper coupling adjustments.

The proper coupling adjustment for the IF transformers will be obtained with the plungers approximately half-way in. These plungers are exposed for adjustment at the tops of the IF cans when the plastic caps are removed. Maximum coupling, which allows maximum band pass, occurs when the plungers are in; minimum coupling, or narrow band pass, is obtained by pulling the plungers out.

It should be noted here that high selectivity (sharp tuning) can be obtained, sacrificing the high frequency response, by using minimum coupling. Sharper response often becomes desirable when two stations are so close to each other that they interfere with normal or broad-band reception.

Even though maximum coupling gives a band width of approximately 25 kc. it also gives a very pronounced undesirable dip as shown in Fig. 9. This double-peak effect becomes quite obvious when tuning the receiver.

After the IF alignment and coupling adjustments are made the waveform of the IF amplifier response will be that shown in Fig. 9. Over-all frequency response of the tuner will be that shown in Fig. 10.

(g) RF Alignment Procedure:

Should it be necessary to touch up the RF alignment, which generally is not required if the dial calibration is reasonably accurate, the procedure in Fig. 2 should be followed.

(h) Mechanical Modifications and Layout:

Even though there are many possible versions adaptable to the BC-946 receiver, the following two tuning dial and panel arrangements have proven very satisfactory. These modifications are intended, where it is desired, to dress up the appearance of the tuner or its receiver version for home use.

The first version, as shown in Fig. 3a, utilizes the existing gear reduction mechanism with a centered knob assembly. The knob shaft is belt driven, with a step-up ratio to the former control shaft. This shaft carries a small flywheel in addition to the pulley which results in a pleasant smooth tuning action. The flywheel and driven pulley shaft utilize the tuning-knob assemblies that are available for the surplus SCR-274 series transmitters and receivers.

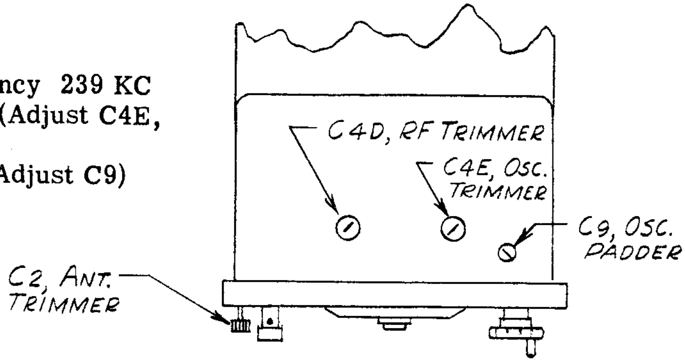
Other controls are brought out symmetrically on the panel by means of extended shafts as shown in Fig. 3a.

The second version for the tuning and panel arrangement uses the conventional type slide-rule dial (180 degrees rotation) mounted directly to the tuning condenser 1/4-inch shaft. This arrangement eliminates the former gear drive since the driven condenser gear, on the condenser shaft, is replaced with the ordinary 1/4-inch shaft coupling or extension.

To remove the condenser driven gear (split type), it is necessary to remove the condenser shield covers and the triangular plate on the right end of the variable tuning condenser. If an ordinary 1/4-inch shaft extension is used, the triangular

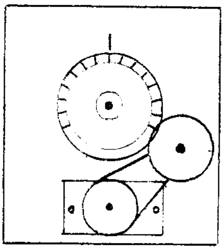
Intermediate frequency 239 KC
High End 1400 KC (Adjust C4E, C4D, & C2)
Low End 570 KC (Adjust C9)

fig 2

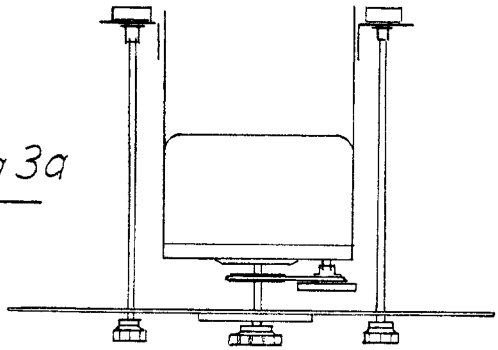


TOP VIEW

fig 3a

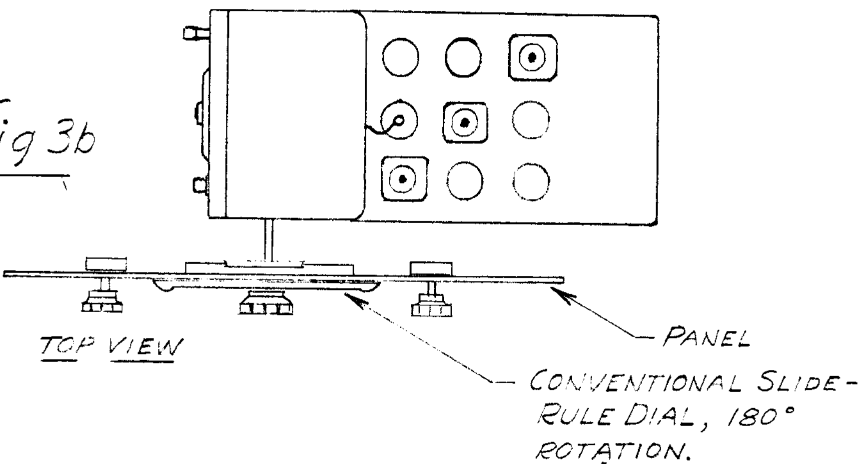


FRONT VIEW



TOP VIEW

fig 3b



TOP VIEW

plate can be replaced and used for additional shaft support. This approach is shown in Fig. 3b.

(i) Complete High-Fidelity System from the BC-946B:

Since the chassis of the BC-946 receiver affords sufficient space for additional components, the additional components to make up a complete radio receiver can be successfully added.

The first version utilizes a power supply mounted in the former dynamotor space, as shown in the photographs. The output stage consists of a 6V6 which occupies the former 12A6 socket. Due to the lack of space and to avoid inductive hum pick-up from the power transformer, the output transformer is mounted on the speaker frame or cabinet.

This version, in Fig. 7, using the single-ended 6V6 is capable of delivering 4 watts at less than 6% distortion. At normal listening level (approximately 1 watt) the percentage distortion is negligible for all practical purposes. With application of inverse feedback, distortion can be reduced.

The second version for the high-fidelity radio and amplifier incorporates the audio amplifier on the BC-946B chassis but uses the power supply as a separate unit. The amplifier section utilizes push-pull 6V6's operating AB_1 and is capable of delivering 10 watts at less than 3.5% distortion when used with the recommended power supply.

It will be noted from the schematic diagram, Fig. 8, that the amplifier section uses the floating-paraphase form of inversion and a small amount of inverse feedback. This design accounts for better performance from the 6V6's. Dual tone controls (bass and treble) are used to give high or low end boost or attenuation. A phono input also is incorporated.

(j) Speaker Cabinet:

The reflex-type speaker cabinet as shown in Fig. 4, for use with a 12-inch speaker, provides exceptional performance. This type of cabinet acts as a resonant cavity toward the lower frequencies and improves the over-all listening response.

NOTE: INSIDE BACK SURFACE IS COVERED WITH HAIR FELT OR GLASS WOOL.

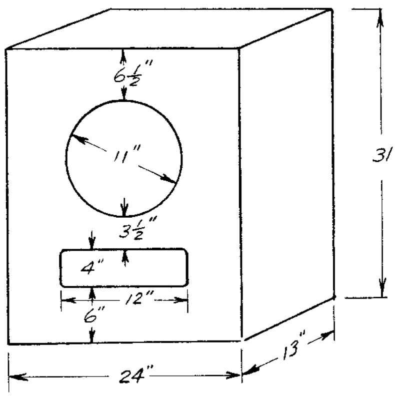


fig 4

For Wiring Diagram (Fig. 5) see pages 8-9.

AUDIO SECTION FOR HIGH-FIDELITY TUNER

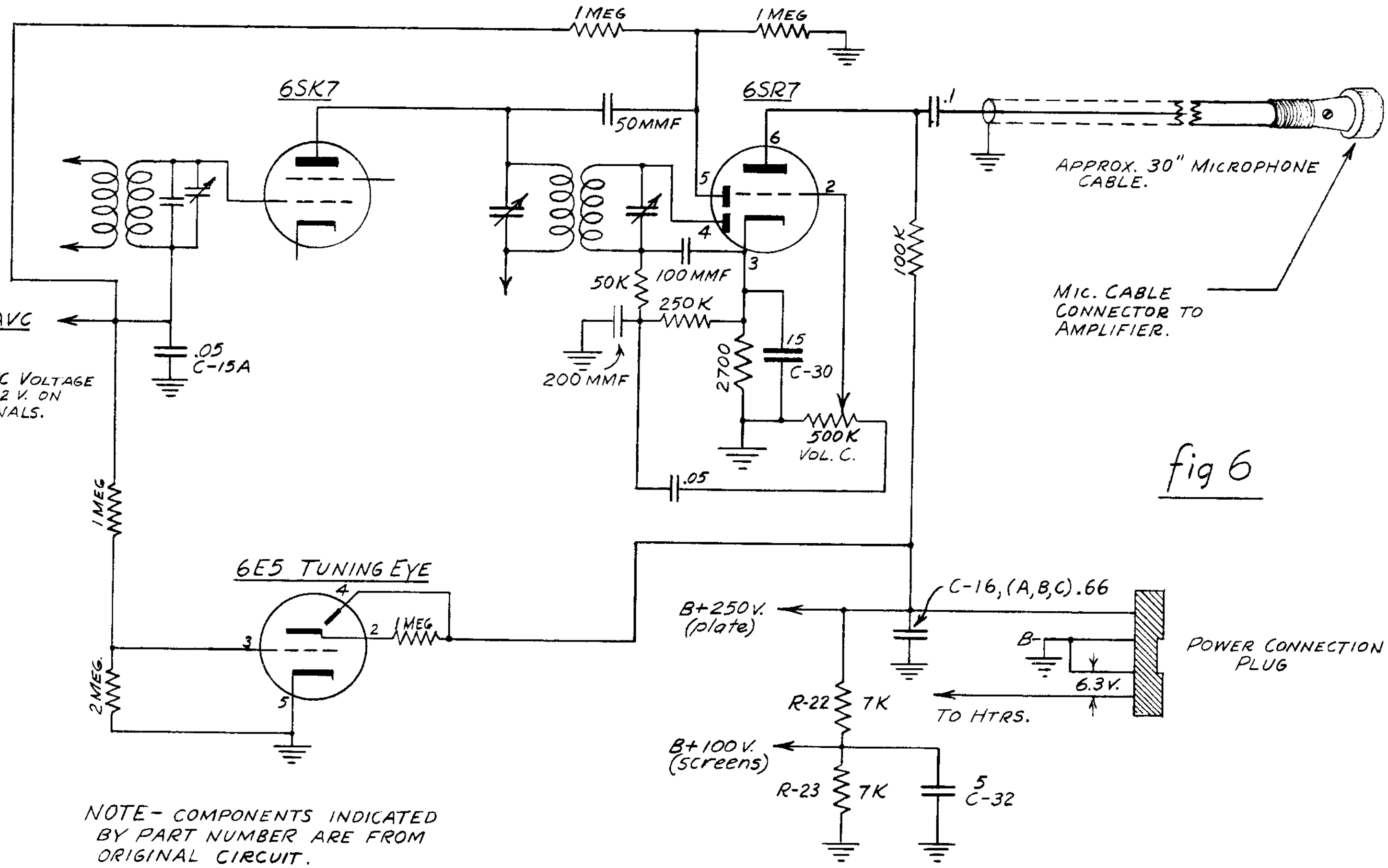


fig 6

NOTE - AVC VOLTAGE APPROX. 12 V. ON LOCAL SIGNALS.

NOTE - COMPONENTS INDICATED BY PART NUMBER ARE FROM ORIGINAL CIRCUIT.

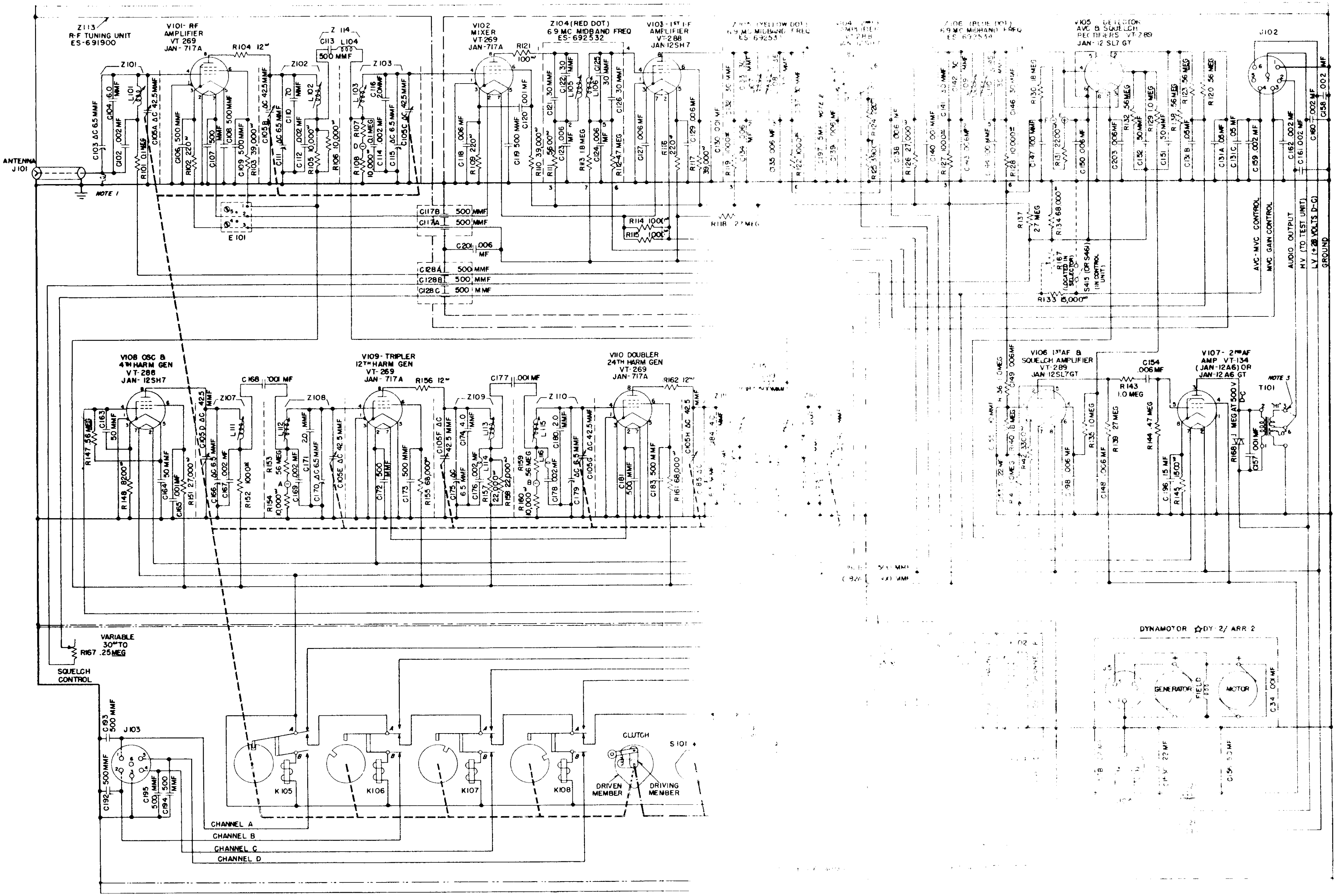
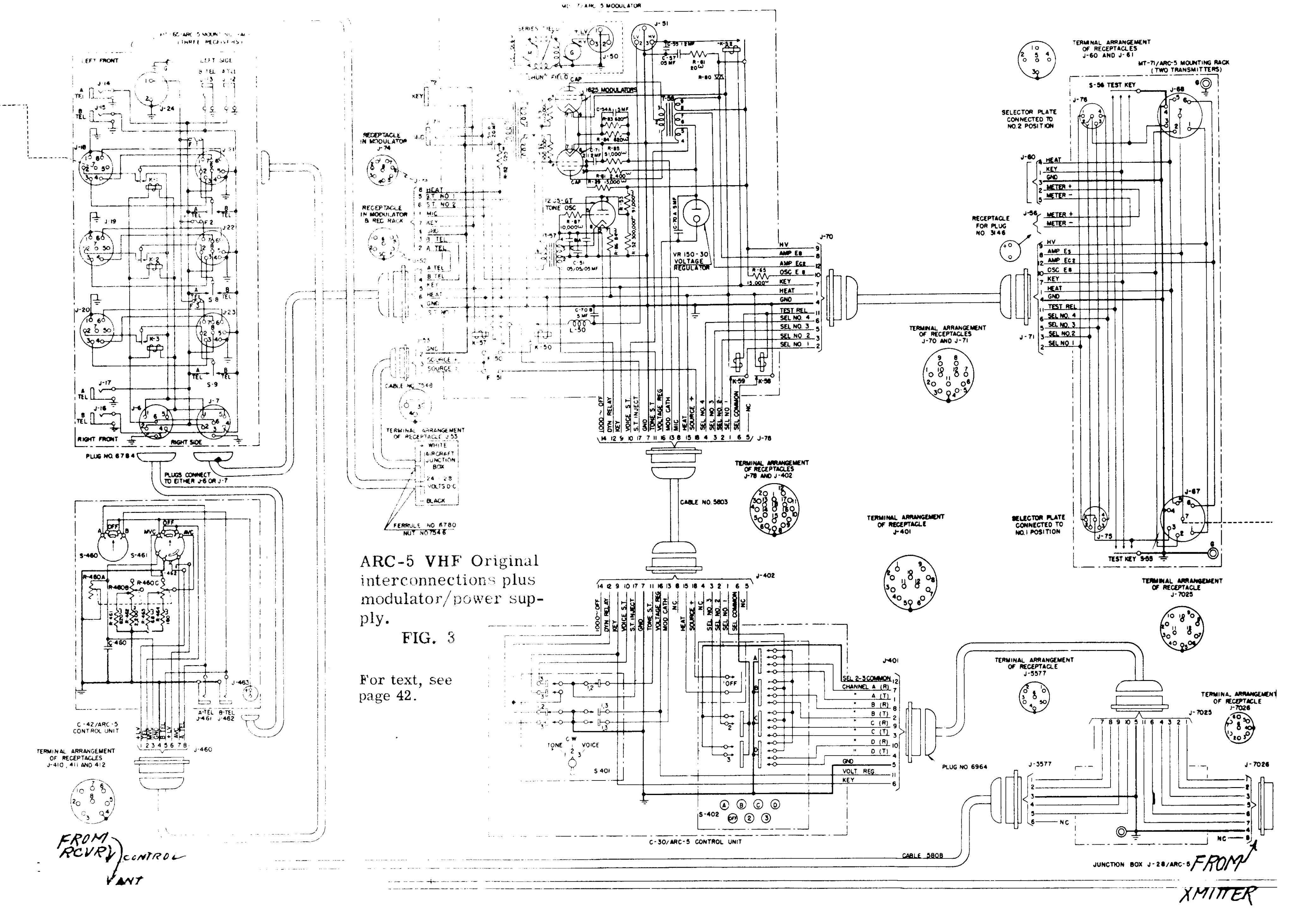


FIG. 2 - ARC-5 VHF RECEIVER (Original Schematic)
For text, see pa



ARC-5 VHF Original interconnections plus modulator/power supply.

FIG. 3

For text, see page 42.

For text, see page 49.

FIG. 5 - ORIGINAL SCHEMATIC OF TBW TRANSMITTER

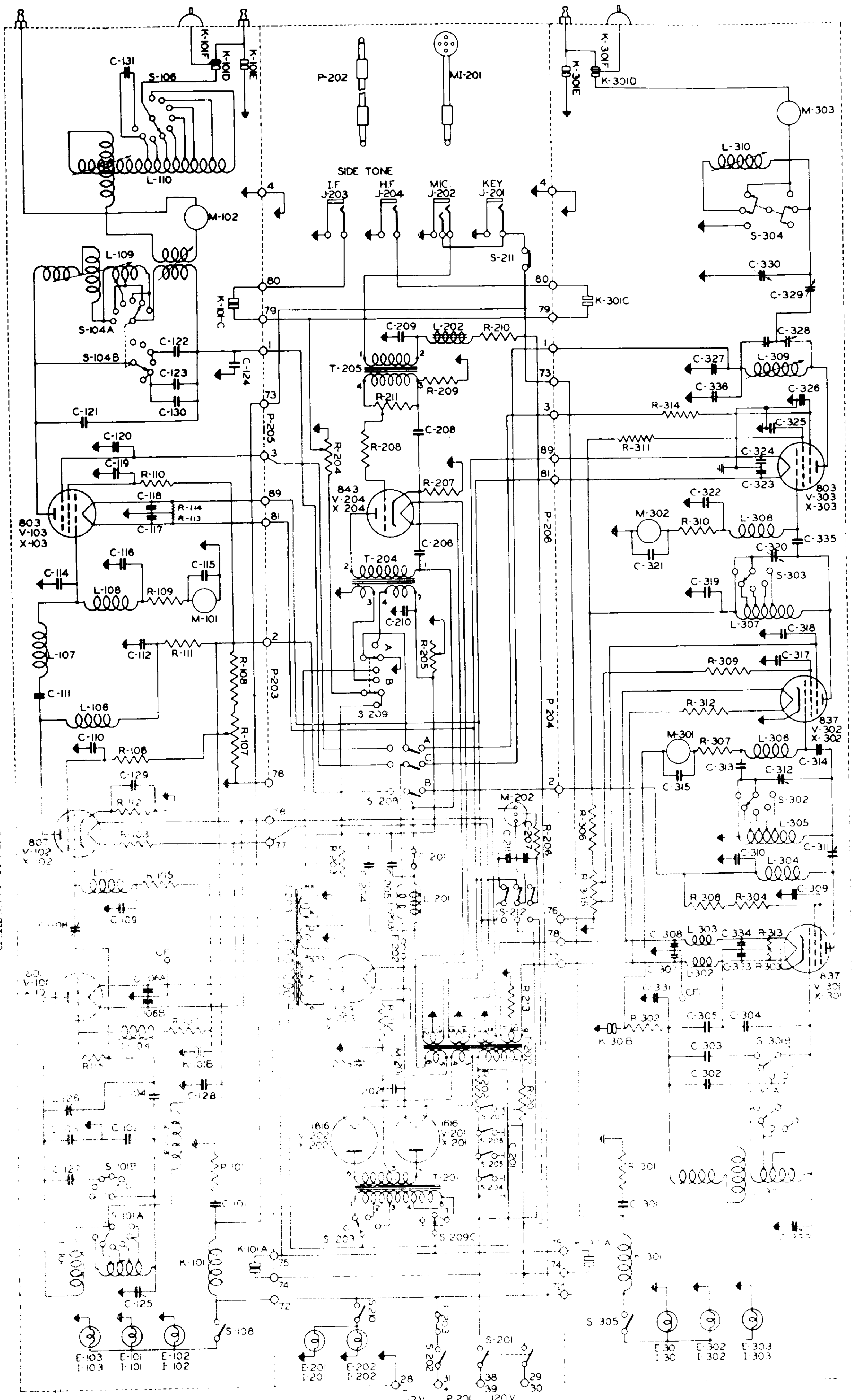


DIAGRAM - SCHEMATIC
H.F & I.F TRANSMITTER & RECTIFIER

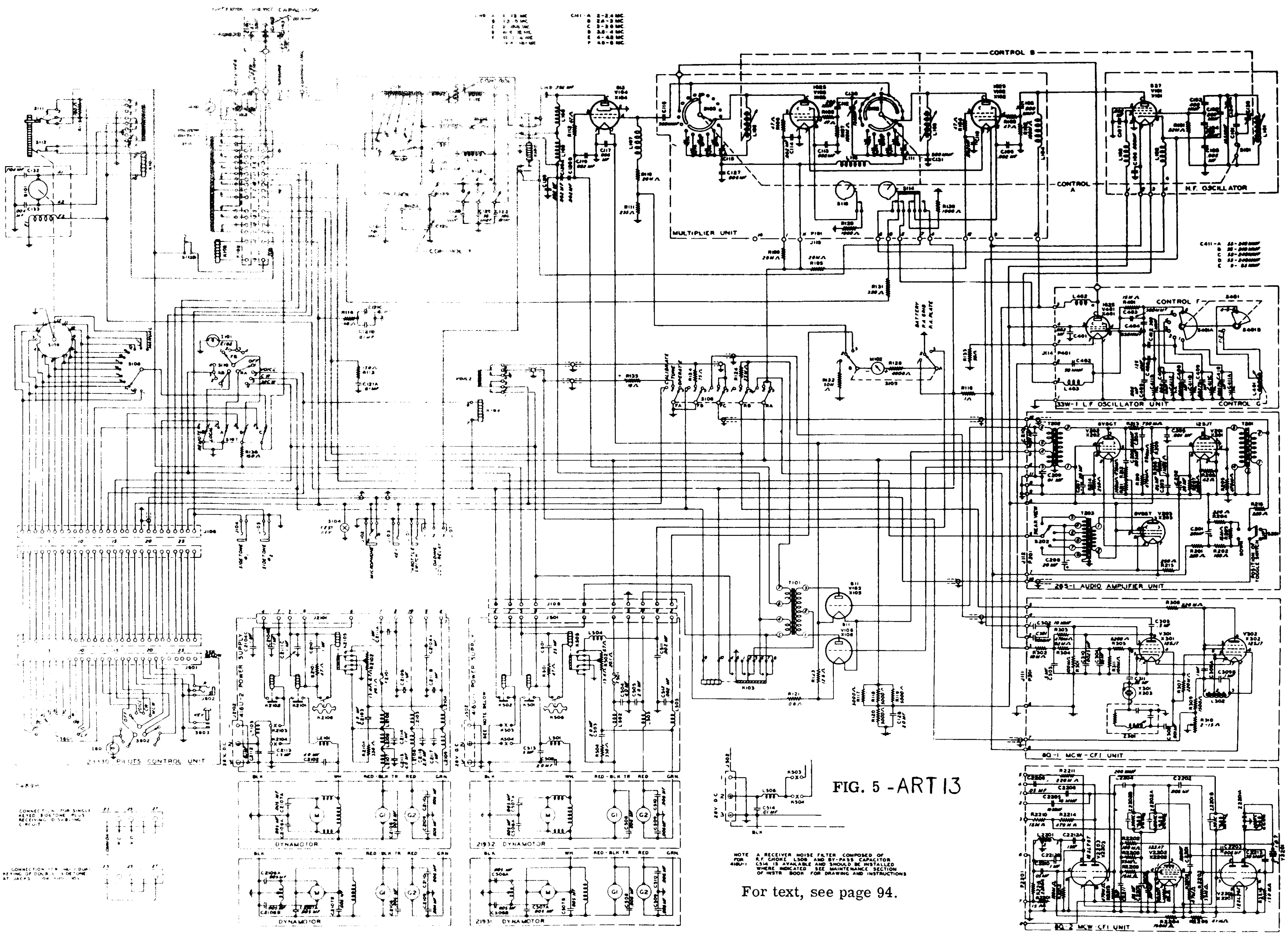


FIG. 5 -ART13

For text, see page 94.

AF AMPLIFIER FOR HI-FI TUNER

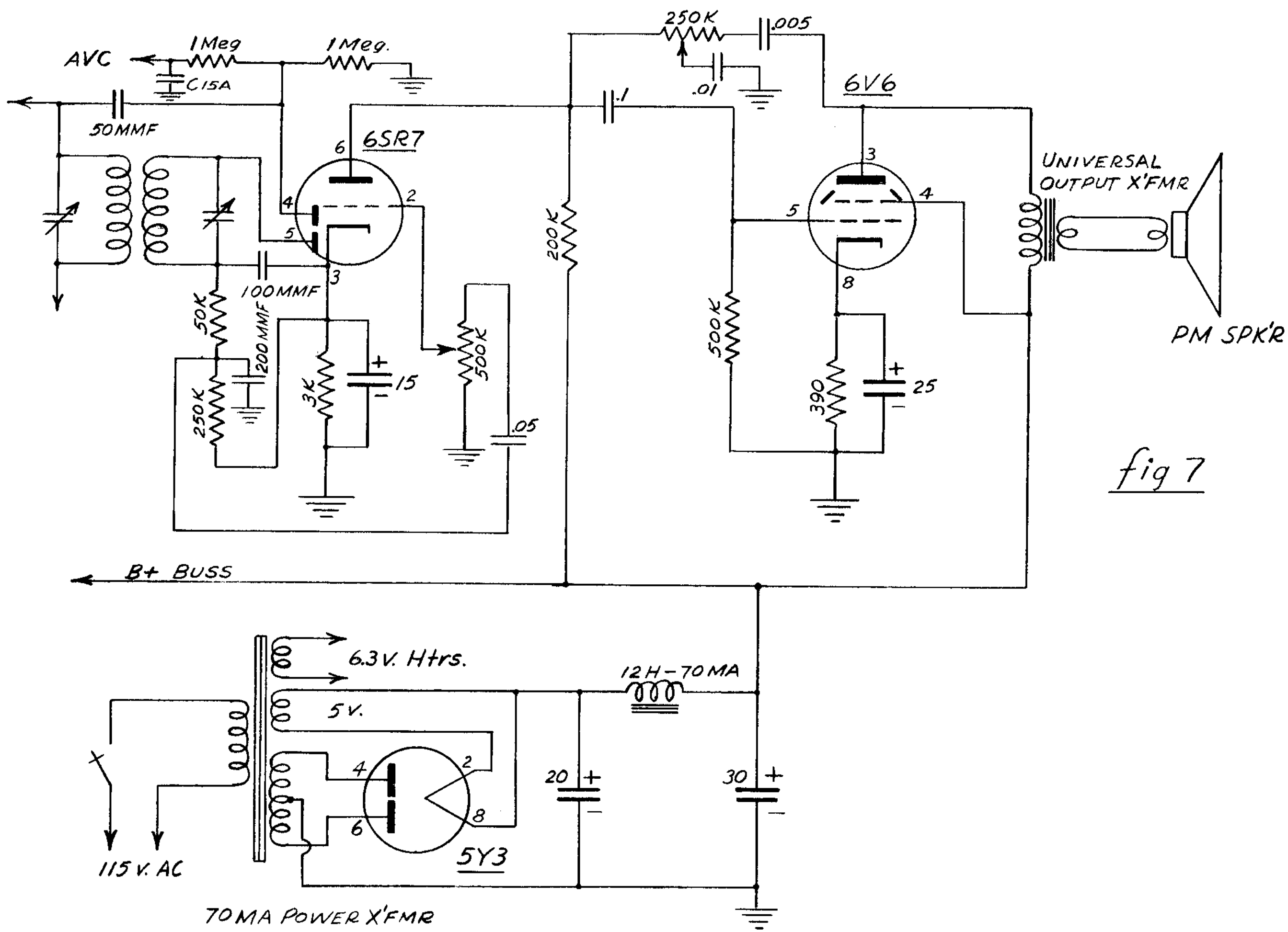


fig 7

10-Watt Audio Section

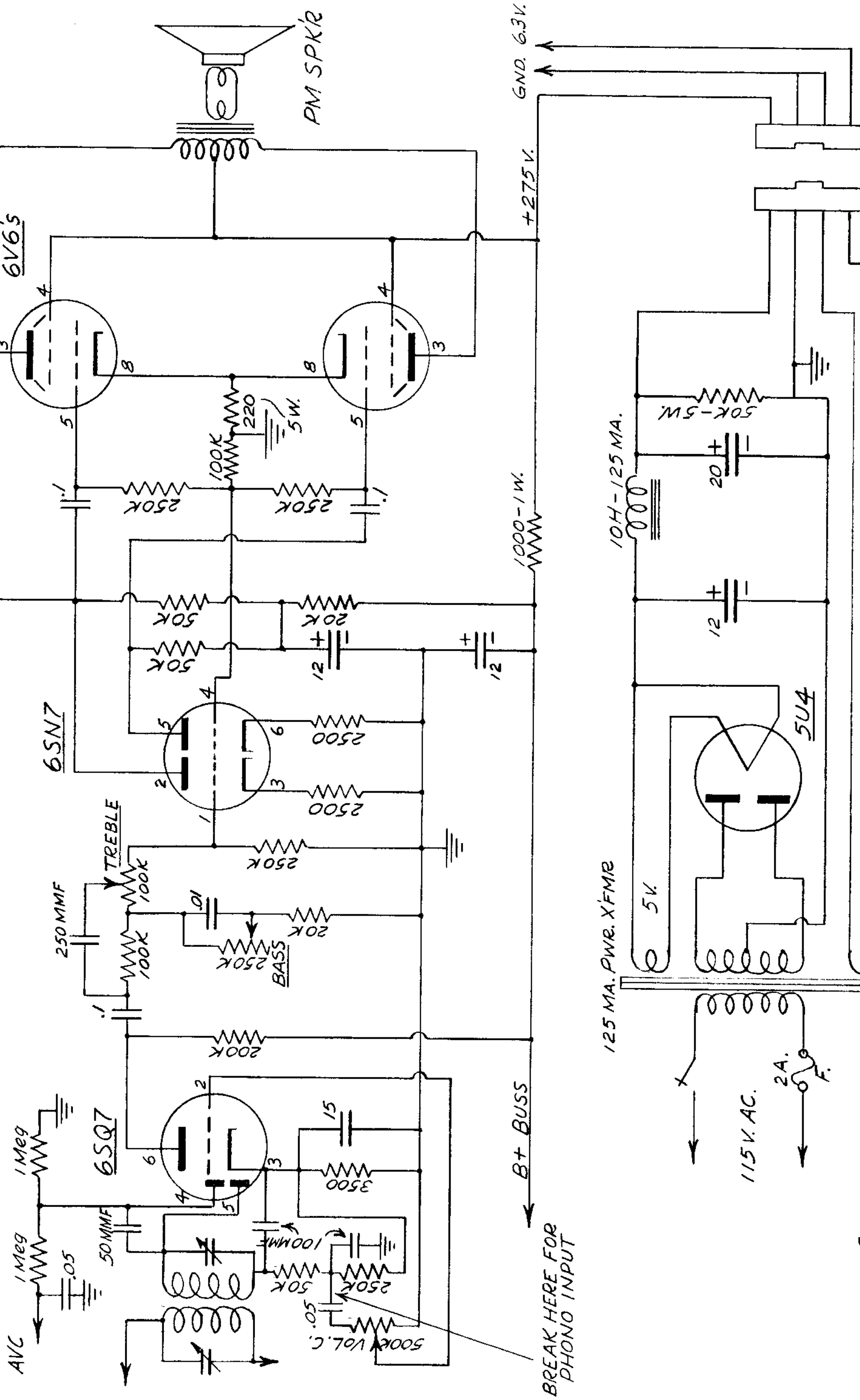


fig 8

By the wobbulator-scope method of IF alignment and coupling adjustment, similar scope patterns can be obtained as shown here. This response is indicative of the audio response of the tuner assuming a flat response of the audio system for the frequency range in question.

The low frequency droop in the over-all response (modulated RF signal) as shown in fig. 4, is due to the audio characteristic of the system used.

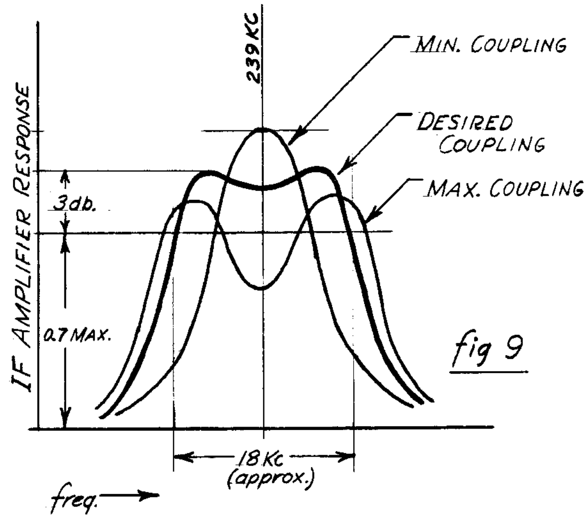


fig 9

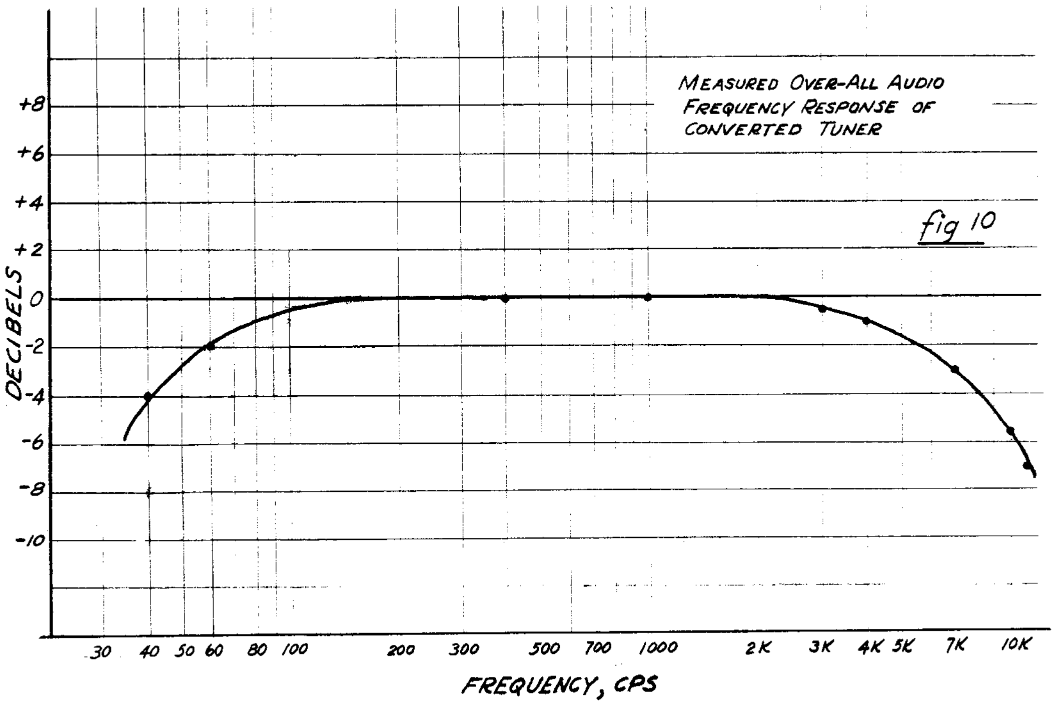
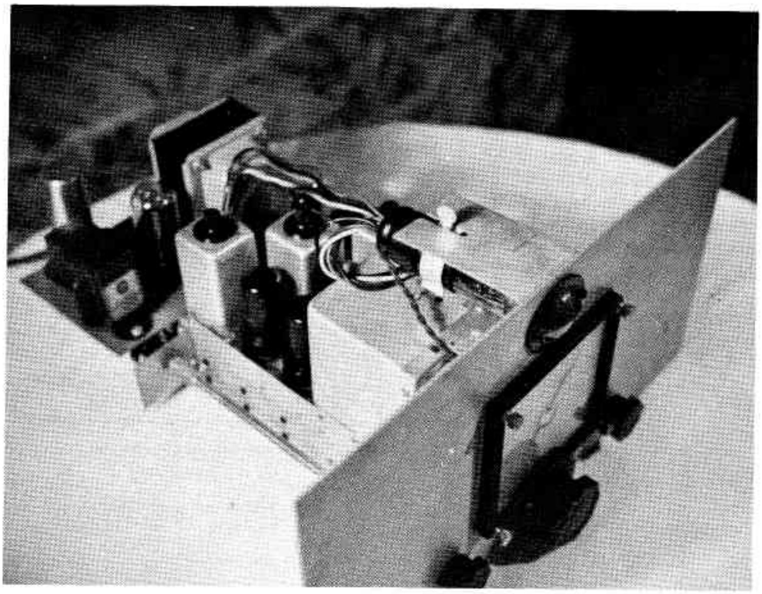
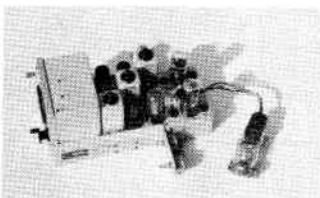
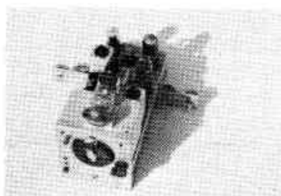


fig 10



CONVERTED BC-946B WITH SINGLE
ENDED AUDIO SECTION





CONVERTED BC-946B WITH PUSH-PULL
AUDIO SECTION

fig 11

BC-375 TRANSMITTER

One of the most widely known and widely available units of surplus transmitting equipment is the BC-375. Due to the relatively poor frequency stability of the transmitter, few amateurs have had the temerity to attempt to operate the transmitter as it originally was designed. By far the majority have disassembled both the transmitter proper and the tuning units for the wealth of usable components which they contain.

However, this section describes a relatively simple and quite practical conversion procedure by which the transmitter may be operated substantially intact and still meet the FCC requirements for transmitted frequency stability of signals on the amateur bands. The conversion procedure consists essentially of two steps: (1) The construction of two power supplies, 24 volts d.c. at 7.5 amperes and 1000 volts at 300 ma., either of which is universal in its application so that it may be used with any item of equipment in addition to serving as a portion of the BC-375 transmitter system. And (2), the modification of the tuning units so that an external v.f.o. may be used to excite the original oscillator of the MOPA transmitter so that this stage operates as a buffer amplifier or as a frequency doubler.

(a) Description of the BC-375 Transmitter:

The BC-375 transmitter originally was designed for and used in larger military aircraft. It is capable of delivering 45 to 100 watts output over a wide frequency range into an antenna system such as could be installed on an aircraft. The r-f circuit uses a 211 (VT-4C) as master oscillator and another 211 as power amplifier. The audio system uses a 210 speech amplifier or tone generator and a pair of 211 tubes in push-pull as modulators.

The transmitter is provided with a quite flexible antenna-loading circuit. The output may be coupled into a single straight wire of any reasonable length.

Power requirements for the BC-375 are 24/28 volts DC at approximately 600 watts for CW operation and about 850 watts for phone. Plate voltage is obtained from the PE-73 28-volt dynamotor which requires approximately 20 amperes under normal operating conditions. Its high voltage output is 1000 volts at 500 ma. Physically identical with the BC-191, the dimensions of the BC-375 are 20" high x 22" wide x 8" deep.

The complete equipment, with the BC-375 as the primary component, is as follows:

Transmitter	BC-375
Tuning Units.	TU-5B (1500-3000 kc.), TU-6B (3-4.5 Mc.), TU-7B (4.5-6.2 Mc.), TU-8B (6.2-7.7 Mc.), TU-10B (10-12.5 Mc.)
Antenna Tuning Unit.	BC-306
Dynamotor.	PE-73
Carbon Microphone	T-17, etc.

The significant difference between the BC-191 and the BC-375 is that the former operates from 12-volt source for its filament and relay circuits. In the DC version (component of the SCR-177), the transmitter plate power was derived from a 12-volt dynamotor, while in the AC version (component of the SCR-188) all transmitter power requirements were derived from AC power unit RA-34. This power unit, designed to operate from 105-125 volts or 210-250 volts, 50/60 cycles, furnishes filament, mike, and plate voltages for the 12-volt transmitter. The dimensions of the RA-34 are 13-7/8" x 12-11/16" with its weight being 140 pounds.

(b) Power Supply Equipment:

If one is not a proud possessor of an RA-34 power unit, two power supplies for the filament and plate requirements of the BC-375 must be constructed. The filament power supply must provide 24 volts DC at approximately 8 amperes. The construction of this unit involves more expense than if only AC transformers are used, but is justified for several reasons. First, it is very difficult to get at the filament circuits to make any changes. Second, direct current must be used to permit the use of the antenna relay. Third, a certain amount of AC hum from the filament tubes must be tolerated unless special balancing circuits are used with AC filament power.

A power supply to meet the requirements is shown in Fig. 2. The selenium rectifier, with a single section filter, provides sufficiently smooth DC for operation of the filament and relay circuits.

The high-voltage plate supply must deliver approximately 1000 volts at about 300 ma. The circuit shown in Fig. 3 for the high voltage supply has proven to be satisfactory. As previously mentioned, this supply is of conventional design so that it may be used with other equipment. Power connections to the transmitter are made at the plug connections as also shown in Fig. 3.

(d) Modification for VFO Excitation:

The two power supplies described above will operate the transmitter as it was originally used in the military service. However, the instability of the master oscillator is considerably outside the limits for amateur operation as specified by the FCC. This situation may be corrected by modifying the original master oscillator to function as a neutralized buffer amplifier stage driven by an external VFO. Any VFO with sufficient power output and the proper frequency range will be satisfactory. However, the surplus SCR-274N transmitter, when converted, serves the purpose very well.* The output frequency of the VFO must be 3.5 Mc. for 3.5 and 7 Mc., and 7 Mc. for 7 and 14 Mc. transmitter operation. The BC-459 (7 to 9.1 Mc.) when used as the VFO permits both 40 and 20 meter operation. For 20 meter operation, the original master oscillator stage functions as a doubler. Although this stage is quite inefficient when operating as a doubler, satisfactory operation can be obtained by supplying adequate drive from the VFO.

If the BC-696 transmitter (converted) is used for the VFO, 80 and 40 meter operation of the transmitter can be obtained. It should be noted that frequency multiplication greater than two in the converted master oscillator stage is unsatisfactory due to low efficiency.

To modify the original master oscillator for operation as a neutralized buffer amplifier stage or as a doubler, it is necessary to construct a tuned grid circuit for the VT-4C (211) stage. This circuit consists of a tank which may be tuned either to the 80 or 40 meter bands. It is link coupled as shown in Fig. 4 to a coaxial connector mounted on the side of the transmitter.

The tuned circuit is mounted on the main frame of the transmitter and should be located as near to the tube as is possible. It should be placed just behind the front panel with its tuning and switch controls brought out through the panel. The circuit and the components required are shown in Fig. 4.

(e) Conversion of the Tuning Units:

Modification of the tuning units primarily involves changing the original oscillator circuit to a neutralized amplifier or doubler circuit. Additional modification of the excitation and neutralization taps for the PA also are suggested for increasing excitation to the PA. The tuning units described provide 80, 40 and 20 meter operation with sufficient excitation to the final to realize an RF output of approximately 100 watts.

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* "Surplus Radio Conversion Manual", Volume I

Tuning Unit TU-6B (3-4.5 Mc.):

This tuning unit requires only minor changes to permit straight-through operation from the 80-meter VFO. An added 50 uufd. variable transmitting-type condenser is used at the cold end of the buffer tank for neutralizing as shown in the converted TU-6B schematic diagram, Fig. 5. The condenser is mounted in the buffer compartment (originally oscillator compartment) with its screwdriver adjustment accessible through the rear panel of the tuning-unit chassis. Stand-off's should be used for mounting the condenser.

For increased excitation to the PA, the excitation tap is moved to the "hot" end of the coil while the neutralizing tap relocated at the bottom or "cold" end. Switching of positions for these two taps should be obvious from the "before and after" diagrams, Fig. 5.

Tuning Unit TU-8B (6200-7700 kc., 40 Meters):

This unit may use the buffer stage as a straight through amplifier or as a doubler, depending on the VFO source. Output is for 40-meter operation.

The same operations for modification are required as in the case of the TU-6B if excitation is to be supplied on 7 Mc. Considerably less capacitance is required for the added neutralizing condenser, thus permitting the use of a 25 uufd. variable. Similarly, the control shaft is extended through the rear of the unit for screwdriver adjustment. The neutralizing condenser is added to the TU-8B in the same circuit position as shown for TU-6B in Fig. 5 if excitation will be supplied on 7 Mc. to the unit. Fig. 6 shows the proper circuit connections for the TU-8B when the first 211 tube is to be operated as a doubler from 3.5 Mc. with 7 Mc. output. Note that it is not necessary to install a neutralizing condenser when this stage is to be operated as a doubler. It is necessary, however, to remove the oscillator feedback condenser from inside the tuning unit, as shown in Fig. 6. The excitation and neutralizing leads to the PA should be interchanged as described for the TU-6B to provide greater drive for the PA.

If the neutralized buffer amplifier stage is to function as a doubler, neutralization for this stage is not necessary. However, to improve its doubling efficiency, the grid bias for the stage is increased. This is accomplished by inserting a 75K ohm resistor in the grid bias lead as shown in Fig. 6. Even though this operation materially improves the doubling efficiency, considerably more drive from the VFO is required for doubling than for straight-through operation.

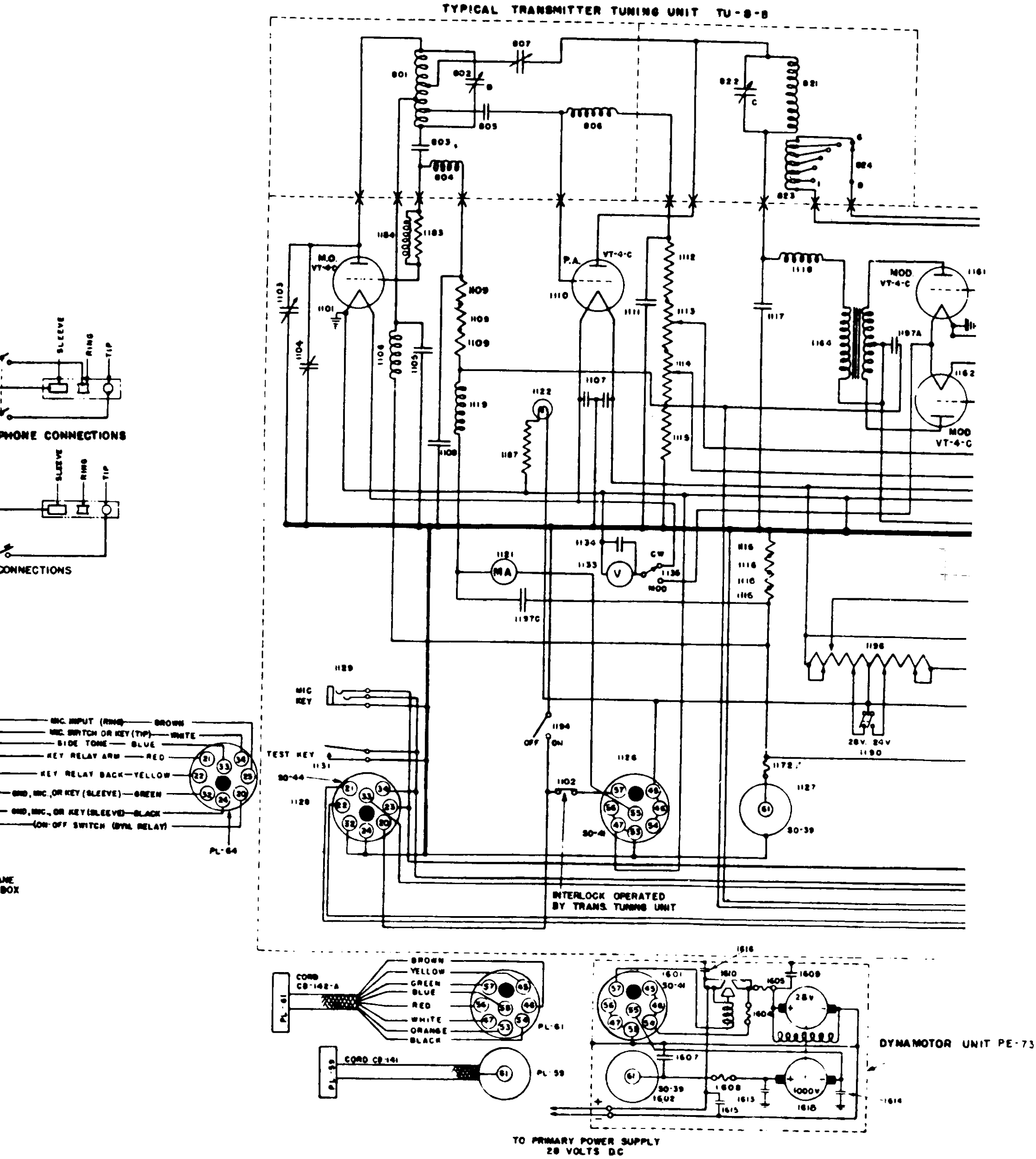
Tuning Unit TU-10B (10-12.5 Mc., 20 Meters):

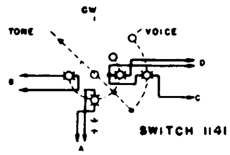
For 14-Mc. operation, with excitation from the VFO on 7 Mc., the buffer amplifier must function as a doubler. As mentioned previously, this stage is not efficient as a doubler. To compensate for the inefficiency, added drive from the VFO is required as well as increased bias for the stage. The additional bias is obtained by insertion of the 100K resistor in the grid-bias lead as shown in the schematic diagram, Fig. 7.

As mentioned above, neutralization is not required for the buffer stage when it functions as a doubler, thus eliminating the need for the neutralizing condenser required for straight-through operation. The PA excitation and neutralization taps are interchanged for increased excitation as with the other tuning units.

One more operation is required to bring the tuning unit into the 14-Mc. range. This involves shorting out one turn at the cold end of both the buffer amplifier and PA tank coils. The shorting can be accomplished by flowing solder across the two end turns in both cases. One point that should be mentioned is that the taps on the buffer coil must remain an equidistant number of turns from the center-tap connection.

BC-375 TRANSMITTER
ORIGINAL SCHEMATIC





BC-375 TRANSMITTER
ORIGINAL SCHEMATIC

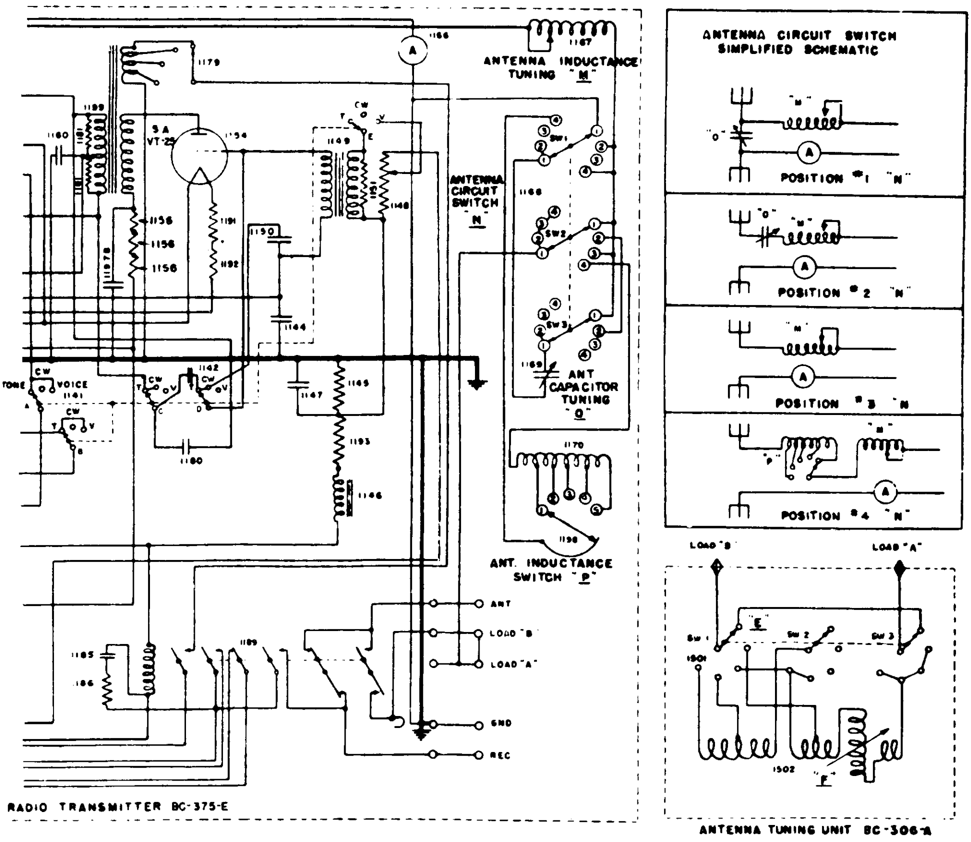


fig 1

(f) Modifications for the Modulator:

The existing modulator is incapable of full modulation of 100 watts output from the PA. This is due to insufficient drive from the carbon mike and the 210 audio amplifier.

Since a pair of push-pull 211's are capable of much more audio than really necessary, increased drive will solve the problem. This may be accomplished by inserting an additional audio stage between the mike and the 210 stage. For convenience, the added tube may be coupled to the 210 through the existing mike transformer, with a plate to 200-ohm transformer used to match the plate of the added tube to the existing mike input.

A more refined solution to the audio amplification problem would be to construct a new preamplifier and driver to replace the 210 stage. The driver transformer to the modulator grids has several taps ranging from 150 to 4000 ohms, thus allowing flexibility in the choice of the output stage of the audio amplifier driver.

Higher bias is required for increased output from the class B 211 modulator. Fixed bias is preferred and can be obtained from a 75 bolt B battery. It should be noted that the modulation can be increased materially without the addition of fixed bias. However, it is suggested that fixed bias be added since modulator bias was obtained from the PA grid leak resistor in the original circuit. Hence the modulator bias fluctuates with the PA grid current.

(g) Operation:

Operation of the BC-375 transmitter on amateur frequencies does not require the BC-306 antenna tuning unit. Various feeding circuits may be selected by the antenna circuit controls. The BC-375 output circuit is not readily adaptable to feeding a balanced load, although satisfactory results often may be obtained.

Antenna loading can be roughly determined by the RF ammeter located in the upper part of the antenna tuning section. During initial tests and tuning, reduced voltage should be used so as to avoid damage to the tubes. The original calibration charts will not be correct for the new tuning unit circuits. Therefore the dials should be recalibrated with a reliable frequency meter.

FILAMENT POWER SUPPLY

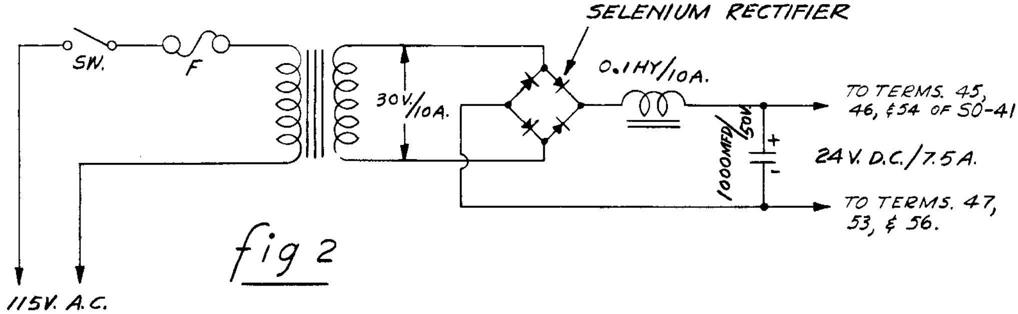


fig 2

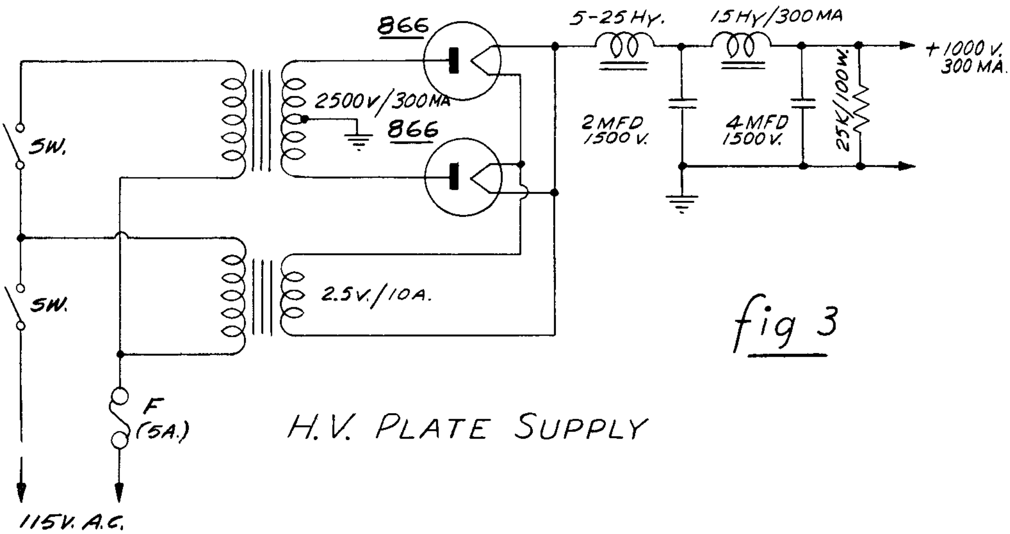


fig 3

H.V. PLATE SUPPLY

MODIFIED NEUTRALIZED BUFFER AMPLIFIER

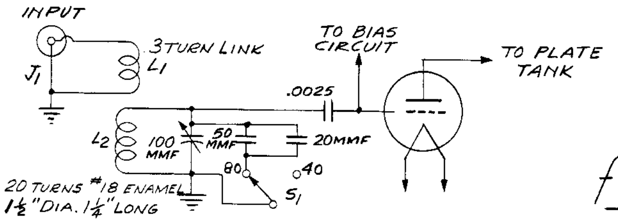


fig 4

NOTE: ALL FIXED CONDENSERS ARE MICA.

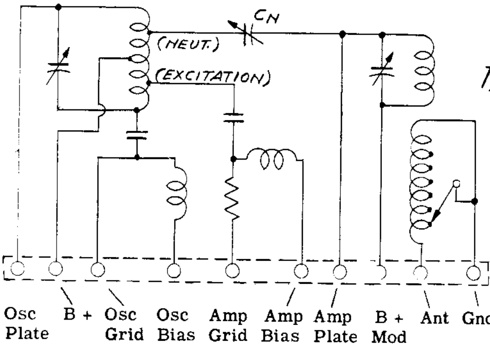
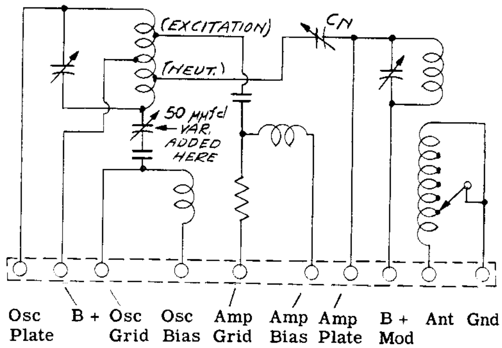


fig 5



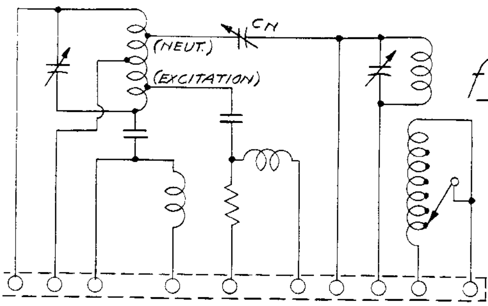
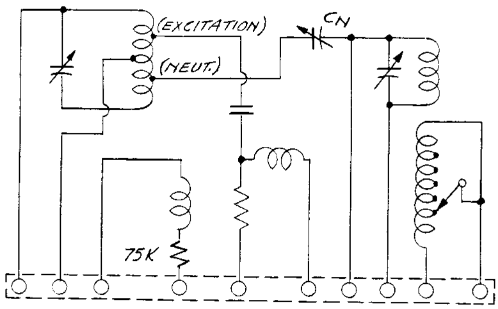


fig 6



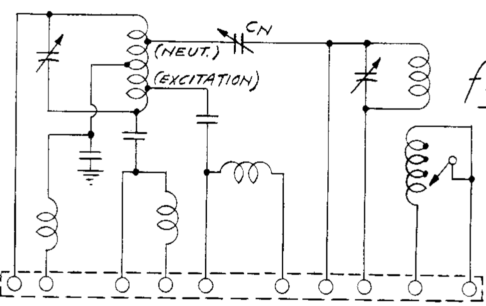
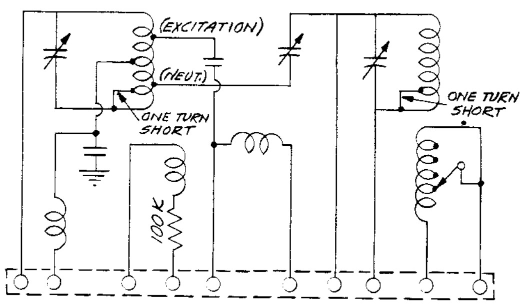


fig 7



(BEFORE)

(AFTER)

CONVERSION DATA FOR THE MODEL TA-12B AND TA-12C BENDIX TRANSMITTERS

The Bendix TA-12B transmitter comprises a remotely controlled, four-channel, 40-watt output, master oscillator type transmitter. The four-channels provide telephone, CW, or MCW operation in the frequency ranges of 300-600 kc. and 3000 to 7000 kc. The TA-12C covers the range 300-600 kc. and 3000-12,000 kc.; otherwise the two are identical.

The transmitter is one of the most attractive to appear on the surplus market and is ideal for the amateur in need of a desk-sized transmitter to cover several of the amateur bands.

The unit is quite light, weighing only about 35 lbs, and in physical size is 15-1/8 inches wide, 10-1/4 inches high and 6-3/4 inches deep.

The equipment was designed to be operated from a primary power unit consisting of a DC dynamotor requiring 24 volts at 14.8 amperes. The modulator is part of the power unit chassis. However, the power supply (MP-28B) is usually not available.

Each of the four channels has its own oscillator and each uses a type 12SK7 tube. The IPA stage consists of an 807, while the PA is composed of (2) 807 tubes in parallel. The modulator (part of MP-28B), is composed of two amplifiers, a 6N7 and a 6F6 driving a pair of 807's in PP.

(a) Filament Conversion:

The tubes in the transmitter proper are wired originally for operation from 24 volts and are in series-parallel. The first step in the conversion is to rewire these for 6.3-volt operation by placing all tubes in parallel. This can be accomplished quite easily be referring to the "before and after" diagrams given in Fig. 1. Note that since the 12SK7 type tubes have 12 volt filaments, it will be necessary to replace them with 6SK7s. If desired, the entire tube line up may be wired for 12-volt filament operation and the 12SK7's will not have to be replaced. But in this article 6.3-volt operation is assumed.

(b) Elimination of Keying Relay K101 and Substitute Circuits:

Relay K101 acted as an antenna change-over relay and switched plate voltage to the osc. and doubler in addition to other functions. As this relay operated from 24 volts DC, it must be removed and the circuit modified.

This procedure is as follows: Clip all wires to K101 and remove it from the transmitter. All of these wires may be taped up or removed, with the following exceptions: The lead from terminal 10, which is the plate voltage lead for the osc. and doubler, should be jumpered to the wire on the relay contact to which it would normally make contact when the relay operated. This will enable application of plate voltage directly to the osc. and doubler. In addition, the lead from the antenna terminal through meter M101 should be jumpered in place of the normal relay contacts. This lead will now run directly from the antenna terminal through M101 and to the swinger of S102F. (S102G is no longer used as it merely applied voltage to an external antenna loading coil relay when the transmitter was set on the low-frequency channel, number 1.) See Fig. 2.

(c) AC Power Supply and Modulator to Replace Original Unit:

As the fundamental power source was a 24-volt DC supply, it will be necessary to build an equivalent AC power supply to furnish voltages for all filaments and for the tube plates. This will have to be constructed on an external chassis. A modulator capable of 100 per cent modulation is also built on the same chassis as the power supply. These two units may be wired in accordance with Fig. 3. Pay special attention to the terminal connection numbers as these will coincide with those at the transmitter.

(d) Metering Information and Keying Data:

M101 on the front panel indicates antenna current at the transmitter output terminal. The two jacks J102 and J103 provide meter connections for measuring cathode currents of the doubler and PA tubes. J103 may also be used to key the transmitter for CW use as it opens the cathode circuit of the PA.

A 22.5-volt battery is placed in series with terminal 14 along with an added metering jack to register PA grid current. See Fig. 2.

(e) Operating Data:

After connecting the power supply/modulator unit to the transmitter as shown on the diagrams, set the OSC TUNING dial for each channel to the reading corresponding to the desired frequency. The frequency calibration curves Figures 4 and 5 will permit setting the frequency to approximately plus or minus .5%. A frequency check should be made with an external frequency meter for greater accuracy.

The following tabulation shows the frequency coverage of each channel:

Channel	TA-12B	TA-12C
1	300-600 kc.	300-600 kc.
2	3000-4800	3000-4800
3	4000-6400	4800-7680
4	4370-7000	7680-12000

The switch (S2) of the power unit should be thrown to the off position, and AC applied to the power unit by closing switches S1 and S5. After a minute or so warm up period, S2 should be thrown on, applying plate voltage to the tubes. (Note: when using CW, switch S3 should be closed, shorting the secondary of the modulation transformer to prevent damage to the transformer. For phone, of course, it should be left open.)

(1) Rotate the output TUNING dial of the desired channel as far as possible in a CCW direction, thus placing the entire load coil in the circuit. Set the antenna capacitor switches (S104, 105 and 106) to the OUT position. These switches are on the same mounting board as the Channel 1 loading switches. (2) Set the plate capacitor switches (S109, 108, 107) to the OUT position. These are accessible when the transmitter is removed from its case. Set the output loading coil of the desired channel to 50, which corresponds to maximum capacitance. (3) Connect an antenna to the antenna terminal (115 feet of straight wire will work very well.) (4) Set the channel selector to the desired number and close the telegraph key, which can be plugged into J103. Rotate the channel loading dial from 50 to 0 observing the PA plate current. (A meter will have to be placed in series with the key to observe this.) Rotate the channel TUNING control and channel LOADING control until a dip in PA plate current is noticed. A setting should be found which will give a dip in plate current to approximately 180 ma. To obtain proper loading it may be necessary to connect the fixed plate capacitor in parallel with the variable by means of the switch (S109, 108, 107) on the rear plate of the coil and capacitor assembly. It may also be necessary to connect the antenna series capacitor in the circuit by means of S104, 105 or 106. The antenna current as indicated by M101 should pass through a peak at approximately the same tuning point that gives minimum plate current. It is possible to tune to a harmonic of the desired frequency, so a wave-

meter should be used at all times as a check on the output frequency.

(f) General Notes:

The test key on the front panel may be wired in series with J103 if desired and used for tuning purposes, allowing a meter to be plugged into J103.

It may be advisable to insert an r-f choke in series with the B plus lead to the transmitter final tank coil. This lead should be by-passed to ground.

Schematic circuit diagrams of the transmitter and original power supply unit are given in Figs. 6 and 7.

With this conversion it will not be possible to make use of the remote control unit, due to the lack of 24 volts DC for operation of the control motors.

