No. 106

COMMAND SETS

CQ

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COMMAND SETS

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The Command Set, by far the most popular surplus item to appear on the market, was a late starter, appearing for the first time in March 1947. I shudder to think how many of these sets were turned over to the surplus dealers, for today, ten years later, even though practically every ham in the country has one or two of the sets, there are still thousands of them left and the price is still ridiculously low for the performance that can be obtained.

Being popular and being inexpensive, many articles have appeared in CQ during the last ten years covering the modifications of the units. The demand for these articles has been so heavy that every issue of CQ that carried them was long ago sold out, leaving the fellow with no library of back issues either to go it blind or else to scrounge from a buddy.

Now, as a public service to all those poor downtrodden hams with no CQ library, and as a foxy way to bleed our ever willing audience of some extra money we are reprinting here in one book *all* of this invaluable information.

If you run into any problems or have any questions baffling you, just remember that several of the authors involved are now silent keys, others have by now forgotten they ever wrote any article, and the editor doesn't know up from down.

The Command Set is made up of Several units. There are five receiver units ranging from 190 kc to 9.1 mc. A few 9 to 18 mc receivers were built but quantity production never was undertaken. The five transmitters cover from 2.1 to to 9.1 mc. Below is a table which should help you to identify them.

Frequency Range	Unit	I.F. (kc)	Service Number
190-550 kc	Receiver	85	R-23, R-23-, R-148, BC-453
520-1500 kc	Receiver	239	R-24, BC-946-
1.5-3.0 mc	Receiver	705	R-25, BC-454
3.0-6.0 mc	Receiver	1415	R-26, BC454-
6.0-9.1 mc	Receiver	2830	R-27, BC-455-
100-156 mc	Receiver	12 mc	R-28
2.1-3.0 mc	Transmitter		T-18
3.0-4.0 mc	Transmitter		T-19, BC-696
4.0-5.3 mc	Transmitter		T-20, BC-457-
5.3-7.0 mc	Transmitter		T-21, BC-458-
7.0-9.1 mc	Transmitter		T-22, BC-459
100-156 mc	Transmitter		T-23
	Modulator		MD-7, BC-456-
	Dynamotor		DM-33-, DY-8
	Control Box		C-29, BC-451-
	Antenna Relay		RE-2

When a (-) appears after the service number as listed above, that type of equipment may have had more than one model as the R-23A, R-23B, etc.

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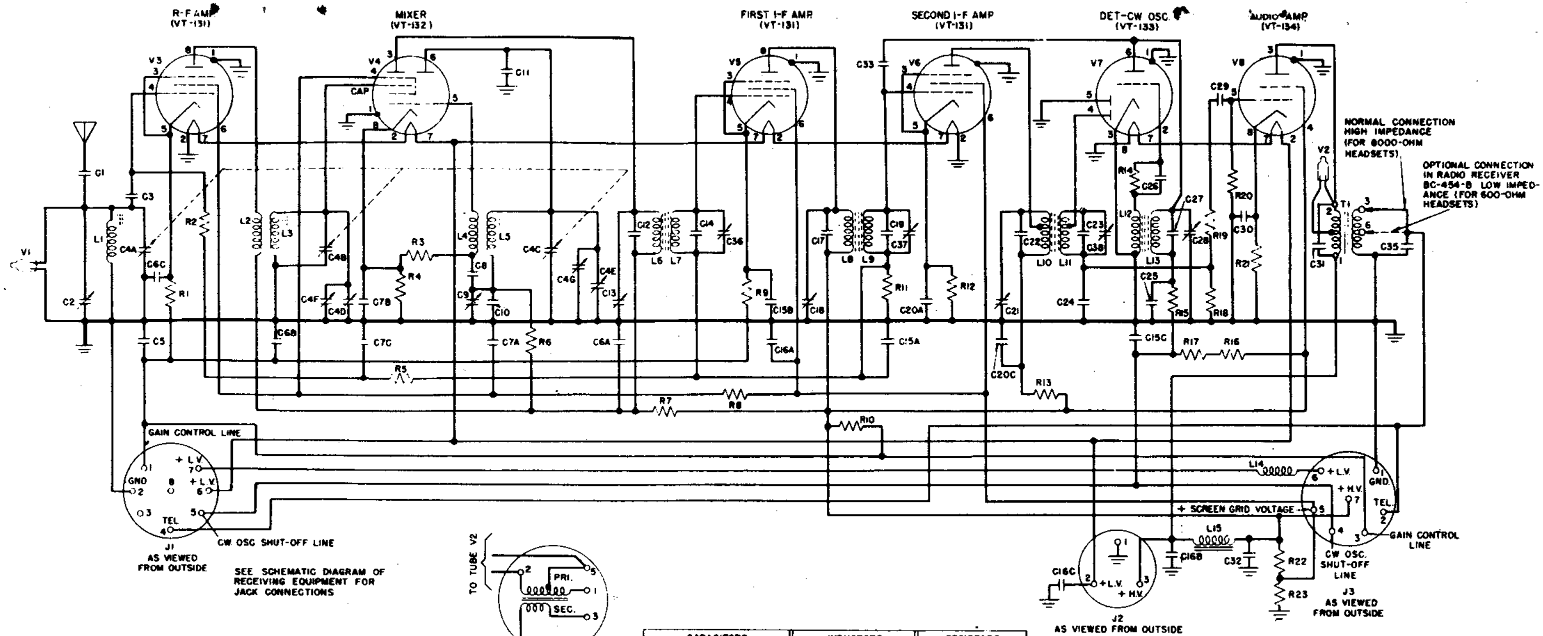
Chapter VII RECEIVERS

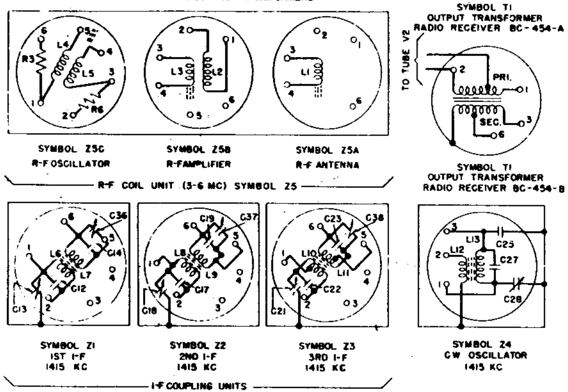
Chapter VIII POWER SUPPLIES

Chapter IX MONITORS



SEE SCHEMATIC DIAGRAM OF RECEIVING EQUIPMENT FOR JACK CONNECTIONS

DETAIL SCHEMATIC DIAGRAMS COIL ASSEMBLIES AND TRANSFORMERS



CIRCUITS IN R-F COIL SET, I-F COUPLING UNITS, C W OSCILLATOR, AND OUTPUT TRANSFORMER. THE TERMINAL NUMBERS ON THESE UNITS AGREE WITH THOSE SHOWN AT THE CORRESPONDING LOCATIONS ON THE PRACTICAL WIRING DIAGRAM.

CAPACITORS

SYMBOL	DESCRIPTION
C1	11 MMF.
C2	15 MMF.
C3	100 MMF.
C4 (A TO G)	6ANG (147 MMF)
C5	3 MF
C6 (A,B,C)	.05/05/05 MF
C7 (A,B,C)	.05/05/05 MF
C8	200 MMF.
C9	40 MMF
C10	365 MMF.
C11	3 MMF.
C12	180 MMF
C13	17 MMF
C14	180 MMF
C15 (A,B,C)	.05/05/05 MF
C16 (A,B,C)	.22/22/22 MF
C17	180 MMF
C18	17 MMF
C19	180 MMF.
C20 (A,B,C)	.05/01/05 MF
C21	17 MMF
C22	180 MMF
C23	180 MMF.
C24	200 MMF
C25	.001 MF
C26	100 MMF
C27	180 MMF.
C28	34 MMF.
C29	.006 MF.
C30	15 MF.
C31	.001 MF
C32	5 MF.
C33	*
C35	750 MMF.
C36	17 MMF.
C37	17 MMF.
C38	17 MMF.

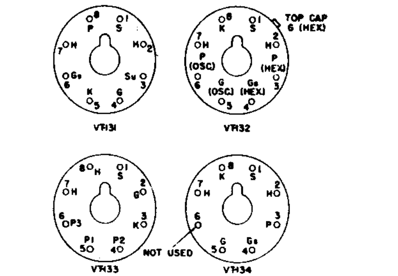
INDUCTORS

SYMBOL	DESCRIPTION
L1	ANT. INPUT
L2, L3	RF AMP.
L4, L5	RF OSC.
L6, L7	IN 1ST IF
L8, L9	IN 2ND IF
L10, L11	IN 3RD IF
L12, L13	CW OSC.
L14	RF CHOKE, 112 MICRO-HENRIES
L15	AF CHOKE 3 HENRIES

RESISTORS

SYMBOL	OHMS
R1	620
R2	2,000,000
R3	51,000
R4	620
R5	150,000
R6	200,000
R7	200
R8	200
R9	620
R10	360,000
R11	100,000
R12	510
R13	200
R14	100,000
R15	5100
R16	51,000
R17	51,000
R18	510,000
R19	100,000
R20	2,000,000
R21	1500
R22	7000
R23	7000

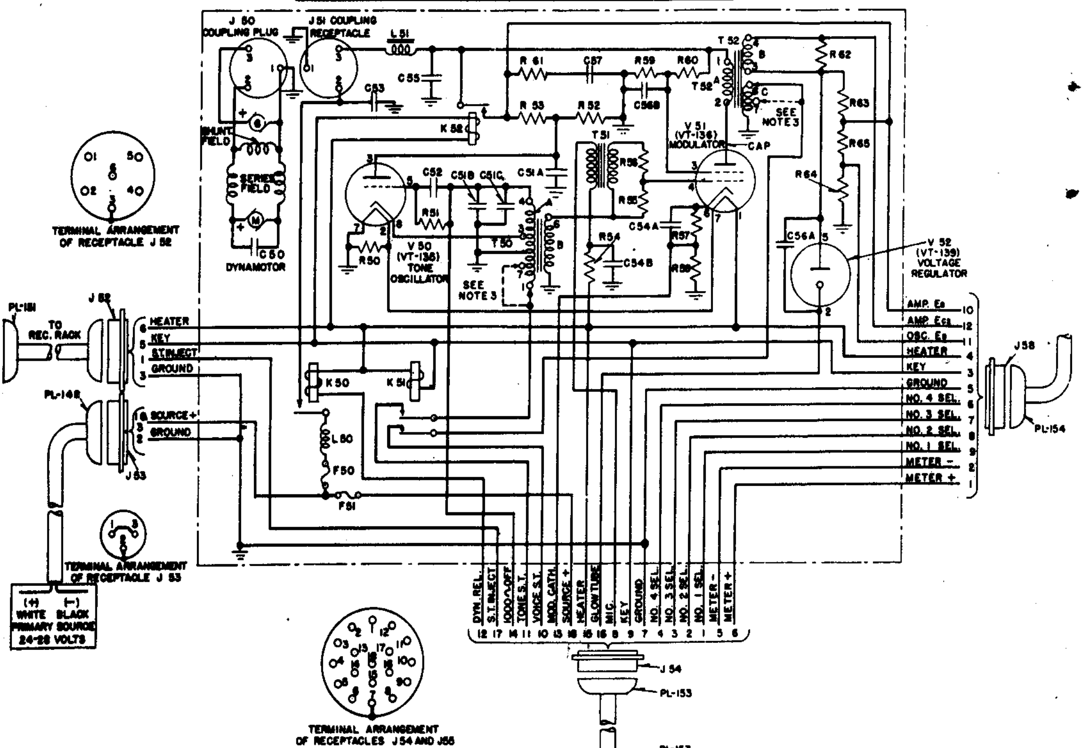
* WIRING CAPACITANCE (LESS THAN 2 MMF.).

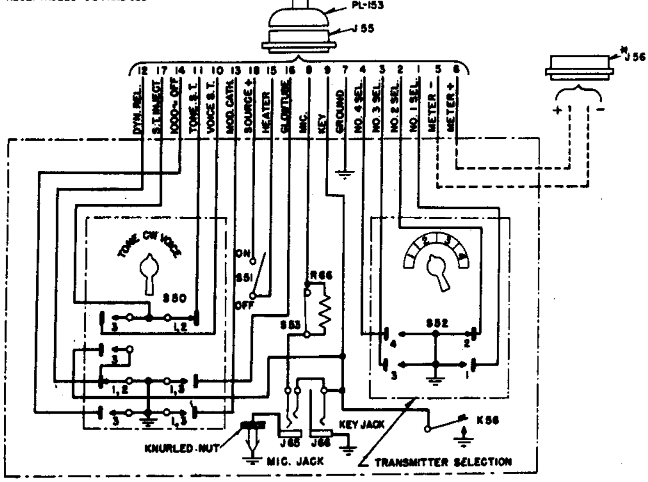


TUBE SOCKET TERMINALS AS VIEWED FROM BOTTOM

G = CONTROL GRID
G (HEX) = CONTROL GRID, HEXODE SECTION
G (OSC) = CONTROL GRID, OSC SECTION
Gs = SCREEN GRID
Gs (HEX) = SCREEN GRID, HEXODE SECTION
H = HEATER
K = CATHODE
P = PLATE
P (HEX) = PLATE, HEXODE SECTION
P (OSC) = PLATE, OSC. SECTION
P1 = FIRST DIODE PLATE
P2 = SECOND DIODE PLATE
P3 = TRIODE PLATE ON TUBE VT-133
S = SHELL
Su = SUPPRESSOR GRID

MODULATOR UNIT BC-456-A (OR-B) WITH DYNAMOTOR DM-33-A





NOTES ON SWITCHES S 50, S 52 AND S 53

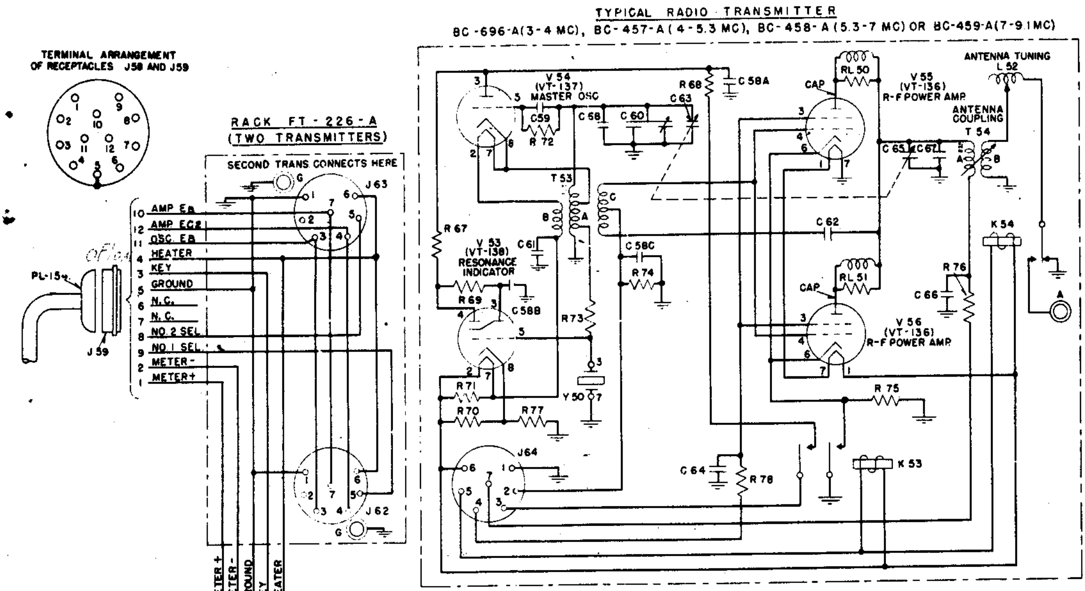
THE NUMBERS ON THE VARIOUS CONTACTS REFER TO THE POSITIONS OF THE SWITCH LEVERS AT WHICH THESE PARTICULAR CONTACTS ARE CLOSED BY THE ACTION OF THE SWITCH. ON S 50, "TONE" IS 1, "CW" IS 2, AND "VOICE" IS 3.

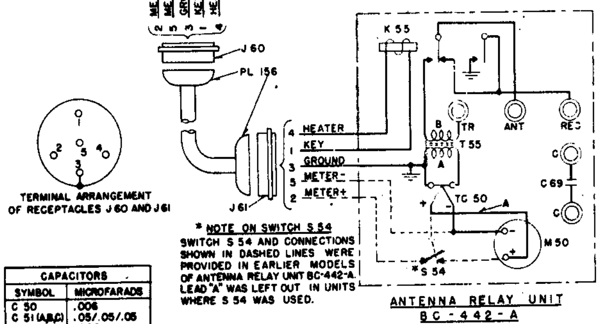
S 53 SHOULD ALWAYS BE KEPT IN "R OUT" POSITION AS INDICATED ON THE RED PLATE FOR SATISFACTORY OPERATION WITH MICROPHONE T 17, T 30 OR EQUAL.

NOTE ON MICROPHONE JACK J 65

THE KNURLED NUT IS USED TO GROUND THE SLEEVE OF JACK J 65 WHEN A MICROPHONE EQUIPPED WITH A PUSH-TO-TALK SWITCH, SUCH AS MICROPHONE T17, IS USED. WHEN THE JACK SLEEVE IS NOT GROUNDED, THE PUSH-TO-TALK FUNCTION MUST BE PERFORMED BY KEY K 56 OR AN EXTERNAL KEY OR SWITCH CONNECTED TO JACK J 66.

RADIO CONTROL BOX BC-451-A





NOTES

1. ALL RELAYS ARE SHOWN IN THE 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.
3. TRANSFORMERS T 50 AND T 52 IN MODULATOR UNIT BC-456-B ARE PROVIDED WITH SIDETONE TAPS FOR LOW IMPEDANCE HEADSETS(7 ON T 50 AND 7 ON T 52). MODULATOR UNITS BC-456-A AND BC-456-B ARE NORMALLY FURNISHED WITH CONNECTIONS SHOWN IN SOLID LINES FOR USE WITH HIGH IMPEDANCE (8000 OHMS) HEADSETS. MODULATOR UNIT BC-456-B CAN BE CHANGED FOR USE WITH LOW IMPEDANCE (600 OHMS) HEADSETS BY SUBSTITUTING CONNECTIONS SHOWN IN DASHED LINES.
4. TERMINAL NUMBERS APPEARING ON RECEPTACLES OF JACK J 51 IN MODULATOR UNIT AND J 64 IN TRANSMITTER AND ALL CIRCUIT SYMBOLS ARE FOR REFERENCE PURPOSES ONLY. THEY DO NOT APPEAR ON THE EQUIPMENT.
5. * DISCONTINUED ON LATER EQUIPMENTS

* NOTE ON SWITCH S 54

SWITCH S 54 AND CONNECTIONS SHOWN IN DASHED LINES WERE PROVIDED IN EARLIER MODELS OF ANTENNA RELAY UNIT BC-442-A. LEAD "A" WAS LEFT OUT IN UNITS WHERE S 54 WAS USED.

CAPACITORS	
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	M.O. PADDING
C 61	.006
C 62	FIXED NEUTR.
C 63	M.O. TUNING
C 64	.002
C 65	P.A. TUNING
C 66	.01
C 67	P.A. PADDING
C 68	.000003
C 69	.00005

INDUCTORS	
SYMBOL	DESCRIPTION
L 50	RF CHOKE APPR. 15 MICROHENRIES
L 51	1.7 HENRIES
L 52	ANT. TUNING INDUCTOR

RELAYS & KEYS	
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.
K 56	BUILT-IN KEY

RESISTORS			
SYMBOL	OHMS	SYMBOL	OHMS
R 50	42	R 70	1000 FOR BC-457-A
R 51	100,000	R 70	1000 FOR BC-458-A
R 52	300,000	R 70	1500 FOR BC-459-A
R 53	91,000	R 70	1500 FOR BC-696-A
R 54	360	R 71	126
R 55	2000	R 72	51,000
R 56	1300	R 73	10,000 FOR BC-457-A
R 57	390	R 73	15,000 FOR BC-458-A
R 58	51,000	R 73	5100 FOR BC-459-A
R 59	30,000	R 73	5100 FOR BC-696-A
R 60	75,000	R 74	15,000
R 61	20	R 75	51,000
R 62	10,000	R 76	20
R 63	20,000	R 77	390
R 64	100,000	R 78	51
R 65	15,000		
R 66	510		
R 67	51,000		
R 68	20		
R 69	1,000,000		

SWITCHES	
SYMBOL	DESCRIPTION
S 50	CHOICE OF EMISSION
S 51	MAIN "ON-OFF" BATTERY LINE
S 52	TRANSMITTER SELECTION
S 53	SHUNTS MIC. SERIES RESISTOR
*S 54	ANT. CURRENT METER SWITCHING

TRANSFORMERS	
SYMBOL	DESCRIPTION
T 50	TONE OSC.
T 51	MICROPHONE
T 52	MODULATION
T 53	MASTER OSC.
T 54	TRANS. OUTPUT
T 55	ANT. CURRENT

MISCELLANEOUS	
SYMBOL	DESCRIPTION
TC 50	THERMOCOUPLE
M 50	ANT. CURRENT INDICATOR (LOCAL)
Y 50	CRYSTAL UNIT
F 50	20 AMP. FUSE
F 51	20 AMP. FUSE
RL 50	PARASITIC SUPPRESSOR
RL 51	PARASITIC SUPPRESSOR

Converting the SCR-274-N

L. W. MAY, Jr., W5AJG-W5JKM

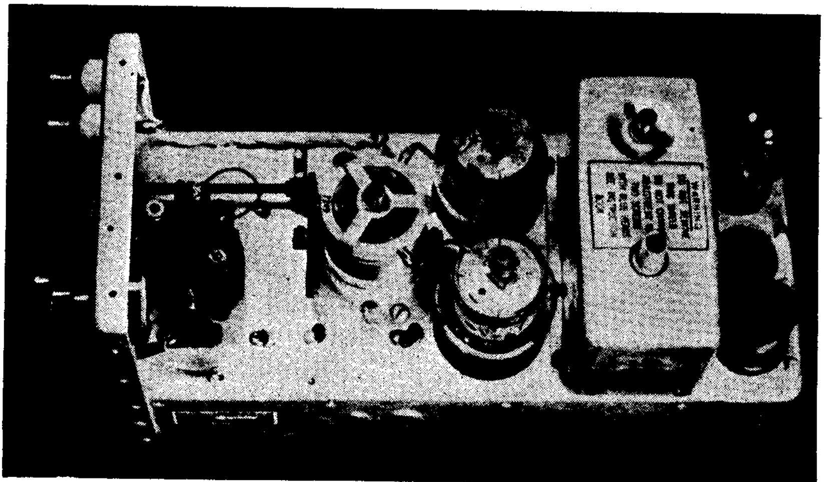
Demobilizing the army unit for variable-frequency control on amateur AM and FM Operation

An increasing amount of surplus Army equipment is appearing on the civilian market. Among various items of interest to the radio amateur is the SCR-274-N, an aircraft unit that is very easily adapted to amateur use as a stable, variable-frequency oscillator (VFO), either for AM or FM operation. The SCR-274-N is the overall designation given the principal components of a multi-channel aircraft radio receiving and transmitting set-up used on thousands of planes and now "declassified." So that the reader may know what to look for, the army numbers of the equipment are as follows:

The receiving end consists of three separate units—the BC-453-A (190-550 kc), the BC-454-A (3.0 to 6.0 mc) and the BC-455-A (6.0 to 9.1 mc). These receivers operate from the airplane 24-28-volt storage battery and each contains a separate dynamotor for plate power. It is an easy matter to substitute 6-volt tubes for the 12-volt series type originally in the receiver, and rewire the filament string for parallel 6.3-volt operation from a standard filament transformer. (Alternatively, a 24-volt transformer may be used to energize the heater circuits with the receiver left as is.) Any light 250-volt receiver power supply will provide plate power for the sets, or a vibrapack may be used if mobile operation is contemplated. These receivers are very sensitive, incorporating an r-f stage, BFO for c.w. reception, and, all-in-all, make excellent receivers up to approximately 10 megacycles.