TA-12 (B&C) FILAMENT CIRCUIT

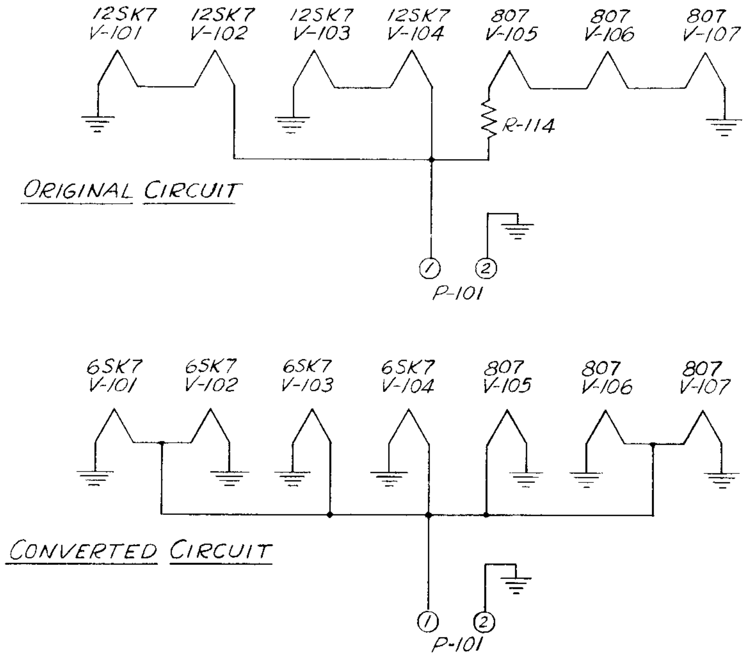


fig 1

CIRCUIT SUBSTITUTION FOR RELAY K-101

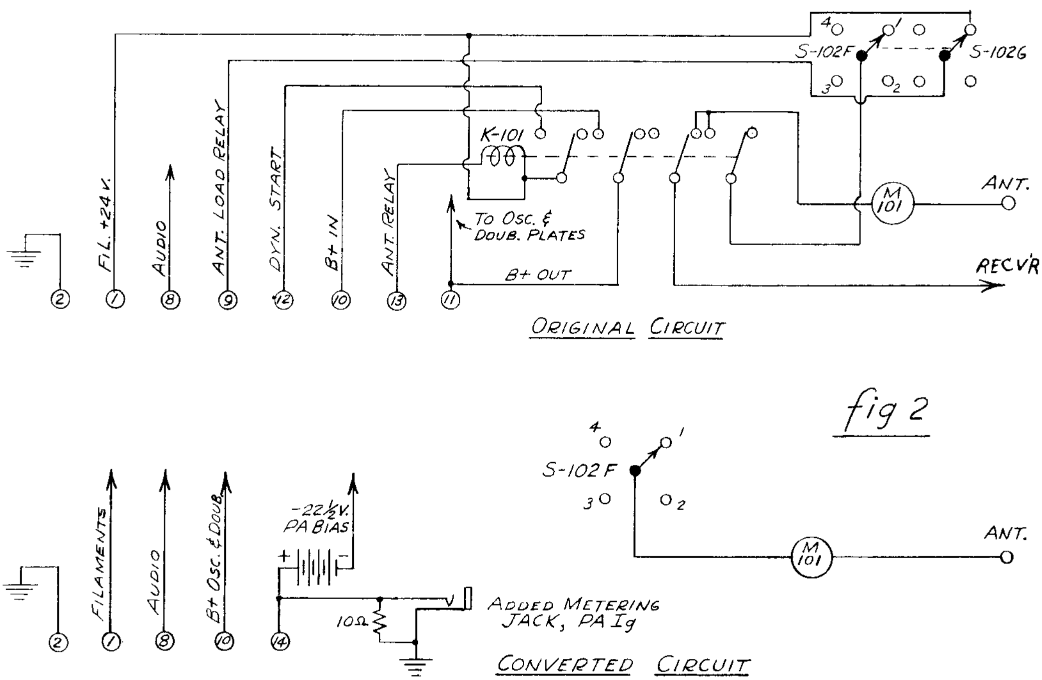
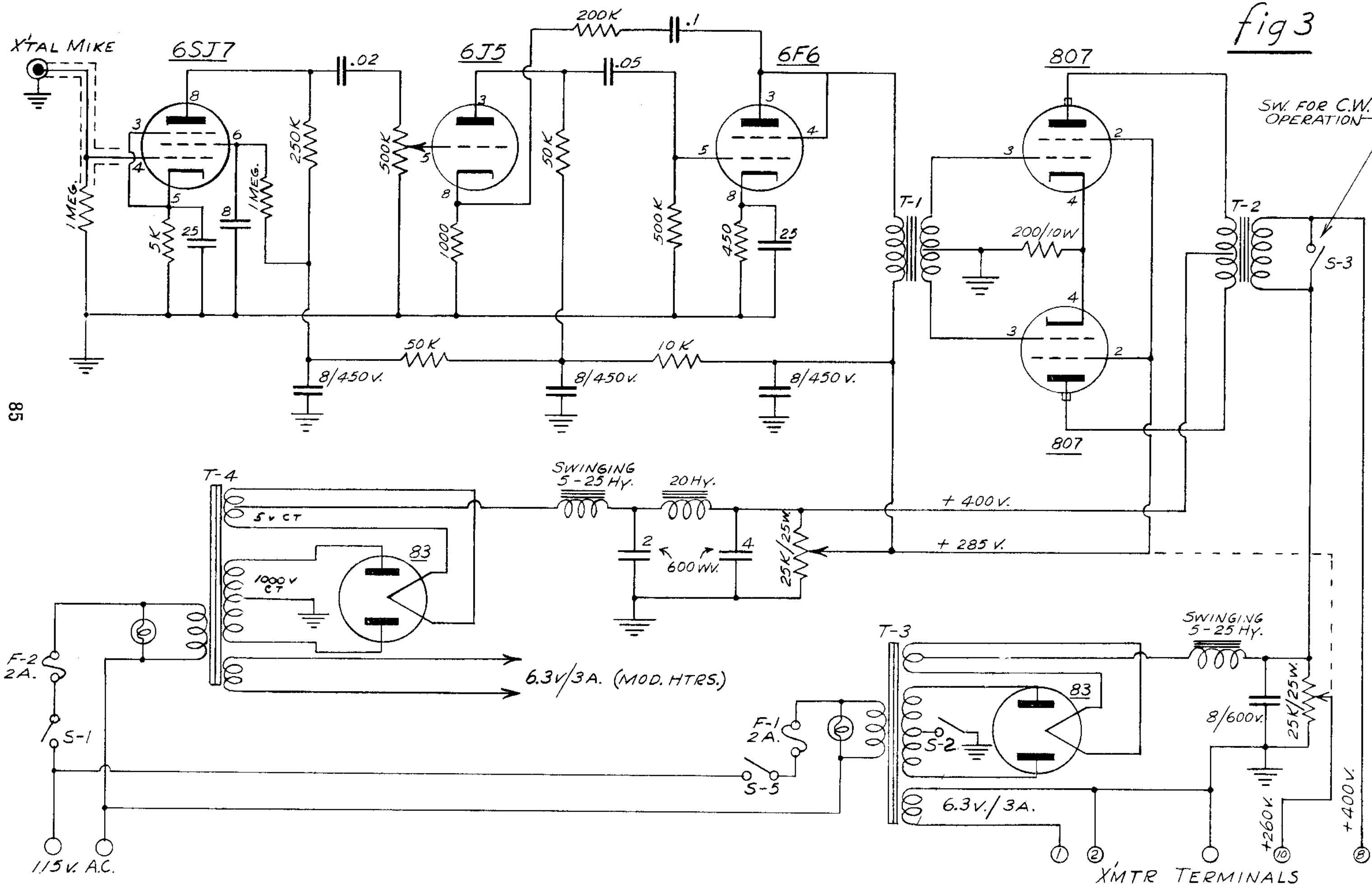


fig 2

MODULATOR AND POWER SUPPLY FOR TA-12 TRANSMITTER

fig 3



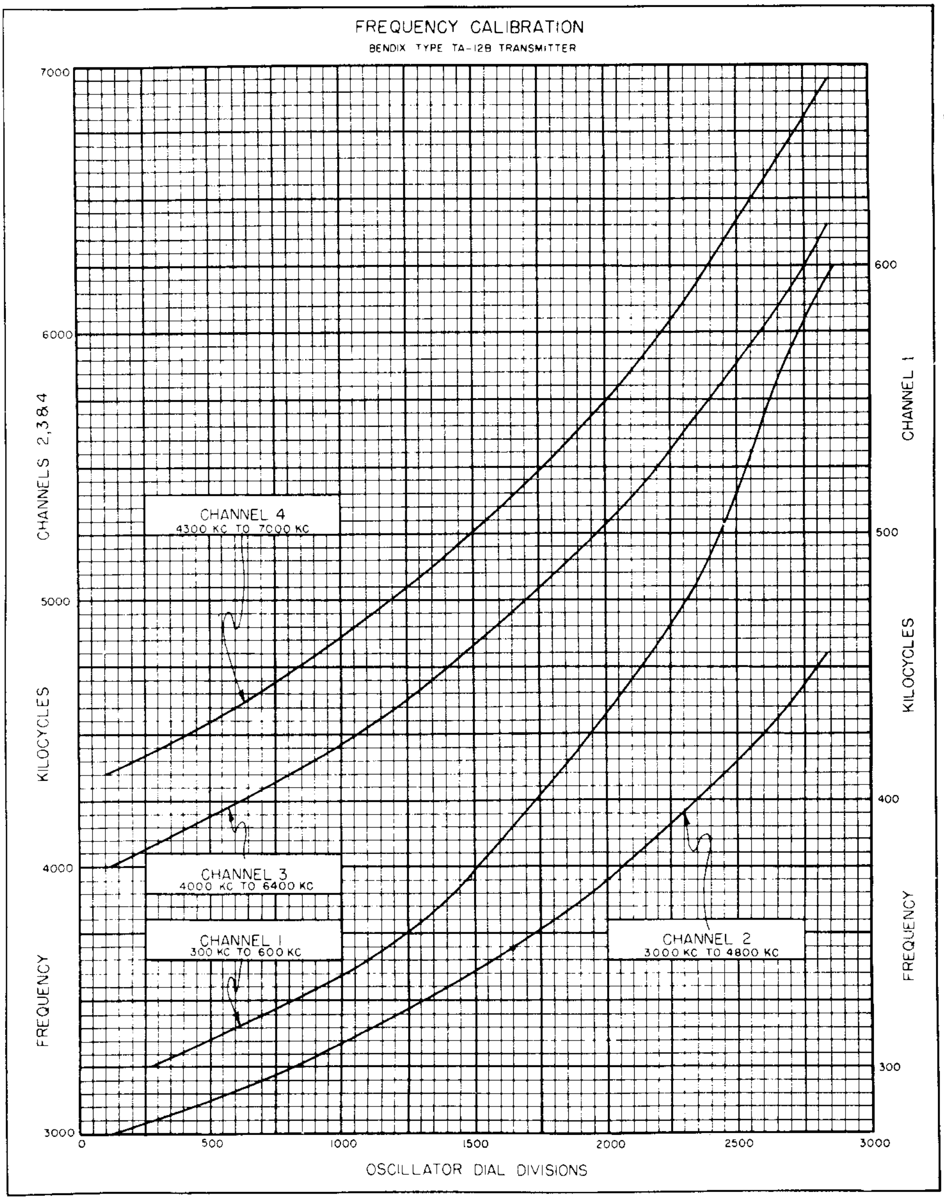


FIG. 4 —FREQUENCY CALIBRATION TYPE TA-12B TRANSMITTER

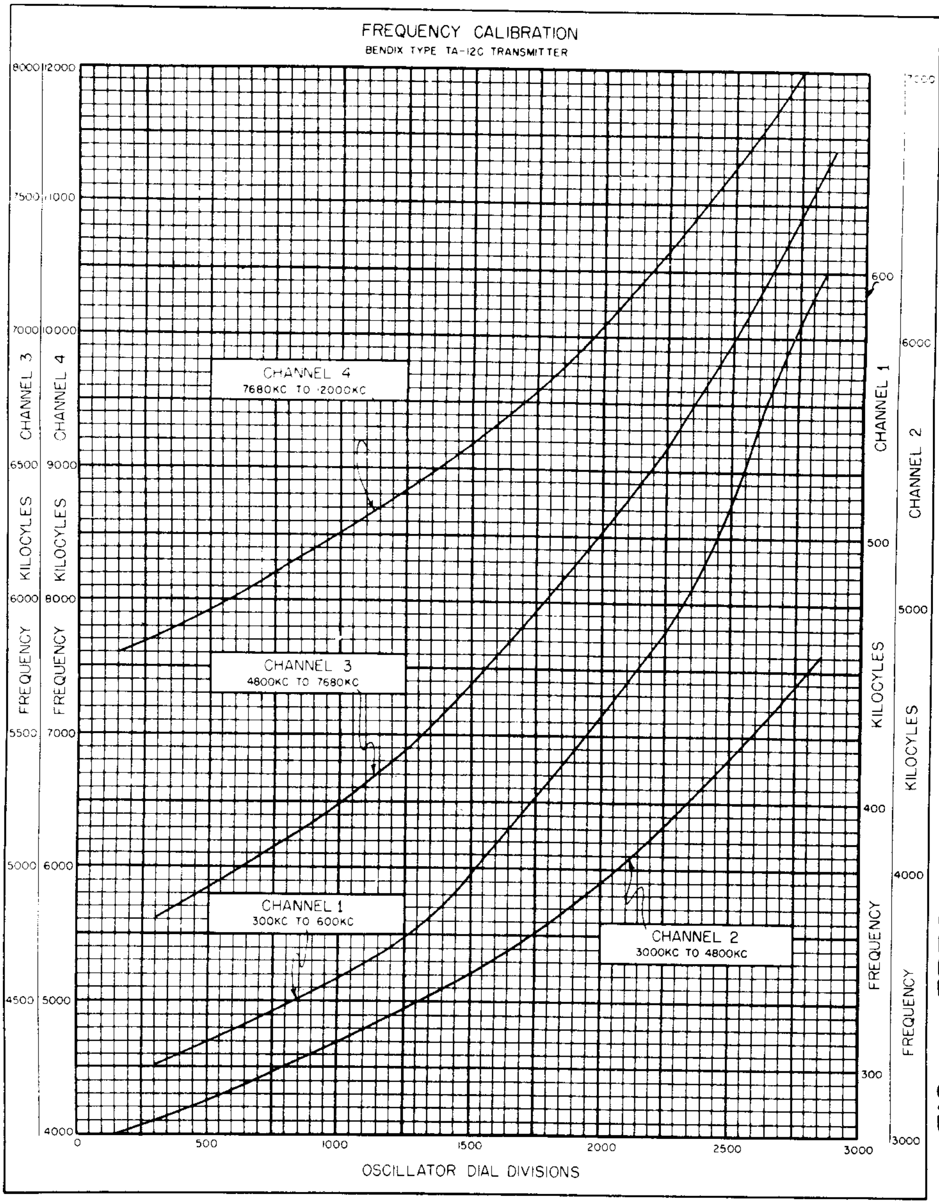
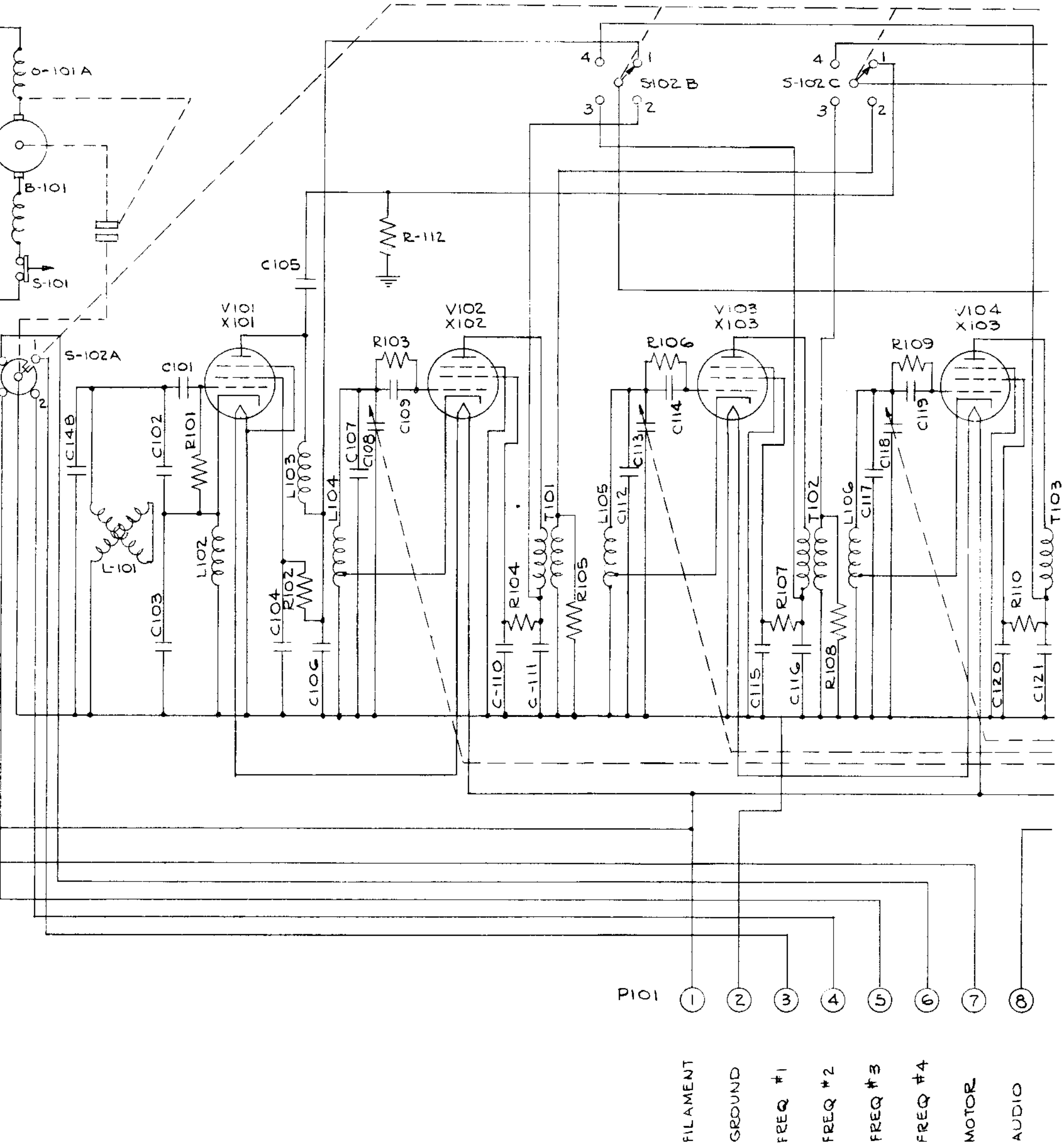
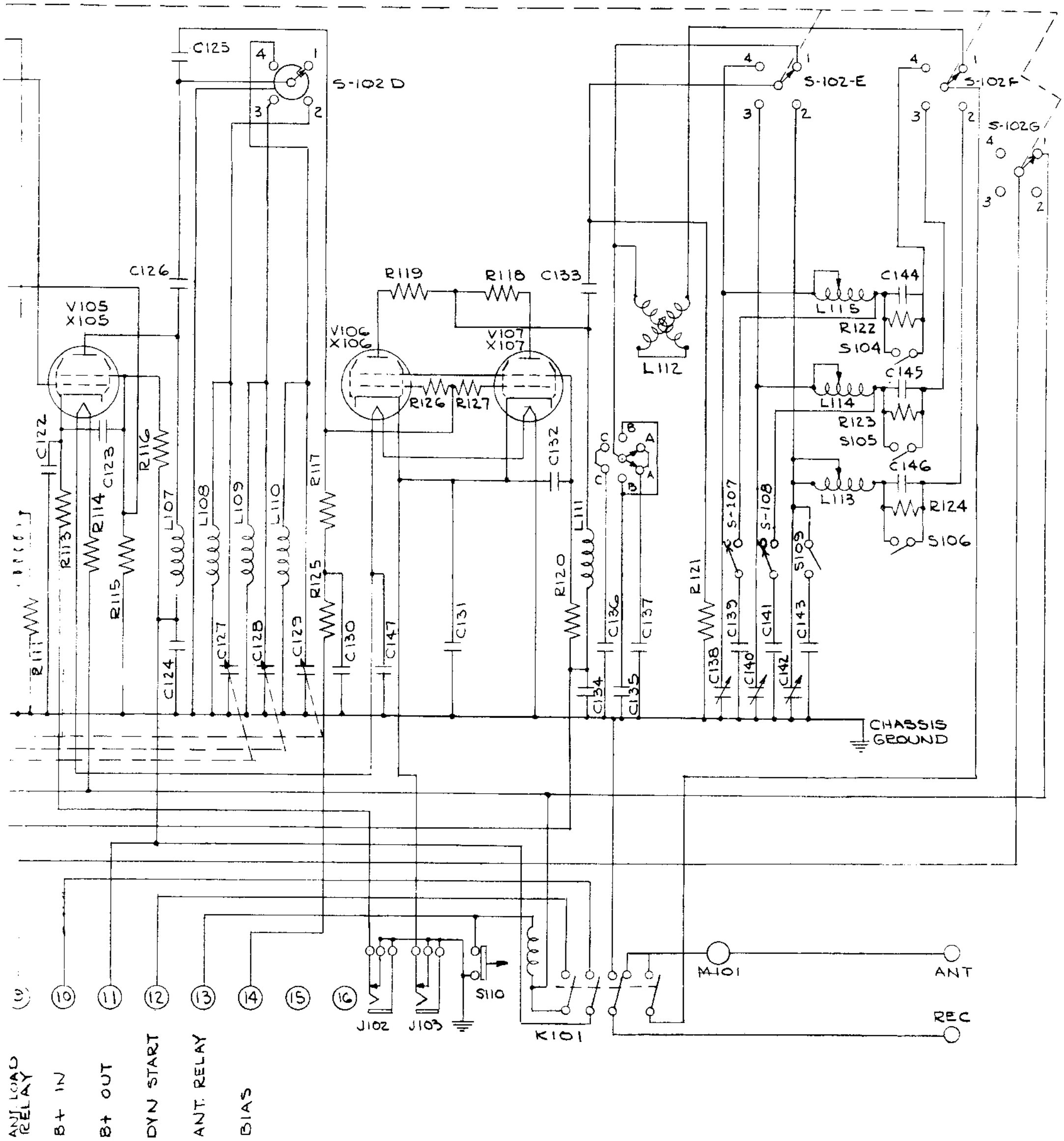


FIG. 5 – FREQUENCY CALIBRATION TYPE TA-12C TRANSMITTER



O-101A
B-101
S-101
S-102A
S102B
S-102C
R-112
C105
V101
X101
V102
X102
V103
X103
V104
X103
C101
R101
C102
C103
C148
L-101
L102
L103
L104
R102
C104
C106
R103
C107
C108
C109
R104
R105
T101
C110
C111
L105
C112
R106
C113
C114
R107
C115
C116
T102
R108
L106
C117
C118
R109
C119
T103
R110
C120
C121
P101
FILAMENT
GROUND
FREQ #1
FREQ #2
FREQ #3
FREQ #4
MOTOR
AUDIO

TA-12
(FIG 6)


C125
S-102 D
S-102-E
S-102 F
S-102 G
C126
V105
X105
R119
R118
C133
V106
X106
V107
X107
L112
C144
L115
R122
S104
C145
L114
R123
S105
C146
L113
R124
S106
R126
R127
C122
C123
R116
R113
R114
R115
R111
L107
L108
L109
L110
R117
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C128
C129
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C147
C131
C132
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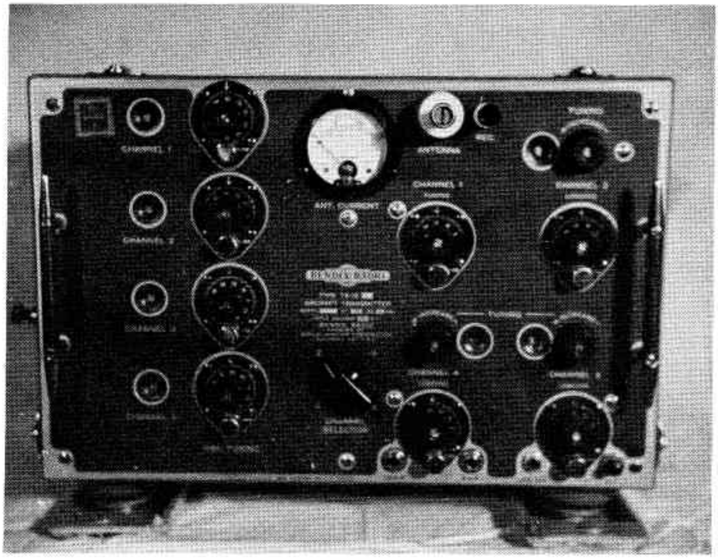
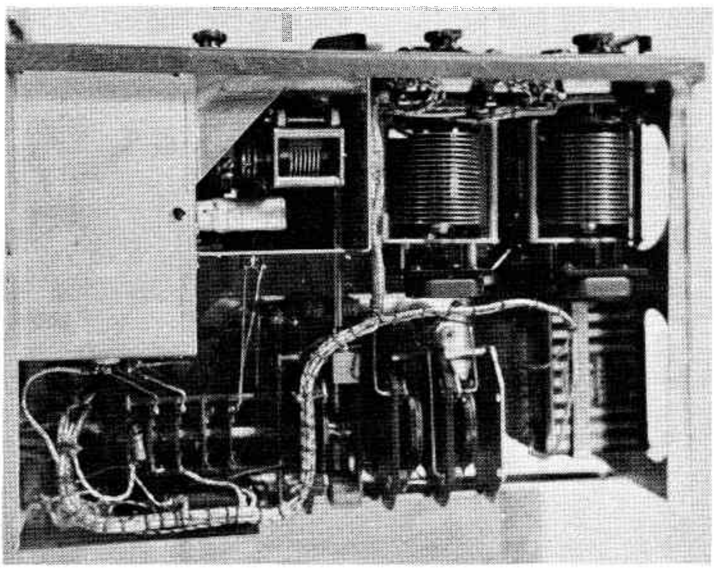
R120
C134
C135
C136
C137
R121
S-107
S-108
S109
C138
C139
C140
C141
C142
C143
CHASSIS GROUND
M101
ANT
REC
J102
J103
S110
K101
ANT LOAD RELAY
B+ IN
B+ OUT
DYN START
ANT. RELAY
BIAS



TA-12B Transmitter



TA-12B Bottom View After Conversion

FIG. 8

CONVERTING THE AN/ART-13 OR (ATC) AIRCRAFT TRANSMITTER

The Collins ART-13 Autotune Transmitter and its Naval counterpart, the ATC, were designed for use in the larger types of Army and Navy aircraft. They are now available on the surplus market in limited quantity.

This unit is truly the answer to the desire for a beautifully versatile rig covering all the amateur bands between 2000 and 18,100 kc. By simple conversion the 10-meter band may be added. Provision is made in the design for addition of a unit to cover the range of 200 to 1500 kc. But, as this range is useless for amateur operation, the space allowed for this section may be used for the addition of a 10-meter stage.

Phone or CW may be used with about 200 watts input to the final. Monitoring circuits are built into the set for both. CW speeds up to 25 WPM are possible. However, if higher keying speeds are desired it is suggested that block-grid keying of the final amplifier be used.

Probably the most noted characteristic of this transmitter is the autotune mechanism which allows selection of any one of 11 preselected frequencies, pre-tuned and ready to operate approximately 30 seconds after the selector dial is set to the channel desired. This mechanism may also be set into operation from a remote position by means of a separate control box, allowing the transmitter to be installed in a basement or garage and yet operated from within the house. In addition, a frequency-meter type VFO is incorporated. A crystal calibrator is included to check the calibration of the VFO.

The transmitter is only slightly larger than the standard communications receiver and weighs just 70 lbs. It is of rugged construction and looks well enough to be placed in the most particular ham shacks. It is housed in a black wrinkled aluminum cabinet 23-5/8 inches wide by 16 inches deep and 11-3/8 inches high. Provision is made for use with a shock-mount base.

The tube complement is as follows:

- 1 - 837 electron coupled oscillator
- 1 - 1625 (12 volt 807) doubler, tripler or quadrupler, depending upon frequency desired
- 1 - 1625 tripler
- 1 - 813 power amplifier
- 1 - 12SJ7 speech amplifier
- 1 - 6V6 driver
- 2 - 811 modulators
- 1 - 6V6 sidetone audio amplifier
- 1/2 - 12SL7-GT calibration-crystal oscillator
- 1/2 - 12SL7-GT frequency tripler
- 1/2 - 12SL7-GT calibration detector
- 1/2 - 12SL7-GT tone oscillator
- 1 - 12SA7 mixer (in frequency divider)

(a) AC Power Supply for the Equipment:

The main problem in converting this transmitter is in constructing a power supply so that the equipment may be operated from the standard 115-volt a-c line. In fact, if operation on the 28 Mc. band is not required, the construction of the power supply is all that is required before placing the transmitter on the air. On the basis of the conversion of a number of these excellent transmitters it has been concluded that the most satisfactory method of constructing the power supply is that method which requires no modification or extensive disassembly of the transmitter.

To meet the above requirement it is necessary that the power supply furnish the following voltages and currents:

27 volts d.c. at 10 amperes
400 volts d.c. at 225 ma.
1250 volts d.c. at 250 ma.

The 27-volt d-c power supply lights all filaments and heaters and the pilot lamp, powers all relays, and operates the autotune mechanism. The 400-volt power supply runs the v.f.o., exciter, crystal calibrator, speech amplifier, and in addition supplies screen voltage to the 813 final amplifier. The 1250-volt power supply provides plate voltage for the 813 when operating on c.w., and in addition supplies plate voltage to the 811 modulators when operating on phone.

Figure 1 shows a complete power supply for the transmitter. A bridge selenium rectifier is used for the 27-volt supply, while mercury-vapor rectifiers are used for each of the other power supplies. Choke-input filters are used in all three of the power supplies. The 12.5-ohm resistor in series with the negative return for the high-voltage power supply will give a full-scale reading of 320 ma. when the meter-selector switch on the panel of the ART-13 is placed in the "P.A. PLATE" position. The lead to terminal 7 of the ART-13 power plug is not used. This lead was used in the aircraft installation to turn the equipment on. With this power supply the equipment is placed into operation by closing the main switch in the 115-volt a-c line. Note that a separate switch has been provided for turning off the high-voltage supply when tuning the transmitter or checking frequency; the low-voltage system operates normally with this switch turned off, but no high voltage is applied to the 813 or to the 811's. Always be sure that the "CALIBRATE-TUNE-OPERATE" switch on the transmitter is in either the "CALIBRATE" or the "TUNE" position when tuning or calibrating the transmitter. If this is not done, damage to the screen of the 813 may occur as a result of excessive screen dissipation. With the power supply circuit as shown, the plate-voltage supplies will be in operation at all times when the "VOICE-CW-MCW" switch is in either the "CW" or "MCW" position, although the "MCW" position of course will not be used. For this reason S_2 has been included to provide for control of the application of plate voltages to the transmitter from the operating position.

(b) Adding the 10-Meter Multiplier:

The upper frequency limit of the ART-13 transmitter is 18.1 Mc. Hence the inclusion of an additional multiplier is necessary if operation on the 28-Mc. band is desired. This multiplier may be mounted in the space in front of the 813 tube which was provided for the low-frequency oscillator. A metal shelf or subchassis is installed in this space. A power plug which carries all necessary voltages for the added stage is already provided in the compartment. A 1625 tube is used for the added stage since its filament may be connected to the power plug after the 28-ohm resistor is removed from the circuit. This resistor was provided to give the same drop as the 1625 tube for which it substitutes when the low-frequency oscillator is not used. The circuit of the stage is given in Fig. 3. A variable condenser across the plate coil of the 1625 may not be required. Tuning is broad and may be accomplished by decreasing or increasing spacing between the coil windings. The stage may be operated either as a doubler or tripler, but in this particular conversion a tripler appeared to give much better results. Coil data for a tripler stage is given in Fig. 3.

A 10-meter final tank circuit must also be constructed. The coil is best mounted on the relay K-105 located just to the left of the new 10-meter compartment as viewed from the front panel. This relay, K105, originally switched the 813 plate to an external loading coil for low-frequency operation. The 10-meter tank circuit is merely hooked between the relay output contact and ground. Coil data is given on the 10-meter circuit diagram Fig. 3. In these units it is advisable to remove the low frequency RF choke L-109, and move C-128 (.002) into the former position of L-109. The high-voltage lead is then connected to one side of C-128 and to the bottom of the high-frequency choke, L-108. The other side of C-128 is grounded. The 10-meter antenna connection can now be made to the external load-coil terminal if a lead is run from the load coil terminal to a tap on the 10-meter tank.

To switch from 10-meter operation to any one of the other frequencies, two methods may be used. The first method allows fully automatic operation and uses a double pole, double throw relay mounted on the panel in the bottom of the transmitter near the grid of the 813. Activation of this relay is accomplished by the same current source which supplies the external antenna change-over relay. The second method involves the use of a four-pole double-throw switch mounted near the grid of the 813 and wired according to Fig. 3. Both methods merely break the lead from the multiplier stage plate to the 813 grid and connect either the 10-meter multiplier section or the normal HF oscillator to the 813.

For 10-meter tuning, the transmitter controls "A" and "B" are tuned in the normal fashion to 1/3 of the required 10-meter frequency. Controls "D" and "E" are not important but control "C" should be placed on position 7 to close the internal switch in series with the key and to short out the HF pi-network coil.

After switching to 10-meter operation, turn on the transmitter and tune the tripler for a maximum reading of 813 grid current with the meter switch in the "Tune" position and the emission switch in the CW position. The 813 tank is then tuned for minimum plate current.

(c) Autotune Mechanism:

To tune manually, the locking bars are left tight and the channel switch turned to "Manual". After the mechanism has stopped, the knobs are set as stated in the calibration book and the transmitter is tuned normally.

To preset a channel, turn the channel switch to the number desired. When the mechanism stops, the locking bars are loosened and the transmitter tuned normally. The knob positions are noted and turned CCW 1/4 turn and then returned to the position noted. The bars are locked while holding the knobs in position. This channel is now preset the another can be set up.

(d) Calibration Instructions:

The internal crystal-controlled calibration oscillator provides an accurate (within .01%) check point every 100 to 600kc. This is accomplished by zero-beating the master oscillator with the output of the crystal-controlled calibration oscillator at the nearest check point given in the calibration book. Then the "B" dial pointer is moved to correct the dial reading at the check frequency. A 200-kc. crystal is used as the controlling standard. The "Calibrate-Tune-Operate" switch must be in the "Calibrate" position during this operation.

(e) Operating Notes:

One feature of this transmitter which may be disturbing is the possibility of tuning to a harmonic of the desired frequency. The remedy for this is to note the dial readings when you are positive of the frequency and suspect any great deviation from these readings at later dates. Meter readings cannot always be relied upon and a simple absorption-type wavemeter will come in very handy when in doubt. Also, MCW operation is legal only on the 11-meter band.

(f) Microphone Data:

The transmitter is designed for use with a low-resistance (40-ohm) carbon microphone or a high-output 200-ohm dynamic microphone, neither of which is readily available. A much better arrangement may be had by rewiring the microphone switch as shown in Fig. 4. R-201, 202, 203 and 204 are removed, along with C-201. If it is desired to use a high-impedance dynamic mike or crystal mike, a speech amplifier stage will have to be built into the space occupied by T-201 and associated parts. This stage may be a 6J5 used in the conventional manner.*

(g) Cooling:

Due to the unusual compactness, this transmitter will operate quite warm. In the event that better cooling is required, the rear plate behind the 813 compartment may be removed. Alternatively, a small blower or fan can be mounted on the rear panel of the transmitter.

(h) General Notes:

A time-delay relay may be advantageous in the power supply to prevent plate voltage from being applied before the tubes have heated up.

It is important to note that when the "Emission" switch is in the "Off" position, it doesn't remove the power when the AC power supply is used. The switches shown in the power unit diagram must be used.

Two antennas will probably be used and, for all bands except 10 meters, a long wire 118 feet long and tapped 16 feet from the center will function very nicely. For 10 meters, a dipole or a rotary array may be fed in the conventional manner.

Full-scale meter readings on the ART-13 are:

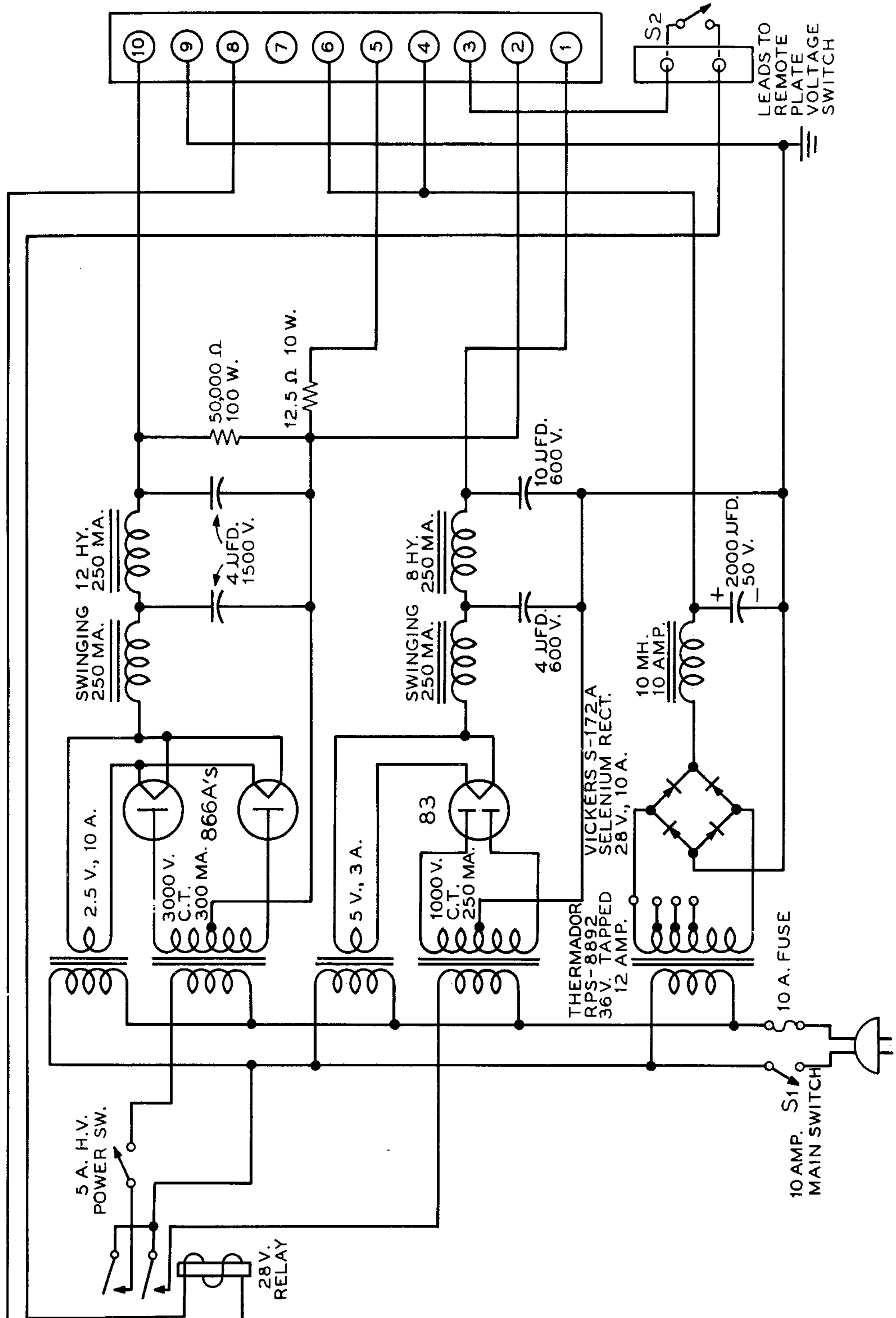
Position:	Full Scale Reading:
Battery Voltage	54 volts (28 volts in marked position)
PA Grid	17 ma.
PA Plate	320 ma.

Tuning should always be done in the CW position so that meter readings obtained will not include the current drawn by the modulator tubes. Static in the modulator is about 40 ma.

(i) Schematic Diagram

See center spread, page 68.

* For information on this added stage, and for other information on the conversion of the ART-13 transmitter, see "SURPLUS RADIO CONVERSION MANUAL", Volume III.


10
9
8
7
6
5
4
3
2
1
S2
LEADS TO
REMOTE
PLATE
VOLTAGE
SWITCH
50,000 Ω
100 W.
12.5 Ω 10 W.
10 µFD.
600 V.
12 HY.
250 MA.
4 µFD.
1500 V.
SWINGING
250 MA.
8 HY.
250 MA.
4 µFD.
600 V.
SWINGING
250 MA.
+
2000 µFD.
50 V.
−
10 MH.
10 AMP.
VICKERS S-172A
SELENIUM RECT.
28 V., 10 A.
2.5 V., 10 A.
866A'S
3000 V.
C.T.
300 MA.
5 V., 3 A.
83
1000 V.
C.T.
250 MA.
THERMADOR
RPS-8892
36 V. TAPPED
12 AMP.
10 A. FUSE
S1
10 AMP.
MAIN SWITCH
5 A. H.V.
POWER SW.
28 V.
RELAY

ORIGINAL FILAMENT OF ART-13 TRANSMITTER

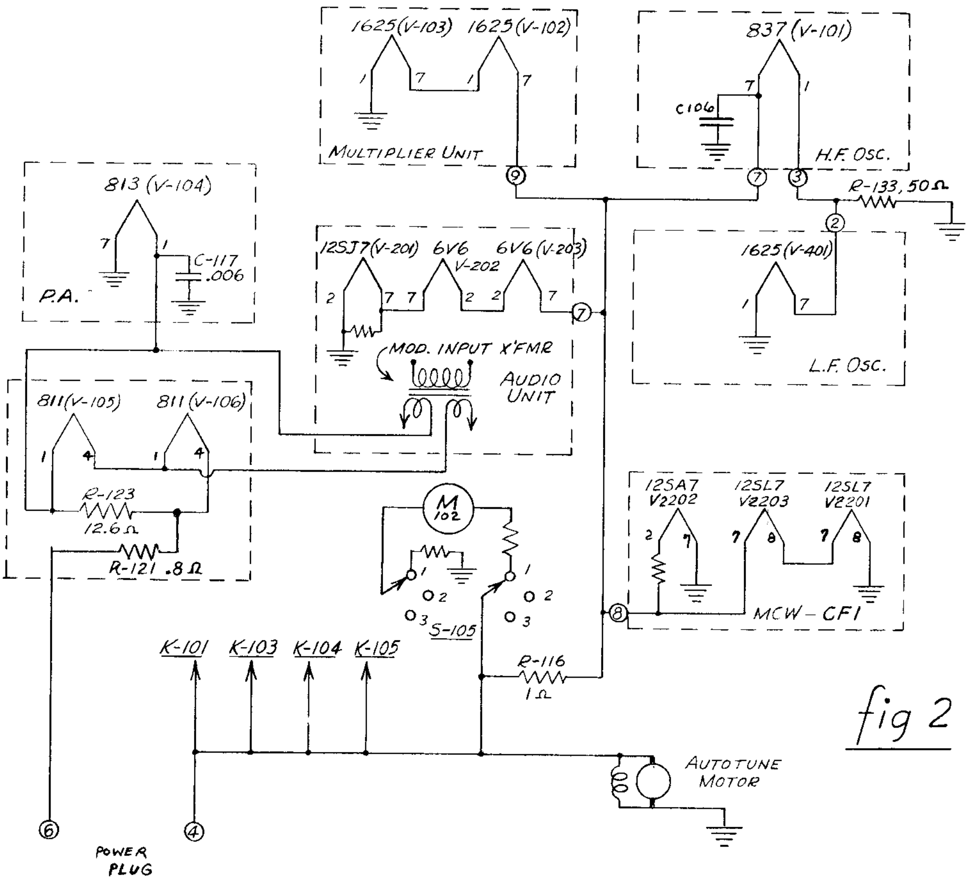


fig 2

ART-13 MICROPHONE SWITCHING CIRCUIT

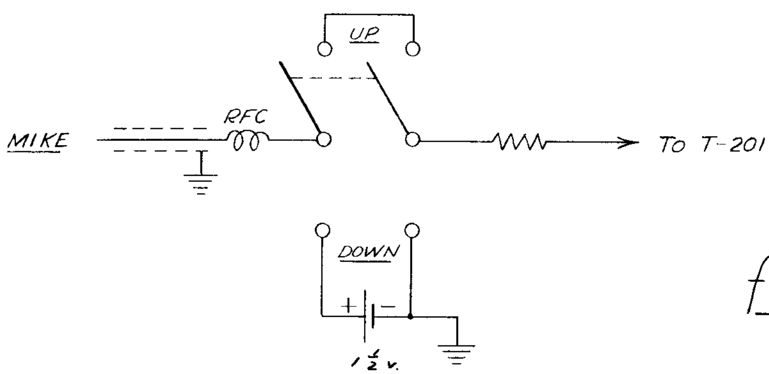
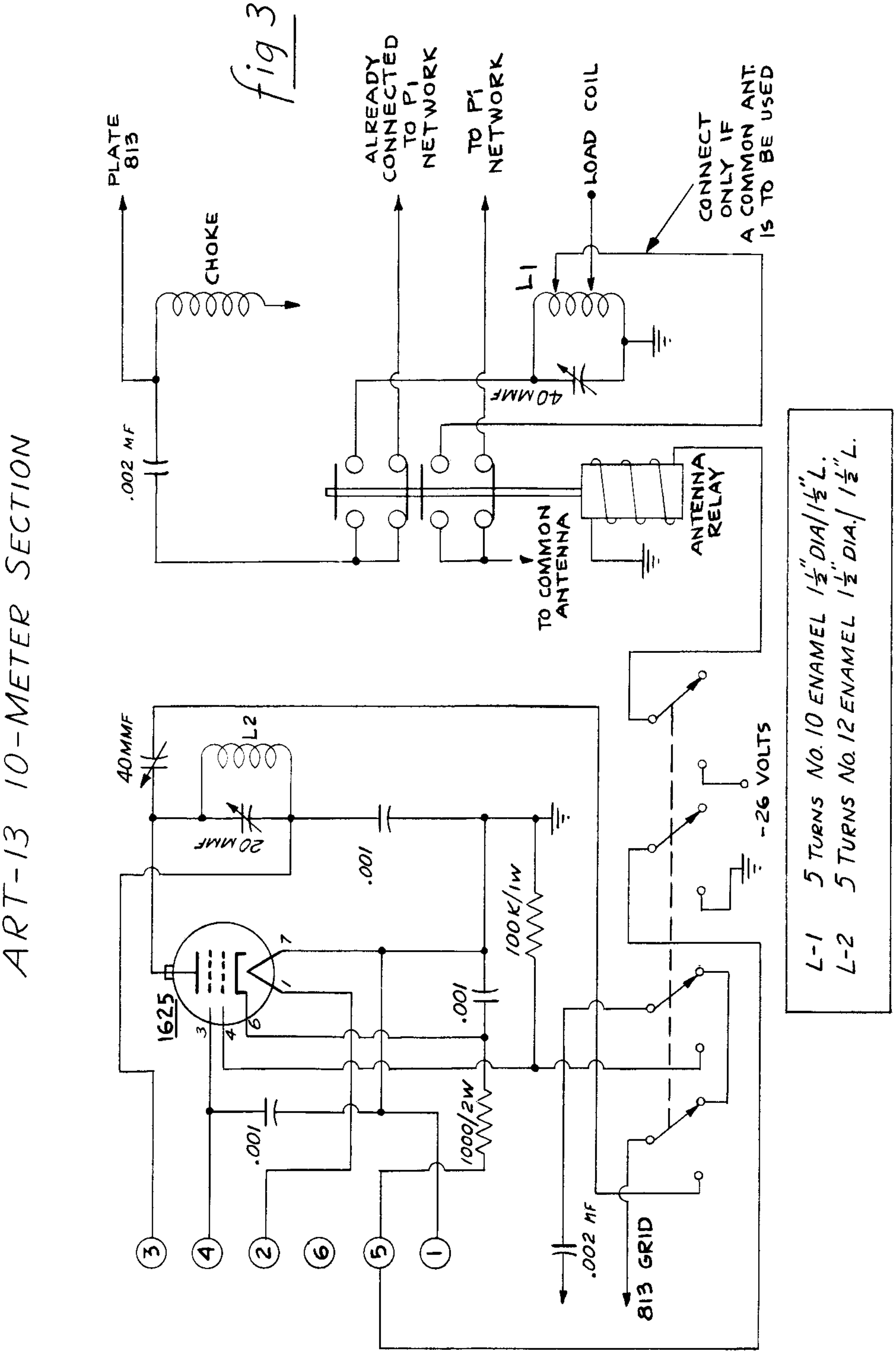
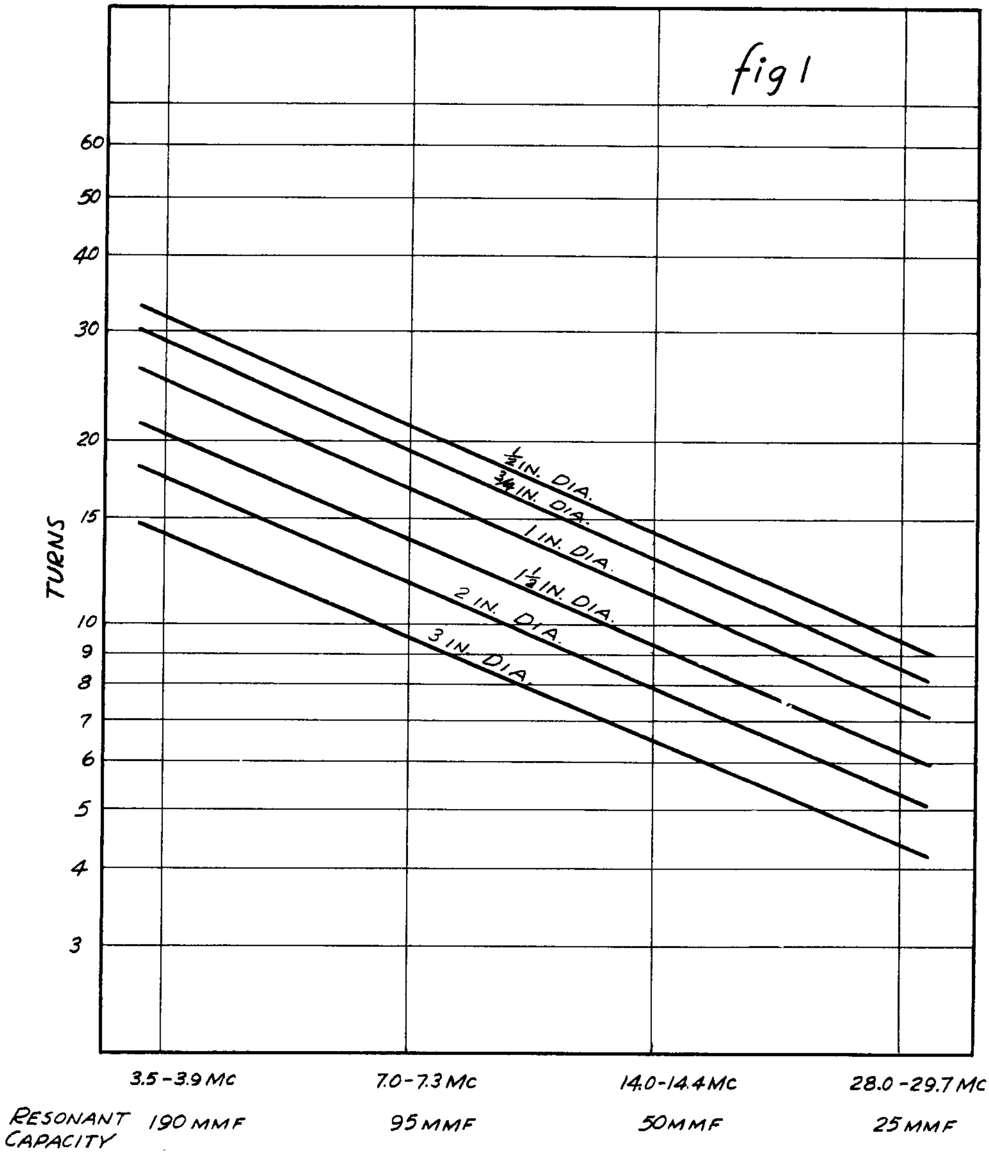


fig 4


ART-13 10-METER SECTION
fig 3
PLATE 813
CHOKE
.002 MF
ALREADY CONNECTED TO PI NETWORK
TO PI NETWORK
LOAD COIL
L1
40MMF
CONNECT ONLY IF A COMMON ANT. IS TO BE USED
TO COMMON ANTENNA
ANTENNA RELAY
40MMF
L2
20MMF
.001
1625
100K/1W
.001
.001
1000/2W
-26 VOLTS
.002 MF
813 GRID
3
4
2
6
5
1
L-1 5 TURNS No. 10 ENAMEL 1½" DIA./1½" L.
L-2 5 TURNS No. 12 ENAMEL 1½" DIA./ 1½" L.

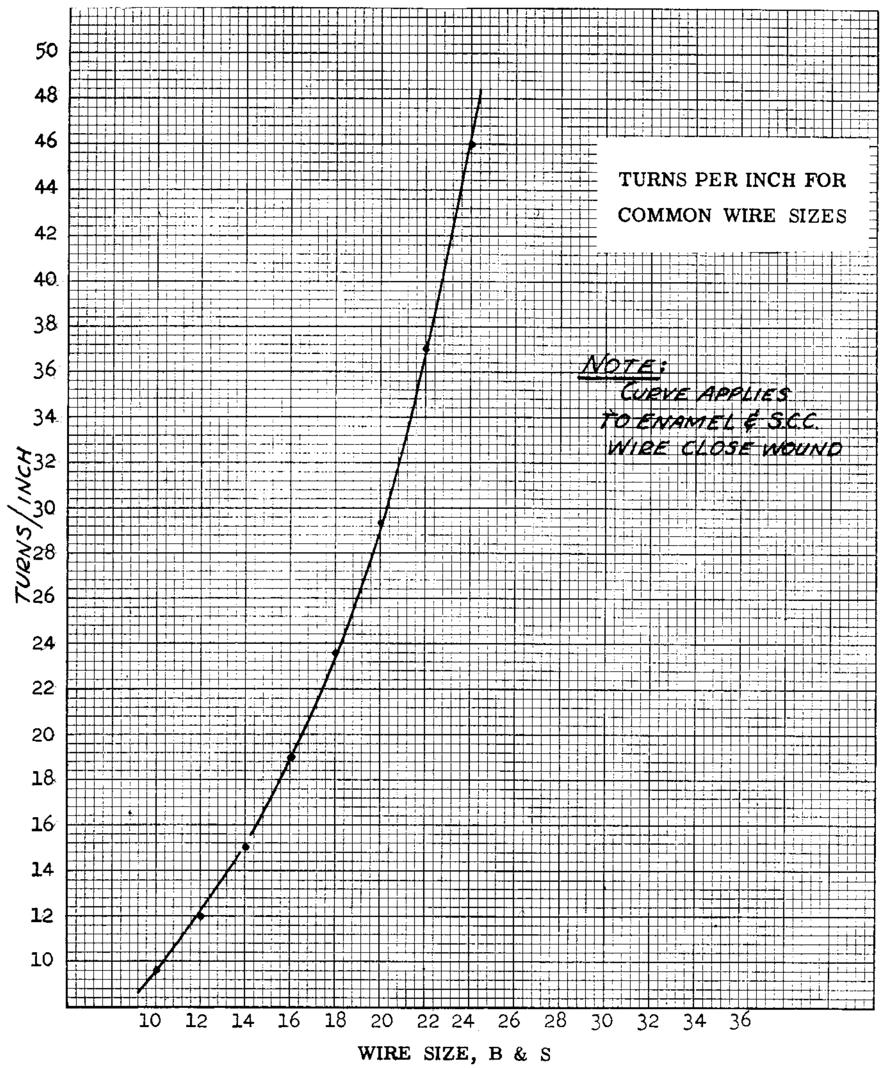
COIL TURNS V.S. FREQUENCY BANDS
(COIL DIAMETER = COIL LENGTH)



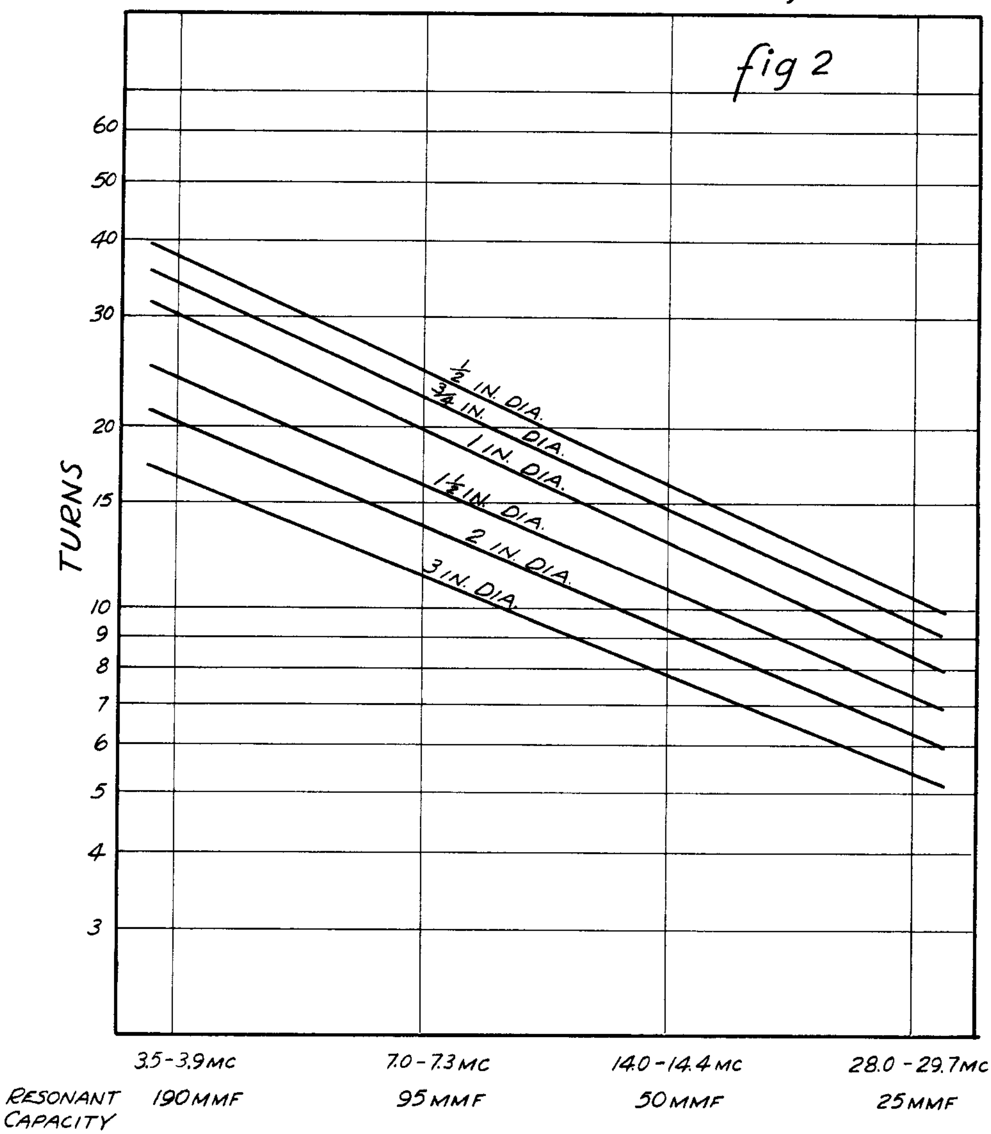
SIMPLIFIED COIL WINDING DATA

It is frequently necessary to wind new coils in the conversion of surplus equipment as well as in the construction of standard communications items. These coil-winding charts were devised as an assistance to those persons who occasionally do have need to wind a coil of relatively standard dimensions. The curves are plotted in terms of the major amateur bands and in conjunction with the resonant capacitance which will give a moderate value of Q under average operating conditions.

The curves of figure 1 and figure 2 are derived in each case for a specified diameter-to-length ratio. The resonant capacitance quoted includes the stray circuit and tube capacitances which exist in the circuit. The curve "Turns per inch for common wire sizes" is included as a guide in determining the length which will be required for a specified number of turns for these wire sizes.



COIL TURNS VS. FREQUENCY BANDS
(COIL LENGTH = 1½ COIL DIAMETER)



RADIO EQUIPMENT FOR LIGHT AIRCRAFT EMPLOYING THE AVT-112A TRANSMITTER

The surplus market has made available a radio equipment, appropriately small and light weight, that is readily adaptable to light aircraft installation. Modification problems are generally quite simple. The complete radio installation may be made at a fraction of the cost of similar equipment on the standard market.

As is apparent to persons connected with the operation and servicing of aircraft, any installation of radio equipment must be subject to CAA inspection and thence operated only by personnel properly licensed by the FCC.

(a) Description:

The AVT-112A transmitter, specifically designed for light-aircraft use, provides reliable radio-telephone and CW transmission over moderate distances on any frequency within the band of 2500 to 6500 kc. It is a crystal-controlled unit capable of delivering 6 to 7 watts of RF power to the antenna. The AVT-112 is 5-3/8" high, 6-1/4" wide, 4-7/8" deep, and weighs 6 pounds.

The unit operates from a 6, 12 or 24 volt source in conjunction with its associated plate voltage power supply which is a separate unit in the installation.

Six tubes are employed in the transmitter as follows:

6V6	Pierce crystal oscillator
6V6	Power amplifier
(2) 6V6's	Modulator (push-pull)
6AF6	Dual type, tuning indicator
6SL7	Tuning Indicator amplifier

The crystal oscillator circuit is of the untuned Pierce type which does not require tuning adjustment regardless of the crystal frequency used. For convenience and quick change of crystals, the crystal holder is located on the front panel of the transmitter. The holder is designed to accomodate the following types of crystals: AVA-10, AVA-53, MI-8412, VC-2, and Signal Corps type FT-243.

A single-ended 6V6 stage is used as the power amplifier and is modulated by a pair of 6V6's operating push-pull. The modulator grids are driven directly by a carbon microphone through a mike-to-grid transformer. Excitation for the microphone is obtained from a tap on the 6V6's common cathode resistor.

Tuning adjustment of the PA and antenna loading is accomplished by the use of the dual electron eye indicator on the front panel. Its two sectors indicate the relative PA cathode current, antenna current, and modulation level. No other metering is required for tuning adjustments. However, actual PA plate current may be determined from a meter plugged into the jack located on the back of the transmitter unit.

In addition to the antenna loading and antenna coupling controls, a loading selector switch provides the required loading adjustments to match most conventional type antennas including the fixed "V" and the trailing wire type. The antenna circuit is also provided with an antenna switching relay which permits receiver use with the same antenna.

An intercommunication system which utilizes the modulator as an AF amplifier is incorporated in the transmitter unit. The intercom system is switched into operation by the fourth position of the antenna selector switch. When in this position, the radio portion of the transmitter is completely disabled. All connections to the transmitter, with the exception of the microphone, are made from the rear of the unit.

(b) Adjustment and Operation of the AVT-112:

After installation with an appropriate power supply, the desired crystal installed, and the microphone plugged in, the transmitter is ready for initial operation adjustments. Approximately 30 seconds warm-up time for the filaments should be allowed before operating.

Tuning adjustments for the AVT-112 fall into two phases: PA tuning, and loading the transmitter to the antenna. These adjustments should be done in the following manner to insure proper operation:

PA Tuning
(1) Set Selector Switch (B) to position 3
(2) Set "Ant. Load." coarse (C) and fine (D) controls to position 1
(3) Set "Ant. Coup." (E) to position "O" (extreme counter-clockwise)
(4) Adjust "PA Tuning" (A) to resonance as indicated by minimum shadow angle on lower sector of tuning indicator tube, and lock. (If two resonant points exist, select the lower frequency which will be the fundamental.)

Loading Transmitter to Antenna:

This adjustment should be made while airborne.

(1) Set "Selector Switch" (B) to,
Position 1 (trailing antenna, all frequencies)
Position 2 (fixed antenna, low and medium freq.)
Position 3 (fixed antenna, medium and high freq.)
(2a) Adjust length of trailing antenna for maximum shadow width on top sector of tuning indicator with "Ant. Coup." (E) set at approximately 30 (dial reading). Readjust both antenna length and "Ant. Coup." for maximum shadow angle on tuning indicator. Note the following approximate antenna lengths versus frequency to aid in antenna adjustments:

Frequency	Approx. Total Length
3000	75 feet
4000	55 "
5000	45 "
6000	40 "

(2b) For fixed type antenna: Set "Ant. Coup." to dial reading of 30, and adjust "Ant. Load", coarse (C) for maximum shadow angle on upper sector of tuning indicator. Increase "Ant. Coup." (E) for maximum shadow angle. Recheck both antenna loading and antenna coupling to obtain widest shadow angle on indicator.

In event that there are two loading points indicated when adjusting "Ant. Load." (C), select the point of maximum dial reading which still provides use of the fine adjustment (D). Proper setting of "Ant. Load." is indicated by greater antenna current with an increase of antenna coupling from its original setting (dial reading, 30).

Upon loading the transmitter, normal increase in PA current, as indicated by the widening shadow angle on the lower sector of the tuning indicator, should be apparent. No retuning of the PA is necessary.

When the antenna circuit is properly tuned, any change in the PA tuning will result in a decrease of antenna current.

Modulation is indicated by variation in shadow angles of both sectors of the tuning indicator. Modulation of 100% is indicated by the top sector of the tuning indicator when the shadow just reaches minimum width (closes).

Control positions for the above adjustments should be apparent from the front photograph of the AVT-112 transmitter unit.

(c) Complete Equipment for Aircraft Installation:

For a complete radio installation, the following described components are necessary with interconnections as shown in Fig. 3:

(1) Radio Transmitter, AVT-112A (described above).

(2) Power Supply Unit:

In addition to the aircraft battery a separate power unit is required to supply the required plate voltages for the transmitter and receiver. The original power unit associated with the AVT-112 is the AVA-126. It is of the vibrator type and capable of supply 320 volts at 110 ma. as required by the AVT-112. This unit is 7-1/16" x 7" x 7-5/16" and weighs 10-1/4 pounds. Further data with the schematic diagram is shown in Fig. 2.

Other types of power supply units utilize the surplus dynamotors which provide the required power when operated from the necessary battery source. One such unit used very satisfactorily is the BD-87 12-volt dynamotor.

(3) Radio Receiver:

The receiver AVR-20, originally used with the AVT-112 and associated equipment is not readily usable for civilian aircraft due to its frequency range (2300 to 6700 kc.). Even though this receiver can be modified, it is a major undertaking and not considered advisable.

Another surplus aircraft type receiver that will satisfy the need is the BC-1206. It can be used very satisfactorily with only minor modifications.

The BC-1206 receiver covers 200 to 400 kc. and was designed to operate from 28 volts DC, which in addition to the filament requirements was also the plate supply.

Modification for 12-volt operation requires reconnecting the filament circuit as shown in Fig. 4 and substituting 6K6's for the original 25L6's. By utilizing approximately 90 volts from the dynamotor (through a dropping resistor) this receiver offers sufficient audio volume for speaker operation. Speaker operation requires an additional matching transformer from the headphone output to voice coil, or the direct substitution of a plate to voice coil transformer for the existing one designed for headphone use only.

It should be noted here that any commercial type of receiver may be used in conjunction with the AVT-112 providing it operates from the same battery-voltage source.

(4) Aircraft Battery:

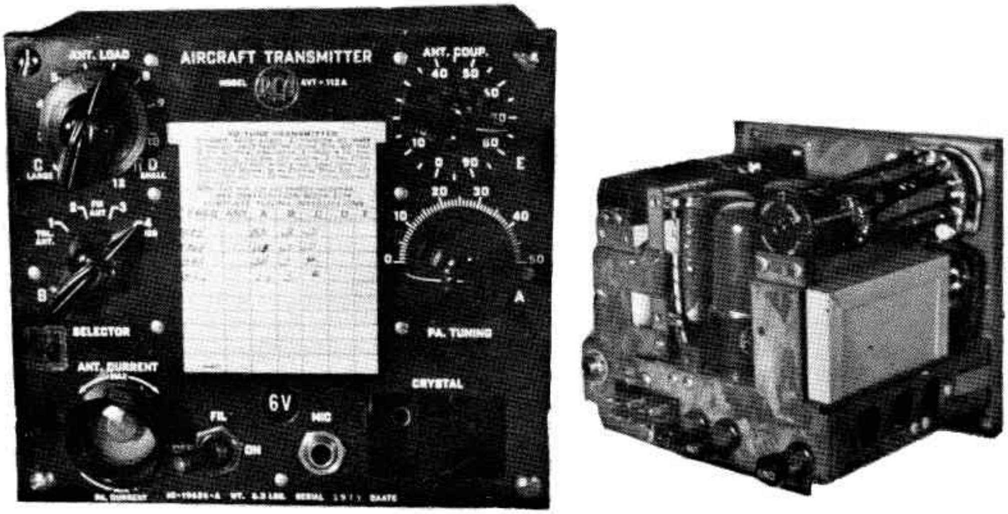
The basic power source for aircraft radio equipment is generally a 12-volt wet-cell storage battery with a rating approximating 50 ampere-hours. Sometimes 24 volt batteries are used. The battery normally supplies the filament requirements for both the transmitter and receiver in addition to the associated relays. The greatest battery load is the plate voltage power unit.

(5) Aircraft Generator:

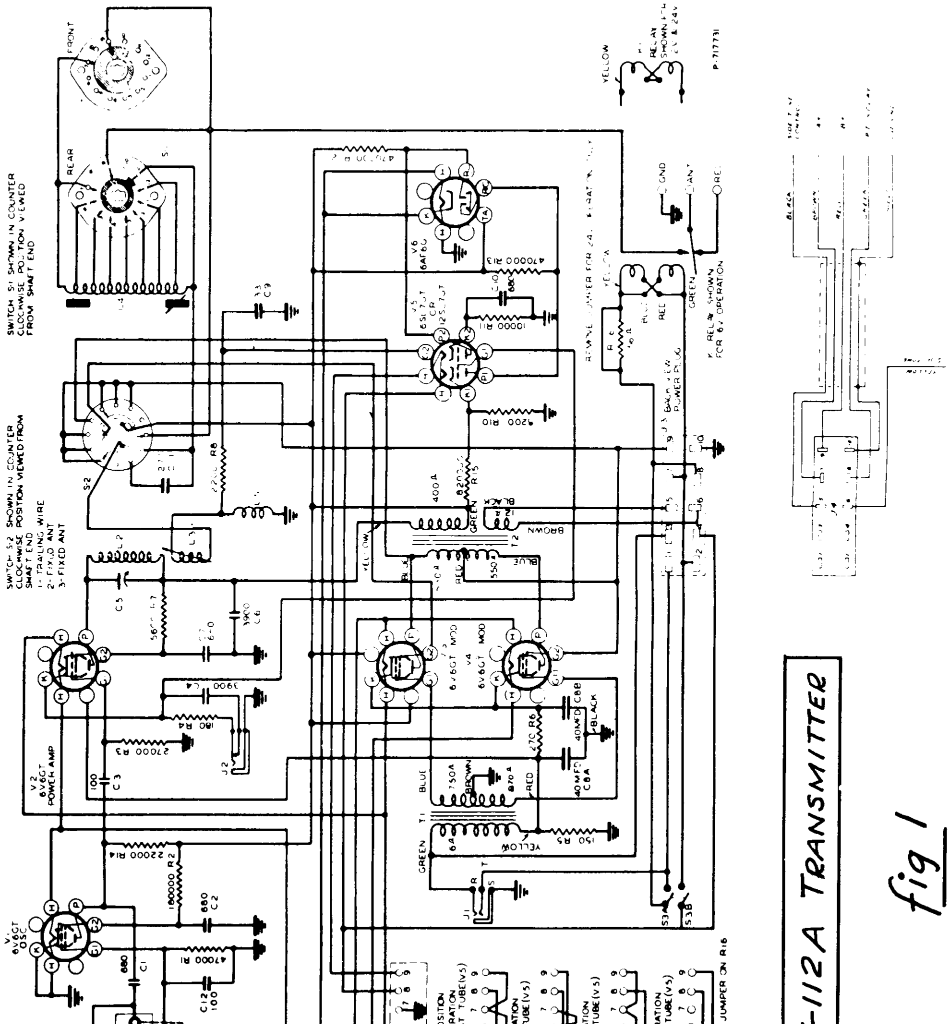
In order to maintain the charge of the small aircraft type battery, the generator is necessary equipment for a satisfactory radio installation. Aircraft not adaptable for engine-driven generators generally employ the wind-driven type.

(6) Aircraft Antenna:

Any conventional type of aircraft antenna, such as the types described above, may be used with the AVT-112 and its associated receiver.



AVT-112A TRANSMITTER



AVT-112A TRANSMITTER

fig 1

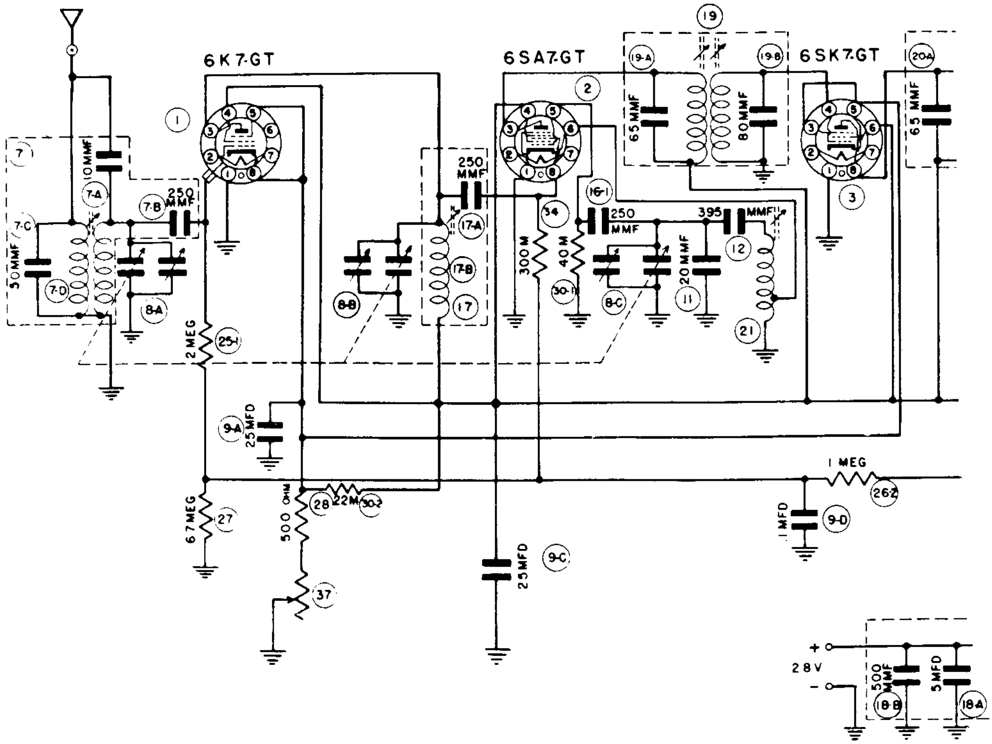


fig 4

SCHEMATIC WIRING DIAGRAM
BEACON RECEIVER BC-1206-A

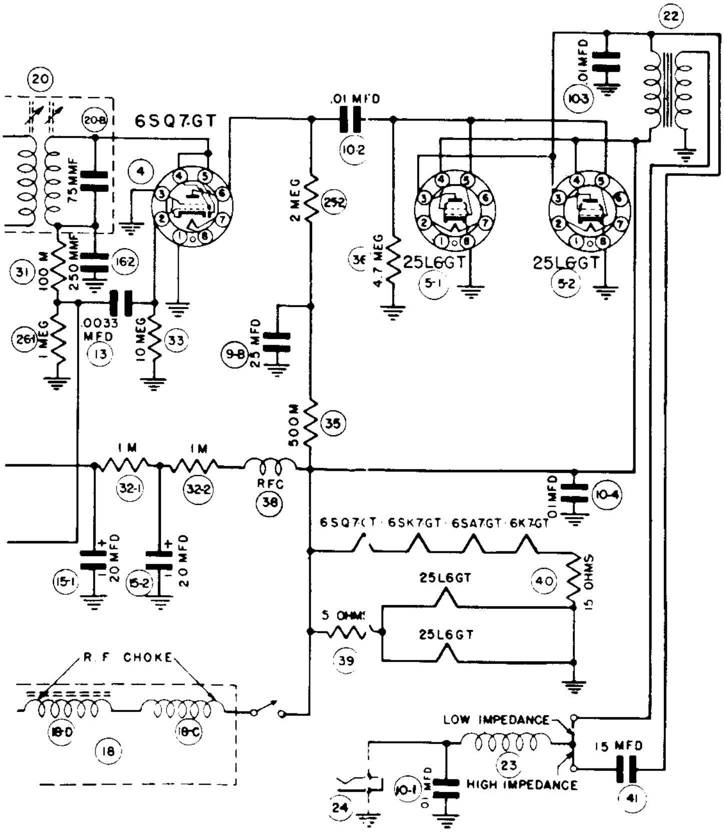
Tube Compliment & Functions:

6K7	-	RF Amplifier
6SA7	-	1st Det. & Osc.
6SK7	-	IF Amplifier
6SQ7	-	2nd Det. & 1st Audio
2 ea 25L6	-	Audio Output

Frequency Range: 200 to 400 Kc
IF Frequency: 142.5 Kc

Receiver Sensitivity: Approx. 5 microvolts for 10 mw power output with 4:1 signal/noise power ratio.

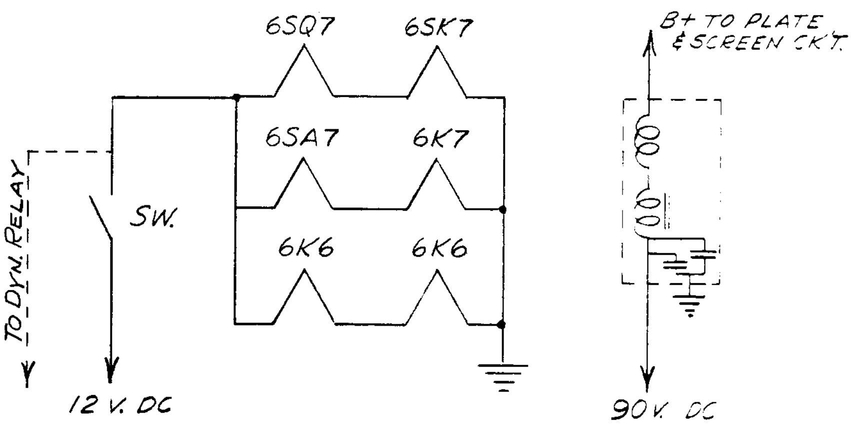
Output Impedance: 300 ohms and 4000 ohms (switched internal)
Power Output: 150 mw (approx.)
Volume Control: RF gain control
Power Requirements: 28 volts dc at 1.0 Amps.
Overall Dimensions: 4-7/16" x 4-1/2" x 7-9/32"
Weight: 3 lbs & 12 oz.



30-1	RESISTOR 40M Ω	G3862
41	COND .15 MFD	G15779
40	RESISTOR 15 Ω	G17299
39	RESISTOR 5 Ω	G17287
38	R F CHOKE	G15055
37	VOLUME CONT	G17507
36	RESISTOR 4.7MEG	G15085
35	RESISTOR 500M Ω	G15914
34	RESISTOR 300M Ω	G15915
33	RESISTOR 10 MEG	G15087
32-1-2	RESISTOR 1M Ω	G15083
31	RESISTOR 100M Ω	G15081
30-2	RESISTOR 22 M Ω	G15080
28	RESISTOR 500 Ω	G17365
27	RESISTOR 6.7MEG	G15086
26-1-2	RESISTOR 1 MEG	G15082
25-1-2	RESISTOR 2 MEG	G15084
24	PHONE JACK	G15011
23	R F CHOKE	G15127
22	OUTPUT TRANS	G15118
21	OSC. COIL ASSY	G15052
20-B	COND 75MMF	G17162
20-A	COND 65MMF	G15954
20	I. F OUTPUT ASSY.	G15009
19-B	COND. 80MMF	G17163
19-A	COND. 65MMF	G15954
19	I. F. INPUT ASSY	G15008
18-C	R. F CHOKE	G17147
18-B	COND. SPECIAL	
18-A	COND. .5 MFD	G15094
18	MOTOR NOISE FILT	G15120
17-B	R. F. COIL	G15053
17-A	COND. 250MMF	G1286
17	R. F. COIL ASSY	G15115
16-1-2	COND. 250MMF	G1286
15-1-2	COND. 20 MFD	G17176
18-D	R.F. CHOKE	G15091
13	COND. .0033MFD	G7313
12	COND. 395MMF	G15106
11	COND. 20MMF	G15108
10-1-2-3-4	COND. .01 MFD	G17151
9-D	COND .1MFD	
9-A-B-C	COND 25MFD	
9	CONDENSER ASSY.	G15033
8-A-B-C	CONDENSER GANG	G15912
7-D	ANTENNA COIL	G15054
7-C	COND. 50MMF	G2780
7-B	COND. 250MMF	G1288
7-A	COND. 10MMF	G15107
7	ANTENNA COIL ASSY	G15060
5-1-2	TUBE 25L6GT	G6090
4	TUBE 6SQ7GT	G17422
3	TUBE 6SK7GT	G17419
2	TUBE 6SA7GT	G17420
1	TUBE 6K7GT	G17421
ITEM	*NAME*	*NO*

SCHEMATIC WIRING DIAGRAM
BEACON RECEIVER BC-1206-A

MODIFIED CIRCUIT FOR 12 VOLT OPERATION



AVA-126A POWER UNIT

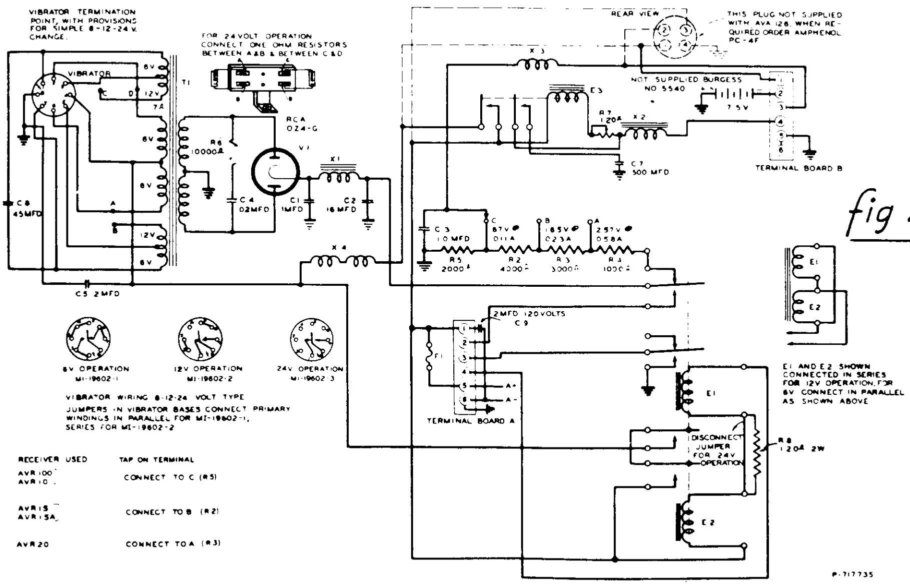


fig 2

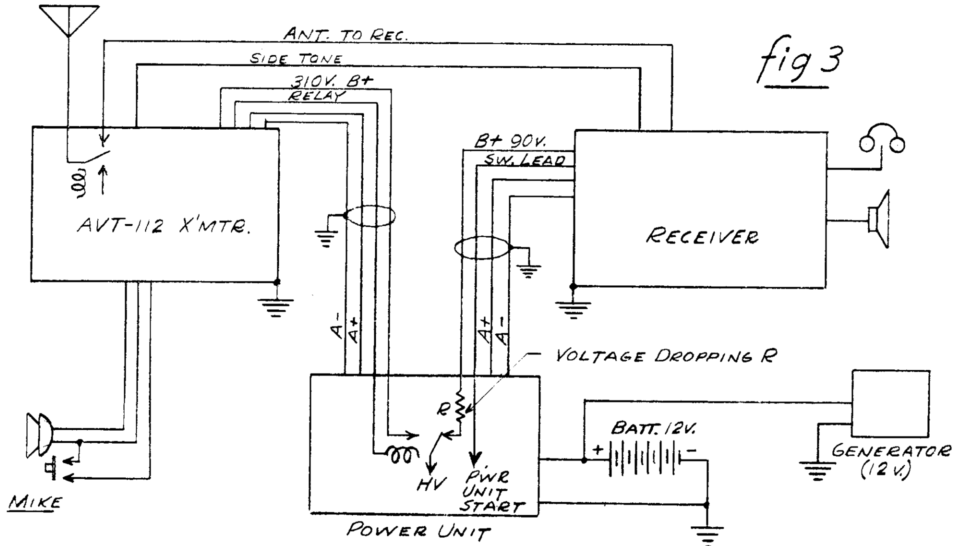


fig 3

INTERCONNECTION DIAGRAM OF UNITS

A 9-WATT UTILITY AMPLIFIER FROM THE AM-26/AIC INTERPHONE AMPLIFIER

The inexpensive, compact, AM-26/AIC Interphone Amplifier which originally served as an inter-communication unit in the larger aircraft, can be converted into a satisfactory audio amplifier. This conversion, which can be made at a very reasonable cost, results in a 9-watt amplifier with sufficient gain to operate from the average crystal phono pick-up. The amplifier is capable of driving a 10 or 12 inch PM speaker.

The AM-26 is physically 9-1/2" long x 5-1/4" wide x 5" high. In its existing form, this amplifier is of low gain with the typical 300-ohm input impedance and 30/300 ohm output impedance. It is designed to operate from 28 volts, DC, at approximately 1.25 amperes with the DM-32 dynamotor (component part) supplying the high voltage (250 volts DC).

The tube complement consists of the following with their respective functions:

(1) 12J5 Voltage Amplifier
(1) 12J5 Phase Inverter
(2) 12A6's Push-Pull Power Amplifiers (output)

Before modification of the amplifier circuit, the following parts, which are not used in the converted circuit, should be removed:

Input transformer 22
Output transformer 23
Connection Plug 28
Dynamotor Plug 27 (dynamotor not used)
Gain Switch 25 and associated circuit
Hash Filter Chokes 26-1 and 26-2
Hash Filter Condensers 19-1, 19-2, and 14
Resistors 1, 2, and 3
Switch 24
Condenser 15

Conversion Procedure:

In order to use the existing tubes, the heaters are rewired in parallel. This requires a few changes in the existing circuit and the use of both transformer low-voltage windings (5.0 and 6.3 v.) connected in series as shown in Fig. 2. Polarity must be observed in order to obtain additive voltage of 11.5 volts. It should be noted that the rectifier, 6X5, operates from the 6.3-volt section of the series windings with the junction of the two windings grounded to the chassis. The heater circuit leads should be twisted where possible in order to minimize hum pick-up.

After the previously mentioned components have been removed, the power supply is constructed as shown in Fig. 2. The rectifier, 6X5, socket is mounted in the former C-14 position while the power transformer and filter choke are mounted in the space formerly occupied by the dynamotor, DM-32.

The second section of the filter utilizes the existing electrolytic filter condensers, 18-1 and 18-2. These are purposely used in the second section due to their lower voltage rating (10 mfd. at 350 volts each).

In order to give the amplifier higher gain, a 12SQ7 is used in place of the voltage amplifier stage, 12J5 (20-1). This necessitates the new associated circuit as shown in Fig. 2. The volume control is located in the grid of the 12SQ7 and replaces the former input transformer.

With slight modification, the phase inverter is changed to the self-balancing type utilizing the existing resistors, (47K) 9-1 and 9-2, in the cathode and plate circuits respectively. It should be noted that these resistors and their associated coupling condensers, 16-1 and 16-2, are left intact with the only changes being those pertaining to resistor 9-1 which is connected into the cathode circuit of the 12J5 (20-2).

In the grid circuit of the 12A6's, R-11 is removed and the grid resistors 10-1 and 10-2 are connected to ground.

It is most desirable to use a universal type output transformer to match the speaker voice coil to the plates of the 12A6's. Other types of output transformers may be used as long as the load impedance reflected to the 12A6's is approximately 12,000 ohms.

The tone control, as shown in the plate circuit of the 12SQ7, is optional. It merely lends more flexibility to the amplifier for average listening use. Other types of tone-control circuits may be substituted as desired. If the frequency response is poor in the high frequency range, the values of condensers 17-1 and 17-2 should be reduced as desired. These values may be approximately .005 or .01 mfd.

It should be noted that the original feedback circuit, condenser 16-3 and R-6 and R-7, is not used in the new circuit. R-6 is used as the cathode-bias resistor in the phase inverter circuit. The other components may be left or removed as desired.

The AC circuit is connected on the original terminal board which contained the former resistors 1, 2, and 3. This board provides neat and convenient tie points for the leads concerned. The AC power switch is incorporated on the volume control.

It will be found that the completed amplifier is a neat and compact unit which has many applications. It may be used as a phono amplifier, inter-com amplifier, modulator for low-power transmitters, and so forth. This unit is capable of delivering 9 watts at less than 5 per cent distortion; distortion of course becomes negligible at the normal listening level of approximately one watt.

An alternative circuit is shown in Fig. 3. It will be noted that this amplifier utilizes the floating paraphase circuit. Also, dual tone controls are used for added flexibility in controlling the frequency response.

AM-26/AIC INTERPHONE AMPLIFIER
(ORIGINAL SCHEMATIC)

NOTE - PART NUMBERS ARE UNDERLINED AS APPEAR ON CHASSIS.