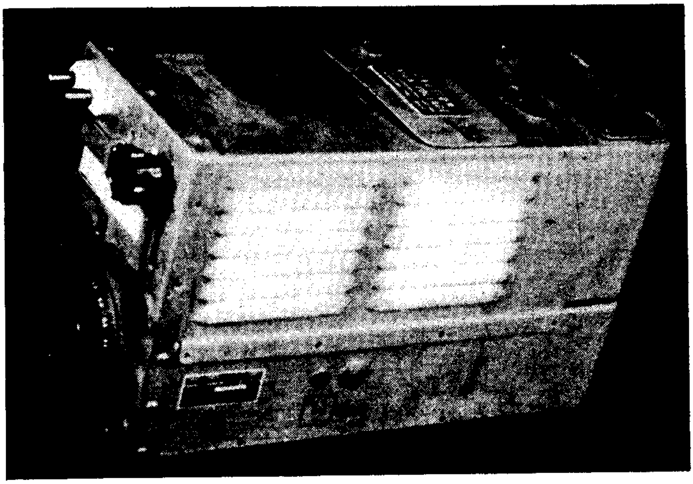
The Transmitters

Four separate transmitters are included in the sending unit. The BC-696-A covers 3 to 4 mc, the BC-457-A from 4 to 5.3 mc, the BC-458-A, 5.3 to 7 mc, while the BC-459-A tunes from 7.0 to 9.1 megacycles. Each transmitter consists of a master oscillator tube (1626 or 12J5) exciting a



Top view of completed VFO with cover off. At front is the audio transformer (500 ohms input) Next can be seen the power amplifier coil with the variable coupling to the link and the twisted pair to the output terminals. Tubes and master oscillator frequency control box next. At the rear are the master oscillator tube and the FM reactance tube. The center socket is not used.

for VFO Operation on FM or AM



View showing completed VFO. Upper left is the output. Upper right is the volume control when used for FM operation. Center is the dial which controls the frequency

pair of beam tetrodes in the power amplifier stage (1625's or twelve volt 807's). The tubes in the amplifier are connected in parallel. The master oscillator and r-f power amplifier tuning capacitors are gauged, and an excellent worm drive, with plenty of reduction, is incorporated in the dial system. Included in each transmitter is a piezo-electric crystal and an electronic resonance indicator for calibration. This may be removed to make way for additional FM features, to be described later, or left as is if only AM VFO operation is contemplated. The power output may be varied from a few watts to approximately 55 watts according to the power supply on hand. Thus, one of these little jobs may be used as a fixed variable-frequency transmitter or as a driver for a higher-power amplifier.

The components are of exceptionally high quality and the assembly rigidly constructed. By using standard aircraft shock mountings (which are attached), the mechanical stability is excellent; and with a stabilized 200-volt supply to power the master oscillator, the drift is very small. This equipment was designed to hold the frequency quite constant in aircraft under vibration and extreme temperature changes; so it can be understood that the frequency variation will be practically nil with the set mounted on the operating table, subject to little vibration and relatively constant temperature.

Modifications for Amateur Use

At W5AJG, we were interested in a VFO unit to work directly into the crystal oscillator tube—in fact, to work in place of the crystal itself. Since all the crystal stages started with either 6 or 7-mc crystals (6 mc for the 144-148-mc band as well as the 50-54- mc band) it was decided to purchase the BC-458-A transmitter unit which covers 5.3 to 7.0 megacycles. Actually, this unit will reach to about 7.5 mc and will replace any 7-mc crystal.

It was decided to add a simple reactance tube modulator circuit and have the choice of either AM VFO or narrow-band FM transmissions. This was accomplished by a simple modification, and the unit works on either frequency or amplitude modulation. Should the crystal stage of the regular station transmitter start with a 3.5-mc crystal instead of a 6 or 7-mc crystal, the BC-696-A, with its range of 3 to 4-mc, should be selected.

The changes necessary to do the job are as follows. Reference is made to the *original* schematic, *Fig. 1*, and to the *modified* diagram *Fig. 2*. To begin with, the 24-volt former airplant battery supply is replaced with a 110 to 24-volt transformer for the heaters. These transformers are surplus stock in any mail-order catalog and sell for around $1.25. This is cheaper and easier than replacing the oscillator tube and the two tetrode finals with 6-volt versions, and obviates wiring changes in the heater circuits.

Next, the unwanted components are removed from the chassis—namely the variable antenna loading inductor $L52$ (this will serve admirably as an antenna tuning coil elsewhere around the station), as well as the antenna change-over relay *K*54. Relay *K*53 is either tied down in the energized position or removed and the wiring circuits closed. This relay switches plate voltage to the master oscillator and shorts out resistor *R*75 which was used for c.w. work. An extra feed-through insulator is employed to bring out the low-impedance line coupling the output transformer, *T*54, to the crystal oscillator stage of the transmitter it drives (*Fig. 3*).

For AM VFO operation, the above changes are all that are necessary. Of course a power supply, preferably a regulated 220-volt unit, is used to power the master oscillator—while anything from 200 to 550 volts, unregulated, is suitable for the amplifier, depending on the desired power output.

The dial is very closely calibrated and a 4,600-kc crystal resonator is used to check the calibration. This is very simply observed by tuning for maximum indication on the electronic eye tube and then noting if the dial reads exactly 4,600 kilocycles. The transmitter is then calibrated over the rest of the dial. This crystal does not stabilize the frequency in any way—it is merely a built-in standard to check the master oscillator dial setting. A crystal of another frequency could be substituted—for instance one spotting a particular pet or net op-

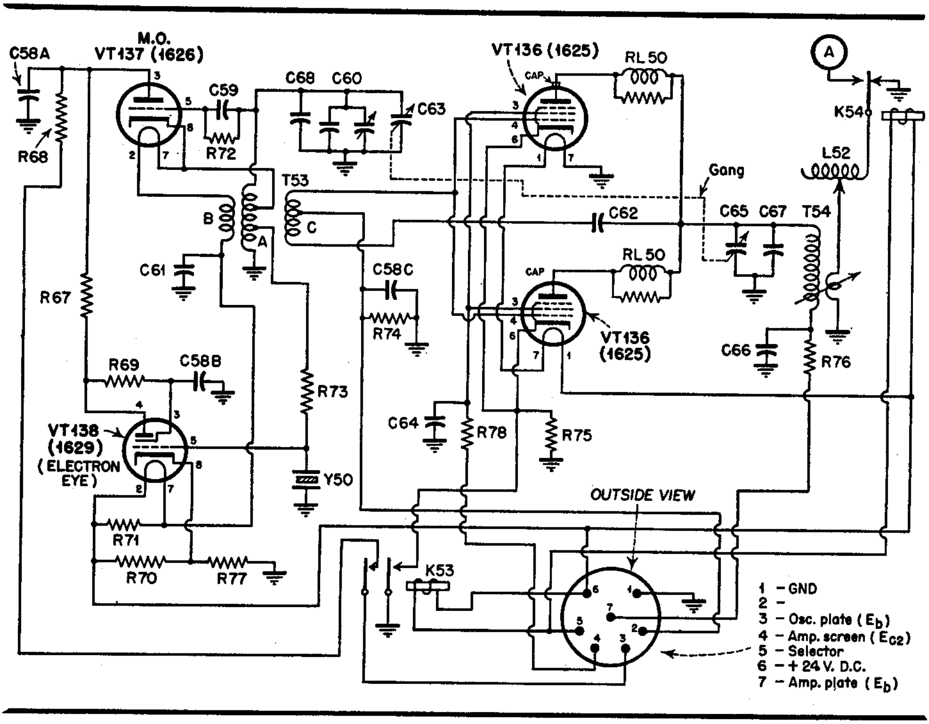


Fig. 1. Original schematic of the BC-458-A (5.3 to 7.0 megacycles with a bit of leeway). The following parts are identified:

C_{58}A, C_{58}B, C_{58}C—.05 µf
C_{59}—.00018 µf
C_{60}—master oscillator padding
C_{61}—.006 µf
C_{62}—fixed neutralizing
C_{63}—master oscillator tuning
C_{64}—.002 µf
C_{65}—power amplifier tuning
C_{66}—.01 µf
C_{67}—power amplifier padding
C_{68}—3.0 µµf
C_{69}—50 µµf
K_{53}—transmitter selector relay
K_{54}—transmitter output relay

L_{52}—antenna loading coil
R_{67}, R_{72}, R_{75}—51,000 ohms
R_{68}, R_{76}—20 ohms
R_{69}—1 megohm
R_{70}—1,000 ohms
R_{71}—126 ohms
R_{73}, R_{74}—15,000 ohms
R_{77}—390 ohms
R_{78}—51 ohms
RL_{50}—parasitic suppressors
T_{53}—oscillator coils
T_{54}—amplifier coils
Y_{50}—crystal unit
7-prong female plug, outside view

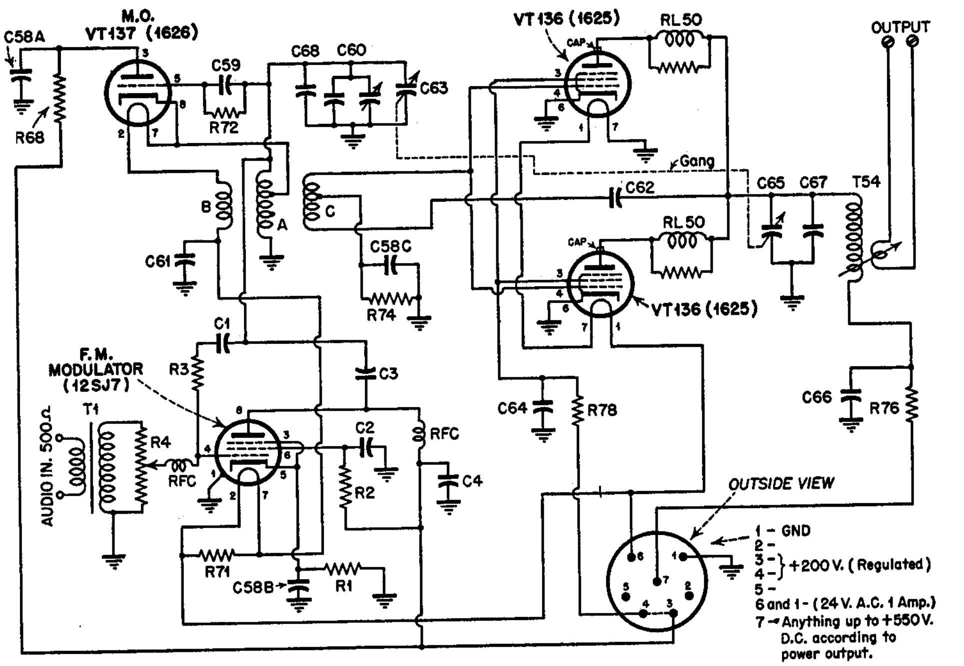


Fig. 2. Modified diagram of transmitter covering from 5.0 to 7.3 megacycles. Referring to Fig. 1., the following components were eliminated mainly from the electronic 'eye circuit: R_{67}, R_{69}, R_{70}, R_{73}, R_{77}, Y_{50}, K_{52}, K_{54} and L_{52}. Parts added for the FM reactance modulator comprise—

C_1—.00025 μf mica
C_2, C_4—.01 μf paper
C_3,—.0005 μf mica
R_1—1,000 ohms, ½, watt carbon
R_2, R_3—50,000 ohms, ½, watt carbon
R_4—500,000 ohms gain control
RFC—2.5 mh r-f chokes
T_1—line input audio transformer, 500 ohms to grid
12SJ7 metal or glass tube

eration frequency. This would enable the operator to place himself exactly on a particular frequency in the band.

Additional Modifications for FM

It is probable that the amateur will engage extensively in FM narrow-band operation in the near future as well as amplitude modulation. Advantages are claimed for FM in services closely paralleling amateur operation, such as mobile police and point-to-point communications. Not the least among these features is the very modest requirement in regard to modulating power. Also, existing superhets will do a good job of receiving FM transmissions. Later, of course, an FM channel will no doubt be standard equipment in all ham receivers.

By making a few more additional changes, the

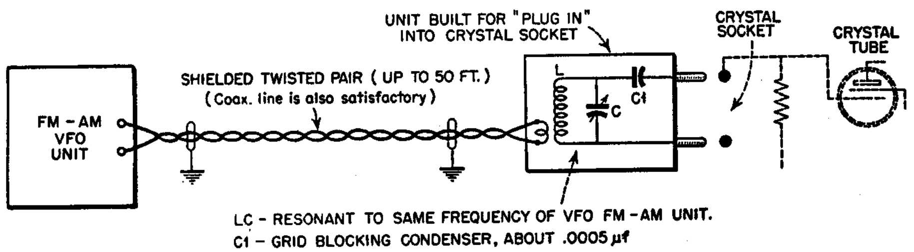
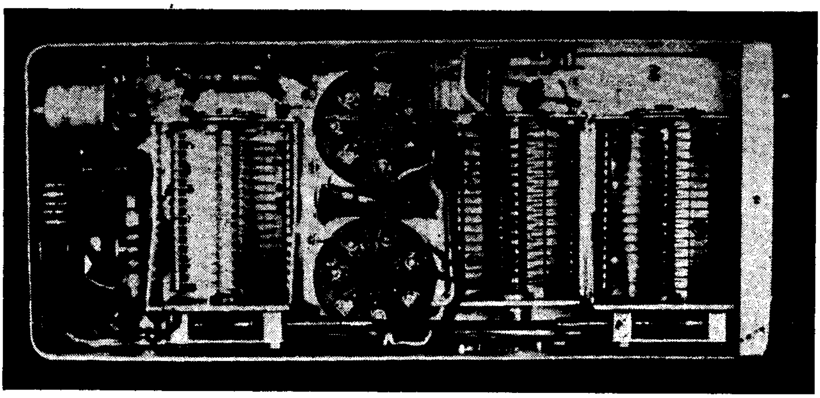


Fig. 3. Suggested arrangement for coupling the VFO to the regular station transmitter when high power is desired



This shows the bottom view and is practically as is when it comes from the ARMY. The reactance tube and components are mounted in the rear. The ganging of the Master oscillator and power amplifier condensers is clearly shown. Notice worm gears on the condensers.

already modified AM VFO can just as easily be converted to narrow-band FM operation. This is accomplished by adding a reactance modulator tube and shunting its output circuit directly across the master oscillator tube—thereby varying the frequency of the master oscillator in accordance with the audio applied to the reactance tube input circuit. Of course purely AM operation is still possible as above. The FM feature is additional.

Again referring to the original and modified schematics, the electronic eye (1629) is removed to make way for the substitute reactance modulator tube. This new addition will be a 12SJ7 type tube. Also the resonator crystal is dispensed with, and all wiring from these two sockets removed, with the exception of the heater leads to the 12SJ7 tube. Note that the original resistor *R*71 remains in the circuit across the heater terminals. The new wiring is simple and follows that in the modified schematic. A 500-ohm line to the grid transformer permits the output of the speech amplifier to modulate the reactance tube. Audio required is approximately zero db.

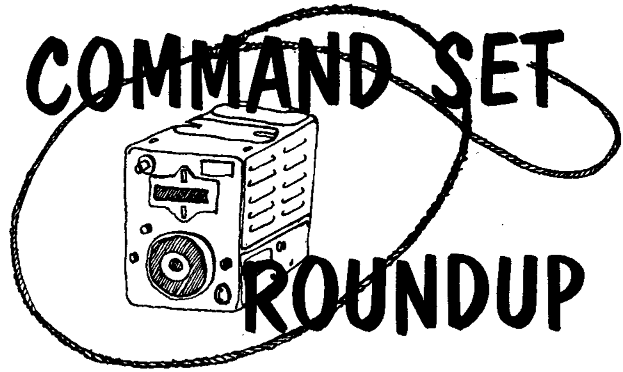
Should AM operation be desired, it is merely necessary to turn off the reactance tube gain control, *R*4, and plate modulate the station transmitter in the usual way. With FM operation, the zero db audio track is fed into the 500-ohm input circuit and the gain control turned up sufficiently to produce the required swing of the carrier. Of course the mean frequency may be spotted anywhere in the band by using the calibrated dial in the usual way. Needless to say, it is necessary, when using FM, to stay within the confines of the FM portion of the band. A swing of a few kilocycles on the fundamental frequency of the VFO will be multiplied by the same ratio of frequency multiplication in the transmitter. Thus, if FM operation in the 144-148-mc band is desired with a VFO frequency of 6 megacycles, a swing of 1 kc at this point will be multiplied by 24, which is more than ample for narrow-band amateur FM work.

Coupling to Main Rig

The output of the FM-AM VFO unit can be coupled to the crystal tube of the regular station transmitter in a number of ways. At W5AJG, a shielded twisted pair runs from the operating desk, upon which the VFO is mounted, to the crystal stage of the transmitter proper across the room (*Fig. 3*). The crystal is removed and a separate tuned tank circuit substituted by plugging into the crystal holder. Should the ex-crystal tube be a harmonic type, this tuned tank can be of the same frequency as the crystal. In tri-tet crystal oscillators, the cathode coil should be shortened. With pentode type oscillator tubes, it is usually possible to work straight through without self-oscillation. However, should 7-mc operation be primarily desired, it is advisable to choose a VFO unit operating on 3.5 megacycles so that the former crystal-controlled tube will operate as a doubler. In any event, care should be taken to avoid shorting the grid bias of the ex-crystal tube by connecting a blocking capacitor in series with the high side of the oscillator tube.

It will be found that the SCR-274-N makes a very nice VFO unit with AM or FM operation optional at a very low cost. It is suggested that those interested in obtaining equipment of this type, contact firms that rebuild and reconvert government aircraft apparatus to civilian requirements. As used in Army service there is usually about three times the amount of equipment needed for civilian purposes, and the surplus gear is generally available at a very moderate cost.

the COMMAND SET ROUNDUP



HERB S. BRIER, W9EGQ

Undeniably the Most Popular Items of War Surplus Gear were the "Command Set" Receivers and Transmitters. Because of the Tremendous Interest They Still Have for Many of Our Readers We Take Pleasure in Presenting a Final-Final Conversion Article

In spite of the many articles published about "Command Sets" in the past several years *(See bibliography)*, there remains an insatiable appetite among new amateurs for conversion data on the *BC-274N* and *ARC-5* equipments.

Information on the following points is in demand:

1. Basic conversion data.
2. Power supply requirements.
3. Simple modification to crystal control for Novice use.
4. Modifying 4-5.3 Mc. *(BC-457)* and 5.3-7 Mc. *(BC-458)* units to cover amateur frequencies.
5. Transmitter de-TVI'ing information.
6. Receiver data.

This "final-final" article will attempt to assemble the above information in one place for the benefit of all concerned.

The Basic Transmitter Circuit

Although they have different nomenclatures and cover different frequency ranges, all "Command" transmitters utilize the basic circuit shown in *Fig. 1*. A 1626 variable-frequency oscillator drives an amplifier, consisting of a pair of 1625's in parallel. A 1629 "magic eye" tube, in conjunction with a quartz crystal, serves as a frequency calibrator.

A roller-type antenna coil, adjusted by means of a thumb wheel through the front panel permits using almost any *non-resonant* length of wire as a *Marconi* antenna. Antenna coupling is varied, also from the front panel, by a pivoted link coil inside the amplifier coil.

Rated transmitter input is about 90 watts on CW and half that on 'phone. All tubes have 12.6-volt filaments wired in series-parallel and operated from a 25-volt (nominal) d.c. source.

The two important differences between the *BC-* and *ARC-5* model transmitters are in the method of plate feed to the 1625's and the power sockets on the rear. In the *ARC-5's*, an r-f choke feeds the voltage directly to the plates, and a 0.0004-μfd. blocking condenser keeps the d-c voltage off of the tank coil. In the *BC*-models, the plate voltage is fed through the 1625 tank coil. This difference has no practical effect on the operation of the transmitters.

Of more immediate importance are the differences in the power sockets, which are noted in *Fig. 1*.

Adapting The Transmitters

Few amateurs have 25 volts of d.c. available; therefore it is necessary to modify the filament circuit of the transmitters for a-c operation. Either 12.6 or 25 volts may be used. For 25-volt operation, the modification entails three steps:

1. Remove the two resistors *(R70* and *R77)* connected to *pin 8* of the 1629 tube socket. Replace them with a single 2500-ohm, ½-watt resistor connected between *pin 8* and the chassis (ground).
2. Jam both relays *(K53* and *K54)* closed.
3. Mount a key jack in the lower right-hand corner of the front panel. Disconnect the 1625 cathodes from relay *K53* and the 51,000-ohm resistor *(R75)* across it. Connect the cathodes to the jack through a 50-ohm, two-watt resistor. Bypass the cathode of each 1625 tube *(pin 6)* to the metal shell of the tube socket with .005-μfd., 600-volt, disc ceramic condensers *(Centralab DD-502)*. The 50-ohm resistor eliminates the effect of having the "dots" on a slightly different frequency than the "dashes," as sometimes happens when a "bug" key is used.

Operating the filaments on twelve volts requires one additional step:

4. Ground *pin 7* of the remaining 1625 socket (one is already grounded). Tie *pin 1* of the two sockets together and to *pin 2* of the 1629 socket. Remove the 126-ohm resistor *(R71)*, which is connected across *pins 2* and *7* of the 1629 socket and mounted on the rear chassis wall. Transfer the wire connecting *pin 7* of the 1629 socket and the oscillator coil terminal strip to *pin 2* of the socket. Ground *pin 7* of the socket, and connect *pin 2* to the filament terminal on the power socket *(pin 6* on *BC*-models and *pin 5* on *ARC-5*'s.)

This completes the basic conversion.

Power Supply

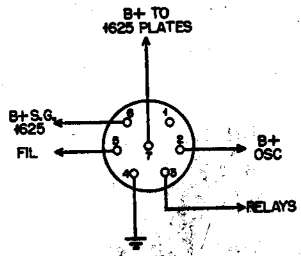
The power supply shown in *Fig. 2* will furnish all power for 75-watt operation of the "Command" transmitters. This level probably represents the best compromise between power output, signal quality, and power supply cost.

Oscillator plate voltage is relatively critical for best results. Approximately 200 volts gives essentially "zero-drift" operation. Either higher or lower voltage causes a frequency drift in one direction or the other. Actually, optimum voltage varies from transmitter to transmitter, but is usually quite close to 200 volts. Fortunately, a deviation of ten or fifteen volts does not degrade performance appreciably. Regulation of the oscillator plate voltage is highly recommended. Two VR-105 tubes in series may be used, between B+ and ground, as shown.

Six hundred volts a-c on the plates slightly exceeds the 550-volt maximum rating of the 5U4G rectifier tube, but such operation does not apparently reduce tube life, especially if the maximum current drawn does not exceed 200 milliamperes. Because the 5U4G is being slightly overloaded, fusing the primary circuit of the transformers is a wise precaution so that, should the tube arc over at the end of its useful life, the fuse and not the transformer will blow.

The transformer, *T1*, in the parts list is one of the very few available stock items that delivers sufficient plate voltage for our purpose and has two 6.3-volt filament windings that may be connected in series to provide 12.6 volts to light the tubes in the transmitter. Transformers with only a single 6.3-volt winding may be used in conjunction with an additional 6.3-volt, two-ampere filament transformer. Connect its primary in parallel with the primary of the plate transformer, and connect the two 6.3-volt windings in series.

The most desirable filter condenser for the power supply is an oil-filled, 1,000-volt unit,



ARC-5 Power Plug Connections.

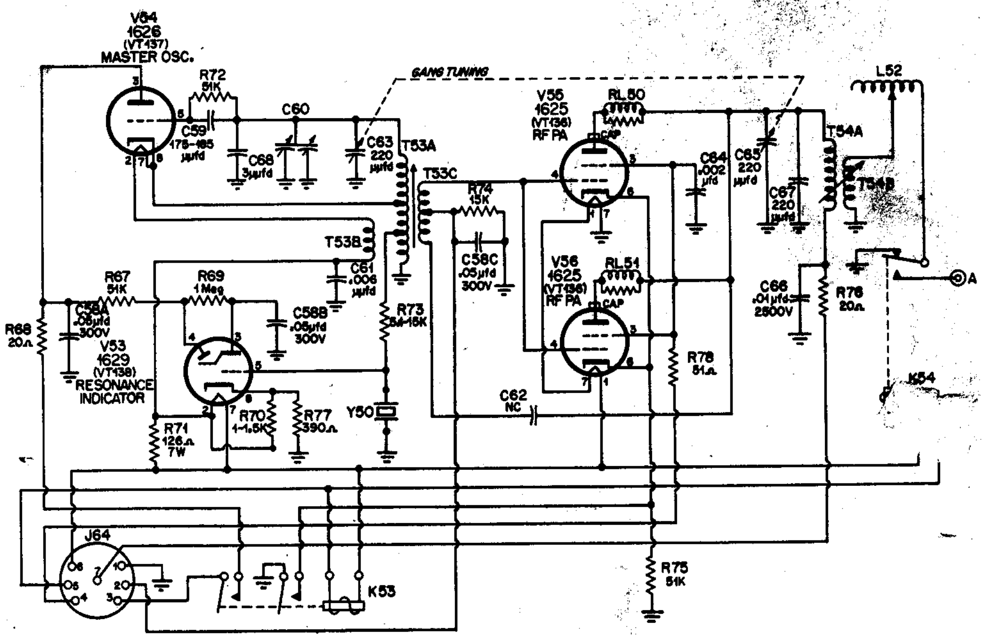
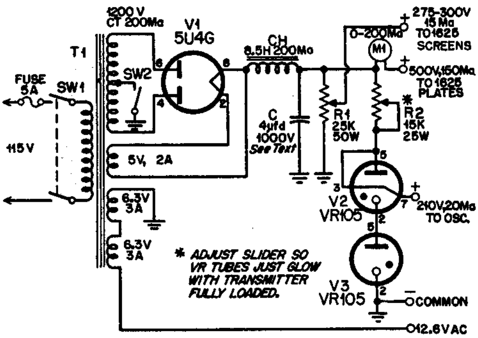


Fig. 1. Typical Command Set transmitter wiring schematic with power plug connections for the "BC-" series.

with a capacity of 4.0 μfd., or more. However, where economy is important, two 8.0 or 16.0-μfd. electrolytic condensers connected in series may be used, with 100,000-ohm 1-watt resistors across each one to equalize the voltage drops.

Probably the easiest way to bring power to the transmitter is through a five-conductor cable soldered directly to the transmitter power socket and terminated in a five-prong male plug for connection to the power supply. Proper terminals to use on the power socket are shown in *Fig. 1*.

To connect the cable to the transmitter, bare and tin about ½-inch of each conductor, and solder them into the appropriate terminals of the power socket. Fasten the cable to the back of the transmitter with a clamp to prevent straining the connections.



T1—Power transformer, 1200v., 200ma., ct.; 5v., 3amp.; 6.3v., 3amp.; 6.3v., 3 amp. (Stancor #8414 or equiv.)
Ch—8.5h., 200ma. (Stancor #C1721 or equiv.)
C—4 μfd. 1000v., oil filled (Cornell-Dubilier TJU, or equiv).
R1—25,000 ohms, 50w. with slider (Ohmite 0585 or equiv).
R2—15,000 ohms, 25w. with slider (Ohmite 0387 or equiv).
SW1—d.p.s.t. toggle.
SW2—s.p.s.t. toggle.
Fuse—5amp.
V1—5U4G
V2—OC3/VR105
V3—OC3/VR105
M1—200ma. milliameter (Triplett 227T or equiv).
Chassis—10 x 17 x 2″ 3 octal tube sockets.
Note: meter may be mounted on power supply chassis or at transmitter.

Fig. 2. Parts list and wiring schematic of a power supply suitable for use with the Command Set transmitters. Although the rectifier tube is slightly overloaded no damage should result if the primary of the transformer is fused. The oscillator voltage must be regulated for v-f-o operation.

Operating and Tuning Up A Command Transmitter

Operating a "Command" transmitter differs little from operating any other transmitter, except in the use of the crystal calibrator, which works in this manner: Normally, the "eye" of the 1629 tube is nearly closed, but when the 1626 oscillator is tuned to the frequency of the calibrating crystal, the "eye" opens to its full width. The transmitter dial reading should then be the same as the frequency marking of the crystal. If it is not, the calibration is corrected by inserting a screwdriver through the slide-covered opening in the transmitter cover and adjusting oscillator condenser *C68*.

Calibrating crystals of other frequencies can be substituted for the one furnished with the transmitter by plugging them into *pins 1* and *3* of the crystal socket.

To load a random length end-fed antenna, connect it to the antenna terminal and ground the transmitter case. Set the link coupling control to about half scale and rotate the antenna loading coil for maximum 1625 plate current, re-adjusting *C65* as necessary to keep the 1625 tank circuit tuned to resonance. Adjust coupling to draw the desired plate current.

Antenna lengths that are an integral multiple of ¼-wave long may be difficult to load, unless a 100-μμfd. variable condenser is available. Connect it *in series with the antenna* for lengths an *odd multiple of* a quarter-wave, and *between the antenna terminal and the case* for lengths that are multiples of a half-wave.

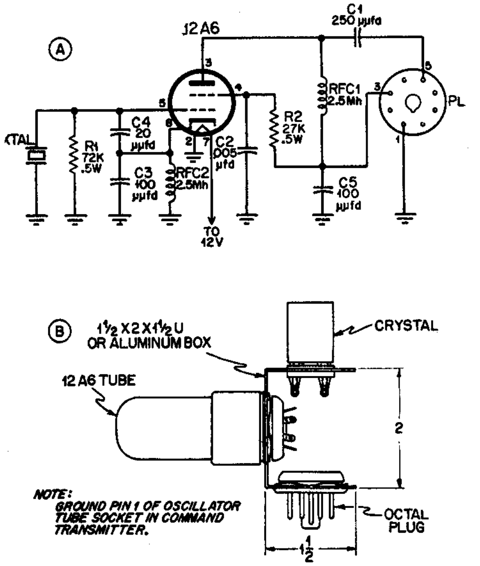
A center-fed doublet using a low-impedance line may be loaded by setting the rotary inductance to minimum inductance and connecting one antenna lead to the antenna post and the other to ground (chassis). Although this theoretically unbalances the antenna system, there does not seem to be any difference in results, on 3.5 and 7 Mc. If insufficient loading is obtained, even with the coupling control set to maximum, a few turns of well-insulated wire may be wound around the bottom (cold end) of the 1625 tank coil and connected in series with the link.

Crystal Control

There are two methods of modifying "Command" transmitters for crystal control, which is mandatory for Novice operation. One is to rewire the oscillator for crystal control.[32] The other is to build a plug-in adapter.[21]

An adapter has the advantage that the transmitter is easily restored to variable frequency control by unplugging it and inserting the regular oscillator tube. The diagram *(Fig. 3)* is a modification of the previous adapter,[21] using a 12A6 tetrode in place of the original triode, since it is a more vigorous oscillator with "sluggish" crystals. However, the triode circuit also works well and uses fewer parts. To use the latter, omit *C2, C3, C4, R2,* and *RFC2,* and connect *pin 8* of the tube socket directly to the common ground point.

There are no special precautions required in constructing the adapter, except to position the octal plug so that the oscillator tube extends horizontally over the crystal and 1629 tube sockets when the adapter is plugged into the 1626 socket. Ground *pin 1* of the 1626 socket to use the adapter and connect the external filament wire from the adapter to the "hot" side of the filament supply. Apply not more than 250 volts to the oscillator B+ pin on the power socket. The voltage need not be regulated.



C1—250 $\mu\mu$fd. 600v. ceramic.
C2—.005 μfd. 600v. ceramic.
C3, C5—100 $\mu\mu$fd. 600v. ceramic.
C4—20 $\mu\mu$fd. 600v. ceramic.
R1—72,000 ohm ½w.
R2—27,000 ohm ½w.
RFC1, RFC2—2.5 mh. r-f chokes
PL—Octal plug, male (base of metal tube or Amphenol CP8).
VT—12A6 or 1626 (see text).
Xtal—3.5 or 7 Mc. crystal.
Built-in U bracket bent of aluminum or aluminum box approx. 1½ x 1½ x 2".
To use adapter, ground pin 1 of 1626 tube in transmitter.

Fig. 3. This adapter may be used with any Command transmitter by following the instructions given in the text on the previous page. A partial structural view is shown in "B" and a schematic (parts list above) is shown in "A."

Without plate or screen voltage on the 1625's, adjust the main transmitter dial until the oscillator functions smoothly. Then apply voltage to the 1625's and resonate the 1625 tank circuit by adjusting *C65*. Antenna tuning and loading are described previously.

Utilizing the BC-457 and BC-458

So far, it has been assumed that 3-4 Mc. or 7-9.1 Mc. transmitters, which cover the 3.5 and 7-Mc., amateur bands, respectively, are available. However, 4-5.3 Mc. and 5.3-7 Mc. units are more plentiful and can be modified to cover these and other bands quite easily.

To cover the 3.5-Mc. band with a 4-5.3 Mc. *BC-457* unit, set the oscillator padding condenser *C60* (under the oscillator coil shield) to maximum capacity and re-resonate the 1625 stage with *C65*. The oscillator coil shield must be in place while this is being done.

The easiest way to cover the 7-Mc. band with a 5.3-7 Mc., *BC-458* unit is to decrease the capacity of both padding condensers just enough to permit covering the entire band. A better way is to short out three turns from the top of each coil, before adjusting the padders.

By shorting out the top turn on each coil, removing two rotor plates from each of the ganged condensers, and judiciously juggling the sett ng of the coil slugs and padders, it is possible to make the 7-Mc. band start at 6.0 on the dial and end at 6.3, giving direct frequency calibration by mentally adding *1* to the dial reading[19].

Covering Other Bands

Modifying the frequency range of "Command" transmitters to cover other bands requires changes ranging from working on the coils to completely rebuilding the unit. Some of the more-successful methods will be described briefly in the following few paragraphs, with full details to be found in the reference articles.

160 Meters: If the scarce 2.1-3 Mc. *BC-456* transmitter is available, set the padding condensers to approximately maximum capacity.[16] Otherwise, the coils of one of the higher-frequency units may be rewound. A new oscillator coil contains 36 turns of #20 enameled wire, with the cathode of the 1626 connected to the eighteenth turn. The 1626 filament wires *(pins 2* and *7)* are cut completely free of the oscillator coil. Disconnect the neutralizing condenser from the oscillator coil and move *R74* and *C58C* to that terminal. Set oscillator padder to maximum capacity. Rewind the amplifier coil with 34½ turns #18, enameled wire. Tune to resonance with *C65*.[22]

20 Meters: The simplest method of covering 14 Mc. with a "Command" transmitter is to use a 7-9.1 Mc. *BC-459* unit. Disconnect tuning condenser *C67*, and use *C65* to tune the 1625 stage as a 14-Mc. doubler. Disconnect neutralizing condenser from the oscillator coil. Move *R74* to that terminal. Replace *C58C* with an 0.002-μfd. mica condenser.[26] A much better method is to insert a frequency multiplier between oscillator and revamp the amplifier.[28]

15 Meters: With a 7-9.1 Mc. *BC-459* unit, add a frequency multiplier between the oscillator and amplifier. Rewind the amplifier coil to have 5 turns, double spaced.[18]

The conversions using an added multiplier stage may have it installed in the space originally occupied by the 1629 calibrator tube socket.

10 and 6 Meters: Operation on these bands requires practically a complete rebuilding job. The process has been described fully in several articles.[3, 15, 16]

Adding Another Stage To The Command Transmitter

Installing an untuned stage between the oscillator and the amplifier of a "Command" transmitter reduces reaction, resulting in better keying, which is discussed a bit later, and eliminates the possibility of frequency modulation when the 1625's are amplitude modulated for 'phone work. Also, as mentioned above, an extra frequency multiplier is usually required to operate the amateur bands above 7.3 Mc. *Figure 4* is a suitable circuit for either application.

A 2.5 mh. r-f choke acts as the plate load impedance when the stage is to be used as an isolating stage, and a slug-tuned coil is substituted for the choke when a frequency multiplier is required. The switch and coil shown in the dashed lines permits using the stage for either purpose. Of course, for this feature to be of any value, a similar switch must be added to the 1625 tank circuit. Then one transmitter may be used on two adjacent bands.

Rewire the crystal socket for the tube, mount the coil on a scrap of metal in place of the 1629 tube socket, and mount the switch on the rear or side lip of the chassis.

The simplest modification of the 1625 tank circuit for two-band operation is to mount another switch on the side of the chassis behind *C65* and *C67* (See *Fig. 1* and bottom photograph) and wire it so that when it is open, *C67* is out of the circuit. Resonance is obtained on the new frequency near minimum capacity of *C65*. It is convenient to add an external shaft and dial to *C65* for adjustment.

Alternatively, the switch may be mounted above the chassis and used to short out the top half of the turns on the amplifier coil *T54*. Resonance on either band will then occur at approximately the same setting of *C65*, depending upon how accurately the tap is placed. Ganged tuning of the oscillator and amplifier is retained. Also a more favorable L/C ratio in the tank circuit for harmonic discrimination is obtained.

De-TVI'ng The Command Set Transmitter

"Command" set transmitters are notorious TVI producers. However, there are tremendous differences in the TVI produced by apparently identical units. Some are very nearly "clean," and others are just the contrary. Also, the oscillator of one may be full of TVI, with the amplifier relatively clean, or vice versa, or both stages may contribute their share to the overall confusion.

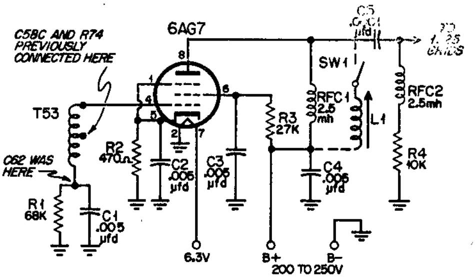
The first step in de-TVI'ing the transmitter is to improve the effectiveness of the bypassing under the chassis, and to cool off the power and key leads. The ingredients required are a handful of 0.005-μfd. disc ceramic condensers and about five feet of shielded wire. Carry out as many of the following steps as are necessary to clean up your troubles:

1. Bypass to ground each of the following points: screen grid of each 1625 *(pin 3)*, plate of 1626 *(pin 3)*, target of 1629 *(pin 3)*, the centertap of the 1625 grid coil, and the point where the filament voltage is fed into the oscillator coil. Disconnect and remove the three-section, 0.05-μfd. condenser *(C58)* mounted on rear lip of the chassis.

2. Replace the leads from the power socket to the various points within the transmitter with shielded conductors, grounding the shield wherever possible throughout its length, especially at each end. At the same time, shorten all ground leads as much as possible and remove unused components and conductors. In low TV-signal areas, it is also desirable to bypass each terminal of the power socket with an 0.005-μfd. disc ceramic condenser. The important point in installing these bypasses is to keep their lead length to an irreducible minimum.

3. With the bottom plate in place, the bottom of the transmitter is quite well shielded, even though there is a theoretical possibility of r-f leakage along the crack between the edges of the chassis and the plate. Use all screws and press the plate firmly into place while tightening them.

4. Another good method of improving the shielding is as follows: Remove the rotary antenna coil and cover the holes in the front panel with a piece of scrap aluminum. Next, bend a piece of bronze screening, 12 x 15 inches, into a trough to fit inside the cover. Then solder another piece across the open back of the trough. When the cover is screwed into place, the screen is clamped firmly between it and the chassis. Pay particular attention to the openings near the rear of the cover at the bottom. They may be sealed off by soldering the edge of the screening at this point.



C1, C2, C3, C4—0.005 μfd. 600 v. disc ceramics.
C5—0.0001 μfd. mica or ceramic.
L1—Wound on National XR-50 or equiv. slug-tuned forms 7 Mc. 20 T. #20, enam. close wound. 14 Mc. 10 T. #20, enam. spaced to occupy ½ inch. 21 Mc. 7 T. #20, enam. spaced to occupy ½ inch. (One only required.)
R1—68 K, ½w.
R2—470 ohms, 2w.
R3—27 K, 1w. (May be varied to adjust excitation to 1625's).
R4—10 K, ½w.
RFC1, RFC2—2.5 mh. 50 ma. radio-frequency chokes.
SW1—S.p.s.t rotary switch, preferably ceramic insulated (Centralab 2043 or equiv.) A similar switch is used in the 1625 stage, described in text.

Fig. 4: Diagram of an isolating stage or frequency multiplier which may be substituted in the frequency calibrator stage space of "Command" transmitters. Referring to Fig. 1, the wire between the oscillator coil (T53) and the 1625 grids is removed from the grids and connected to pin 4 of the 6AG7 socket, and the output of the 6AG7 connected to the 1625 grids. Other changes required are to remove the 1625 neutralizing condenser (C62) and disconnect C58C and R74 from the oscillator coil terminal strip. Connect R1 and C1 to the terminal to which C62 was previously connected. When only an isolating stage is required, L1 and SW1 are omitted, and when only a frequency multiplier is required, L1 is substituted for RFC1, SW1 again being omitted

5. Other methods of improving the shielding of the cover include backing up the ventilating louvres with perforated sheet metal and sealing the tube-access openings on the top with electronic weatherstripping.[44]

6. Undoubtedly the most efficient way to keep harmonic energy out of the antenna circuit is to substitute a coaxial fitting for the original output terminal and feed the antenna through a low-pass filter, in conjunction with an antenna tuner if necessary. Any conventional link-coupled antenna tuner may be used. Also, by remounting the original rotary coil on a small metal base and link coupling it to the transmitter, it will function in much the same fashion as it did before being removed from the transmitter.

After the coil is remounted, close wind a three-turn link of stiff, well-insulated wire (about #16) of a diameter just sufficient to slip over the rotary coil. Slip the link coil over one end of the rotary coil, with the link fitting between the coil and the rod upon which the roller slides. Terminate the link winding in a coaxial cable chassis fitting mounted on the base on a small angle plate. The fitting serves the dual purpose of supporting the link winding and bringing r-f power from the transmitter to the tuner.

Ground the end of the rotary coil under the link winding and connect the roller to the antenna. Adjustment and limitations of the loading coil will be as already described, but with the possibility of inserting a low-pass filter in the link line for further attenuation of harmonic output from the transmitter.