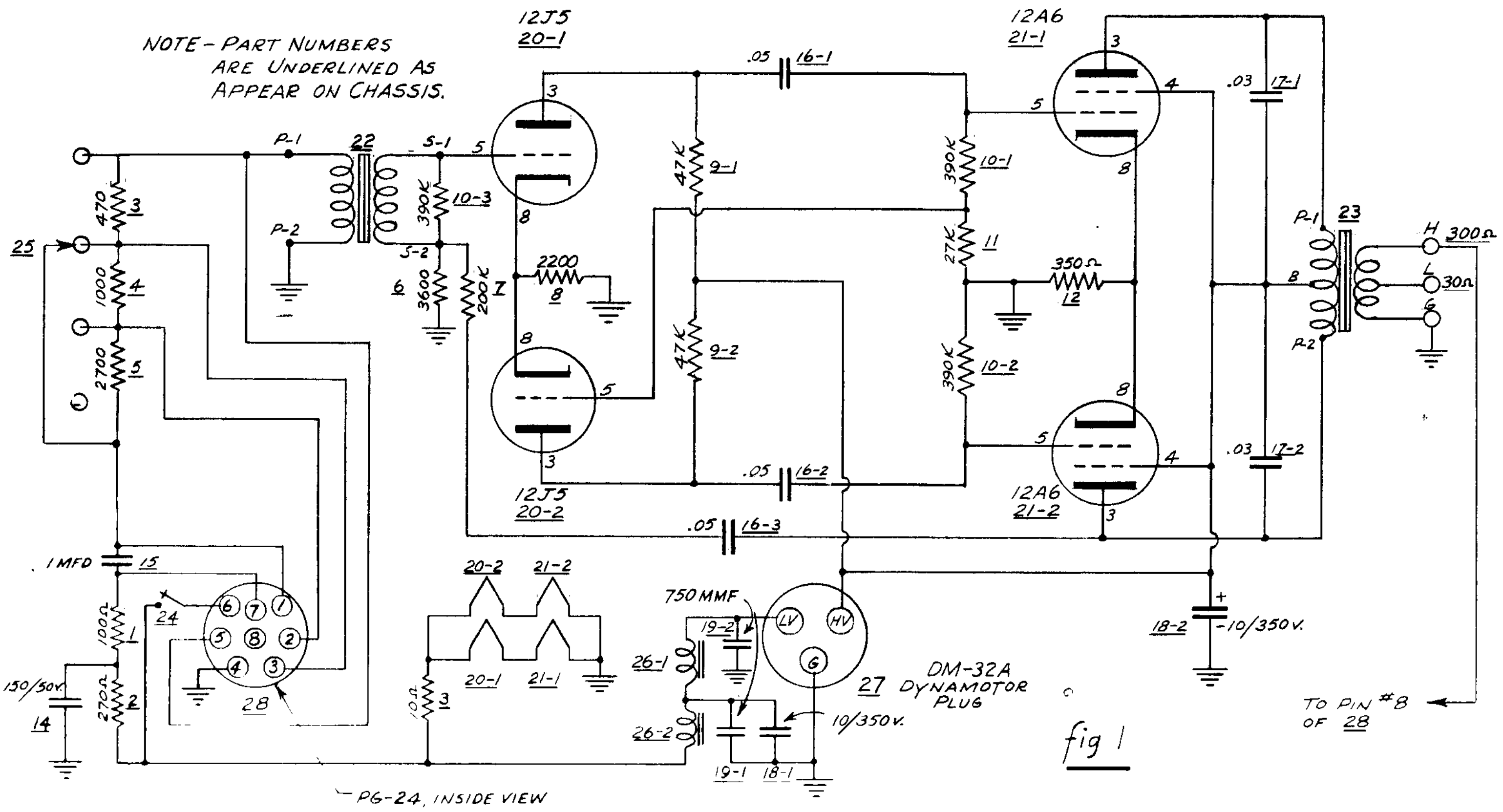


fig 1

CONVERTED AM-26 AMPLIFIER

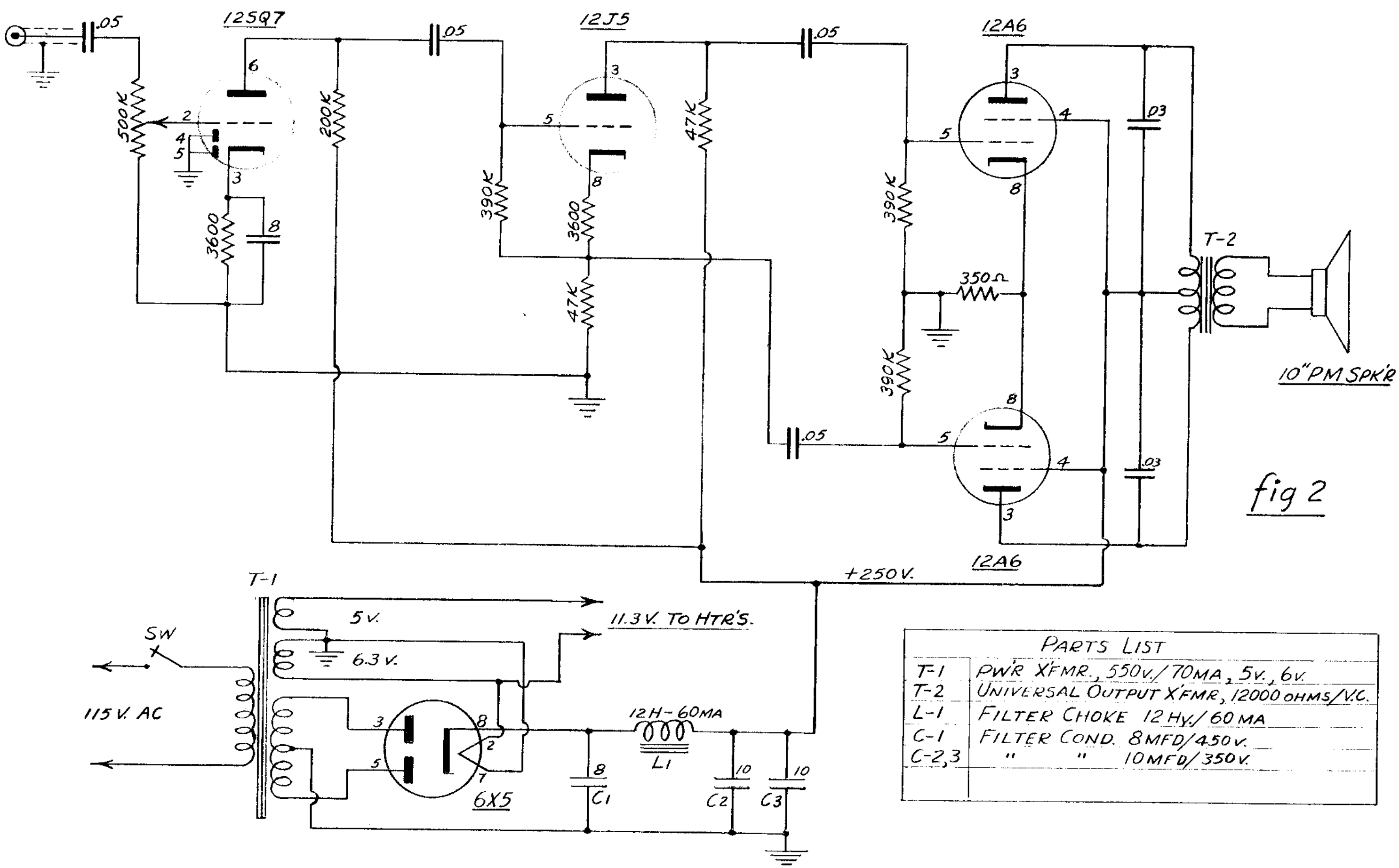


fig 2

Parts List	
T-1	PWR XFMR., 550V./70MA., 5V., 6V.
T-2	UNIVERSAL OUTPUT XFMR, 12000 OHMS/V.C.
L-1	FILTER CHOKE 12 HY./60 MA
C-1	FILTER COND. 8MFD/450V.
C-2,3	" " 10MFD/350V.

A High Quality Radio/Phono Amplifier
From the AM-26

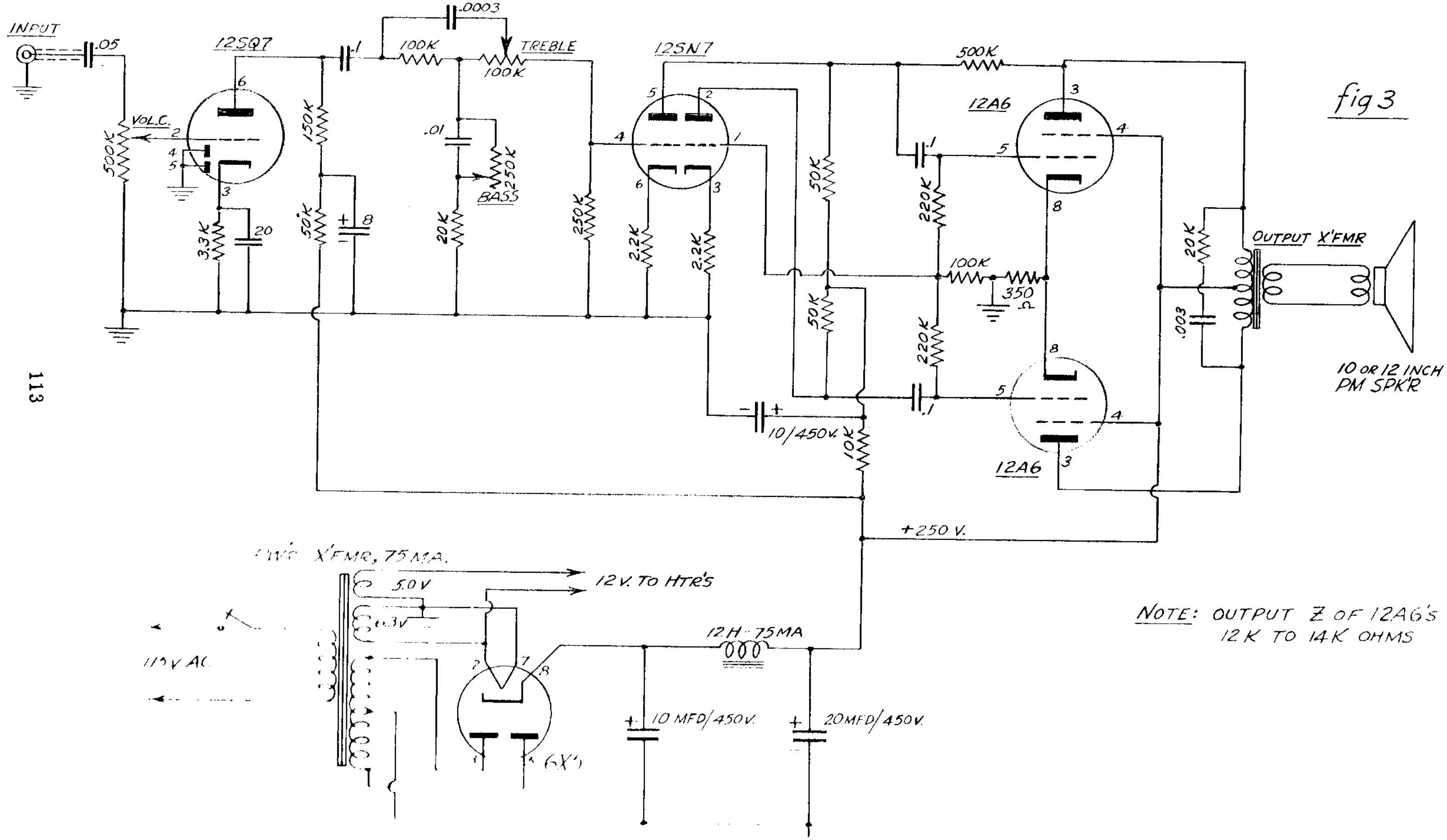


fig 3

NOTE: OUTPUT Z OF 12A6'S
12 K TO 14 K OHMS

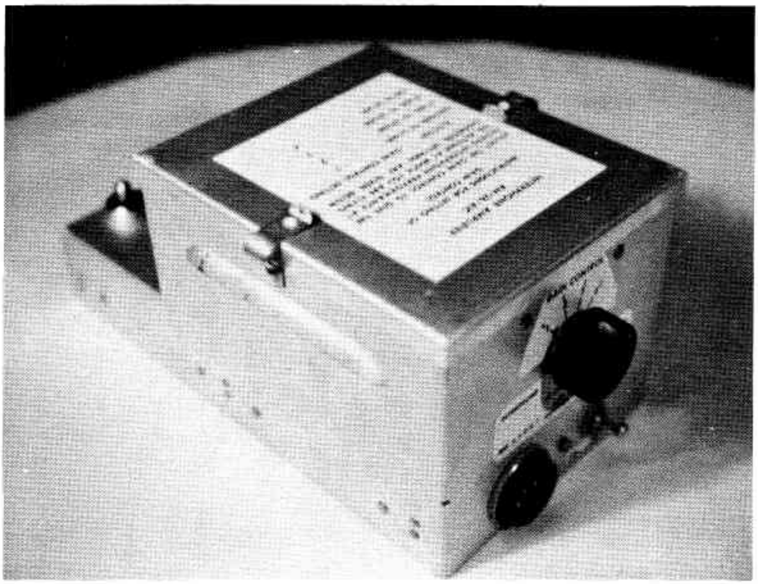
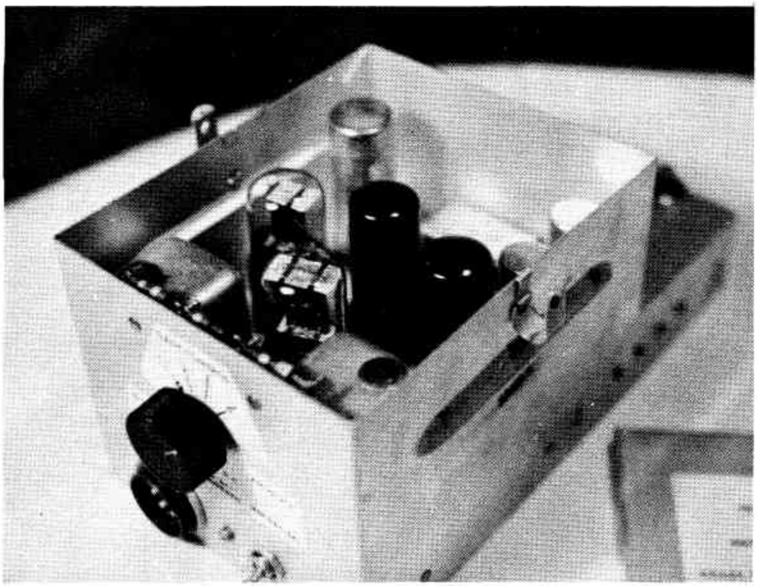


fig 4



AM-26/AIC AMPLIFIER (ORIGINAL)

THE MODEL LM FREQUENCY METER

One very satisfactory item of test equipment that has appeared on the surplus market is the Navy Model LM Frequency Meter. The unit covers the frequency range shown in Fig. 1 for different models.

The LM Frequency Meter is very similar in design and operation to the Army BC-221.* Similarly, it has many successive models designated by a number suffix (LM-1, LM-2, etc.). The general characteristics of all models are identical. Later models have minor improvements and changes as indicated in the comparison chart, Fig. 1.

(a) Description

The primary component of the LM Frequency Indicating Equipment is the heterodyne frequency meter (C-74028, Navy component designation). Physical dimensions of this unit are approximately 8-1/2" x 8" x 8-1/2" with its weight being about 11-1/2 pounds. Other components necessary for operation of the heterodyne frequency meter are the calibration book, low impedance headset (600 ohms), and a power supply capable of supplying the required voltages as listed in the comparison chart. Complete equipment also includes the frequency meter shock-mounting base, carrying case, shielded power cable with plugs, instruction books, and operating spare parts.

Essentially, the electrical circuits of the LM heterodyne frequency meter consist of a crystal calibration oscillator (1000 kc.), a manually-tuned VFO, a high-gain detector, and an audio-frequency amplifier. By manually switching the circuit of the audio frequency amplifier, it functions as an audio oscillator which modulates the VFO.

The 1000-kc. crystal oscillator is used as a reference standard for calibrating the VFO at a number of points over the tuning range. High stability of the crystal oscillator is maintained due to special design of its components. The crystal unit is hermetically sealed in an evacuated metal envelope, resembling a small metal vacuum tube with an octal base. Due to this type of construction, the crystal unit is relatively unaffected by physical variations such as barometric pressure, humidity, vibration, shock or mounting position. The temperature coefficient of the crystal unit is less than 0.0001 per cent variation in frequency per degree Centigrade over an ambient temperature range of 80 degrees. Inherent design of the crystal oscillator circuit provides an output rich in harmonics thus providing a number of useful check points over the entire tuning range of the VFO.

The VFO is an electron coupled, hetrodyne type of oscillator, capable of being calibrated by the "zero-beat" method at various predetermined points over the two manually-tuned ranges. Fundamental ranges of the VFO are 125 to 250 kc., and 2000 to 4000 kc. Employing the calibrated 1st, 2nd, 4th and 8th harmonics, the first range gives continuous coverage from 125 to 2000 kcs; likewise, by the use of the calibrated 1st, 2nd, 4th, and part of the 5th harmonics, continuous coverage is obtained from 2000 to 20,000 kcs. in the second range.

Tuning of the VFO is accomplished by a low-temperature-coefficient, variable condenser with a 100:1 gear reduction from the external control. This ratio requires 50 revolutions of the vernier dial for 180-degree rotation of the variable condenser. Backlash in the gear mechanism is held to less than 0.3 of 1 division on the dial units scale.

The low temperature coefficient of the VFO tuned circuit is maintained by temperature compensated components used in conjunction with the tuning condenser. The temperature coefficient of the VFO is less than 0.003 per cent of the frequency per degree Centrigrade over an ambient range of 97 degrees for the entire range.

Arrangement of the detector circuit allows the mixing (comparison) of three RF sources. These are the Crystal Calibration Oscillator (electron coupled), the VFO output (control grid injection), and the incoming RF signal from the antenna terminal

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* "Surplus Radio Conversion Manual," Volume I

COMPARISON BETWEEN MODELS OF THE MODEL LM SERIES

Model	*Freq. Measuring Unit Type*	*Het. Osc. Freq. Range—Kcs.*	*Operating Voltage*	*Mechanical Design*	*Remarks*
LM	None	195-400 2000-4000	12/14 200/260		
LM-1	None	195-400 2000-4000	External battery supply	Same as LM	
LM-2	None	195-400 2000-4000	12/14 200/260—260/475	General minor improvements throughout	Voltage regulator circuit added
LM-3	None	195-400 2000-4000	External battery supply	Same as LM-2	
LM-4	None	195-400 2000-4000	12/14 200/260—260/475	Same as LM-2	Symbol designations reassigned
LM-4a	None	195-400 2000-4000	24/28 200/260—260/475	Same as LM-4	
LM-5	None	195-400 2000-4000	12/14 200/260—260/475	Same as LM-4	
LM-6	CRR-74023	195-400 2000-4000	Rectifier Power Unit Type CRR-20104	Same as LM-4	
LM-7	CRR-74024	195-400 2000-4000	12/14—24/28 200/260—260/475	Redesigned shockmount base and capacitor and drive assembly	
LM-8	CRR-74024	195-400 2000-4000	Rectifier Power Unit Type CRR-20104	Same as LM-7	
LM-9	CRR-74024	195-400 2000-4000	12/14—24/28 200/260—260/475	Same as LM-7	Included in Type CRR-10086 Waterproof Carrying Case
LM-10	CRR-74028	125-250 2000-4000	12/14—24/28 200/260—260/475	Minor mechanical revisions	LF Het. Osc. fund. freq. range changed
LM-11	CRR-74028	125-250 2000-4000	Rectifier Power Unit Type CRR-20104 or Rectifier Power Unit Type CRR-20104A	Same as LM-10	
LM-12	CRR-74028	125-250 2000-4000	12/14—24/28 200/260—260/475	Same as LM-10	Included in Type CRR-10086 Waterproof Carrying Case
LM-13	CRR-74028	125-250 2000-4000	Self contained batteries	Same as LM-10	Mounted in Type CRR-10111 Carrying Case with batteries
LM-14	CKB-74028	125-250 2000-4000	12/14—24/28 200/260—260/475	Same as LM-10	
LM-15	CKB-74028	125-250 2000-4000	Rectifier Power Unit Type CKB-20104A	Same as LM-10	
LM-16	CKB-74028	125-250 2000-4000	12/14—24/28 200/260—260/475	Same as LM-10	Included in Type CKB-10086 Waterproof Carrying Case
LM-17	CKB-74028	125-250 2000-4000	Self contained Batteries	Same as LM-10 less shock mount base	Mounted in Type CKB-10111 Carrying Case with batteries

fig 1

(also control grid injection). By means of switching, either the crystal oscillator signal or the incoming signal is manually selected for heterodyning with the VFO.

The detector output, after being amplified by the AF stage, is brought out through a jack on the front panel for a 600-ohm load. The audio output is intended for low-impedance headphones; however, other indicating devices can be used.

Frequency response of the audio section is intentionally peaked at 250 cps. At 100 cps and 500 cps the response drops approximately 1.5 db below the 250 cps reference.

When the heterodyne oscillator is being used to radiate an RF signal, the signal can be amplitude modulated with a 500 cps tone by manually switching the AF amplifier circuit to the "Modulation On" position. Under this condition the audio amplifier becomes an audio oscillator capable of modulating the VFO about 40 per cent.

Power requirements for the LM Frequency Meter involve filament supply and plate supply voltages. By setting the links in the filament circuit, the filaments may be operated from either 12 or 24 volts. Similarly, links are used for the selection of the plate voltage range. The settings are: low range, 200 to 260 volts; and high range, 260 to 475 volts. Plate and screen voltage for the VFO stage are regulated by means of neon glow lamps.

It should be noted that the plate circuit can be manually switched ON and OFF independently from the filament circuit. This permits warming up of the unit or keeping it in readiness without radiation from the VFO or unwanted output in the headphones.

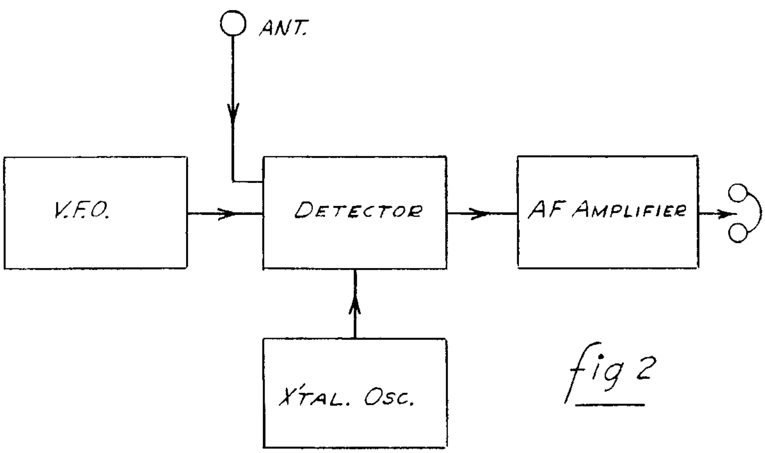


fig 2

(b) Operation:

Before attempting accurate frequency measurements with the LM Frequency Meter, the heaters should be allowed a minimum 10-minute warm-up period. In order to utilize the VFO dial readings (not calibrated in frequency), the calibration book which specifically accompanies the instrument must be used. From this book the calibration point for the VFO may be determined in the range in which the frequency measurement is desired. The crystal check points for the respective ranges are indicated at the bottom of each page, printed in red.

After allowing a sufficient warm-up period, and switching on the plate voltage, the VFO is carefully calibrated to the designated check point by adjusting the "Corrector" dial for "zero-beat" as head in the headphones. The Modulation switch must be in the "OFF" position for this adjustment.

Having calibrated the VFO, as described above, the frequency meter is ready for frequency indication. It should be noted that prolonged intervals between the VFO calibration and frequency measurement should be avoided to eliminate the possibility of frequency drift in the VFO.

In measuring the frequency of a local RF source (transmitter), it is necessary that a short antenna lead be connected to the frequency meter's antenna post. This antenna lead should be only loosely coupled to the transmitter output. Over coupling should be avoided so as not to damage the frequency meter circuits.

Adjustment of the "RF Coupling" control is made for the desired listening level in the headphones. By manually tuning the VFO, "zero-beat" is obtained with the incoming signal as heard in the audio output. The frequency is then determined from the VFO dial reading by referring to the calibration book.

It should be noted that in the reverse procedure from that described above, the transmitter may be tuned to "zero-beat" with the frequency meter, thus adjusting the transmitter to the desired frequency.

In adjusting a receiver to a desired frequency, or checking its dial calibration, the VFO of the frequency meter is used to radiate a signal from a short antenna lead. Loose coupling to the receiver concerned is generally adequate. After setting the calibrated VFO to the desired frequency, the receiver is tuned for zero-beat as heard at its output. A modulated signal from the frequency meter is required for receivers not equipped with a beat-frequency oscillator. Receiver alignment can be accomplished by using the frequency meter's modulated VFO as a signal generator in the conventional manner.

From the above, it is also apparent that frequency measurement of a distant RF source may be made by "zero-beating" it in a receiver with the radiated VFO signal.

(c) Accuracy of Measurements:

In the calibration book, the low frequency fundamental range is logged at each 0.1-kc. point between 125 and 250 kc. Similarly, the high frequency fundamental range is calibrated at each 1-kc. interval. By use of the interpolation table in the calibration book, frequencies that fall between the logged frequencies may be determined.

Accuracy of frequency measurement in reference to the crystal frequency is better than 0.02 per cent for any frequency within the 125-2000 kc. range, and better than 0.01 per cent for any frequency in the 2000-20,000 kc. range.

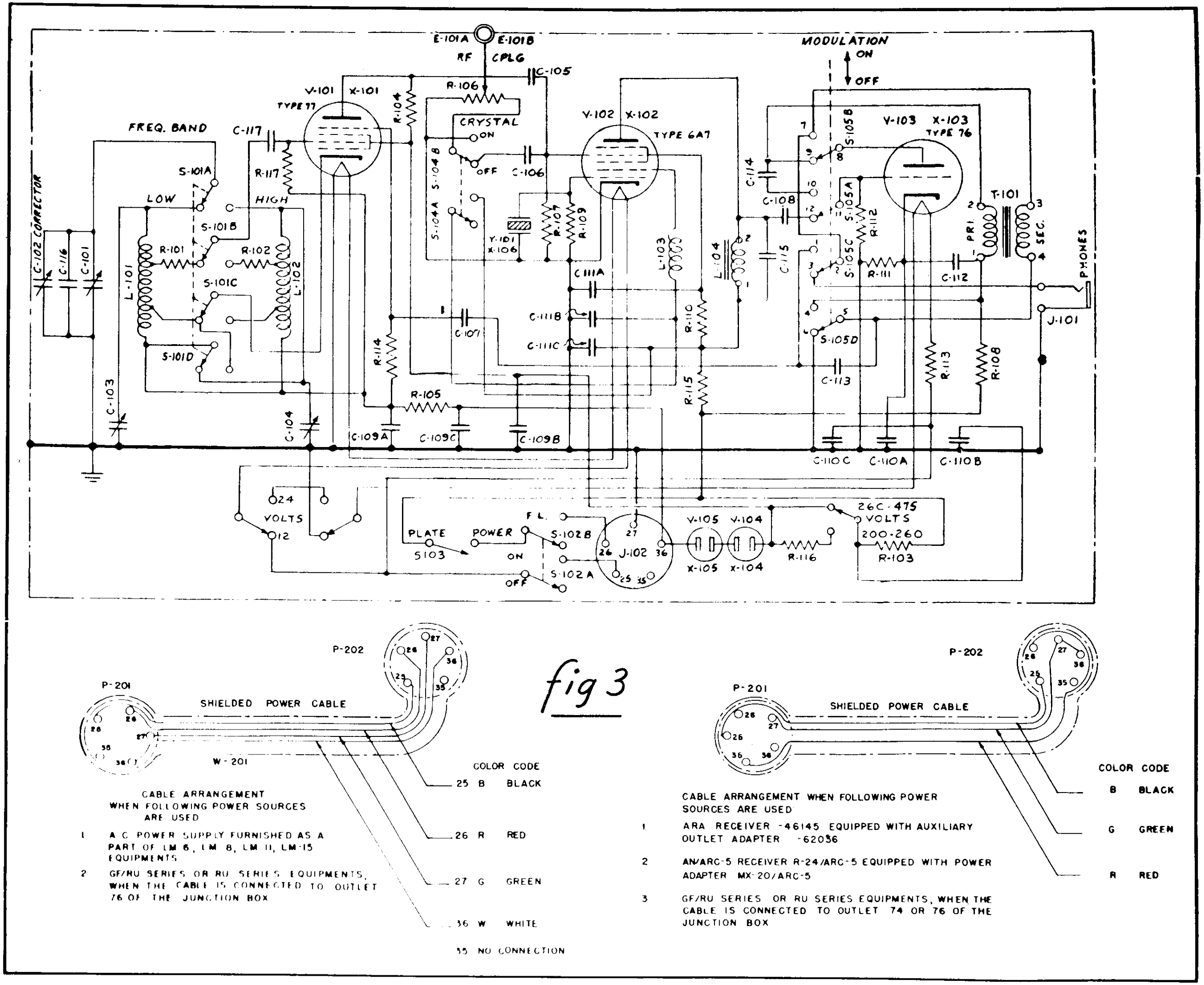
A desirable feature included in the exceptionally good design of this unit is the non-locking-in characteristic between the heterodyne oscillator and the RF source to which it may be coupled. Even though the headphones become rapidly inefficient in reproducing beat tones below 100 cps, characteristic audible "rushes", which coincide with the beat frequency, are recognizable well below the low frequency limit of audibility.

In some models of the LM Frequency Meter, the crystal oscillator is provided with a trimmer capacitor across the crystal. By this adjustment, the crystal frequency may be calibrated against WWV.

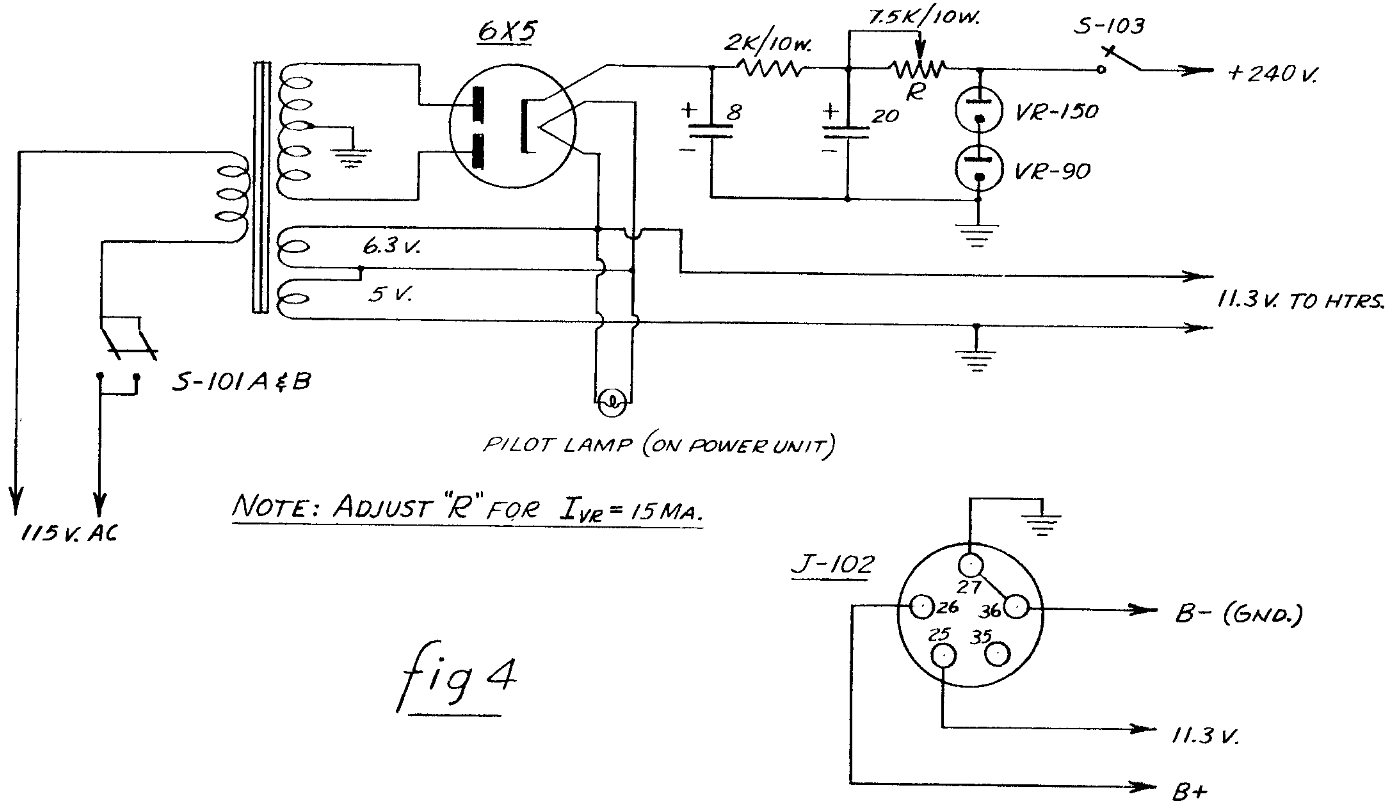
(d) Addition of An AC Power Supply:

The nominal power requirements for the Model LM series Frequency Meter are, 12 volts at 0.6 amperes (filament supply) and 250 volts at 20 ma. (plate supply). An AC power supply to satisfy these requirements is shown in Fig. 4. It should be noted that for portable use the frequency meter may be powered with batteries without any alteration of the power circuits. Socket connections can be determined from the schematic diagram, Fig. 3.

Details for adapting the LM Frequency Meter for the added AC power supply are given in Fig. 4. If a mating plug for J-102 is not available, the plug can be removed with the necessary leads to the power unit being brought out through the hole formerly occupied by J-102.

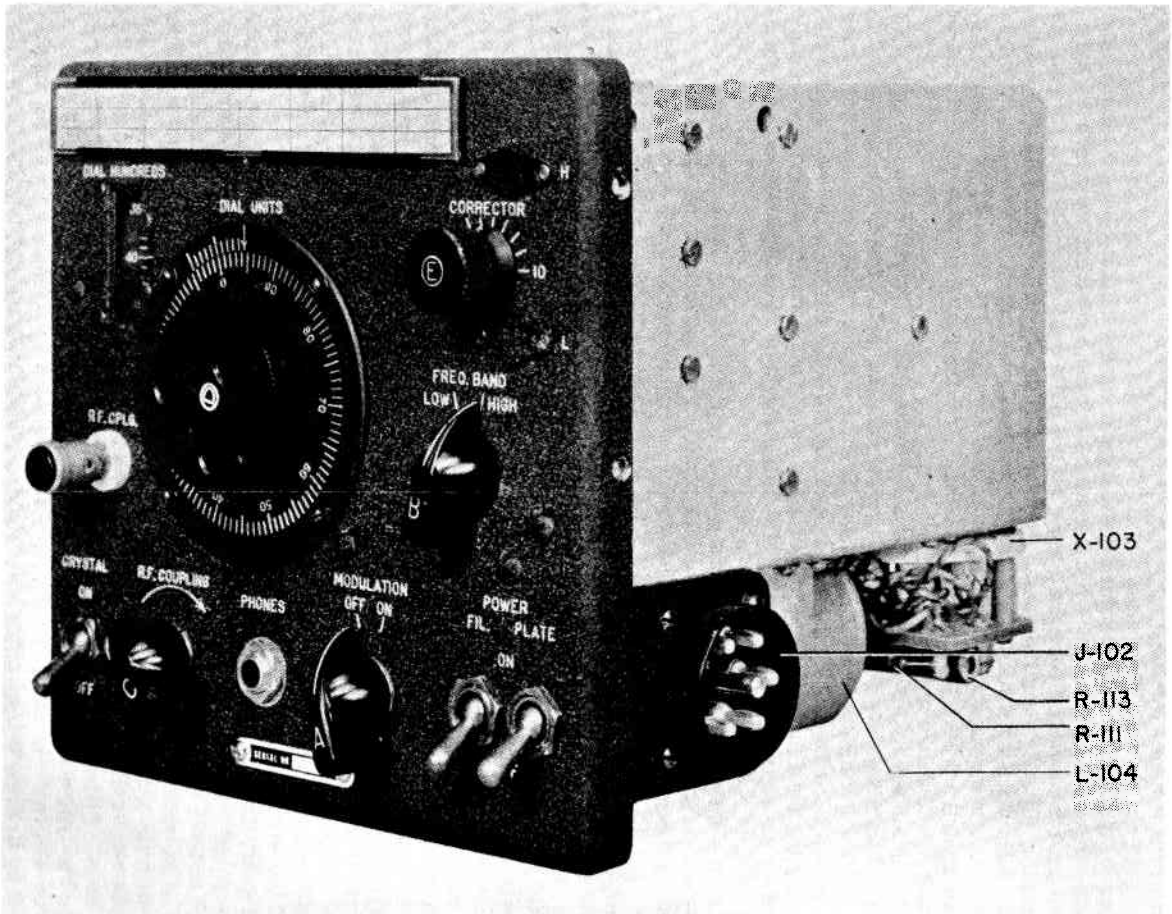

E-101A E-101B
RF CPLG
MODULATION
ON
OFF
FREQ. BAND
LOW
HIGH
CRYSTAL
ON
OFF
V-101 X-101 TYPE 77
V-102 X-102 TYPE 6A7
V-103 X-103 TYPE 76
T-101
PRI.
SEC.
PHONES
J-101
C-102 CORRECTOR
24 VOLTS 12
PLATE S103
POWER
ON
OFF
F.L.
S-102B
S-102A
J-102
V-105 V-104
X-105 X-104
26C-475 VOLTS
200-260
R-103
R-116
P-201
P-202
SHIELDED POWER CABLE
W-201
COLOR CODE
25 B BLACK
26 R RED
27 G GREEN
36 W WHITE
35 NO CONNECTION
CABLE ARRANGEMENT WHEN FOLLOWING POWER SOURCES ARE USED
1 A C POWER SUPPLY FURNISHED AS A PART OF LM 6, LM 8, LM 11, LM-15 EQUIPMENTS
2 GF/RU SERIES OR RU SERIES EQUIPMENTS, WHEN THE CABLE IS CONNECTED TO OUTLET 76 OF THE JUNCTION BOX
P-201
P-202
SHIELDED POWER CABLE
COLOR CODE
B BLACK
G GREEN
R RED
CABLE ARRANGEMENT WHEN FOLLOWING POWER SOURCES ARE USED
1 ARA RECEIVER -46145 EQUIPPED WITH AUXILIARY OUTLET ADAPTER -62036
2 AN/ARC-5 RECEIVER R-24/ARC-5 EQUIPPED WITH POWER ADAPTER MX-20/ARC-5
3 GF/RU SERIES OR RU SERIES EQUIPMENTS, WHEN THE CABLE IS CONNECTED TO OUTLET 74 OR 76 OF THE JUNCTION BOX
fig 3

AC POWER SUPPLY FOR THE LM FREQUENCY METER



NOTE: ADJUST "R" FOR $I_{VR} = 15$ MA.

fig 4



LM FREQUENCY METER (Cover Removed) Fig. 5

SURPLUS BEAM ROTATING MECHANISMS

The surplus market has brought several economical means for rotating beam antennas within the reach of the average amateur. This section covers the conversion necessary to adapt several surplus mechanisms for this purpose.

Signal Corps Antenna Reel:

One of the less expensive devices to appear is the Signal Corps Antenna Reel RL-42B. It consists of a 24-volt reversible motor (8500 RPM) attached to a reduction gear box which drops the speed to 120 RPM with considerable torque. It will rotate, directly, small beams, or can be used to turn a gun mount unit (described later) at a still further reduction in speed with resultant increase in torque to turn the heaviest beams. The Antenna Reel has an extra take-off gear which can be used to drive a Selsyn generator for direction indication as this shaft turns at the same speed as the main shaft.

The motor was intended to operate on 24 volts DC, but it will run on 24 volts AC. One factor exists, however, to make alteration necessary. Inside the motor casing is a clutch mechanism actuated by a 24-volt DC solenoid. This clutch chatters when operated on AC. Therefore it must be permanently locked or removed and a suitable coupling used to replace it. Two micro switches and a bathtub condenser should also be removed from the gear box. The following steps will describe these operations:

First, remove the reel, if it is snapped on to the gear box shaft, and take out the 8 flat-head screws holding the top cover plate. This allows the top plate to be removed, although it may have to be pried off. The main shaft and associated gear will come off with this cover plate. The inspection side plate should be removed also which will now give access to the gear box interior. The two micro switches may be easily removed by taking out the two large screws on the side opposite the motor, allowing a screwdriver to be inserted for removing the long retaining screws. Clip off the wires to the switches, as the only wires needed are the three from the motor itself. The bathtub condenser should be clipped out and removed. All wires to the plug should be clipped off close, as the entire length of the motor leads will be needed.

Remove the four screws holding the motor to the gear box, and then pull off the motor. Now remove the fibre ring from the motor and take out the four long screws of the motor end plate. This will allow the clutch mechanism to be exposed. The problem from here on is to eliminate the clutch action. This may be accomplished by two methods: the first is to remove both clutch plates and substitute a metal or flexible coupling; the second, merely connect the two plates together permanently.

If the substitution of a coupling is desired, proceed as follows: Push in on the small gear, insert a hacksaw blade, and cut off that clutch plate. The other plate can be pried off its shaft after removing the retaining allen screw. (Be very careful not to bend the shafts during this process.)

The solenoid can now be removed by clipping the leads and sliding it off the shaft with its associated fibre washers and parts. Should a coupling be used to connect the two shafts, it will be necessary to drill out or shim the coupling to take the shaft ends. Added length of the shaft on the gear end may be obtained by removing the spring-type washers under the gear.

The alternate method, joining the clutch plates permanently, can be accomplished by drilling two or more holes through the plates and tapping the set of holes in the plate on the motor side. It will be necessary to drill completely through the heavy end plate and through the one clutch plate unless the small gear can be removed and the plate pulled off to work on it. Short 6-32 screws can now be screwed through the plate on the motor side, allowing about 1/16 inch to extend out and fit into the holes of the plate on the gear side, acting as pins.

Before assembling the unit, it will be necessary to replace the present electrical connection plug with another which can be fitted with a mating section.

The unit may now be assembled and connected for operation. One of the motor leads (usually black) is common and either one of the other leads will give rotation when connected to 24 volts AC. One lead gives CW rotation, the other CCW rotation. A transformer will be required to step down the 115 volts AC to approximately 24 volts required.

If a light beam is used, it may be fitted on to the main shaft of the gear box by various means, depending of course upon the beam support used. If a heavier beam is used, it will be necessary to obtain a surplus gun-mount mechanism to increase the torque and correspondingly lower the speed of rotation. This unit is described in the following section.

See photos at end of this article for the appearance of the unit. Fig. 1 is a typical installation.

K7 Gun Mount:

Another outstanding surplus item which can be used as a beam rotating device is the K7 Gun Mount which was originally used by the Armed Services for rotating machine guns. This gun consists of a fairly large gear box about the size of a gallon paint can, on top of which is a flat rotating mounting plate. Originally, the unit was used to rotate a gun in both the horizontal and vertical planes with two flexible shafts used for controls. Only the horizontal rotation flexible shaft is practicable for beam rotation. It can be made as long as desirable for remote control.

The unit has an approximate gear ratio of 40:1, that is, the mounting plate will complete one revolution for 40 revolutions of the flexible shaft.

The flexible shaft can be turned by hand or by some motor drive mechanism such as the Antenna Reel RL-42B, described in the preceeding paragraphs. The antenna reel has sufficient power to turn the gun mount when coupled through a flexible shaft even when a very heavy beam is used. In the installation described, the gun mount rests on an outside platform with a 4" x 4" pole 20-feet high bolted to the gun mount plate. A 20-foot flexible shaft extends into the shack and is driven by the Signal Corps antenna reel, which is wall mounted.

Lubrication is very important in the use of the K7 gun mount. Before placing it in operation, the mounting plate and gear box cover should be removed and the top gear compartment filled with transmission grease (about SAE-90). This will prevent freezing of the gears and rust formation. All other rotating parts should be well lubricated if the unit is not protected from the weather.

Selsyn Generators Type 2J1F3:

There are many types of Selsyn units available on the surplus market, all operating on the same principle. But most of them are quite expensive. The type 2J1F3 is one of the smaller Selsyns and it is economical for use as a remote indicator. These units are about 4-1/2 inches long and approximately 2-1/4 inches in diameter. They will operate from 24 volts AC and thus work very well in conjunction with the Antenna Reel described previously. A pair of the units is necessary, of course, for the indication system. One is geared to the beam itself and the other is at the operating position with a compass card attached for indicating 0 to 360 degrees. The only problem involved in the use of the Selsyns is that of obtaining the correct gear ratio at the indicator end, so that the beam and indicator are rotating at the same speed. This is a mechanical problem and will vary with the type of beam rotators used; however, some of the surplus dial mechanisms as used in tuning units and so forth have gear ratios which will work out nicely with the K7 gun mount and Signal Corps antenna reel. The diagram in Fig. 2 is typical of all Selsyn motor circuits.

Rotator Motor Type G303AY2:

Another popular and extremely practical beam rotating device is the Rotator type G303AY2. This motor was originally designed and used on 400 cycles. However, by the simple addition of a phasing condenser, (12-20 mfd., oil or paper), the motor will operate directly on 110 volts AC, 60 cycles and provide an economical and husky beam rotator.

Since the motor is of the induction type, no noise is created by brushes or moving mechanical parts. It is of the reversible type, requiring only 3 wires for operation. Its weight is 3 lbs. and it is approximately 5" x 5" x 4" in size. It revolves at a speed of 3/4 RPM.

The motor will drive satisfactorily most 10 and 20 meter beams, providing they are of light construction. For the heavier beams a bearing surface is recommended. Two-meter, six-meter, television, and FM beams can easily be driven directly from the motor shaft.

To place the motor in operation, remove the elastic stop nut and lever arm, remove the three screws and top cover plate, being careful to save the gasket and slip off the plate containing the two wiper arms (this plate merely served as a stop mechanism and will not be required). In order to remove the wiper arm plate, the motor will probably have to be connected to 110 volts as per Fig. 3 and allowed to rotate until the wiper arms are in the center position where they can be slipped off. The gear of the wiper arm assembly can be used on the end of a length of thin-walled tubing as a beam support if desired. This is accomplished by using a hacksaw as per Fig. 4 and cutting out the gear, being careful not to damage the gear teeth. The gear can now be pressed into a piece of tubing or other support.

Do not remove the four screws held by safety wires on the end of the motor opposite the rotating gears, as the motor and gears are sealed in oil. A drain plug is provided on the side of the motor case for draining and filling as required.

Connect the motor through a condenser and switch as per Fig. 3 and the unit is ready for operation. It can easily be mounted by means of the four tapped holes on the side.

The photos at the end of this article will give a general idea of the appearance.

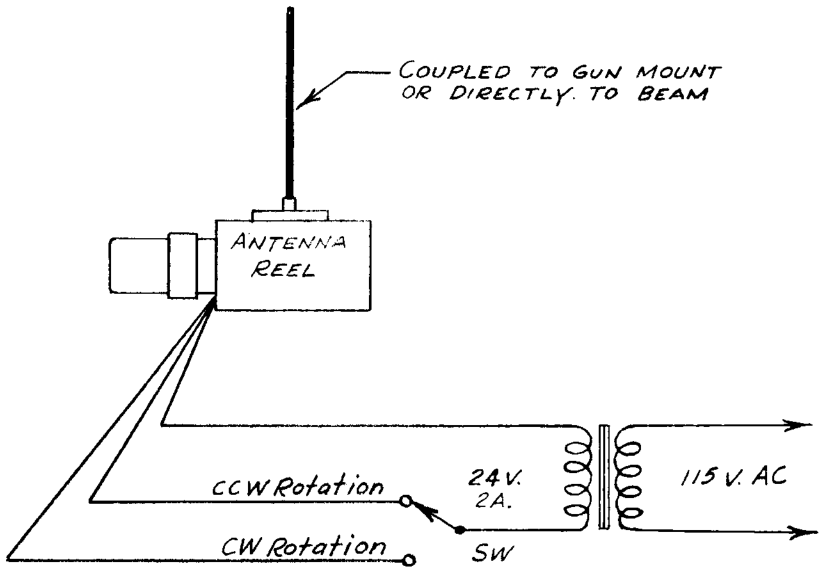

COUPLED TO GUN MOUNT
OR DIRECTLY TO BEAM
ANTENNA
REEL
CCW Rotation
CW Rotation
24 V.
2A.
SW
115 V. AC

fig 1

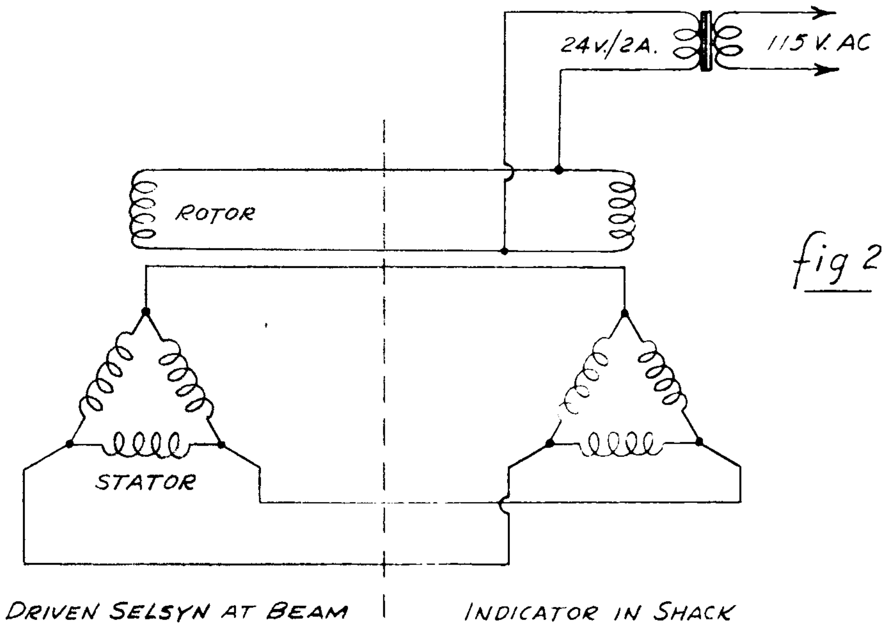

24 V./2A.
115 V. AC
ROTOR
STATOR
DRIVEN SELSYN AT BEAM
INDICATOR IN SHACK

fig 2

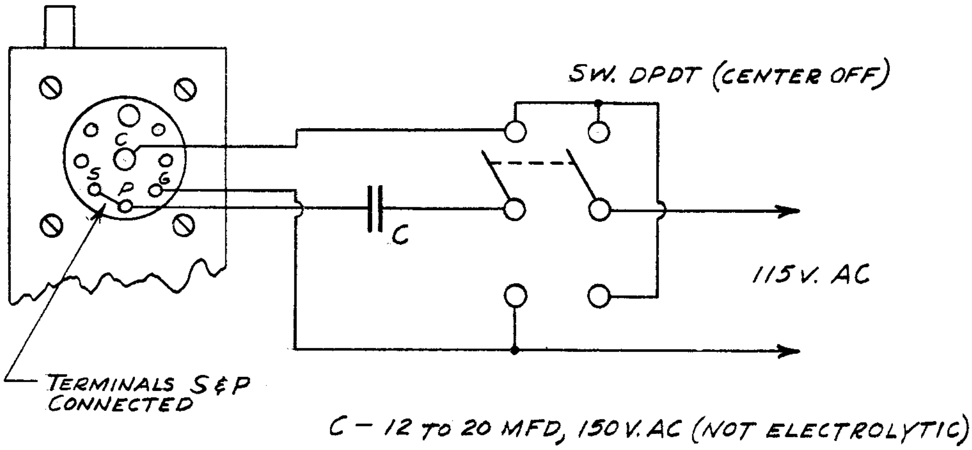

SW. DPDT (CENTER OFF)
C
S
P
G
C
115 V. AC
TERMINALS S & P CONNECTED
C – 12 TO 20 MFD, 150 V. AC (NOT ELECTROLYTIC)

fig 3

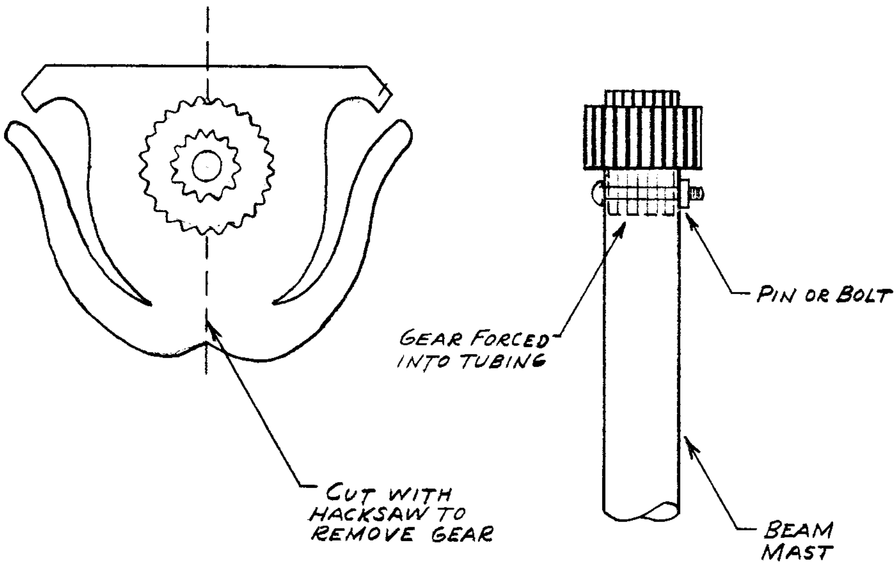
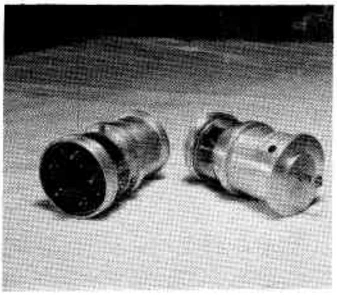
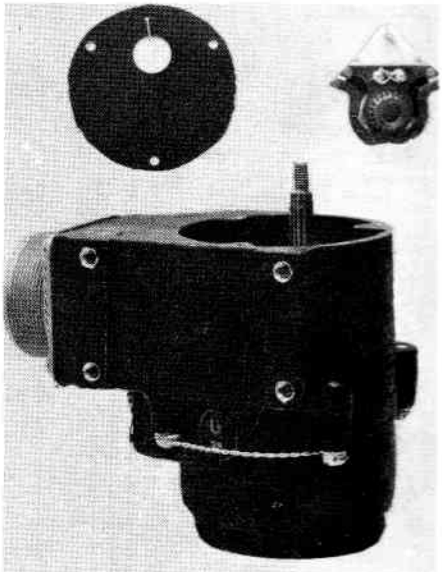

CUT WITH HACKSAW TO REMOVE GEAR
GEAR FORCED INTO TUBING
PIN OR BOLT
BEAM MAST

fig 4

SURPLUS BEAM ROTATING MECHANISMS

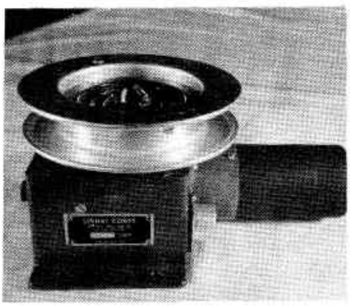


SELSYN GENERATORS
TYPE 2J1F3

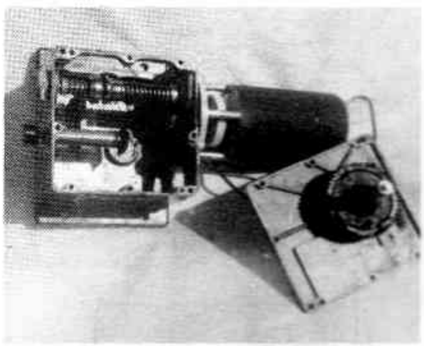


BEAM ROTATOR (G303AY2)

K7 GUN MOUNT

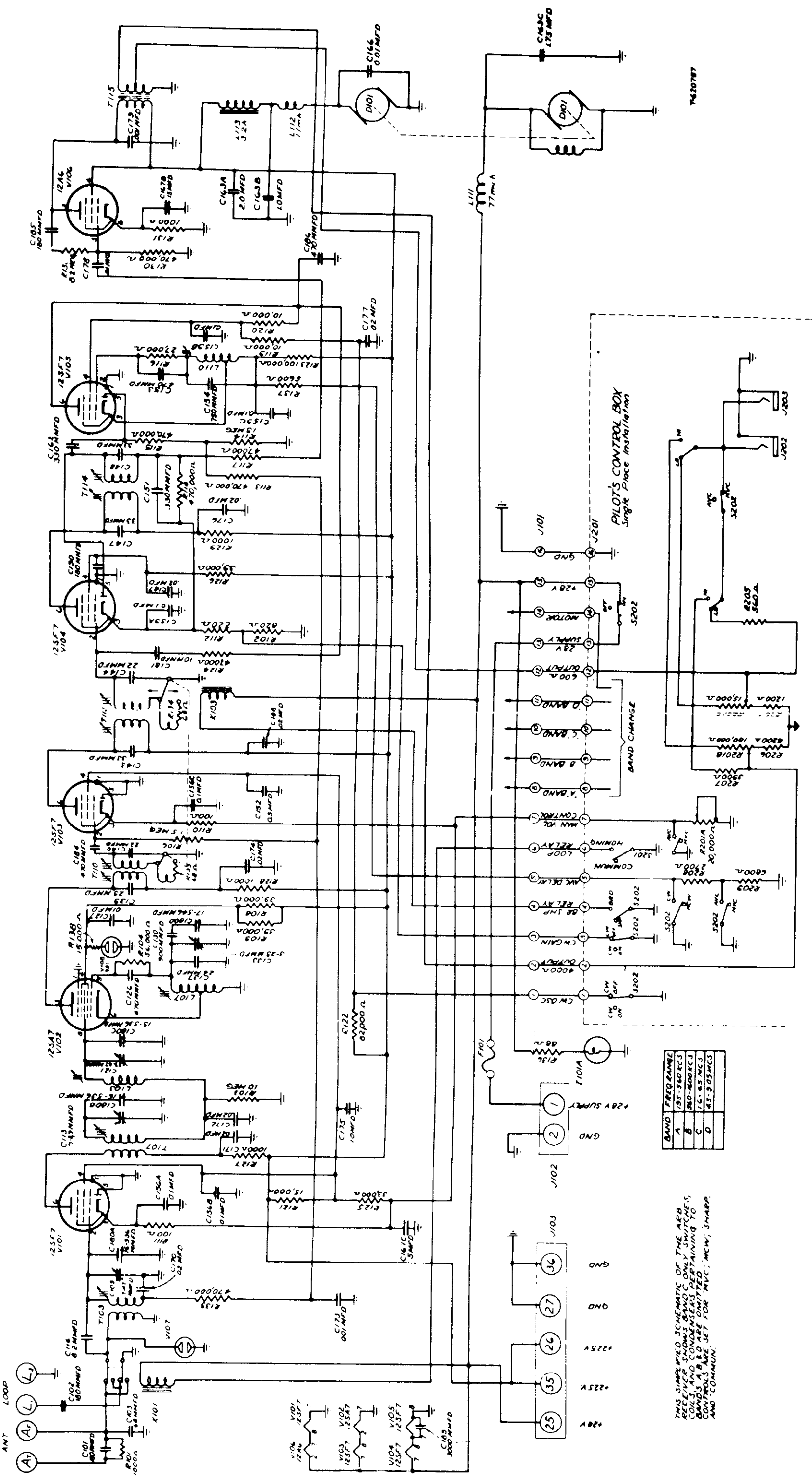


SIGNAL CORPS
ANTENNA REEL



SIGNAL CORPS
ANTENNA REEL

ARB
Radio Receiver and Single Control Box



$3.50
Cat. No. EE-322

SURPLUS RADIO CONVERSION MANUAL

VOLUME III

Conversion of

701-A
AN/APN-1
AN/CRC-7
AN/URC-4
ARA
BC-442, 453-455, 456-459, 603
696, 950, 1066, 1253
CBY-29125, 50083, 50141,
52208-11, 52232, 52302-09
FT-241A (for crystal filter)
MBF (COL-43065)
MD-7/ARC-5
R-9/APN-4
R23-R28/ARC-5
RAT, RAV
RM-52 (53)
RT-19/ARC-4
SCR-274N
SCR-522
T-15/ARC-5 to T-23/ARC-5

SEE TABLE OF CONTENTS ON PAGE 4

For

Amateur, Novice, Technician

and

Citizen's Radio Service

Just like *Ol' Man River* surplus equipment keeps rolling along. The supply waxes and wanes, but never completely dries up. Untold amounts of equipment are snapped up by "surplus hounds" only to be replaced by new, larger amounts of equipment arriving from unknown locations. Surely there must be some huge, hidden factory turning out tons of surplus equipment each day which will be sold to hams and others at bargain prices!

Modifying surplus equipment to fit the needs of the Amateur or Citizen Radio fan is interesting and exciting work. The high quality of most surplus equipment cannot be matched by commercial equipment selling at many times the cost of the surplus item. The converted surplus item can be made a piece of high-grade "ham" equipment at a money saving price!

However, every silver lining has a cloud. Some pieces of surplus equipment do not have schematic diagrams. Many items are modified from the original diagram, making the conversion process akin to a crossword puzzle. Other items are not worth the time to convert them! The enthusiast "surplus hound" must choose wisely and well when he buys, and must be adept at improvisation and "make-do."

Because of the time required to enter into personal correspondence, and because of the rapid and chaotic changes in the surplus market (and surplus equipment) it is impossible for the editors of this Manual to answer questions relating to conversions of equipment, to requests for schematics, or for purchasing information. The reader is referred to CQ magazine, which runs a surplus column. This column often contains answers to the perplexing questions which may confront the "surplus hound."

Good luck, and may your conversions always work!

Special thanks are due the Arrow Sales Company, North Hollywood, California for the use of several difficult-to-locate schematics.

$3.50
Cat. No. EE-333

SURPLUS RADIO CONVERSION MANUAL

VOLUME III

WILLIAM I. ORR
Editor

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SURPLUS RADIO CONVERSION MANUAL

VOLUME III

LIST OF EQUIPMENT
on which data is given in this volume

The "Command" Sets

The "Command" Sets are probably the most popular pieces of radio equipment on the surplus market. Designed in 1938, they were produced in prodigious quantities for over a decade for the Army, the Navy, and the Air Force. The various items of equipment that make up a complete set form a multi-channel radio transmitting and receiving package for use on airplanes equipped with a 24 volt d.c. power source. The equipment is designed to transmit and receive voice, tone modulated, or continuous wave signals. Included in the equipment are various receivers, transmitters, modulators, and auxiliary items, tabulated in figure 1.

The basic circuit for all Command transmitters is shown in figure 2. A master oscillator excites a pair of beam power amplifier tubes connected in parallel. The master oscillator and power amplifier tuning capacitors are ganged for simplification of controls. A quartz crystal resonator (Y-50) is supplied with each transmitter for use with a "magic eye" tube to check frequency calibration at *one spot* on the dial. The crystal does not control transmitter frequency. Continuously variable coupling between the power amplifer tank circuit and the antenna circuit is achieved by a rotary loading coil (L-52) and a rotary link coil in the amplifier tank circuit.

The basic circuit for the Command receivers is shown in figure 3. All receivers are one-band superheterodynes, and except for L-C elements forming the r.f. and i.f. tuned circuits, they are essentially alike electrically and physically. Each receiver employs six metal 12 volt tubes.

All Command equipment is designed to mount in racks which make electrical interconnections via built-in plugs. In general, the racks for one series of equipment are not interchangeable with racks of other series, as the plug sizes and pin connections differ for the different branches of the Armed Forces. The use of the racks is not necessary, however, for amateur service.

The following information concerns the adaptation of the Command equipment for amateur use. *Additional conversion information for this popular equipment is given in Volumes I and II of this surplus conversion series.* The material included herewith is new, and does not duplicate material given in the previous manuals.

Converting the Command Receiver to Six Meters

Technicians and v.h.f. operators are interested in a method of converting the Command receivers for v.h.f. operation. The conversion involves constructing a power supply, rewinding the receiver coils, and replacing a tube. This conversion may be done with any receiver, but the use of the 3–6 Mc. receiver is recommended as the i.f. bandwidth is about optimum for general usage.

Remove the top covers and the bottom plate, saving the screws. Clean off the rear area of the receiver where the dynamotor was mounted and wire in the power supply shown in figure 4. Note that the two filament windings of the transformer must be correctly phased to produce 11.6 volts, a.c. The 12 volt tubes operate perfectly at this voltage. Make sure the receiver works on a.c. before you start the rest of this conversion.

Now, remove the coils by taking out the screws on each side of the receiver case that hold the assembly. Lift out the triple coil can and remove the 12 screws holding the coils in the cans. Remove the coils from the base and clean the terminals. Discard the original coils. Wind the self-supporting coils shown in figure 5. Reassemble the coils in the shields and replace the unit in the receiver.

Next, remove the 12SK7 r.f. tube (immediately behind the tuning capacitor) and replace it with a WE-717A, available at any large surplus store. (This tube is an octal based 6AK5, and has the same pin connections as the 12SK7). Rewire the "hot" filament pin to the six volt winding of the filament transformer, as shown in figure 4.

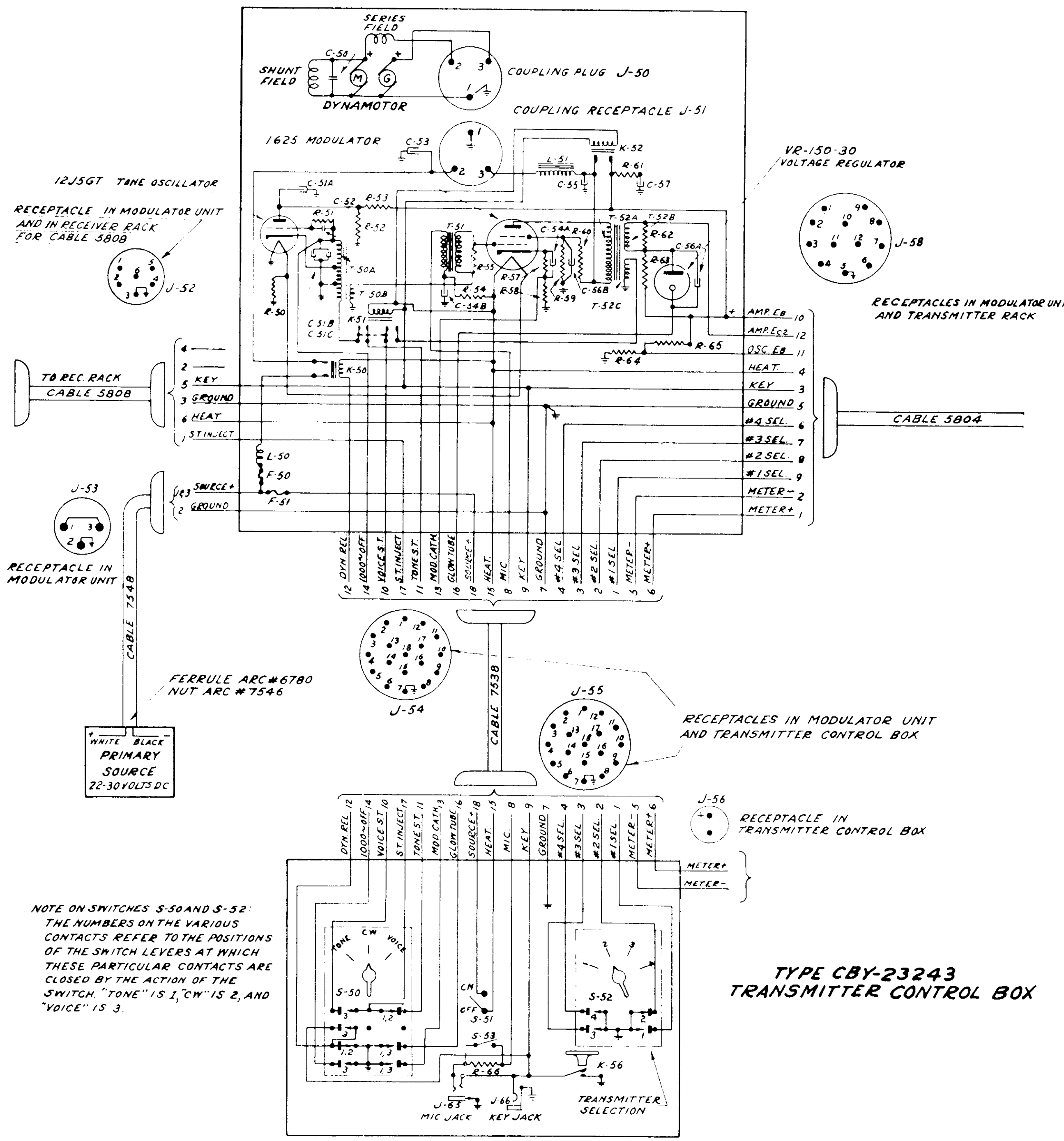
Inject a 50 Mc. signal into the receiver, holding the signal level down to prevent receiver overload. Adjust the oscillator padding capacitor (C-4E, atop the tuning capacitor) until the 50 Mc. signal appears at 5.7

"COMMAND" TRANSMITTERS

FREQ. RANGE (MC)	NOMENCLATURE			DESIGN MODIFICATION
	JOINT ARMY-NAVY (JAN)	SIGNAL CORPS (BC)	NAVY (ATA)	
2.1-3.0	— T-18/ARC-5	— —	CBY-52232 CBY-52305	— A
3.0-4.0	— T-19/ARC-5	BC-696 —	CBY-52208 CBY-52306	— A
4.0-5.3	— T-20/ARC-5	BC-457 —	CBY-52209 CBY-52307	— A
5.3-7.0	— T-21/ARC-5	BC-458 —	CBY-52210 CBY-52308	— A
7.0-9.1	— T-22/ARC-5	BC-459 —	CBY-52211 CBY-52309	— A
0.5-0.8	— T-15/ARC-5	— —	— CBY-52302	— A
0.8-1.3	— T-16/ARC-5	— —	— CBY-52303	— A
1.3-2.1	— T-17/ARC-5	— —	— CBY-52304	— A
100-156	— T-23/ARC-5	— BC-950	— —	— B
MODUL. UNIT	— MD-7/ARC-5	BC-456 —	CBY-50083 CBY-50141	— A
ANTENNA RELAY	—	BC-442	CBY-29125	—

NOTES: A—PLATE AND SCREEN MODULATED.
B—MODULATOR INCLUDED IN TRANSMITTER.
C—PLATE CIRCUIT OF P-A IS SHUNT-FED IN JAN MODELS

Figure 1
CHART OF VARIOUS MODELS OF "COMMAND" TRANSMITTERS



CAPACITANCES	
SYMBOL	MICROFARADS
C-50	.006
C-51 (A,B,C)	.05/.05/.05
C-52	.006
C-53	1.2
C-54 (A,B)	5/20.
C-55	1.2
C-56 (A,B)	.5/.5
C-57	.05
C-58 (A,B,C)	05/.05/.05
C-59	.00018
C-60	MO PADDING
C-61	.006
C-62	FIXED NEUTR
C-63	MO TUNING
C-64	.002
C-65	PA TUNING
C-66	.01
C-67	PA PADDING
C 68	.000003
C-69	.00005

RELAYS	
SYMBOL	DESCRIPTION
K-50	DYNAMOTOR INPUT
K-51	SIDETONE, VOICE AND TONE
K-52	DYNAMOTOR HIGH VOLTAGE (KEYING)
K-53	TRANSMITTER SELECTOR
K-54	TRANSMITTER OUTPUT
K-55	ANTENNA SWITCHING, REC. TO TRANS

INDUCTANCES	
SYMBOL	DESCRIPTION
L-50	RF CHOKE APPROX. 15 MICROHENRIES
L-51	1.7 HENRIES
L-52	ANT. TUNING INDUCTOR

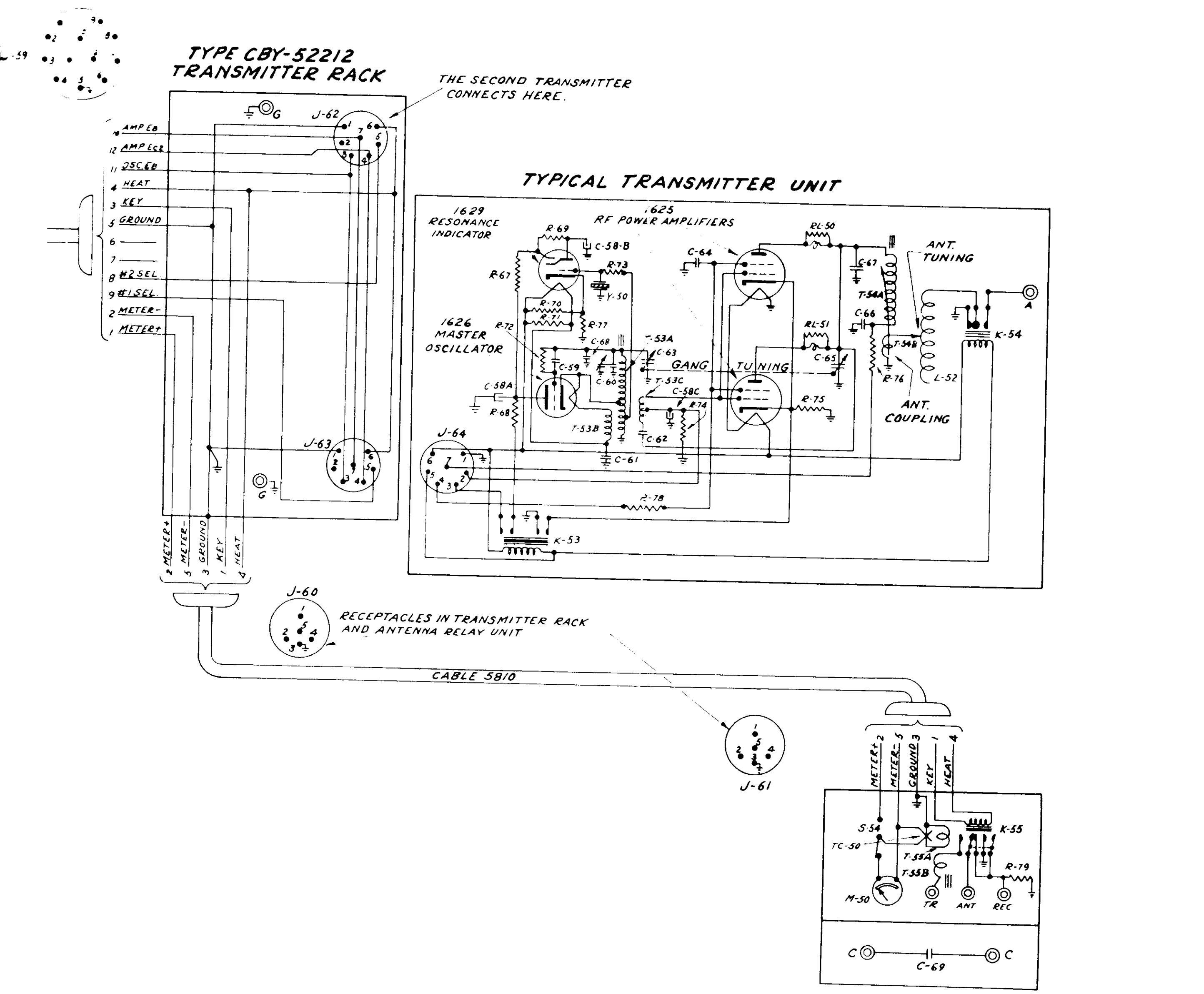
RESISTANCES	
SYMBOL	OHMS
R-50	42
R-51	100,000
R-52	300,000
R-53	91,000
R-54	200
R-55	15,000
R-57	390
R-58	51,000
R-59	30,000
R-60	75,000
R-61	20
R-62	10,000
R-63	20,000
R-64	100,000
R-65	15,000
R-66	510
R-67	51,000
R-68	20
R-69	1,000,000

RESISTANCES CONT.	
SYMBOL	OHMS
R-70	1000 FOR 2.1-3 MC TR.
R-70	1500 FOR 3-4 MC TR.
R-70	1000 FOR 4-5.3 MC TR.
R-70	1000 FOR 5.3-7 MC TR.
R-70	1500 FOR 7-9.1 MC TR.
R-71	126
R-72	51,000
R-73	15,000 FOR 2.1-3 MC TR.
R-73	5,100 FOR 3-4 MC TR.
R-73	10,000 FOR 4-5.3 MC TR.
R-73	15,000 FOR 5.3-7 MC TR.
R-73	5,100 FOR 7-9.1 MC TR.
R-74	15,000
R-75	51,000
R-76	20
R-77	390
R-78	51
R-79	510,000
RL-50	PARASITIC SUPPRESSOR
RL-51	PARASITIC SUPPRESSOR

Figure 2-A
SCHEMATIC, "COMMAND" TRANSMITTER, MODULATOR AND CONTROL BOX (ATA-TYPE PLUGS).

TYPE CBY-50083 MODULATOR UNIT WITH TYPE CBY-21626 TRANSMITTER DYNAMOTOR UNIT

NOTES:
1. ALL RELAYS SHOWN IN NON-ENERGIZED POSITION.
2. ALL COUPLING PLUGS AND RECEPTACLES SHOWN AS VIEWED FROM THE OUTSIDE. ALL PLUGS AS VIEWED FROM THE CORDAGE END HAVE THE SAME ORIENTATION OF CONDUCTORS AS THAT SHOWN HERE FOR THEIR RESPECTIVE RECEPTACLES.



TYPE CBY-29125
ANTENNA RELAY UNIT

SWITCHES SYMBOL	SWITCHES DESCRIPTION	TRANSFORMERS SYMBOL	TRANSFORMERS DESCRIPTION	MISCELLANEOUS SYMBOL	MISCELLANEOUS DESCRIPTION
S-50	CHOICE OF EMISSION	T-50	TONE OSC.	TC-50	THERMOCOUPLE
		T-51	MICROPHONE	M-50	ANT. CURRENT INDICATOR (LOCAL)
		T-52	MODULATION		
S-51	MAIN "ON-OFF" BATTERY LINE	T-53(A,B,C)	MASTER OSC.		
		T-54(A,B)	TRANS. OUTPUT	K-56	BUILT-IN KEY
		T-55(A,B)	ANT. CURRENT	Y-50	CRYSTAL UNIT
S-52	TRANSMITTER SELECTION			F-50	20 A FUSE
S-53	SHUNTS MIC. SERIES RESISTOR			F-51	20 A FUSE
S-54	ANT CURRENT-METER SWITCHING				

Figure 2-A
SCHEMATIC, "COMMAND" TRANSMITTER, MODULATOR AND CONTROL BOX (ATA-TYPE PLUGS).