Alternate Keying Methods

The problem of which is the best method of keying "Command" transmitters has caused more hair tearing than any other question. When operated conservatively, excellent keying can be obtained on 3.5 Mc., and good keying on 7 Mc. On the higher frequency bands, however, keying is seldom better than passable, unless a frequency multiplier has been inserted between the oscillator and power amplifier in the course of the modification, and if only the 1625's are keyed.[18, 28]

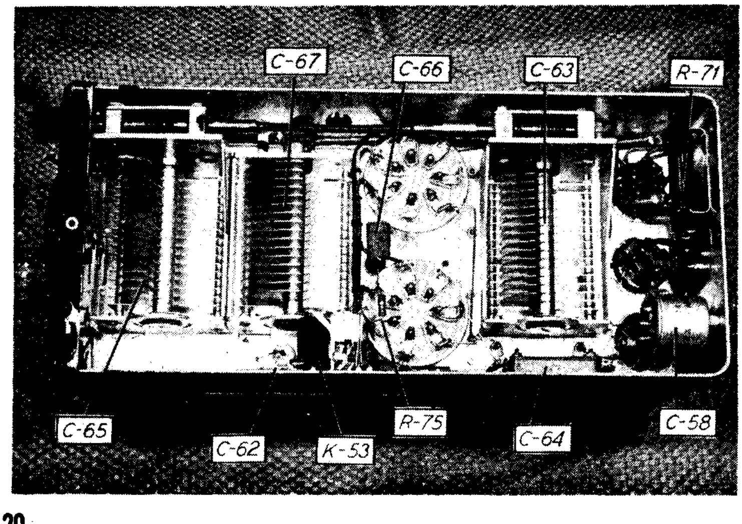
In our opinion, on 3.5 and 7 Mc., straight cathode keying of the 1625's is as good as any type, and better than some. It suffers the disadvantage of not permitting "break-in." Keying the oscillator permits "break-in" operation, but almost invariably accentuates chirps. Expedients used to permit oscillator keying include keying the B— lead of the power supply,[34] keying oscillator B+ and amplifier screens simultaneously through a relay,[14, 31] and replacing the jumper between *pins 7* and *8* on the 1626 socket with a 0.002-μfd. condenser and connecting *pin 8* to the key jack through a 2.5-mh. r-f choke.[13]

Modulation

The transmitters work well on phone at inputs of approximately fifty to sixty watts. In fact, many amateurs run considerably higher power than this on phone, without too much trouble. For an input of fifty watts, any modulator capable of delivering twenty-five watts of audio power may be used. Assuming a 1625 tube plate voltage of 500 volts and a total current of 100 milliamperes, the modulation transformer should be capable of matching the plate load impedance of the modulator tubes to a 5000-ohm load. The screens of the 1625's should be modulated as well as the plates. This is most easily accomplished by feeding the screen voltage through a 10-henry, 50-milliampere filter choke, which will allow them to be self-modulated.

Command Receivers

The most commonly available "Command" receivers are the *BC-453*, covering 190-550 kc; the *BC-454*, covering 3-6 Mc; and the *BC-455*,



Bottom view of the typical Command type transmitter.

covering 6-9 Mc. They all use the same, basic, six-tube circuit, with the filaments of the 12.6-volt tubes wired in series-parallel for operation from twenty-five volts.

As in the case of the transmitters, there are both *BC-* and *ARC-5* models, but the only important difference between them is that the *ARC-5* receivers use a 12SG7 tube in the second i-f stage, while the *BC* models use a 12SK7 tube.

The receivers are quite sensitive and stable, but the two units that cover the amateur 3.5 and 7-Mc. bands leave much to be desired from the selectivity standpoint. Nevertheless, they make excellent "first" or standby receivers. The bibliography contains many references to articles describing how to cover these and other bands with "Command" receivers.[2, 6, 8, 9, 17, 19, 20, 33, 35]

The *BC-453,* 190-550 kc., receiver has proved to be an extremely useful gadget around many amateur shacks. It uses an 85-kc., i-f amplifier, which is very selective. By tuning the main dial to 455 kc., the standard intermediate frequency of most communications receivers, and using a wire connected to the antenna post of the *BC-453* with the other end wrapped loosely around the lead from the last i-f transformer to the second detector in the communications receiver, the combination becomes an extremely selective "dual-conversion" receiver.[25]

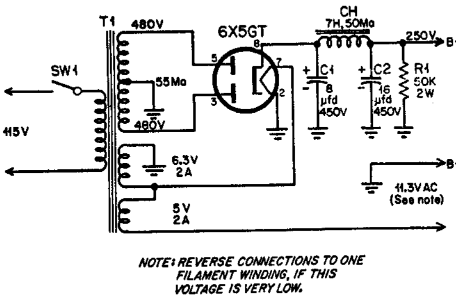
Some amateurs however, just take the i-f transformers from the *BC-453* to build a selective i-f channel in less space.[24, 27]

Modifying The Receivers

To use the receivers in amateur service entails adding a gain control, a beat-oscillator switch and a phone jack, and building a power supply.[2, 35] Also, as it is easier to obtain 12.6 volts than twenty-five volts, it is usually necessary to rewire the filaments in parallel for twelve-volt operation. When this is done, the six-volt equivalents of the original tubes may be substituted and the receivers then operated from a six-volt filament source.[3, 17, 19, 38]

The logical place to mount the new gain control, phone jack, and beat-oscillator switch is on the front panel in the space occupied by the adapter box. Remove the screws holding the box in place. Unplug it and remove the aluminum box holding the socket into which the adapter plugged. Mark the wires that were connected to *pins 1, 4,* and *5.* Remove the rest. Cover the hole in the panel with a flat piece of aluminum upon which is mounted a midget, 25,000-ohm wire-wound potentiometer, flanked by a s.p.d.t. toggle switch and a small phone jack.

Ground the middle terminal of the potentiometer and one terminal of the switch to the ground lug of the phone jack. Connect the *No. 1* wire to the *left-hand* terminal of the potentiometer (viewed from the back with terminals down), wire *No. 5* to the switch, and wire *No. 4* to the phone jack.



T1—Power transformer. 480v., 55ma., c.t., 5v., 2amp.; 6.3v., 2amp. (Stancor PC-8402 or equiv.)
Ch—7 h., 50ma. filter choke. (Stancor C-1707 or equiv.)
C1, C2—dual 8 µfd., 450v. electrolytic.
R1—50,000 ohm, 2w.
SW1—s.p.s.t. toggle.
Octal tube socket
6X5GT tube
7 x 7 x 2" chassis
Additional receiver conversion parts:
25,000-ohm, wire-wound pot. small size.
S.p.s.t. toggle switch.
Single-circuit phone jack.

Fig. 5. Wiring schematic and parts list of a power supply unit suitable to operate the Command Set receivers.

To rewire the filaments of tubes, ground one filament pin of each tube socket and connect the other filament pins of each socket together and to *Pin 2* of the three-terminal plug at the rear of the receiver. *Pins 2* and *7* are the filament terminals on all tubes, except the 12SR7 and 12SG7, on which they are *pins 7* and *8.*

Connect power to the three-terminal plug thusly: B— and one side of the filament circuit to *pin 1;* twelve volts, a.c., to *pin 2;* and 200 to 250 volts, d.c., at fifty milliamperes, to *pin 3.*

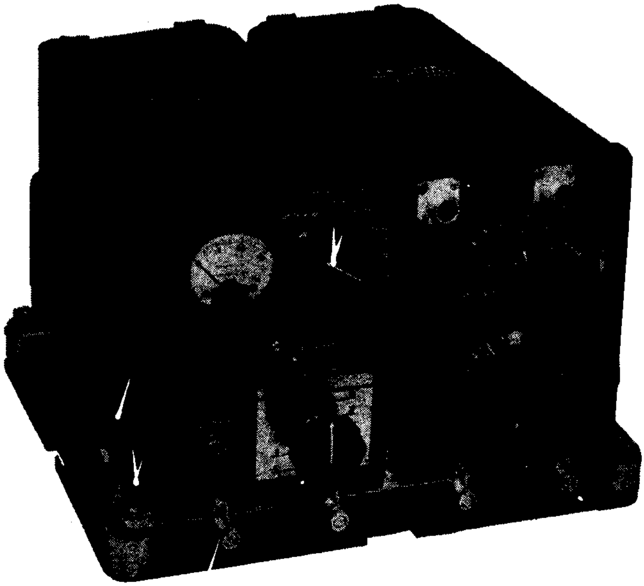
WARNING! Do not apply more than 250 volts to the receiver; otherwise there is danger of blowing some of the condensers in it.

Figure 5 is the diagram of a power supply suitable for use with "Command" receivers. It is conventional, except for the 6X5 rectifier tube and the use of two filament windings connected in series to operate the tubes in the receiver. The total of 11.3 volts is a little low, but it will satisfactorily operate the receiver.

Obviously, this article just scratches the surface of the vein of information available on the use of "Command" equipment, but we hope that, combined with the bibliography, it serves a useful purpose.

P. S. RAND, W1DBM*

WAR SURPLUS for CIVIL DEFENSE



Probably the most popular equipment in surplus, many of the ARC-5 series are still available. Here is W1DBM's conversion for CD mobile use.

This article will describe the conversion of war surplus SCR-274 transmitters for use on the newly announced Civil Defense frequencies . These particular surplus units are very well suited for emergency use, first, because they are v.f.o., second, because they are available, and third, because they were originally designed for mobile use and may be used with their original shock units.

During the last war, the author was Radio Aide for Middlesex County in Connecticut, and remembers that when the W.E.R.S. net frequencies were changed from time to time, it was so difficult to obtain new crystals that v.f.o.s. were finally built for the two net control stations. Now again in 1951, we must change crystals because the Connecticut Emergency Mobile crystals, 29680 kc, are not in the Civil Defense bands.

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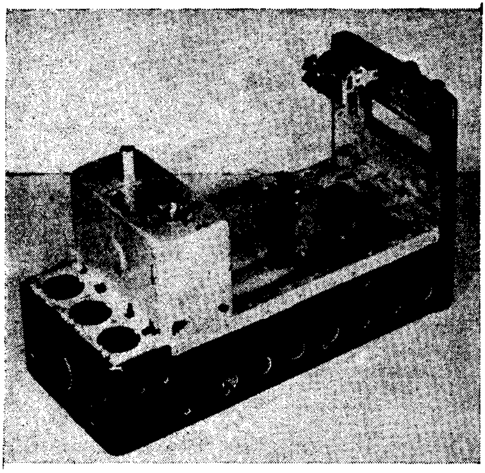
Circuit

With the above in mind, five of the popular SCR-274 command sets were converted for use as either fixed or mobile transmitters. These transmitters are so laid out that they may all be used with the same modulator and power supply by simply plugging the desired unit into the shock-mounted rack, and connecting the coax feed lines to the antenna and converter.

For mobile use on 28, 50 and 144 mc, instant heating filament type tubes are used, while for fixed stations, a heater type of tube such as a 6AQ5 and 2E26 may be used if preferred. There is a very great saving in storage battery life if the transmitter is off completely during standby. Therefore, the former is recommended.

The tubes are 2E30's and 5516's, manufactured by Hytron, although comparable types by other manufacturers could be used as well[2]. The v.f.o section uses a 2E30 connected as a triode, followed by 2E30 pentodes as frequency multipliers, with

[2] Comparable Tubes 2E30, 5618, 6AQ5, 5763, etc.
5516, 2E24, 2E26, etc.



The first step is to strip the chassis.

two 5516's in the final. The modulator unit is constructed on a similar chassis and consists of a 2E30 triode connected as a speech amplifier followed by a 5516 as a clamp tube[3] screen grid modulator. A PE-103 Dynamotor is used for mobile use.

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3 For more information on clamp tube modulation see:
"Practical Screen Modulation," CQ, Dec. 1949, p. 24
"Screen Modulated Command Set," CQ, Sept, 1949, p. 35
"Clamp Tube Modulation," QST, Mar. 1950, p. 46
"High Output Grid Modulation," QST, Feb. 1951, p. 40

TABLE I

28 mc Coil Data for v.f.o. 4.666 mc to 5.000 mc using variable condensers C_1 and C_2 across coils.

Coil	Frequency Coverage	No Turns	Dia.	Length	Wire	Form	uh
L1	14 to 15 mc	28	1/2"	5/8"	#24	XR-50	5.0
L2	28 to 30 mc	14	1/2"	5/8"	#18	XR-50	1.4
L3 & L4	Links	2	1/2"		#16		
L5	28 to 30 mc	15	3/4"	1"	#16	Poly	1.8
L6	28 to 30 mc	14	1"	2"	#12	Air	1.8
L7	Ant. Link	3	1"		#16	Air	

Coil Table for 28 mc conversion.

28 mc Conversion

Referring to Fig. 1, the area within the dotted lines indicates that part of the original ARC-5 circuit is retained with minor changes in the three highest frequency units. The lead from the grid coil going to the magic eye tube has been removed, along with the tube and its resistors, as they are no longer needed. The crystal is also removed. The neutralizing condenser, which was formerly attached to the secondary of the v.f.o. coil, is discarded. For 6 volt heater operation a 6J5 may be used in place of the 1626 without change in socket connections. However, for the filament type 2E30, it is necessary to remove the octal socket and replace it with a 7-pin miniature. At this same time, all three octal sockets are removed and a small plate with two 7-pin miniature sockets is screwed on the rear edge of the chassis. The second socket is for an OA-2 voltage regulator tube. This is shown in the photographs.

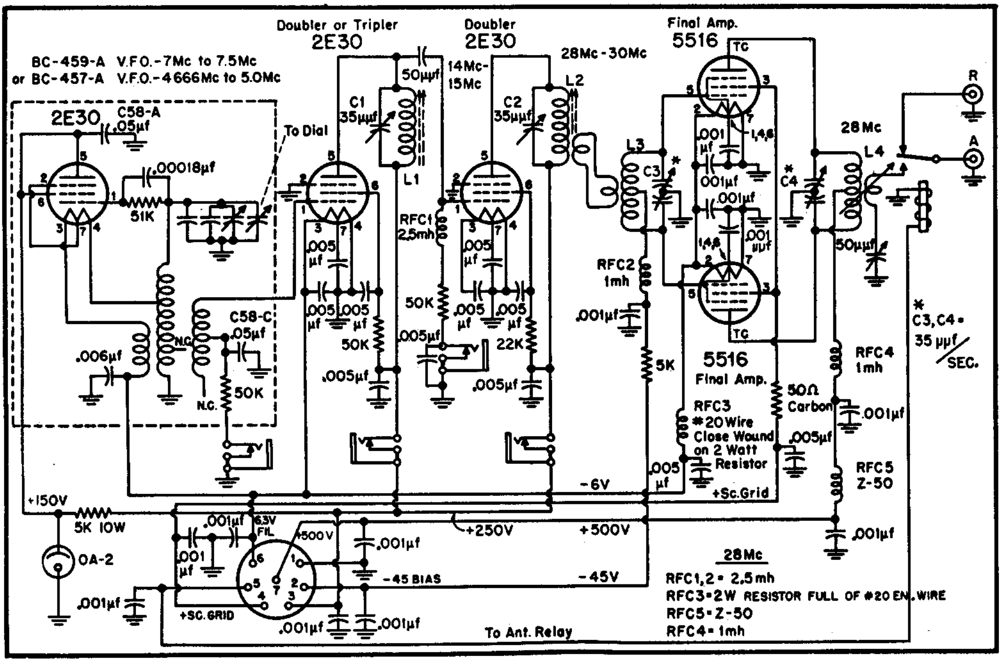


Fig. 1. Ten meter conversion circuit diagram.

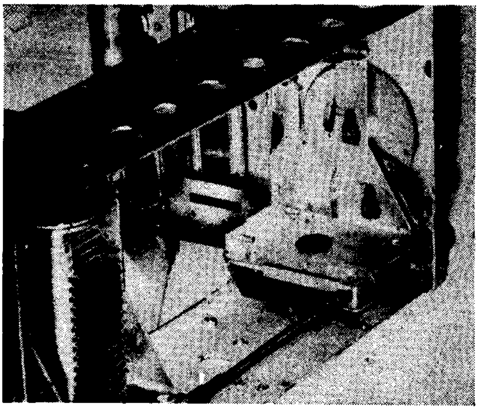
A further study of the diagram reveals that the first frequency multiplier is inductively coupled to the oscillator, and capacity coupled to the second frequency multiplier. The output of this second stage could be capacity coupled to the final as far as output is concerned; however, we used inductive coupling in an effort to keep harmonics from feeding through to the antenna. The final amplifier may be either single ended or push-pull, using either 2E30's or 5516's[4], depending on the dynamotor available. In our case we chose push-pull 5516's for added power inasmuch as screen grid clamp tube modulation is not very efficient at best, due to the low average screen voltage. A send-receive antenna relay is mounted next to the antenna coax fittings on the front panel, and a low pass filter is used externally on the ten meter unit.

TABLE II

	GRID		PLATE		SCREEN	
	-Volts	MA	+ Volts	MA	+ Volts	MA
Osc. 2E30	30	1	150	5	---	--
1st Mult. 2E30	30	1	250	15	110	5
2nd Mult. 2E30	150	3	250	18	80	7
Final 2-5516	95	10	500	75	150	10
Sp. Amp. 2E30	10	-	250	10	---	--
5516 Clamp Mod.	25	-	150	25	---	--

Measurements made with V. T. voltmeter and milliammeter

Operating voltages for 28 mc conversion. Transmitter and Modulator.



This is the condenser frame after alterations.

This can now be replaced in the unit so that we will have a means of tuning the v.f.o. from the front panel, and yet will have enough space above and below the chassis to mount the 5516 sockets, grid coil and condenser. The two coax fittings and 6V antenna relay are now mounted on the rear of the front panel at the top.

A small bracket is bent up to hold the 35 uufd per section tank condenser high enough off the chassis so that a shaft extension can be brought out through the plastic window on the front, for tuning the final amplifier plate coil. The final amplifier grid is tuned through a clearance hole in the right hand side of the chassis.

Construction

Or should we say destruction? Before starting to rewire these units, it is first advisable to remove all parts that will not be used in the final version, and this means everything above and below the chassis ahead of the master oscillator. Start with the coils, then the variable condensers, the 1625 tube sockets, and finally all the small parts, relays, etc. All this junk, of course, is saved for some future use. Take another look at the

Now, with a keyhole saw, cut a nice rectangular hole about 2 inches wide and the width of the chassis where the 1625's used to be. This hole will photos.
later be covered by an aluminum plate, $2\frac{1}{2}'' \times 5''$, upon which are mounted the two 2E30 multipliers, along with their tuning condensers, coils, resistors, etc.

The front variable condenser that holds the tuning dial and worm drive mechanism to the chassis, which you have already removed, must now be taken apart and cut with a hack saw so that all that remains of it is part of the frame—just enough to still hold the dial and worm drive.

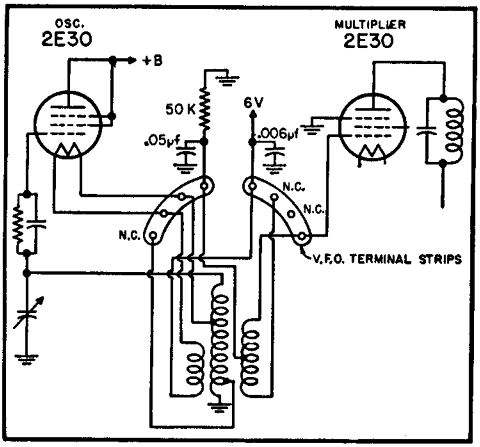


Fig. 2. V.F.O. coil connections.

Closed circuit jacks for metering the various stages are mounted along the side of the chassis and insulated from it with fibre washers. These jacks may seem unnecessary; however, they will save a lot of time in tuning up and trouble shooting later on.

These metering jacks were added after the photographs had been taken, and therefore do not show in the pictures.

[4] Screen resistor and clamp modulator changed accordingly.

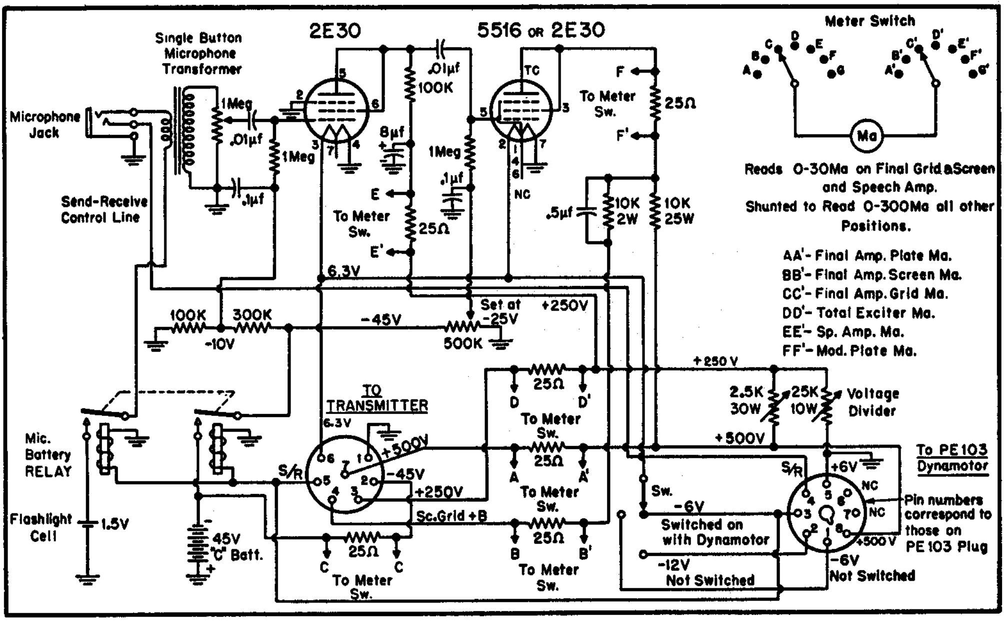


Fig. 3. Modulator circuit diagram.

Frequency Multipliers

The frequency multiplying strip is a small subassembly built up on a piece of aluminum large enough to cover the rectangular cut-out in the chassis where the 1625's used to be mounted. The parts are so laid out that the first 2E30 frequency multiplier grid is close to the tap on the secondary of the v.f.o. grid coil assembly. See Fig. 2 for v.f.o. coil connections. The plate coils and tuning condensers of the 2E30's are located near the edges of the aluminum strip with the two 2E30's in the middle, allowing room to pile up the necessary plate, filament, grid and screen grid by-pass condensers. This arrangement allows the operator to tune the condensers and coil slugs through the access door on top of the dust cover that was formerly used to get at the 1625's.

As shown in the photos, the 5516's are mounted on the left side of the final tank condenser, and the coil is mounted on the right side. The antenna coupling link is adjusted by hand by bending its pigtails and the loading is adjusted by varying the series antenna condenser which mounts on the front panel.

The link line between the last doubler plate coil and the final grid coil is a short length of receiving type 72 ohm twinlead, anchored at each end on tie points.

Coils

The 2E30 coils are wound on National XR-50 slug-tuned coil forms or equivalent, according to the coil table, and are mounted and preadjusted to resonance with a grid dip oscillator before mounting the aluminum strip in the main chassis. The grid coil of the final is wound on a plain ¾" diameter coil form, and after adjustment with the grid dipper is cemented with coil dope. The final plate coil is wound with #12 wire and soldered to the condenser terminals.

To cover from 28.5 mc to 29.7 mc, the v.f.o. frequency range will be 7.125 mc to 7.425 if a BC 459-A is used, requiring two doubler stages. If you are using a BC457-A, the frequency range will be 4.750 mc to 4.950 mc, necessitating a tripler and a doubler. If you are using a BC 696-A, the frequency range is 3.166 mc to 3.300 mc, following with two triplers. Of course, a BC 458-A can be made to tune the 7.125 to 7.425 mc range by opening out the air padder that is in the shield next to the v.f.o coil, or to tune the 4.750 to 4.950 mc range by closing in the same air padder. The latter will give better band spread, and that is what the writer did. Rotor plates may be removed from the oscillator tuning condenser with a pair of pliers for increased band spread.

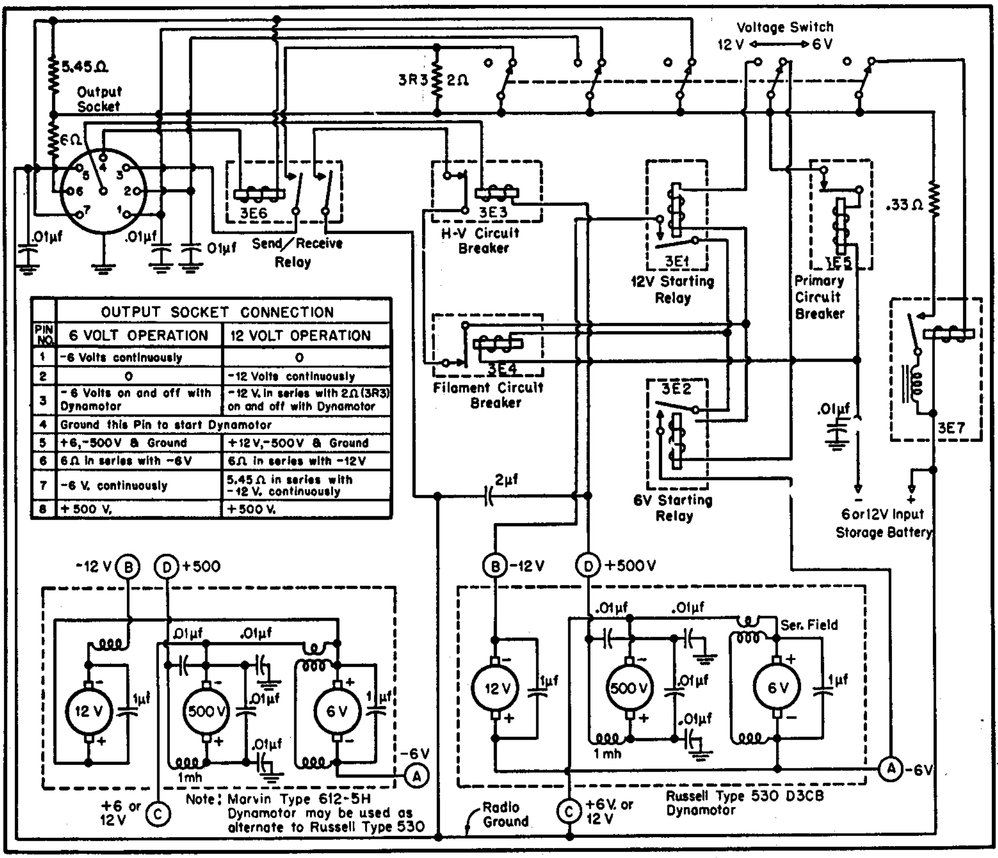
The writer ended up by removing 2/3 of the rotor plates. This gave considerably more band spread on the V.F.O. dial than is shown in the photos. Care must be exercised in twisting these plates and pulling them out with a pair of long-nosed pliers. The force should be exerted with a twisting motion by the pliers between the plates and the rotor shaft and not with a straight pull between the plates and the chassis, as there is danger of pulling the rear rotor shaft bearing out of its socket. (If this does happen, be sure to catch all the tiny ball bearings so that the condenser may be repaired. This is done by removing the condenser from the chassis and removing the rotor so that the ball bearings may be replaced. To do this, drive out one of the taper pins in the flexible shaft, remove the screws holding the condenser to the chassis, unsolder the connections to the coil and tube, remove the spring-loaded gears on the condenser shaft, and unscrew the bearing on the opposite end of the condenser shaft. The rotor now lifts out easily. Holding the condenser vertically with the shaft end down, drop the ball bearings into the race with a pair of tweezers and replace the rotor shaft. Holding the rotor shaft so that the balls cannot fall out, reverse the position of the condenser and replace the balls in the other bearing and then replace the screws. The condenser is now as good as new, and may be put back in the unit. If any balls are lost, they may be replaced from one of the two condensers that you have previously removed. You may even practice on one of these before trying to remove plates from the V.F.O. condenser if in doubt.)

Modulator

The speech amplifier-modulator unit is built on a SCR-274 transmitter chassis so that it may be plugged into a double shock-mounted transmitter rack alongside the transmitter. The circuit diagram is shown in Fig. 3, and consists of a 2E30 triode driving a 5516 clamp tube modulator. If desired, the reader can build up almost any type of modulator ; however, for the power involved and the overall battery drain, we decided in favor of the clamp tube[3], especially since no modulation transformer was needed. Since it is not feasible to use a cathode resistor with a filament type tube, a "C" battery is necessary to set the operating bias for the clamp tube. This same 45V battery supplies fixed bias for the RF units and in this way provides protection for the 5516 tubes in the case of excitation failure. A one megohm pot is connected across the battery as a convenient means of adjusting the clamp tube bias. One leg of this parallel resistor is broken by a relay during receive, so as not to run down the battery. This same relay also breaks the mike battery for the same purpose.

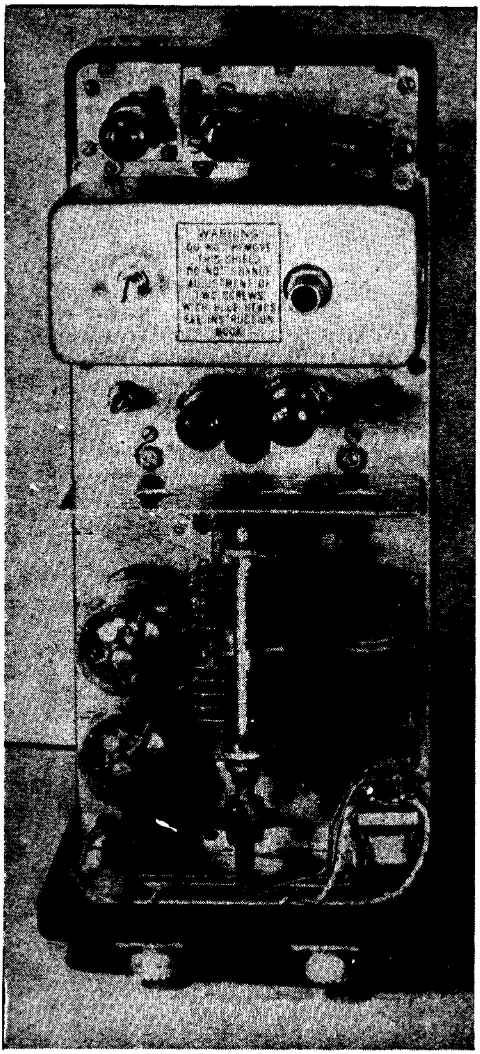
The Modulator unit carries an 0-30 ma meter with meter shunts[6] on the switch for reading the final plate, grid and screen grid in addition to

[6] Correct meter shunts for your particular meter may be calculated from the formula in the ARRL Handbook. p. 18



PIN NO.	OUTPUT SOCKET CONNECTION	
	6 VOLT OPERATION	12 VOLT OPERATION
1	-6 Volts continuously	0
2	0	-12 Volts continuously
3	-6 Volts on and off with Dynamotor	-12 V. in series with 2Ω (3R3) on and off with Dynamotor
4	Ground this Pin to start Dynamotor	
5	+6,-500V & Ground	+12V,-500V & Ground
6	6Ω in series with -6V	6Ω in series with -12V
7	-6 V. continuously	5.45Ω in series with -12 V. continuously
8	+500 V.	+500 V.

Fig. 4. PE-103 dynamotor plug connections and circuit diagrams.



Top view of the completed r.f. unit.

modulator plate current which is necessary when tuning up. The voltage divider for the exciter stages, as well as the final screen dropping resistor, are also included in the modulator unit.

Shock Mounting

A standard SCR-274 double transmitter shock-mounted rack is utilized to hold the two units in place either for mobile or fixed station use. A power connector plug is mounted on this rack or one of those already there may be used to make connections to additional racks. The PE-103 dynamotor connects to the modulator chassis. Fig. 4 gives the circuit and output plug connections for the PE-103.

Wire the plugs on the rack into which the transmitter and modulator plug in parallel; that is, pin 1 to pin 1, pin 2 to pin 2, etc. Now make suitable connections between them and the plug that goes to the other rack. See Fig. 5. At the dynamotor, the wiring must be arranged so that the filament voltage is switched on simultaneously with the primary to the dynamotor if other than a PE-103 is used. A switch at the modulator turns the filaments on continuously when using the low frequency units to be described later.

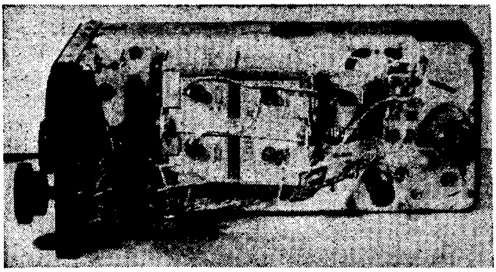
The switches shown in Figure 5 are mounted on the rear of the racks and are for breaking the filaments and plus 250V on the units that may be plugged into the additional racks, but which are not in use at the moment. This feature allows the operator to have up to three racks all connected in parallel, with five transmitters and a modulator plugged in. Any transmitter may be put in operation simply by turning filaments and plus 250V on. The others remain inoperative because their filaments are off. The plus 250V switch prevents all the unused OA-2 voltage regulators from igniting and drawing current.

PE-103 Dynamotor

Figure 4 gives the complete circuit diagram, copied out of the base of one of these units with some difficulty. It will be noted that the output power plug contains all the necessary voltages for operating the rig without any alterations. A S.P.D.T. toggle switch at the modulator selects pin #1 for 6 volt continuous heater operation for use with heater type tubes and pin #3 for 6 V intermittent filament operation for use with instant heating filament type tubes. Note that the + 6 volts is grounded while the —6 volts is above ground. Pin #3 is used to operate antenna relays because it is only energized when the send/receive relay #3E6 in the PE103 is operated.

The push to talk button on the mike, one side of which is grounded, connects to pin #4 to operate relay 3E6. The other contacts on relay #3E6 operate either the 6 volt or 12 volt dynamotor starting relays depending on the position of the 5PDT wafer switch at the top of the diagram. This circuit will be broken if either the H.V. or L.V. circuit breakers, #3E3 and #3E4, kick out due to an overload or short. #3E3, #3E4 and #3E5 are the three big switches behind the door on the side of the PE103 base, #3E5 is the primary circuit breaker.

For six volt operation, the S.P.D.T. wafer



The modulator. Batteries are for mike and bias.

switch, located under the cap on the top of the base next to the output connector, must be turned with a screw-driver to the six volt position. If it is desired to cut down on battery current, two six volt batteries may be used in the car; however, in this event, resistor 3R3, two ohms, must be shorted out and the filaments of all the tubes in the transmitters must be put in series-parallel for 12 volt operation. In addition, 12 volt antenna relays must be used. In the two low frequency conversions, the original 1625's and 1626's may be retained by wiring their heaters in parallel as they are 12 volt tubes. The PE103 wafer switch is now set for 12 volt operation. The filament/heater switch in the modulator unit referred to above is wired between pins #2 and #3 instead of #1 and #3.

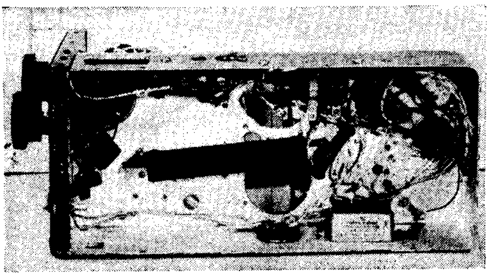
If trouble is experienced with the H.V. circuit breaker #3E3 kicking out too easily, it may be corrected by soldering a 10 ohm 1 watt resistor in parallel with the coil. This will increase its current handling ability, but will still allow it to kick out on a H.V. short circuit.

The two dynamotor diagrams at the bottom of Figure 4 are two different combinations that you may find in the PE103.

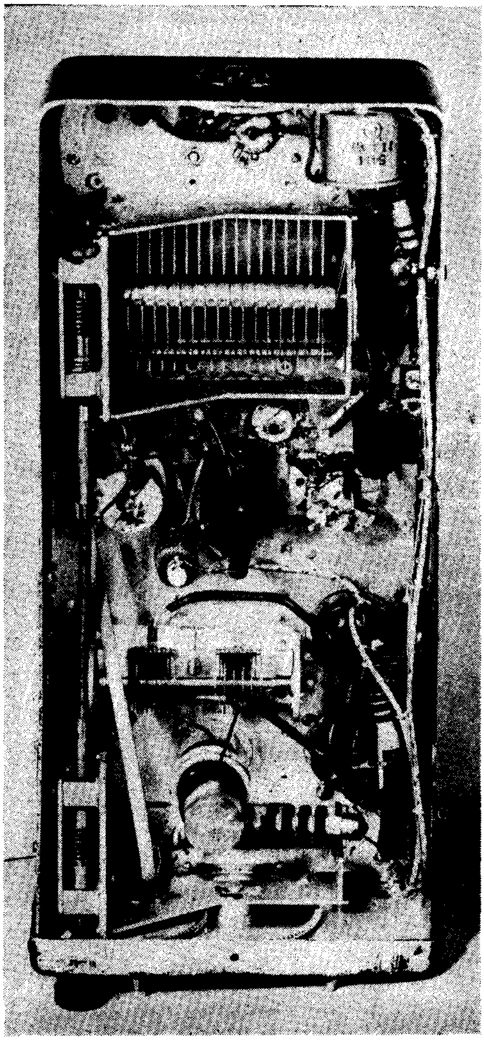
Tuning Up

The first step is to recalibrate the v.f.o. section. The dial is given a coat of Automobile Touch-up Black paint to cover the old calibrations and is then marked with a pencil and later the new calibrations are painted white with a fine pointed paint brush. The frequency lettering may be put on with "decals" if desired. With all the tubes removed except the oscillator, 250V is applied and the oscillator is adjusted until the frequency coverage is about right. Next, all the tubes are replaced in their sockets and the coils are tuned up with a grid dipper to their proper frequencies. Now, with the final plate and screen voltage temporarily disconnected, the plus 250 is again applied and the 2E30's are tuned for maximum final grid current. With the transmitter operating in this condition, the main v.f.o. dial should be calibrated directly in output frequency so that you will not have to carry a slide rule to calculate your frequency each time you QSY.

You will find that you can move around in the band quite a lot without retuning the two 2E30's, especially if you stagger-tune them a bit. It is perfectly possible to put in band-pass couplers if desired; however, they will not be covered in this article.



Bottom view of the modulator unit.



Bottom side of the converted r.f. chassis.

The unit under test should now be plugged into the dual rack alongside the modulator and the whole works turned on. An antenna or dummy load should be connected to the antenna coax connector so that the final can be loaded up to the rated plate current. The clamp tube bias is adjusted to approximately -25V, and the screen dropping resistor is adjusted until the screen voltage on the 5516's is about 150 volts. When modulation is applied, this voltage will swing up and down at audio frequency. Adjust the antenna coupling or loading until a flashlight bulb coupled to the tank brightens up when modulation is applied. Table 2 gives operating voltages and currents for the transmitter.

Clamp tube modulation, if correctly set up and adjusted with a scope, does a good job and sounds fine. However, it is not something you just wire up with a handful of parts, connect to any screen grid final and get good-sounding 100 per cent modulation. The wave form shown on an oscilloscope can be about as awful as the writer has ever seen if the clamp tube bias, the final grid current, the final screen voltage, or the antenna loading are incorrectly adjusted. Without the screen dropping resistor, by-passed for audio, between the clamp tube plate and the final screen, it is difficult to get more than about 50 per cent modulation. If you try to increase the percentage by opening the gain, all you do is produce square waves with the resultant distortion. On the other hand, if you set the thing up right with a scope, it will sound fine and becomes a very economical means of modulation. Straight transformer type of screen grid modulation could be used if desired, by utilizing one of the modulation transformers, T52, out of the original SC274 modulator, BC-465-A. The plus B goes to terminal #1, the 5516 modulator plate to terminal #2, terminal #4 goes to the final screens, and terminal #3 goes to plus 150V for the final screen voltage. Terminals #6 and #7 are not used. See Figure 6.

In any form of screen grid modulation, the screen grid voltage must be run at about 1/2 of the normal plate modulated value with the resultant reduced output. The stage must also be run more like a class B linear amplifier with the decreased efficiency of such an amplifier.

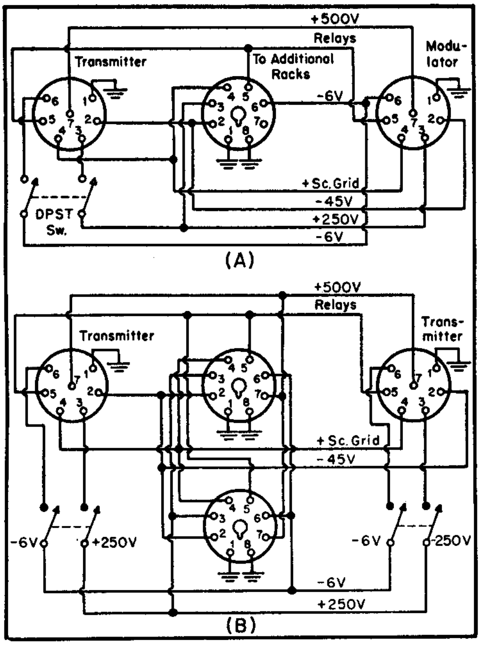


Fig. 5. Shock mounted rack connections.

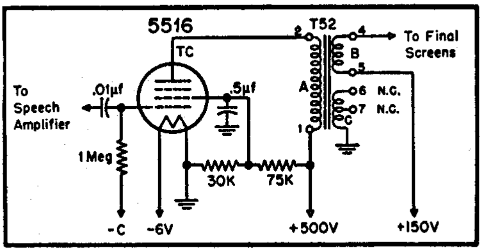


Fig. 6. Optional modulator, using transformer T-52.

By far the most efficient form of modulation is narrow band frequency modulation. This is excellent for mobile use providing crystal control is used with a phase modulator. However, all the mobiles and net control stations should be equipped with FM receivers (NBFM adapters) which might not always be practical. V.F.O. could not be used because the vibration of the V.F.O. in mobile use would produce frequency modulation. With AM modulation the FM component is not objectionable because the signal is tuned "on the nose", and there the FM is the weakest.

The circuit diagram of the clamp tube modulator shown in Figure 3 calls for either a 5516 or a 2E30. Either may be used with slight difference in performance. The writer used a 5516 because one was available. For further information, on clamp tube operation, the reader is referred to the footnotes.

Neutralizing

The final amplifier should be checked for neutralization by observing whether or not the grid current changes when the plate circuit is tuned through resonance with both the plate and screen voltages of the final turned off. A grid current change indicates the need of neutralization. It was found necessary to neutralize the 5516's in our case, and this was done in the usual fashion by crossing over the grid leads and extending two pieces of stiff insulated wire about 2 inches long up beside each tube. These wires were bent towards or away from the glass envelopes while reading a crystal diode wavemeter, coupled to the final tank, for the lowest possible indication.

TVI and Antenna

This 10 meter transmitter incorporates the most essential TVI measures, such as filtering of the power leads, link coupling to the final and the use of a low pass filter in the 52 ohm coax feeding the whip. It is not 100 per cent TVI-proof but if the dust cover and bottom plate are screwed on well, it does not bother Channel 2 unless the car is parked right in front of the house containing the TV set.

Added TVI proofing can be accomplished by improving the shielding on the transmitter itself by covering the louvres, the rear corners and the plastic window on front with copper screening.

The standing wave ratio should be checked on the RG8-U line feeding the whip, with an "Antennascope," or resistance bridge, and the length of the whip adjusted for a minimum SWR at your operating frequency. This will insure that the Niagara low pass filter will work properly. In my case, the whip length turned out to be about nine feet long, to reflect 50 ohms at the transmitter. An eight foot whip looked like 15 ohms. The RG8-U in my installation was only two feet long. Signal strength reports were about the same with both whip lengths, however.

50—54 MC Unit

If you use a BC 458-A, the v.f.o. tuning range will be 5.555 to 6.000 mc followed by two triplers. If you use a BC 459-A, the v.f.o must cover from 8.333 to 9.000 mc and must be followed by one doubler and one tripler. Here, as in the case of the ten meter transmitter, other SCR 274 transmitters may be used by altering the coil and condenser in the v.f.o., so that they tune either of the above ranges.

The conversion to be described used a BC 458-A, and to get more band spread on the v.f.o. dial, the powdered iron slug was screwed all the way out of the coil, and the air padder was turned nearly all the way in. We ended up tuning 5.555 to 6 mc with considerably more band spread as shown in the photos. Plates may be removed from the oscillator condenser to obtain added bandspread if desired.