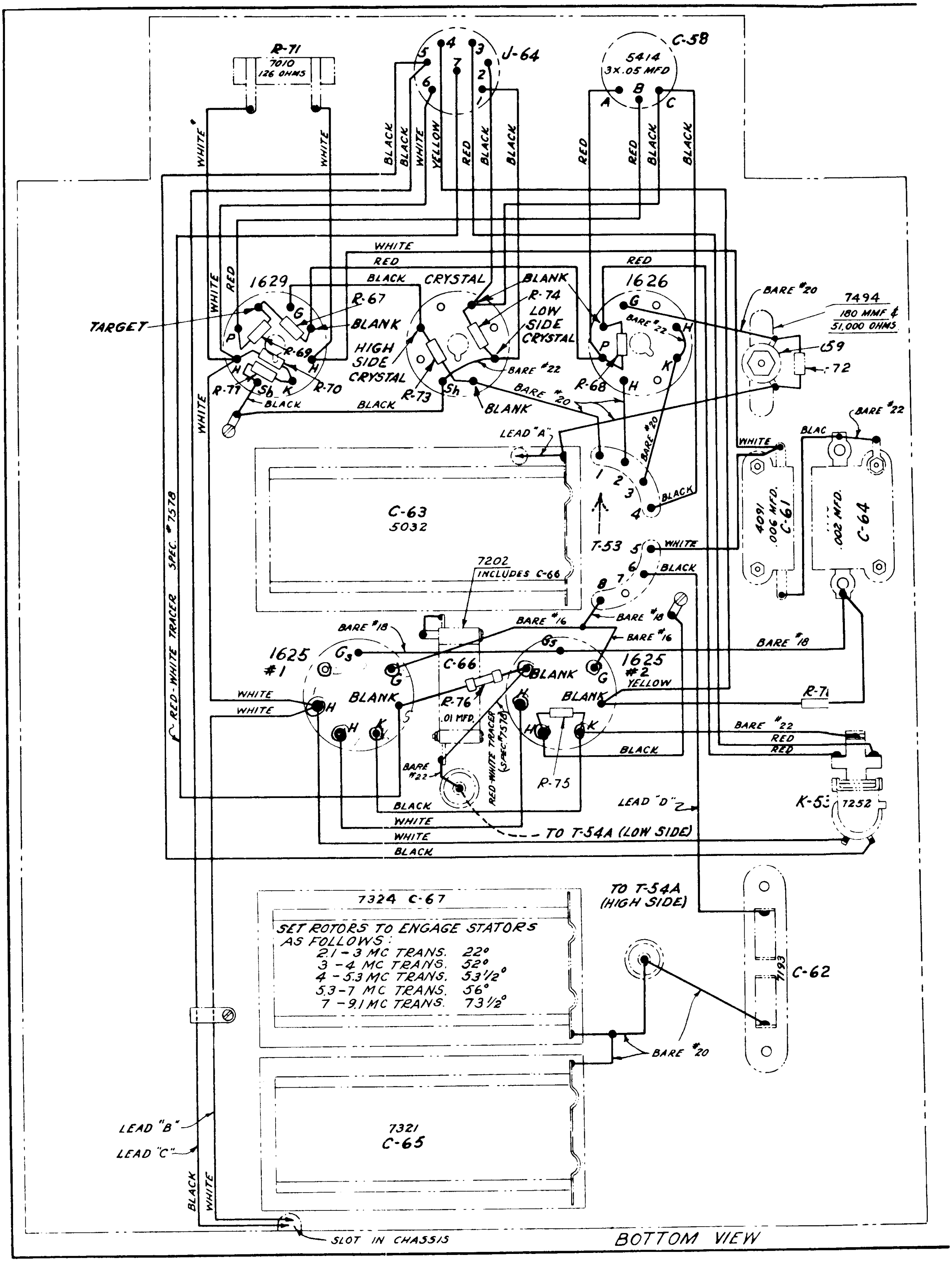


Figure 2-B
WIRING DIAGRAM AND PARTS PLACEMENT, "COMMAND" TRANSMITTER.

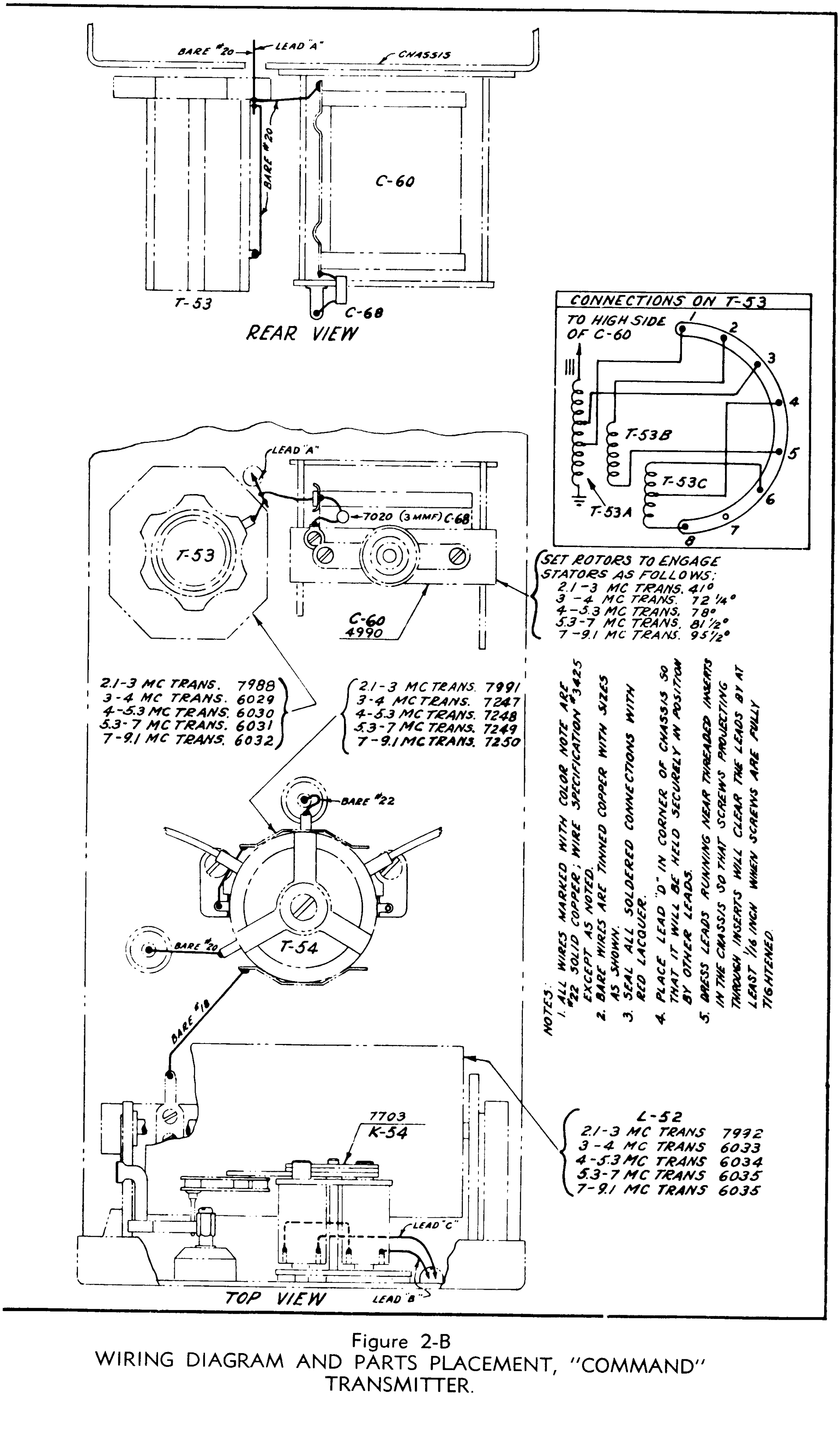
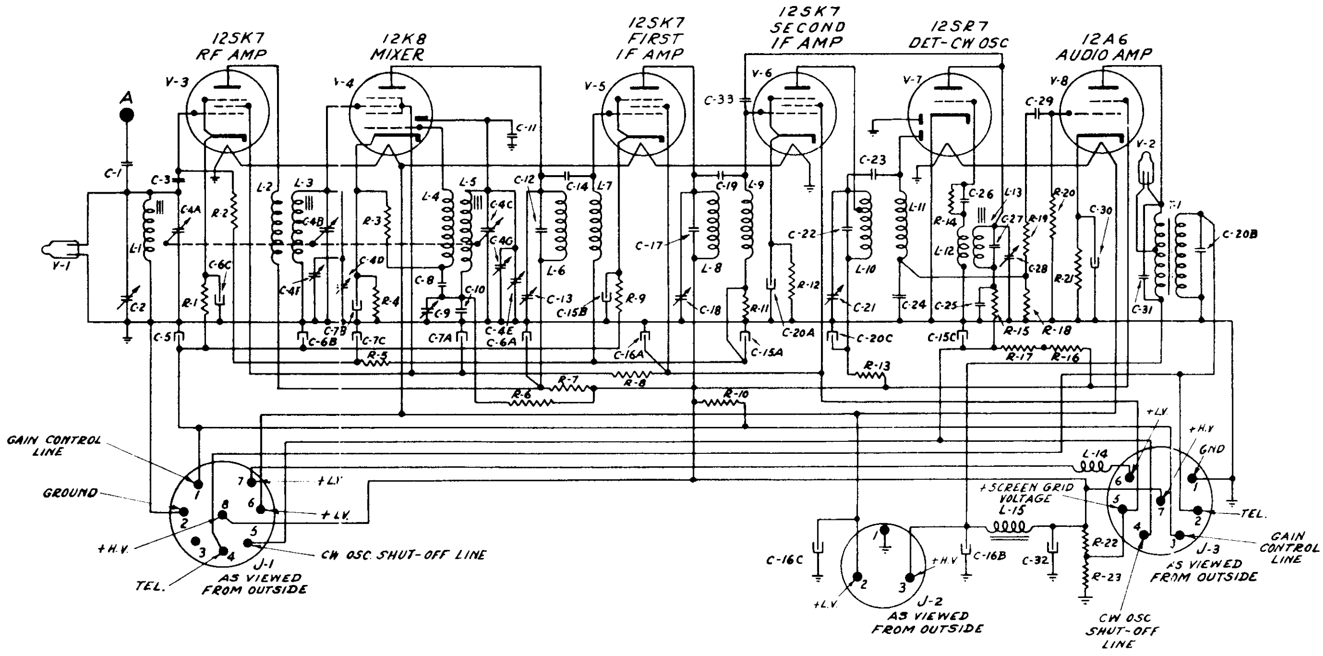


Figure 2-B
WIRING DIAGRAM AND PARTS PLACEMENT, "COMMAND" TRANSMITTER.



CIRCUITS IN RF COIL SET, IF COUPLING UNITS, CW OSCILLATOR, AND OUTPUT TRANSFORMER.
THE TERMINAL NUMBERS ON THESE UNITS AGREE WITH THOSE SHOWN AT THE CORRESPONDING
LOCATIONS ON THE WIRING DIAGRAM.

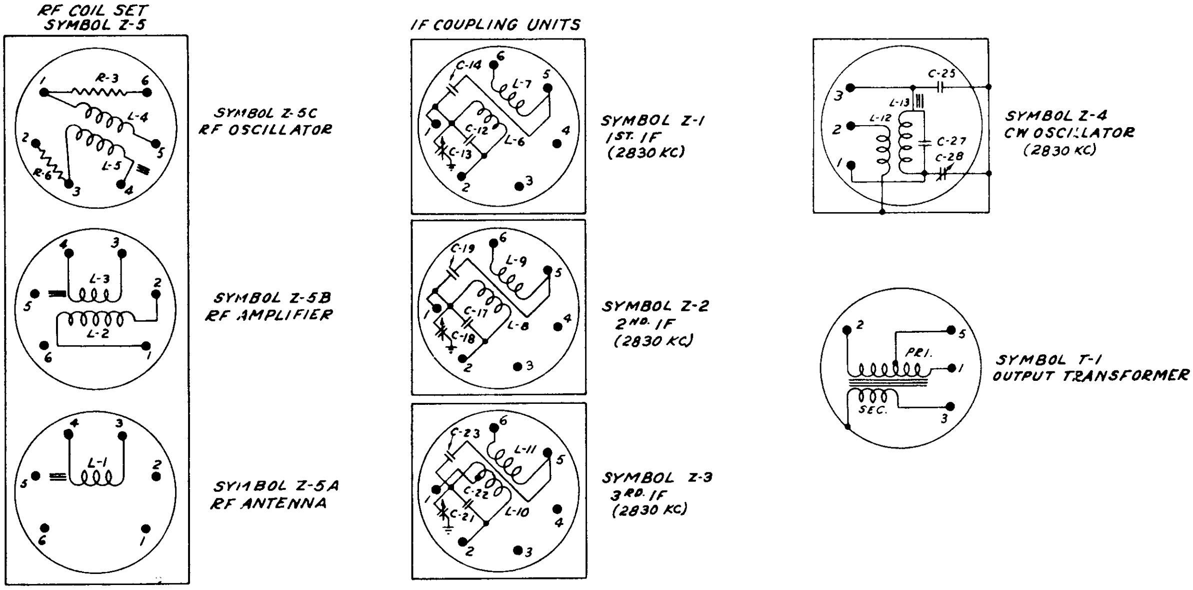
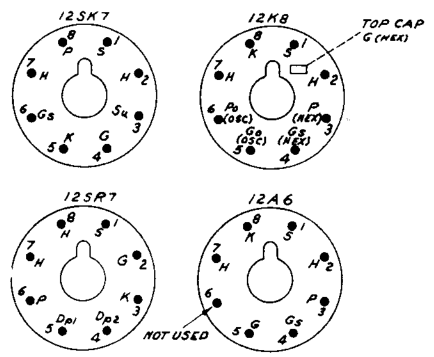


Figure 3-A
SCHEMATIC, "COMMAND" RECEIVER (ATA-TYPE PLUGS).

CAPACITANCES		INDUCTANCES		RESISTANCES	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	OHMS
C-1	8.5 MMF	L-1	ANT INPUT	R-1	620
C-2	15 MMF	L-2, L-3	RF AMP	R-2	2,000,000
C-3	100 MMF	L-4, L-5	RF OSC	R-3	51,000
C-4(A TO G)	GANG (62 MMF)	L-6, L-7	IN 1ST IF	R-4	620
C-5	3 MFD	L-8, L-9	IN 2ND IF	R-5	150,000
C-6 (A,B,C)	.05/.05/.05 MFD	L-10, L-11	IN 3RD IF	R-6	150,000
C-7(A,B,C)	.05/.05/.05 MFD	L-12, L-13	CW OSC	R-7	200
C-8	200 MMF	L-14	RF CHOKE,	R-8	200
C-9	40 MMF		112 MICRO-	R-9	620
C-10	240 MMF		HENRIES	R-10	360,000
C-11	3 MMF	L-15	AF CHOKE	R-11	100,000
C-12	180 MMF		3 HENRIES	R-12	510
C-13	17 MMF			R-13	200
C-14	180 MMF			R-14	100,000
C-15(A,B,C)	.05/.05/.05 MFD			R-15	5,100
C-16(A,B,C)	.22/.22/.22 MFD			R-16	51,000
C-17	180 MMF			R-17	51,000
C-18	17 MMF			R-18	510,000
C-19	180 MMF			R-19	100,000
C-20(A,B,C)	.05/.01/.05 MFD			R-20	2,000,000
C-21	17 MMF			R-21	1500
C-22	180 MMF			R-22	7000
C-23	180 MMF			R-23	7000
C-24	200 MMF				
C-25	.001 MFD				
C-26	100 MMF				
C-27	180 MMF				
C-28	34 MMF				
C-29	.006 MFD				
C-30	15 MFD				
C-31	.001 MFD				
C-32	5 MFD				
C-33	WIRING CAPACITANCE (LESS THAN 2 MMF)				

TUBE SOCKET TERMINALS AS VIEWED FROM BOTTOM



TUBE TERMINAL CODE

S = SHELL	Gs = SCREEN GRID
H = HEATER	Gs(HEX) = SCREEN GRID, HEXODE SECTION
K = CATHODE	Go(OSC) = CONTROL GRID, OSC SECTION
Su = SUPPRESSOR GRID	P = PLATE
Dp1 = FIRST DIODE PLATE	P(HEX) = PLATE, HEXODE SECTION
Dp2 = SECOND DIODE PLATE	Po(OSC) = PLATE, OSC. SECTION
G = CONTROL GRID	G(HEX) = CONTROL GRID, HEXODE SECTION

Figure 3-A (continued)

Mc. on the tuning dial. Retune the signal generator to 54 Mc. This should appear at 6 Mc. on the receiver dial. Peak up the mixer trimmer (on the side of the tuning capacitor) and the antenna trimmer on the front panel for maximum signal. Calibration may be varied by juggling the oscillator padding capacitor C-9 and the auxiliary oscillator capacitor C-4 on the side of the tuning capacitor. When the coverage is correct, the dial may be re-painted with white paint and the new calibration marks placed on the surface with India ink.

A suitable "control panel" for the front of the receiver is shown in figure 6. Remove the auxiliary plug at the bottom of the front panel, knock off the knob and use the panel as a mount for the components.

Make a Novice Receiver for 40 and 80 Meters from the 3—6 Mc. Command Receiver!

The 3–6 Mc. Command receiver "just misses" the 7 Mc. Novice amateur band. An excellent and easy-to-perform conversion of this receiver will permit it to cover both Novice bands! Simply remove the coil rack from the receiver, and remove the coils from the cans. Mark the coils so you can distinguish between them. With a pair of "needle-nose" pliers pull out the micarta clip that secures the powdered iron slugs within the coils. Remove the three slugs and discard them. Be careful not to damage the coil windings or the terminal connections. Reassemble the coils, solder all connections, and install the coil rack in the receiver.

Using a signal generator, set the 6 Mc. dial marking to a generator frequency of 7.4 Mc. by adjusting the high frequency oscillator padder (C-4G). Next, set the 3 Mc. dial marking to a generator frequency of 3.4 Mc. Go back to 7.4 Mc. and recheck this point. Re-set C4-G slightly, if necessary. Peak up the mixer trimmer, and the antenna trimmer. The receiver will now tune the range of 3.4 Mc. to 7.4 Mc., covering both the 80 meter and the 40 meter Novice bands.

A Plug-in Power Supply for Your Command Receiver

Many amateurs and experimenters have a whole "stable" of Command receivers. Not only is it expensive to purchase power transformers for each receiver but it is very difficult to adapt a receiver converted in such a manner for mobile operation. Described herewith is a plug-in power unit that fits in the dynamotor space of the receiver. The supply can be easily removed and a converted dynamotor used for mobile operation.

First, wire all filaments in parallel for 12 volt operation. Locate a Command receiver dynamotor (DY-8, or DY-2A/ARR-2) and remove the base mounting plate. Discard the dynamotor. Remove everything from the base plate, including the sliding clips, but retain the three pin connector. Mount the new power transformer, rectifier tube, socket, and filter capacitor as shown in figure 7A. Note that the capacitor and rectifier tube socket are mounted on ¾" metal spacers. The transformer is mounted on ¼" metal spacers so that the leads will not be pinched between the core and the plate. It is only necessary to drill holes in the base plate for the four metal spacers and the 6-32 screws that secure the power transformer. The line cord is held in place with a cable clamp secured under one of the transformer mounting bolts. A switch may be placed in the line cord.

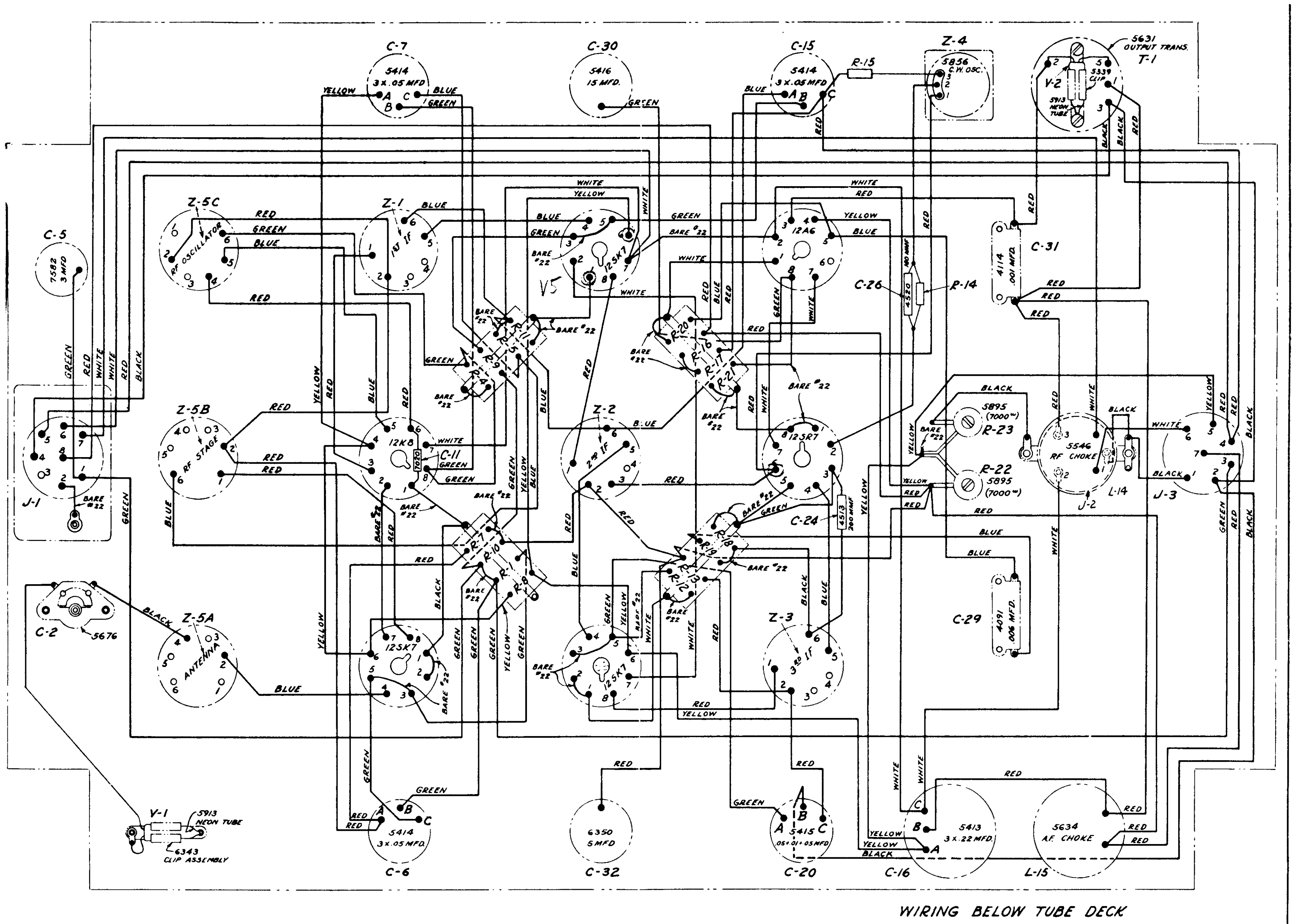


Figure 3-B
WIRING DIAGRAM, "COMMAND" RECEIVER.

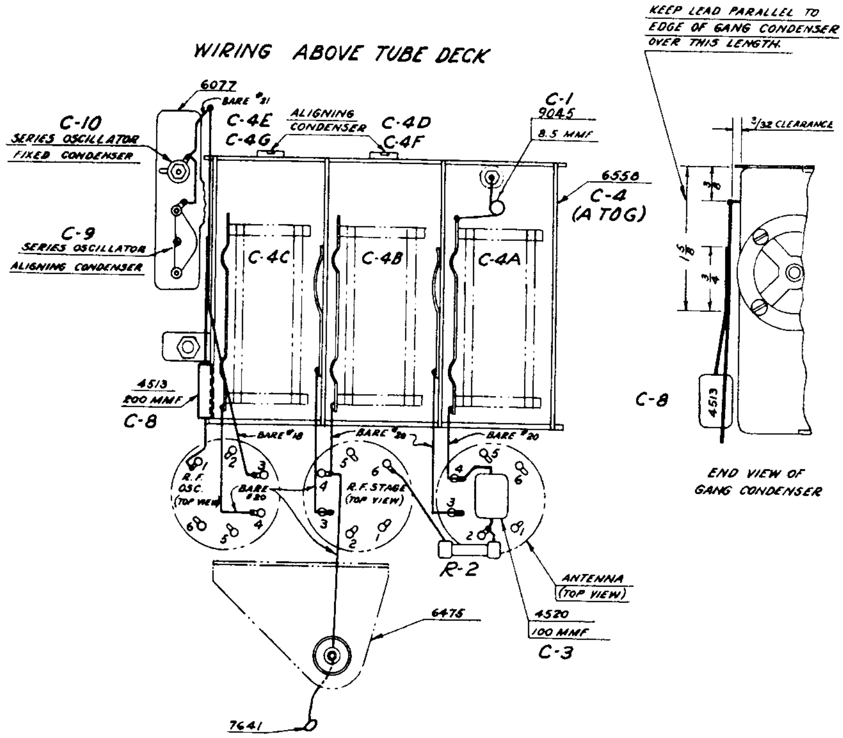


Figure 3-B (continued)

NOTES:
1. ALL WIRES MARKED WITH COLOR NOTE ARE #22 SOLID COPPER; WIRE SPECIFICATION #3425 EXCEPT AS NOTED.
2. BARE WIRES ARE TINNED COPPER WITH SIZES AS SHOWN.
3. SEAL ALL SOLDERED CONNECTIONS WITH RED LACQUER.
4. TERMINAL NUMBERS SHOWN ARE FOR IDENTIFICATION PURPOSES. THEY DO NOT APPEAR ON THE EQUIPMENT EXCEPT ON TUBE SOCKETS AND OUTPUT TRANSFORMER.

The schematic of the supply is shown in figure 7B, and a photo of a typical supply, installed in a receiver is shown in figure 8.

A Twelve Volt Command Dynamotor for Mobile Service

It is often desirable to employ a Command receiver for mobile or Field day operation. When using the a.c. power pack described in the previous section, the receiver may be easily powered with a 12-volt dynamotor. Although 12-volt dynamotors for Command receivers have occasionally appeared on the surplus market, they are not generally available. The DM-34D (part of the BC-603 equipment) is quite common, however, and is the same physical size as a Command set dynamotor, delivering 220 volts at 80 ma., with a primary drain of 12–14 volts at 2.8 amperes. It may be used with the Command receiver with a simple conversion.

Obtain a 28-volt Command receiver dynamotor. Remove the mounting base, complete with sliding latches, socket, and ground lug. Discard the dynamotor. Now, cut the DM-34 mounting brackets to 2-9/16" so that the brackets will just fit inside the upturned flanges of the Command dynamotor base. Drill a small hole in each DM-34 bracket and a corresponding hole in the base so that the dynamotor may be

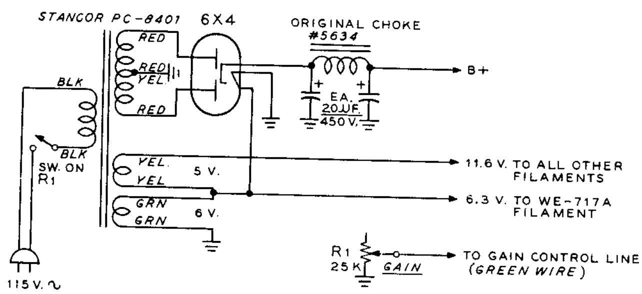


Figure 4

A.C. POWER SUPPLY FOR COMMAND RECEIVER. Power transformer delivers 235-0-235 volts at 40 ma., 5 volts at 2 amperes, and 6.3 volts at 2 amperes. If 6.3 volt winding has two center-tap wires, cut them short and solder them together, then tape.

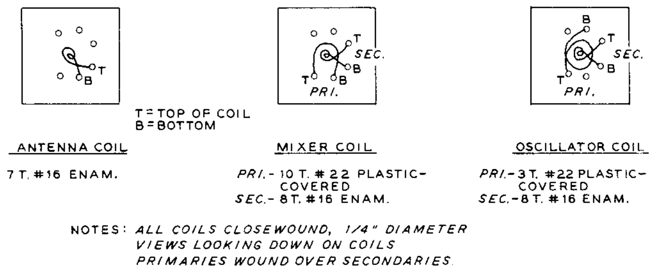


Figure 5
COIL DATA FOR SIX METER CONVERSION OF "COMMAND" RECEIVER.

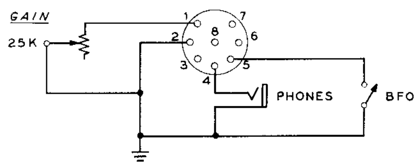
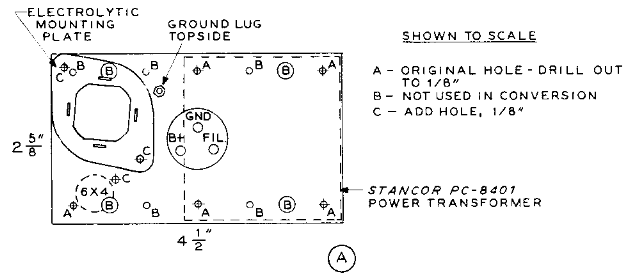


Figure 6
CONTROL PANEL CONNECTIONS FOR "COMMAND" RECEIVER.



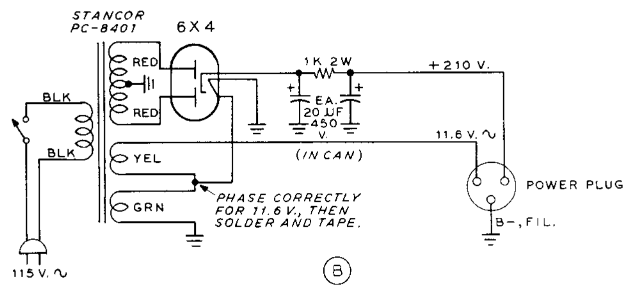


Figure 7
A—Layout, power supply mounting plate for Command receiver.
B—Schematic, power supply. Power transformer is the same as shown in figure 4.

bolted to the base. Connect the *white wire having a black tracer* and also the *white wire having a red tracer* to the ground lug. Connect the *white wire* to the filament lug on the dynamotor base (see figure 7A for base connections). Finally, connect the *white wire with the blue tracer* to the B-plus lug of the base.

The above connections are for automobiles having the positive terminal of the battery grounded. If your car has the negative terminal grounded, reverse the *white wire* with the *white wire having a black tracer.* A reworked dynamotor is shown in figure 8.

Converting a Q-5'er for Broadcast Reception

The Q-5'er (BC-453) covers 190—550 kc. and is generally used as a selective i.f. strip for communication receivers. By modifying the coils it may be made to cover the broadcast band (550—1500 kc.) for general broadcast reception. It also can be used with a converter for mobile work, or it can serve as a Q-5'er for receivers such as the BC-348 which have a 715 kc. intermediate frequency channel.

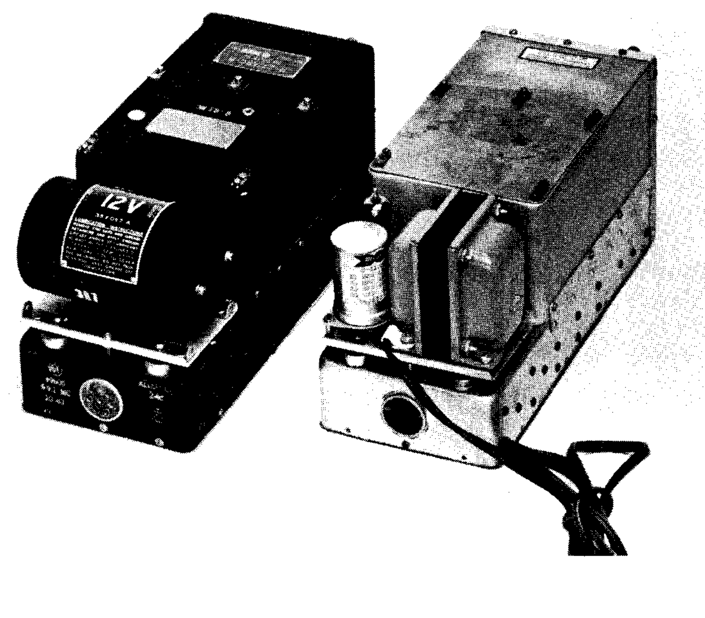


Figure 8
"COMMAND" RECEIVER POWER SUPPLIES. At left is converted DM-34 dynamotor, and at right is the power supply of figure 7.

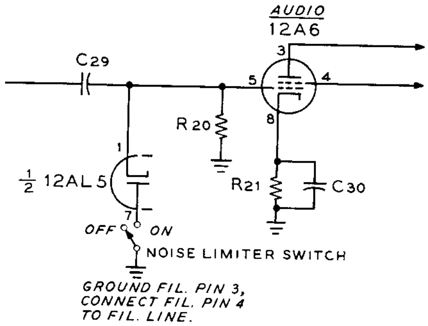


Figure 9
SCHEMATIC, NOISE LIMITER FOR COMMAND RECEIVER.

The coil rack is removed and the following alterations are made to the coils:

1—Remove 210 turns from the antenna coil (L-1).
2—Remove 500 turns from the mixer coil primary (L-2).
3—Remove 220 turns from the mixer coil secondary (grid).
4—Remove 195 turns from the oscillator coil secondary (L-5).

Do not remove any turns from oscillator coil primary (the grid winding). When completed, replace the coil rack. The receiver will now tune the frequency range of 550 kc.—1600 kc. Adjust high frequency alignment with the oscillator shunt padders (C-4E, C-4G) on the variable tuning capacitor. Track the low frequency end of the band with the adjustable powdered iron slug cores in the three coils, plus the oscillator series padder (C-9) on the end of the tuning capacitor.

A Noise Limiter for Your Command Set

Tired of automobile QRM or static on your Command set? A very simple but effective noise limiter can be connected as shown in figures 9 and 10. A 12AL5 tube is used. The cathode of one-half of the diode is connected to the 12A6 control grid. The grid of the 12A6 is slightly negative, so the diode does not conduct; however, when a noise peak arrives (or a strong audio peak) the diode conducts and shorts the grid circuit out to ground. The limiting action is as good as the more complicated shunt-type limiter, but the audio distortion is a little higher. A switch may be incorporated to remove the limiter from the circuit when it is not required.

Automatic Volume Control for Your Command Set

Automatic volume control is extremely effective in preventing distortion or overloading on strong local signals. It is very simple to add a.v.c. to the Command receivers. (Note: A few "ARC" series receivers have a.v.c. incorporated). All the essential a.v.c. components are incorporated in all receivers, but there is

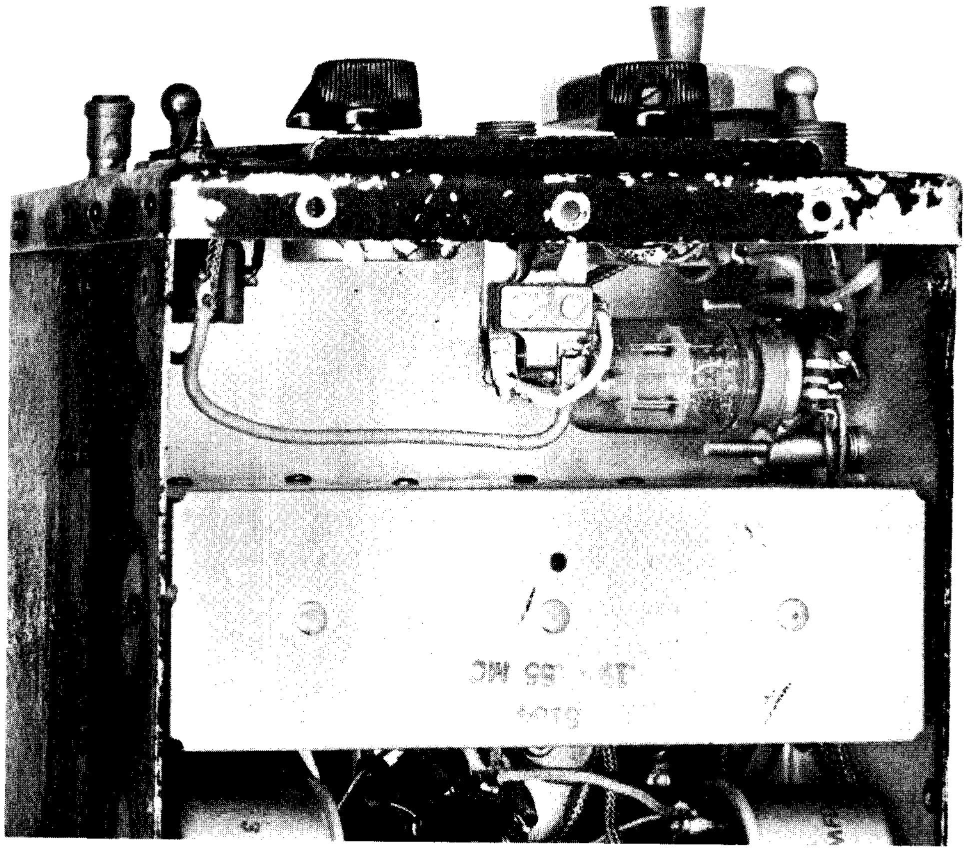


Figure 10
The 12AL5 noise limiter tube may be placed in the under-chassis area behind the panel of the receiver.

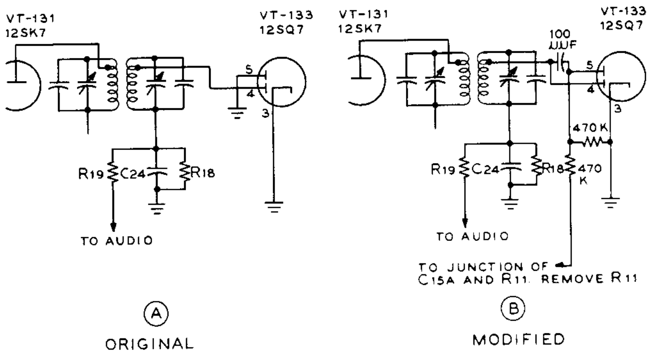


Figure 11
SCHEMATIC, A.V.C. CIRCUIT FOR "COMMAND" RECEIVER.

no connection between them. The purpose of this conversion is to provide a.v.c. action to the r.f. and i.f. amplifier stages by completing the a.v.c. circuit. It requires two additional resistors and a capacitor. Refer to figures 11A and 11B. First, unground pin 5 of the 12SQ7 (VT-133). Connect the 100 $\mu\mu$fd. capacitor across pins 4 and 5 of the tube socket. Connect the 470K resistor from pin 5 to an adjacent ground lug. Connect the second 470K resistor between pin 5 and the junction of C-15A and R-11. Remove R-11 from the circuit to increase the effect of the a.v.c. action.

A Built-in Speaker for Your Command Receiver

A small speaker may be mounted in the removable adapter plate in the front of the Command receiver. The "speaker" is the small receiver element in standard use in telephone handsets. It is only 1½" in diameter, and 11/16" thick. It is available on the surplus market, and identifiable by the letters *HA-1* stamped on the face.

A blank aluminum plate replaces the original adapter plate. A hole is cut in the plate just large enough to clear the HA-1 unit. A second hole is made for the gain control, shown in figure 6.

If the b.f.o. switch is not used, placement of parts on the new plate is not critical. However, if a b.f.o. switch is desired it will be a tight squeeze to get the three components together on the new adapter plate.

A single layer of "Scotch" electrical tape is wrapped around the shell of the speaker to isolate it from

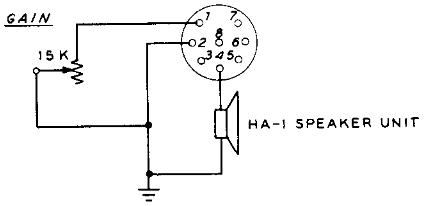


Figure 12
SCHEMATIC, HA-1 SPEAKER FOR USE IN "COMMAND" RECEIVER.

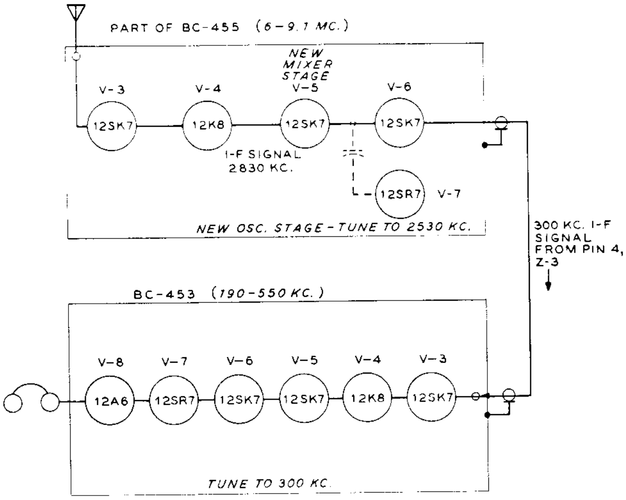


Figure 13
BLOCK DIAGRAM OF DOUBLE-CONVERSION AMATEUR BAND RECEIVER MADE FROM TWO "COMMAND" RECEIVERS. BC-455 serves as r.f. portion, and BC-453 serves as "i.f. strip."

the chassis, and after placing the speaker in the hole in the plate a second piece of tape is wrapped around the body of the speaker to hold the unit from slipping out of the hole.

Wire the positive side of the speaker directly to pin #4 of J-1 (the front plug in the back of the adapter plate). Mount the gain control. Wire the "hot" arm of the control to pin #2 of J-1, and the other side of the control to pin #1 of J-1. Finally, connect the other side of the speaker to ground. Screw the adapter plate to the front of the receiver, and you have a sensitive, clean-sounding speaker, audible many feet from the receiver. The complete wiring changes are shown in figure 12.

A "Double Conversion" Command Receiver for Single Sideband Reception

It is possible to combine two Command receivers to form a double conversion receiver, well suited for single sideband reception or selective c.w. reception. The BC-453 (190–550 kc.) and BC-455 (6–9.1 Mc.) receivers are used. A block diagram of the combination is shown in figure 13. The BC-455 tunes the 7 Mc. amateur band (or it may be modified for other bands as described later) and the intermediate frequency signal of this receiver (2830 kc.) is converted to 300 kc., within the tuning range of the BC453. The combination provides excellent sensitivity, selectivity, and freedom from bothersome "image" signals.

Only a portion of the BC-455 is used. The r.f. amplifier, mixer, and first i.f. stage function in the usual manner, and are unmodified. The second i.f. stage (12SK7) V-5 is changed into a mixer, and the b.f.o. section of the 12SR7 (V-7) is converted to a mixing oscillator. The 12A6 audio tube is removed.

The first step is to lower the frequency of the 12SR7 beat oscillator until it operates 300 kilocycles *below* the intermediate frequency of 2830 kc. The new frequency of oscillation is therefore 2530 kc. To effect this change, solder a 100 $\mu\mu$fd. mica capacitor between the plate (pin #5) and ground (pin #1) of the 12SR7 socket. The desired frequency of 2830 kc. may now be tuned by adjusting the b.f.o. trimming capacitor C-28 on the side of the receiver. Check the frequency by listening to it on a nearby receiver or frequency meter. The old b.f.o. has now been transformed into a suitable mixing oscillator.

The next step is to couple the new i.f. output frequency of 300 kc. (2830 kc. minus 2530 kc.) into the BC-453 which serves as the low frequency i.f. amplifier. Remove the third i.f. transformer from the BC-455 (transformer Z-3). Solder a 30K, 1-watt resistor between pin #1 and pin #2 of the i.f. socket. Solder a 100 $\mu\mu$fd. capacitor between pin #1 and pin #4, which is used as a tie-point terminal. Finally, cut a short length of shielded wire, long enough to reach from pin #4 to the antenna terminal of the BC-453. Solder the center conductor to pin #4 of i.f. transformer socket Z-3 and solder the shield to a nearby ground lug (pin #5 of 12SR7 socket). Connect the inner conductor to the antenna terminal of the BC-453, and ground the shield to the chassis of the second receiver.

Tune the BC-453 to 300 kc., and tune the BC-455 to 7 Mc. You can now tune in 40-meter signals by tuning either receiver. In general, tune the BC-455 to the edge of the amateur band, and then cover the band on the BC-453. The i.f. bandwidth of the high frequency receiver is broad enough to allow you to tune the BC-453 for 100 kilocycles or so without a drop in received signal strength. Use the b.f.o. in the BC-453 for s.s.b. or c.w. reception.

As an example, suppose you want to tune in a signal at 7150 kc. Set the BC-453 to 300 kc. and then tune the BC-455 to 7100 kc. Next, tune up 50 kc. on the BC-453, and you are "on the nose" at 7150 kc. In this way, you can read your frequency of reception to one or two kilocycles. Always remember to set the BC-453 tuning dial to 300 kc. for general tuning with the BC-455.

Converting the BC-455 for 20, 15, and 10 Meters

Conversion for Citizens Radio Service

It is possible to buy extra r.f. coil racks on the surplus market for the Command sets. To change bands, it is only necessary to rewind these racks, and then to use them as plug-in coils in your BC-455.

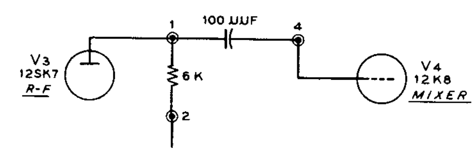
To rework a rack, the data of figure 14 may be used. You will need to borrow another receiver or frequency meter in order to listen to the mixer oscillator of the BC-455 during the tracking process. Remove the coils and rewind them to the specifications given in figure 14. You can check the approximate resonant frequencies by placing the coils in the receiver (without the shields) and noting the resonant frequency on a grid-dip oscillator. Be sure to remove the iron core from the mixer and oscillator coils. When you have modified the coils, solder all connections, place them in the rack, and replace the rack in the receiver. Turn on the Command set, and then look for the signal of the high frequency oscillator in a nearby receiver. Adjust the trimming capacitors on the oscillator section of the tuning capacitor (C-4E, C-4G, and C-9) until the oscillator tuning covers the desired range. Finally, trimmers C-2, C-4D, and C-4F are adjusted for maximum strength of received signals. The last step is to cover the tuning dial with white enamel and recalibrate the high frequency bands with India ink directly on the dial face. Only one or two markings are required for each band, as the main tuning is done with the BC-453 dial. The 28 Mc. coil data, also applies to the 27 Mc. Citizens Radio Service.

"Hop-Up" Your Command Receiver for Improved High Frequency Reception

It is possible to boost the gain of the Command set and to materially improve reception on the 10, 15, and 20 meter ranges. To do this, the 12SK7 i.f. amplifier tubes are replaced with 12SG7 tubes, and the 12SK7 r.f. amplifier tube is replaced with a 12SG7. It is also necessary to lower the cathode bias resistor R-1 on the r.f. tube. Shunt R-1 with a 620 ohm, ½-watt resistor. In addition, bypass socket pin #5 to ground with a 0.01 μfd. disc ceramic capacitor. To boost the gain of the i.f. amplifier, shunt the screen resistor (R-22) with a 10K, 10 watt resistor.

BAND	ANTENNA COIL (L_1)		MIXER COIL (L_5)		OSCILLATOR COIL (L_{13})	
	N° OF TURNS	LENGTH	N° OF TURNS	LENGTH	N° OF TURNS	LENGTH
14 MC.	11	3/8"	11	3/8"	7 1/2	1/4"
21 MC.	5 1/2	1/4"	5	1/4"	6	1/4"
27 MC. 28 MC.	3	1/8"	5	1/8"	2 1/2	1/8"
WIND ALL COILS WITH N° 18 ENAM. WIRE.						

NOTE: *REMOVE WINDING L_2 FROM ALL MIXER COILS. (PLATE WINDING OF 12SK7 R-F STAGE).*
PLACE 100 UUF CAPACITOR BETWEEN PIN #1 AND PIN #4 OF MIXER COIL SOCKET Z-5B.
PLACE 6K, 1-WATT RESISTOR BETWEEN PIN #1 AND PIN #2 OF THE SAME SOCKET.



(SEE FIGURE 38)

Figure 14
COIL DATA FOR CONVERTING BC-455 TO 14, 21, OR 28 Mc.

If the gain of the receiver is too high, instability may result. It can be eliminated by experimenting with the value of these two shunting resistors. Try 1000 ohms across R-1 and 15K across R-22 if the receiver shows signs of feedback or oscillation. See figure 3 for receiver schematic and parts placement.

Conversion of the BC-603 to a 10-11-15 Meter AM/FM Receiver

(Ideal for the Citizen's Band!)

The BC-603 f.m. receiver is a component part of Radio Sets SCR-508, 528, and 538. It provides f.m. reception over the range of 20—27 Mc., has a sensitivity of one microvolt, and 80 kc. bandwidth. An intermediate frequency of 2.65 Mc. is employed, and a self-contained audio amplifier provides 2 watts of power for a speaker, or 0.2 watts for headsets. On 12 volts the battery drain is 4 amperes. Properly converted, this inexpensive surplus item makes a good high frequency a.m./f.m. receiver. The original BC-603 schematic is shown in figure 16.

Adding An A.C. Operated Power Supply

The purchaser of the BC-603 should try to obtain both the 12-volt dynamotor (DM-34) and the 24-volt dynamotor (DM-36). The 28-volt unit is of little value, but the base makes an excellent foundation for the a.c. power supply. Remove all components from

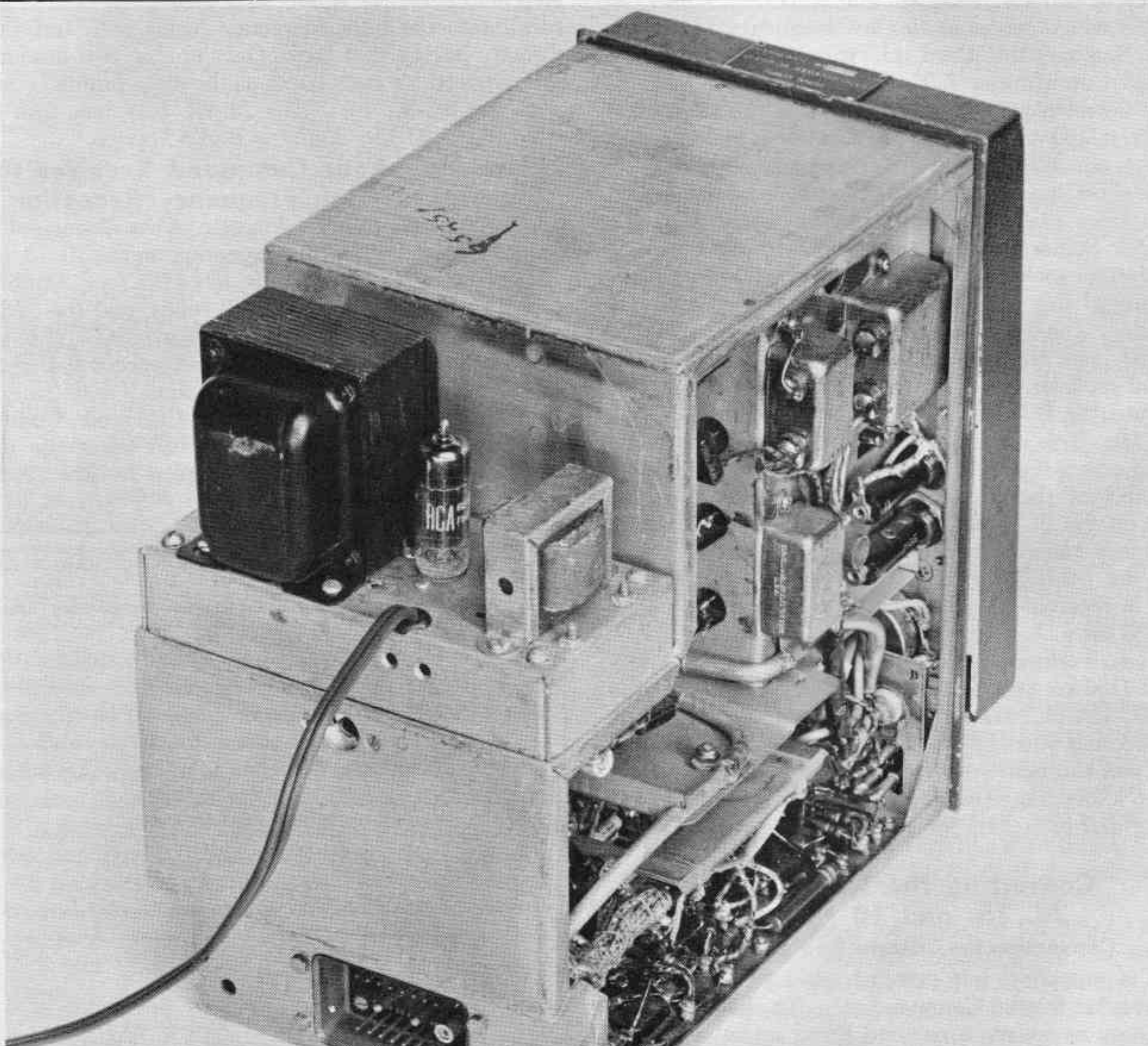


Figure 15

BC-603 F.M. RECEIVER MAKES HANDY 10-11-15 METER A.M./F.M. RECEIVER. A.c. power supply is shown mounted in dynamotor well of receiver.

this base and discard them all, except the 18-pin "Jones" connector. Clean all lugs on this connector and open the eyelets. Jumper pins #3, 6, 9, 12, 15, and 18, as shown in figure 17. Also jumper pins 16 and 17. Finally, jumper pins #1 and 2, and attach a three-inch length of hook-up wire to pin #1. This lead is grounded. Mount the new power transformer at the end of the chassis opposite the connector as shown in figure 15. Mount the 6X4 tube socket near the power connector and place the filter choke above the connector. Wire as shown in figure 17. Be sure the filament windings of the power transformer are phased properly to provide about 11.8 volts. Place the power supply atop the receiver, and you are ready for a.c. operation of the BC-603.

Converting the BC-603 to A.M. Reception

The BC-603 was designed for f.m. reception only. However, some farsighted designer included an audio choke in the cathode circuit of the 6AC7 limiter (V-6). It was probably incorporated to facilitate sweep-alignment of the r.f. and i.f. circuits. In any event, this choke (L-1) permits the limiter also to act as an infinite impedance detector for a.m. signals, and an audio signal appears across this choke when an a.m. signal is tuned in on the receiver. The problem, then, is to switch the audio circuit of the BC-603 between the f.m. detector and this choke. This conversion uses the "intercom" switch (D-2) as an a.m./f.m. switch.

Remove the front panel of the receiver by taking out the four screws at each corner of the cast iron panel guard. The front panel controls will separate from the chassis, being interconnected by J-3 and PG-3. Locate the "intercom" switch (stamped D-2 on the back) and remove the wire between D-2 and J-2. Also remove the wire running from D-2 to the resistors R-22, R-32, and R-33. (Some of these resistors are omitted from certain receivers. They are used as volume correctors). Now, locate the blue-green wire that runs from the audio output transformer T-1 to resistors R-22, R-32, and R-33. Unsolder this wire from the resistors and connect it to the "hot" lug of phone jack J-1. Remove the three resistors.

Next, remove switch D-2 and replace it with a s.p.d.t. toggle switch. Connect three pieces of short shielded wire to the three switch terminals. Mount the switch and ground the shield braids to the panel. On the main chassis, locate C-11, the audio coupling capacitor connected to pin #1 of the audio amplifier tube V-10. One terminal of C-11 is connected to pin #1 of socket V-10, the audio amplifier tube. Leave this terminal of C-11 alone. Unsolder the other terminal of C-11. Connect the shield wire from the switch arm to this terminal of C-11, as shown in figure 18. Connect one of the other shielded wires from the switch arm to the terminal just vacated by capacitor C-11. Connect the remaining shielded lead to pin #5 of socket V-6 (6AC7 limiter). Replace the panel.

10—15 Meter Coverage and Citizens Radio Service (27 Mc.) with the BC-603

It is possible to retune the BC-603 to cover the 10 meter band, as well as 11 meters (the Citizens Radio Service) and 15 meters. This is accomplished by adjusting the capacitors on the left side of the chassis and the tuning slugs on the right side. Presetting the adjustments is an easy way of tuning the receiver to the proper ranges.

Looking at the left side of the set (with the front of the panel toward you) set the red dot on capacitor C-1.7 toward the front panel (6 o'clock). Set the red dot on capacitor C-1.5 to 9 o'clock. Set the red dot on capacitor C-1.3 to 10 o'clock. Finally, set the antenna trimming capacitor C-1.1 to 4 o'clock.

Next open the covers exposing coils LCU-1, LCU-2, and LCU-3. Screw all slugs out counter-clockwise. Screw in the upper slug of LCU-2 three turns, and the lower slug eight turns. Screw in the slug of LCU-1 eleven turns. It should now be possible to receive the full 10-meter band and 27 Mc. Citizens Radio Service at the high end of the tuning dial, and the full 15-meter band at the low end of the dial. Peak up the slugs (except LCU-3) for maximum gain at the low end of the dial. Peak up the capacitors (except C-1.7) for maximum gain at the high end of the dial. Repeat this process a few times until the receiver tracks across the entire range. Finally, adjust oscillator slug LCU-3 and oscillator padding capacitor C-1.7 for full coverage of the amateur bands at each end of the dial. This completes the conversion.

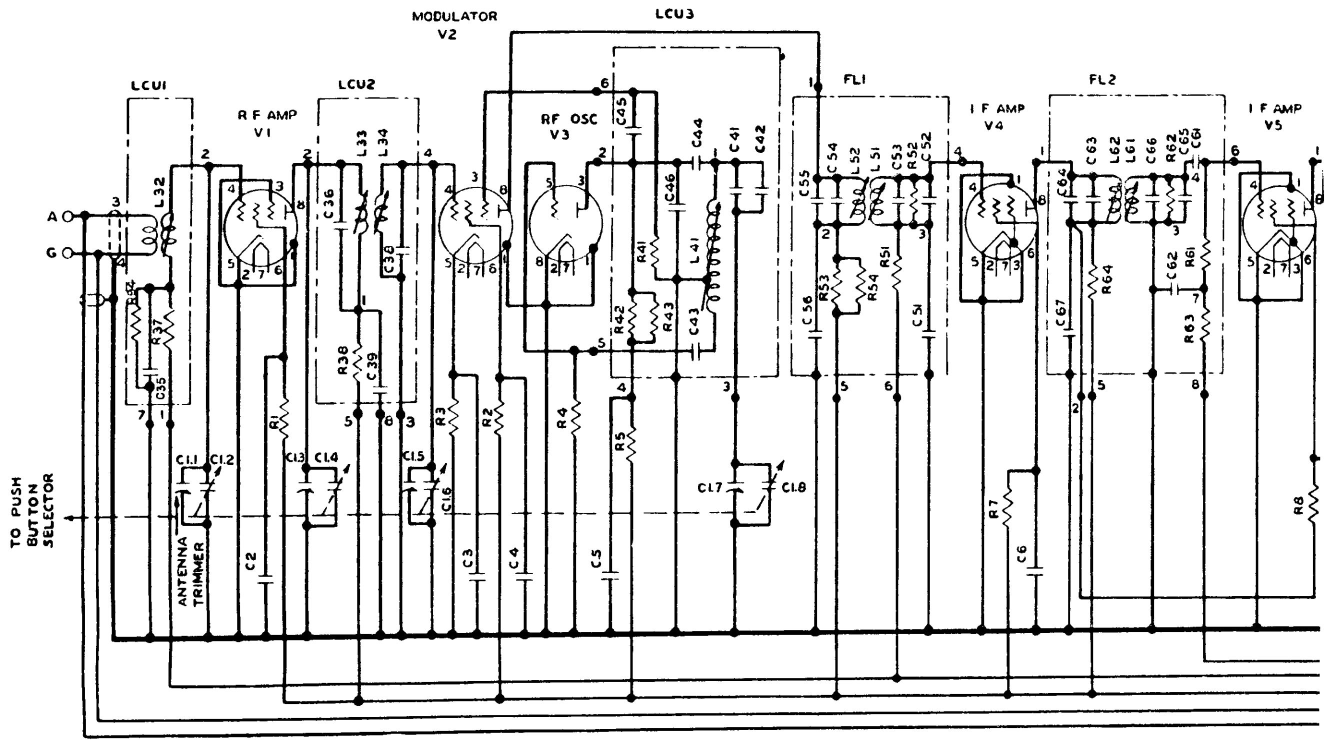
Using the AN/APN-1 Transmitter Section for 420 Mc.

The APN-1 radio altimeter is widely available in surplus stores. Usually the frequency modulator (Y-101) is removed for use in television sweep generators. The rest of the unit can often be bought for a very few dollars. The transmitter section is usable on the 420 Mc. amateur band for short-range work. The actual operating range depends upon the gain of the antenna system, rather than the power of the transmitter, however!

Remove the transmitter from the APN-1 (figure 19). The transmitter will be converted for six-volt filament operation, and a power supply and modulator will be constructed. Remove the modulator (Y-101) from the transmitter if it is still in place.

The first step is to locate the filament wire running between L-105 and L-106. Clip this wire near the end of L-105. Ground the end of the wire emerging from L-105 to the chassis of the transmitter. Connect the free end of the wire emerging from the end of L-106 to the center terminal of the filament feed-through capacitor C-111. The filaments are now wired in parallel for six-volt operation. Next, remove link coil L-107 and the associated coaxial line.

The circuit of the power supply-modulator unit is shown in figure 20. It can be built upon one end of



APPARATUS LEGEND

CAPACITORS

C1.1	16 UUF MAX.
C1.3	16 UUF MAX.
C1.5	16 UUF MAX.
C1.7	16 UUF MAX
C1.2	62 UUF MAX
C1.4	62 UUF MAX.
C1.6	62 UUF MAX.
C1.8	62 UUF MAX.
C2	0.006 UF 300V
C3	0.006 UF 300V
C4	0.006 UF 300V
C5	0.006 UF 300 V
C6	0.006 UF 300 V
C7	0.006 UF 300V
C8	500 UUF 500V
C9	0.006 UF 300V
C10	0.75 UUF 500V
C11	0.006 UF 300 V
C12	0.01 UF 300V
C13	500 UUF 500V
C14	0.006 UF 300V
C15	0.5 UF 600 V
C16	2 UF 600 V
C17	0.01 UF 300V
C18	0.01 UF 300V
C19	0.002 UF 500V
C20.1	0.1 UF 600V
C20.2	0.1 UF 600V
C20.3	0.1 UF 600 V
C21	0.01 UF 300V
C22	0.005 UF 300V
C23	40 UF 25 V
C24	1 UF 600 V
C25	2 UF 600 V
C26	0.0005 UF 500 V
C35	0.006 UF 300 V
C36	10 UUF 500V
C38	10 UUF 500V
C39	0.006 UF 300V
C41	700 UUF 500V
C42	200 UUF 500V
C43	100 UUF 500V
C44	30 UUF 500V
C45	100 UUF 500V
C46	20 UUF 500V
C51	0.006 UF 300V
C52	10 UUF } OR 60 UUF 500 V
C53	50 UUF } SEE NOTE 2
C54	50 UUF } OR 60 UUF 500V
C55	10 UUF } SEE NOTE 2
C56	0.006 UF 300V
C61	100 UUF 500V
C62	.001 UF 500V
C63	50 UUF } OR 60 UUF 500V
C64	10 UUF } SEE NOTE 2
C65	10 UUF } OR 60 UUF 500V
C66	50 UUF } SEE NOTE 2
C67	0.006 UF 300V
C71	50 UUF 500V
C72	.001 UF 500V
C73	50 UUF } OR 60 UUF 500V
C74	10 UUF } SEE NOTE 2
C75	10 UUF } OR 60 UUF 500V
C76	50 UUF } SEE NOTE 2
C77	0.006 UF 300V
C81	250 UUF 500V
C82	0.006 UF 300V
C83	0.006 UF 300V
C84	5 UUF 500V
C85	50 UUF OR 60 UUF 500V } SEE NOTE 1
C86	50 UUF OR 60 UUF 500V }
C87	25 UUF } OR 35 UUF 500V
C88	10 UUF } SEE NOTE 2
C91	50 UUF 500V
C92	50 UUF 500V
C93	100 UUF 500V
C94	50 UUF 500V

SWITCHES

D1	REC ON-OFF
D2	RADIO-INT
D3	ON-OFF SPEAKER
D4	ON-OFF SQUELCH
D5	TUNE-OPERATE
E1	CALL SIGNAL
F1	FUSE 15 AMP

JACKS

J1	PHONES
J2	PHONES
J3	FRONT PANEL JACK

COILS

L1	LIMITER CATHODE CHOKE
L32	ANTENNA COUPLING
L33	R F PLATE
L34	MOD GRID
L41	R F OSCILLATOR
L51	1ST IF GRID
L52	MODULATOR PLATE
L61	2ND IF GRID
L62	1 ST IF PLATE
L71	LIMITER GRID
L72	2ND IF PLATE
L81	DETECTOR INPUT
L82	LIMITER PLATE
L91	IF OSCILLATOR
LS1	LOUD SPEAKER

POTENTIOMETERS

P1	100,000 Ω
P2	200 Ω

PLUGS

PG1	RECEIVER PLUG
PG2	DYNAMOTOR PLUG
PG3	FRONT PANEL PLUG

RESISTORS

R1	30,000 Ω 1W
R2	250,000 Ω 1/2 W
R3	500 Ω 1/2 W
R4	50,000 Ω 1/2 W
R5	300 Ω 1/2 W
R6	100,000 Ω 1/2 W
R7	30,000 Ω 1W
R8	70,000 Ω 1/2 W
R9	1,000 Ω 1/2 W
R10	250,000 Ω 1/2 W
R11	1,000,000 Ω 1/2 W
R12	2,000 Ω 1/2 W
R13	10,000 Ω 1/2 W
R14	250,000 Ω 1/2 W
R15	1,000,000 Ω 1/2 W
R16	1,000,000 Ω 1/2 W
R17	250,000 Ω 1/2 W
R18	100,000 Ω 1/2 W
R19	2,000,000 Ω 1/2 W
R20	300 Ω 1W
R21	30,000 Ω 2W
R22	30,000 Ω 1/2 W
R23	5,000 Ω 1/2 W
R24	50 Ω 1/2 W
R25	2,500 Ω 1/2 W
R26	1,200 Ω 1/2 W
R27	2,500 Ω 1/2 W
R28	2,500 Ω 1/2 W
R29	13,000 Ω 2 W
R30	5 Ω 4 W
R31	6,800 Ω 1W
R32	30,000 Ω 1/2 W
R33	30,000 Ω 1/2 W
R37	250,000 Ω 1/2 W
R38	1,000 Ω 1/2 W
R41	100,000 Ω 1/2 W
R42	30,000 Ω 1W
R43	30,000 Ω 1W
R51	250,000 Ω 1/2 W
R52	30,000 Ω 1/2 W
R53	100,000 Ω 1/2 W
R54	100,000 Ω 1/2 W
R61	100,000 Ω 1/2 W
R62	43,000 Ω 1/2 W
R63	10,000 Ω 1/2 W
R64	1,000 Ω 1/2 W
R71	250,000 Ω 1/2 W
R72	30,000 Ω 1/2 W
R73	10,000 Ω 1/2 W
R74	1,000 Ω 1/2 W
R81	70,000 Ω 1/2 W
R82	250,000 Ω 1/2 W
R83	70,000 Ω 1/2 W
R84	250,000 Ω 1/2 W
R85	1,000 Ω 1/2 W
R91	100,000 Ω 1/2 W
R92	40,000 Ω 1/2 W
R93	40,000 Ω 1/2 W
R94	2,000,000 Ω 1/2 W
R95	15,000 Ω 1/2 W
R96	30,000 Ω 1/2 W

T1	OUTPUT TRANSFORMER

VACUUM TUBES

V1	VT-112 (6AC7)
V2	VT-112 (6AC7)
V3	VT-94 (6J5)
V4	VT-209 (12SG7)
V5	VT-209 (12SG7)
V6	VT-112 (6AC7)
V7	VT-90 (6H6)
V8	VT-107-A (6V6GT)
V9	VT-229 (6SL7GT)
V10	VT-229 (6SL7GT)

DYNAMOTORS

DM-34-D 12 VOLT

CAPACITORS

C701	0.003 UF 1000 V
C702	0.003 UF 1000 V
C703	0.003 UF 500 V
C704	0.003 UF 500 V
C705	0.003 UF 1000 V
C706	0.003 UF 1000 V

COILS

L701	HV FILTER
L702	LV FILTER
L703	HV FILTER
L704	HV FILTER
J701	DYNAMOTOR JACK
MG701	12V DYNAMOTOR

DM-36-D 24 VOLT

CAPACITORS

C801	0.003 UF 1000 V
C802	0.003 UF 1000 V
C803	0.003 UF 500 V
C804	0.003 UF 500 V
C805	0.003 UF 1000 V
C806	0.003 UF 1000 V

COILS

L801	HV FILTER
L802	LV FILTER
L803	HV FILTER
L804	HV FILTER
J801	DYNAMOTOR JACK
MG801	24V DYNAMOTOR

Figure 16

SCHEMATIC, BC-603 RECEIVER.

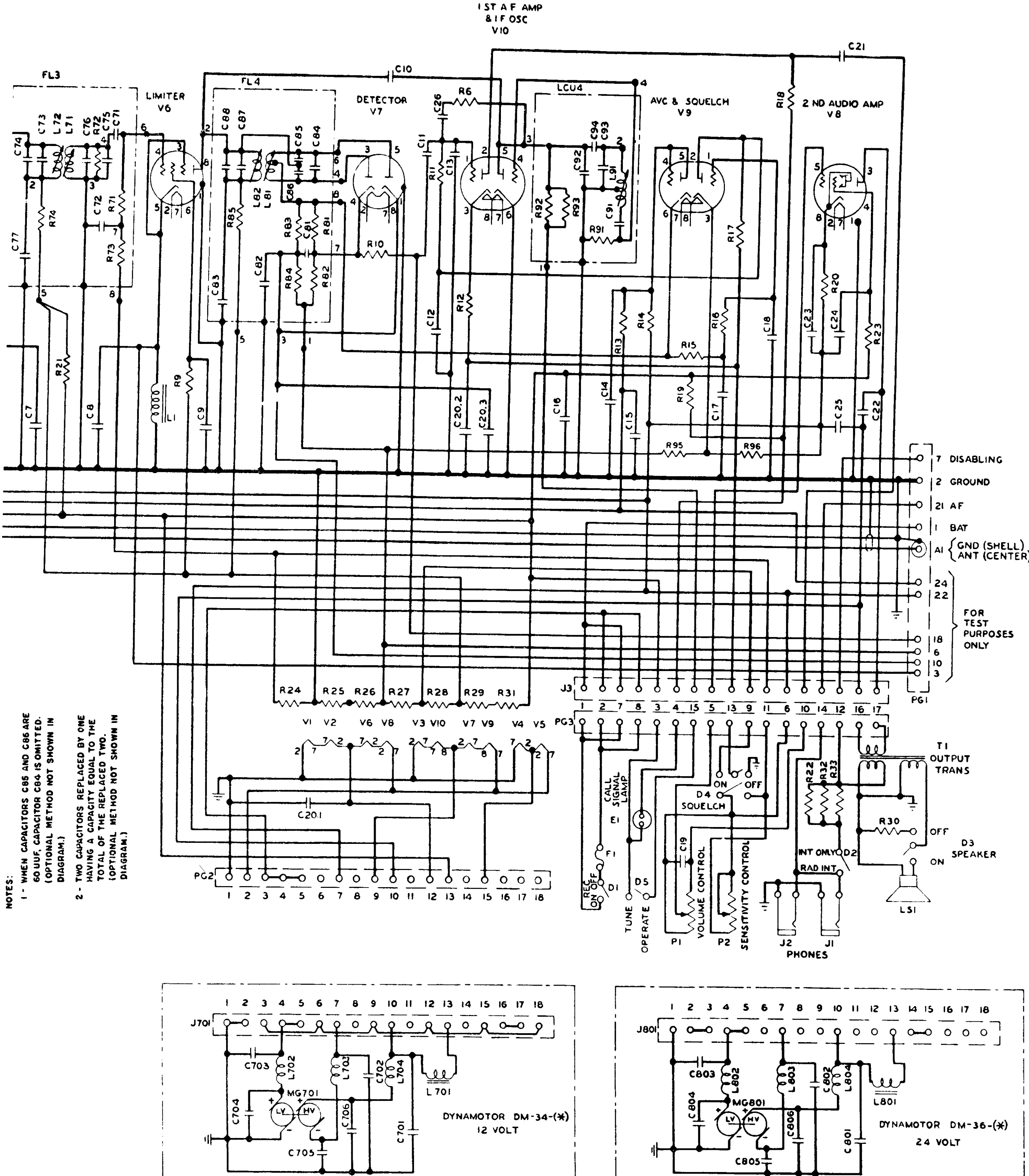


Figure 16
SCHEMATIC, BC-603 RECEIVER

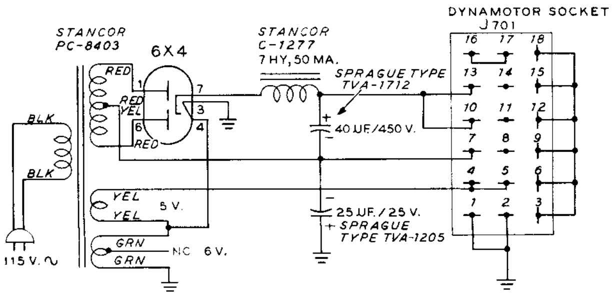


Figure 17
SCHEMATIC, A.C. POWER SUPPLY FOR BC-603. Power transformer delivers 250-0-250 volts at 70 ma., 5 volts at 2 amperes, and 6.3 volts at 2.5 amperes.

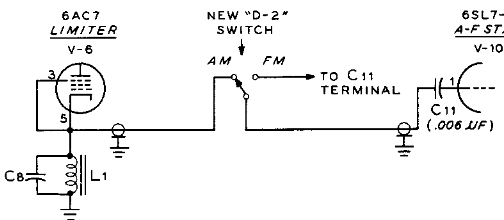


Figure 18
MODIFICATION OF BC-603 FOR A.M./F.M. RECEPTION.

a 8"x10"x2" aluminum chassis. The APN-1 oscillator unit is bolted to the opposite end of the chassis.

Adjustment of the sliding bar on L-108 will tune the oscillator between 425 Mc. and 440 Mc. The spacing between L-111 and L-110 will determine the antenna loading. A 6.3 volt, 150 ma. pilot lamp (brown bead) mounted in a coaxial plug will serve as a dummy antenna for tuning adjustments. A suitable antenna for the 420 Mc. band is shown in figure 21.

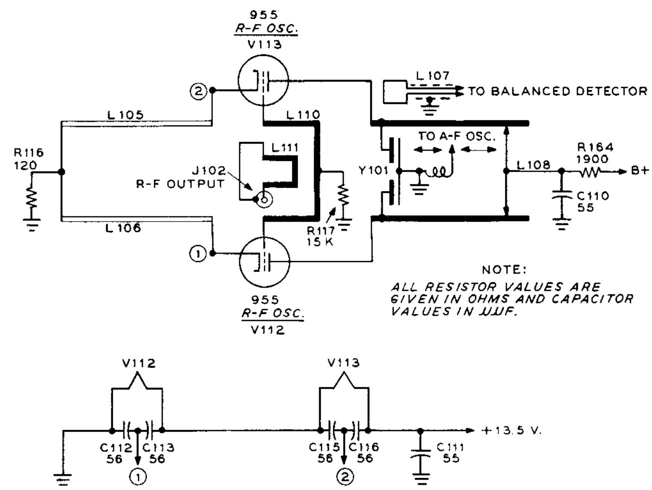


Figure 19
SCHEMATIC, APN-1 OSCILLATOR.

Converting the AN/CRC-7 to 144 Mc.

The AN/CRC-7 is a battery operated transmitter-receiver used for Air-Sea rescue work. It is capable of operation in the 144 Mc. amateur band, and purchase of components other than a set of batteries is unnecessary. The complete unit is shown in figure 22, and an "exploded" view is shown in figure 23. The circuit is given in figure 24.

The CRC-7 uses 1.4 volt d.c. tubes—three 3A5's and one 3Q4. One half of a 3A5 is used as a super-regenerative detector having a tuning range of 135—150 Mc. The second half of this tube is used as an

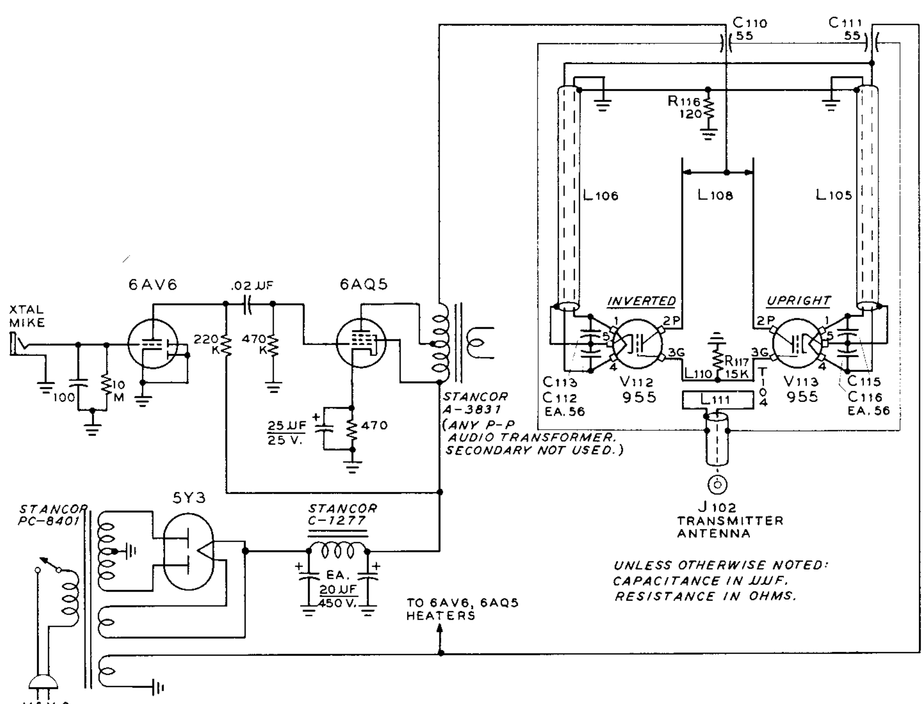


Figure 20
SCHEMATIC POWER SUPPLY-MODULATOR CIRCUIT AND REVISED APN-1 OSCILLATOR
Power transformer delivers 235-0-235 volts at 40 ma., 5 volts at 2 amperes, and 6.3 volts at 2 amperes.

audio amplifier for reception and transmission. The 3Q4 is employed as an audio power amplifier for reception and as a modulator for transmission.

One 3A5 section is used as a crystal oscillator on 17.573 Mc., with the second section acting as a frequency doubler to 35.146 Mc. A second 3A5 is used as a dual doubler, the first section doubling to 70.292 Mc., and the second section doubling to 140.58 Mc. Transmitter output is on this frequency.

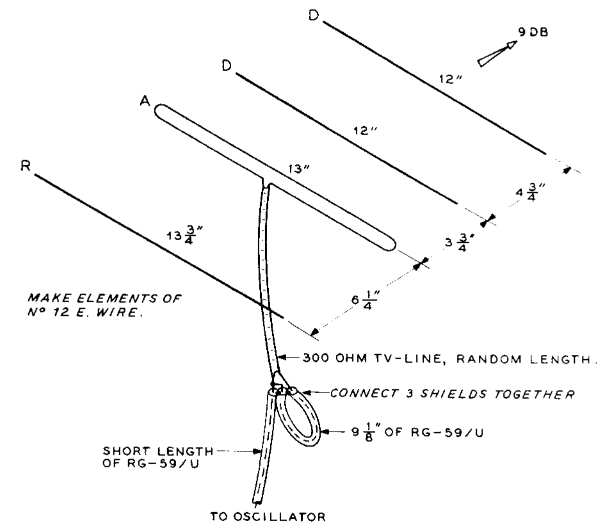


Figure 21
FOUR-ELEMENT BEAM ANTENNA
FOR 420 MC.

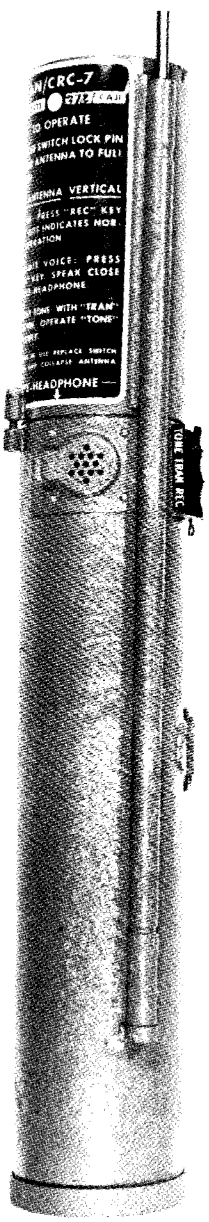


Figure 22

The AN CRC-7 is a battery-operated receiver easily converted for 2-meter amateur operation.

Opening the Case A good, sharp hack-saw is an asset in opening the CRC-7 case. The unit is completely heremetically sealed against moisture. Since the batteries are not available, the first step is to cut off the battery compartment. Measure along the side of the unit to the end of the brass butt plate. This will be 8$\frac{7}{8}$". Measure your unit to cut just below this brass plate. Do not cut too far into the interior of the battery compartment or you will saw off the battery pins. Remove and discard the shell. Incidentally, the antenna should be fully extended to avoid sawing it off during the cutting operation.