When substituting a 2E30 for a 1626, the frequency will be lowered slightly due to the higher grid-to-filament capacity in the 2E30, so if you intend to use the present dial calibrations, be sure to compensate for this by adjusting the padder.

Frequency Multiplier

Regardless of whether you double or triple in the first 2E30 multiplier, its plate coil must tune the range of 16.666 mc to 18.0 mc. The next 2E30 triples to 50 to 54 mc, and is link-coupled to the push-pull 5516 grid coil. This exciter strip is built up on a small 2½" x 5" aluminum plate, and is mounted over a cutout on the chassis exactly as was described in Part I for the 28 mc transmitter. In fact, the entire chassis conversion, removal of parts, mounting coax connectors, antenna change-over relay, etc., is identical on both the ten and six meter units and so will not be repeated here. The reader is referred to April 1951 CQ for details.

If desired, the builder may dispense with the small APC variable condensers shown tuning the 2E30 plate coils, and utilize the fixed input and output tube capacities of the 2E30 and tune with the powdered iron slug in the National XR-50

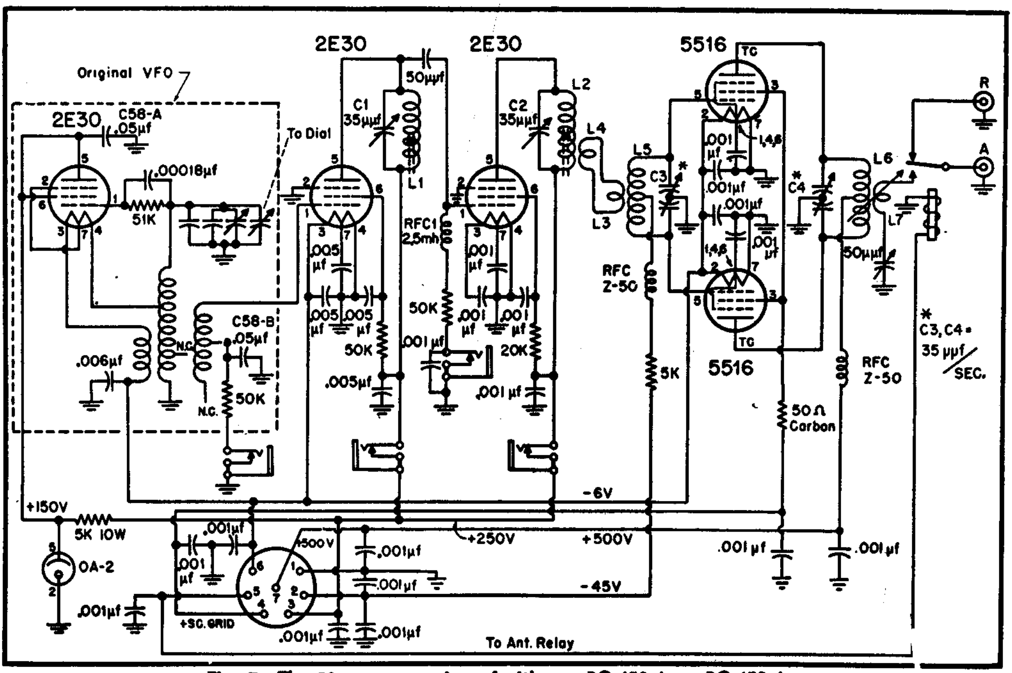


Fig. 7. The 50 mc conversion of either a BC-458-A or BC-459-A.

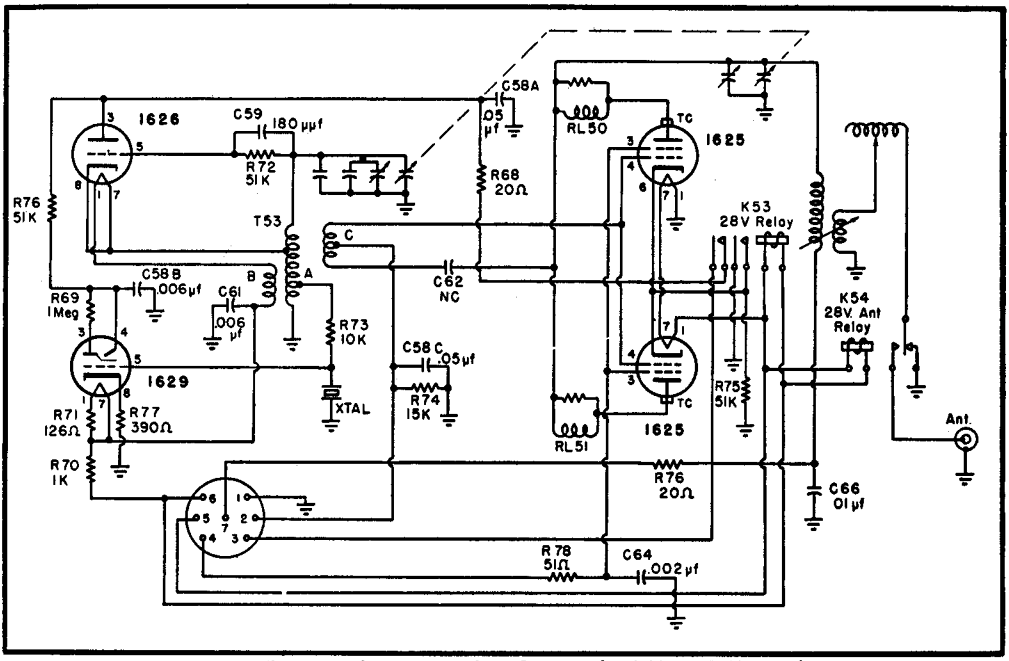
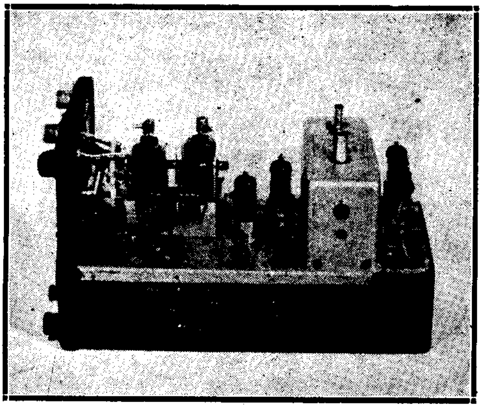


Fig. 8. The original circuit of the BC-696-A (and Navy CBY-52232).



Right hand view of the converted 50 mc transmitter. The remaining grid current jack is on the left hand side of the chassis.

coil form. Winding the coils is a little more critical as the tuning range with the slug is much more limited than with the variable condenser arrangement. Figure 7 shows the 50-54 mc circuit diagram. The first 2E30 multiplier plate coil tunes 16.6 to 18 mc and is shunted by 4.5 μμf, the plate-to-filament capacity, plus 10 μμf, the grid-to-filament capacity of the following 2E30, plus strays of about 5 μμf. This makes a total of around 20 μμf across the coil. The inductance necessary to cover the above range then becomes 3.8 μh to 4.5 μh. This can be made by winding 21 turns of 24 enamel wire on a National XR-50

TABLE III
Coil Data for 50-54 mc Output

Coil	Frequency Coverage	No. Turns	Dia.	Length	Wire	Form	μh
L1	16.666 to 18.000 mc	20	1/2"	5/8"	#22	XR-50	3.0
L2	50.0 to 54.0 mc	6	1/2"	5/8"	#18	XR-50	.25
L3 & L4	Link	2	1/2"		#16		
L5	50.0 to 54.0 mc	11	5/8"	1 1/2"	#14	Air	.75
L6	50.0 to 54.0 mc	12	5/8"	2"	#12	Air	1.1
L7	Antenna Coil	3	5/8"		#16	Air	

See Text for coil dimensions if C_1 and C_2 are omitted.

The second 2E30 multiplier only has about 8 μμf across it, so it requires 1 μh to 1.2 μh to tune the range of 50 to 54 mc. This is a coil of 10 turns of #18 enamel wire wound on an XR-50 coil form. The link is 2 turns, wound on the cold end.

It is wise to check the ranges covered by the coils before applying the coil dope and mounting them permanently in the chassis. This is conveniently done by mounting them temporarily on the small sub-chassis together with the 2E30 sockets before the sub-chassis is mounted on the transmitter. The filament, screen grid, and other wiring is completed and the coils are temporarily soldered into the circuit. With both 2E30's in their sockets, the slugs are screwed from minimum to maximum while checking the resonant frequency with a grid dip oscillator. A turn or two is added or taken off from the coils as required, so that the slugs will tune the desired range with some leeway. The coils may now be "doped" and permanently mounted in place and the sub-chassis may be bolted to the main chassis. See Table III for coil winding data if parallel condensers are used to tune the coils.

Final Amplifier

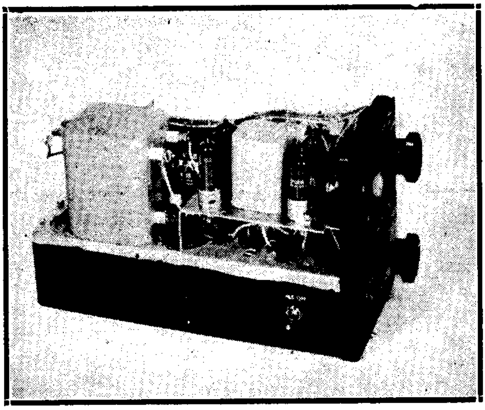
The components for the push-pull 5516 final amplifier are mounted in much the same fashion as for the 28 mc transmitter. The reader is referred to the photographs which show the general layout. The final tank condenser is raised off the chassis by means of a small aluminum bracket so that the plate leads will be short and so that the condenser shaft will protrude through a hole in the plastic window. The antenna loading condenser is mounted under the antenna change-over relay on the right hand side of the front panel. The grid tuning condenser is mounted for screw driver adjustment through a clearance hole in the right hand side of the chassis. Incidentally, to be sure to keep all your metering jacks and screw driver adjustments on the right hand side of the transmitters and all the switches, power plugs, etc., of the modulator on the left hand side, so that they will all be available when the two units are plugged in side by side in a double mounting rack with the modulator to the left and the transmitter to the right.

Tuning Up

The tuning up precedure for this 50 mc unit is similar to that of the 28 mc unit. First pretune all stages to the desired frequency with a grid dip oscillator so that they will be in approximate resonance when first turned on. Then with final screen and plate voltage off, peak the multipliers for maximum final grid current. Calibrate the v.f.o. dial in output frequency, marking the calibrations in white paint. Attach the antenna 52 ohm coax feed line and adjust the antenna coupling and loading for optimum output consistent with upward modulation as indicated by a flashlight bulb coupled to the final tank coil. See Table IV for operating voltages and currents.

1.75 to 2 mc and 3.5—4 mc Conversions

Inasmuch as these frequencies are proposed for communications between various disaster services and for some type of medium distance C.D. communications and probably will not be used for mobile work, these two units were designed for portable emergency use. They retain their original circuit details except for changing to 6 volt tubes,



The class B modulator; microphone and bias batteries are on the far side of the chassis.

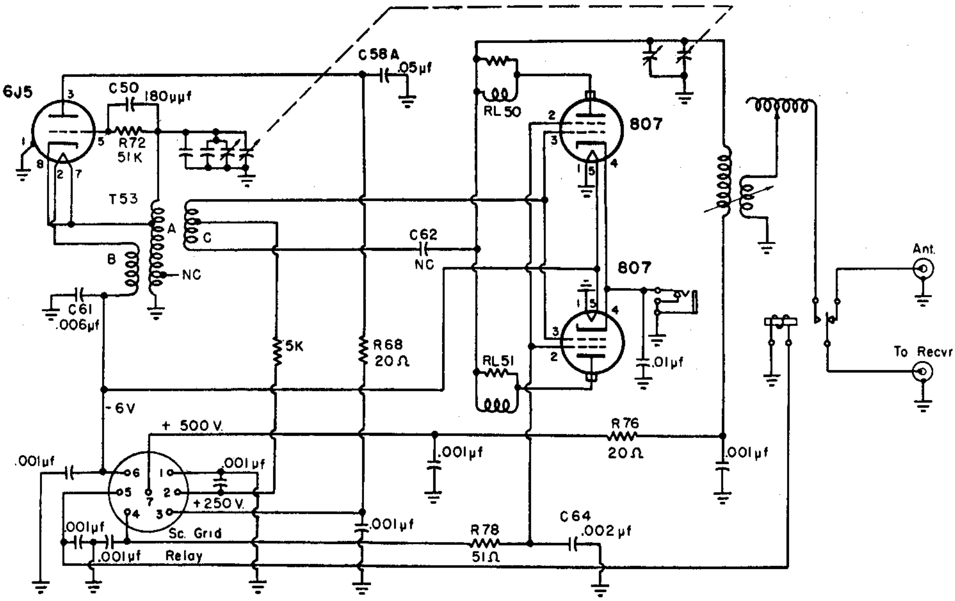


Fig. 9. WIDBM's 80 and 160-meter conversion from the circuit of Fig. 8.

TABLE IV
Voltage and Current Measurements 50-54 mc r.f. unit

	GRID		PLATE		SCREEN	
	Volts	MA	Volts	MA	Volts	MA
Osc. 2E30	-50	1.0	150		Triode Connected	
1st Mult. 2E30	-35	0.7	250	20	110	3
2nd Mult. 2E30	-100	2.0	250	20	110	3
Final 2-5516	-70	5.0	450 to 500	80-100	150	10

Class B Modulator

1st Sp. Amp. 2E30	-10	0	220	1.6	Triode Connected	
2nd Sp. Amp. 2E30	-22.5	0	220	25	220	5
Mod. 2-2E30's	0	0	450-500	5-80	Triode Connected	

Measurements made with V.T. Voltmeter and Milliameter.

a 6J5 and 2-807's,[9] and minor changes in wiring to enable them to be plugged into our shock-mounted rack for power and modulation. The units used are the 2.1 to 3.0 mc Navy Model CBY-52232, and the 3.0 to 4.0 mc Signal Corps BC-696-A. The conversion of these two units is identical except for changing the frequency of the v.f.o. in the Navy model. Figure 8 shows the original circuit diagram of these units before conversion and Figure 9 shows the circuit after conversion. Note that the relay under the chassis which originally broke the plus B for the oscillator and shorted the cathode of the 1625's has been removed. The plus B to the oscillator now runs directly to Pin #3 on the socket at the rear of the chassis, and the cathodes, and one side of the heaters of the 807's are now grounded. The antenna shorting relay on the inside of the front panel is removed and replaced by a s.p.d.t. 6 volt relay mounted on the outside of the front panel due to lack of space inside. This relay may be omitted if separate antennas are provided for the transmitter and receiver. The old grid leak of the final, mounted on spare pins #5 and #7 of the crystal socket, is simply clipped out of the circuit. A new 5000 ohm grid leak is put in the lead from Pin #5 on the crystal socket to Pin #2 on the power socket at the rear where it picks up minus 45 volts of battery bias. This is necessary to prevent the old resistor from shorting the bias battery.

The magic eye tube may be replaced with a 6E5, a six volt type, by changing the socket, or may be discarded along with the crystal. In either event the only circuit changes necessary are the rewiring of the heaters of the two tubes on the rear of the chassis in parallel instead of in series, and the removal of the resistor that parallels the magic eye tube heater.

9 "Mobile with the SCR-274N." George M. Brown, W2CVV.

In the event that you use a BC-696-A, it is of course all calibrated for the 3.5—4 mc range. However, you can use the BC-457-A, which covers 4—5.3 mc, just as easily by cranking in on the two air padding condensers, one on the v.f.o. and the other on the final. (This is exactly what is now done on the Navy Model CBY-52232 to lower its frequency from 2.1—3 mc to 1.7 to 2.1 mc.) To do this, it is necessary to remove the cover from the v.f.o. and loosen the set screws on the shaft of the padding condenser. A 3/8" diameter hole is now drilled in the shield can so that the shaft of this condenser can be tuned with a screw driver after the can has been replaced. After the oscillator has been trimmed to cover the desired frequency range, the can is again removed and the set screws on the condenser shaft are tightened. Now replace the can and you are all set to re-calibrate the dial in the same fashion as outlined for the other units. Figure 10 shows my 160 meter calibration; yours should be similar.

Tuning Up on 160 and 80 meters

The voltage on the oscillators in the two low frequency units will run higher than in the 10 and 6 meter conversions, since there are no frequency multipliers pulling current through the voltage divider in the modulator unit. An auxiliary voltage divider may be built into each of these units if necessary, so that the correct voltage, +250, will be obtained. In tuning up these two low frequency units it is first necessary to couple a lamp load to the 807 tank coil and then switch the modulator to "filaments on all the time" position. Start the dynamotor and with a screw driver, "zero dip" the final padding condenser through the hole in the side of the chassis. This is the middle condenser under the chassis, and must have its set screws loosened first. After bringing the final to resonance, the set screws are tightened again, after which the final should track pretty well with the ganged-tuned v.f.o.

Antennas

It has been the author's experience that the 3-4 mc BC 696-A transmitters will feed voltage to a short antenna of from 10 to 30 feet in length, providing a 50 $\mu\mu$f condenser is connected from the antenna binding post to ground. They will also end feed an antenna approximately ½ wave long, between 100 and 150 feet. For other lengths it will be necessary to use a series condenser or a loading coil to shorten or lengthen the antenna electrically. With a little experimenting these units will feed a base loaded whip; however, the exact antenna will be left up to the reader. Probably the greatest C.D. use to which these low frequency units would be put would require the operator to drive to some favorable spot, park his car, string up a long wire to a tree and get a message through to some other city.

C. W.

If conditions require the use of c.w., this may be accomplished in a simple manner by inserting a key in the cathode jack of the 807's. This does

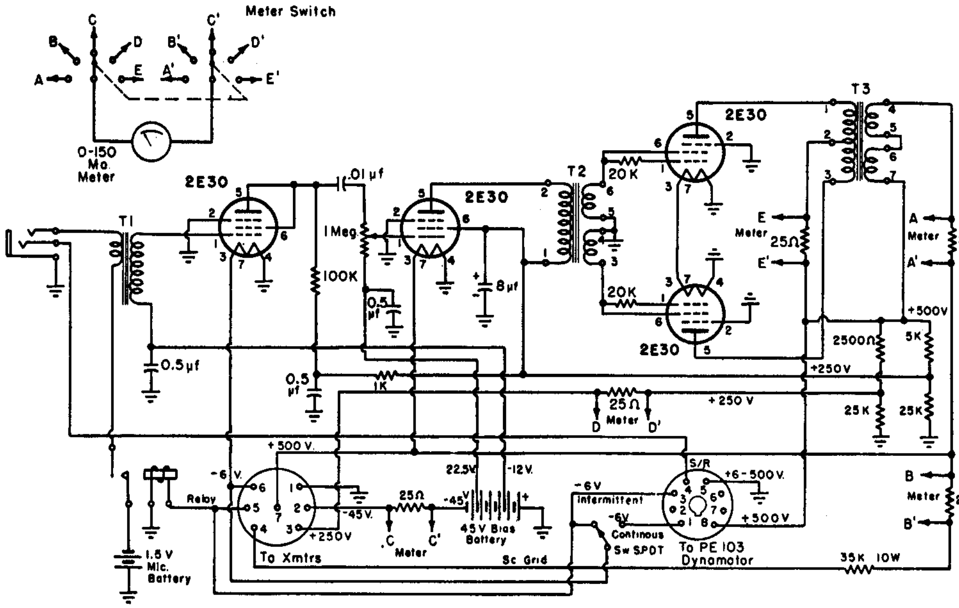


Fig. 11. The speech amplifier and class B modulator.

not permit break-in operation; if much c.w. operation is anticipated, the reader is referred to one of the many articles dealing with improved break-in keying of these units.[10]

Plate Modulator

A good many hams will prefer to build a conventional push-pull Class B plate modulator on general principles, while others may wish to avoid some of the fussy adjustments necessary for the correct operation of screen grid modulation.

For the benefit of these who have some spare milliamperes left in their dynamotors and who would like to use regular plate modulation, the circuit shown in Figure 11 may be plugged into the rack interchangeably with the clamp tube modulator described in Part I. By so doing, you will gain: about half an "S" unit of signal strength, slightly higher percentage of modulation, oftentimes of better quality (no clipping), and greater ease of adjustment. Total cost: upwards of 100 ma more plate current drain at 500V, which equals 50 watts or more out of your storage battery while transmitting. At 6V this is another 10 amps.

Modulator Circuit

Referring to Figure 11, it will be seen that two 2E30's are used to drive another pair as modulators. The transformers shown in the photos are war surplus from the ART-13, which were used by the Signal Corps for 811's in Class B to modulate a single 813. They obviously will handle ten times the audio necessary in this case. However, they are cheaper and smaller than the usual 25 watt multimatch transformers which may be substituted of course. The r.f. load will be around 5000 to 6000 ohms, 500 volts at 80 to 100ma. This particular surplus modulation transformer has a primary to secondary impedance ratio of about 2 to 1 and, therefore, our r.f. load will reflect an impedance of ten to twelve thousand ohms in the primary. A pair of 2E30's in Class AB_2 requires 3800 ohm plate to plate load resistance, so we would have a pretty bad mismatch. We can correct this somewhat by putting both the r.f. plate and screen

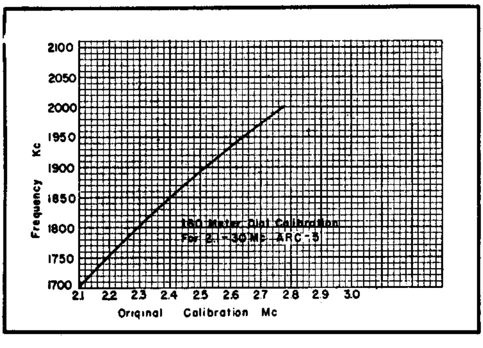


Figure 10.

secondaries in series, assuming that an 813 screen winding will carry the 80 to 100ma without burning out. If the two windings are connected so as to add, we will get a 1.44 to 1 or a reflected impedance of between 8000 and 9000 ohms.