Next, remove the two screws that *appear* to hold the two halves of the unit together. Mark a line ½-inch

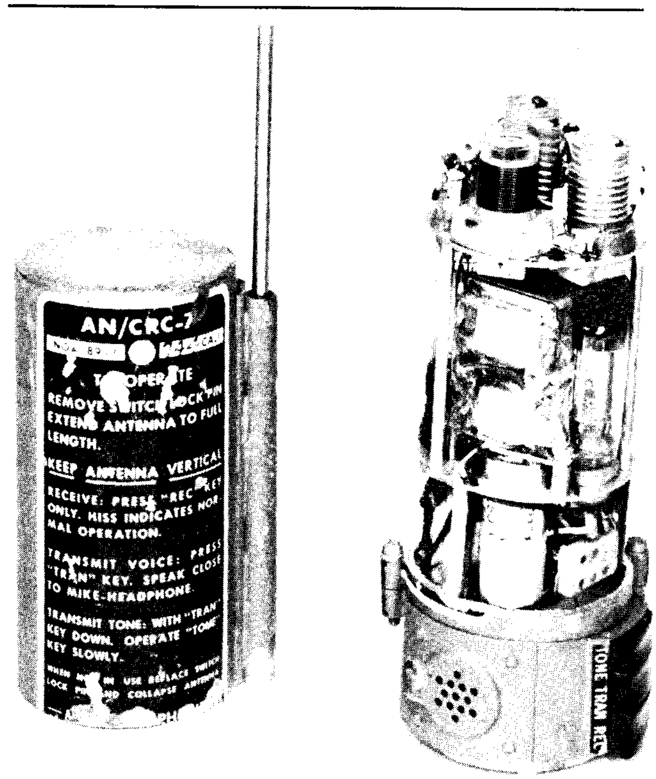


Figure 23
"EXPLODED" VIEW OF AN CRC-7
The battery box is cut off, and the top section is cut open as shown. Cut top section ½-inch above push buttons, being careful not to cut too deeply into the case.

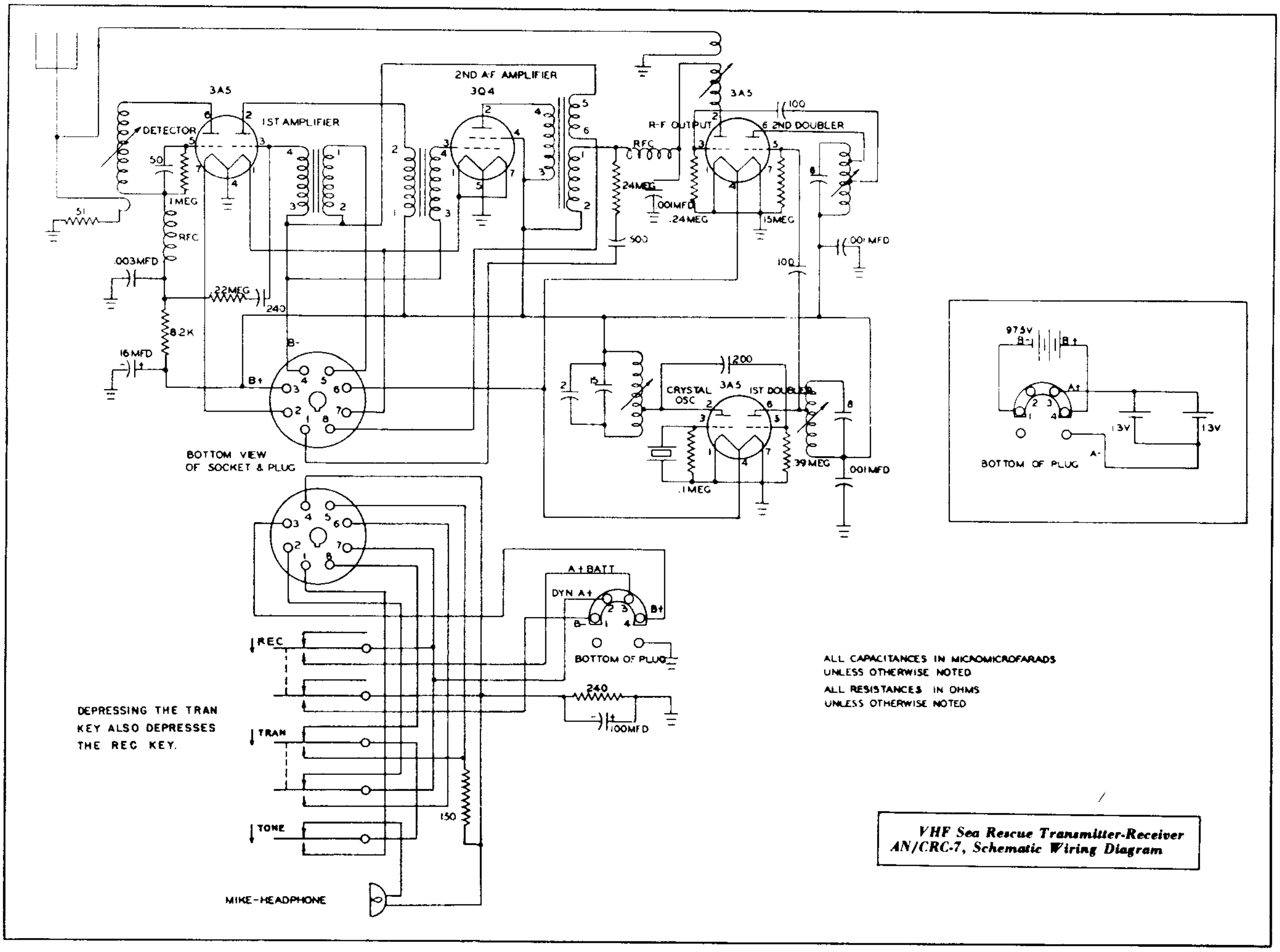


Figure 24
SCHEMATIC, AN/CRC-7 V.H.F. TRANSMITTER-RECEIVER

above the push buttons, and scribe this line all the way around the cannister. Saw along this line, being careful not to cut into the interior of the case, particularly near the screw mounts. Just beneath this area are the audio transformer and r.f. choke, so take care!

Now, you can slide off the cannister. It may take a little jiggling, but use only moderate pressure. Remove the insulating tape to reveal the components of the set. To make sure that no damage has been done during the sawing process, connect a set of batteries as shown in figure 24. Press the "receive" button and you should immediately hear a hissing noise in the earphone unit.

144 Mc. Operation of the Transmitter The transmitter should be adjusted for 144 Mc. operation. All of the coil slugs are silver-plated and raise the resonant frequency of the tuned circuits as they are screwed clockwise into the coil. Since it is necessary to raise the frequency of the transmitter for 144 Mc. operation, it will be necessary to turn all slugs clockwise. This is fortunate, as the slugs are usually sealed with "glyptal" cement, and turning the slugs counter-clockwise will usually "freeze" them in the cement.

The first step is to remove the transmitter crystal, which is held underneath the 17 Mc. coil form (the one having the most turns). Unscrew the coil bolts from the under-side of the chassis and remove the coil and the crystal. Handle the crystal with care. It is possible to mount a crystal holder on the outside of the case, grounding one lug of the holder to the case, and connecting a small piece of spring brass to pin #3 of the 3A5 oscillator tube socket. Then, when the case is slipped on, the spring brass will contact the ungrounded pin of the crystal socket. A second brass spring is soldered to the chassis deck to make ground connection to the case for the return lead. Crystals in the 18 Mc. range are used for 2-meter work.

A less expensive conversion is to make use of the crystal used in the original equipment. Take a piece of flat glass and put a few drops of water and a little tooth powder on it. Place the crystal blank on the glass and press it lightly but evenly, taking ten or 15 circular "swipes" across the glass plate. Clean the

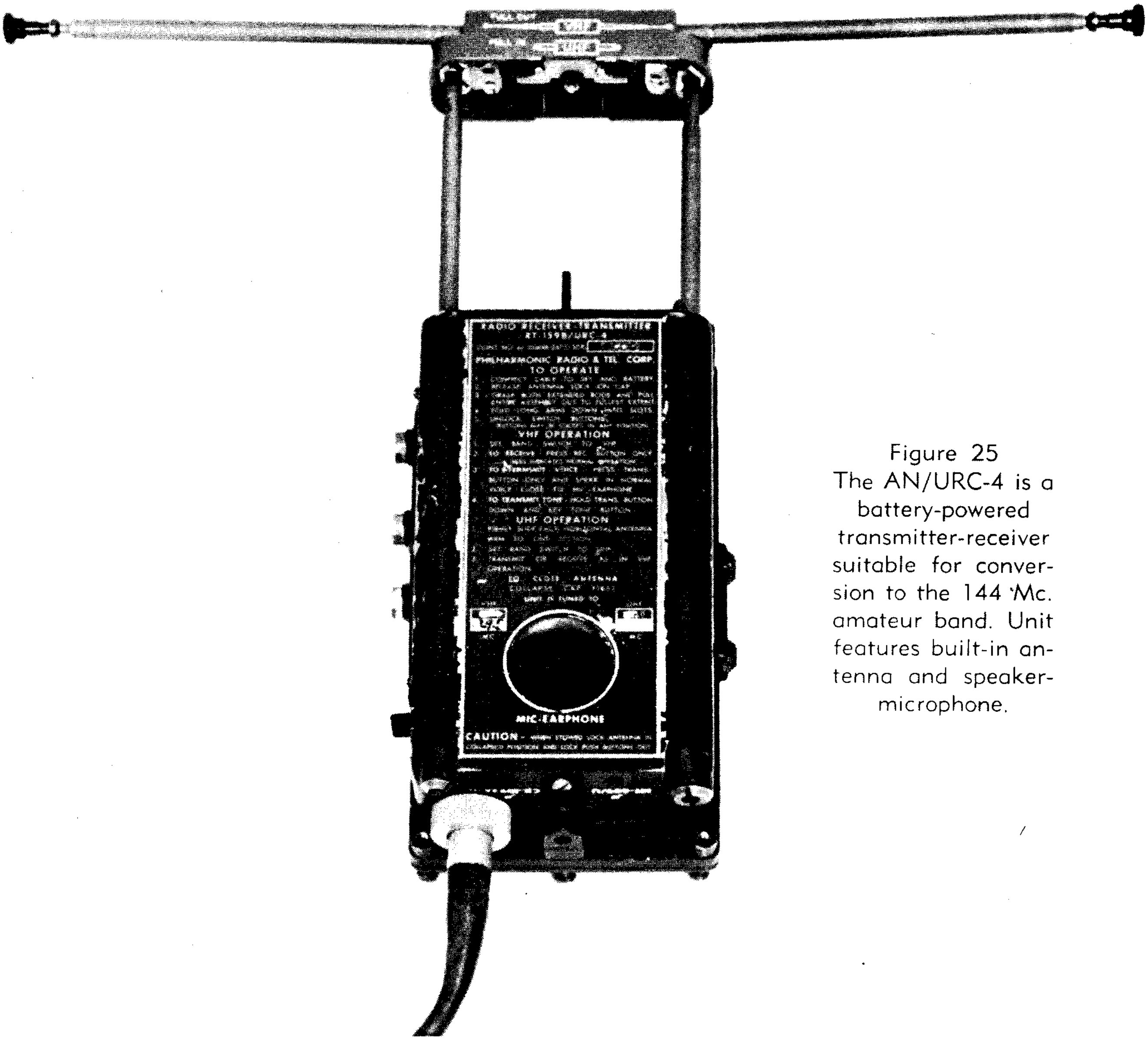


Figure 25
The AN/URC-4 is a battery-powered transmitter-receiver suitable for conversion to the 144 Mc. amateur band. Unit features built-in antenna and speaker-microphone.

crystal with carbon tetrachloride (Caution! Do not breathe the fumes!), replace it in the holder and check the frequency. It will probably be necessary to repeat this procedure several times (retuning the crystal oscillator coil each time) until the harmonic of the crystal falls at the desired spot in the 144 Mc. band.

Next, cut holes at appropriate spots in the top of the cannister to gain access to the tuning slugs when the cover is replaced. It is necessary to tune the transmitter in this manner, since the cannister causes a considerable amount of detuning when it is removed. Peak the slugs of the four coils for maximum signal strength in a nearby receiver, with the antenna whip of the unit fully extended. This completes the transmitter modifications.

144 Mc. Operation of the Receiver

The receiver section of the CRC-7 only requires retuning for 2 meter operation. Screwing the slug into the detector coil about three turns will hit the band. Some receivers will not tune above 147 Mc. and it will be necessary to remove one turn from the detector coil to tune up to 148 Mc. If desired, the receiver slug can be removed and a ¼-inch extension shaft soldered to it. By slotting the side of the case, you can tune the receiver manually by means of a knob placed on the shaft. The sensitivity of the receiver is such that a signal of less than 3 microvolts can easily be heard and copied.

The CRC-7 requires two flashlight batteries parallel-connected for the filament supply (1.4 volts), and two 45 volt B-batteries series-connected for the B-plus

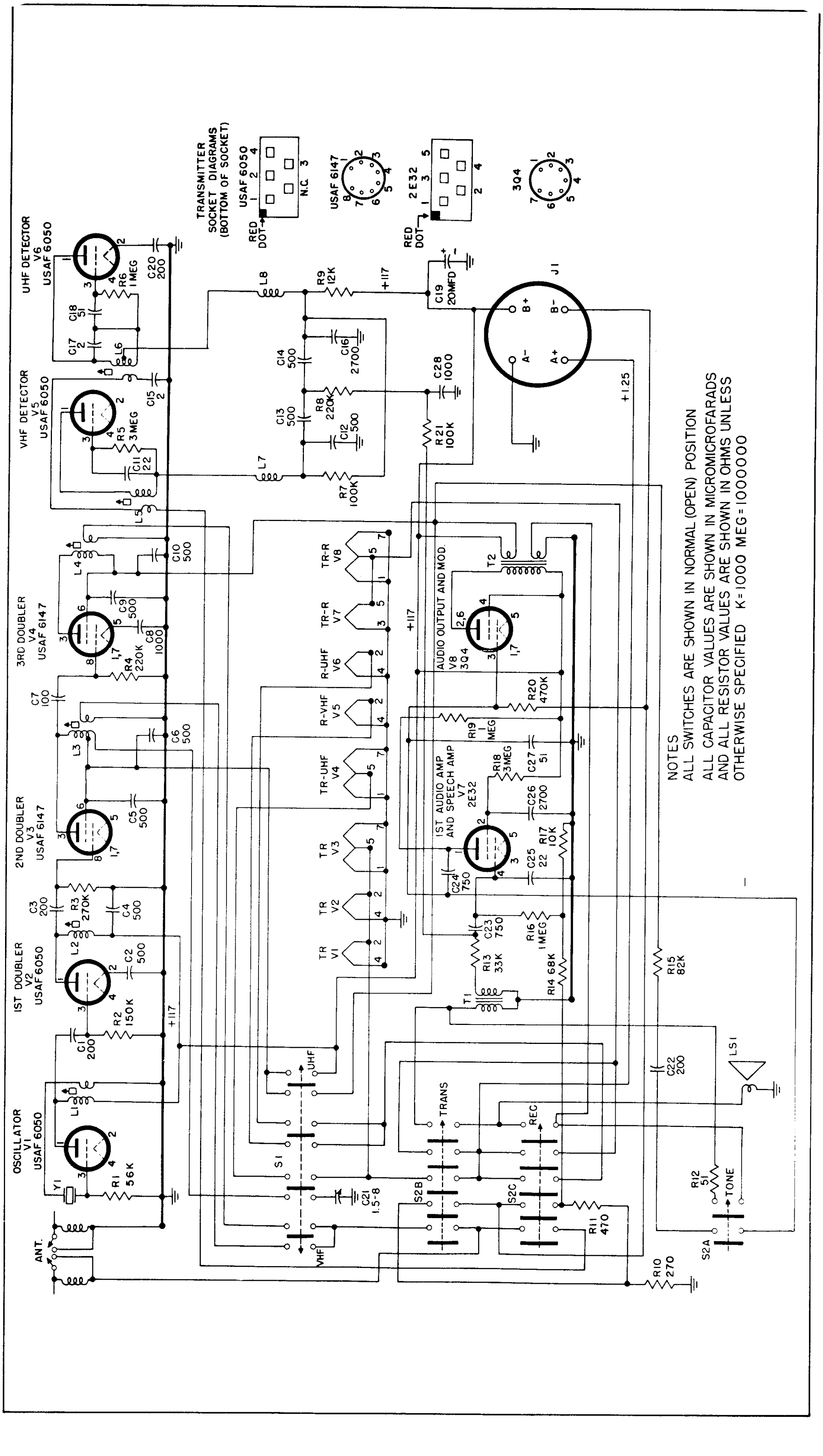


Figure 26-A
SCHEMATIC, AN/URC-4 TRANSMITTER-RECEIVER FOR RT-159 UNIT

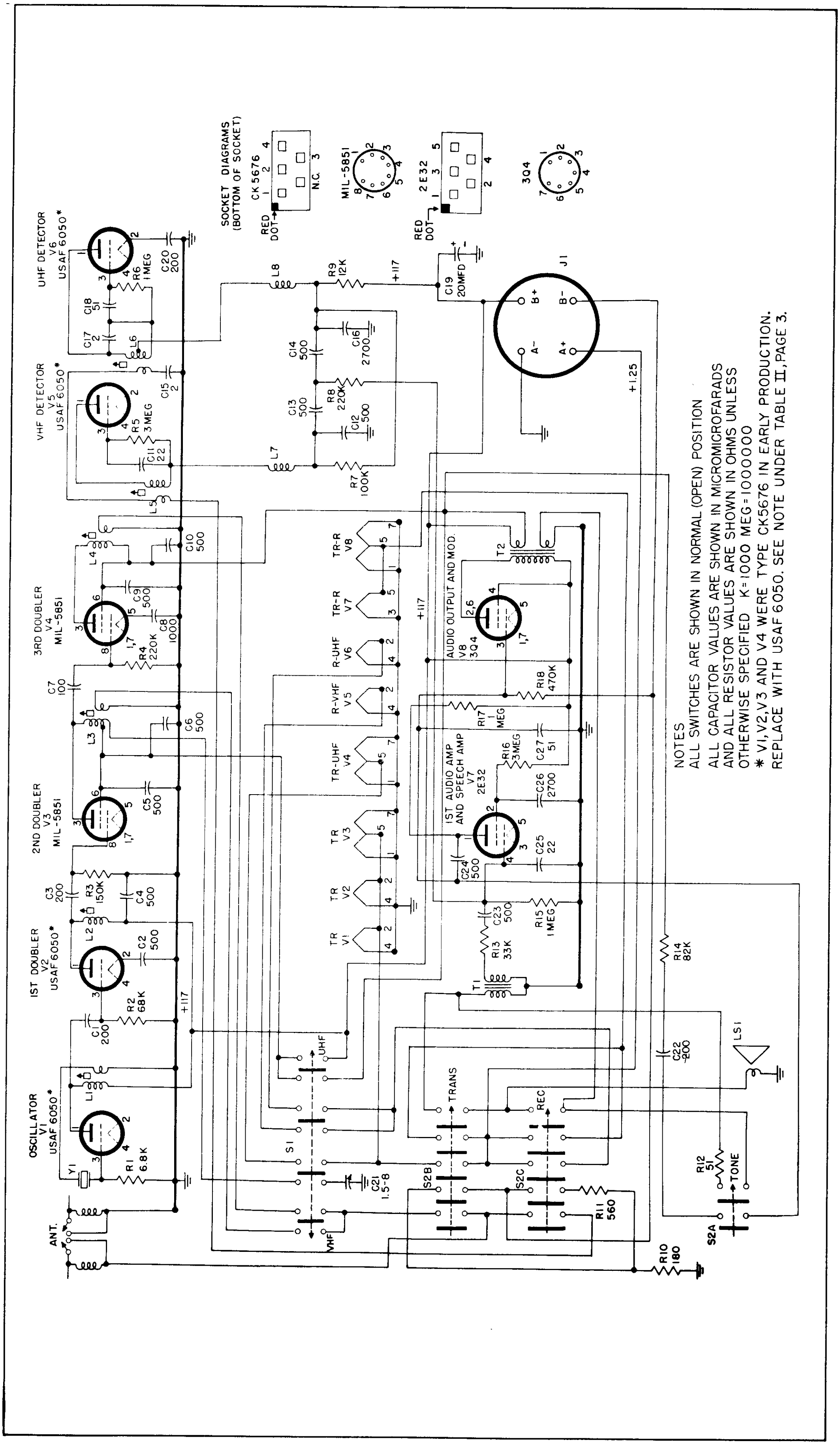


Figure 26-B
SCHEMATIC, AN/URC-4 TRANSMITTER-RECEIVER FOR RT-159A UNIT

supply. The RCA battery pack VS-064 will work well with this unit.

Using a converted CRC-7 with the self-contained antenna, contacts up to 30 miles distance have been made.

Converting the AN/URC-4 to a 2 Meter Handie-Talkie

The AN/URC-4 is a battery powered transmitter-receiver intended for Air-Sea rescue service like its predecessor, the CRC-7. Unlike the CRC-7, the URC-4 employs more "exotic" circuits, components and smaller construction. In addition, it is designed to operate on two frequencies: 121.5 Mc. and 243 Mc. To convert the URC-4 to 144 Mc. it is necessary to rewind a few coils, purchase a new crystal, and connect a set of batteries. The unconverted URC-4 is shown in figures 25 and 27.

The URC-4 employs eight tubes, all of which are sub-miniature with the exception of the audio output tube. A dual frequency antenna folds completely into the case. Telescoping the antenna automatically shorts out the v.h.f. antenna loading coils and converts the antenna to u.h.f. use at 243 Mc. For a two meter conversion, the u.h.f. circuitry and tubes are not used.

A complete circuit of the URC-4 is shown in figures 26A and 26B. Two separate detectors are used, one for v.h.f. and one for u.h.f. Each super-regenerative detector employs a type 6050 miniature high-μ triode. (Note: Some early models use 5676 tubes). Bandswitch S-1 lights the filament of the tube in use. The detector audio output circuit is novel in that it incorporates a "bridge-T" filter tuned to the quench frequency of super-regeneration. A variable quench control is thus not required and improved audio response is realized. The v.h.f. detector (V-5) tunes only to 144 Mc. and must be modified for 2-meter work.

The transmitter section employs a CR-24/U crystal at 10.12 Mc., ground for third-overtone operation with a 6050 oscillator (V-1) operating at 30.375 Mc. This tube drives a second 6050 doubling to 60.75 Mc. A beam-power pentode (type 5851) is used as a doubler to 121.5 Mc. For v.h.f. operation, signals are link-coupled out of the plate circuit of this stage. A second 5851 acts as a doubler to 243 Mc. for u.h.f. service and is activated by the u.h.f./v.h.f. switch, S-1. This last tube may be removed and kept as a spare.

The audio section consists of a 2E32 speech amplifier driving a 3Q4 power amplifier (reception). During transmission, the 3Q4 serves as a modulator. A feedback circuit is incorporated in the audio system for modulated tone transmission, operated by switch S-2A.

The Two Meter Conversion It is a good idea to establish first that the URC-4 is in working order on 121.5 Mc. when you receive it. The original battery pack is unobtainable, but a good substitute is the RCA VS-064 pack (1.4 volts, and 90 volts). Battery cables are usually avail-

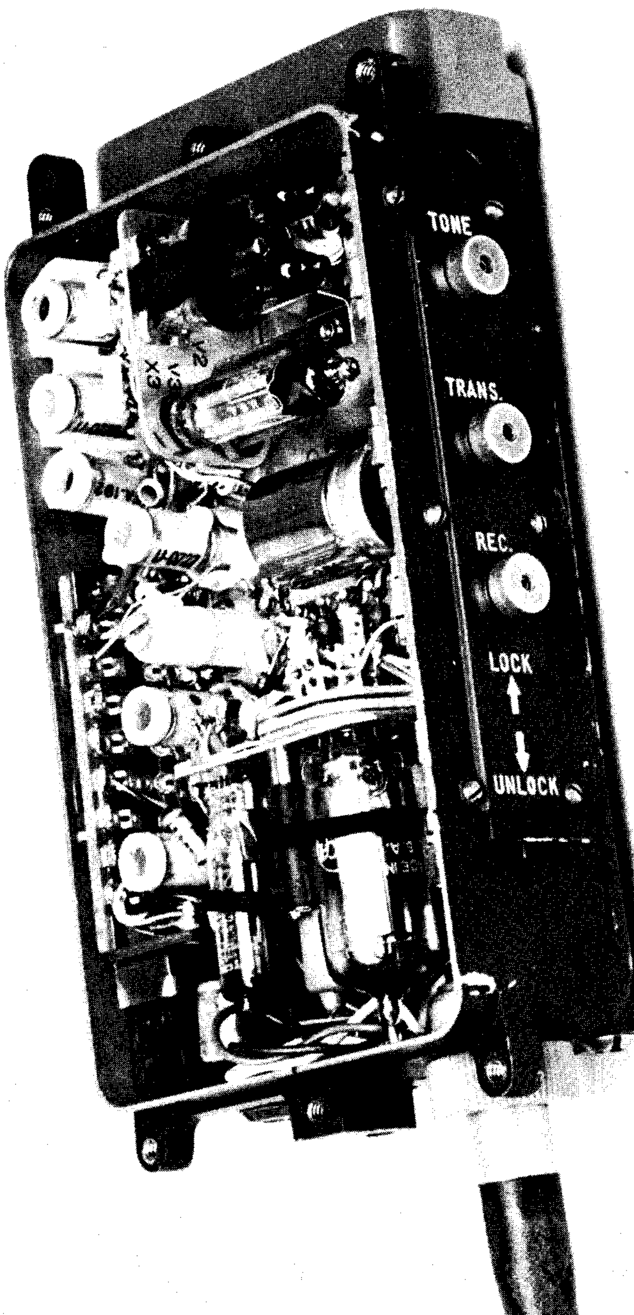


Figure 27
AN/URC-4, WITH COVER REMOVED
At top of cabinet are tubes V-1, V-2, and V-3. Oscillator coil L-1 is behind V-1 and is tuned to 30.375 Mc. Doubler coil L-2 is behind V-2 and is tuned to 60.75 Mc. Doubler coil L-3 is behind V-3 and is tuned to 121.5 Mc. Coil L-4 is behind capacitor C-19 (20 μfd.) and is tuned to 243 Mc. Tuning capacitor C-21 is next to L-4. Receiver coils L-5 and L-6 are at bottom of case.
Coil L-1 is retuned to 36 Mc., coil L-2 to 72 Mc., coil L-3 to 144 Mc. Tubes V-4 and V-6 (under the chassis) are removed.

able at the surplus store. Connect the battery as indicated in figure 26 to receptacle J-1. Press the receive button and a loud hiss should be heard from the combination microphone-earphone. Press the transmit button and check for r.f. with a field strength meter. *Do not* leave the transmitter operating for more than a few seconds when making this check as the 121.5 Mc. frequency is still used for military communication.

The first step in the conversion is to modify the tuned circuits. Remove the chassis from the case by loosening the chassis mounting screws. Remove the u.h.f. detector (type 6050, V-6) located under the chassis. Save the tube for a spare. Remove the u.h.f. power amplifier tube (type 5851, V-4) and save for a spare. Coil L-3 of the second doubler stage (V-3) will now resonate to 144 Mc. without re-winding.

Next, remove the neoprene waterproof cover over the microphone-earphone grill. This will improve the modulation. Now, locate the end of coil winding L-1 that connects to pin #1 of socket V-1 (6050, oscillator). Unsolder this end of the winding, pull it through the eyelet of the coil form and unwind three turns. After unwinding, feed the wire back through the eyelet and solder to pin #1 of socket V-1, trimming off the excess wire.

The next step is to locate coil winding L-2 that attaches to pin #1 of socket V-2 (6050, doubler). In the same manner as before, disconnect the wire, unwind two turns, and resolder. Coil L-3 is left "as is." Coil L-4 may be removed, as it is no longer used.

A transmitter crystal between 36 and 37 Mc. must be used for 2 meter service. A replacement type CR-24/U crystal is expensive, and a low-cost hermetically sealed type FM-1 crystal is recommended as a substitute. This crystal may be obtained from International Crystal Mfg. Co., 18 North Lee St., Oklahoma City, Oklahoma. The new FM-1 crystal may be secured by lifting the old pressure spring and sliding the new crystal into position. Solder the two wires to the original crystal holder terminals. Make sure the crystal is not free to move about, or dropping the CRC-7 might fracture the crystal. This completes the transmitter modification.

Receiver Modification for 2 Meters Identify the wire running between detector coil L-5 and the transmit-receive switch S-2. Unsolder this wire at the switch, pull back to the coil, and unwind one turn from the coil, leaving 1-1/6 turns on the link. Route the wire back to the switch, slip a piece of "spaghetti" tubing over the wire, and resolder to the original switch terminal. Next, identify the wire running between coil L-5 and pin #1 of detector socket V-5. Disconnect this wire at the socket, and as before, unwind one turn from L-5, and reconnect the wire end to socket V-5. This completes the receiver modification.

Antenna Modification for 2 Meters For 121.5 Mc. operation the dipole antenna system employs two loading coils. For best results on 144 Mc., these coils must be retuned. Unfold the antenna completely to the v.h.f. position. Note that one of the vertical support rods of the antenna structure is grounded to the chassis and the other passes through an insulator into the case. Mark near the appropriate coil (on the cap) the letters "A" (for antenna) and "G" (for ground). Unscrew the vertical rods near the cap with a small wrench. Solder a one-inch loop of wire across the two contacts near the center of the antenna cap. Lift out the two loading coils and remove all but one turn from the coil marked "G". Remove all but two turns from the coil marked "A". Replace the coils.

Now, insert the coil of a grid-dip oscillator into the loop of wire. Make sure the antenna is fully extended and clear of nearby metallic objects. Check the resonant frequency of the antenna, which should be close to 145 Mc. If not, adjust the coil "A" by spreading or compressing the turns which should put the antenna on frequency. Replace the antenna assembly.

Testing the Unit Insert the FM-1 crystal, and connect the batteries. Press the "transmit" button and listen for the carrier in a nearby receiver. If no signal is heard on the proper frequency, slowly unscrew the slug of coil L-1 until the oscillator starts operation. Peak coils L-1, L-2, and L-3 for maximum received signal with the URC-4 antenna fully extended.

To tune-up the receiver, press the "receive" button and adjust the slug of coil L-5 until local two-meter signals are heard. The slug should be almost completely inside the coil form. Placing the cover on the URC-4 will detune the circuits, so holes should be drilled at appropriate places in the cover, and final slug adjustments are made after the cover is in position. Under proper conditions, the unit is capable of transmitting and receiving over distances up to 30 miles or more. The power of the transmitter and sensitivity of the receiver are well matched, and you should be able to work anyone you can hear.

Converting the MD-7/ARC-5 Modulator for Amateur Use

The MD-7 modulator unit is readily available on the surplus market and may be easily converted to a 75-watt modulator for the ARC-5, or other transmitter, running up to 150 watts input. The MD-7 includes two 1625 modulators (12 volt 807's), a VR-150 voltage regulator, and a 12J5 tone modulator for m.c.w. service.

The easiest way to adapt the modulator for general use is to strip the chassis of all components except the tube sockets, the input transformer T-1, and the output transformer, T-2. The modulator should now be rewired according to the diagram of figure 28. The circuit is designed to be used with a surplus

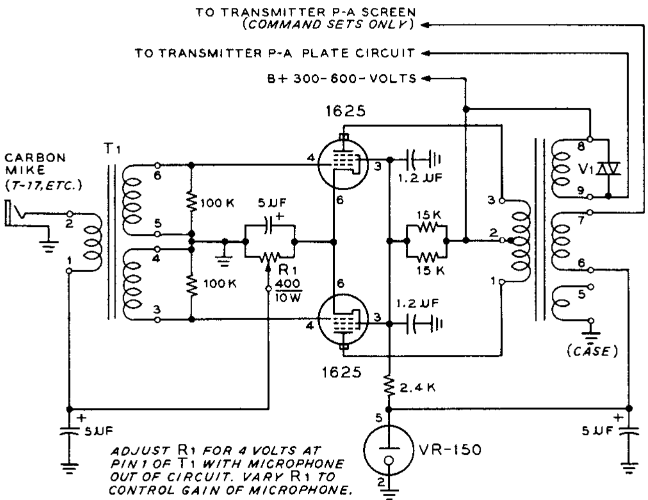


Figure 28
MODIFIED MD-7/ARC-5 UNIT MAKES MODULATOR FOR AMATEUR USE
T-1 and T-2 are original transformers.

carbon microphone, such as the T-17. Adjust the sliding tap on the cathode resistor to produce six volts as measured across the microphone jack with the microphone removed.

Rectifier V-1 connected across pins #8 and 9 of modulation transformer T-2 is a "varistor" that serves as a protective device for the transformer. It is a round, red unit with black caps, and is mounted beside the two large, black 15K wire wound resistors. Pins #1 and 3 are atop the modulation transformer, T-2. The empty 12J5 socket can be employed as a power socket.

Converting the Command Transmitter Relay for Antenna Change-Over Use

When converting Command transmitters such as the "ARC-5" or "BC" series, the antenna switching relay is usually discarded. This relay may be adapted for either 6- or 12-volt mobile operation.

The relay (identified as K-54 in the ARC-5 units) employs two series-connected coils. The pole pieces pull the armature from both directions, so to speak. The armature in turn moves a spiral-wound silver-plated contact between the antenna and ground posts of the transmitter.

Mount the relay on a small sheet of aluminum, as shown in figure 29. It may be placed on one side of a small chassis-box. Mount the spiral to one SO-239 coaxial receptacle, and permit the contact arm to move between the old contacts which have been soldered to two SO-239 connectors mounted on each side of the movable arm.

As wired, the relay coils are connected in series and work on 24 volts. To use the coils on 6 volts, wire the coils in parallel with the magnetic fields aiding each other. For 12-volt operation, merely connect to one of the coils.

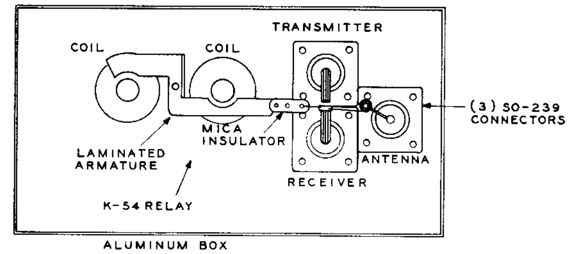


Figure 29
K-54 relay of BC-442 Antenna Control Unit is mounted on aluminum plate. Three coaxial receptacles are used for relay terminals. Coils may be connected for 6, 12, or 24-volts, d.c.

Converting the RM-52 (RM-53) Telephone Unit to a Phone Patch

Two pieces of military telephone equipment readily available on the surplus market are the RM-52 remote control unit, and the RM-53 control unit. Both of these units contain a high quality transformer suitable for phone-patch service. The transformer carries the military part number C-280A, and the manufacturer's part number 83718. The transformer has balanced 600, 150, 250, and 4000 ohm windings, and is well suited for many other devices, such as line matching, isolation, impedance step-up, etc.

The phone-patch is built in a small aluminum case, and wired as shown in figure 30. A simple r.f. filter is placed in series with the telephone line to prevent r.f. feedback. A d.p.d.t. toggle switch is used to disconnect the phone line and return the microphone to normal use. Always disconnect the patch when it is not being used.

To use the patch, turn on the control switch and insert the phone plug in the receiver headphone jack. If your receiver has a 500 ohm output, it can be permanently connected to the 500 ohm terminals. Attach your crystal microphone to the microphone jack, and run a shielded line to your speech amplifier. Attach the phone patch to the telephone line at the base of the phone. Receiver output will now pass over the phone line, and the phone will modulate your transmitter.

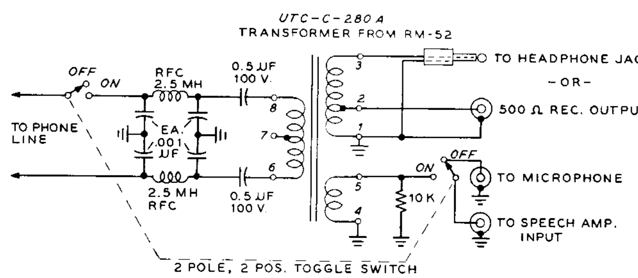
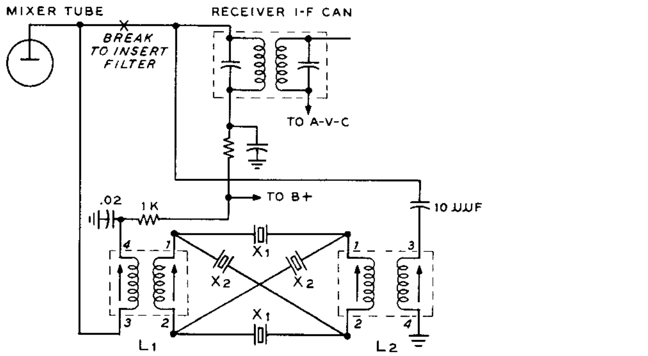


Figure 30
SCHEMATIC, PHONE PATCH MADE FROM RM-52 TELEPHONE UNIT



CRYSTAL MARKING	FREQUENCY
CHANNEL 44	451.85
CHANNEL 45	453.70
CHANNEL 326	452.77
CHANNEL 327	454.16

X1 - LOWER CHANNEL (SUCH AS 44)
X2 - HIGHER CHANNEL (SUCH AS 45)
L1 - L2 - MILLER 12-C1 455 KC. I-F

Figure 31
SCHEMATIC, CRYSTAL FILTER FOR 455 KC. I.F. AMPLIFIER

Make a Single Sideband Crystal Filter for Your Receiver with Surplus Crystals!

The type FT-241A crystals (used with the BC-604) are plentiful and cheap on the surplus market. These crystals cover the range of 370 kc. to 500 kc. in 1.85 kc. segments. The crystals are used on their 54th harmonic, and are marked 20.0 Mc. to 27.9 Mc. in 100 kc. jumps. Other crystals in the same range are available that are separated by a frequency difference of 1.39 kc. These crystals are marked 27.0 Mc. to 34.6 Mc. (Channels 270–346).

An efficient crystal filter may be made from four of these surplus crystals. The one stage full-lattice filter is shown in figure 31 and may be used in any receiver having a 455 kc. intermediate frequency amplifier. For everyday use it is not necessary to match crystals. The filter will greatly increase the selectivity of the receiver, reducing the interference level and permitting better reception.

Any two adjacent channels may be used that fall in the i.f. range of the receiver. Channels 44 to 48, and 326 to 330 all fall within the tuning range of standard 455 kc. i.f. transformers.

Building the Filter The layout of the filter is determined by the available space within your receiver. In general, the filter components should be mounted on a small aluminum plate having a small shield across the middle (on both the top and bottom sides) to separate the input and output circuits of the filter. The filter should be located between the mixer tube and the first i.f. transformer can in the receiver. All interconnecting leads should be kept very short. The lead connecting the mixer tube to the transformer is broken, and the filter is inserted in this circuit as shown in the diagram.

Upon completion, tune a signal generator to the center frequency of the filter. (If channel 44 and 45 crystals are used, tune the signal generator to 452.77 kc. A surplus BC-221 frequency meter will come in handy). Peak filter transformers L-1 and L-2 to this new frequency as well as all the i.f. transformers in the receiver. The insertion loss of the filter is only about 6 decibels, so the addition of an extra tube to boost the gain of the receiver is not required. The filter may be used for s.s.b., a.m.-phone, and c.w. reception.

Converting the T-23/ARC-5 Transmitter to 144 Mc. or 50 Mc.

The T-23/ARC-5 transmitter covers the v.h.f. range of 100–150 Mc. in four channels. It is a companion piece of equipment to the R-28/ARC-5 receiver. Together, these two pieces of equipment make up the v.h.f. portion of the ARC-5 radio set. The equipment is designed to operate from a 24–28 volt d.c. power supply. The T-23 transmitter mounts in a MT-69/ARC-5 rack. Power output of the transmitter is 10 watts into a 50 ohm antenna.

The transmitter channels cover the following frequency ranges:

Channel A: 100-124 Mc.
Channel B: 122-146 Mc.
Channel C: 122-146 Mc.
Channel D: 132-156 Mc.

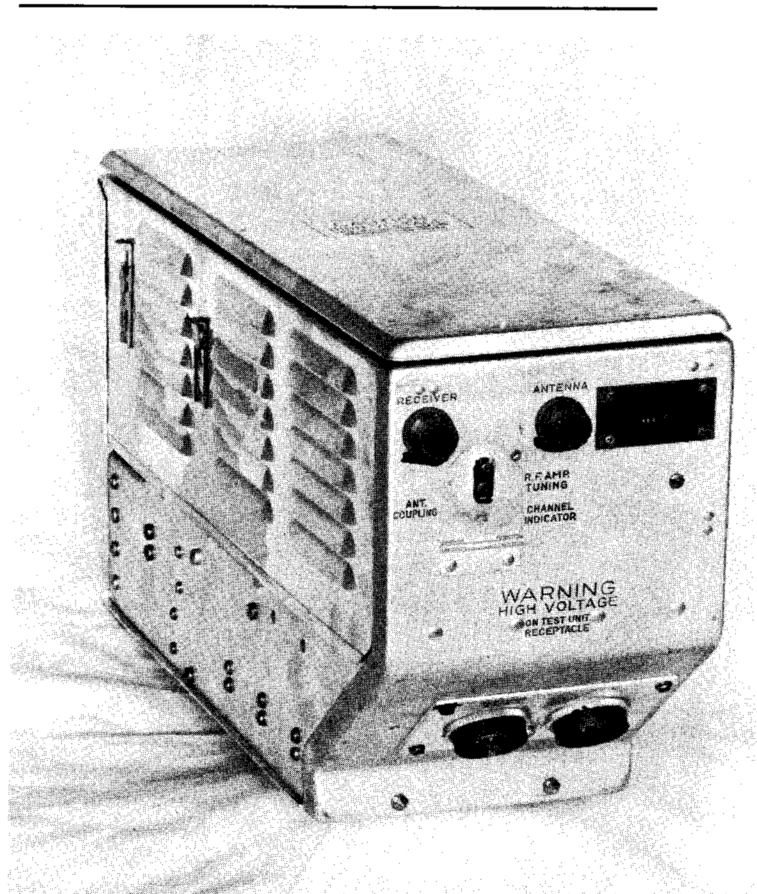


Figure 32
THE T-23/ARC-5 V.H.F. TRANSMITTER
Coaxial connectors J-301 and J-302 are at upper left, with connectors J-307 and J-309 at bottom of sloping front panel. R.f. tuning adjustments of amplifier stage may be accomplished through "door" on panel.

The crystal frequency is 1/18 of the carrier frequency in all cases. Front, top, and bottom views of the unconverted transmitter are shown in figures 32, 33, and 35, and the schematic is given in figure 34.

Three of the transmitter channels (B, C, and D) will function on 2 meters without alteration. Channel A is converted to 50 Mc. (six meters). The tube line-up of the transmitter is:

1–1625 (V-301) crystal oscillator
1–1625 (V-302) first harmonic generator
1–832A (V-303) second harmonic generator
1–832A (V-304) r.f. amplifier

The power amplifier is plate and screen modulated by the separate MD-7/ARC-5 modulator. This unit is shown fully converted in another section of this Manual.

In order to use the original tubes, a 12-volt filament transformer is included in the power supply unit. The ARC-5 transmitter employs six d.c. relays. These are:

K-301–Antenna changeover relay
K-302–Plate and screen voltage control
K-303–Modulator screen and key control
K-304–Motor tuning control
K-305–Auxiliary plate and screen voltage control
K-306–Modulator plate and voltage regulator interlock

All relays except the antenna changeover unit (K-301) are removed in the conversion. The complete conversion is outlined in steps to ensure that changes are made properly and in the correct sequence. Check off each step as you do it.

1–Cut the wires going to the coil of relay K-305. Tape the leads.
2–The red/white wire coming from one of the terminals of K-305 is cut, stripped, and soldered to the top terminal of resistor R-315 (300 ohms). This resistor is in the cathode circuit of the 832A amplifier (V-304). The top terminal has two green and white wires attached to it. Leave these wires in position.
3–Remove the ground connection from R-315. The resistor now serves only as a tie-point.
4–Slip the large, black 15.000 ohm resistor, R-329 (front of chassis near 1625 oscillator socket) out of its bracket. Save the resistor.
5–Remove the two wires from the back end (toward the crystal socket) of the bracket. Twist the wires together. They will be attached to a terminal strip in a later operation.
6–Remove R-327 (3,600 ohms–orange, blue, red) from the contact terminal of relay K-303 and attach it to the back end of the 15,000 ohm resistor bracket.
7–Remove the two leads from the front end of the 15,000 ohm resistor bracket and tie them together. They will be attached to a terminal strip in a later operation.
8–Remove the green/white wire from the contact terminal of relay K-303 and attach it to the front end of the 15,000 ohm resistor bracket.
9–Replace the 15,000 ohm resistor in the bracket.
10–Remove the three relays K-303, K-302, and K-305 from the side of the chassis. Do not remove the wires from the relays.

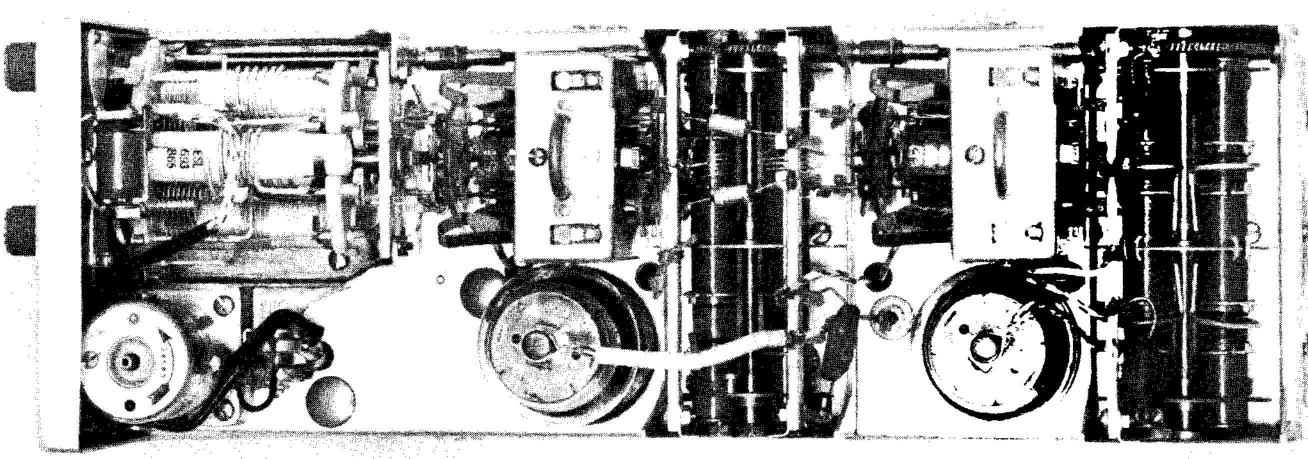


Figure 33
TOP VIEW OF T-23/ARC-5 WITH DUST COVER REMOVED
Amplifier coils are near front panel, next to tuning motor, with 832-A tripler at rear. Oscillator and multiplier tubes are next to 832-A's. Drive shaft for rotary turrets runs along the side of amplifier chassis. Each 832-A stage mounts in removable sub-chassis.

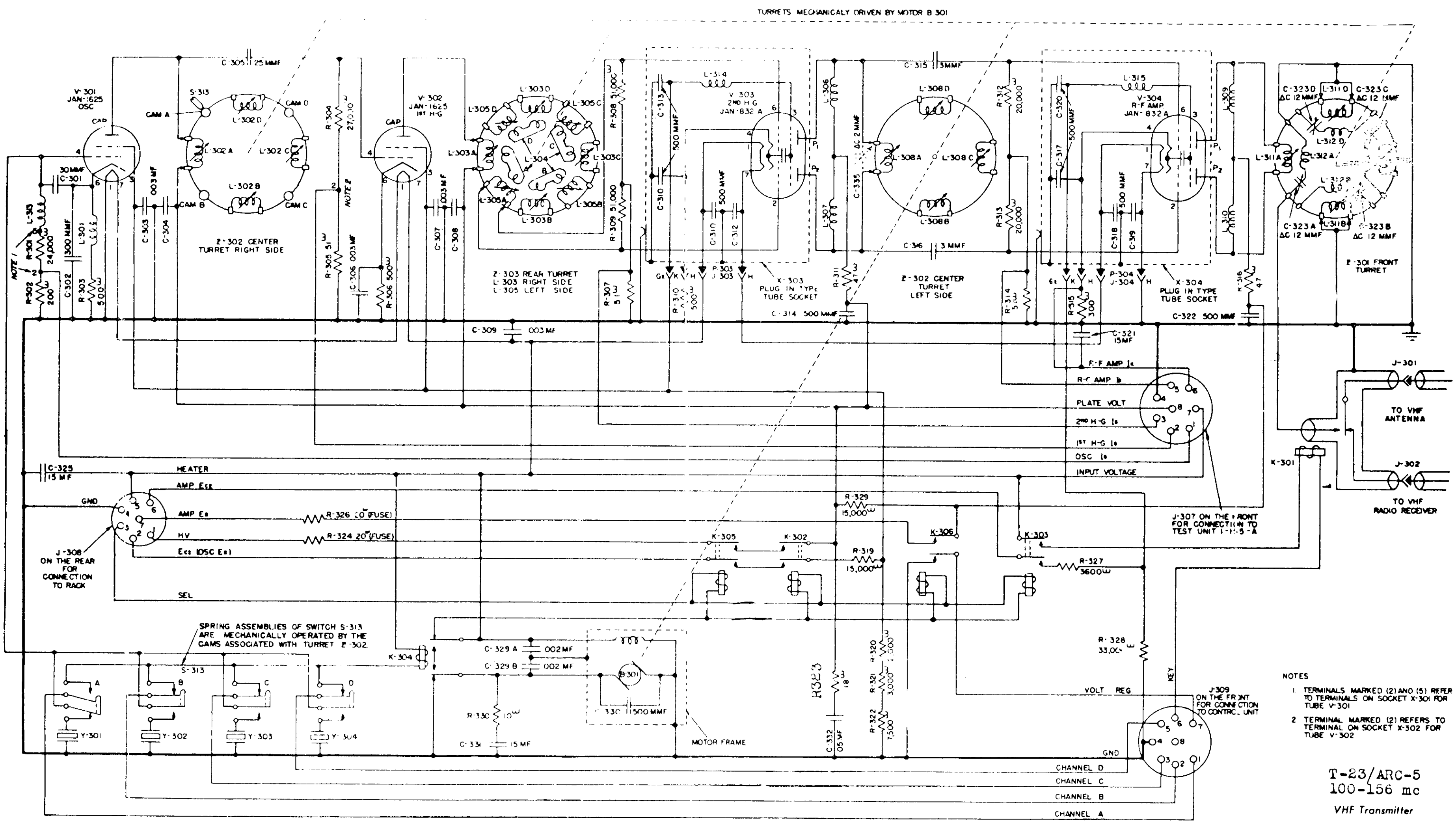


Figure 34
SCHEMATIC, T-23/ARC-5 V.H.F. TRANSMITTER

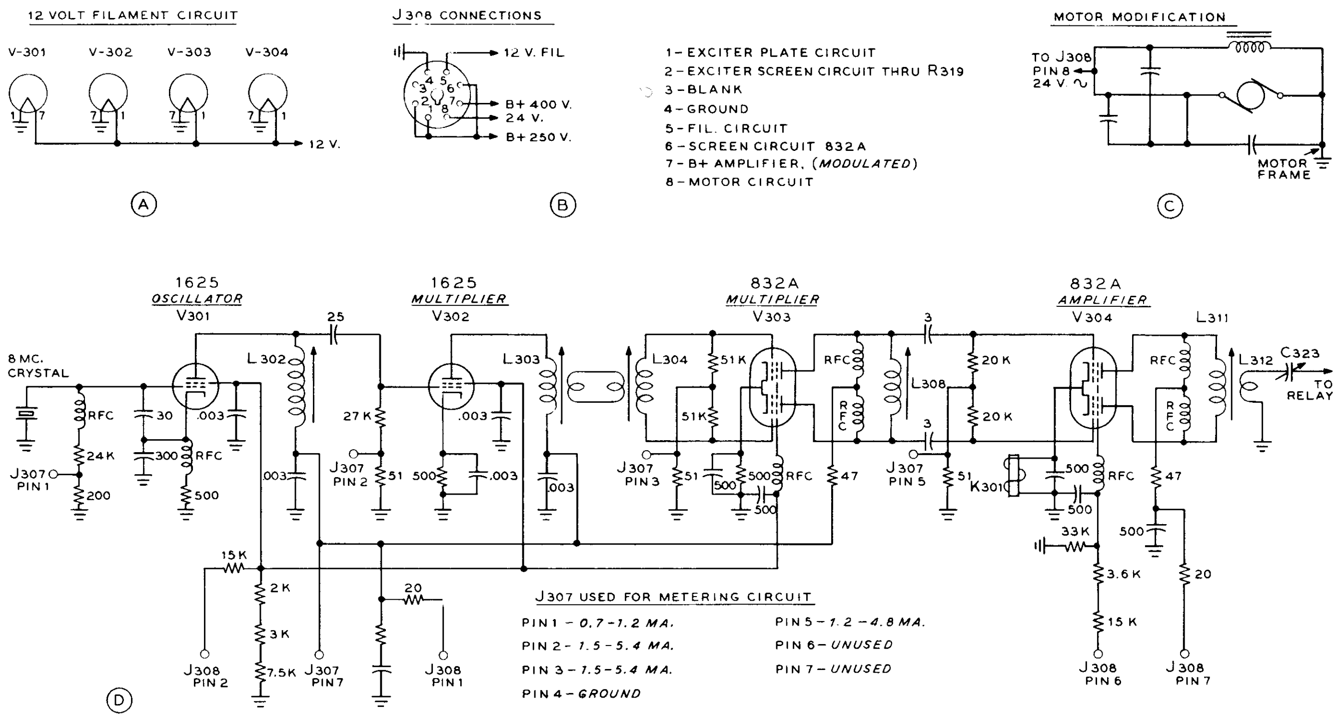
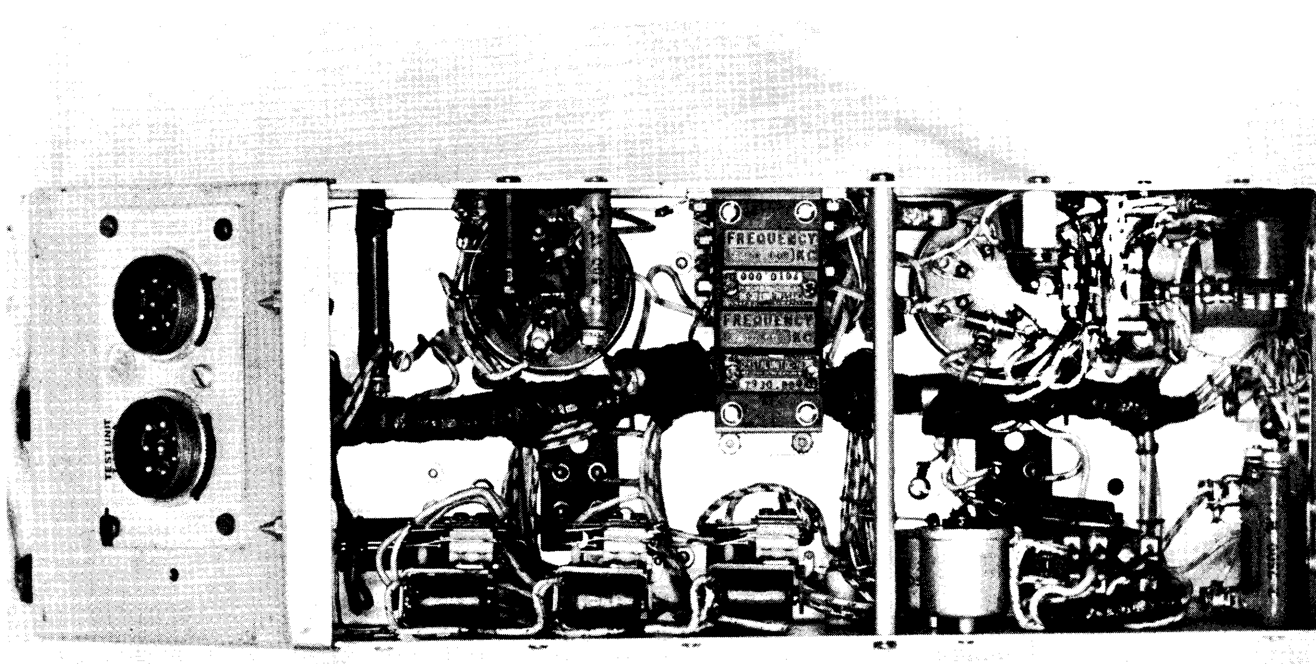


Figure 36
A—12-volt filament circuit for T-23/ARC-5
B—New octal plug to replace J-308
C—Bandswitching motor circuit modifications
D—Schematic of modified r.f. circuit

Figure 35
UNDER-CHASSIS VIEW OF T-23/ARC-5 TRANSMITTER
Relays K-303, K-302, and K-305 are mounted to side of chassis. Crystal receptacles are placed between 1625 tube sockets.



11—Install a terminal strip having five *ungrounded* terminals in the space left by the removal of the relays.

12—Attach the two wires removed in step 5 to one of the terminals of the strip.

13—Attach the two wires removed in step 7 to a second terminal of the strip.

14—Attach the two solid white wires going to relay K-303 to a third terminal of the strip.

15—Locate the yellow and white wire going to relay K-302. Locate the blue and white wire going to relay K-305. Remove and solder these wires together and attach to a fourth terminal of the strip.

16—Locate and remove the blue and white wire going to relay K-302. Locate and remove the red, black, and white wire going to relay K-305. Solder these wires together and attach to the fifth terminal of the strip.

17—Remove completely the red and white wire attached to the coil of relay K-306.

18—Disconnect the 20 ohm resistor-fuse (R-326), and the red, green, and white wire from the ceramic end plate of relay K-306. Solder the resistor and wire together. Tape the joint.

19—Cut the other two leads going to relay K-306. Tape each end so they will not short out against the chassis, or to each other.

20—Remove relay K-306 from the chassis. Install a cable clamp to hold the cable next to the side of the chassis. Install a terminal strip with one ungrounded tie-point under the relay bolt.

21—Attach the 20-ohm resistor to the tie-point.

22—J-308, the 7-pin plug on the rear of the chassis, should be replaced with an 8-prong male plug for convenience. Remove the wires one at a time from J-308. Remove the wire from terminal #1 and place it on pin #1 of the tube socket. Do the same with terminal 2. Continue this procedure until all of the wires are transferred. Remove J-308 and mount the male plug in its place.

23—Cut all the wires connected to relay K-304. Remove from the chassis the 10-ohm resistor (R-330, brown, black, black) and the 15 μfd. capacitor associated with K-304. Remove K-304 from the chassis, and in its place substitute a terminal strip having one ungrounded tie-point. Take the green and white wire from the K-304 wiring cable and attach it to the terminal. Tape the other wires separately for insulation.

24—Install a lead connecting the wires on the terminal strip to terminal 8 of receptacle J-308 on the front of the unit.

25—Locate the two 0.002 μfd. bypass capacitors (C-329A, B) at the base of the tuning motor. Disconnect the white lead, leaving the green and white wire connected. Tape the white wire. Short together the two leads coming from the motor. The motor windings are now connected in parallel instead of in series. The motor will now function on 24 volts, a.c., rotating the coil assembly when 24 volts a.c. is applied to pin #8 of J-308.

26—Remove the black and white wire from the coil terminal of relay K-301, the antenna relay. Ground this terminal. Tape the wire.

27—The sockets of V-301 (oscillator) and V-304 (832-A amplifier) need not be modified for 12-volt filament operation. On socket V-303, the two solid white wires should be disconnected and then attached to the terminal that is occupied by the single black and white wire. The terminal formerly occupied by the two whites wires is now jumpered to the ground terminal located next to it.

28—Now go to socket V-302 (1625 multiplier). Remove the green and white wire from pin #7 and solder it to pin #1. Ground pin #7. Check all connections. Modification of the transmitter for 144 Mc. is now complete. See figure 36.

Transmitter Modification for 50 Mc.

1—Remove tube V-303 (832-A tripler) from the transmitter. Save the tube for a spare.

2—Set the transmitter turret on channel D.

3—Remove the 20,000-ohm resistors (R-312, R-313) and the 3 $\mu\mu$fd. coupling capacitors (C-315, C-316) from the grid circuit of tube V-304 (832A amplifier).

4—Run a jumper wire from pin #6 (grid terminal) of socket V-303 (tripler) to grid pin #6 of socket V-304 (amplifier).

5—Run a second jumper from pin #2 (grid terminal) of socket V-303 to grid pin #2 of socket V-304.

6—Remove coil turret Z-301 (front turret for 832A amplifier stage). Mark the channel D coil, L-311-D.

7—Remove the plate circuit winding, and replace it with 19 turns of #18 enameled wire, close-spaced. Replace the coil in the turret. The 50 Mc. conversion is complete.

A crystal having a frequency between 8.334 Mc. and 9.0 Mc. is required for six-meter operation. Tube V-301 is an oscillator doubler, producing output in the 17 Mc. region. Tube V-302 is a tripler to the 50 Mc. region and tube V-304 is a straight amplifier at six meters.

It is possible to return to 144 Mc. operation by replacing the buffer tube and reworking the grid circuit to the original configuration. If two-band operation is desired, there is no reason why a plug-in board could not be adapted to replace the 832A buffer, in-

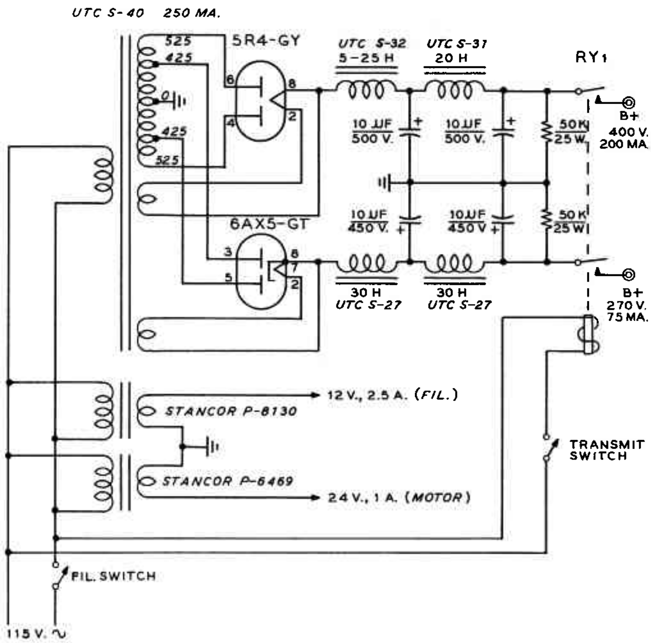


Figure 37
A.C. POWER SUPPLY FOR T-23/ARC-5 TRANSMITTER

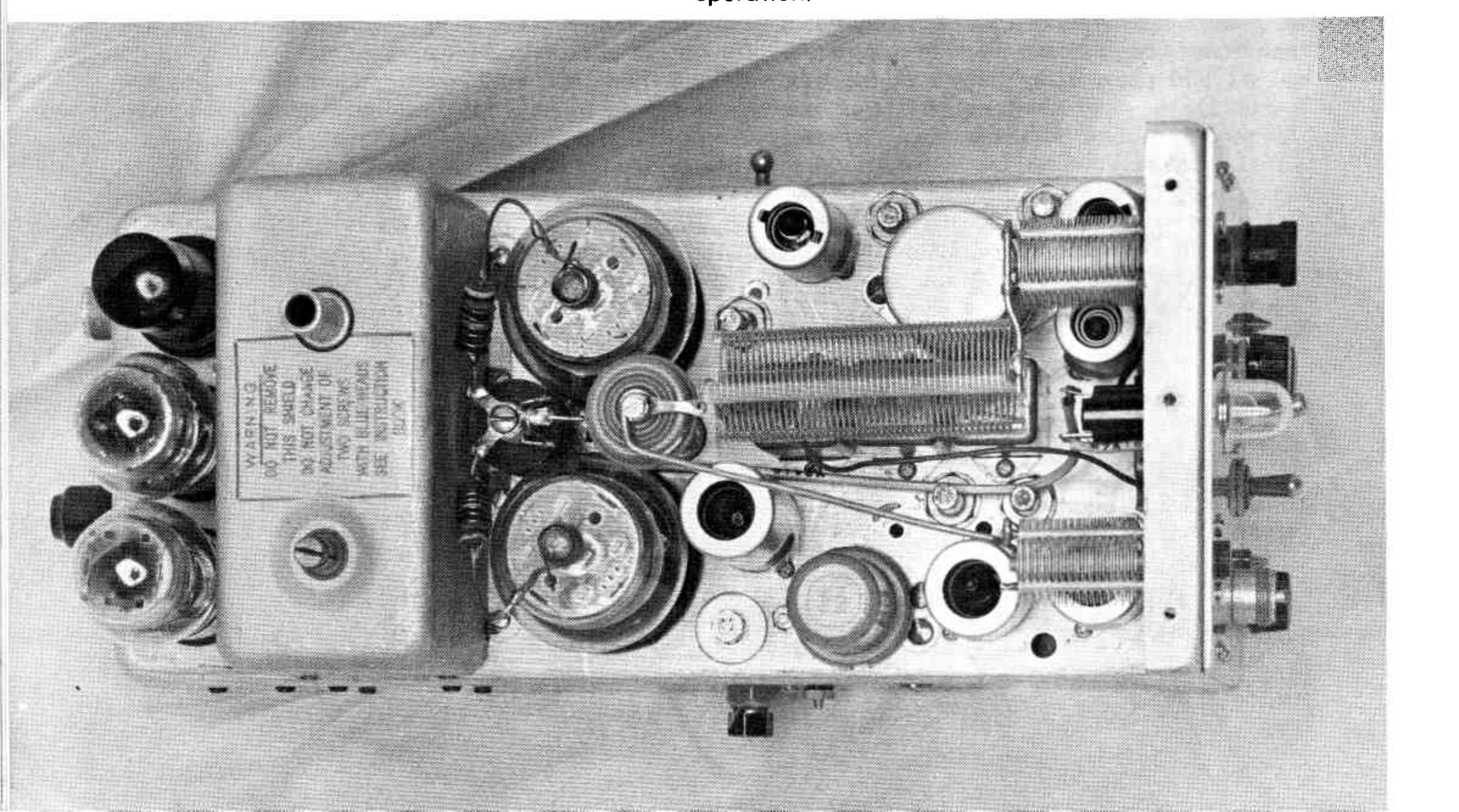
corporating the necessary 50 Mc. circuit changes. In this fashion, one transmitter would serve for both six- and two-meter operation.

Transmitter Tuning The transmitter may be aligned with the aid of a small neon bulb. A tuning wand may be made from a pencil. Remove the eraser from the end of a wooden pencil and crimp the metal band with a pliers to fit the end of the tuning slugs. Tuning may be facilitated if a drop of penetrating oil is placed on the threads and allowed to stand overnight. The slugs are at a high d.c. potential so it is necessary to wrap the pencil completely with two layers of electrical tape for protection.

First, adjust the oscillator coil (turret Z-302, center, right side) for output at the third harmonic. Use a nearby receiver as a monitor, or check frequency with the aid of a grid-dip oscillator. Next, tune each buffer stage for maximum brilliance of the neon bulb when held near the plate lead of the tube in question. Check for correct frequency tuning with the grid-dip oscillator. Channel D is best suited for operation at the high frequency end of the 144 Mc. band.

Transmitter Power Supply The transmitter requires a power supply delivering 400 volts at 200 ma. for the plate supply, 270 volts at 75 ma., 12 volts a.c. at 2.5 amperes for the filaments, and 24 volts at 1 ampere for the tuning motor. A suitable supply is shown in figure 37. Plate input to the amplifier stage is about 30 watts (400 volts at 80 milliamperes). Note: Turn off the high voltage before you run the tuning motor, or

Figure 38
TOP VIEW OF COMMAND TRANSMITTER CONVERTED FOR SINGLE SIDEBAND SERVICE
Placement of major components is shown in figure 40. Pi-network circuit for linear amplifier is at right of chassis. Unit shown is for 80-meter operation.



it is possible to blow out the 47-ohm resistor (R-316) in the 832-A plate circuit.

Convert Your BC-458 Into a Single Sideband Transmitter!

The BC-458 is part of the SCR-274N radio equipment. It is a compact v.f.o. transmitter, covering the range of 5.3–7.0 Mc. (Navy version is the T-21/ARC-5). Four tubes are used in the transmitter: 1626 oscillator, 1629 "magic-eye" tuning indicator, and two 1625 power amplifiers.

This Command transmitter may be easily converted to a phasing-type s.s.b. transmitter for either

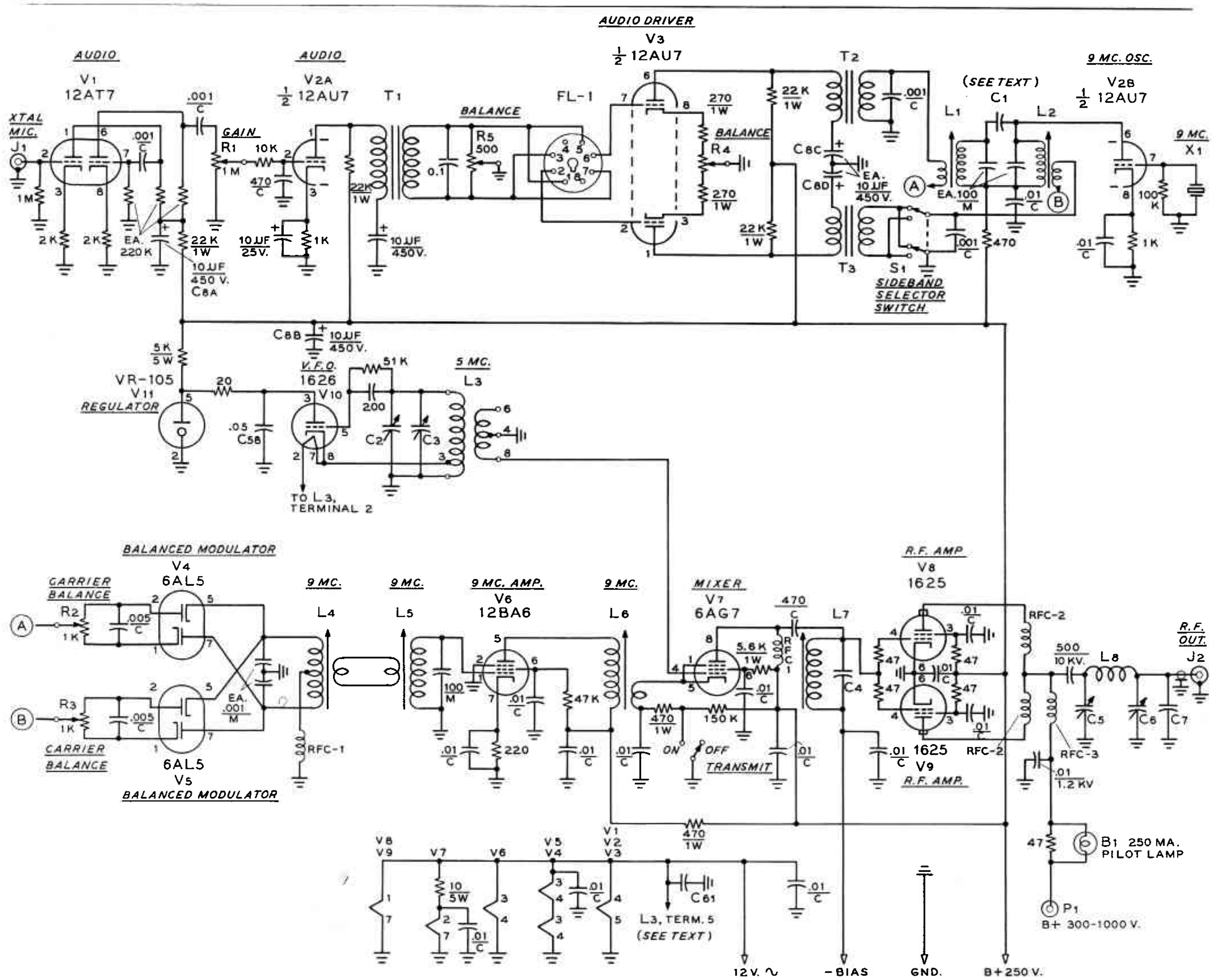


Figure 39
SCHEMATIC, SINGLE SIDEBAND TRANSMITTER

C-1—3 $\mu\mu$fd. This capacitor may not be necessary. Leave it out unless carrier balance can not be set with slugs of L-1 and L-2.
C-2—Original oscillator tuning capacitor, panel-driven
C-3—Original oscillator padding capacitor
C-4—See coil table
C-5, C-6—140 $\mu\mu$fd.
C-7—1250 volt mica padding capacitor, 300 — 1500 $\mu\mu$fd.
C-8A-B-C-D—10-10-10-10 μfd. electrolytic in metal can.
FL-1—Barker & Williamson type 350 phase-shift network.
T-1—20K to 600-800 ohms. Thordarson TR-17, or Arrow Sales Co. type TR-29.
T-2, T-3—15K to 200 ohms. Thordarson TR-25, or Arrow Sales Co. type TR-29 (use ½ of secondary winding).
RFC-1—2.5 mh. choke
RFC-2—5 turns #18 e. wire around 47 ohm, 2-watt composition resistor.
RFC-3—2.5 mh. "transmitting type" choke
See figure 43 for coil data

80- or 40-meter operation. Either sideband may be transmitted, and the completed transmitter includes a high stability v.f.o. Peak power output is about 100 watts when a 1000-volt plate supply is used.

The Sideband Circuit The complete circuit of the converted command transmitter is shown in figure 39. The original oscillator tube and circuitry (V-10) is retained, as well as the 1625 amplifier tubes and sockets (V-8, V-9). The sideband signal is generated at a crystal controlled frequency of 9 Mc. Tubes V-1 and V-2A are the audio stages that develop sufficient voltage from a crystal microphone to drive phasing network FL-1 properly. The two audio output signals from the network are further amplified by tube V-3 and applied in series with the r.f. output of the 9 Mc. crystal oscillator through circuits T2-L1 and T3-L2. Two r.f. signals are available at points "A" and "B". Each signal is amplitude modulated, but of a different r.f. phase. These two signals are applied to the diode balanced modulator (V-4, V-5) through two balancing potentiometers, R-2, and R-3. The signal developed in the output circuit of the balanced modulator (L-4) is a single sideband signal at 9 Mc. The action of the modulator has balanced out the carrier and one sideband, leaving the desired single sideband. Reversing switch S-1 will change the sideband appearing at the output of the balanced modulator. This signal is amplified by V-6.

The 9 Mc. signal must now be changed in frequency by a mixing process to the desired output frequency in either the 80-meter or the 20-meter band. This is done by combining the 9 Mc. sideband signal with the 5 Mc. output signal of the variable frequency oscillator, V-10. Mixing is done in tube V-7. Twenty-meter output is a summation of the two signals (9 Mc. plus 5 Mc. = 14 Mc.) and eighty-meter output is the difference of the two signals (9 Mc. minus 5 Mc. = 4 Mc.). Both signals appear in the plate circuit of V-7, and the desired signal is obtained by tuning the circuit C-4—L-7 to either 20 or 80 meters. Data for this circuit for either band is given in figure 43.

The final step is to amplify the s.s.b. signal to a usable level. This is done in the linear amplifier, V-8, V-9. When operated at 1000 volts plate potential, s.s.b. peak output is over 100 watts, dropping to 20 watts at 300 volts. The transmitter is placed on the air by energizing V-7 when switch S-2 is closed.

V.f.o. operation is obtained by tuning capacitor C-2. The range of 5.0–5.4 Mc. covers the 20-meter band (14.0–14.4 Mc.), and the range of 5.2–5.0 Mc. covers the 80-meter band (3.8–4.0 Mc.). It is a simple matter to increase the setting of the oscillator padding capacitor C-3 to lower the oscillator frequency to 5.0 Mc. at the low frequency end of the dial.

Converting the Command Transmitter The first job is to strip the Command transmitter of all the parts you do not require. Refer to figure 2 for wiring diagram of original transmitter. Remove all of the original wiring below the chassis except the 1626 oscillator circuit. Remove R-71, C-64, C-66, K-53, C-62 and R-76. Also remove C-65. Leave capacitor C-61. The amplifier capacitor (C-67) of the tuning gang is removed, and a new tuning shaft for oscillator tuning capacitor C-63 is made from the knob and shaft from the variable link coupling coil above the chassis (part of T-54). Above the chassis, the loading coil, antenna relay, and plate coil T-54 are removed.

The new parts, tube sockets, and other components are now laid out atop the chassis, as shown in figure 38, and the chassis is drilled. A new aluminum panel is placed over the old front panel of the transmitter. At the rear of the chassis a miniature coaxial receptacle (J-2) is mounted, and the original power plug is removed and an 8-pin socket substituted. Also mounted on the back apron is a high voltage terminal *(Millen)*. Placement of the components is indicated in figures 40 and 41.

Wiring the S.S.B. Transmitter The filament circuits are wired first. Next, the oscillator coil (L-3, figures 39 and 40, old T-53, figure 2) is wired. Terminal #5 of L-3 is attached to capacitor C-61, and the opposite terminal

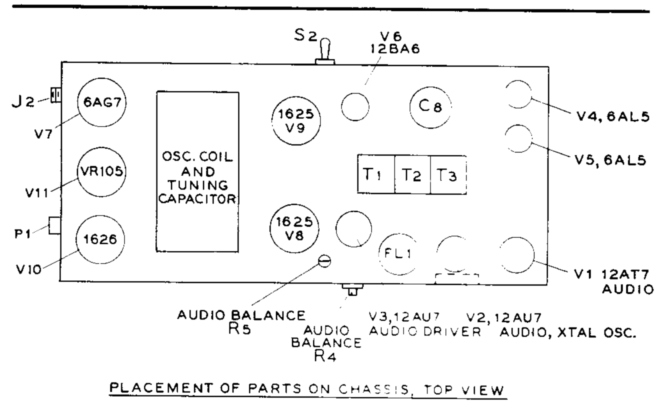


Figure 40
Placement of parts on chassis, top view

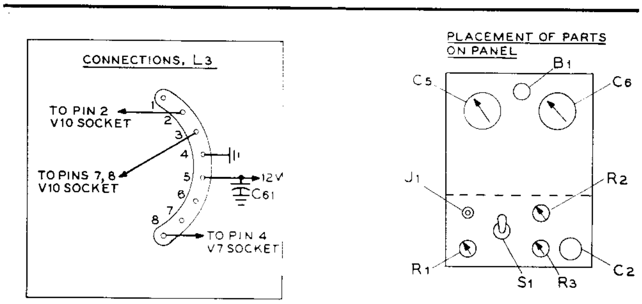


Figure 41
Panel layout and coil connections, L-3

of C-61 is grounded. The "hot" terminal of C-61 is wired to the 12-volt filament circuit. Pins #1, 6 and 7 of L-3 are left empty.

The next step is to wire the audio stages and the audio filter. Mount the ½-watt resistors and ceramic capacitors directly on the socket pins to conserve space wherever possible. Capacitor C8A-B-C-D is a four-section can mounted to the chassis, and balance control R-5 is on the chassis deck, above R-4. Because of restricted space, R-5 is a subminiature control, only ¾" diameter *(CTC type "Mini-pot")*.

Now, wire the crystal oscillator, balanced modulator, and 9 Mc. amplifier stages. Wind coils L-1, L-2, L-4, and L-5 according to the data of figure 42. Mount 9 Mc. crystal X-1 to the inner wall of the chassis by means of a small aluminum clamp. Capacitor C-1 is merely the capacitive coupling between coils L-1 and L-2, which are separated about one inch, center to center. The leads from the link coils to potentiometers R-2 and R-3 are twisted together. Silver mica capacitors are employed across L-1, L-2, L-4, and L-5, and also across L-7.

Finally, wire the mixer, V-7, and the 1625 amplifier stage. Plate coil L-8 is supported at one end by the stator of loading capacitor C-6, and at the opposite end by the 500 μμfd. TV-type coupling capacitor, which is mounted on a small metal bushing between the 1625 sockets. Choke RFC-3 is placed between the capacitor and the oscillator shield, as seen in the top view photograph. Capacitors C-5 and C-6 are mounted to the front panel, with their rotors grounded to the panel. A short length of coaxial line is run from capacitor C-6 to coaxial receptacle J-2 mounted on the rear of the chassis. Ground the outer shield of the line at both ends.

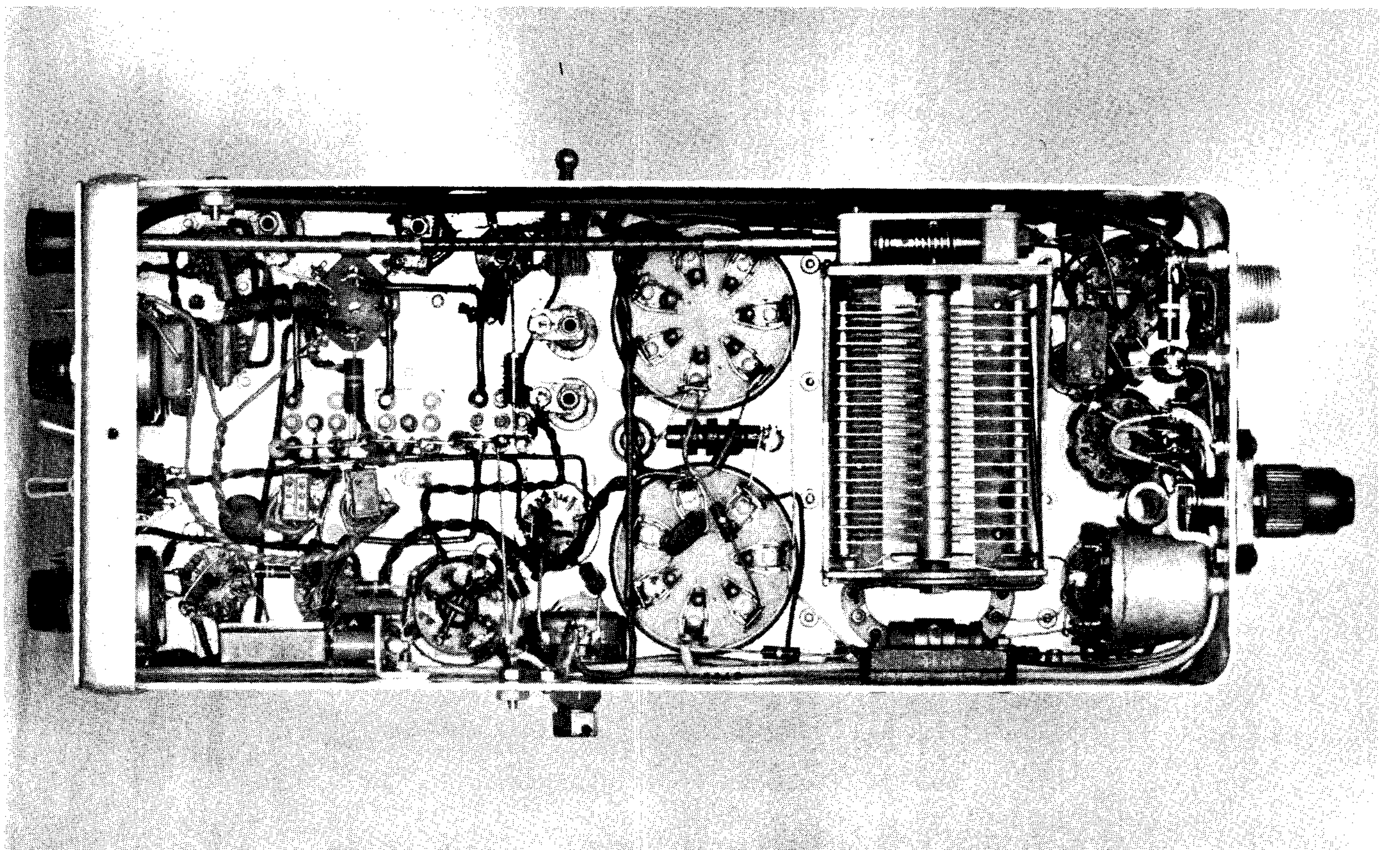
As a last step, check all your wiring against figure 39.

L-1, L-2, L-5, L-6—25 turns #22 e. wire, slug-tuned form, 5/16" diam. Link 4 turns over "cold end"
L-3—Original oscillator coil, see figure 41
L-4—8 turns #16 e., slug-tuned form, 5/16" diam. Link, 1 turn at center
L-7—3.5 Mc. 39 turns #26 e., slug-tuned form, 5/16" diam., tuned by 150 μμfd. capacitor (C-4), 14 Mc., 25 turns #22 e., slug-tuned form, 5/16" diam., tuned by 56 μμfd. capacitor (C-4).
L-8—3.5 Mc. 46 turns #20, 16 turns per inch, 1" diam. (B. & W. 3015) 14 Mc. 12 turns #14, 1" diam., 1 - 5/8" long.

Figure 43
COIL TABLE FOR S.S.B. EXCITER

Adjusting the S.S.B. Transmitter Adjustment of this transmitter is done in steps. First, plug in all tubes and determine that the filaments operate when 12.6 volts is applied between the filament pin and ground of the power plug. Remove all tubes except the oscillator

Figure 42
Under-chassis view of S.S.B. transmitter. Audio system components occupy space of old amplifier tank capacitors. Coils L-1 and L-2 are mounted behind one 1625 tube socket, near center of chassis. Coaxial lead runs from C-6 to coaxial output jack J-2 on rear of chassis.



tube V-10 and the regulator tube, V-11. Apply 300 volts to the transmitter and check v.f.o. operation by listening to the 5 Mc. region in a nearby receiver. Adjust capacitor C-60 (atop the chassis, see figure 2) to bring the 5.3 Mc. dial point down to 5 Mc. Now, plug in tube V-2 and listen at 9 Mc. Adjust the slug of coil L-2 until the crystal stage oscillates.

You now need an audio oscillator for the next adjustment step. A high quality, low distortion oscillator (such as the Heathkit AG-10 or AG-9A should be employed). A low level, 1200 cycle audio signal is injected in microphone jack J-1. Coils L-4, L-5, and L-6 are peaked for maximum 9 Mc. signal as measured with a vacuum tube voltmeter connected from pin #5 of socket V-7 to ground, or with a antenna lead of a nearby receiver held close to pin #5.

As long as the audio signal is applied, a signal at the sideband frequency will appear in circuit C-4—L-7. Let us assume, as an example, that this circuit is tuned to 80 meters. Tune your receiver to 80 meters and listen for the signal. You will hear a signal, modulated with the 1200 cycle tone at a frequency that is the difference between 9 Mc. (the crystal frequency) and the frequency of the v.f.o. Adjust L-7 for maximum signal. Next, turn off the audio signal, and adjust carrier balance potentiometers R-2 and R-3 for minimum signal.

The audio balance controls and coils L-1 and L-2 are best adjusted with the aid of an oscilloscope using "ripple" patterns. These adjustments are covered in detail in the RADIO HANDBOOK (published by Editors and Engineers, Summerland, Calif.), or in the Handbook *Single Sideband for Radio Amateurs*, published by the American Radio Relay League. In brief, the vertical plates of the 'scope tube are link-coupled to coil L-6, and oscillator tube V-10 is removed, leaving only the 9 Mc. signal input to V-7. The 'scope pattern will have a modulation "ripple" upon it. Listening to the 9 Mc. signal in a nearby receiver will allow you to hear the 1200 cycle audio tone impressed upon the speech system. During adjustments, the audio level should be held as low as possible to prevent overloading the phasing system of the transmitter. Couple the receiver to coil L-6 and reduce the gain to prevent overloading. Now, adjust balance controls R-5 and R-4 for minimum "ripple" on the 'scope pattern. Also adjust the slugs of coils L-1 and L-2 for minimum ripple. Keep the audio level as low as possible, and go over the adjustments several times. Also rebalance the carrier balance controls R-2 and R-3 for minimum pattern. Reverse sideband switch S-1 and recheck your adjustments. You should strive to obtain minimum "ripple" regardless of the setting of switch S-1. Once this point has been reached, disconnect the audio generator and 'scope and connect a microphone to J-1. You should hear a clean s.s.b. signal at 9 Mc.

Linear Amplifier Adjustment Plug in the 1625 tubes and apply about —18 volts bias (use flashlight batteries or small "C" batteries) and jumper high voltage terminal P-1 to the 250 volt supply, placing 250 volts on the plate circuit of the tubes. Resting plate current will be about 90 milliamperes or so. Unbalance carrier control R-2 or R-3 and you will obtain an 80-meter carrier in the plate circuit of the linear stage. You can now resonate and tune this stage like any other amplifier. For 80-meter operation, capacitor C-7 must be placed across the output jack J-2. The value of this capacitance depends upon the impedance of the antenna system, and will vary between 300 $\mu\mu$fd. and 1500 $\mu\mu$fd. As a starter, parallel two sections of a broadcast-type variable capacitor and use it for C-7. Set it at maximum capacity.

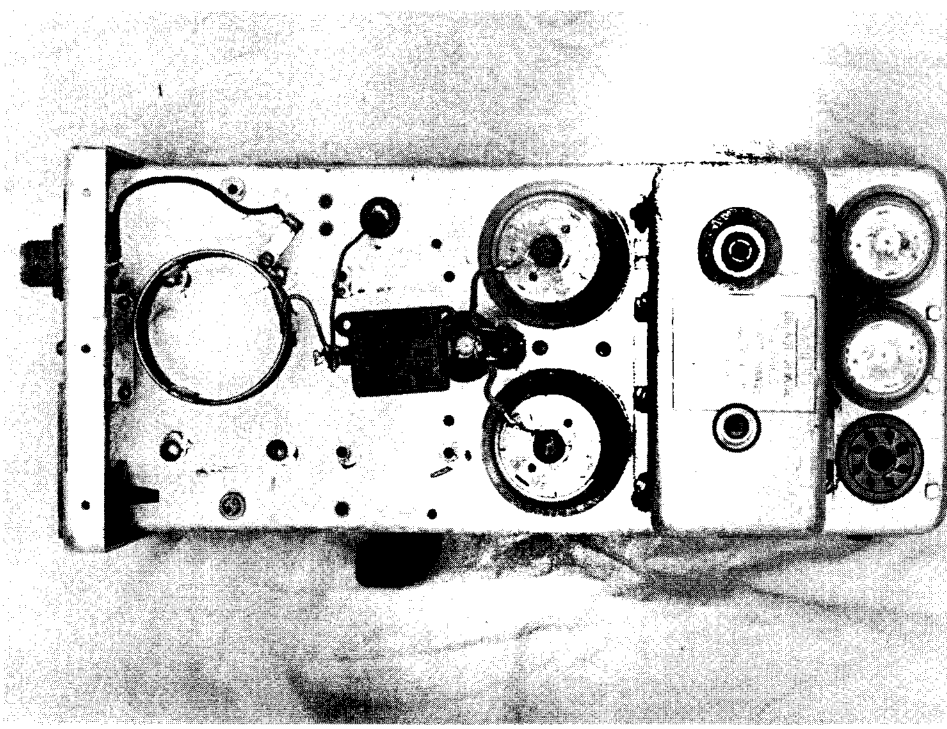


Figure 44
"COMMAND" TRANSMITTER MAY EASILY BE CONVERTED INTO HIGH POWER S.S.B. LINEAR AMPLIFIER
250 watts peak power is run by inexpensive 1625 tubes (center). Voltage regulator tubes are at rear of chassis.

After you have become familiar with operation at 250 volts, you can boost the plate voltage to 1000 volts or so. The bias voltage for the 1625 tubes should be raised until the no-signal plate current is about 35 ma. at 1000 volts. For other plate voltage values, the bias should be adjusted so that the product of the voltage and the no-signal plate current results in a power input of 35 watts to the two tubes. Under full voice input signal, the plate current will kick up to 120 milliamperes or so.

Convert Your Command Transmitter to a S.S.B. Linear Amplifier

The Command transmitter makes an excellent linear amplifier for 40- or 80-meter operation, capable of running a peak power input of 250 watts. It makes a good linear amplifier for the *10A* or *20A* sideband exciter, or for any s.s.b. exciter capable of delivering a few watts of power in the 40- or 80-meter amateur band.

For 80-meter operation, the 3–4 Mc. (BC-696, or T-19/ARC-5) or the 4–5.5 Mc. (BC-457, or T-20/ARC-5) transmitter may be used. For 40 meters, the 5.3–7 Mc. (BC-458, or T-21/ARC-5) or the 7–9.1

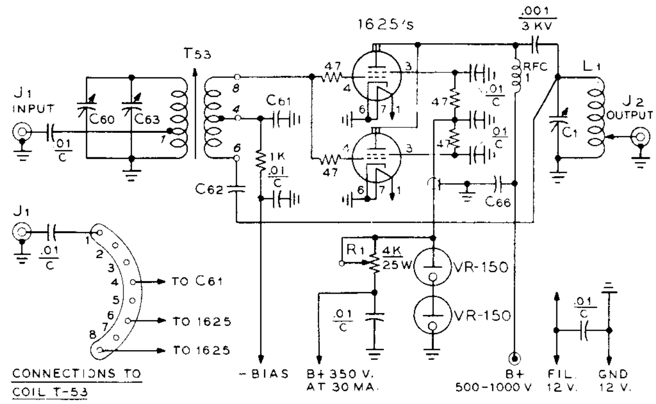


Figure 45
SCHEMATIC, S.S.B. LINEAR AMPLIFIER MADE FROM A "COMMAND" TRANSMITTER

C-1—300 $\mu\mu$fd. Bud MC-1860
L-1—Adjust to tune to output frequency with C-1 nearly fully meshed. Air-Dux 1610, or B&W 3907-1 coil stock (2" diam., 10 turns per inch). Adjust antenna tap for optimum loading
RFC-1—2.5 mh. choke "transmitting type."

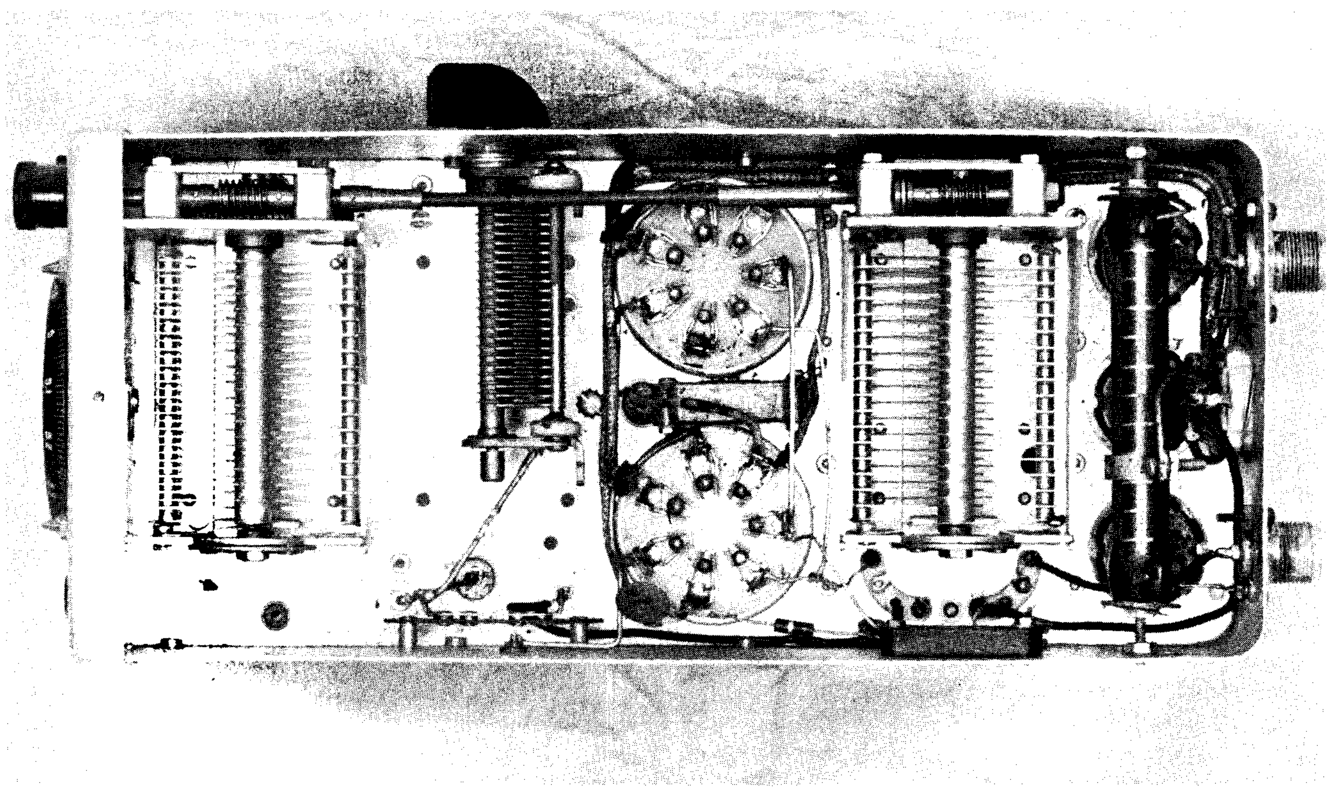


Figure 46
UNDER-CHASSIS VIEW OF S.S.B. LINEAR AMPLIFIER
Screen resistor R-1 is mounted to rear of chassis above the voltage regulator tube sockets. Plate tuning capacitor C-1 is adjustable through side of chassis. Shielded wire is employed for filament, screen, and bias leads. Tuning capacitor near dial is not used, serving only as a bearing for extension drive shaft.

Mc. (BC-459, or T-22/ARC-5) transmitter may be used. Power requirements are 12.6 volts at 0.9 amperes, 350 volts at 35 ma., and 500 to 1000 volts at 150 ma. plate potential.

Conversion to S.S.B. Service This conversion entails the removal of the oscillator and auxiliary equipment, and the conversion of the oscillator coil to form an amplifier grid coil. Voltage regulator tubes are added to the screen circuit of the final amplifier. A new amplifier plate circuit is also required.

The first step is to remove the unwanted components. Beneath the chassis, remove R-71, C-58, C-64, and all small components on the three rear tube sockets. Remove R-75, R-76, and auxiliary padding capacitor C-67. Remove relay K-53, and resistor R-78. Above the chassis, remove the antenna relay K-54 and the loading coil. Remove the plate coil T-54 and the rotary link control. Remove all loose leads and wires.

Wiring the Linear Amplifier A schematic of the converted Command set is shown in figure 45, and top and bottom photographs are given in figures 44 and 46. A five-prong socket replaces the rear power receptacle, J-64. The VR-150 and VR-105 regulator tubes are placed in two empty octal sockets at the back of the chassis.

Tap #1 on the old oscillator coil (T-53) is used as the r.f. input circuit for the amplifier. Excitation may be controlled by tuning the main dial of the transmitter for greatest grid drive. The plate circuit of the linear amplifier uses a new tuning capacitor, C-1. The old, ganged capacitor is not used, but is retained to act as a bearing for the oscillator tuning shaft.

Plate coil L-1 is mounted above the chassis as seen in figure 44. It should be pruned so that resonance on 80 meters occurs with C-1 almost fully meshed, and 40-meter resonance occurs with C-1 about 75% meshed. The antenna tap on L-1 is connected to a coaxial receptacle mounted on the front panel of the amplifier. An external 0—250 ma. d.c. milliammeter may be placed in the B-plus lead for tune-up purposes. Pins #6 and #7 of each 1625 socket are grounded to the metal shell, and the "hot" filament line is bypassed with a 0.01 μfd. ceramic disc capacitor. Pin #3 of each socket is also bypassed to the metal shell with a similar capacitor.

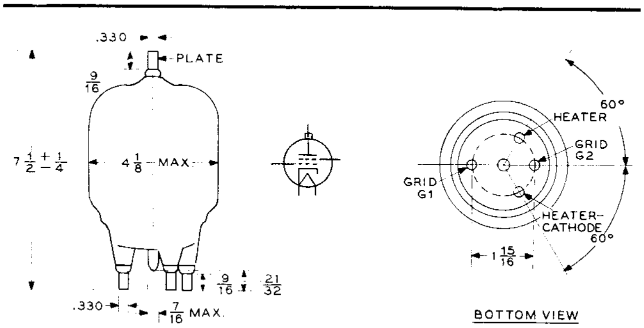


Figure 47
OUTLINE DRAWING OF W.E. 701-A VACUUM TUBE, SHOWING TERMINAL CONNECTIONS

Linear Amplifier Operation Bias voltage is applied to the amplifier, and the B-plus lead is temporarily connected to the 350 volt supply for tune-up purposes. Bias voltage is varied (about —18 volts) until the no-signal plate current of the amplifier is about 90 milliamperes. A small s.s.b. signal is applied to the input and the tuning dial varied until a rise in the plate current of the amplifier is noted. It may be necessary to adjust padding capacitor C-60 or the slug of coil T-53 to obtain resonance. Plate tuning capacitor C-1 is tuned for plate circuit resonance, and the tap on coil L-1 is adjusted for optimum antenna loading. Resistor R-1 should be adjusted for about 30 ma. of regulator tube current. When the amplifier is operating properly, the 1625 plate voltage may be raised to a maximum of 1000 volts. Bias should be adjusted to provide a no-signal plate current of about 35 ma. Under full excitation, maximum average plate current will be about 125 ma., providing a s.s.b. input signal of about 300 peak watts. The antenna tap on coil L-1 may be readjusted at the higher value of plate voltage for optimum antenna loading.

Using the Western Electric 701-A Tetrode

The large Western.Electric 701-A tetrode is available on the surplus market for a low price. The physical size of the tube (7½" high, 4¼" diameter) suggests that it would make a good high power r.f. amplifier. The tube is a tetrode intended for pulse modulator operation. It has an indirectly heated cathode, with the plate terminal of the tube at the top of the glass bulb. Connections to the terminals and the outline of the tube are shown in figure 47. A modified Western Electric 153A socket may be used, or the experimenter can easily build his own socket. The tube should be mounted in a vertical position, and there should be a free circulation of air around the glass envelope.

The pulse modulator ratings of the tube are:
Heater Voltage, 8.0 volts, a.c. or d.c.
Heater Current, 7.5 amperes.
Maximum plate voltage (pulse), 12,500 volts.
Maximum screen voltage (pulse), 1,200 volts.
Average plate current (pulse), 80 ma.
Peak pulse plate current, 10 amperes.
Plate dissipation (pulse), 100 watts.
Screen dissipation (pulse), 15 watts.

The suggested class-C operating conditions for amateur service are:

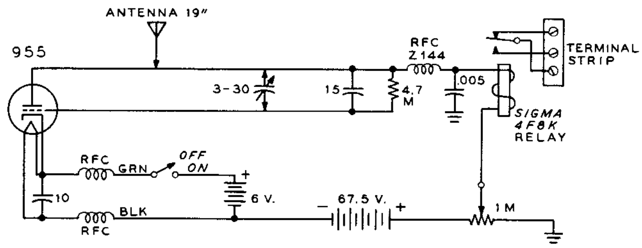


Figure 48
SCHEMATIC, MODIFIED BC-1253
METEOROLOGICAL TRANSMITTER

Filament voltage, 7.5 volts.
Filament current, 7.0 amperes.

Plate Voltage	2000	2500	3000	3500	(volts)
Plate current	350	300	250	250	(ma.)
Power Input	750	750	750	875	(watts)
Plate dissipation	220	200	160	175	(watts)
Screen voltage	400	400	400	400	(volts)
Screen current	40	40	40	40	(ma.)
Screen dissipation	20	20	20	20	(watts)
Grid voltage	−150	−150	−150	−150	(volts)
Grid current	15	15	15	15	(ma.)

Note: It is suggested that a 6Y6-G be used as a screen clamper tube to protect the 701-A from excessive screen dissipation.

Inter-electrode capacitances:

Input	15.6 $\mu\mu$fd.
Output	8.5 $\mu\mu$fd.
Grid-plate	0.16 $\mu\mu$fd.

Converting the BC-1253 to a Sensitive Radio Control Receiver

The BC-1253 meteorological transmitter, available in quantity in the surplus stores can easily be converted to an excellent radio control receiver, featuring high sensitivity, good stability, and light weight. The receiver is suitable for use in model airplanes, boats, etc. The BC-1253 was originally used in weather balloons to send upper-atmosphere weather information back to earth. The transmitter is contained in a small, strong cardboard box that is attached to the sounding balloon. A lightweight battery pack accompanies the transmitter on its flight into the heavens.

The BC-1253 employs a single 955 acorn triode tube as a milliwatt oscillator, with the socket of the oscillator built into the end of a silver-plated tank circuit. The converted circuit of the oscillator is shown in figure 48. Note that the only steps necessary for the conversion are to remove the unnecessary components, change the value of the 955 grid resistor, and make the wiring changes shown.

Conversion to a Radio Control Receiver The original transmitter circuit uses several connections on a socket strip that it is mounted on. All connections to this strip are removed. To do a neat job, the contact pins should be drilled off and the space provided used to mount the additional parts. It is necessary to add a 3–30 $\mu\mu$fd. variable compression trimmer capacitor across the tuned circuit line. It will be necessary to slide the trimmer up and down the lines while adjusting the capacitor to hit the 2 meter (144 Mc.) amateur band. Varying the antenna tap and the tuning capacitor will permit the detector to remain in oscillation across the complete band.

A super-regenerative detector circuit is employed for maximum sensitivity. For optimum results, the plate circuit relay (Sigma type 4F) should be set to pull in at 1 milliampere of plate current. This can be checked by connecting the relay coil in series with a 50K potentiometer, a 45 volt battery, and a milliammeter. Adjust the point spacing of the contacts and the spring tension so that the relay pulls in at about 1 milliampere, and drops out at about 0.8 ma. Now, insert the relay back into the receiver circuit and adjust the variable plate voltage control until the relay pulls in. Next, back off slightly on the control until the relay drops out. A nearby 2-meter r.f. signal picked up by the receiver should now cause the relay to pull in. Adjust the antenna tap for maximum receiver sensitivity.

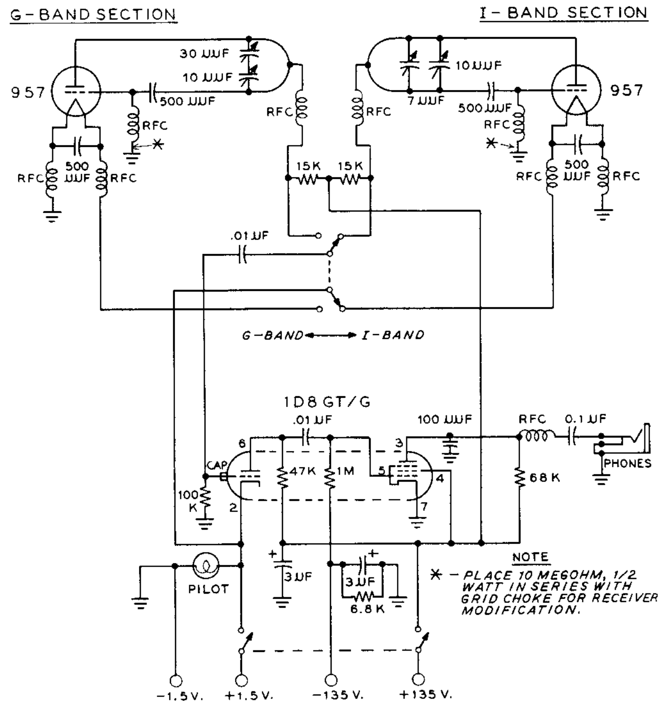


Figure 49
SCHEMATIC, MODIFIED BC-1066 I.F.F.
TEST SET

Converting the BC-1066 to a 144 Mc.—220 Mc. Receiver

The BC-1066 Test Equipment is a dual v.h.f. oscillator intended to check the operation of the SCR-695 "I.F.F." radio equipment. The BC-1066 consists of two

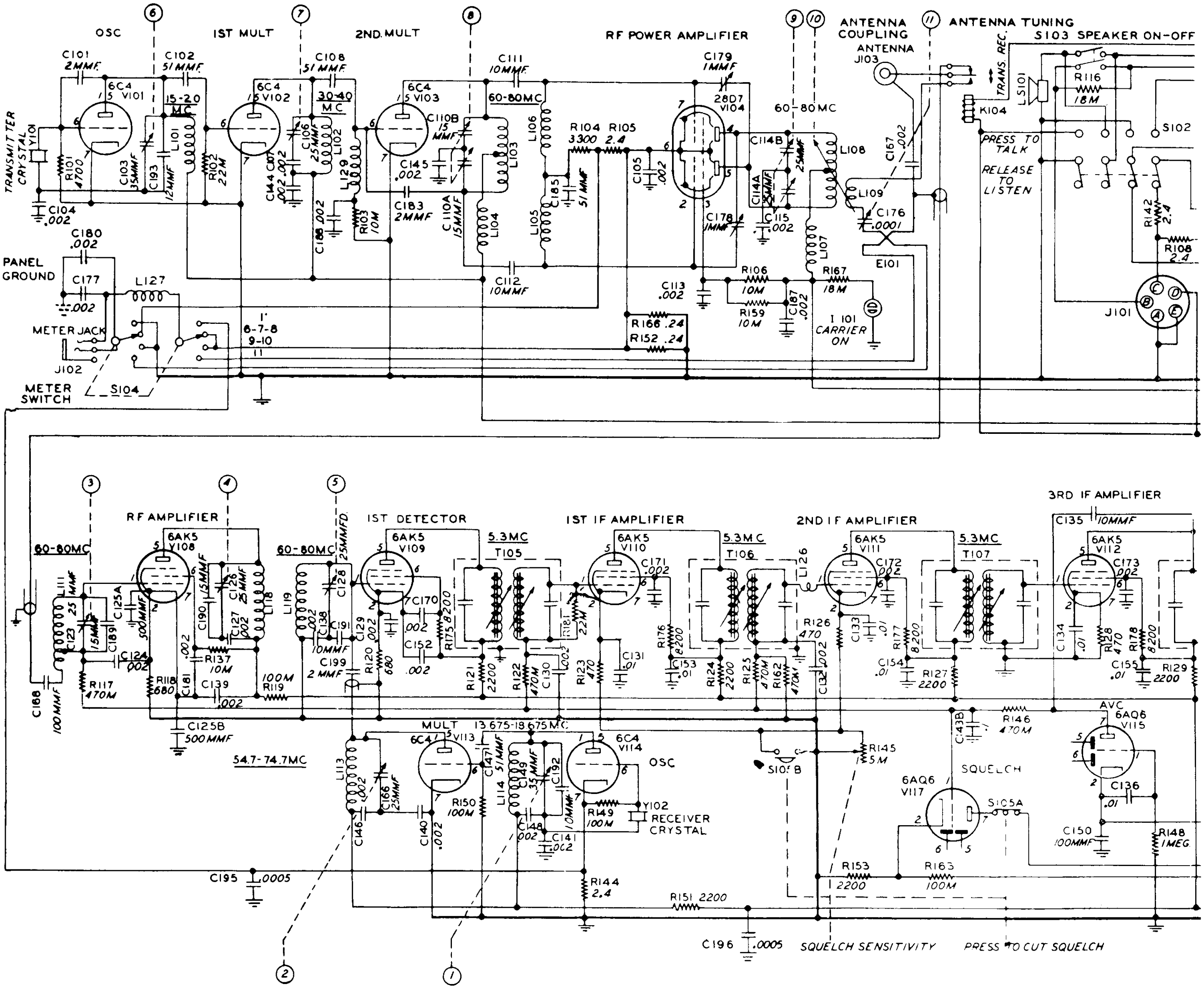


Diagram continued on page 45

Figure 50
SCHEMATIC, NAVY TYPE COL-43065 (MBF)
TRANSMITTER-RECEIVER

Diagram continued from page 44

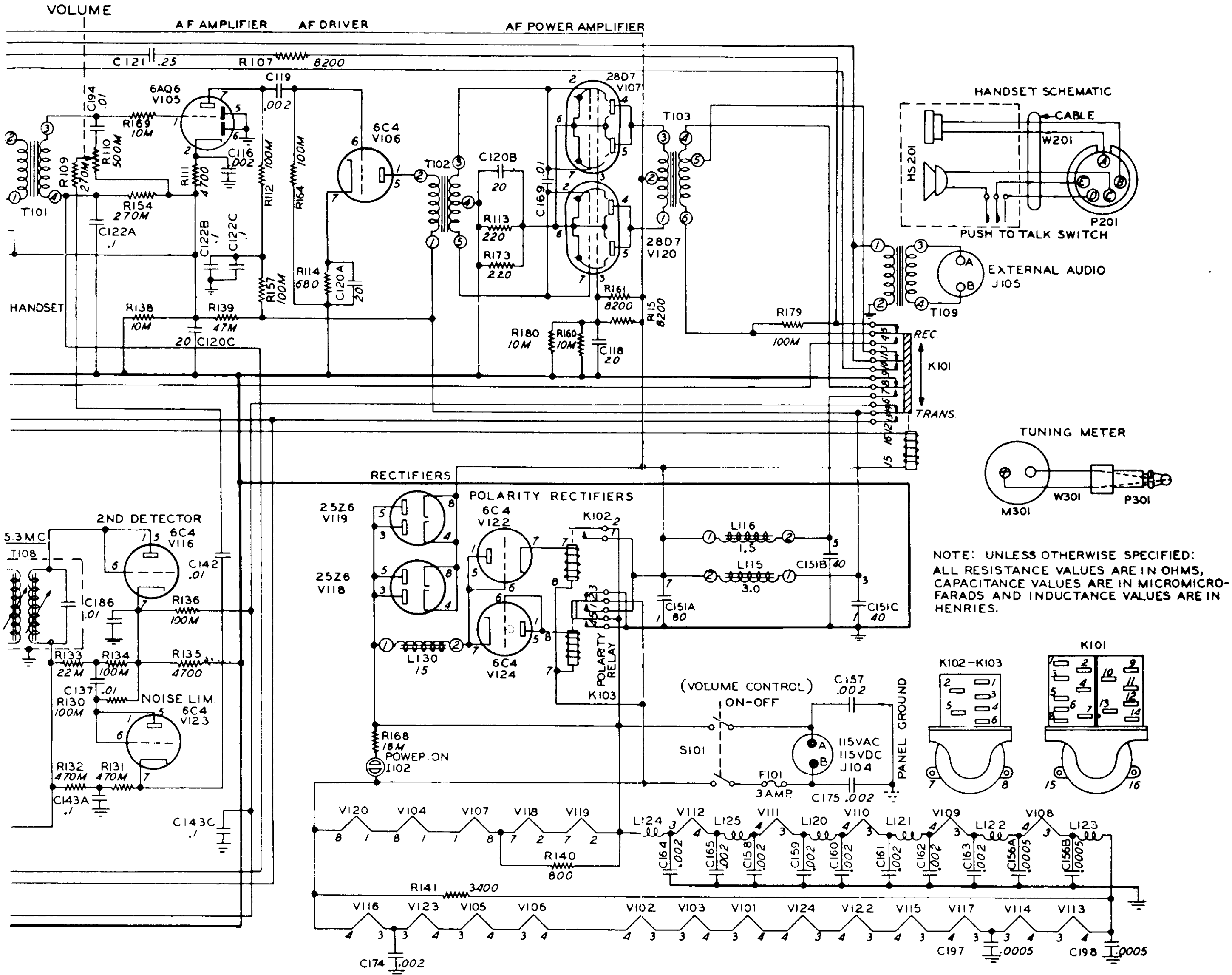


Figure 50
SCHEMATIC, NAVY TYPE COL-43065 (MBF)
TRANSMITTER-RECEIVER

super-regenerative detectors, tunable over the two I.F.F. bands. The weak pulses of the detectors were picked up by the I.F.F. set, which responded by returning a series of coded pulses which could be heard by the receiver portion of the BC-1066. This inexpensive surplus item consists of two type 957 acorn triode tubes used as v.h.f. detector-oscillators, and a 1D8-GT audio amplifier. The two tuned circuits are tunable over ranges close to the 144 Mc. and 220 Mc. amateur bands. A panel switch (I-band: G-band) selects the audio output of either detector. The audio is amplified by the 1D8-GT tube.

Conversion to a V.H.F. Receiver The BC-1066 can be converted to a sensitive receiver for the amateur 144 Mc. and 220 Mc. bands. The original circuit of the unit is shown in figure 49. It is only necessary to unground the end of each r.f. choke in the 957 circuits. In series with this choke, connect a 10 megohm, ½-watt resistor to ground.

The G-band receiver can be tuned up to the 220 Mc. band by adjusting the padding capacitor, and the I-band receiver will tune to 144 Mc. with a simple adjustment of the padder capacitor. The BC-1066 draws only a small amount of current, and a size D cell, plus two small 67½-volt batteries will last for many months. It is an excellent receiver for "Field Day" or any portable v.h.f. use. Two ¼-wave whip antennas mounted atop the case and link coupled to the respective tuned circuits will be satisfactory for portable work.

Conversion of R-9/APN-4 for 115 Volt A.C. 60 Cycle Operation

R-9/APN-4 makes a good 160 meter receiver when converted for 50–60 cycle operation. The receiver operates on four preset channels, any one of which can be selected by the main channel switch. In this conversion, the power supply is adapted for operation from your light line, and the receiver is modified for operation without auxiliary equipment. The 1400-volt supply in the receiver for the Loran 'scope tube is not used.

Receiver Section Conversion Check off each step as you do the conversion.

1–Remove J-104 (red) from the panel and install a phone jack in its hole. Solder the center wire of the coaxial cable to the tip connection of the jack.

2–Remove the wires from the "Filter In–Out" switch. Splice the wires together near the 6SL7 socket. Tape the wire joint.

3–Cut away the wire between pin #8 of 6SN7 socket and pin #1 of 6SL7 socket.

4–Remove J-103 (blue) but leave its wire. Install in its hole a 3K potentiometer. Connect the wire to the center terminal of the potentiometer, and ground one other terminal. This is now the audio volume control.

Power Supply Section Conversion 1–Remove J-102 (yellow) and switch S-103 (line voltage).

2–Remove the wires between pins #3 and #4 of J-106 and the power switch.

3–Unsolder the black wire (which goes to terminal #1 of T-105) from standoff insulator and resolder to terminal #3 of J-106.

4–Remove the white wire from terminal #3 of T-105 and connect terminal #3 of T-105 to pin #4 of J-106. Tape the end of the white wire.

5–On T-105: Move blue (blue-red on R9-B receiver) wire from terminal #2 to terminal #3. Solder other end of this wire to end-lug of spare fuse holder.

6–Connect side-lug of spare fuse holder to one side of old "Filter Out–In" switch. Solder white wire which went to S-103 to other terminal of old "Filter Out–In" switch.

7–Remove blue wire from end-lug of F-101 and connect in its place the white-black lead which used to go to the line voltage switch. Tape the blue wire end.

8–Remove the voltage control potentiometer R-121 together with its series resistor and re-install in old line voltage switch mounting hole. Ground the loose end of resistor R-128.

9–Move red-black wire from terminal #2 of T-104 to the point on the terminal board where blue (blue-red on R9-B receiver) wire from R-121 originally terminated (see step 5). Solder the other end of this red-black wire (find correct one of two) to potentiometer R-121 in its new location.

10–Connect center terminal of R-121 to point on terminal board where green wire was connected.

11–Install switch S-103 in J-102 hole. Run wire from the center terminals to terminal #12 of T-104. Connect lower pair of terminals to "hot" lug of pilot lamp receptacle.

12–Protection from heavy current surge must be used in series with primary winding of power transormer. Place three 200-watt, 115 volt light bulbs in series with the line, using primary terminals #1 and #3. Safe operating voltage for the transformers is indicated by a voltage of 5½ across terminals #12 and #13. Ninety-eight to 100 volts should be indicated across terminals #1 and #3 for good operation.

Converting the MBF Transmitter-Receiver for 6 Meters

The Navy MBF transmitter-receiver (Navy type COL-43065) is designed to operate in the 60–80 Mc. range. It will operate from 115 volts, a.c. or d.c. The MBF has crystal controlled receiving and transmitting channels, but may be converted for manual receiver tuning. The schematic of the MBF is shown in figure 50. The following tubes are used, with their filaments connected in series-parallel across the 115 volt line:

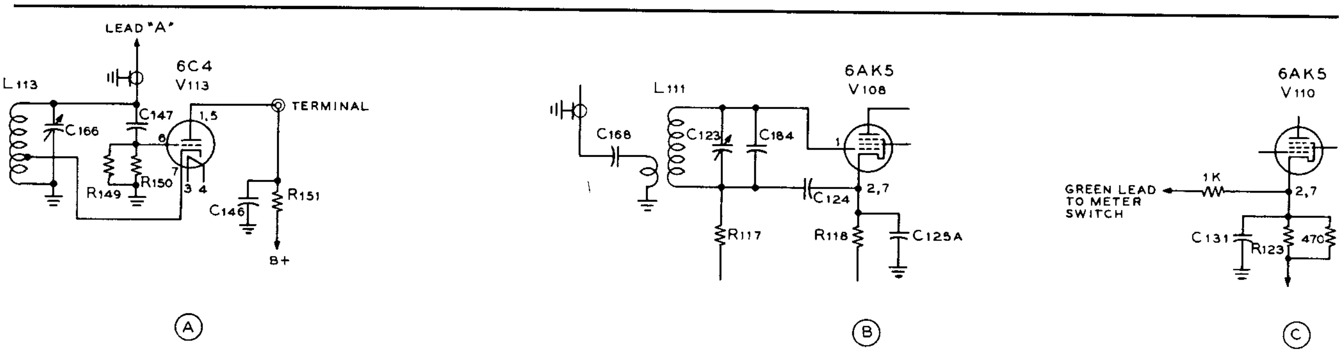


Figure 51
A—Modified oscillator circuit for MBF receiver section
B—Modified r.f. circuit for MBF receiver section
C—S-meter circuit modification

Transmitter tubes
- V-101—Transmitter oscillator, 6C4
- V-102—Frequency multiplier, 6C4
- V-103—Second multiplier, 6C4
- V-104—R.f. power amplifier, 28D7

Receiver tubes
- V-108—R.f. amplifier, 6AK5
- V-109—Mixer, 6AK5
- V-110—5.3 Mc. i.f. amplifier, 6AK5
- V-111—5.3 Mc. i.f. amplifier, 6AK5
- V-112—5.3 Mc. i.f. amplifier, 6AK5
- V-113—Injection frequency multiplier, 6C4
- V-114—Injection crystal oscillator, 6C4
- V-115—A.v.c. amplifier, 6AQ6
- V-116—Second detector, 6C4
- V-117—Squelch amplifier, 6AQ6
- V-123—Noise limiter, 6C4

Modulator and Power supply
- V-105—A.f. amplifier, 6AQ6
- V-106—A.f. driver, 6C4
- V-107—Modulator, 28D7
- V-118—Rectifier, 25Z6
- V-119—Rectifier, 25Z6
- V-120—Modulator, 28D7
- V-121—Not used
- V-122—Relay rectifier, 6C4
- V-124—Relay rectifier, 6C4

Receiver Modification for 50 Mc. Operation First, remove the MBF from the case, and set it on end with the receiver section up. Remove the screws and cover which is over the first two receiver stages. The long bar on the back should also be removed. This bar connects the receiver chassis to the transmitter chassis. There are also several bolts holding the receiver chassis to the main chassis which should be removed. Place all of the nuts, bolts, and washers in a safe place as you will need them later. Now the receiver chassis is loose with the exception of the wiring passing through a grommet to the main chassis. Do not turn the equipment on when disassembled, for if the chassis touches the front panel you will either blow a fuse or receive a shock.

Remove the receiver crystal holder Y-102, the first variable capacitor C-192, and the capacitors and resistors from the first oscillator tube socket V-114. Save all parts. Leave the 6C4 tube filaments in series with the rest of the circuit. Leave the tube in the socket. Now, remove oscillator coil L-114, being careful not to break the form. Remove the solvent from the coil form bolts, and it will be easier to remove the coil.

The second 6C4 (V-113) will now become the tunable oscillator for the receiver. The new oscillator circuit is shown in figure 51A. Compare it with the existing circuit of figure 50. First, take the 100K resistor (R-149) that you removed from the old oscillator stage and connect it in parallel with R-150, the grid resistor of tube V-113. The old coupling capacitor (C-147) is returned to the rotor of tuning capacitor C-166.

Remove capacitor C-140 from pin #7 of socket V-113. Remove the wire from pin #7 and clip it off. Remove capacitor C-146 attached to the coil and to tuning capacitor C-166. Now, take out the plate coil, L-113. This coil has 5 turns. Remove the wire, and rewind it with similar size wire, 8 turns tapped approximately one turn from the bottom. Leave the coil wire ends long and run them through the eyelets on the coil form, the bottom wire about 1" long, and the top wire about 3" long. Put the new coil back in place and rewire as shown in figure 51.

Lead "A" is the original length of coaxial cable coupling the stage to the mixer tube, V-109. It connects to its original place, at the top of the coil, or to the variable capacitor. The plate terminal of V-113 is attached to the top of the tall stand-off insulator, which is bypassed to ground with capacitor C-146 which was removed previously. Make sure that one terminal of the variable capacitor is grounded, and that pin #7 of the socket is not grounded, but returns to the coil tap. This completes the oscillator conversion.

The r.f. input circuit is converted next. The antenna coil L-111 is tapped. It is near the r.f. amplifier tube, V-108. Note where the coil leads go, then re-

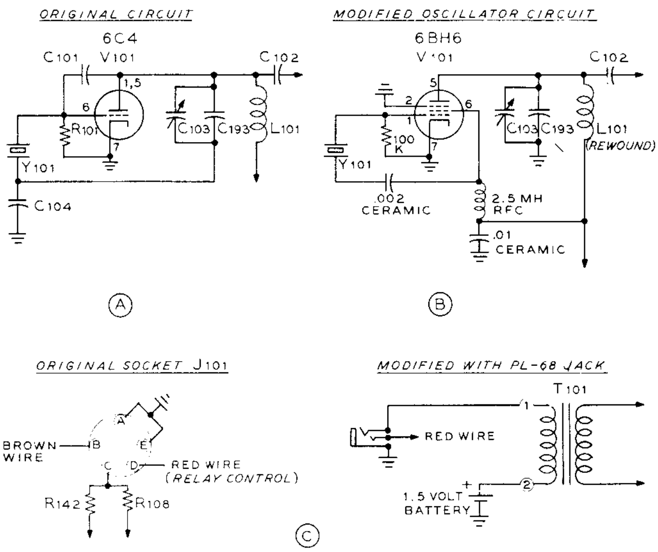


Figure 52
A—Original MBF transmitter oscillator circuit
B—Modified oscillator circuit for use with surplus crystals
C—Replacement of socket J-101 with microphone jack

move the coil. Unsolder the connections carefully, as they must be replaced later. Unwind the 5 turns on the coil, and replace with 7 turns of similar size wire, bend the ends around the eyelets and solder. Leave the hole open in the eyelets. Replace the coil. The bottom terminal goes to pin #1 of socket V-108, and to tuning capacitor C-123 and padding capacitor C-189. The top goes to the other side of the tuning capacitor, and to C-124A, and R-117.

The antenna lead is terminated near the coil at a stand-off insulator. The capacitor (C-168) attached to the insulator now goes to the top of a new two turn coil wrapped over the top turns of coil L-111. Use insulated wire for the new coil, and ground the free end to the chassis next to the coil form. Use a hot iron, and don't damage coil L-111. See figure 51B.

The final modification in the receiver r.f. section is to modify mixer coil L-118-119. Both coils are wound on the same form. Remove the form, remembering where the connections are attached. The coils have 4 turns each. Remove the windings, and rewind with similar size wire, 6 turns each. Replace the coil, and solder all leads.

Other Receiver Modifications 1—The "Press to cut Squelch" switch (S-105) should be changed to a d.p.d.t. toggle switch. The wires to the top two terminals should be interchanged with the wires to the bottom two terminals on the new switch to make the panel markings read right. Be sure not to cross-connect the wires.

2—Remove the two brackets on the panel holding the cover over the receiver tuning capacitors.

3—It is easy to make meter position #1 a "S-meter" for the receiver. Remove the green lead attached to pin #7 and R-144 of socket V-114. Connect this lead to the cathode (pin #2) of the first i.f. tube socket, V-110 through a series resistor of 1K. Shunt cathode resistor R-123 with a 470 ohm, ½-watt resistor (figure 51C).

The receiver chassis is now remounted to the front panel. Remember to replace the phenolic insulator the right way with the bolt holes in the right place. Make sure the front panel mounting screws do not touch the chassis since there is a potential difference between the two.

Testing the Receiver Place a short antenna on the receiver (use J-103), and tune the oscillator tuning capacitor until you hear a station. You can probably hear TV channel 2 or 3 (a strong, a.c. buzz). Peak the other stages by ear. If you hear nothing, check your squelch switch.

Transmitter Modification for 50 Mc. Operation The original MBF circuit uses expensive high frequency crystals. In order to employ the plentiful 6 Mc. type FT-243 crystals, the oscillator circuit must be modified as shown in figure 52. A 6BH6 regenerative oscillator replaces old oscillator tube V-101 (6C4). The new tube has the same filament current as the old for proper series string operation. Terminals #3, 4, and 7 are untouched, and terminal #2 of socket V-101 must be grounded. Terminals #1, 5, and 6 are rewired as shown in figure 52B. Plate coil L-101 tunes to the second harmonic (12 Mc.) of the crystal and is rewound with 26 turns of #26 e. wire. The multiplier stage (V-102) now should tune to the 24–25 Mc. region. Coil L-102 should be altered to 17 turns of #22 e. wire. Space the turns to grid-dip to 25 Mc. The second multiplier tube (V-103) doubles to 50 Mc. Rewind L-103 to 18 turns, center-tapped, #14 e. wire, ½-inch diameter, turns spaced one wire diameter. Adjust spacing to grid-dip the circuit to 51 Mc.

The plate coil of the push-pull 28D7 is modified to 8 turns, center-tapped, #14 e. wire, one-inch diameter, turns spaced two wire-diameters. Adjust spacing to grid-dip to 51 Mc. The new antenna coil, L-109 is 3 turns, #12 e. wire, one-inch diameter, turns spaced one wire diameter. This completes modification of the r.f. circuitry.

Miscellaneous Transmitter Modifications 1—Change socket J-101 to a PL-68 microphone jack mounted on an insulating plate. Remove the two back wires from terminals #1 and #2 of transformer T-101. Tape each wire. Run a wire from the PL-68 sleeve contact to terminal #1 of T-101, and another wire from terminal #2 of T-101 through 1½-volt flashlight battery to ground. Tape the tube shield next to the microphone jack to keep it from shortening out (figure 52C).

2–Place a 10 μfd. 25-volt electrolytic capacitor across cathode resistor R-111 (4.7K) of tube socket V-105 (6AQ6). Positive terminal of the capacitor goes to pin #2 of the socket.

3–Parallel audio coupling capacitor C-119 with a 0.01 μfd. ceramic disc capacitor.

Convert Your Surplus 24-Volt Dynamotors to 115 Volt A.C. Motors

You can convert almost any 28-volt dynamotor to a 115-volt motor by the following changes: Remove the brushes from the motor end of the dynamotor. Next, move the two field wires from the motor end to the generator end, and connect them in parallel with the generator field winding. (You have a fifty-fifty chance of guessing the correct polarity of the connections. If the motor does not run, reverse the motor field connections.) Finally, connect a 115-volt line cord across the field coils and generator brushes. You might have to drill and tap the shaft for an extension if it is not long enough to fasten a coupling to it. Your converted motor does not have as much torque as a standard motor, but it may be used for turning fans, grinding wheels, etc.

Adding a Tuning Control to the R-28/ARC-5 V.H.F. Receiver

The R-28/ARC-5 receiver is a ten tube superheterodyne covering the frequency range of 100–156 Mc. in four crystal controlled channels. The receiver requires 24 volts a.c. for the filaments, and 250 volts at 75 ma. plate potential. The complete schematic of the receiver is given in figure 54. It is a very simple matter to change the crystal controlled oscillator to a tunable oscillator for 144 Mc. reception. The receiver can thereby be used for general 2-meter reception.

First, remove the sides and top cover, and the oscillator compartment covers. Locate the crystal oscillator stage, V-108. Connect a 100 $\mu\mu$fd. mica capacitor from the junction of coil L-111 and R-152 to pin #4 (grid) of socket V-108 (12SH7). Install a variable 10 $\mu\mu$fd. tuning capacitor in series with a 3–30 $\mu\mu$fd. zero temperature coefficient ceramic variable capacitor. Ground the rotor of the variable capacitor to the chassis. Connect the free terminal of the ceramic capacitor to pin #8 of socket V-108 (plate). The 3–30 $\mu\mu$fd. capacitor acts as a bandspread capacitor so that the 144 Mc. band can be spread across the full dial of the 10 $\mu\mu$fd. tuning capacitor. When the ceramic capacitor is fully meshed, the tuning range of the receiver is 140–150 Mc. Converted in this manner, the oscillator acts as a tunable oscillator in the region of the original crystal frequency. The succeeding multiplier stages increase this frequency up to the region required for local oscillator injection. Set the receiver to channel B or C for optimum 2-meter reception. The automatic tuning unit may be reworked as described in the section of this book dealing with the T-23/ARC-5 transmitter.

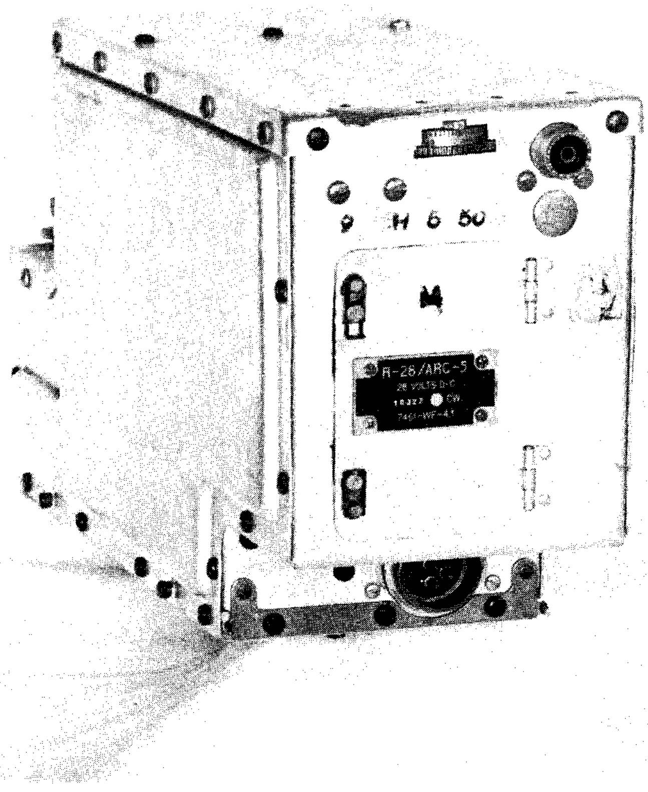


Figure 53
R-28/ARC-5 V.H.F. receiver may be used for 2-meter reception. Receptacle J-103 is at bottom of front panel. Dynamotor space is at rear of receiver deck. Approximate tuning of receiver is indicated by edge-dial at top of panel.

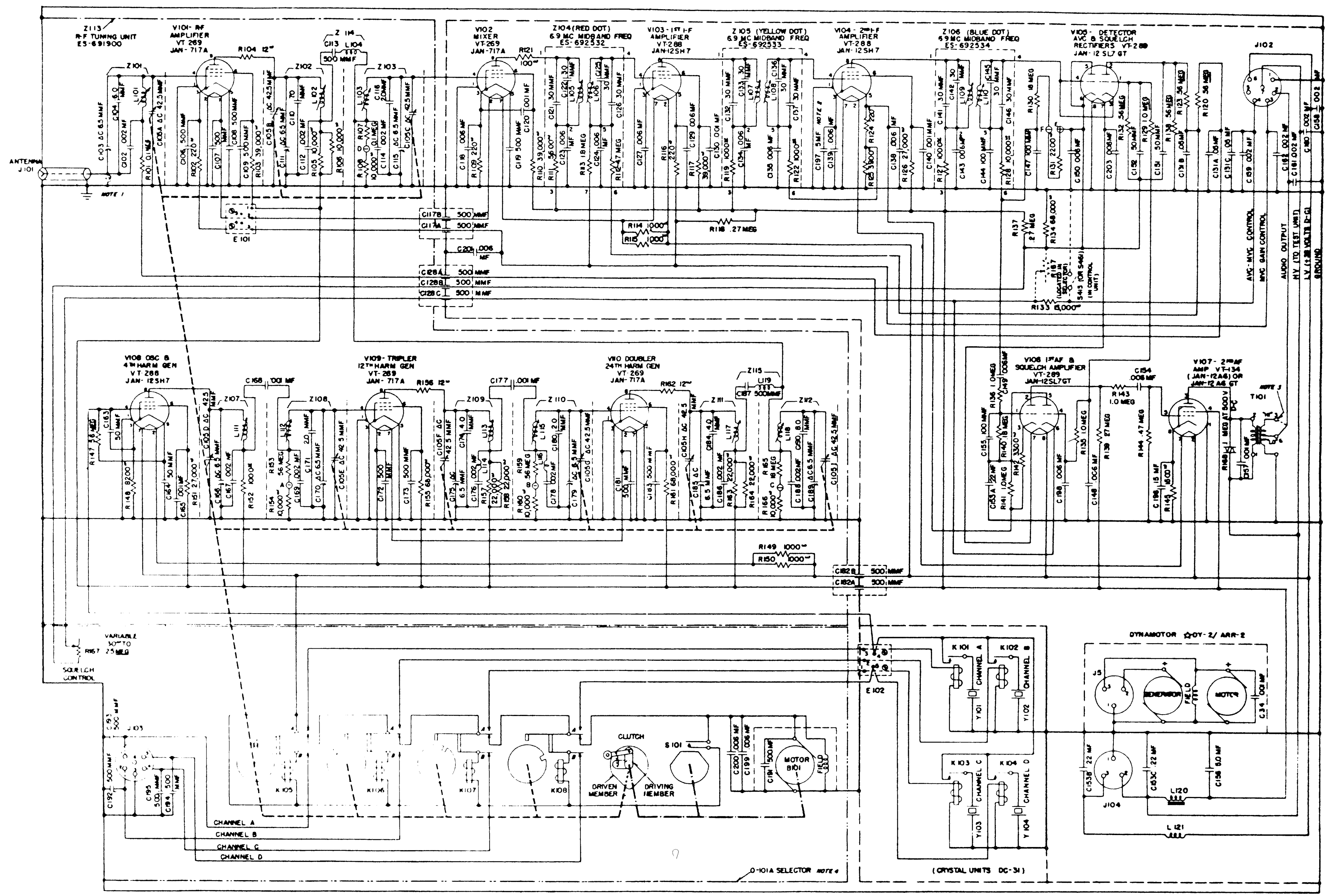


Figure 54
SCHEMATIC, R-28/ARC-5 RECEIVER

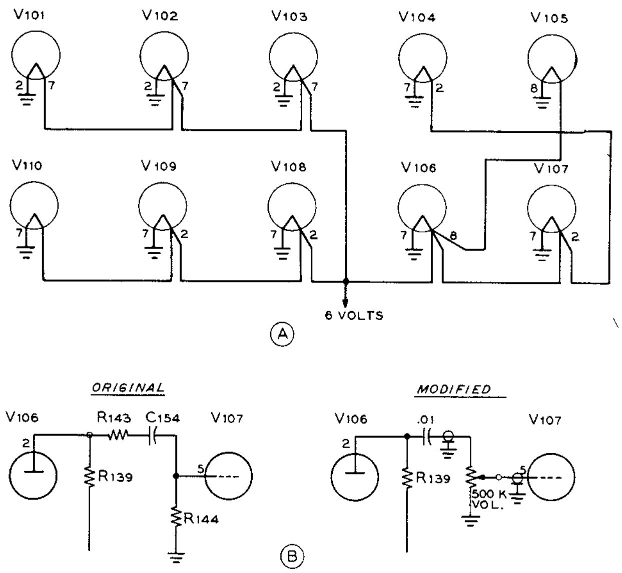


Figure 55
A—Modified filament circuit for 6 volt operation, R-28/ARC-5
B—Modified audio circuit

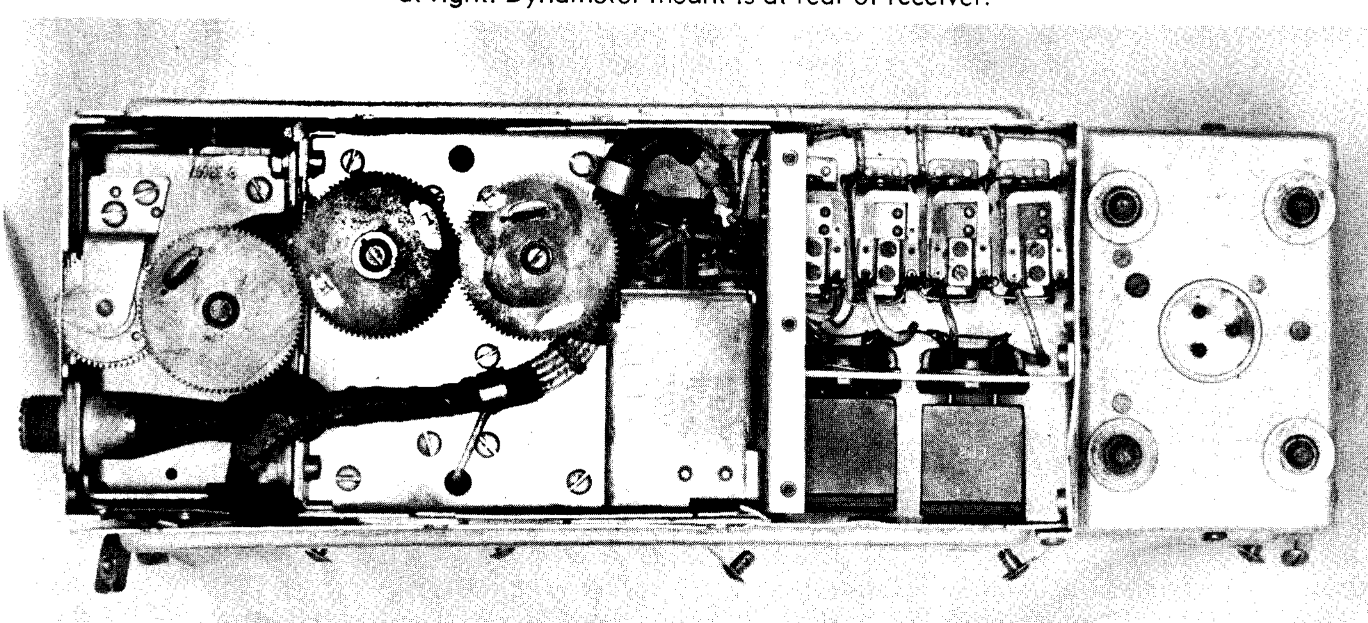
Rewiring the Filament Circuit for Six Volt Operation It is necessary to replace all the 12-volt tubes with their 6-volt equivalents for 6-volt operation. The 717-A tubes have 6-volt filaments and are not changed. The following wiring changes in the filament circuit are made:

1–(Refer to figure 55A). Remove the wire from pin #2 of socket V-102 and connect this lead to pin #7 of socket V-102. Ground pin #2 of V-102.
2–Remove the wire from pin #2 of socket V-103 and connect this lead to pin #7 of socket V-103. Also remove the two 1K resistors connected between pin #2 and pin #7 of V-103. Ground pin #2 of V-103.
3–Remove the wire from pin #7 of V-109 and connect it to pin #2 of V-109. Ground pin #7 of V-109.
4–Remove the two 1K resistors between pin #2 and pin #7 of V-108. Remove the wire on pin #7 of V-108 and connect it to pin #2 of V-108. Ground pin #7 of V-108.
5–Remove the wire on pin #7 of V-107 and connect it to pin #2 of V-107. Ground pin #7 of V-107.
6–Remove the wire on pin #7 of V-106 and connect it to pin #8 of V-106. Ground pin #7 of V-106.

This completes the conversion of the filament circuit for 6-volt operation.

Modifications of Audio Circuits 1–Remove R-143 (1 meg.), C-154 (0.006 μfd.), and R-144 (0.47 meg.) in the grid circuit of the 12A6 (V-107). Replace R-143 and C-154 with a 0.01 μfd. capacitor. Replace R-144 with a 500K potentiometer. Connect the arm of the potentiometer to pin #5 of V-107. This volume control is mounted on the front panel and leads to it are run in shielded wire. Ground the shields at both ends of the leads.
2–Remove R-145 (1.5K) from pin #8 of V-107. Re-

Figure 56
TOP VIEW OF R-28/ARC-5 RECEIVER WITH DUST COVER REMOVED
Tuning system gear drive is at left, with crystal relays and crystal receptacles at right. Dynamotor mount is at rear of receiver.



place it with a 470 ohm, 1-watt resistor from pin #8 to ground.

3—Remove output transformer T-101, capacitor C-157, and limiter R-16B (all in plate circuit of V-107). Replace T-101 with small 5K plate to voice coil output transformer. Connect 0.01 μfd. ceramic disc capacitor between pin #3 and pin #4 of V-107 socket. The secondary leads of the new transformer connect to your low impedance speaker.

4—Connect the rear power plug (J-102) as follows:
- Pins #1, 3, and 4: B minus, one side of 6-volt fil.
- Pin #7: B-plus 250 volts.
- Pin #6: 6 volt filament.
- Pin #2: Auxiliary audio output.
- Pin #3: A.v.c. lead. Open connection between pin #3 and pin #1 to disable receiver during transmissions.

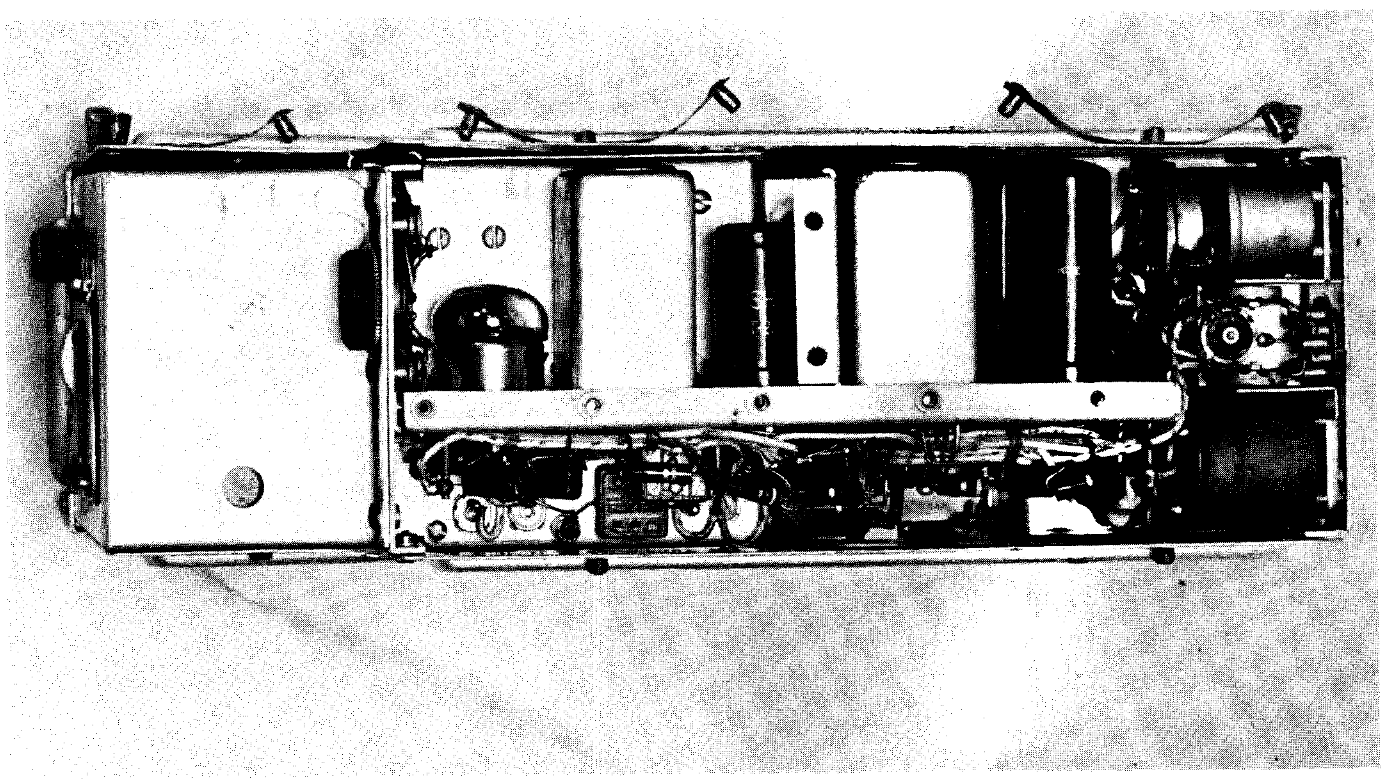
Converting the RT-19/ARC-4 Receiver-Transmitter for 2 Meter Operation

The RT-19/ARC-4 is a complete v.h.f. station capable of operation on any one of four crystal controlled frequencies in the 140–148 Mc. range. The transmitter develops approximately 10 watts output over a 1 megacycle bandwidth without retuning. Crystals in the 5.83–6.0 Mc. frequency range are employed. The complete schematic of the ARC-4 is shown in figure 58.

Description of the Transmitter Section The transmitter of the ARC-4 consists of a crystal-controlled oscillator stage (6 Mc.), followed by three harmonic generators. The oscillator (6V6-GT, V1-T) plate circuit is tuned to approximately 18 Mc. The second 6V6-GT (V2-T) doubles to 36 Mc., and V3-T (1614 or 6L6) doubles to 72 Mc. The final multiplier V4-T (1614 or 6L6) doubles to 144 Mc. The r.f. amplifier (V5-T) is an 832-A, which is plate modulated by two class AB 6L6's (V6-T and V7-T). A carbon microphone is used, and a push-to-talk system is incorporated in the transmitter. The transmitter is designed to be used with a 50–70-ohm coaxial transmission line system.

The Receiver Section The receiver portion of the ARC-4 employs ten tubes and has two complete r.f. input circuits connected to a common i.f. amplifier. One input circuit ("plane-to-plane") will be removed, and the other one ("plane-to-ground") will be reworked for 2-meter reception, and provided with a tunable oscillator. The "plane-to-

Figure 57
UNDER-CHASSIS VIEW OF R-28/ARC-5 RECEIVER WITH DUST COVER REMOVED
717-A tube is at left, with i.f. stage at center. Power receptacle is at rear of chassis.



ground" section employs a 6AC7 (V3-R) mixer, coupled to three stages of 10 Mc. i.f. amplification (V4-5-6-R) having a passband of about 80 kc. A 12SQ7 (V7-R) is used as an audio squelch tube, and a second 12SQ7 (V8-R) serves as the second detector and audio stage. Two audio output stages employing 12A6 tubes (V9-R and V10-R) are provided. The output of V9-R may be taken from pins 22 and 23 of the plug terminals on the rear of the unit (500 ohm circuit), and the output of V10-R appears at panel jack J1-R and pins #24 and 25 of the same plug.

A 6N7 double triode (V1-R) serves as a conversion crystal oscillator and frequency quadrupler. A second 6N7 (V2-R) acts as a tandem doubler to the v.h.f. conversion frequency.

Power Supply and Control System The ARC-4 is powered from either 12- or 24-volts d.c., and employs either a DY-9/ARC-1 dynamotor (24 volts), or a DY-10/ARC-4 (12/24 volt) dynamotor. Neither dynamotor is required for the following conversion. The ARC-4 is designed to be remotely controlled from the C-51/ARC-4 control box which has a channel selector and audio input and output circuits. The control box is not required for the conversion.

Transmitter Conversion Crystals of the surplus FT-243 type are used in this conversion. The two-meter band requires crystals in the range of 6.0 Mc. to 6.16 Mc. For the Novice band, crystals ranging from 6.045 Mc. to 6.125 Mc. should be employed. To make these crystals operate properly, two capacitors in the oscillator circuit must be changed. Remove C2-T (50 $\mu\mu$fd.) (between pin #5 and pin #8) on socket V1-T and replace with a 15 $\mu\mu$fd. mica capacitor. Next, remove capacitor C3-T (400 $\mu\mu$fd.) across oscillator coil L1-T and replace with a 100 $\mu\mu$fd. mica capacitor.

Microphone Voltage for Transmitter At the rear of the chassis on the transmitter side are two resistors: R3-C (30 ohms, marked Z30 W-L), and R32-T (200 ohms, marked Z200). Remove R3-C from the chassis and disconnect the white wire with red-yellow tracer connected to the junction of the two resistors. Ground the end of R32-T that was connected to this wire. Terminals #19 and 7 on the rear chassis plug are connected together to complete the circuit of R26-T and R32-T. This places R32-T in series with R26-T, which is the modulator cathode bias resistor. Next, the lead of R29-T is disconnected from the filament circuit and attached to the terminal of R32-T (figure 60A). Both terminals of R29-T are bypassed to ground with 50 μfd., 50 volt electrolytic filter capacitors.

Receiver Audio Modifications A portion of the audio signal voltage from the microphone is fed to the receiver audio section for the intercom circuit. Disconnect the bare wire lead from the grid (pin #5) of 6L6 tube socket V7-T that runs to the terminal board adjacent to the tube, and connects to resistor R28-T (250K). Now disconnect the white wire with green tracer on the grid (pin #5) of 12A6 tube socket V10-R. Disconnect the white wire with red-brown tracer that connects to the junction of R47-1R and R47-2R (10,000 ohms), which is mounted on the receiver side of the chassis. Now, connect a wire from this center tap junction to the end of R42-R (1500 ohms) located on the side at the rear of the chassis. The correct terminal is the one nearest the rear. This removes the B-plus from the receiver audio stages when transmitting.

Relay Circuit Modifications A Sarkes-Tarzian M-500 silicon rectifier is used in the circuit of figure 60B to rectify the filament voltage for operation of relay S5-C. The rectifier and filter capacitor are mounted near the crystal sockets. The two leads (white with blue-green tracer) that were formerly connected to R3-C (30 ohms) are attached to the positive terminal of the rectifier. The negative terminal of the rectifier is attached to the 12.6-volt filament line through a 100 ohm resistor. A 500 μfd., 25 volt electrolytic capacitor is placed between the positive terminal of the rectifier and ground as shown in the schematic drawing. Finally, remove the crystal switching relays.

Filament Circuit Modifications To operate the filaments from the power supply, strap the following terminals on the rear power receptacle plug in groups, as follows: Group 1: 1 and 2. Group 2: 5, 6, 15 and 16. Group 3: 3, 4 and 19. Group 4: 28 and 18. Group 5: 8 and A1. Connect a 30K, 1-watt resistor from pin #18 to A2. Filament voltage is applied to pins A1 and A2 (ground), as shown in the power supply schematic (figure 65).

Receiver Modifications Remove the "plane-to-plane" channel tuning unit located in the center of the chassis by unscrewing the four 10-32 machine screws beneath the chassis. Remove the top cover plate of the first i.f. transformer FL1-R and loosen the screw inside that holds the coaxial line entering the top of the transformer. Pull up on the tuning unit and it will come free. Take the sides off the tuning unit and remove the 6N7 oscillator plate coil L5-R. This coil may be identified by the great number of turns on it. Also remove one of the 50 $\mu\mu$fd. ceramic capacitors in the unit. It will be needed later, along with the coil. Finally, remove the plate holding the auxiliary capacitors of the tuning unit from the back of the ARC-4 panel.

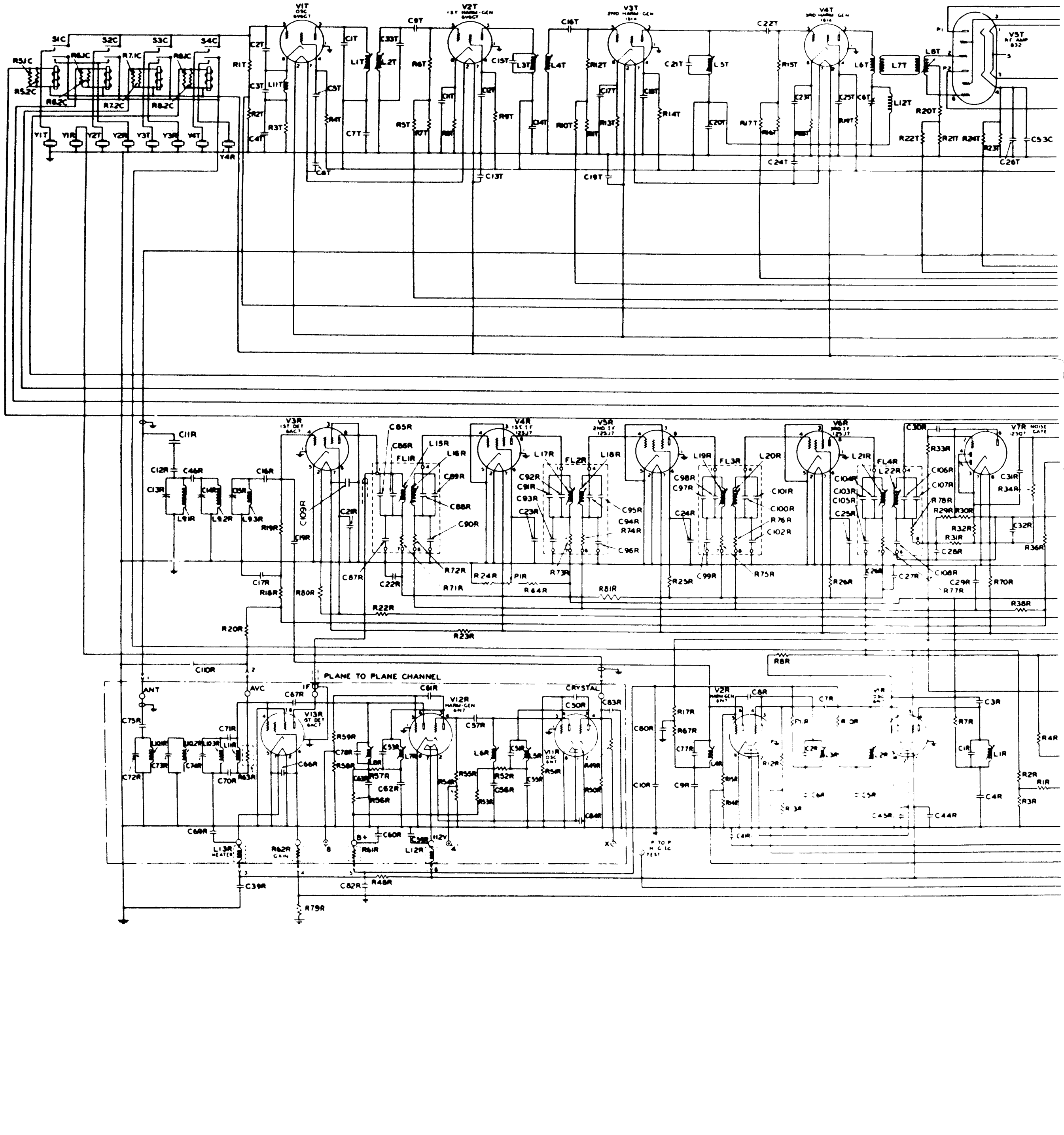


Diagram continued on page 55

Figure 58
SCHEMATIC, RT-19/ARC-4

Diagram continued from page 54

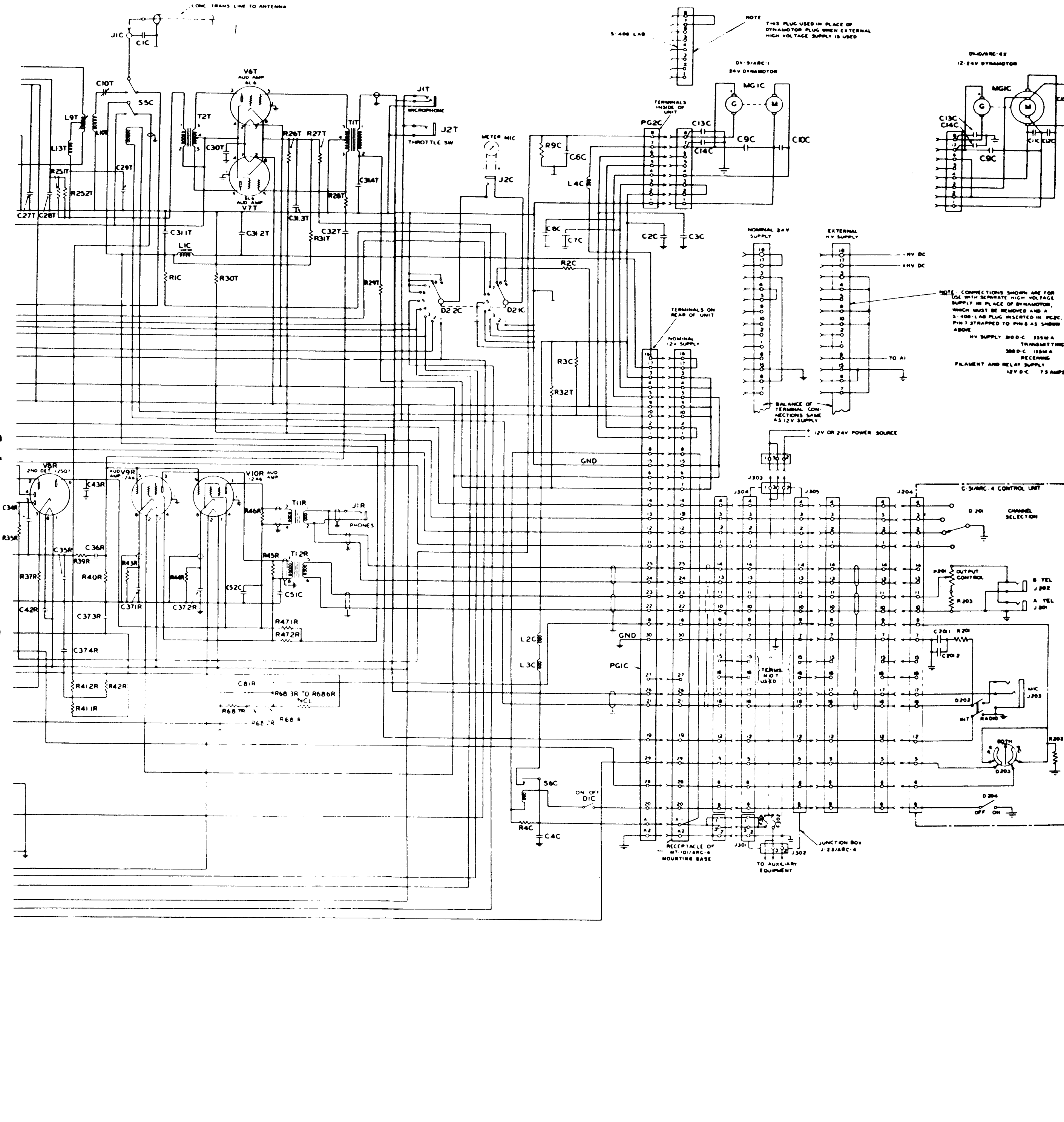


Figure 58
SCHEMATIC, RT-19/ARC-4

Figure 59
PANEL LAYOUT OF CONVERTED ARC-4, SHOWING PLACEMENT OF MAJOR CONTROLS
0-1 d.c. milliammeter and selector switch are at left of tuning dial. Type FT-243 crystal mounts in holder beneath dial. Pilot lamp, a.c. switch and i.f. gain control are above dial.