By using the 2E30's as triodes in Class B, we will save on the plate current drain from the dynamotor. One way is to tie the screens to the control grids so that zero bias may be used. A simple improvement on this method, which permits driving the screens to a higher potential than the control grids, uses dropping resistors in series with the control grids.[11 12] For instant-heating filament tubes it is necessary to use transformer coupling. This requires a transformer, with a secondary that can handle the screen current of the modulator. In our case the surplus transformer used to drive the above mentioned 811's in Class B worked out satisfactorily. To get the required power to drive the modulator by this means, it was necessary to use two 2E30's from a single button mike, one triode and one pentode.

Additional information on suitable modulators can be found in the ARRL Handbook.

Construction

The chassis upon which the modulator was built was salvaged from a beat-up BC 457-A. All the parts were removed and a new front panel was bolted on over the old one. The four 2E30's were mounted on a small sub-chassis as shown in the photograph, with the driver transformer in the middle. The modulation transformer and relay are mounted on the rear of the chassis with the bias batteries along the right hand edge. Smaller batteries such as the hearing aid type may be used if available. All the voltage dividers, decoupling resistors, by-pass condensers and mike transformer are mounted at convenient spots under the chassis. The dynamotor plug and the filament switch are mounted on the left hand side, as in the clamp tube modulator previously described.[8] The meter switch, gain control and mike jack are on the front panel, together with the meter.

Tuning Up

The first thing to do in checking the modulator unit is to set the sliders on the variable resistors in the two voltage dividers so that around 250V is available under load. One of these dividers is for the exciter and the other feeds the modulator and speech amplifier.

The unit must of course be plugged into the dual transmitter rack with either the ten or six meter transmitter, while this adjustment is made. Once this has been done, the modulation of the transmitter can be tried out. If an oscilloscope is available, it should be hooked up to observe the modulation envelope and the gain control setting determined for 100% modulation. Be sure the antenna loading is the same as you will use in the car.

---

11 RCA "Ham Tips," Vol. VII, No. 2, May-June 1947.
12 "A High-Power Modulator for Mobile Operation," George M. Brown, W2CVV.

Substitute for the ARC-5 Plug

I have noticed that around Los Angeles it is pretty difficult to locate surplus plugs for the ARC-5. However, the PL-153 plugs are quite common, and, with a slight modification, they may be used.

Take a PL-153 plug and draw a line through the center of pins *1* and *7*, and then through pins *3* and *11*. At the intersection of these two lines drill a #33 hole. This plug will now fit on the ARC-5 modulator and control box in place of rare ARC-9585 plugs. Every function will be available except the #1 channel selector. This makes it suitable for use on all models except the T-23, which must be on the #1 channel. It is necessary to paint an aligning mark on the plug and receptacle, as there is no longer a self-indexing feature in the pin arrangement, although possibly by plugging the number one socket with a length of wooden match it can be restored.

John B. Riley

25. "Lazy Man's Q5-er, The," Technical Topics, QST, January, 1948, p. 40.
26. "ARC-5 Transmitter Modifications," T. A. Previtt, W9UKT; John McIntosh, W8ZGO; B. Goodman, W1DX; F. W. Wright, Jr., W2UWK; J. R. Abbott, W6ZOL; Don Imhoff, W8YFS, QST, June, 1948, p. 6.
27. "Triple Conversion for the Communications Receiver," William I. Orr, W6SAI, QST, September, 1948, p. 53.
28. "Adapting the 274N Series Transmitters for 14 Mc," William I. Orr, W6SAI, QST, September, 1948, p. 31.
29. "Crystal-Controlled Plug-In Converter for the Q5-er," John L. Steward, W6UJD, QST, October, 1949, p. 31.
30. "Plug-In Exciters From Surplus Transmitters," T. Glade Wilcox, W9UHF; Charles Hoffman, W9ZHL. QST, January, 1950, p. 54.
31. "Keying the BC-696," Holland M. Carter, W4ADE, QST, July 1951, p. 41.
32. "Novice Conversion of a Command Transmitter," R. M. Smith, W1FTX, and W. E. Bradley, W1FWH, QST, November, 1951, p. 41.
33. "Command Set Receiver for 6 and 10," Charles L. Faulkner, W6FPV, QST, September, 1953, p. 22.
34. "Conversion Notes on the BC-696A," John T. Frye, W9EGV, Radio News, March, 1948, p. 57.
35. "Conversion of SCR-274N Receivers," C. W. Roeschke, W5MLX, Radio News, June, 1948, p. 49.
36. "Modernizing The SCR-274N Transmitter," Carl V. Hays, W6RTP, Radio and Television News, January, 1953, p. 50.
37. "VFO From Surplus," George F. Marts, WØTDH, Radio Electronics, January, 1949, p. 38.
38. Radio Amateurs' Mobile Handbook, by William I. Orr, W6SAI, p. 166.
39. Surplus Radio Conversion Manual, Vol. 1, by R. C. Evenson and R. O. Beach.
44. "Is Your Rig R-f Tight," W2UHH, QST, August, 1953, p. 29.

Command Set Special

GOOD

F. A. BARTLETT, W6OWP/6*

Another compact portable or auxiliary station based on the popular SCR-274N. Built-in electronic keying is only one of the novel features incorporated.

HAVE YOU EVER noticed the maze of interconnecting wires, key leads, "outboard meters" and other paraphernalia which so often characterizes portable operation? And balancing a bug on the edge of an orange crate doesn't make for the smoothest sending on the air, either.

The writer must confess to his share of just such installations. But recently when the need arose for an auxiliary layout at W6OWP, it was decided that the new rig would be different. It would be easy to put on the air. And a few of the operating comforts of the home rig would be incorporated. Then, to add the final touch, the transmitted signal must conform to fixed station standards—no excusing a chirpy signal on the basis of "operating portable hr, OM."

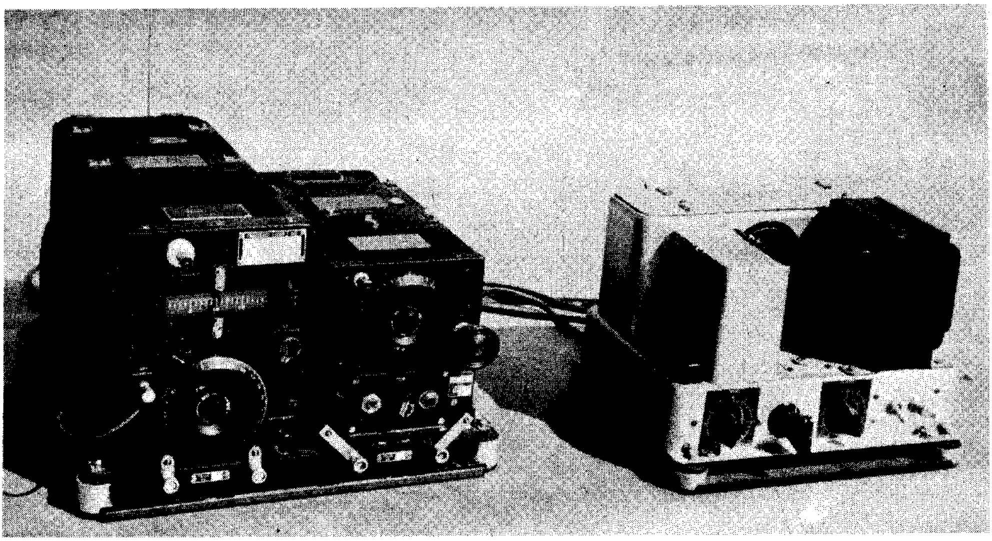
An SCR-274N—the familiar Command Set—was chosen as the basic equipment, both from the standpoint of utility and availability at reasonable cost. Either 40-or 80-meter units may be used, depending on range within which it is desired to operate. At this writing, all SCR-274N components used in the author's set are still advertised by surplus dealers. Here are the items used and SCR designations:

- Transmitter, BC-459 or BC-457 (latter retuned to 3.5-mc band)
- Receiver, BC-455 or BC-454
- Modulator Unit BC-456 (chassis only used)
- Dual Transmitter Rack FT-226
- Transmitter rack shock mounts FT-227
- Modulator unit shock mounts FT-225
- Triple-Receiver rack FT-220 (Used for parts only)
- Antenna Relay unit BC-442 (Meter only used)
- Receiver Dynamotor DM-32

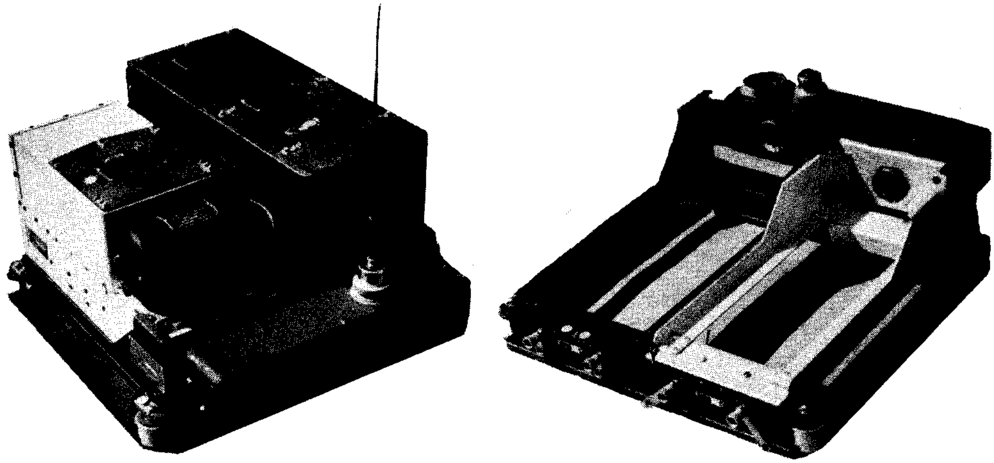
Two major units comprise the station proper: (1) the transmitter and receiver, mounted together in rack FT-226 and, (2) the power supply, keyer and controls, built as one unit on the BC-456 modulator chassis. Shock mounts listed above are used for the respective units. Inter-unit wiring is by means of cable and plugs.

To provide receiver accomodation in the dual transmitter rack, a section from the receiver rack is cut and fitted into the right-hand compartment.

*2210 Cipriani, Belmont, Calif.



Overall view of the complete station. Note the built-in electronic key and many SCR-274N components.



Left: Rear view showing receiver power unit built into DM-32 dynamotor case. The receiving antenna is plugged into a banana jack mounted in one of the two original connectors on rear deck of the rack. Receiver gain-dropping relay for transmitting is mounted inside the rear compartment. Right: Dual transmitter rack with receiver rack installed in right hand compartment. The author converted both 80- and 40- meter Command units. Desired frequency range is covered by plugging in proper transmitter and receiver.

This is chiefly a hack-saw job and step-by-step details will not be given. The photograph shows the final result. The male power plug in the right rear section of the transmitter rack is removed, thus providing an opening for connections to the receiver.

The BC-456 modulator is stripped of all major components, a procedure not nearly as wasteful as it might appear. The present low cost of these units can be written off on the basis of the tubes and chassis alone. The power supply/keyer as seen in the photograph is *not* a converted BC-456. The chassis is all the present and former units have in common.

Transmitter Electrical Conversion

Basically, the Command transmitter consists of a Hartley oscillator inductively coupled to a neutralized parallel beam tube power amplifier. Because of the lack of an isolation stage, keying and antenna loading must be arranged to minimize reaction on the oscillator if a satisfactory signal is to be had.

Oscillator keying is the logical choice in view of the original circuitry since there can be no isolation of a keyed stage from the oscillator without drastic circuit changes. Furthermore the most click-free form of triode oscillator keying is blocked-grid.

To provide power supply load voltage stabilization, the final stage is self-biased to draw 100 ma key-up plate current, nominal loaded current being this same value. However, a swing of 30% can be tolerated without serious signal deterioration with average power supplies.

The combination of these two relatively simple modifications results in an exceptionally clean c.w. signal. Power input (loaded) runs between 50 and 75 watts. It must be conceded that this conversion will not run the power claimed for certain other arrangements. It was felt, however, that the added signal quality made up the difference—especially since a 60-watt high voltage supply is about all a small rig such as this would normally require.

Pertinent circuit data is contained in *Fig. 1.* The former relay control line connection is removed from terminal #5 on the transmitter power socket and this pin is used for the keying lead. Other pin connections are unchanged.

The oscillator grid leak is cut free on the coil side of the grid condenser, then connected through an r.f. choke to pin #5, as shown in *Fig. 1.* Blocking bias of around 100 volts negative is applied from an external source through a 250,000-ohm resistor. Grounding pin #5 keys the transmitter. No other pin connections are changed.

The cathode bias resistor for the 1625s and its associated bypass condenser are located adjacent to the screen grid bypass to the side of the oscillator tuning condenser. If a cathode bypass similar in type to the one used originally for the screen is available, the two may be mounted together by removing the existing mounting screws and replacing with ones of sufficient length to secure both capacitors.

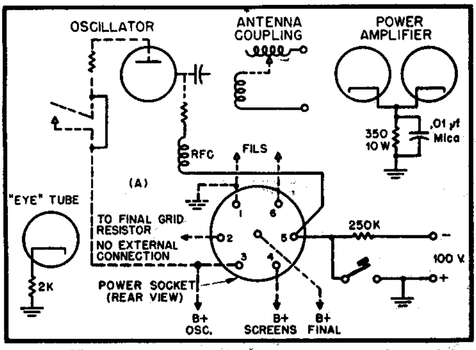


Fig. 1. The transmitter circuit changes, as shown here, can be made in a few moments.

Neither the under-chassis control relay nor the one in the antenna circuit is used. In the latter, the spring contact is soldered directly to the antenna post. In the former, the cathode connection is cut free, the wiring being changed to permanently ground the cathodes through the added 350-ohm self-biasing resistor. The former 51,000-ohm standby bias resistor is removed. The oscillator plate contacts on the control relay are short-circuited by wiring together the contact connections.

Normal operation of the electric-eye tube is achieved by removing the two resistors connected to the eye-tube cathode and replacing them with a single 2000-ohm 1-watt resistor to ground.

Except for wiring filaments in parallel, the only other transmitter change is removal of the chassis ground from the antenna coupling coil. The low side of this coil is connected to an insulated binding post installed in place of the antenna coupling lock. Since the transmitter chassis is common with the ground side of the a.c. line (the result of a receiver half-wave rectifier power supply), the antenna isolation becomes desirable.

Ordinarily, the short antenna used for portable work loads satisfactorily against the a.c. line as a "ground."

The manner of obtaining screen and oscillator plate voltages is important to the proper functioning of this conversion arrangement. A bleeder of from twenty to thirty thousand ohms should be used across the power supply. Oscillator plate voltage is obtained from a tap and should be adjusted to give 150 to 175 volts under load. Screen voltage should be obtained through a series resistor of approximately 15,000 ohms connected to B+. These points are mentioned for the benefit of the reader interested only in the transmitter conversion. The required circuit is incorporated in the power unit to be described in a later portion of this article.

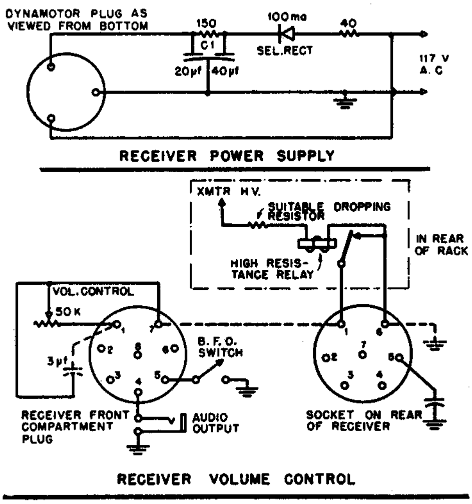
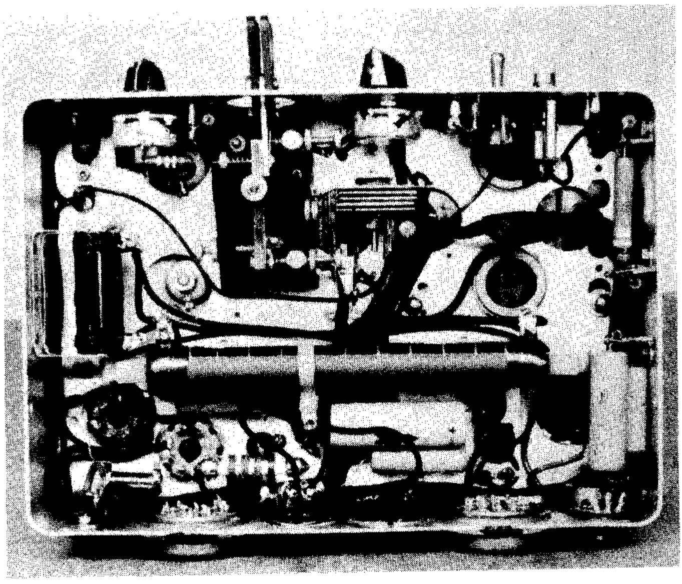


Fig. 2. The receiver power supply (top) fits into the dynamotor housing nicely, and the volume control circuit changes are simple.

Receiver Electrical Conversion

In principle, the receiver conversion follows the lines of previous suggestions carried in the pages of *CQ*. Filaments are wired in series and a 50L6 is substituted for the 12A6 output tube.

Instead of returning the volume control ground lead directly to ground, it is connected to *pin 7* in the front receiver compartment. This pin con-



Under-chassis view of power-supply/keyer unit. Note compactness without undue crowding of parts.

nects to *pin 1* on the rear power socket. The return then reaches ground through contacts of a relay in the rear deck of the rack. This relay operates whenever the transmitter high voltage is applied, opening the volume control ground return. This drops receiver gain to a comfortable level for monitoring the transmitted signal.

Effectiveness of this arrangement requires changing the ground connection of the 3-μf volume control line bypass condenser from chassis to volume control ground return line. This condenser is fastened to the inside front of the receiver adjacent to the control compartment. Since the case serves as its ground connection, it is necessary to mount the condenser on an insulated bracket. This can be made from a composition tie-point connector. The case is then re-connected to the volume control ground return as shown in *Fig. 2*.

The c.w. selectivity of both the BC-455 and BC-454 will be improved by connecting a .02-μf bypass condenser across the audio output. This is most easily done under the chassis and to the rear of the set. *Pin 5* is common with the audio output pin on the front receiver plug. No effort was made to increase bandspread.

Ease of tuning, however, will be enhanced if a wedge-fit knob is substituted for the wobbly, spline-type currently sold for command receivers. A simple five-cent plastic drawer pull can be altered to provide a very satisfactory control. The tapped hole in the base of the pull is first enlarged with a 7/32" drill. Then excess outside stock is trimmed off until the base fits freely into the dial collar. A little pressure will force the new knob onto the tuning shaft spline.

Power supply for the receiver is a half-wave selenium rectifier and filter housed in what was formerly receiver dynamotor DM-32. Once the field coils and armature are removed from the original power unit, there is ample space for mounting the 100 ma rectifier, a dual 40-20 μf 150-volt tubular filter and two resistors making up the assembly.

The a.c. connection is made by means of a line cord directly to this supply rather than through the receiver power socket. Since the supply is a.c.-d.c. a recommended hookup method is shown in the circuit diagram. In this way, the receiver may be used independently of the portable set-up by merely grounding the volume control line at the rear socket (*pin 1* to *pin 6*). The male plug removed from the right-hand section of the transmitter rack when installing the receiver compartment makes a handy shorting plug by merely soldering these two pins together.

Power Supply and Keyer

The over-all schematic for this unit is shown in *Fig. 3*. The mechanical and electrical layout can be seen from the photographs. Perhaps additional comment is needed on the power supply concerning the small filter employed. Stability of the converted BC-459 or BC-457 is so good that further filtering is not required for c.w. operation. Should a BC-458 (tuned to 7 mc) or an 80-meter BC-696 be used, a small input filter choke will be necessary. The lower "*C*" oscillators of these two transmitters result in excessive ripple with the capacity filter alone.

A 5T4 rectifier tube is used since it fits neatly inside the BC-456 shield.

The built-in electronic keyer uses the author's

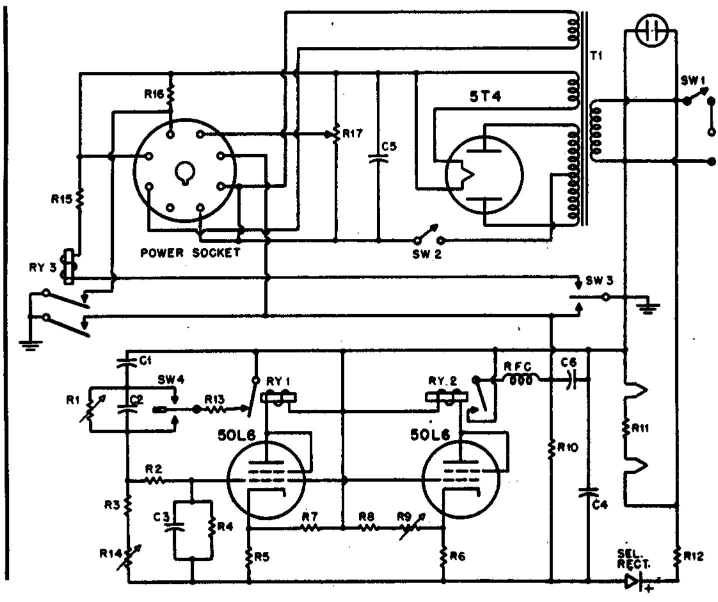


Fig. 3. Power supply-keyer.
C1—.1 μf, 600 w.v.
C2—.03 μf, 600 w.v.
C3—.05 μf, 600 w.v.
C4—40 μf, 150 v. filter.
C5—10 μf, 150 v. filter.
C6—.002 μf.
R1—.5 meg. variable.
R2, R3—.25 meg., 1/2 w.
R4—4 meg., 1/2 w.
R5, R6—2200 ohms, 1 w.
R7—10,000 ohms, 2 w.
R8—7000 ohms, 1 w.
R9—5000 ohms, variable.
R10—.25 meg., 1 w.
R11—150 ohms, 5 w.
R12—40 ohms, 1 w.
R13—500 ohms, 1/2 w.
R14—2 meg., variable.
R15—Refer to text.
R16—15,000 ohms, 25 w.
R17—25,000 ohms, 100 w.
T1—Power Transformer.
Ry1, Ry2—Pulse relay, 3500 ohms.
Ry3—Refer to text.
Sw1—A.C. switch.
Sw2—H.V. switch.
Sw3—Refer to text.
Sw4—Key lever.
RFC—2 1/2 mh. choke.