Coil L5-R is now mounted on the ARC-4 chassis, about 6½" behind the front panel, and positioned as shown in figure 61. The bottom end of the winding is grounded, and a 20 $\mu\mu$fd. ceramic capacitor is connected across the winding. Connect the coil to a 50 $\mu\mu$fd. ceramic capacitor which goes to the bottom end terminal on the nearby phenolic strip as shown in figure 62. This coil converts the oscillator from crystal control to a tuned-plate tuned-grid circuit (figure 60 C).

A clearance hole is now drilled through the chassis near the second bottom terminal of the phenolic strip, and a small ceramic feed-thru insulator is placed in the chassis hole. The terminal of the insulator is connected to pin #6 (plate) of the 6N7 socket V1-R, behind the phenolic strip.

About this stage of the game, a new panel plate should be cut and mounted in position on the front of the ARC-4. Position of the main controls can be seen

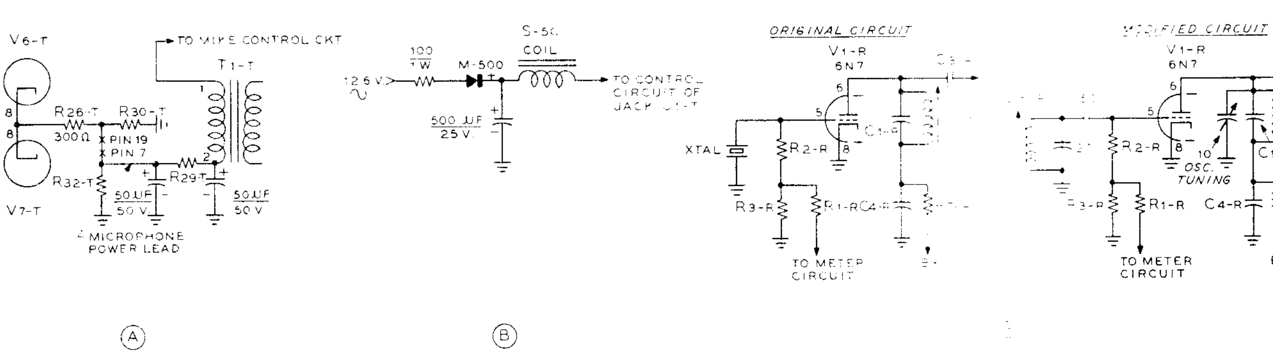


Figure 60
A—Microphone circuit of ARC-4. The microphone power lead to R32-T may be removed and attached to cathode pin #8 of socket V6-T to raise modulation level if a low output carbon microphone (T-17 type) is employed.
B—Rectifier system for relay control.
C—Revised receiver oscillator circuit. The 10 $\mu\mu$fd. capacitor is tuned from the front panel, as shown in figures 63 and 59.

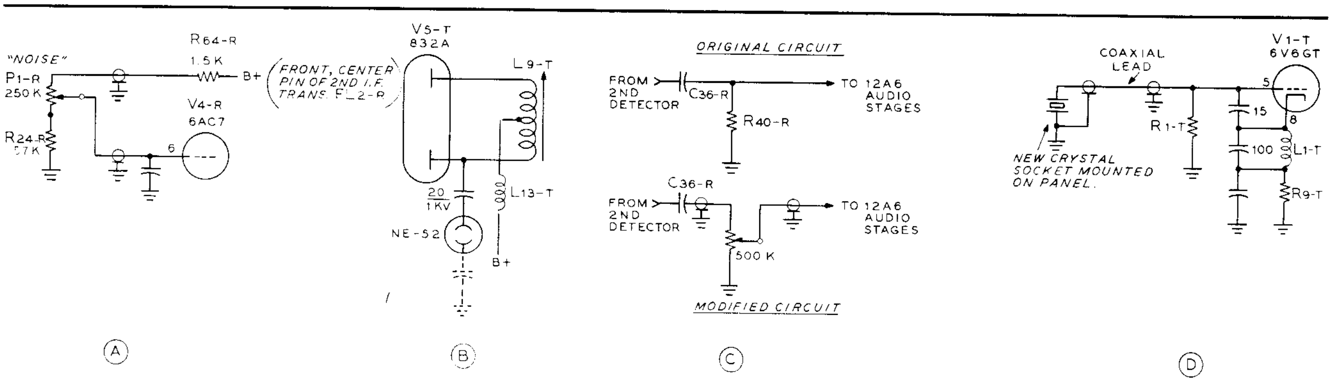
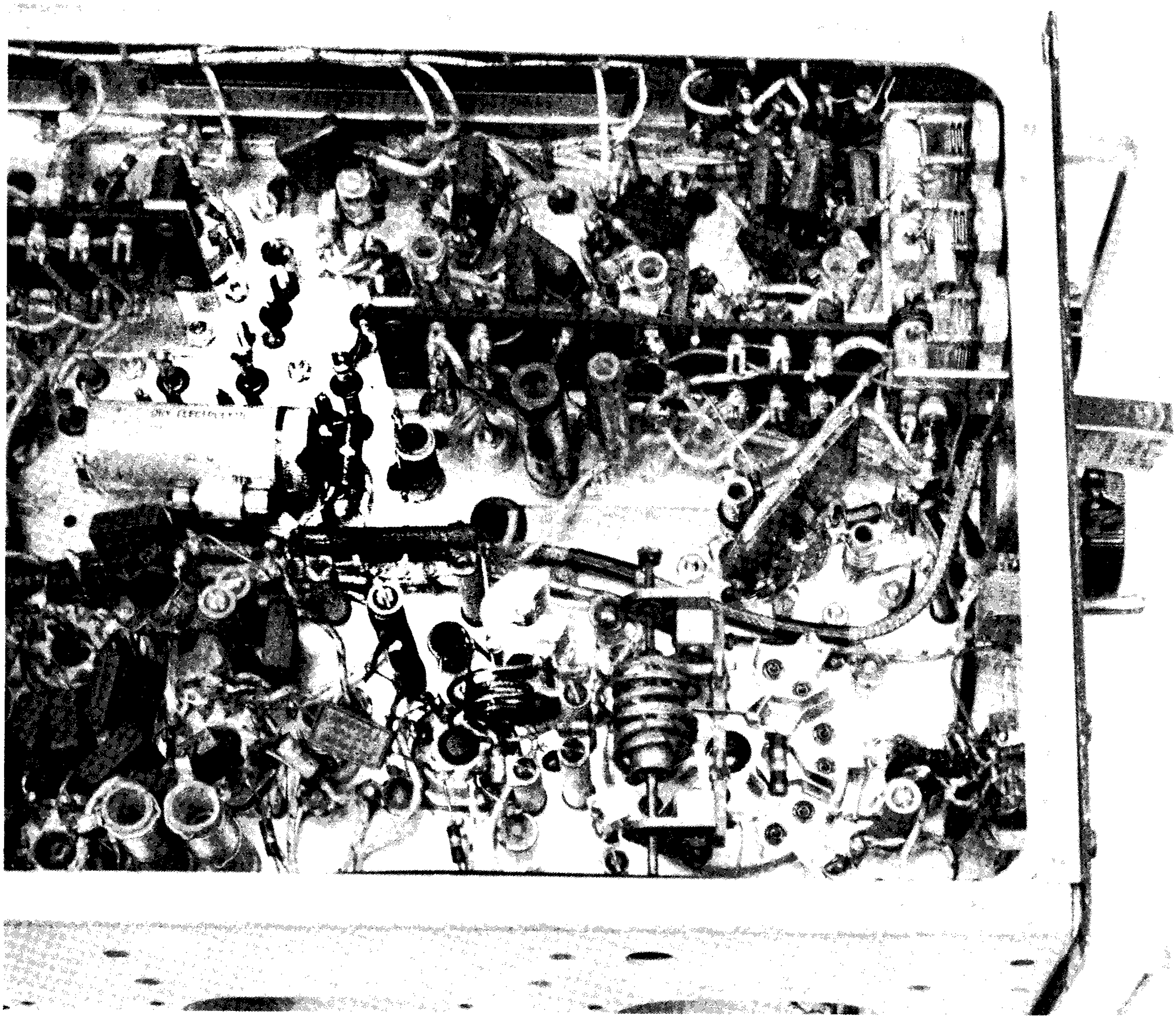


Figure 62
A—I.f. gain control (labeled "noise") for ARC-4
B—Small neon tube makes inexpensive modulation indicator. Neon lamp is mounted in rubber grommet in panel. Capacitance to ground of shell permits bulb to light (see dotted line).
C—Modified volume control circuit for ARC-4
D—Coaxial lead for transmitter crystal socket (see figure 61).

Figure 61
UNDER-CHASSIS VIEW OF ARC-4 SHOWING CASCODE R.F. AMPLIFIER (RIGHT) AND MODIFIED RECEIVER OSCILLATOR
Coaxial lead to panel crystal holder passes along center of chassis. Silicon power supply for change-over relay is at left.



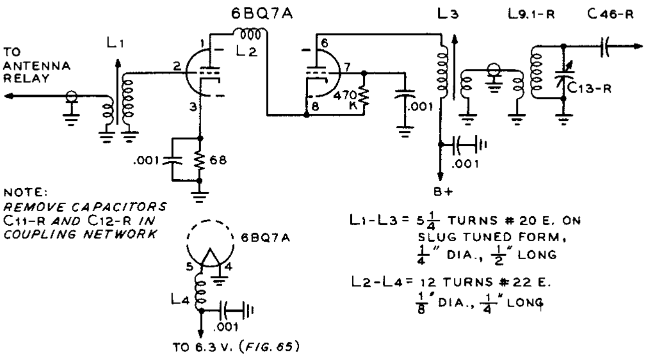


Figure 64
CIRCUIT OF CASCODE R.F. AMPLIFIER FOR ARC-4
Grid-dip coils L-1 and L-2 to center of 144 Mc. band. Shield is placed across center of 6BQ7-A socket to reduce coupling between the coils (see figure 61). Link coils are two turns of hookup wire.

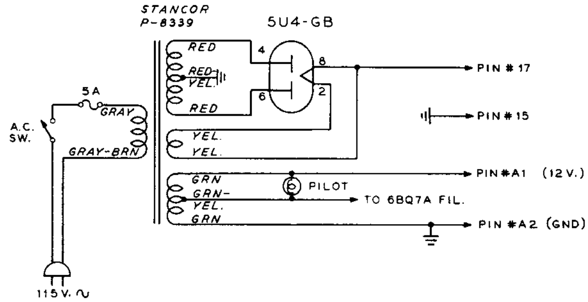


Figure 65
POWER SUPPLY FOR ARC-4
Transformer is rated at 325-0-325 volts at 255 ma., C.C.S., 5 volts at 3 amperes, and 12.6 volts, center-tap at 5.3 amperes. Pilot lamp balances current drain of 6BQ-7A cascode tube.

in figure 59. A soft aluminum plate is placed over the opening left by the removal of the auxiliary tuning unit, and a National type MCN dial is mounted on the panel. The shaft of the dial is about 4" from the top edge of the panel, and about 4½" from the left edge of the panel. The dial drives a small 10 $\mu\mu$fd. "APC-type" variable air capacitor that is mounted on an aluminum bracket placed about 4½" behind the front panel (figure 63). The capacitor, therefore, is immediately adjacent to the ceramic feed-thru insulator mounted on the chassis deck. The capacitor is driven by the dial through a phenolic rod and a shaft coupler. The rotor of the capacitor is grounded, and the stator is attached to the terminal of the feed-thru insulator. The modified oscillator circuit is shown in figure 60C.

Panel Controls Various other controls are placed on the front panel, as seen in figure 59. Across the top are (left to right) a 0–1 d.c. milliameter used as a tuning meter, an i.f. gain control (250K, see figure 62A), the a.c. power switch, and the antenna loading capacitor, C10-T. Below this, at the

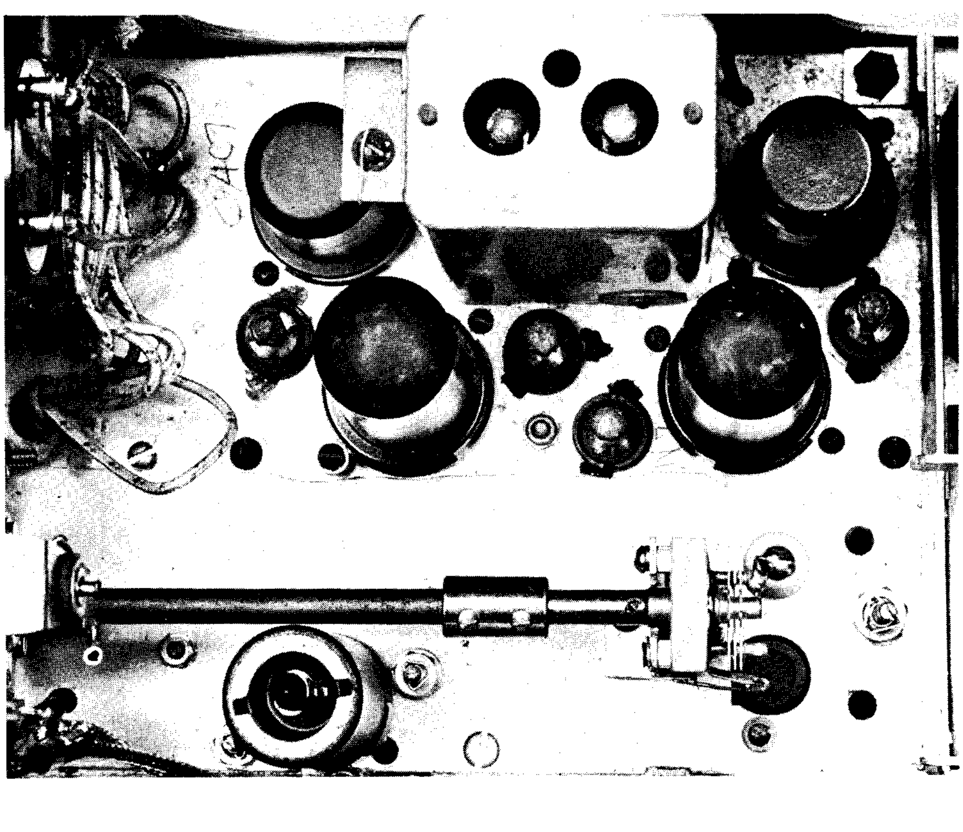


Figure 63
TOP VIEW OF ARC-4 SHOWING TUNING CAPACITOR
The opening left by removal of auxiliary tuning unit is covered with aluminum plate. "APC-type" tuning capacitor is mounted to bracket atop the plate, and connected to oscillator circuit via ceramic feed-thru bushing. Oscillator coil is at rear of capacitor, with slug projecting through chassis.

left is the meter selector switch, receiver tuning control, and modulation indicator (figure 62B). The transmitter amplifier tuning control is at the far right. Receiver adjustment controls, transmitter crystal socket, transmit switch, and phones and microphone jack are placed at the bottom panel edge.

The 500K volume control has one terminal grounded. Remove the wire connecting the grid of 12A6 socket V59-R to resistor R40-R (100K) which is the second resistor from the end of the terminal board located near the four relays beneath the chassis. Connect a wire from the grid of tube VS9-R to the center arm of the volume control (use shielded wire). Connect a wire from the remaining terminal of the volume control to resistor R40-R at the terminal where the wire was previously removed (use shielded wire). Remove resistor R40-R by clipping the leads.

A short length of RG-59/U coaxial cable is used to connect the crystal socket to the oscillator tube, as shown in figure 62D. The shield is grounded to the chassis at both ends of the conductor.

A Cascode Amplifier for the Receiver The sensitivity of the ARC-4 receiver leaves much to be desired if stations beyond the line of sight are to be worked. A simple 6BQ7-A cascode amplifier may be built into the receiver section that will greatly enhance the performance. The placement of the amplifier can be seen in figure 61. A small copper shield plate is mounted across the 6BQ7-A socket, and is grounded to pins #4 and 9 and the center stud of the socket. The neutralizing coil L-3 passes through a ¼-inch hole drilled in the shield. Coils L-1 and L-2 are mounted on either side of the shield plate. The cascode schematic is shown in figure 64.

The Power Supply The power supply is placed in the rear chassis area, as shown in figure 66. The wiring of the supply is shown in figure 65. To balance the filament drain, the 6BQ7-A and the pilot lamp are wired as shown in the schematic. All other filaments are wired correctly when the rear power connector terminals are strapped as previously described. It is necessary to insert a 750-ohm, 20-watt resistor in series with the *receiver B-plus* terminals of relay S5-C to hold the receiver voltage to 300.

Alignment of the ARC-4 The first step is to align the receiver oscillator. The slug of the oscillator grid coil (L5-R) is adjusted to resonate the circuit to 8550 kc. (use a grid-dip oscillator). The plate coil slug (L1-R) should be adjusted so the receiver tuning capacitor tunes the range 8.5 Mc. to 8.8 Mc. Set the oscillator to approximately 8.65 Mc. and tune the harmonic generator circuits for maximum meter reading as shown in figure 67. The slugs in these circuits are set very close to the correct adjustment when you receive the ARC-4, so do not alter the setting too much! With an antenna on the receiver, you should now start to hear two-meter signals. Adjust the three r.f. trimmers (lower left corner of the panel) from left to right for maximum signal strength. One adjustment will hold over a tuning range of about one megacycle. Finally adjust

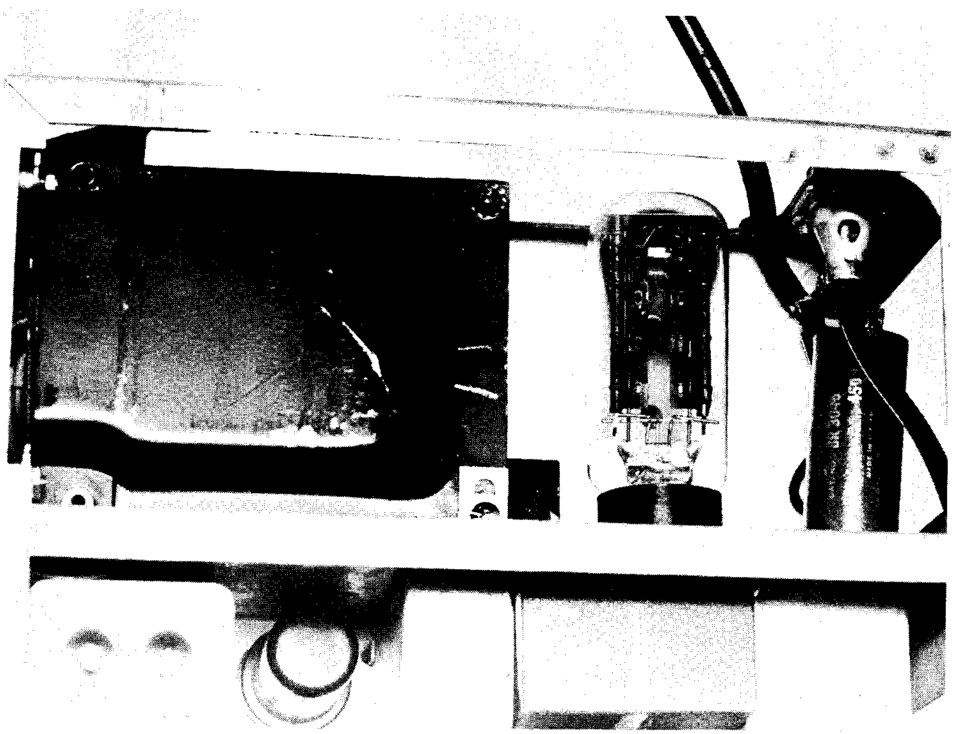


Figure 66
POWER SUPPLY IS INSTALLED IN DYNAMOTOR AREA OF ARC-4
Transformer is at left, with filter capacitor to right of tube. Extra 20 μfd., 450 volt capacitor is added to output of supply to reduce hum. Small aluminum box is placed over rear of rectifier tube socket to prevent danger of shock from terminals.

RECEIVER TUNING CHART		
METER POSITION	TUNING ADJUSTMENT (TUNE FOR MAX. READING)	METER READING (0-1 MA)
OSC. GRID	L1-R	0.2-0.6
2ND MULT. GRID	L2-R	0.1-0.14
3RD MULT. GRID	L3-R	0.08-0.1
A.V.C.	L4-R	MEASURE WITH VTVM ON A.V.C. BUSS
TRANSMITTER TUNING CHART		
METER POSITION	TUNING ADJUSTMENT (TUNE FOR MAX. READING)	METER READING (0-1 MA.)
OSC. GRID	——	0.2
1ST MULT. GRID	L1-T — L2-T	0.3-0.5
2ND MULT. GRID	L3-T — L4-T	0.3-0.5
3RD MULT. GRID	L5-T	0.3-0.5
R.F. AMP. GRID	C6-T	0.25
R.F. AMP. GRID	L8-T	0.25
R.F. AMP. PLATE	L9-T (MIN. READING)	0.5

Figure 67
METER CHART FOR TUNING RT-19/ARC-4

the slugs of cascode coils L-1 and L-2 for best signal reception.

The crystal is now plugged in the transmitter and the multiplier circuits are tuned for maximum meter current, as indicated in figure 67. Load the antenna by increasing the loading capacitor (C10-T) and then tune the r.f. amplifier stage for minimum dip. Repeat until maximum loading is obtained while still observing a plate current dip.

Modern, TVI-Proof Conversion of the SCR-522 Transmitter

Many conversions have been shown for the BC-624 transmitter portion of the SCR-522 v.h.f. receiver-transmitter. The conversion described in this section is recommended for two and six meters, as it eliminates the t.v.i. difficulties normally encountered with this equipment. The unconverted transmitter is shown in figure 68.

First of all, remove the transmitter from the cabinet and strip off unnecessary components, such as the tuning slides, etc. Move the power connector to the rear of the chassis as shown in figure 69A. Make up a power cable as shown in figure 69B, using #14 wire for the filament leads, as shown. Next, mount a SO-239 coaxial connector near the tripler stage, as shown in figure 69C, and run a coaxial lead from the connector to the antenna link of the transmitter.

If a carbon microphone is used, it is necessary to install four "pen-lite" batteries in series with the primary winding of the microphone transformer. Better still, a crystal microphone can be employed with the transmitter if the simple transistorized speech amplifier shown in figure 70 is installed in the transmitter. It is recommended over vacuum tube amplifiers since there is less danger of audio feedback. A 1N34 diode rectifies the filament voltage to deliver a small negative potential suitable for the transistor. Remove the microphone transformer and connect the output of the transistor amplifier to the "hot" terminal of volume control #125.

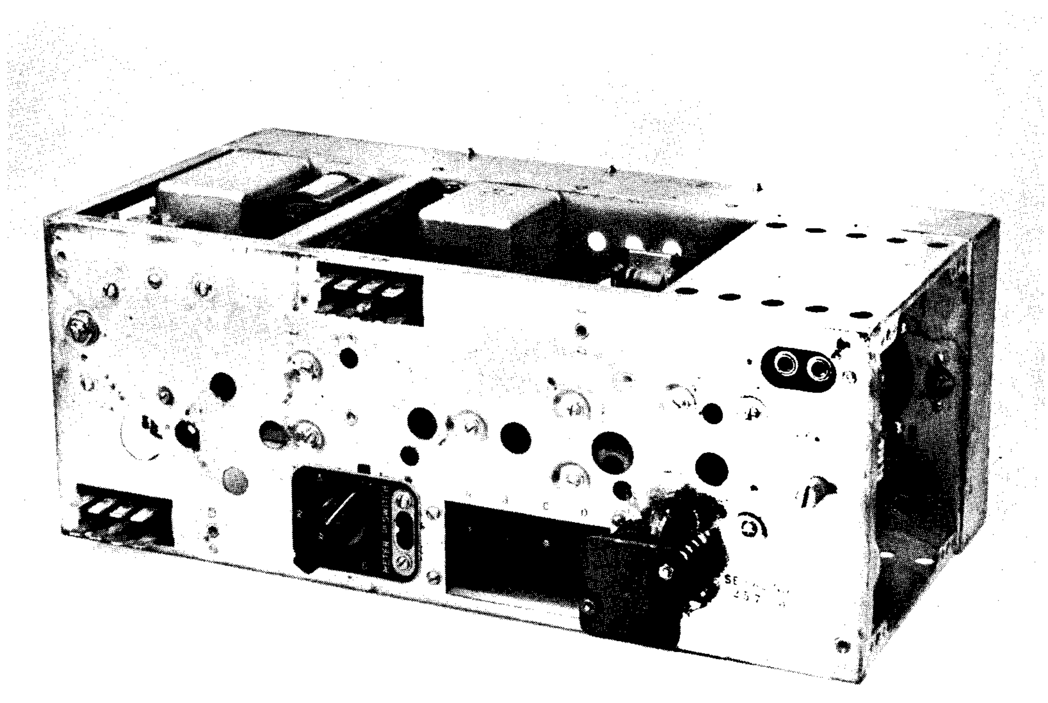


Figure 68
THE UNMODIFIED BC-624 TRANSMITTER SECTION OF THE SCR-522 V.H.F. TRANSMITTER-RECEIVER

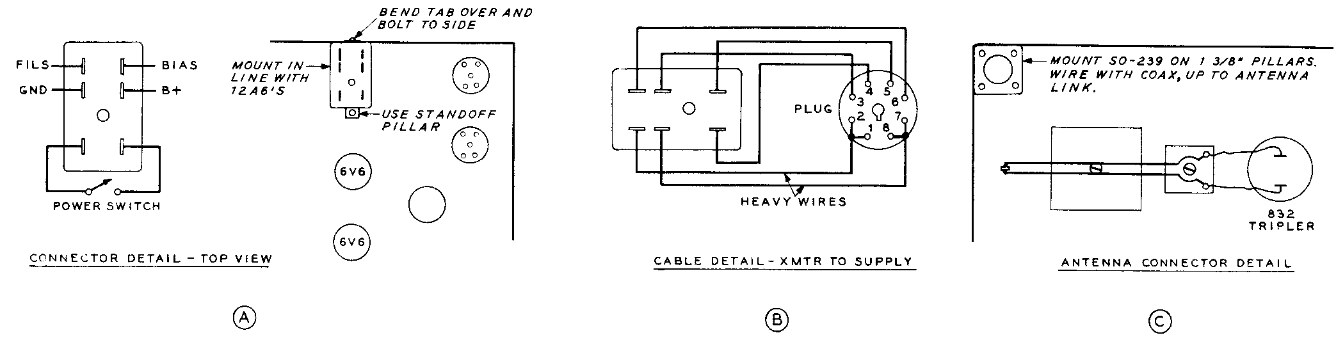


Figure 69
A—Power plug modification for 522 transmitter, for use with a.c. supply shown in figure 75.
B—Connecting cable between transmitter and power supply.
C—New coaxial antenna receptacle is mounted in corner of transmitter chassis near 832-A tripler stage.

T.V.I.-Proofing the Transmitter Install a 0.001 μfd. disc ceramic capacitor across the filament pins of each tube socket. By-pass all leads on the power connector with 0.001 μfd. disc ceramic capacitors. In addition, bypass each meter lead with 1.5 KV, 0.001 μfd. disc ceramic capacitors. Use a meter with a metal case, or else cut a section of a tin can to cover the rear of the meter if a phenolic-cased meter is used. Ground the can to the transmitter panel, permitting the meter terminals to pass through holes cut in the rear disc of the can.

To shield the transmitter completely, it may be mounted in the metal case from a BC-375 tuning unit. Small, ¼-inch holes should be drilled in the case to aid ventilation. The completed transmitter, mounted on a relay rack panel is shown in figure 71.

Circuit Modifications The braid straps that connect the plate terminals of the 832-A tubes to the tank circuits should be removed and replaced with copper strap. The braid gets warm during operation of the transmitter because of the high r.f. resistance. Transmitter output increases when the braid leads are replaced. Modulation is also improved when the 12A6 audio tubes are replaced with 12V6-GT's. No wiring changes are necessary.

A crystal–v.f.o. selector switch that may be incorporated in the transmitter oscillator circuit is shown in figure 72.

To operate the 522 transmitter on six meters, the following coil changes are necessary: Replace the tripler (first 832-A) plate coil with a new inductance consisting of 14 turns of #14 enamel wire, ⅝" diameter, and about 1½" long. The B-plus lead is attached to the center of the coil. The antenna coil consists of 5 turns of #14 insulated wire wound over the center of the plate coil. The tripler stage now acts as a six-

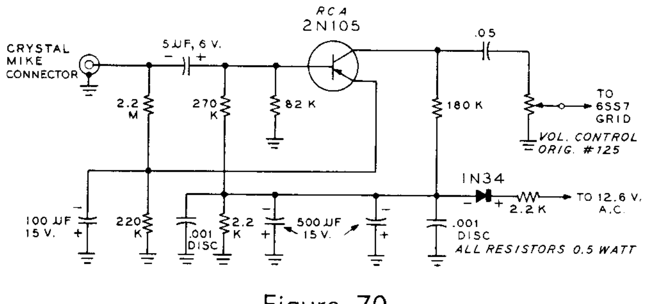


Figure 70
SIMPLE TRANSISTOR SPEECH AMPLIFIER PERMITS USE OF CRYSTAL MICROPHONE WITH SCR-522 TRANSMITTER
Small amplifier may be mounted between volume control and the microphone jack on the inside of the chassis.

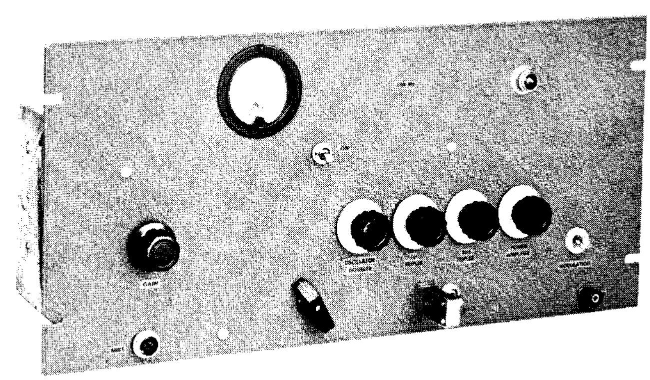


Figure 71
MODIFIED 522 TRANSMITTER IS MOUNTED ON RELAY RACK PANEL
Case from BC-375 tuning unit is slipped over chassis to complete anti-T.V.I. shielding. Additional conversion information is given in Vol. I of the "Surplus Radio Conversion Manual."

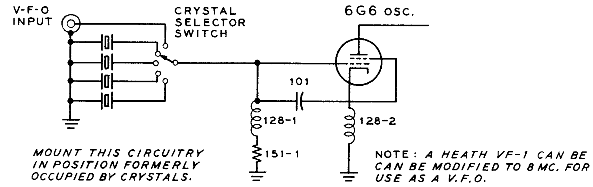


Figure 72
MODIFIED TRANSMITTER OSCILLATOR CIRCUIT PERMITS USE OF HEATH VF-1 V.F.O. (RETUNED TO 8 MC.) WITH 522 TRANSMITTER

meter amplifier, and the 832-A two-meter amplifier tube is removed. Six Mc. crystals are used, and all multiplier stages can be retuned for six-meter operation. See Volume I of the Surplus Conversion Manual series for additional circuit modification information.

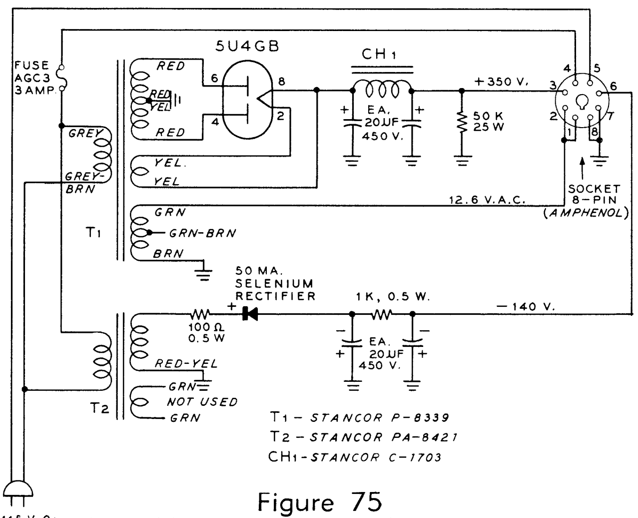


Figure 75
SCHEMATIC, POWER SUPPLY FOR SCR-522 TRANSMITTER
Transformer T-1 delivers 325-0-325 volts at 255 ma., C.C.S., 5 volts at 3 amperes, and 12.6 volts at 5.3 amperes. Transformer T-2 delivers 125 volts at 50 milliamperes. Choke CH-1 is 4 henries at 250 ma.

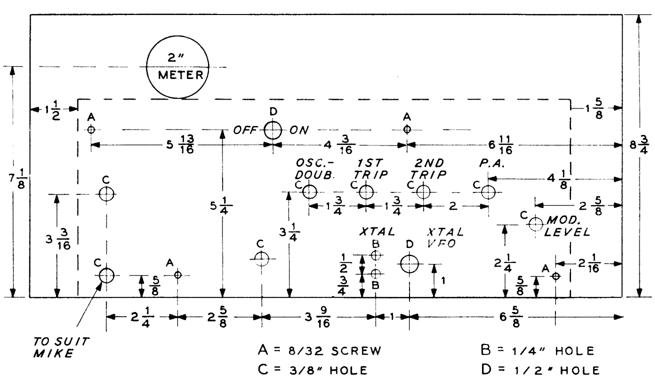
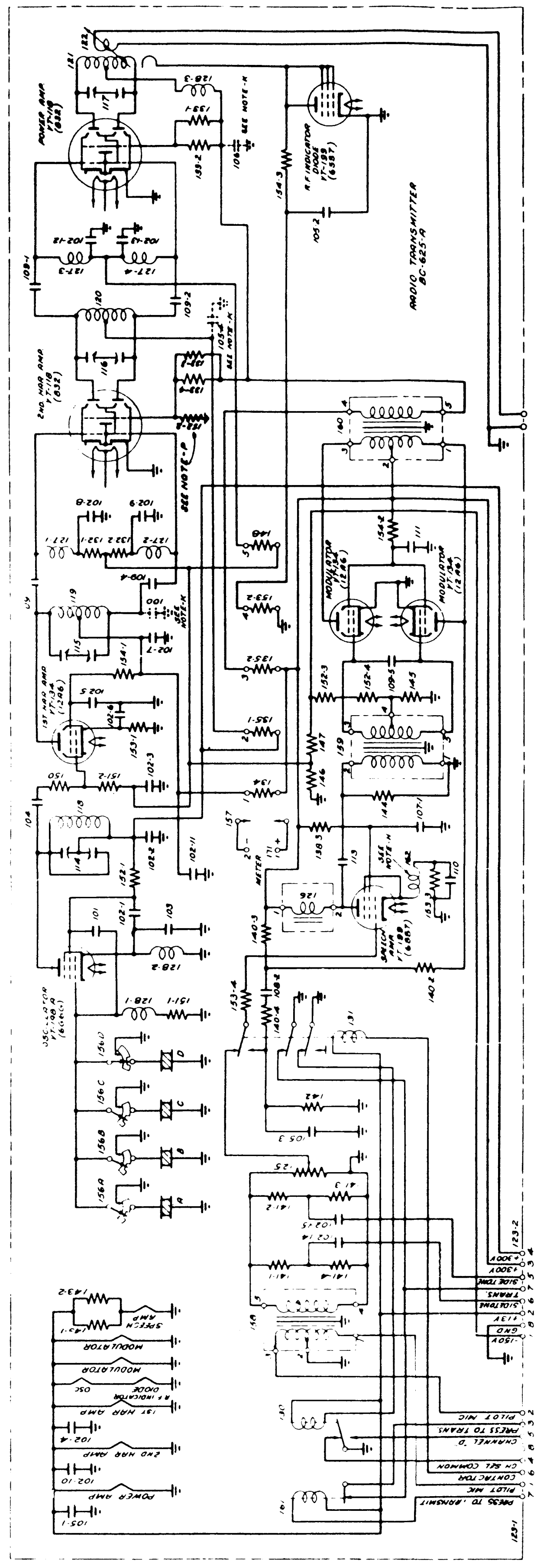


Figure 76
LAYOUT OF PANEL FOR SCR-522 TRANSMITTER



ORIGINAL SCR-522 TRANSMITTER SCHEMATIC DIAGRAM
Figure 73

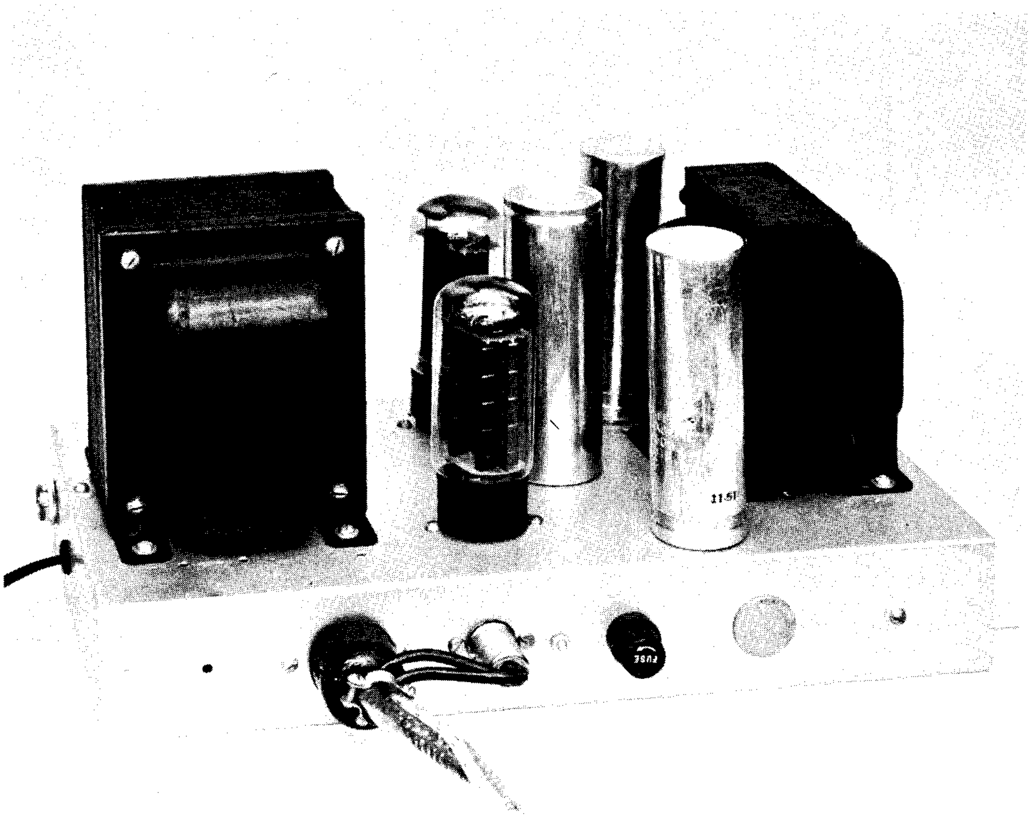


Figure 74
POWER SUPPLY FOR SCR-522 TRANSMITTER IS ASSEMBLED ON AUXILIARY CHASSES
See figure 75 for schematic

The BC-312 and BC-342 Series Receivers

The BC-312 and BC-342 series receivers are, without modification, acceptable communications receivers. However, their performance can be greatly improved for amateur communication work by making certain modifications in various portions of the receiver. Any one of the changes or all the changes may be made, each change adding a certain amount to the performance and flexibility of the receivers. The various changes will be treated separately so that any one or all the changes may be made at the discretion of the owner of the receiver.

Power Supply for the BC-312 If the receiver is a BC-312, a power supply must first be constructed. The BC-342 is equipped with an integral 115-volt power supply but the BC-312 has a 12-volt dynamotor in place of the a.c. power supply of the BC-342. Otherwise the receivers are substantially identical. It will be assumed throughout this and subsequent discussions that the owner of the receiver has a copy of TM 11-850 or one of the other instruction books on this series of receiver since these instruction books were furnished with the receivers or were generally available at the time the receivers were sold.

The Dynamotor must first be swung out on its hinges, and then the leads from the dynamotor to the 9-terminal connection strip removed. A power supply such as shown in Figure 77 and diagrammed in Figure 79 must then be constructed. The one illustrated employs a Signal Corps C-228 power transformer, which is the same one as was used in the RA-20 power supply for the BC-342. A large number of these power transformers have been available, but if one cannot be obtained, any power transformer having a 650-volt to 750-volt center-tapped high-voltage winding, a 5-volt filament winding for the 5Y3-GT, and one or two 6.3-volt filament windings at 1.75 amperes or greater will be satisfactory. If the transformer has two 6.3-volt filament windings (such as the UTC type R-12) they are connected in series to obtain the 12.6 volts necessary for heater operation of the receiver. If the transformer has only one 6.3-volt winding an additional very small 6.3-volt 2-ampere filament transformer must be placed in the power supply and connected in series with the 6.3-volt winding on the main power transformer to obtain the 12.6 volts. The junction between the two 6.3-volt filament windings should be grounded in the power supply.

One complication is introduced by the fact that the dial-lamp circuit uses two 6.3-volt lamps in series to ground, so that if the lead to the dial lamps is connected to either of the hot 6.3-volt filament leads the lamps will only receive half voltage. This may be satisfactory, since the lamps give adequate light at this voltage, or the two lamps may be connected in parallel by removing the bezel that covers the two lamps and rewiring them.

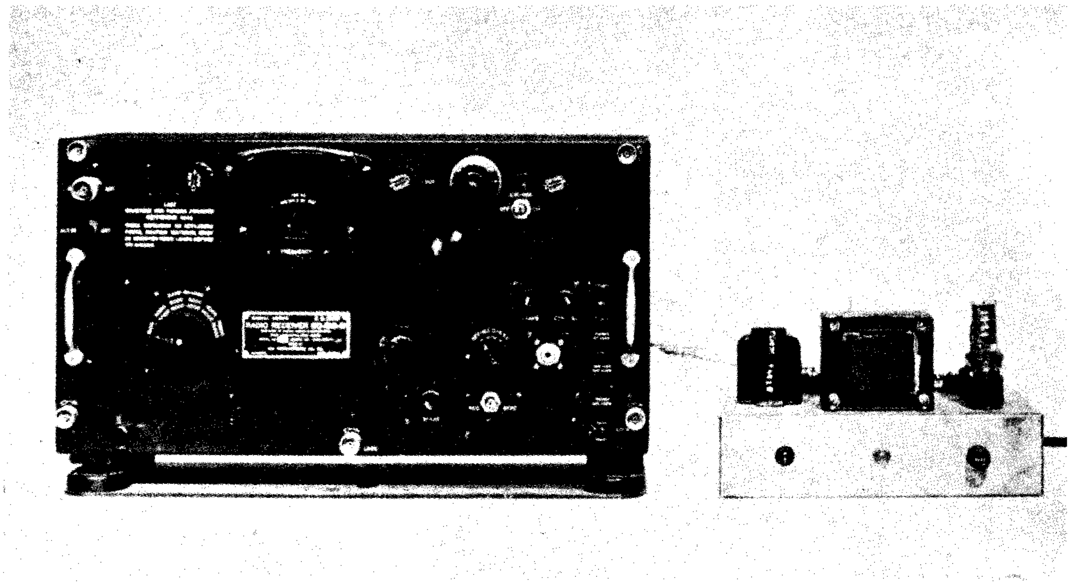


Figure 77.
FRONT VIEW OF THE CONVERTED BC-312 RECEIVER WITH THE POWER SUPPLY ALONGSIDE.
The coaxial i.f. energy output fitting can be seen on the panel in the position formerly occupied by the power connector. The switch mounted at the bottom of the vertical row of jacks is the noise-limiter on-off switch. The power supply is normally mounted remotely from the receiver and controlled by the OFF-MVC-AVC switch.

The balance of the power supply is quite conventional. The VR tube shown in Figure 79 need not be used unless desired, but its use does afford improved oscillator stability.

Voltage Regulation for H.F. Oscillator The high-frequency oscillator used in the receiver is quite stable, but when operating on the 14-Mc. band there is some variation in the tone of a c.w. signal when the r.f. gain is varied, or when the line voltage varies as a result of a household refrigerator turning on or off or from some similar cause. This condition is cured by using voltage regulation on the plate supply voltage to the high-frequency oscillator. The incorporation of voltage regulation on the oscillator requires that a lead be brought out of the oscillator compartment for separate plate-voltage feed to the tube. This operation requires removal of the cover from the oscillator compartment, and the removal of 30,000-ohm resistor R_{41}. This resistor is replaced by a 1000-ohm ½-watt carbon resistor. The r.f. stage chassis is then lifted back, after removing the leads to the tube caps, and the plate-voltage terminal coming out of the oscillator compartment is by-passed with a 0.002-μfd. postage-stamp mica capacitor which can be placed flat against the chassis below the terminal strip. The lead for plate voltage to the oscillator is then brought under the r.f. chassis and down through the hole where the other leads feeding the r.f. chassis pass. This plate-voltage lead then goes, of course, to the plate of the VR-105.

R.F. Changes The r.f. system in the standard receiver is slightly lacking in gain and signal-to-noise ratio on the highest frequency range. This condition can be checked by removing the antenna lead from the receiver, turning the receiver wide open on MVC, and then rotating the trimmer APC on the first r.f. stage through resonance. Only a very slight increase in noise level will be noticed when this trimmer passes through resonance.

The most satisfactory way of correcting this condition (and this method was proven best after trying a number of other expedients) is to replace the 6K7 first r.f. stage with a 6SH7. It so happens that the receiver is laid out in such a manner that a single-ended tube in the first r.f. stage gives much more direct leads than the double-ended tube originally used. The procedure is as follows:

Remove the tubes from the r.f. chassis and invert the chassis as far as possible. Remove the leads from pins 3, 4, 5, 6, and 8 of the tube socket for the first r.f. stage. Remove the old cathode-bias resistor RS-164. Run a 100-ohm 1-watt resistor from the small micarta terminal block for the MVC lead to pin 5, and also run to pin 5 a lead from the cathode by-pass section of the capacitor block for the stage. Install an additional 0.002-μfd. postage-stamp mica capacitor as a cathode-by-pass from terminal 3 to terminal 1. Separate the screen-voltage lead that went to terminal 4, shorten it until it fits more neatly and solder to pin 6. Now run the plate lead for the tube, which did go to terminal 3 and run it *under* all the wires near the heater end of the socket and connect this lead to terminal 8. Remove the lead which went to the grid cap of the 6K7, solder a wire about 1½ inches long to this terminal on the main chassis, push the sub-chassis down as far as it can go and still reach terminal 4 on the tube socket with a soldering iron, and solder this new lead to terminal 4. Then push the chassis back into place gently, at the same time making sure that the grid lead to the tube (terminal 4) keeps free of the chassis and bends out toward the ganged tuning capacitor.

It will now be necessary to re-align the r.f. stages of the receiver slightly (*not* the h.f. oscillator how-

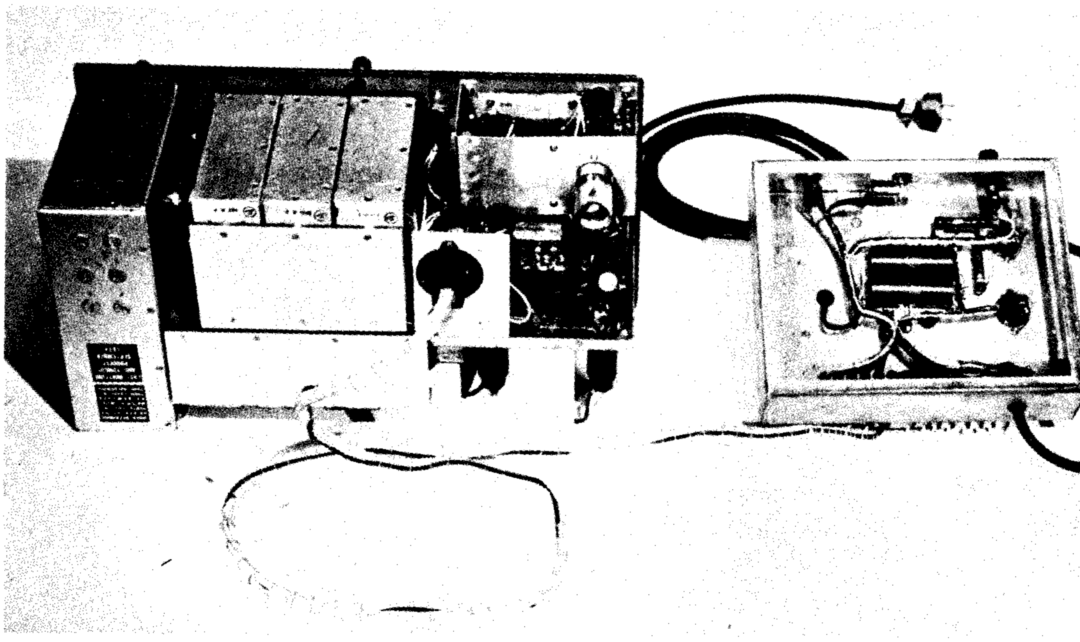


Figure 78.
UNDERCHASSIS VIEW OF THE RECEIVER AND POWER SUPPLY.
The bent-aluminum chassis holding the 7A6 noise limiter tube can be seen behind the power-cable receptacle. The added chassis is mounted to the front panel.

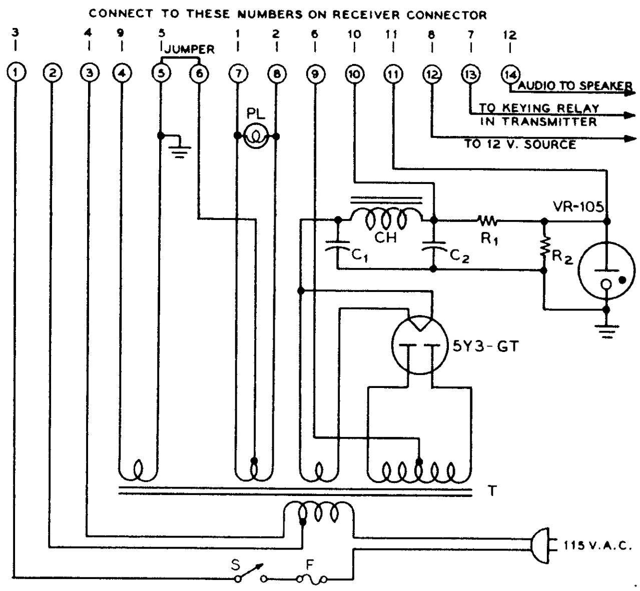
ever). Peak up the 6L7 mixer stage first, then the second r.f. stage, and then the first r.f. stage. The gain will be found to be much greater than before, and the increase in noise when the first r.f. stage is trimmed through resonance will be found to be very pronounced. If a tendency toward instability is encountered near maximum gain on MVC, re-trim the *mixer* stage padders slightly until the instability disappears.

All these receivers have a certain amount of backlash in the vernier tuning control. In several receivers the amount of backlash has been reduced to a very small amount by carefully lubricating all the gears with a small amount of vaseline, using a toothpick or a matchstick to apply the lubricant. Then the backlash, which in the receivers mentioned was caused by axial motion of the tuning-capacitor gang, can be substantially eliminated by careful adjustment of the ball thrust bearing at the *oscillator* end of the tuning gang. This bearing is inside the oscillator compartment.

I.F. Amplifier Changes The i.f. amplifier operates quite satisfactorily, but the action of the crystal filter leaves much to be desired. The reduction in set gain when the crystal filter is switched into operation can be greatly reduced by the following procedure: Remove the cover from the crystal-filter transformer. Scrape the stud which serves as a stop for the rotation of the crystal-phasing capacitor and solder a very small wire to this stud and to the small switch contact on the other side of the phasing capacitor. Then turn the phasing control until the moving contact rests firmly against the stud. Re-install the cover of the transformer and align the slug which comes out of the *top* of the crystal-filter transformer for maximum noise with the antenna removed from the receiver. This position of the control (180° from the old position) now serves as the crystal-out position, and the reduction in gain when the crystal filter is switched into the circuit will be very small.

A further change in the i.f. amplifier was made in the receiver shown in Figure 77 to bring out i.f. energy for the operation of external devices such as a panoramic adapter, a narrow-band F.M. adapter, or another external unit such as a single-sideband channel. The change consisted in merely wrapping 7 turns of hookup wire around the form between the two i.f. coils inside the last transformer, connecting one side of this coil to ground and the other side to the center conductor of a piece of RG-58/U cable. The cable is brought into the transformer by first removing the black wire going into the transformer and grounding the capacitor to a soldering lug under the screw adjacent to the terminal from which the black wire was removed. It may be necessary to ream the hole from which the black wire was removed slightly in order to be able to insert the insulation and the inner conductor of the coaxial cable. The outer conductor of the coaxial cable is grounded outside the transformer. The coupling connector for the coaxial cable was mounted on the front panel of the receiver in the position formerly occupied by the power-cable connector, which had previously been removed.

With the i.f. energy obtained from the panel coaxial connector coupled to an external coil resonated to the intermediate frequency by means of a small 7-turn coupling coil, approximately 10 volts peak was measured with a normal signal input and the receiver operating on a.v.c. With the receiver on MVC, more than 50 volts peak could be obtained. This voltage is of course quite adequate to operate any of the accessories mentioned in the previous paragraph.



POWER TRANSFORMER COLOR CODE: FOR C-228 TYPE
RED = 110 VOLTS COMMON, BLACK = 120 VOLTS
GREEN = 105 VOLTS
BROWN = 12 VOLTS, NO C.T.
BLUE = 12 VOLTS, SLATE WITH TRACER = C.T.
BLACK = H.V., YELLOW = C.T.

Figure 79.

SCHEMATIC DIAGRAM OF THE POWER SUPPLY UNIT.

The color code shown at the bottom of the drawing is for the C-228 power transformer which may be available. If this transformer is not available a conventional power transformer having two 6.3-volt windings may be used as described in the text.

C_1, C_2—16-μfd. 450-volt elect.
T—700 v. c.t. 100 ma.; 5 v. 3 a.; 6.3 v. 3 a., 6.3 v. 3 a. in series with center grounded. Or 12.6 v. c.t.
CH—15 henrys 100 ma.
R_1—12,500 ohms 10 watts
R_2—100,000 ohms 2 watts
S—S.p.s.t. a.c. line switch
F—3-ampere fuse

Audio System Changes The audio system of the 312 and 342 receivers leaves much to be desired. There is inadequate gain for reception of weak signals on crystal filter, the frequency response is quite poor (though intentionally so for military use), and the harmonic distortion is severe. All these undesirable conditions were overcome by the relatively simple change in the audio system shown in Figure 80. A 6B8 diode-pentode was used to replace the 6R7 diode-triode previously used, and the 6F6 was replaced with a 6V6. Shunt feedback from the plate of the 6V6 to the plate of the pentode section of the 6B8 was used to improve the frequency response and reduce harmonic distortion. Also, the feedback almost completely eliminates the hum in the audio system of these receivers. The cathode resistors for the two stages were left the same, but an additional 25-μfd. 25-volt electrolytic was placed across the cathode resistor of the 6B8 so that the gain control would completely cut off the audio output when turned clear down in the a.v.c. position.

The audio transformer that was used in the plate circuit of the 6R7 is removed from the circuit but was left in place since the space was not required and it appeared to be difficult to remove. When a noise silencer, to be described later, is to be used in receivers of the BC-342 series, it would probably be best to remove this transformer and install the noise limiter tube in the place formerly occupied by the transformer, since the presence of the power supply inside the receiver will preclude installing the noise silencer in the place shown in the photograph of the BC-312.

If desired, the volume control and gain control system can be left unmodified, in which case the green wire coming from S_{12} is removed from the bottom end of R_{49} on the Group 1 terminal board on the right outside wall of the chassis and run to the noise silencer. The grid leak on the power audio tube R_{33} is removed and changed to a 470K ½ watt. Capacitor C_6 has been added to couple to a conventional 5000 to 8000 ohm output transformer on the external loudspeaker. The impedance ratio of T_2 inside the set is 7:1 so that an impedance of about 1000 ohms is required on the speaker transformer if the audio output is to be taken through transformer T_2. Due to the voltage step down in T_2 the secondary of this transformer was used to feed the phones. The 60-ohm filament current equalizing resistor R_{47} should be removed, and if a 7A6 is used as noise limiter its heater should be placed across the heater of the 6V6-GT. In any event it is wise to ground terminal 7 of the socket for the 6B8 to insure that all the tubes will be operating at proper heater voltage.

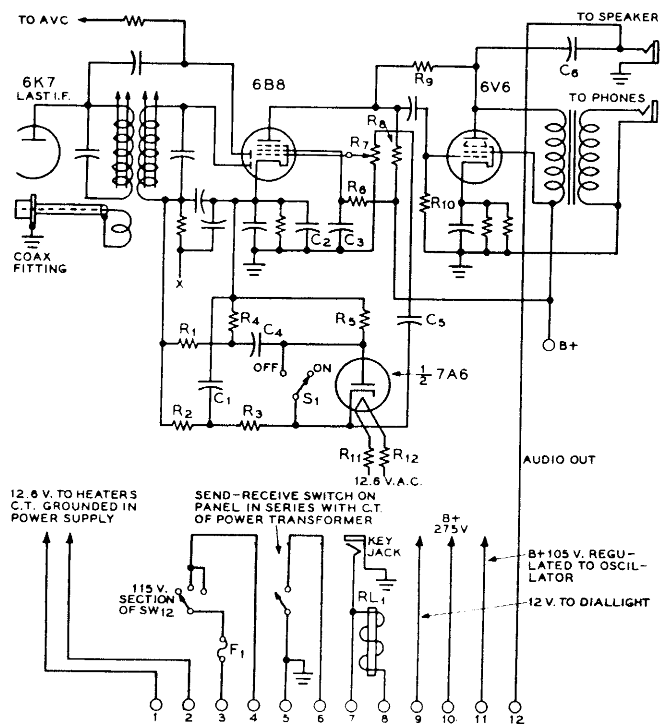


Figure 80.

CHANGES IN THE BC-312 RECEIVER

Unmarked components are already in the receiver and need not be removed or replaced.

C_1—0.1-μfd. 400-volt tubular
C_2—25-μfd. 25-volt elect.
C_3—0.1-μfd. 400-volt tubular
C_4—0.05-μfd. 400-volt tubular
C_5—0.01-μfd. 400-volt tubular
C_6—8-μfd. 450-volt elect.
R_1—100,000 ohms ½ watt
R_2, R_3—1.0 megohm ½ watt
R_4, R_5—470,000 ohms ½ watt
R_6—1.0 megohm ½ watt
R_7—1.0-megohm potentiometer
R_8—220,000 ohms ½ watt
R_9, R_{10}—470,000 ohms ½ watt
R_{11}, R_{12}—22 ohms 2 watts
RL_1—Relay inside receiver

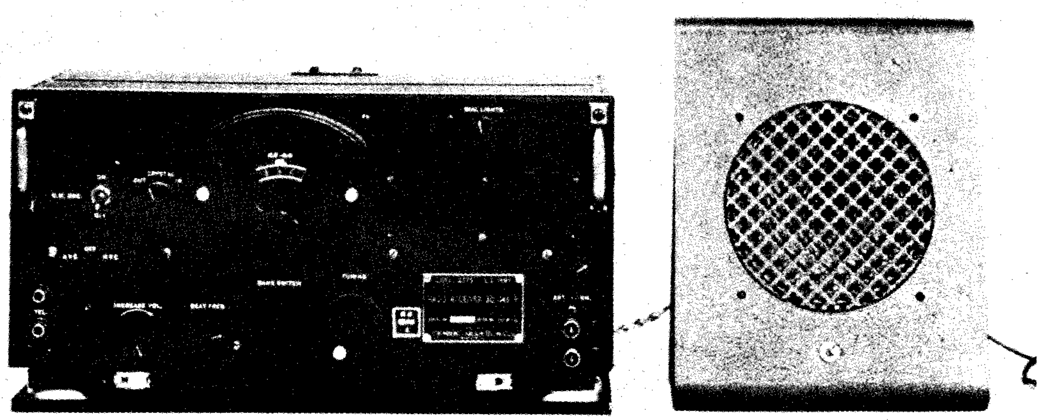


Figure 81.
BC-348P RECEIVER, SPEAKER AND POWER SUPPLY
The power supply is mounted in the speaker housing.

Noise Silencer The noise silencer shown in Figure 80 has been found to be very effective on the 14-Mc. band, and on the 28-Mc. and 50-Mc. bands when a converter is used ahead of the receiver. One half of a 7A6 tube has been used, and since this tube draws only 150 ma. of heater current the heater may be fed with a balance to ground by means of two 22-ohm 2-watt carbon resistors from the 12.6-volt heater line. Or, if desired, the heater may be placed in parallel with the 6V6-GT heater as discussed in the previous paragraph. One half of a 6H6 or 6AL5 tube could also be used for the noise limiter, but these latter tubes require 300 ma. of heater current. It is possible that a 12H6 could also have been used, but one has not been tried. Make sure that the return for the noise limiter (the bottom end of C_1, R_5 and R_4) is made to the *cathode* of the 6B8 and not to ground—if the return is made to ground proper noise-limiting action will not be obtained. A switch S_1 has been provided to take the noise silencer out of the circuit, since the circuit does introduce a detectable amount of distortion on a short-wave broadcast program.

Gain Control Changes It is a convenience in a communications receiver to have a separate control for audio and r.f. gain. To accomplish this in the series of receivers under discussion it is suggested that the dual control at the top of the panel be replaced by a single ½-megohm audio-taper potentionmeter. C_{81} and R_{32} are removed, and the low-potential end of the audio gain control is returned to ground. The r.f. gain control leads can be pulled down to the underside of the chassis and connected to a separate 15,000-ohm r.f. gain taper rheostat which can be placed either in the position formerly occupied by the MIKE jack or just to the right of the SEND-RECEIVE switch. The a.v.c. position of the switch will still short out the r.f. gain control in the conventional manner.

Control Circuits In the case of the BC-312 receiver as shown the 9-terminal power-connection strip was removed and the somewhat unsightly multi-connection receptacle on the front panel was removed and replaced by the "i.f. output" coaxial receptacle. Power and control connections were brought out to a 12-contact Jones P-312-RP connector which was mounted by means of a bracket to the rear of the chassis. The receptacle was aligned with the hole which already exists on the rear of the cabinet housing. The connector on the end of the power cable is a Jones S-312-FHT. The key, shorting relay, and switch inside the receiver were then rewired to connections on the connector on the rear of the cabinet as shown on Figure 80. The switch is connected so that it is in series with the center tap of the power transformer. Since a 12-volt keying relay is used on the transmitter, the antenna-shorting relay inside the receiver was wired so that it closed every time the transmitter keying relay closed.

In modifying the BC-342 series of receivers the external control circuit connections for the transmitter can be brought out of the front panel by replacing the connector which is installed on the front panel by an Amphenol MIP-8 octal socket, which fits the same mounting holes.

Hints on the BC-348 Series Receivers

The BC-348 series of receivers are quite satisfactory for communications use in the amateur station, but as in the case of the BC-312/BC-342 series, there

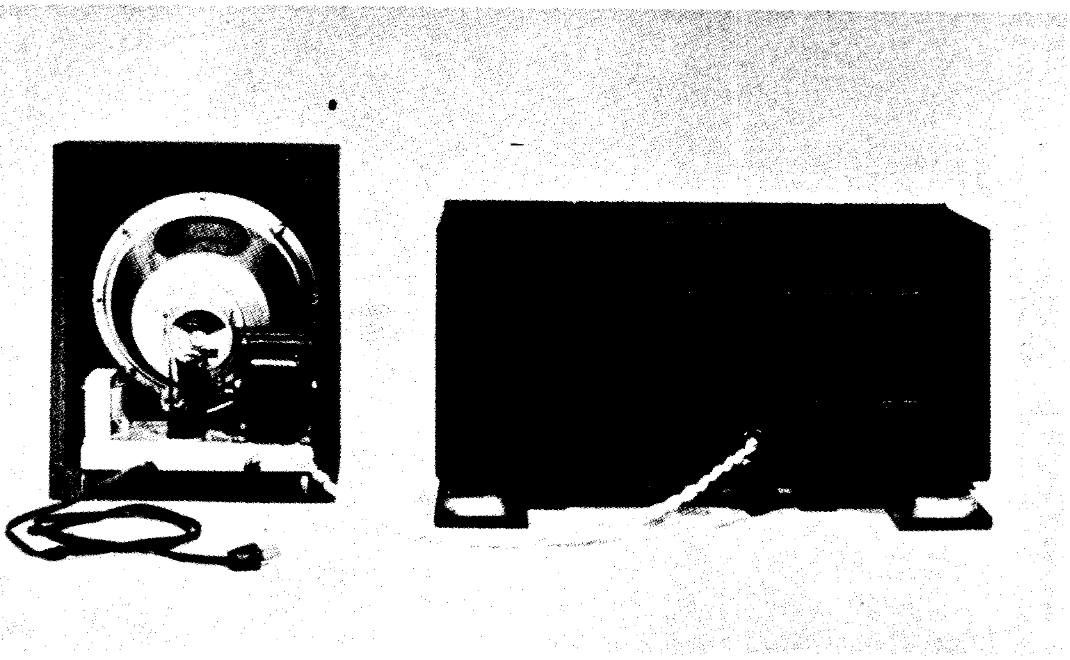


Figure 82.
REAR VIEW OF THE BC-348P ASSEMBLY.
Showing the power supply mounted in the speaker housing and the octal power plug on the receiver.

are several minor modifications which may be made to improve the performance and flexibility of the equipments.

BC-348Q General Information The BC-348 series of receivers may be operated with the heater circuits unchanged from a 26-volt a.c. supply. But a power transformer with such a filament winding is not readily available (although the C-228 transformer mentioned in connection with the BC-312 may be used with the filament windings in series) so it is in most cases best to rewire the heaters for operation from 6.3 volts. This means that one side of the heater of each tube should be grounded and the other side should be brought out as a common for feeding from the 6.3-volt line. In many cases the original "seriesing" wires between tube sockets may be used either for the grounded side or the hot side of the heater circuit, requiring addition of fewer wires and a solution to the problem of working in cramped spaces.

The a.c. power supply for the receiver may be mounted in the space formerly occupied by the dynamotor if space considerations and portability are very important. However, this procedure is not desirable from the standpoint of ventilation since an a.c. power supply dissipates a great deal more heat than the dynamotor originally installed. The space is more useful for additions to the receiver such as a noise limiter, an extra audio stage, or a broad-band converter.

The external a.c. operated power supply may be made somewhat oversize for operation of a frequency meter or a converter or an additional station accessory. In this event it is desirable to be able to ground the negative lead of the plate supply, which is not done on the BC-348Q. It is necessary to change the bias circuits of the 6K6-GT audio stage and the 6SA7 converter to accomplish this. The first step is to ground the B minus and remove connections to choke 155-B and resistor 108-2. This leaves both the above stages unbiased. A 470-ohm 2-watt resistor should be placed in series with the cathode terminal of the 6K6-GT audio stage. A 25-volt 25-μfd. electrolytic capacitor should be placed across this cathode resistor.

About 1.8 volts of bias is used on the grid of the 6SA7 converter stage. To obtain this, resistor 108-1 in the oscillator can should be clipped out of the receiver. The contact at the junction of this resistor and resistor 87-2 is available as a projecting lug. Upon this lug may be mounted a standard miniature bias cell with the positive side grounded and the negative side to the lug.

Audio Considerations in the BC-348Q Addition of a noise-limiter (see *Radio Handbook*) will improve operation in the presence of ignition interference on the 14-Mc. band and is almost a necessity for use of the receiver with a converter on the 28-Mc. or 50-Mc. bands. The addition of an extra stage of audio is also desirable, especially for use with the crystal filter on 14-Mc. c.w. The added tube may be a 6SF5 triode with conventional circuit values (see any standard reference), or a 6SJ7 stage with feedback may be added.

Difficulty may be encountered with the audio system of the receiver after the addition of the audio stage and the noise limiter due to the common cathode resistor on the second detector and the third i.f. stage. This trouble may be avoided by isolating these two cathode circuits. The lead between the two cathodes is removed and resistor 105 is either removed or shorted. This leaves the third i.f. stage with resistor 102 and capacitor 61-4 in its cathode circuit to ground. The cathode of the second-detector tube is now grounded to the chassis. The large capacitor can 70-A and 70-B may now be removed to make additional room inside the equipment. The 6-μfd. section is ideal as a portion of the filter capacitance in the external power supply. The lead at the low-potential side of the third i.f. transformer should be opened and the noise limiter inserted at this point. Capacitor 27-3 should be left to by-pass the secondary of the transformer. The on-off switch for the noise silencer may be placed in a panel position in place of one of the headphone jacks.

Mechanical Considerations If a plug to fit the rear connector block cannot be secured, an octal socket may be fitted into the set by liberal use of a round file and then by drilling and tapping mounting holes for the socket. If the cast aluminum guide box is removed from the case it will not be necessary to enlarge the rectangular hole in the case to pass an octal power plug.

A socket punch may be used to make two holes in the back of the case. One hole is used to pass the plug for the speaker connection, and the other hole to reach a two-post terminal strip which is wired to the receiver silencing circuit (terminals 2 and 6 in the circuit diagram). These two terminals may then be shorted or wired into the transmitter control circuit in such a manner that the receiver is disabled whenever the transmitter is on the air.

The seriesed dial lamps should be parallel and connected to the 6.3-volt heater circuit with the dial light control resistors 111 and 81 out of the circuit.

BC-348E, M, and P Receivers Changes in this series of receivers are generally the same as in the (J), (N), and (Q) series of 348's, except that only the power audio stage must be modified when grounding the negative lead of the power supply. Also, the second detector and third i.f. stage cannot be isolated since they are in the same tube envelope.

Figures 81 and 82 show a convenient method whereby the power supply for a BC-348 series receiver may be mounted in the housing for the loudspeaker.

A 120 to 140 Watt Modulator from the BC-375 or BC-191

One way in which to solve the problem of making good use of the BC-375E or the BC-191 is to disassemble the tuning drawers for components, use the housings for the tuning drawers as cabinets for accessory pieces of test equipment, and use the main housing of the transmitter along with the audio transformers and miscellaneous other components to assemble a modulator. Figures 83 and 84 show one such assembly which operates quite satisfactorily.

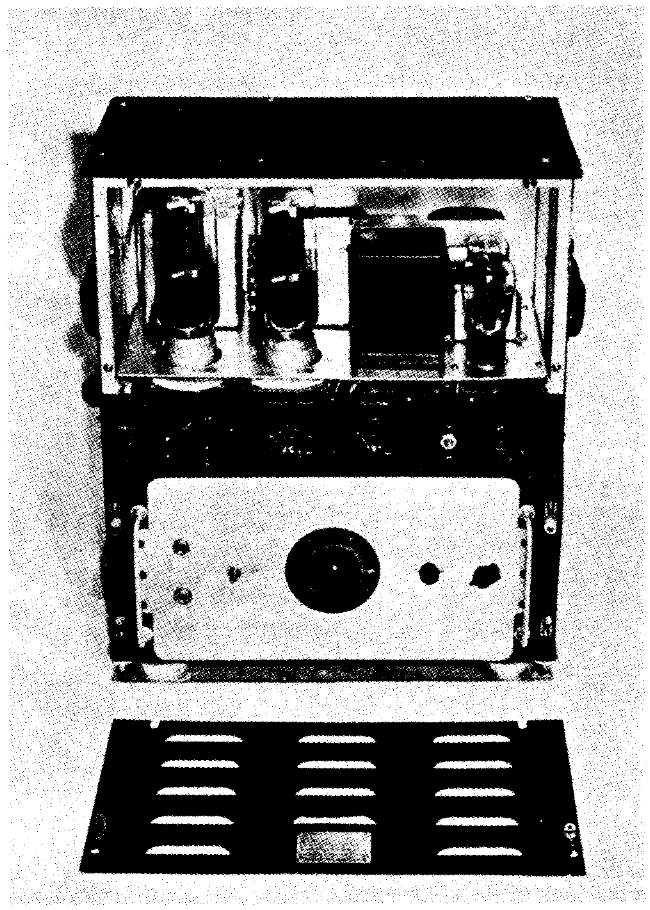


Figure 83.
MODULATOR AS MADE FROM A BC-375E.
The front cover has been removed to show the placement of components on the new chassis.

All components on the upper deck were removed, including the chassis, and a new chassis was bent from sheet aluminum to hold the components shown in Figure 85. The end of the main housing which held the antenna tuner was sawed off as unnecessary, but it might be retained to house the power supply for the modulator if components of the proper dimensions should be obtainable. The components mounted on the upper deck of the chassis include the power supply for the speech amplifier, a simple regulated bias circuit for the negative 100 volts on the 211 grids, and the audio transformers.

The clipper-filter audio amplifier and driver is mounted in the housing for one of the tuning drawers after all the r.f. components had been removed. The circuit for the speech amplifier is shown in Figure 86. An additional panel was placed in front of the original panel to cover the multitude of holes that had been left by removal of the r.f. components. The clipper-filter speech amplifier is quite conventional, ending in a single-ended 6B4-G which acts as driver for the 211's. Provision has been made in the input circuit of

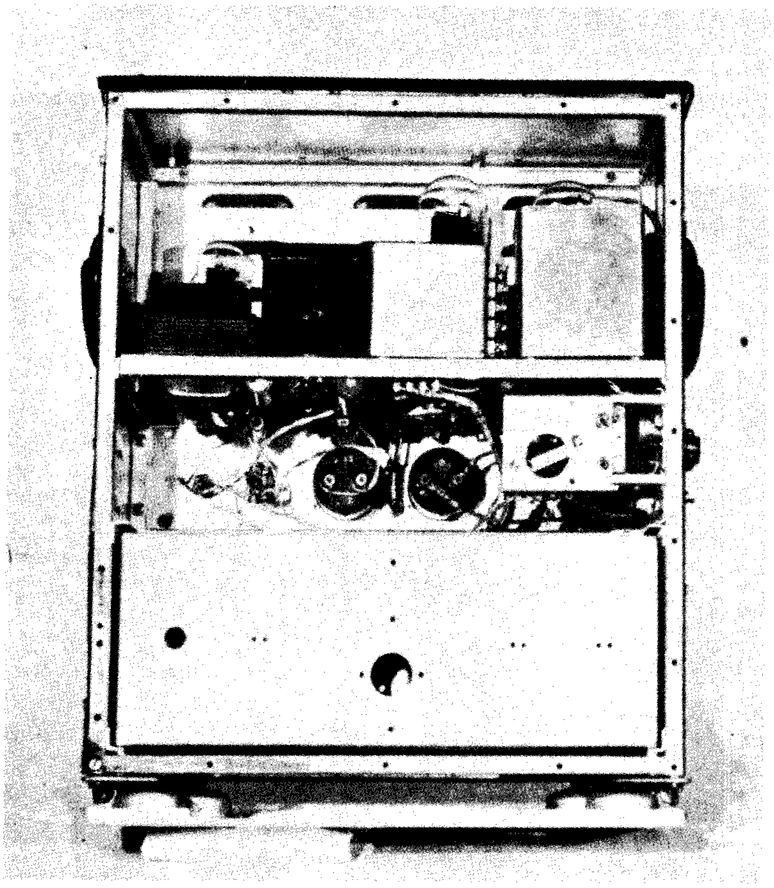


Figure 84.

REAR VIEW OF THE BC-375E MODULATOR.

the speech amplifier for both a single-button microphone and a crystal-microphone input, with a switch S to select either input circuit. The clipping level control R_{14}, must be substantially full open for maximum undistorted output from the 211 tubes in the output stage.

Measurements of the complete modulator, with a 1250-volt power supply feeding plate voltage to the 211 tubes, showed that it was possible to obtain 120 watts of audio output from the tubes with no distortion discernible to the ear or noticeable on the oscilloscope. An output of 145 watts was obtained with an amount of distortion which would be quite tolerable for amateur communications work. No heating of the output transformer was noticed with 120 watts output from the stage into a 7000-ohm load resistor over a test period of about one hour.

The 7000-ohm load impedance could be represented by a Class C modulated r.f. amplifier operating from the same plate supply as the 211's (1250 volts) at a plate current of 180 ma. This represents an input of 225 watts to the Class C stage, an amount which may be modulated without difficulty by the modulator unit.

AN/ART-13 Autotune Aircraft Radio Transmitter

The AN/ART-13 Autotune aircraft radio transmitter makes a very satisfactory amateur transmitter for phone and c.w. operation on the 80, 40, 20 and 10 meter bands. Under normal conditions the transmitter operates very stably and puts out a cleanly modulated or smoothly keyed signal when it is running about 200 watts input. The Autotune feature is a great operating convenience whether the transmitter is to be remotely controlled or controlled from the operating position. With the circuit modifications described herein the Autotune system allows operation on 10 preset frequencies throughout the 80, 40 and 20 meter bands and one additional frequency in the 10 or 11 meter band. Operation with phone or c.w. on any one of these frequencies is obtained simply by moving the panel selector switch to the desired position and waiting approximately 25 seconds for the Autotune system to operate. If desired, several frequencies separated by not more than about 50 kc. may be set up in the 28-Mc. band with an increasing reduction in the frequencies available for lower frequency operation.

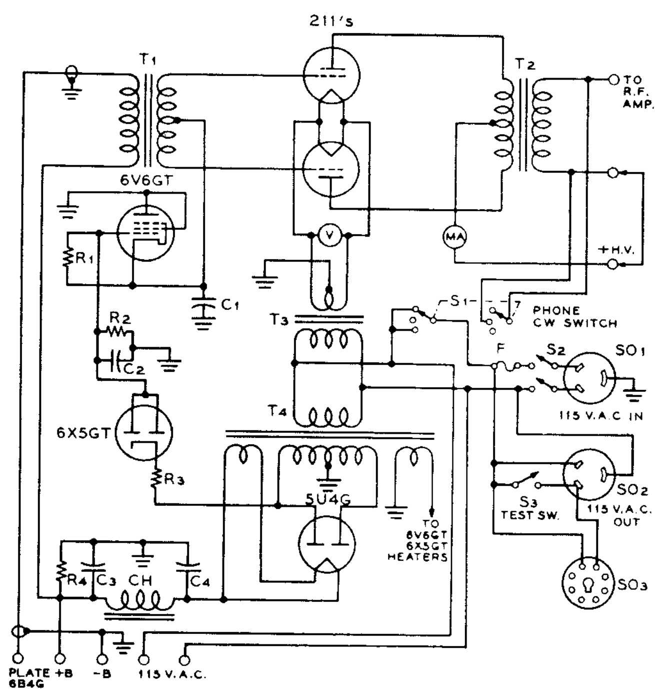


Figure 85.

MAIN ASSEMBLY SCHEMATIC OF THE BC-375E MODULATOR.

C_1—8-μfd. 450-volt elect.
C_2—40-μfd. 350-volt elect.
C_3, C_4—8-μfd. 450-volt elect.
R_1—100,000 ohms ½ watt
R_2—7500 ohms 10 watts
R_3—5000 ohms 10 watts
R_4—50,000 ohms 20 watts
T_1—Driver trans. from 375E
T_2—Mod. trans. from 375E
T_3—10-volt 6.5-amp. fil. trans.
T_4—700 v. c.t. 90 ma., 5 v. 3 a., 6.3 volts 2 amperes
CH—12-hy. 90-ma. choke
MA—0-500 d.c. ma. from 375E
V—Voltmeter from 375E
S_1—Phone c.w. switch from 375E
S_2—Main a.c. line switch
S_3—S.p.s.t. test switch
SO_1, SO_2—Twistlock receptacles

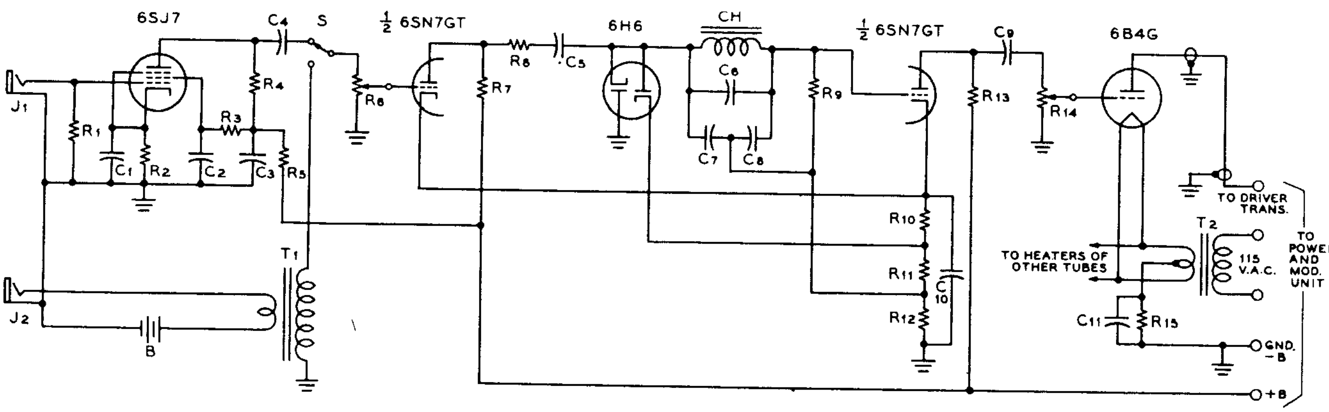


Figure 86.

SCHEMATIC OF CLIPPER-FILTER SPEECH AMPLIFIER FOR THE BC-375E MODULATOR

C_1—25-μfd. 25-volt elect.
C_2—0.1-μfd. 400-volt tubular
C_3—8-μfd. 450-volt elect.
C_4—0.01-μfd. 400-volt tubular
C_5—0.1-μfd. 400-volt tubular
C_6—175-$\mu\mu$fd. mica
C_7, C_8—200-$\mu\mu$fd. mica
C_9—0.01-μfd. 400-volt tubular
C_{10}—25-μfd. 25-volt elect.
C_{11}—10-μfd. 100-volt elect.
R_1—1.0 megohm ½ watt
R_2—1300 ohms ½ watt
R_3—1.5 megohms ½ watt
R_4—220,000 ohm ½ watt
R_5—47,000 ohms ½ watt
R_6—500,000-ohm potentiometer
R_7—100,000 ohms 1 watt
R_8—100,000 ohms ½ watt
R_9—100,000 ohms 1 watt
R_{10}—330 ohms ½ watt
R_{11}, R_{12}—620 ohms ½ watt
R_{13}—47,000 ohms 1 watt
R_{14}—250,000-ohm potentiometer
R_{15}—750 ohms 10 watts
T_1—Mike-to-grid transformer
T_2—6.3 volts at 3 amperes
CH—3.5 to 3.75 henry choke
J_1—Crystal-mike jack
J_2—Carbon-mike jack

Power Supply The major change required to adapt the ART-13 for amateur use is that of providing for operation of the equipment from the 115 volt a.c. line. All other changes described are in the nature of operating conveniences or are for the purpose of obtaining operation in the 28 Mc. region.

The simplest way of converting the equipment is to provide a source of 26 volts d.c. at about 9 amperes for operation of the tube filaments and heaters and for the relays and Autotune motor. Conventional a.c. operated power supplies are then used for plate and grid bias voltages. However, due to the difficulty in obtaining components for a high current 26-volt d.c. supply, it was deemed desirable in the conversion portion to use a 4-ampere 26-volt d.c. supply for the heater tubes relays and Autotune motor, and to supply the filaments of the 813 and the 811 from filament transformers.

The power supply unit shown in Figure 88 has been designed and constructed especially for operation with the AN/ART-13 transmitter. In addition to a complete set of control circuits the unit supplies the following potentials to the ART-13 through the power cable: 1250 volts at a maximum of 300 ma., 400 volts at 225 ma., 26 volts at 4 amperes, 350 volts of negative bias for keying the 813, and 115 volts a.c. for the blower and for the filament transformers for the 811's and the 813. The power supply is housed in a standard cabinet which takes a 12¼ by 19 inch front panel. Careful component placement is necessary to house the power supply unit in a cabinet of this size.

Several of the components used in the 26-volt d-c supply are surplus items since standard manufactured items are not available. In certain cases it will be necessary to have either the transformer or the filter choke for the 26-volt d.c. supply made up especially for the job. If a 10-ampere 26-volt output selenium rectifier is obtainable it will probably be best to have a 10-ampere power transformer and choke wound also so that no changes will be required in the filament circuits of the transmitter. The high voltage power supply and control circuits can be the same whether the filaments are all lighted from d.c. or some of them are lighted from d.c. and some from a.c.

Initial operation of the equipment at full input for a period of time showed that considerable heating takes place in the region behind the plate tank circuit for the 813. It was therefore deemed desirable to install a cooling exhaust blower on the back of the equipment. The particular blower used is a surplus item but similar a.c. operated blowers running at approximately 1500 r.p.m. are available from the larger hardware stores. With this blower in operation the unit runs quite cool and overheating of components is completely eliminated even with long periods of operation. In the particular unit shown in Figure 87 the blower has been mounted in a box on the rear of the housing for the transmitter with the filament transformers for the 811's and the 813 also included within this box.

Control Circuit A time-delay relay which operates from the 26-volt d.c. supply has been included in the equipment to insure that all tubes have reached normal operating temperature before plate voltage is applied. If a 26-volt time delay is not available, a 115-volt a.c. relay of the same type may be used. Protective interlocks have been provided in the power supply unit and in the actual cabinet for the ART-13 transmitter. These two interlocks are connected in series and in turn the two of them are connected in series with the lead to the plate power relay

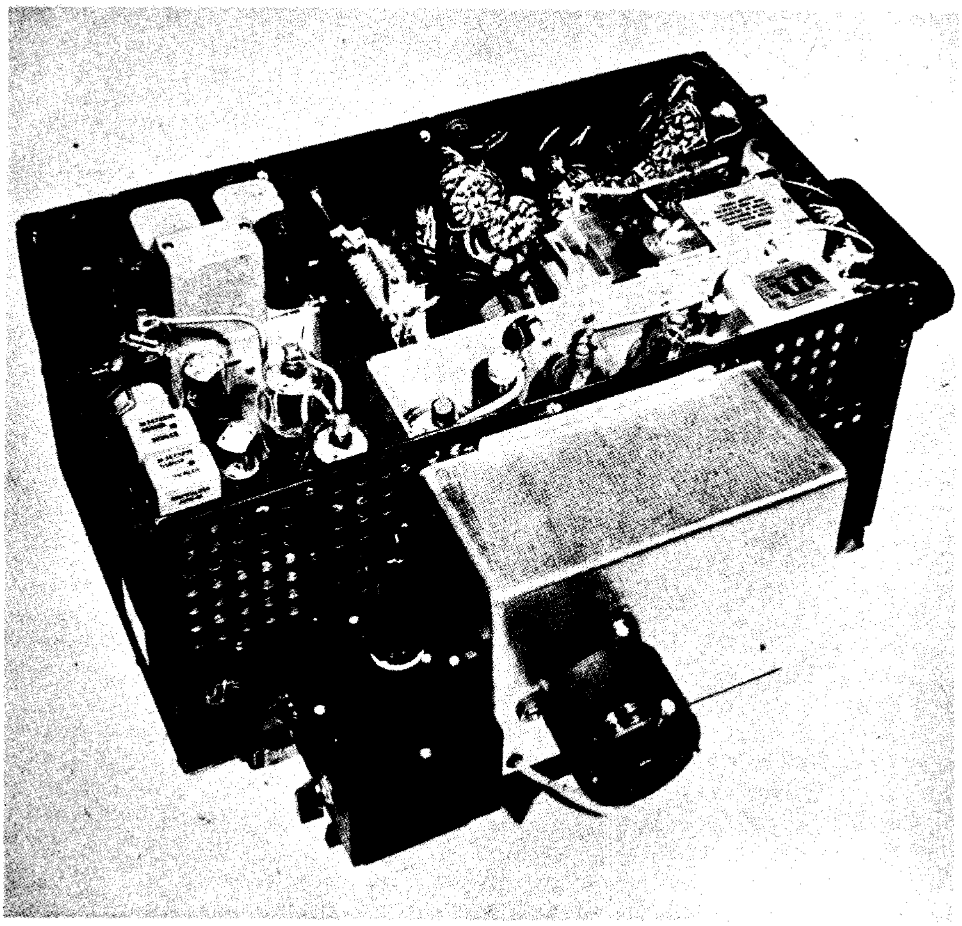


Figure 87.

TOP OF THE CONVERTED AN/ART-13.

The box containing the blower and the filament transformers for the 813 and the 811's can be seen on the rear alongside the small box which holds the 6L6 multiplier for the 28-Mc. band. The 28-Mc. tank for the 813 can be seen inside the Cabinet.

RY_1 so that plate voltage cannot be applied to the transmitter if the cover has been removed from the ART-13 or if the top door to the power supply box has been opened.

Provision has been made in the control circuit for the transmitter so that when S_{110} on the front of the ART-13 or its counterpart at the remote control position is moved from the off to either the voice or the c.w. position, the transmitter will be turned on. Since this switch closes a circuit to ground, it was necessary to find an isolated source of potential to operate the main control relay. This source of potential was obtained by leaving the small transformer T_4 connected across the line at all times that the unit is plugged into the socket. However, when the transmitter is switched off there is no power drain from any of the secondaries of this transformer.

The push-to-transmit circuit which has been included in the power supply unit is very pleasing to operate and relatively simple in design. It consists of a single 6C5 tube operating from the bias supply along with its associated components. The complete circuit is shown in Figure 88. When the key is up relay RY_5 is open and the voltage drop across R_5 to the slider is impressed on the grid of the 6C5 tube, cutting off its plate current. When the key is pressed RY_5 closes and the right-hand side removes the blocking grid bias from the 813 by shorting the grid return to ground through R_9 and CH_6. These latter two components in conjunction with C_8 make up a very effective key-click filter. The effectiveness of the circuit is illustrated by the fact that clicks cannot be heard from the transmitter on a communication receiver tuned to the same band for break-in c.w. operation.

At the same time that RY_5 is closing, the other set of contacts on this relay shorts the grid of the 6C5 to its cathode, causing full plate current to flow through RY_6 and R_7, thus closing RY_6. When RY_6 closes the antenna changeover relay in the ART-13 operates and plate voltage is applied to the transmitter by RY_1. Then when the key is lifted RY_5 opens so that plate current to the 813 is stopped, but due to the time constant of the R_6-C_6 combination, plate current still flows through RY_6. Hence the plate voltage remains on the transmitter and the antenna relay is still in the transmit position. The transmitter remains in this condition until the voltage across C_6 has built up to such a value that RY_6 drops out, changing everything back to the receive condition. The amount of this delay is variable, by adjustment of potentiometer R_5 from a fraction of a second up to about 15 seconds. The normal setting is for about 3 seconds so

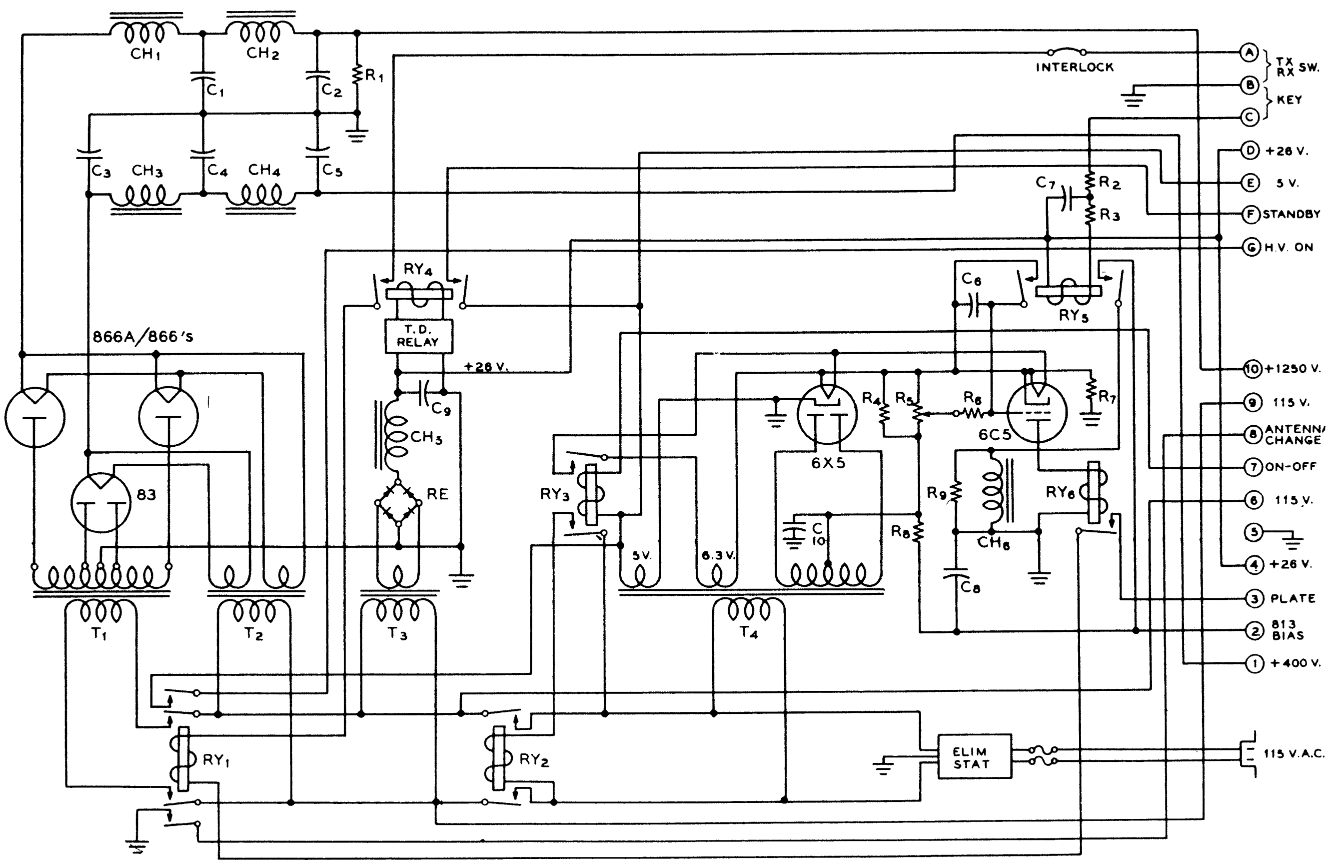


Figure 88.

SCHEMATIC DIAGRAM OF THE POWER SUPPLY FOR THE AN/ART-13.

C_1, C_2—4-μfd. 1500-volt capacitors
C_3, C_4—4-μfd. 600-volt capacitors
C_5—10-μfd. 600-volt capacitor
C_6—0.5-μfd. 600-volt tubular
C_7—0.1-μfd. 400-volt tubular
C_8—0.05-μfd. 400-volt tubular
C_9—4000-μfd. 50-volt elect.
C_{10}—8-μfd. 450-volt elect.
R_1—50,000-ohm 100-watt bleeder
R_2, R_3—22 ohms 2 watts
R_4—10,000 ohms 10 watts
R_5—100,000-ohm potentiometer
R_6—2.7 megohms ½ watt
R_7—15,000 ohms 10 watts
R_8—50,000 ohms 20 watts
R_9—15,000 ohms 2 watts
T_1—1500 v. each side at 300 ma., 400 v. each side at 175 ma., common c.t. (UTC PA-303)
T_2—5 v. 3 a., 2.5 volts 10 a.
T_4—700 v. c.t. 70 ma., 5 v. 2 a., 6.3 v. 2 a. (UTC R-2)
T_3—35 volts at 5 a. (special)
CH_1—250-ma. swinging choke
CH_2—250-ma. filter choke
CH_3, CH_4—200-ma. filter chokes
CH_5—0.05 henrys at 4 amp. (special)
CH_6—13-henry 65-ma. filter choke
RY_1—28-volt d.c. 4-pole d.t. relay
RY_2—115-volt a.c. 2-pole relay
RY_3—6.3-volt or 5 volt 2-pole relay (RY_2 and RY_3 may be combined if contacts of RY_3 can carry about 8 amperes and if 3 contacts are available.)
RY_4—28-volt d.c. time-delay relay (115-volt a.c. time-delay relay may be used across primary of T_3 if 28-volt relay not avail.)
RY_5—28-volt d.p.d.t keying relay
RY_6—2500-ohm sensitive relay
Elimstat—A.c. line filter

that the plate voltage will remain on for the normal short pauses in a c.w. transmission but will drop back to the receive condition 3 seconds after a transmission has been completed.

Changes in ART-13 Control Circuits

It is necessary to make a certain number of modifications in the various circuits of the ART-13 in order to allow the equipment to operate from the power supply unit described before and illustrated in Figure 88. It is necessary first that the meter switch circuit be changed in the following manner: Remove ground from bottom end of R_{111} (235-ohm resistor) and connect this end of the resistor to terminal A_2 of S_{105}. Remove the wire that now goes to terminal B_3 of S_{105} and connect this wire to terminal A_2 of S_{105} along with the bottom end of R_{111} above. This series of changes brings the grid return of the 813 tube out to terminal 2 on the main power connector J_{108}.

The following changes are required in the power control circuits: Ground the lead inside the cabinet which now goes to terminal 8 on J_{108}. Remove the lead now going to terminal 14 of J_{116} which is mounted on the side of the antenna changeover relay K_{102}. Insulate this lead. Now run a lead from terminal 8 of J_{108} to terminal 14 of J_{116}. A lead is now run from terminal 2 on the loading coil relay connector J_{107} to terminal C in the power supply unit. This is the only lead brought out of the transmitter which does not go through the main power connector J_{108}.

The filaments of the 813 and of the 811's should be re-wired to operate from separate transformers mounted on the rear of the equipment. One side of the filament may be left grounded on the 813 but the center tap of the filament supply to the 811's must be grounded in order to eliminate hum modulation on audio peaks. The primary of the filament transformer and the cooling blower for the equipment should now be connected to terminals 6 and 9 on J_{108}. These terminals are supplied with 115 a.c. from the power supply unit when the equipment is in operation. The driver transformer returns which formerly went to one side of the filament of each 811 are now grounded to the chassis of the transmitter.

Several changes may be made in the vicinity of the high-frequency/low-frequency relay K_{105} whether or not the 10-meter band is to be included in the transmitter. In the first place the low-frequency choke L_{109} may as well be removed from its present position and C_{128} mounted in the space formerly occupied by L_{109}. One additional hole must be drilled in the fire wall of the equipment. It is suggested that a protective interlock now be mounted in the position formerly occupied by C_{128} on the fire wall of the transmitter. The leads to this interlock should be connected in series with the lead now going to terminal 3 of J_{108}. The interlock should of course be mounted in such a manner that it is closed only when the cover is firmly in place on top of the transmitter.

A slight increase in operating convenience can be obtained through replacing the 0-5 r.f. ammeter with a 0-300 or a 0-500 d.c. milliammeter. The r.f. transformer T_{102} may be removed after the leads have been clipped by unscrewing it from the chassis. With the installation of this additional milliammeter it is possible to read grid current and plant current on the 813 simultaneously.

Converting for 28-Mc. Operation The conversion of the ART-13 for 28-Mc. operation may be accomplished in several different ways of varying difficulty. However, in converting the unit shown in the photographs it was felt that a conversion method which did not involve any dis-assembly of the Autotune mechanism and which required no changes in the exciter of the transmitter would be best. So it was felt best simply to add a 6L6 outboard tripler stage on the rear of the transmitter in the vicinity of the grid of the 813. The 6L6 tripler is fed energy from the 1625 second multiplier in the ART-13 in the 9.0 to 10.8 Mc. frequency range. The plate circuit of the 6L6 then may be tuned to any frequency between 27 and 32.4 Mc. for feeding excitation to the grid of the 813 amplifier. In fact, if desired, the 6L6 may be used as a doubler from the same frequency range to deliver excitation to the grid of the 813 in the 21-Mc. range.

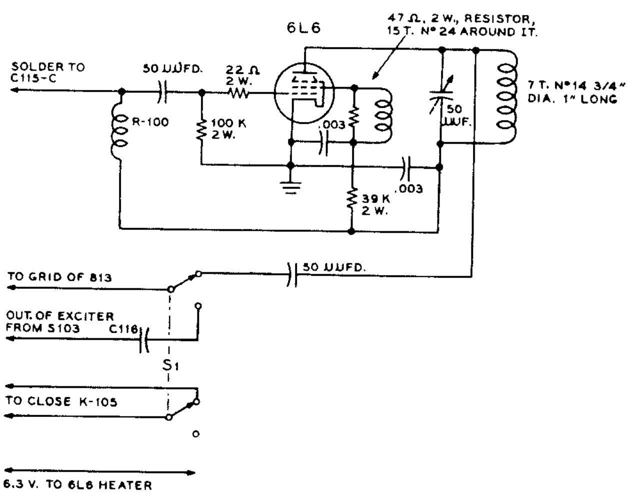


Figure 89.

SCHEMATIC OF THE 28-MC. MULTIPLIER STAGE.

The 6L6 multiplier is housed in 2" by 4" by 4" standard metal "cabinet" which has been mounted to the side of the cabinet which houses the blower and the filament transformers for the 811's and 813. S_1 in the circuit diagram of the multiplier, Figure 89, may be either a double-pole double-throw ceramic switch or a 28-volt d.p.d.t. relay which may be operated from the 28-volt supply for the transmitter. In the particular unit shown in the photographs a switch is used but it is planned to replace the switch with a relay for completely remote operation of the transmitter. The relay will be operated by another set of contacts on the channel-selector switch which will be closed whenever the 28-Mc. band is chosen. Heater voltage for the 6L6 may be obtained from a small transformer or from the supply for the 811's if they are operated from a.c.

The circuit of the 6L6 multiplier is otherwise quite conventional except for the manner in which plate voltage is obtained for the 6L6 multiplier. Careful inspection of the circuit diagram of the ART-13 will show that the 400 volts applied to the plate of the 1625 multiplier appears across only one section of the padder capacitor C_{115} at a time and only when that particular section of the padder capacitor is in use. Hence, by connecting an r.f. choke to padder capacitor which is used to excite the grid of the 6L6 in the 9.0 to 10.8 Mc. range, 400 volts from the exciter power supply may be obtained by filtering the r.f. out of the d.c. line with an r.f. choke and a by-pass capacitor. A 50-$\mu\mu$fd. mica capacitor is then used to excite the grid of the 6L6 multiplier from the hot side of the r.f. choke. In this way the 6L6 multiplier is completely out of the circuit except when control A is in position 9.

The lead from coupling capacitor C_{116} to the grid of the 813 is broken and a lead brought out from each side of the point where the connection is broken. These two leads are then connected as shown in Figure 89 to the 6L6 multiplier unit. One set of contacts on S_1 is used in addition to close K_{105}, which switches the plate of the 813 from the network used on the low-frequency bands to the separate 28-Mc. tank

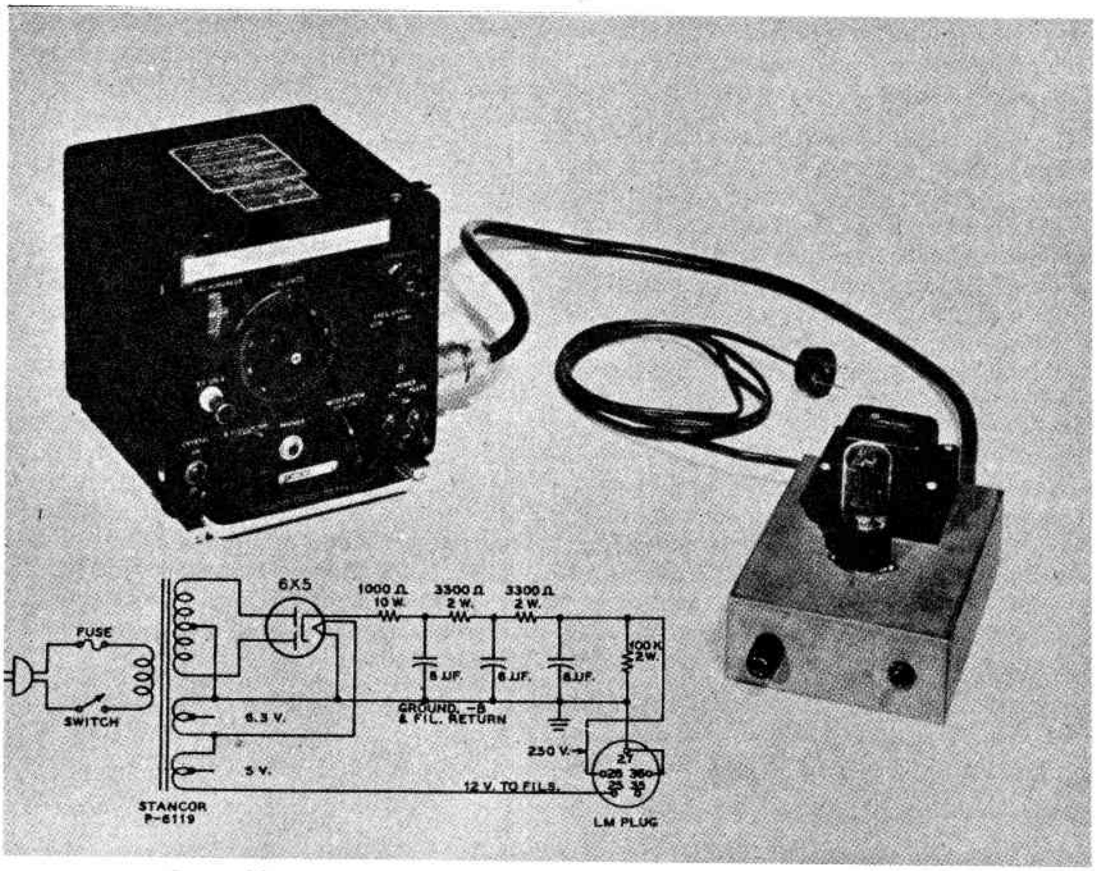


Figure 90.
SCHEMATIC OF THE SIMPLE LM POWER SUPPLY.

The 5-volt and 6.3-volt windings on the transformer are connected in series to obtain filament voltage for the LM. Due to the light load on the filament windings the filament voltage measures about 11.9 volts on the filament lead. This value of voltage is well within the filament voltage tolerance of the heater tubes used in the frequency Meter.

Figure 91
PHOTOGRAPH OF THE SIMPLE LM POWER SUPPLY.

An LM frequency meter is shown alongside the power supply for comparison.

which has been placed in the position inside the cabinet of the ART-13 which was designed to hold the low-frequency oscillator unit. In the particular transmitter shown the 28-Mc. tank for the 813 consisted of a 6-turn coil of number 10 enamelled wire 1¼ inches in diameter and 1½ inches long. A two-turn link feeding a piece of 300-ohm line is then run over to the left wall of the transmitter where it terminates in a pair of terminals. With this tank the 813 dips to about 30 ma. on 28 Mc.

The two terminals which close K_{105} may be picked up as terminals 7 and 4 on the connector J_{115} which feeds plate and filament supply to the multiplier unit of the ART-13. Two leads from these two terminals are run to the 6L6 multiplier unit so that they are closed whenever the 6L6 is in operation. With the 6L6 frequency tripler as shown it is possible to obtain half scale on the grid current meter throughout the 28-Mc. band; this represents about 8 to 9 ma. of grid current on the 813.

Note in Regard to the Output Network of the ART-13 The output network of the AN/ART-13 is designed to operate as an "L" network on frequencies up through about 5 Mc. This is required since the transmitter was designed to feed an antenna installed on an aircraft which would have a very low radiation resistance at these low frequencies but would have a relatively large value of capacitance to ground. This network will *not* feed satisfactorily the type of antennas commonly used by amateurs for fixed-station use in the 3.5 to 4 Mc. band. Hence it is desirable to convert the L network into a pi network when operating on the 80-meter band. The simplest way to do this is merely to place a capacitor of 100 to 400 $\mu\mu$fd. from the "COND" terminal on the left end of the transmitter to the ground terminal on the case. A variable capacitor may be used to determine the best value for this capacitor, and then a fixed air capacitor or a ceramic transmitting capacitor of the type used in the transmitter may be hooked in place. Experiment showed that a value of about 200 $\mu\mu$fd. was best for feeding a folded dipole with 300-ohm twin line on the 3.5-Mc. band.

Tests of the completed transmitter have shown that there is no appreciable increase in output after the plate current on the 813 is increased above 160 ma. This represents a power input of 200 watts at 1250 volts and the plate circuit efficiency runs from 70 to 75 per cent on all bands. The out-of-resonance plate current will be from 180 to 200 ma. with normal excitation, and antenna coupling should be adjusted until 160 ma. of plate current is drawn by the 813 tube.

Simple A.C. Power Supply for the LM Frequency Meter

Figures 90 and 91 illustrate a very simple power supply for operation of one of the LM series frequency meters from the 115-volt a.c. line. Plate voltage for the frequency meter is obtained from a small power transformer with a 6X5-GT rectifier. Due to the very low plate current requirements of the frequency meter a resistance-capacitance filter has been used on the plate voltage supply. With the transformer shown and the values of resistance and capacitance listed the plate voltage supplied to the frequency meter is 255 volts. This voltage is sufficient to cause the neon regulator tubes to strike with certainty when the voltage-change strap in the LM is adjusted to the 200-260-volt position.

By connecting the two filament windings on the power transformer in series it is possible to obtain adequate heater voltage for the frequency meter. Due to the light load on these two filament windings the voltage applied to the LM under normal operating conditions is 11.9 volts; this value of voltage is well within the plus or minus 10 per cent heater voltage limit on the tubes used in the equipment. Through the use of a 6X5-GT rectifier, which has the heater well insulated from the cathode, the rectifier may be lighted from the same filament windings, which light the tubes in the frequency meter. No changes whatever are required inside the LM frequency meter when it is used with the power supply shown in these illustrations.

LIST OF EQUIPMENT
on which data is given in Volume I of the "Surplus Radio Conversion Manual"

BC-221 Frequency Meter

BC-342 Receiver

BC-312 Receiver

BC-348 Receiver

BC-412 Radar Oscilloscope (Conversions for TV Receiver and Test Oscilloscope)

BC-645 Transmitter-Receiver (420 Mc.)

BC-946B Receiver (Conversion to Auto Receiver)

SCR-274N (BC-453A Series) Receivers (Conversion to 10-meters)

SCR-274N (BC-457A Series) Transmitters (Conversion to V.F.O.)

SCR-522 (BC-625) Transmitter (Conversion to 2 meters)

SCR-522 (BC-624) Receiver (Conversion to 2 meters)

TBY Transceiver (Conversion to 10 and 6 meters)

BE-103A Dynamotor

BC-1068A/1161A Receiver (2 meters)

LIST OF EQUIPMENT
on which data is given in Volume II of the "Surplus Radio Conversion Manual"

ARC-5 (B-454) Receivers (Conversion to 28 Mc.)

AN/APS-13 Transmitter-Receiver (Conversion to 420 Mc.)

ARC-5 (BC-457) Transmitters (Conversions to 28 Mc.)

Selenium-Rectifier Power Units

ARC-5 V.H.F. Transmitter-Receiver Operation

GO-9/TBW Transmitter (Conversion to 28 Mc.)

BC-357 Marker Receiver (Conversion to Capacity Relay)

BC-946B Receiver (Conversion to High-Fidelity Tuner)

BC-375 Transmitter (use with external V.F.O.)

TA-12B/C Transmitter Conversion

AN/ART-13 Transmitter (Conversion to A.C. and 28 Mc.)

Coil-Winding Charts

AVT-112A Transmitter for Light Aircraft

AM-26/AIC Interphone Amplifier (Conversion to 9-watt Amplifier)

LM Frequency Meter

Beam Rotating Mechanisms

ARB Receiver (Schematic only)

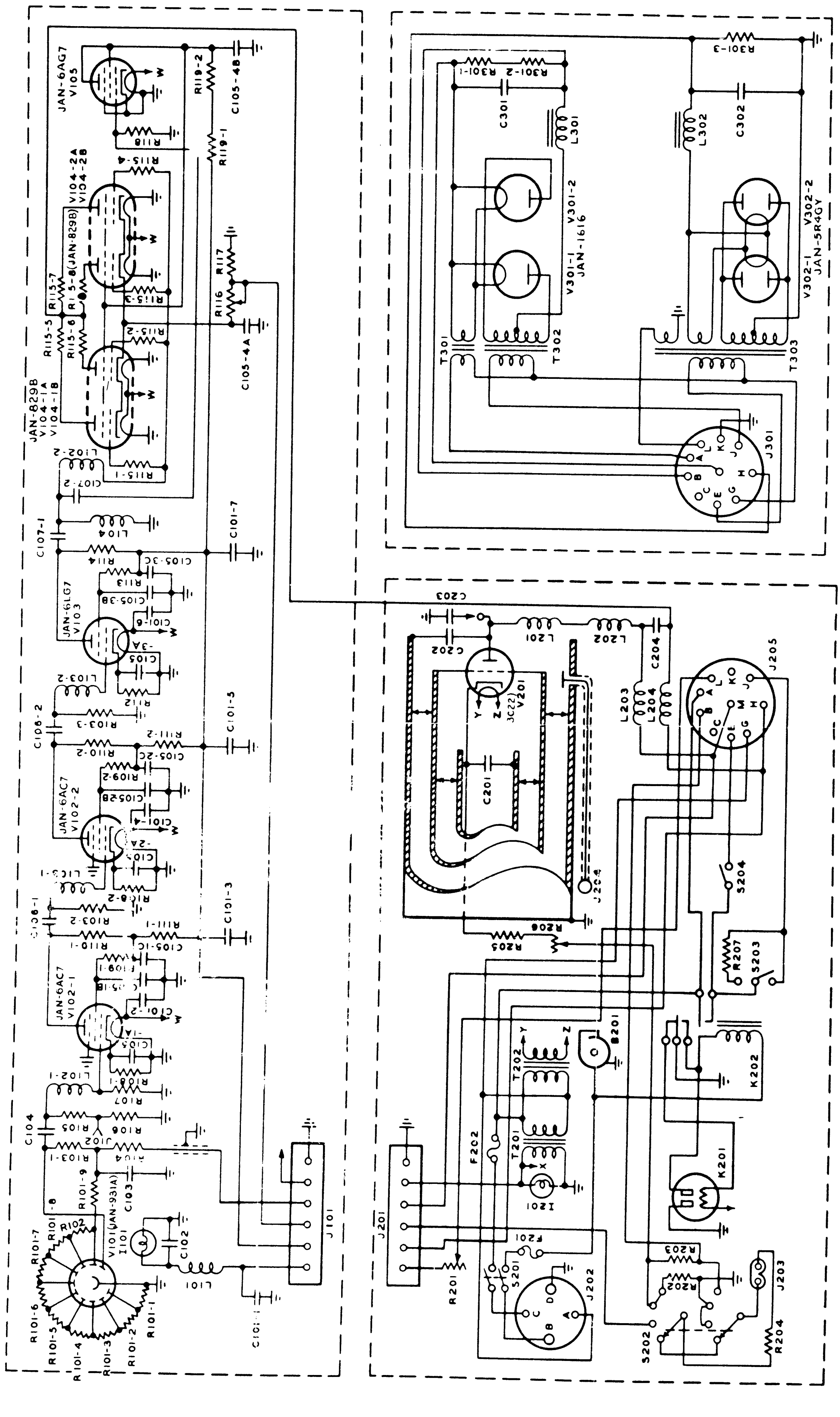


Figure 92
RADAR SET AN/APT-5 — SCHEMATIC DIAGRAM

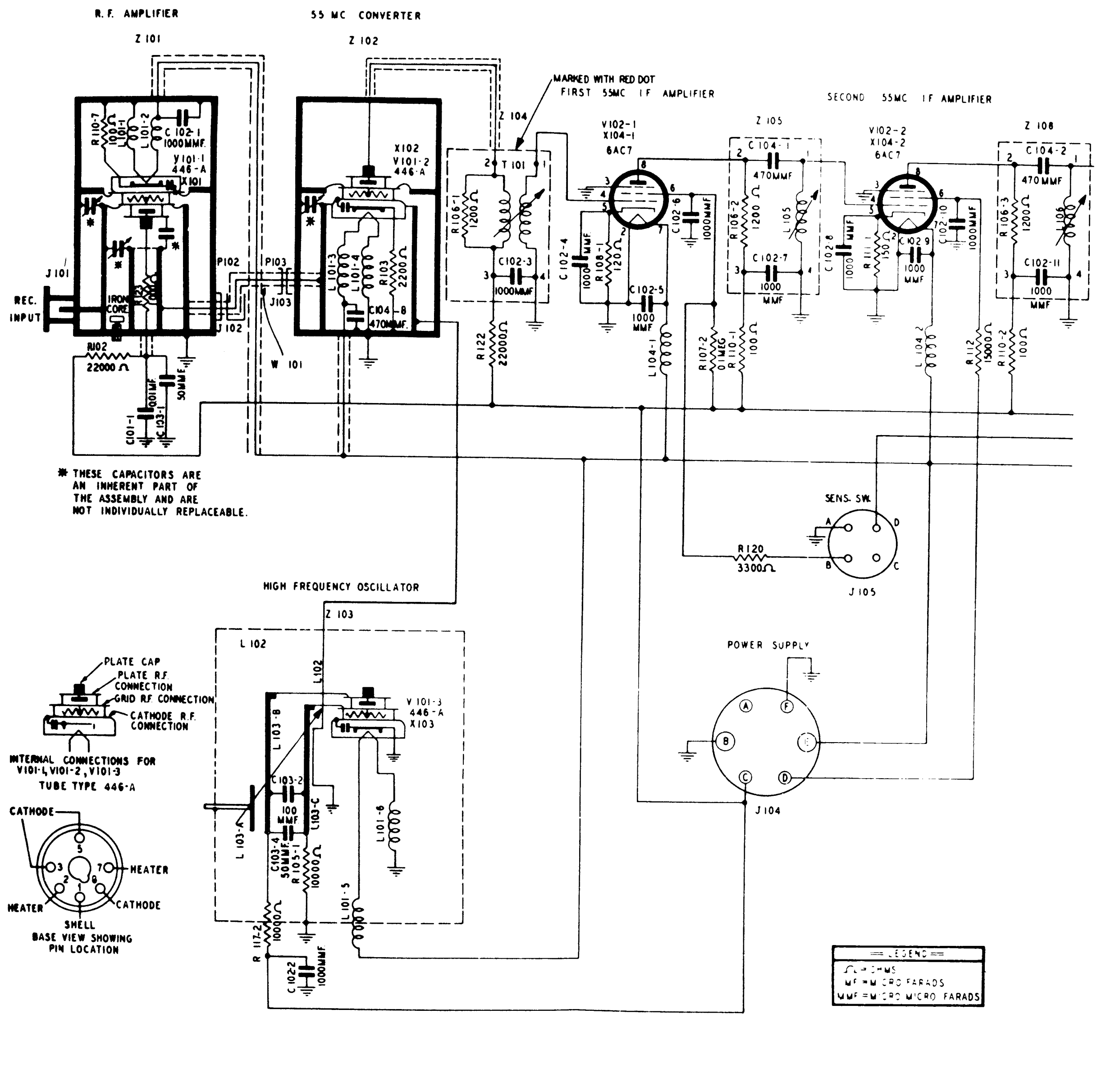


Diagram continued on page 79

Figure 93

RECEIVER UNIT, CPR-46ACJ, SCHEMATIC DIAGRAM

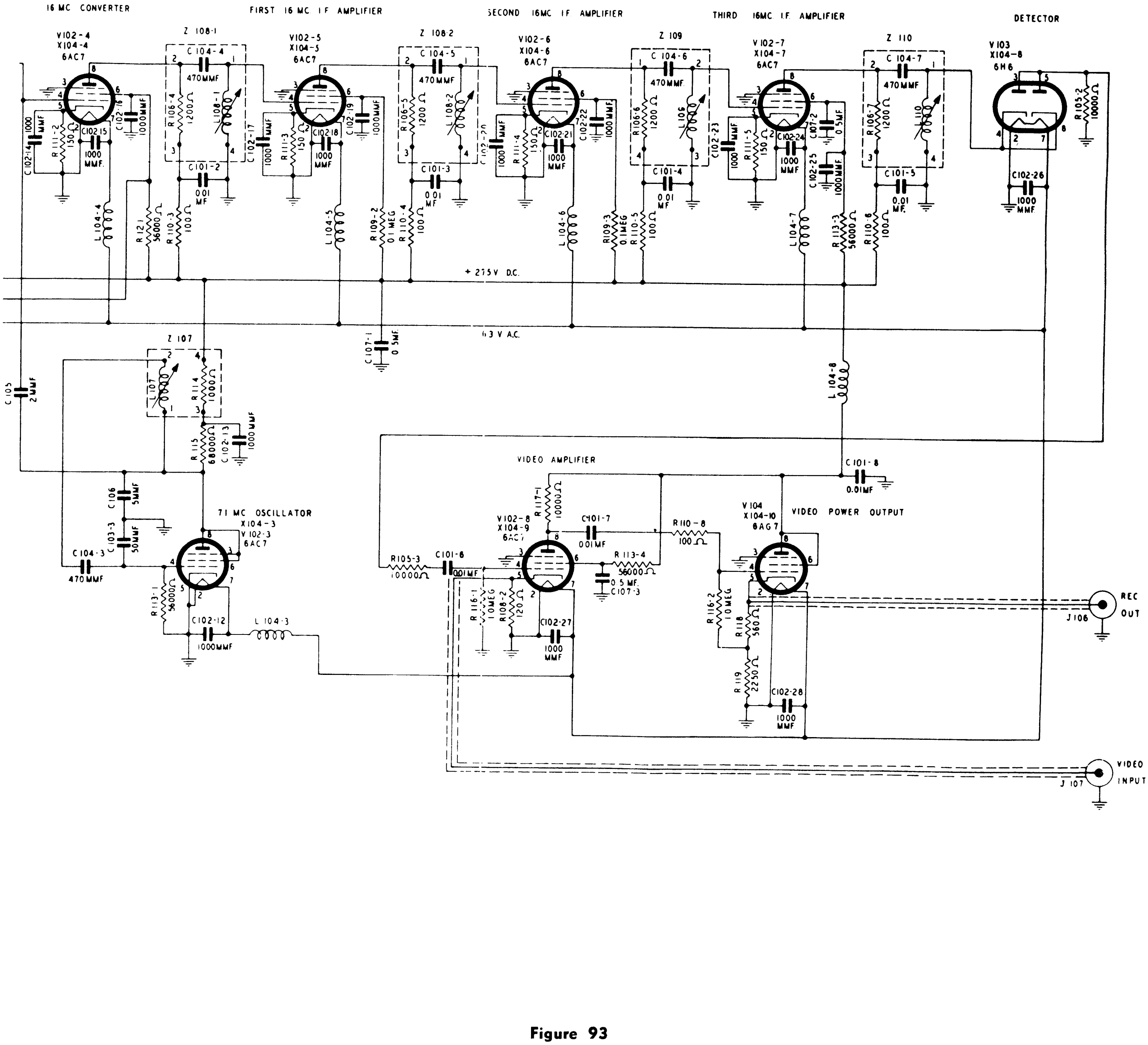


Figure 93

RECEIVER UNIT, CPR-46ACJ, SCHEMATIC DIAGRAM

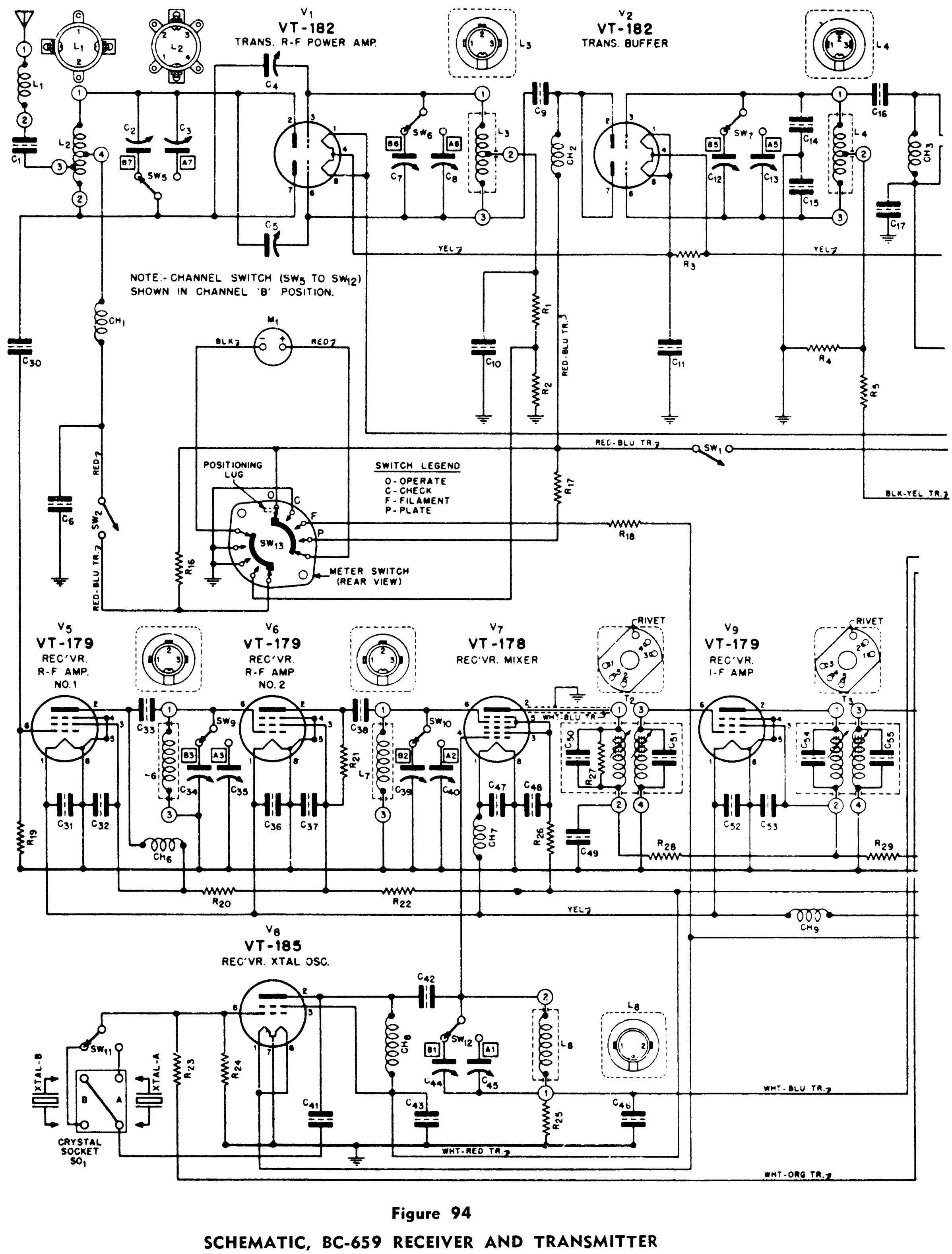


Figure 94

SCHEMATIC, BC-659 RECEIVER AND TRANSMITTER

Diagram continued on page 81

Diagram continued from page 80

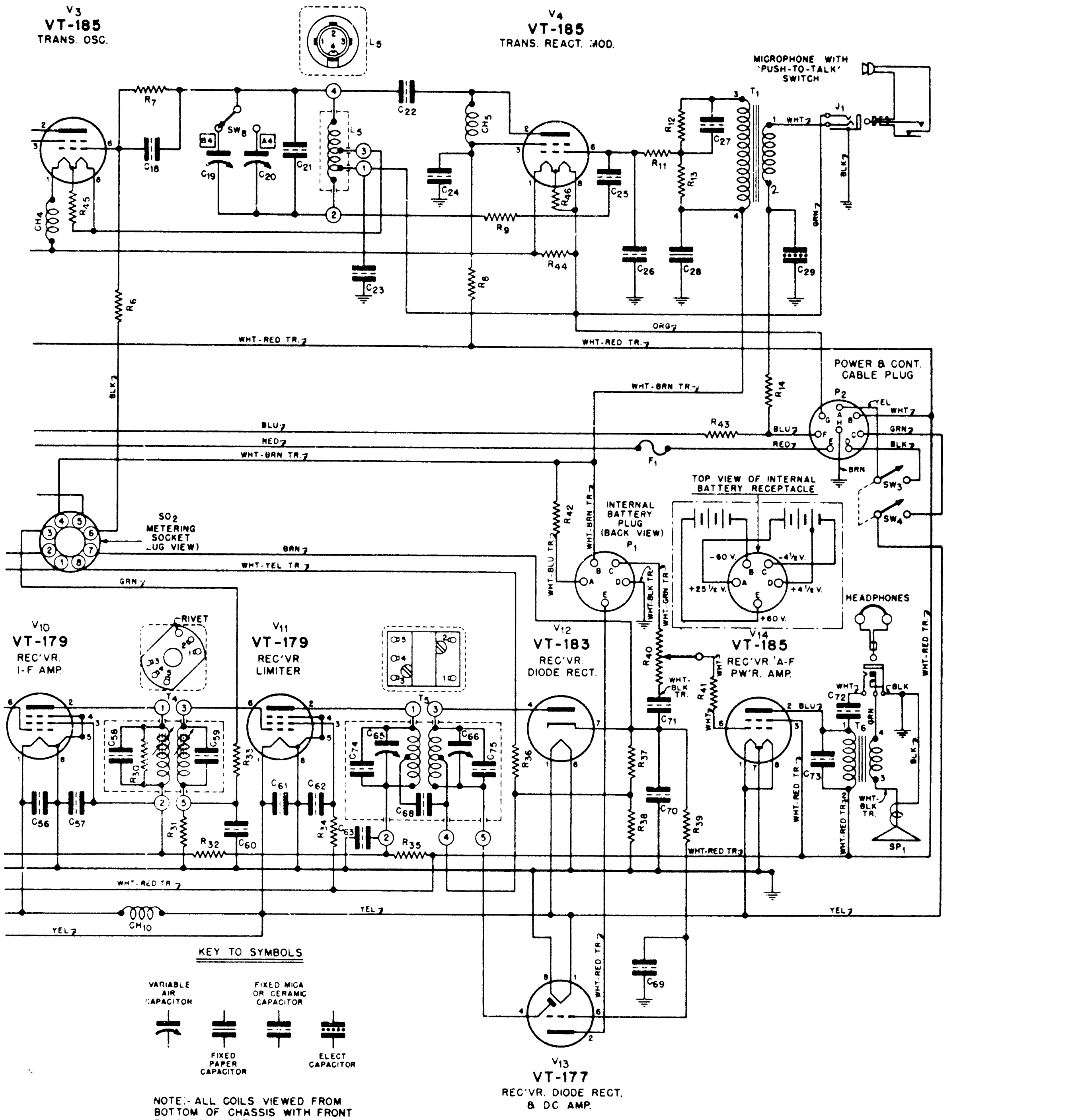


Figure 94

SCHEMATIC, BC-659 RECEIVER AND TRANSMITTER

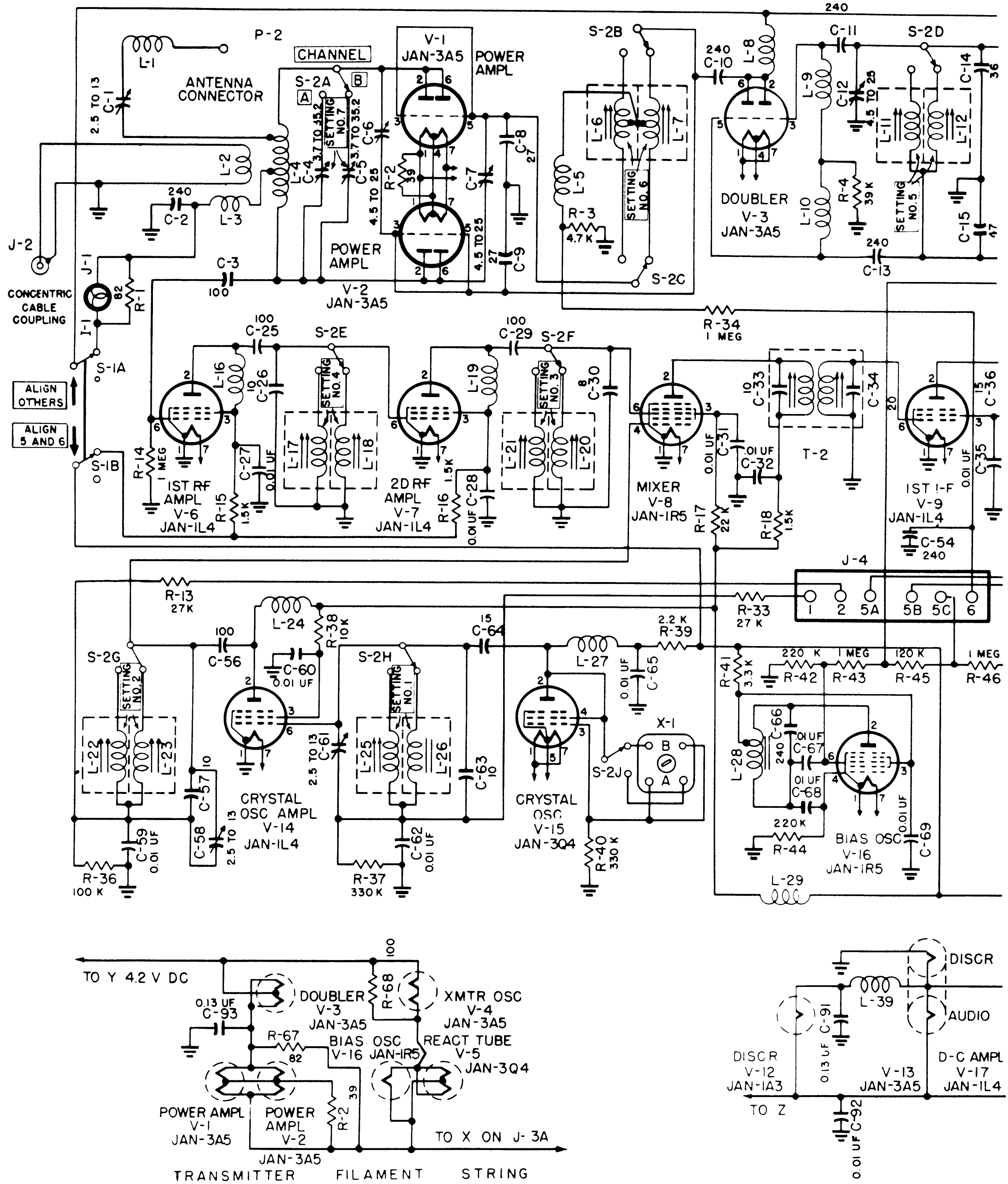


Diagram continued on page 83

NOTE: CHANNEL SWITCH S-2A, S-2B, S-2C, S-2D, S-2E, S-2F, S-2G, S-2H, S-2J SHOWN IN B POSITION.

Figure 95

SCHEMATIC, BC-1335-A, TRANSMITTER - RECEIVER

Diagram continued from page 82

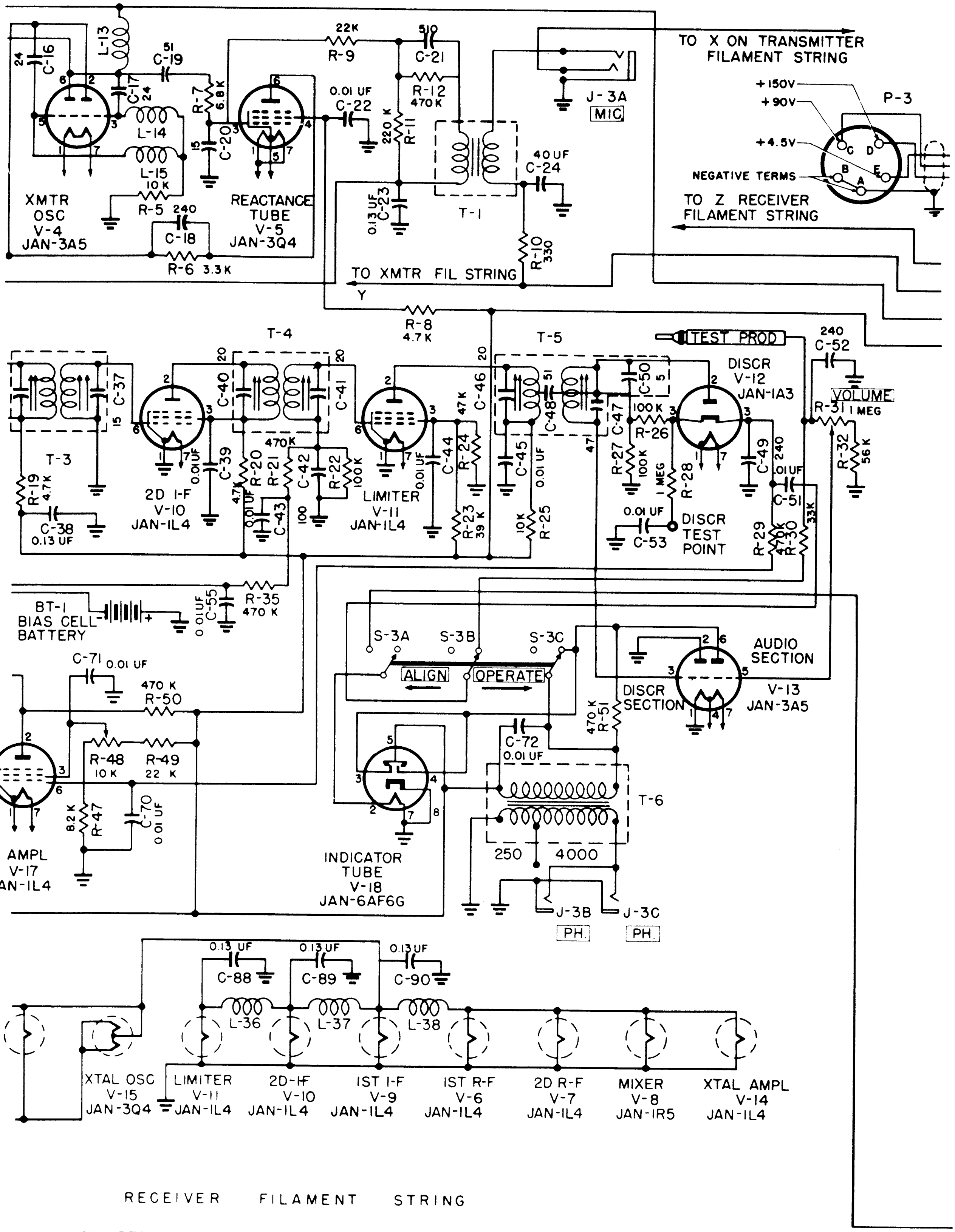


Diagram continued on page 84

ALL RESISTOR VALUES IN OHMS UNLESS OTHERWISE SPECIFIED.
ALL CAPACITOR VALUES IN UUF UNLESS OTHERWISE SPECIFIED.

Figure 95

SCHEMATIC, BC-1335-A, TRANSMITTER - RECEIVER

Diagram continued from page 83

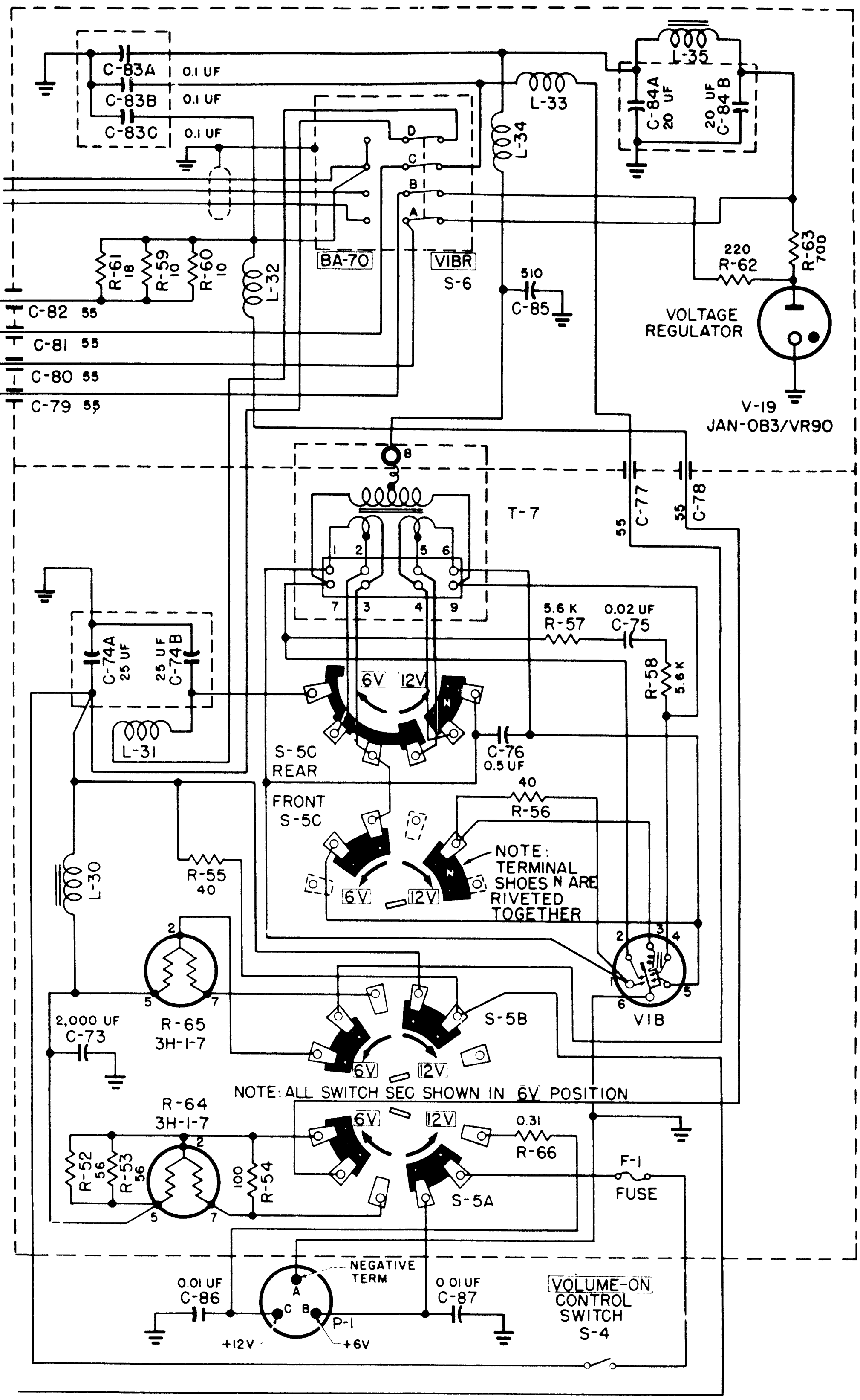


Figure 95 (continued)

SCHEMATIC, BC-1335-A, TRANSMITTER - RECEIVER

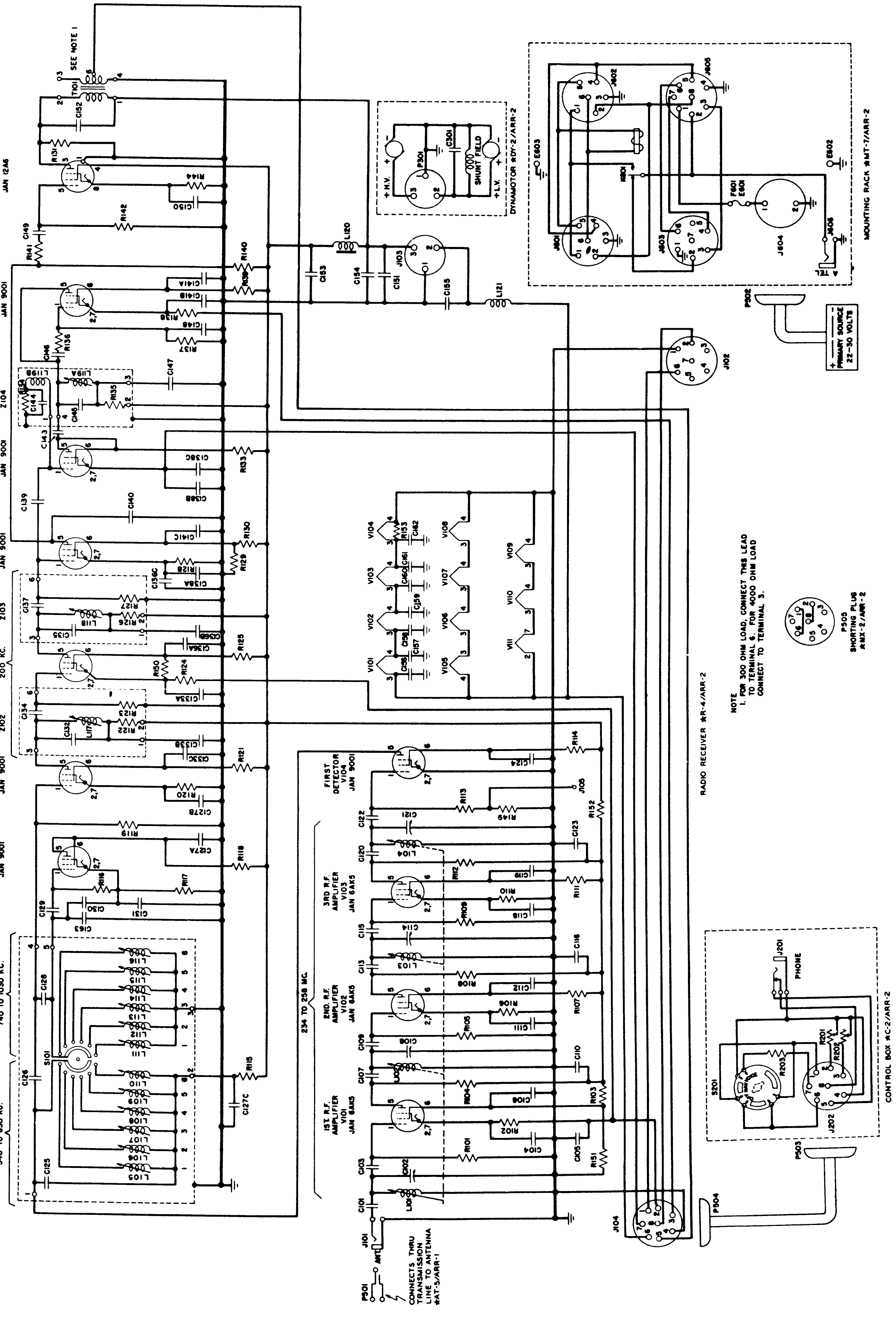


Figure 96
SCHEMATIC, AN/ARR-2 RECEIVER

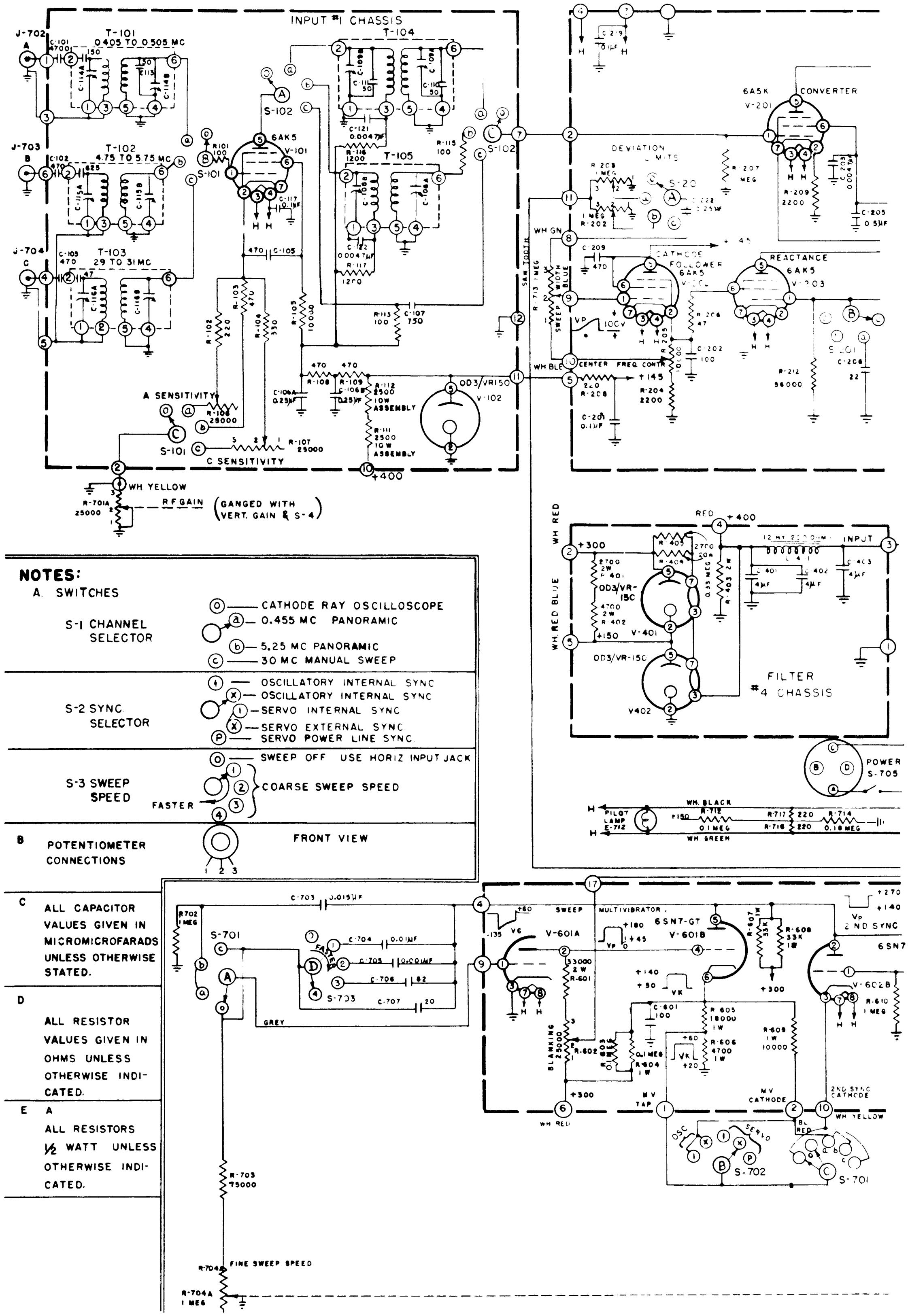


Diagram continued on page 87

Figure 97

SCHEMATIC, AN/APA-10 PANORAMIC ADAPTER

Diagram continued from page 86

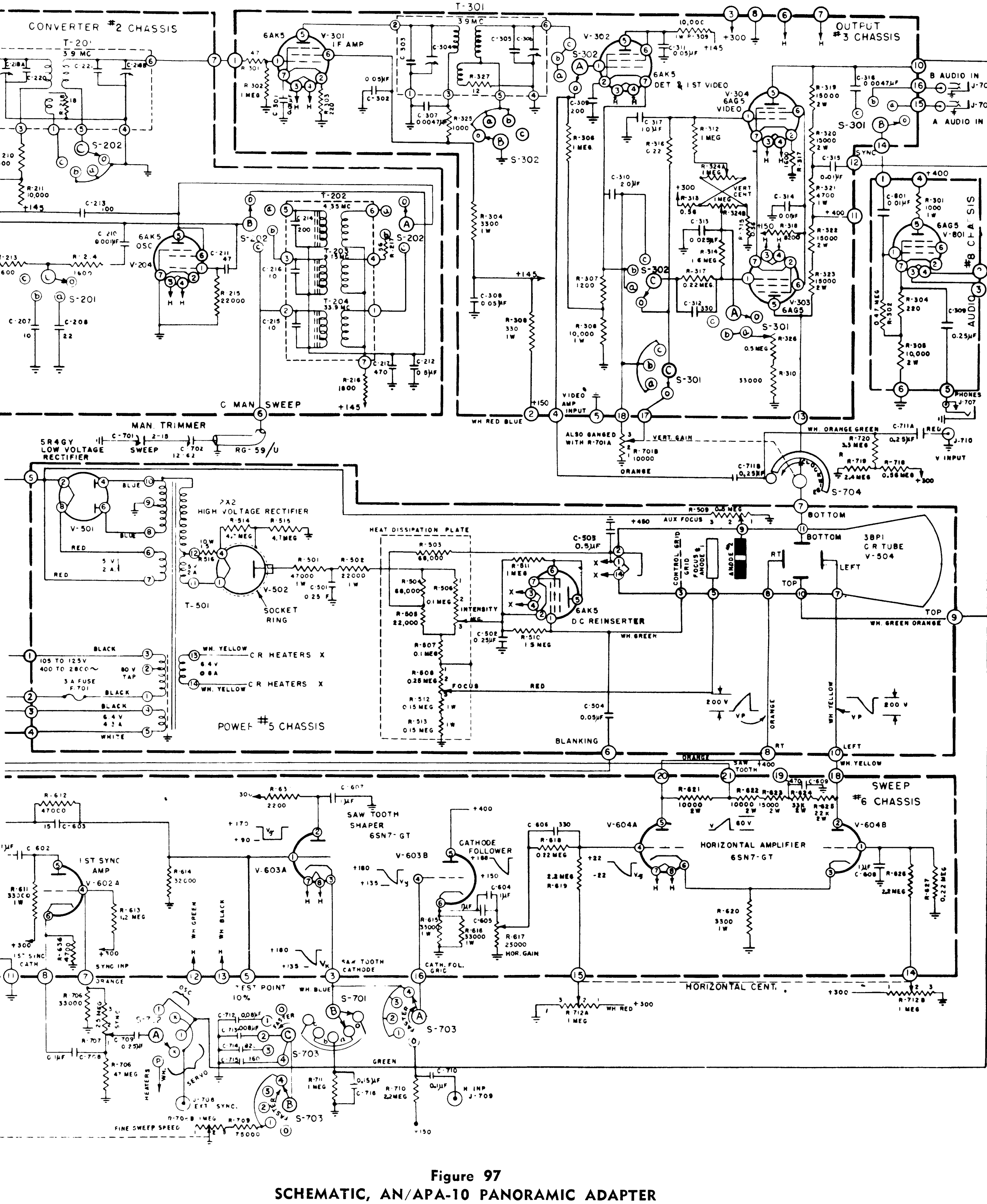


Figure 97
SCHEMATIC, AN/APA-10 PANORAMIC ADAPTER

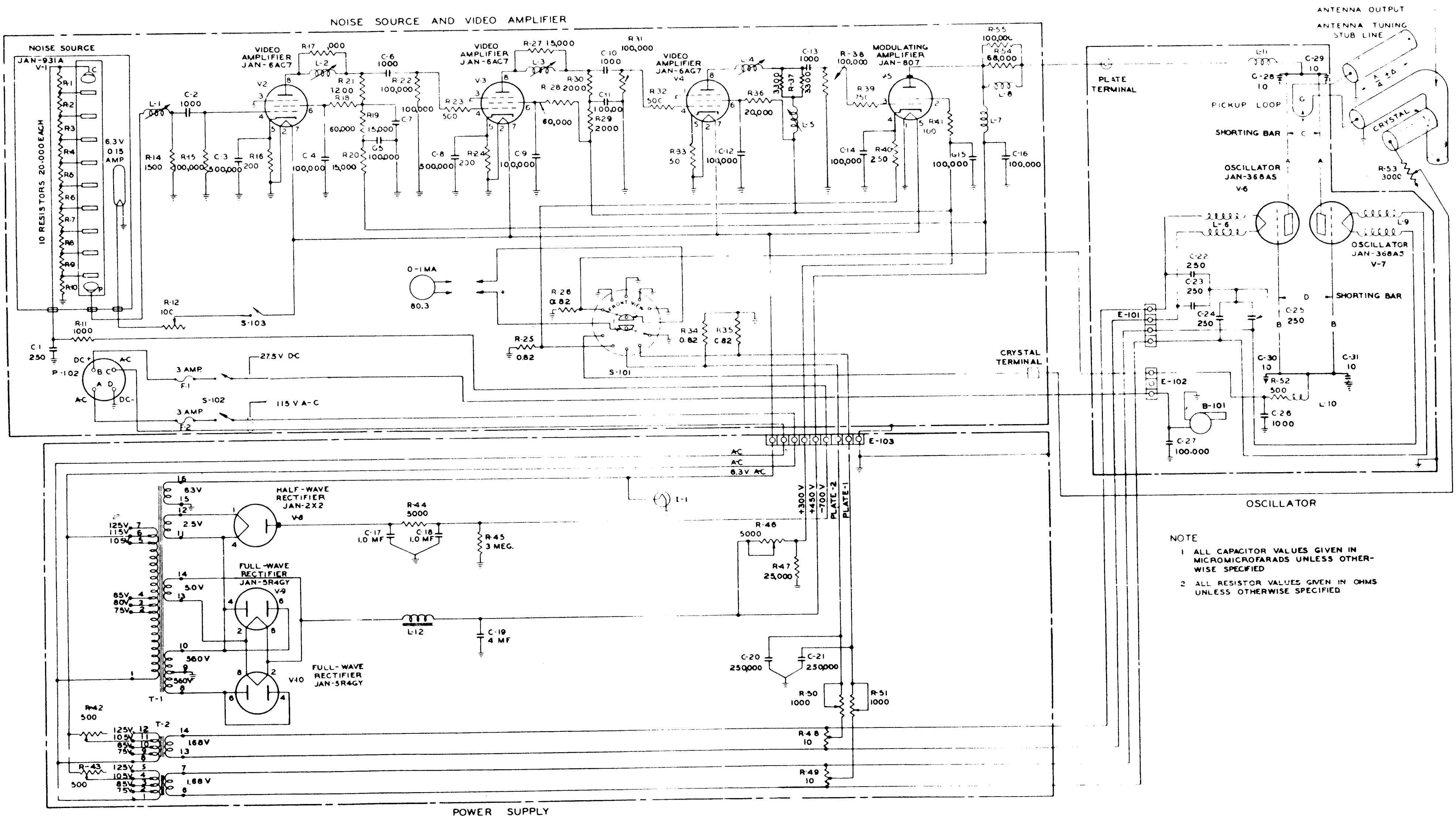


Figure 98

SCHEMATIC, RADAR SET AN/APT-2

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