"self-completing" circuit—so called since a dot or dash once started completes itself automatically. This assures freedom from clipping and makes for easier, more uniform sending.

Electrically, the circuit consists of two stages. The first, or pulse stage, develops the basic timing voltage for the automatic dots or dashes. The second stage shapes the operating cycle of the keying relay to conform with correct telegraph mark-to-space characteristics.

Tubes used are 50L6s. These, together with their associated plate circuit relays, are housed in the BC-456 shield enclosure.

A half-wave selenium rectifier furnishes d.c. for the keyer and supplies the blocking bias for the transmitter oscillator keying. The polarity of the selenium stack should be strictly observed in connecting the circuit in the manner shown.

Speed and shaping controls are mounted on the chassis front to the left and right respectively of the key lever. The a.c. line switch is mounted on the speed control potentiometer. The shaping control adjusts keying from light to heavy to suit the operator's particular style. As a general rule, sending with an automatic key sounds better when adjusted on the "heavy" side since a natural tendency to exaggerate letter spacing is less noticeable.

Fixed adjustment, wiping contact relays of identical characteristics are a must for the keyer circuit shown. Either short or long telephone type 2000 to 4000-ohm relays are satisfactory.[1] High quality capacitors, preferably of the new plastic-moulded type, should be used at C_1, C_2, and C_3.

R_1 in the timing circuit sets dot-to-dash ratio. Adjustment should be made starting from minimum resistance to a value which gives correct ratio. Should difficulty with dot distortion be encountered, the rule to follow is: if first dots of a series are foreshortened, add capacity to C_1 and readjust R_1; if the opposite condition prevails, increase capacity of C_2 and readjust R_1. Note that this rule applies only when distortion is present at a setting of R_1 where the correct dot-dash ratio otherwise prevails.

Operating Controls

Transmitter high voltage off or on is controlled by a switch (SW_2) in the transformer center tap. This switch is next to the keyer shaping control. When thrown to the "on" position, a low-current relay (Ry_3) mounted in the rear deck of the transmitter/receiver rack is energized, removing the volume control ground return as described earlier. A second switch (SW_3)—a three-position one removed from the FT-220 receiver rack—is mounted adjacent to the high voltage control. In its "up" position, a second low-current relay (Ry_4) in the power unit is energized. Contacts are connected to short the oscillator key line and at the same time reduce final screen voltage to zero. This serves as a QRP position for QRM-less setting frequency. With the switch in center position, the transmitter is set for normal sending with the electronic keyer. In the "down" position, the key line is shorted for tune-up purposes.

The low-current relays referred to may be any of numerous listings by surplus houses. Coil resistance is usually five to ten thousand ohms and appropriate series resistors must, of course, be chosen.

The plate current meter was taken from antenna relay unit BC-442. This meter has a 10-ma scale. A length of resistance wire shunted across the terminals boosts the range to 100 ma. The exact shunt was found by cut-and-try.

Although available, the original SCR plugs are not used. Standard octal connectors have been substituted for utility. The two small SCR female plugs on the modulator chassis were removed. In one of these an octal socket was mounted and in the other a 117 v. socket for the receiver power cord was placed. Polarity of the latter is clearly marked to match the polarity of receiver line plug. This precaution is necessary because of the separate half-wave rectifiers working off the a.c. line. Using a common ground and only running a hot leg to the a.c. is a desirable safety precaution.

A second octal socket is mounted on the back plate of the transmitter/receiver rack and wired to the appropriate transmitter plug terminals as shown in the diagram. All wiring to the original sockets on the rack is removed. The plug for the smaller of these is fittted with a banana jack and rewired to provide the antenna connection for the receiver. The lead from the socket to the front of the receiver runs in the channel between the two compartments. A six-wire power cable was made up for interconnecting the two units.

For all normal portable operation, a 4-foot whip of #14 steel wire, fitted with a banana plug to mount in the jack, provided above serves as the receiving antenna. This has proved entirely adequate. And it has the advantage of evening up the ratio of transmitted power to received signal. In other words, if you hear 'em, you can work 'em.

For transmitting, a short antenna worked against ground was the system for which the Command transmitters were designed. In the writer's case, a 12-foot whip with a universal-type mounting bracket is used. The whip plus a nominal span of lead-in usually gives a length which can be satisfactorily loaded. Except where a direct external ground to the antenna coupling coil is needed for loading, a wire connects the low side of this coil to chassis, which should be well grounded, and the antenna is tuned up.

Where the total length of antenna, lead-in and ground connection exceeds thirty feet, a 50-$\mu\mu$f series variable condenser is required in the antenna circuit.

The writer has operated the rig described from a score of QTHs in a half dozen western states. The dozens of enjoyable QSOs attest to its good performance. It beats anything of a comparable nature used in 19 years of hamming.

---

1 Both the key lever assembly and keyer relays can be obtained in limited quantity from Electronic Signal Devices, Box 283, San Carlos, Calif.

POWER HOUSE *Portable*

Fig. 1. The complete station. From left to right the units are: transmitter, a-c power supply, and receiver. The hand key is mounted underneath the receiver.

CLYDE C. LARY, W6GCS*

A completely self-contained station made from surplus SCR-274N units.

This article does not deal with the conversion of the individual transmitters and receivers of the SCR-274N, but rather is a suggested method of incorporating the converted units into an efficient portable station.

Fig. 1 shows the portable station ready for operation simply by plugging in the a-c line cord and connecting up an antenna. To the left is the transmitter, in the center is the power supply built into an old transmitter cabinet, and to the right is the receiver covering the corresponding frequencies of the transmitter. The baseboard is a solid piece of white pine, one inch thick, twelve inches wide and fifteen and one-half inches long. Under each corner is a rubber foot. The chrome metal trim on the front of the baseboard serves not only to beautify, but as a common ground for all three units.

The receiver is raised to match the height of the other units by building a small shelf from two pieces of white pine, ¾ × 1-5/8 × 12 inches. A small metal panel is fitted to the front underneath the receiver and in this space is placed the hand key with the knob extending about one and one-half inches out from the panel. The tail room in this shelf can be used to hold a key-click filter which is generally necessary for the SCR-274N.

The antenna changeover switch is mounted on the upper left-hand corner of the transmitter. This switch is a simple SPDT knife switch obtainable in most dime stores. A No. 12 wire runs across the face of the units from the switch to the receiver antenna post.

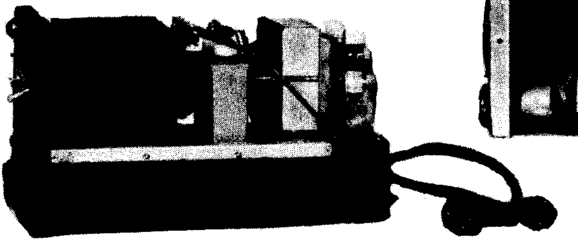
* *400 Sierra Drive, Visalia, Calif.*

The Power Supply

A fly-cutter hole has been cut in the lower center of the front panel to take the 2¼ inch, 0–200 d-c milliammeter. Inside the power supply cabinet the meter is just under and clear of the deck of the chassis. This meter is connected in series with the high-voltage lead to the plates of the final amplifier tubes.

At the lower left of the panel is a key lock switch of the ordinary auto ignition type. It prevents anyone, other than the holder of the key, from putting the station on the air accidentally or intentionally. Turning this switch on connects in the a-c line to the primaries of the three heater transformers. The a.c. is applied to the primary of the plate transformer through a switch on the upper right side of the front panel. Since there is no room for a time delay relay within the power supply cabinet this switch has been arranged to prevent the application of the high voltage to the rectifier tubes before they are properly heated. The movable lock must be swung to the right side before this switch can be actuated.

At the right of the milliammeter is a DPDT rotary switch which throws the high voltages either to the transmitter or the receiver. Some care must be exercised here to select a switch with adequate insulation or substitute a relay.



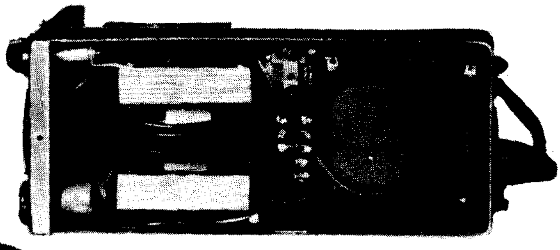


Fig. 2. and Fig. 3. The power supply is built into an extra transmitter can to match the other units in the portable self-contained station.

Fig. 2 and *Fig. 3* show the side and bottom of the power supply. On the top of the deck near the front panel is the plate transformer. Next is the 3-μf oil-filled condenser and then the choke, and finally the two 816 mercury vapor rectifiers. These tubes are mounted in the holes that were once occupied by the oscillator and magic eye tubes. The center hole (where the calibrating crystal was located) is left open for ventilation.

On the underside of the chassis is mounted the two 24-volt heater transformers and 2½-volt 10-ampere filament transformer for the rectifier tubes. On each side of this transformer are the two 50-watt resistors, mounted to the back of the chassis through 2½-inch carriage bolts. The 117 v. a-c line enters through a female socket on the back skirt of the chassis; beside it is the a-c fuse.

The heater and high-voltage leads are cabled out through rubber grommeted holes on each side of the a-c plug. Tube base connectors are used and the leads are sufficiently long to reach the sockets on the backs of the transmitter and receiver.

Operation

Practically no difficulties should be encountered either in setting up these units or getting them on the air. For loudspeaker reception we have cut a hole in the rear of the receiver can and a two-inch speaker is mounted over it. A small output transformer is mounted at the side of the speaker. When in operation the front middle slide on the lid of the receiver is opened for sound release.

With the power supply shown in *Fig. 4* the measured voltages were as follows:

Final plate.........	650 volts
Final screen........	275 volts
Oscillator plate......	235 volts
Receiver...........	260 volts

With the transmitter in operation the milliammeter should read about 180 ma.

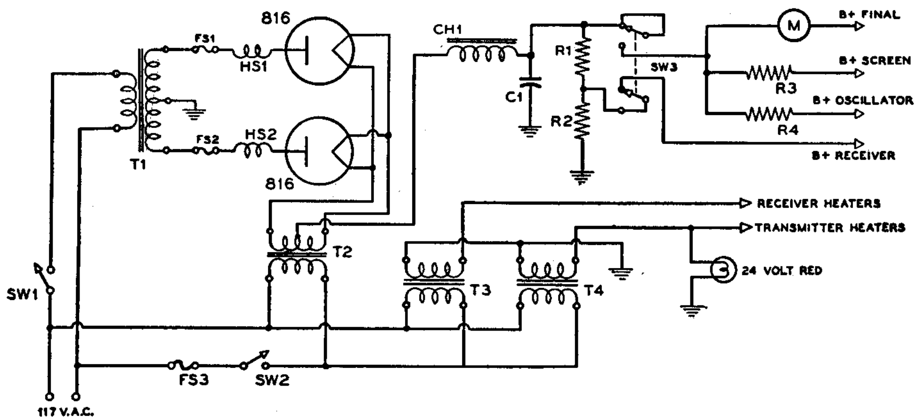


Fig. 4. Wiring diagram of the power supply.

C1—3.0 μf, 2000-volt oil filled.
R1—6000 ohms, 50 watts.
R2—50,000 ohms, 50 watts.
R3—18,500 ohms, 25 watts.
R4—20,000 ohms, 25 watts.
T1—Power transformer 1500 volts c.t. (Stancor 3535).
T2—Filament transformer 2½ volts, 10 amps c.t. (U.T.C. 53S).
T3, T4—Filament transformers, 24 volts.
HS1, HS2—Hash suppressor (Millen).
FS1, FS2—Fuse, 500 ma (Littlefuse).
FS3—Fuse, 6 amps.
CH1—Filter choke, 20 henry, 250 ma (INCA D-4).
SW1—Effort switch (see text).
SW2—Key lock auto ignition switch.
SW3—DPDT switch h.v. insulation.
M—milliammeter, 0-200 (Triplett).

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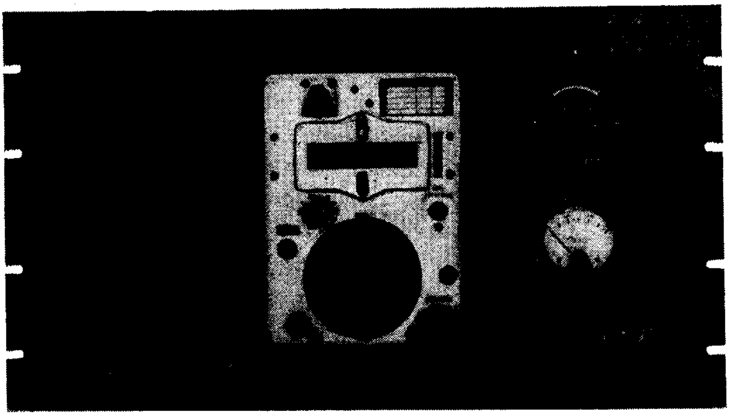


Fig. 1. An attractive appearance is easy to attain with 274-N transmitters.

SCR-274N Transmitter Modifications

JAMES N. WHITAKER, W2BFB*

Some helpful suggestions and words of warning to those planning to use these excellent units for amateur transmitter and VFO applications. Particular emphasis is placed on good keying.

The SCR-274N command sets have unquestionably been the most popular of all war surplus equipments for conversion to amateur use. The transmitters are by far the most useful of all units included. They not only are used as transmitters directly, but are also very popular as exciters and variable frequency oscillators for larger transmitters.

As is the case in most war surplus items, the amateur use of these excellent little transmitters requires a certain amount of modification. Articles too numerous to mention have been written describing various ways of modifying the units for amateur service, each modification having its own particular advantages and disadvantages. With such a well-designed piece of equipment to start with, it is reasonable to expect that the most satisfactory modification would be the one that disturbed the original circuitry the least. Actually, very little is required in the way of modifications to the sets which cover the amateur bands as is. For instance, the BC-696-A and the BC-459-A cover the 3.4–4 mc band and the 7-mc band respectively. The only absolutely necessary modification to these two units is the provision of a suitable output connection and a means for operating the keying relay. It is also generally desirable to parallel the heaters for 12-volt operation.

*93 *Shepard Ave., West Englewood, N. J.*

If the unit is to be used as a VFO for driving a string of multipliers for operation in the higher amateur bands, it is wise to provide for operating the oscillator heater from rectified and fairly well filtered power. This is to prevent the slight amount of frequency modulation at a 60-cycle rate which is present in some instances when raw a.c. is used for the oscillator tube heater power. This frequency modulation is not sufficient to be noticeable on the fundamental or even at twice the oscillator frequency. It is also not present in all sets. It is present in some, however, and in some instance, is very noticeable on 28 mc.

The power requirement for the oscillator tube is rather low, and a 250 ma selenium rectifier followed by about 250 µf of capacity (dry electrolytic) is all that is required. Listen to the 28-mc harmonic of the transmitter with a good receiver. If no a.c. hum is noted, it is safe to say that your particular unit is free from serious 60-cycle frequency modulation.

The original schematic diagram is shown in *Fig. 2*. The modification preferred by the author appears in the modified schematic diagram, *Fig. 4,* which includes the changes required to produce satisfactory keying to be described.

Numerous ways have been suggested for changing the frequency of the BC-457-A (4–5.3 mc) and the BC-458-A (5.3–7 mc) to the amateur frequencies.

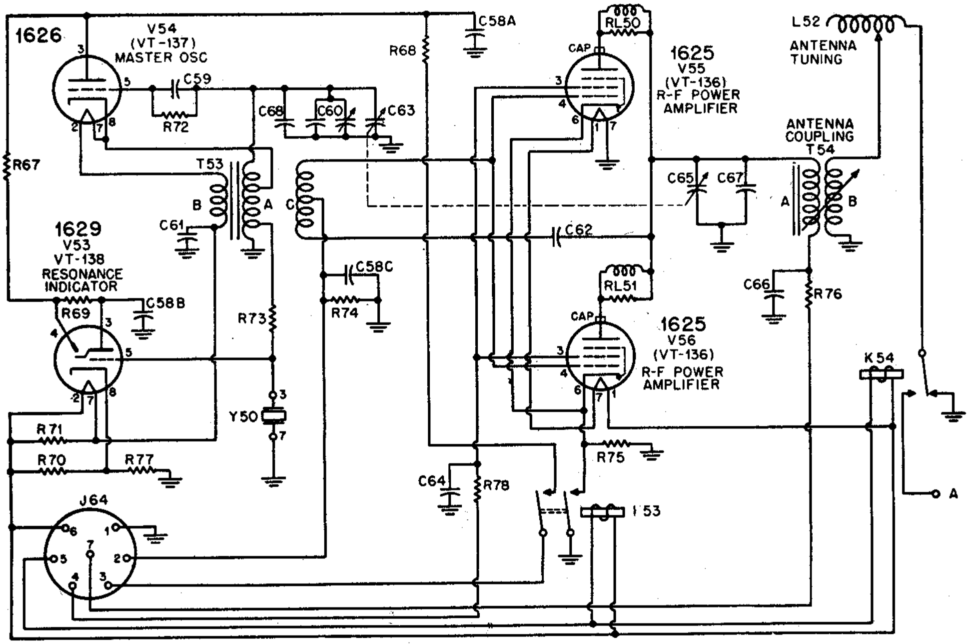


Fig. 2. The original circuit of the 274-N series transmitters.

Most of the suggested systems involve modifications to the inductances of the oscillator and P. A. tank circuits. The BC-457-A may be changed to cover the 3.5 mc amateur band by the simple addition of a good quality capacitor of between 25 μμf and 50 μμf capacity in parallel with the oscillator tuning capacitor, and by a readjustment of the variable padders in both the oscillator and P. A. plate tank circuits. The BC-458-A may be adjusted to cover the 7-mc band by simply adjusting the oscillator and P. A. padder capacitors.

To adjust the BC-457-A to frequency after adding the capacitor to the oscillator circuit, insert a 4-mc crystal in the crystal socket. (An FT-243 type crystal is excellent for this purpose, and is inserted in the socket using pins 3 and 7.) Next, remove the cover from the oscillator coil and capacitor assembly, using care not to disturb the iron core setting (screwdriver slotted screw on top, sealed with blue glyptal). Cut a screwdriver opening in the end of the shield opposite the variable capacitor shaft. Loosen the setscrews which lock the capacitor shaft, and replace the shield cover over the oscillator tuning assembly. Turn on the transmitter, and with the tuning eye in place, adjust the main tuning dial to 5.2. Adjust the oscillator padder until the eye indicates resonance with the crystal. The oscillator is now operating at 4 mc. Remove the oscillator tuning assembly cover, tighten the capacitor shaft lock setscrews, and replace the cover.

Tune the fixed padder of the P. A. stage for resonance as indicated by a minimum of P. A. plate current. If the iron cores in the tuning coils have not been disturbed, or if the coils have not been modified, the tuning will track over the entire range, and the new range will be 3.4 to 4.1 mc. The dial may be

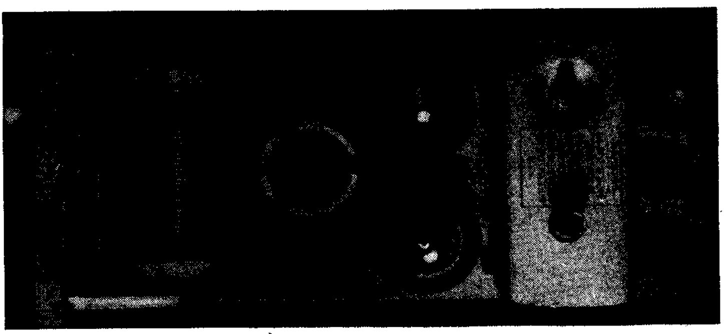


Fig. 3, illustrating the location of the mounting holes for the time constant capacitor C69.

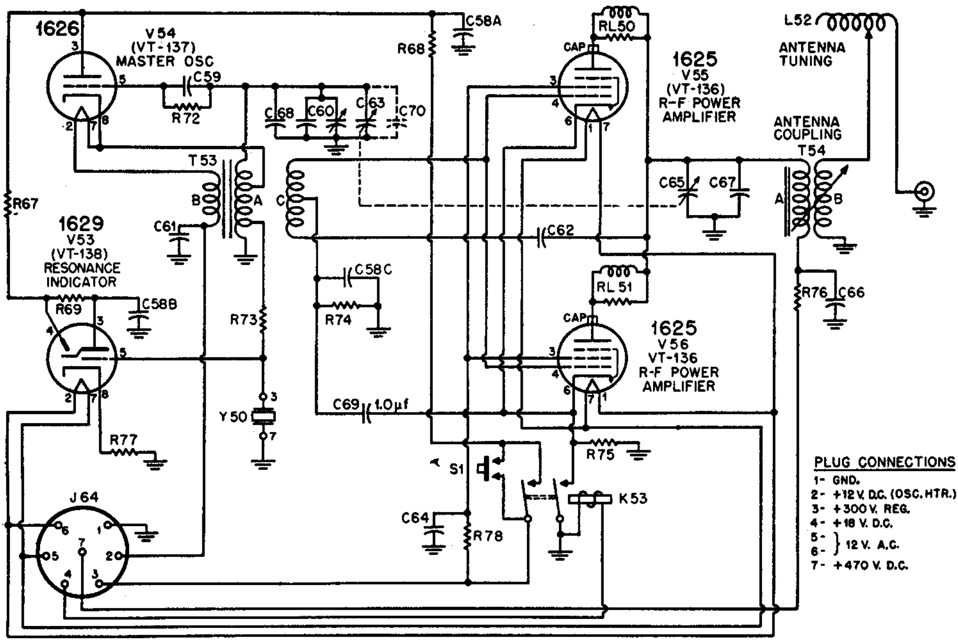


Fig. 4. The circuit of the modified transmitter. K53 is used as the keying relay.

C58A, B, C—.05 μf	C64—.002 μf	C70—25 to 50 μμf (BC-457A only)	R73—10K
C59—.00018 μf	C65—Amp. tuning	RL50, RL51—42 ohms	R74—15K
C60—Osc padder	C66—.01 μf	R67, R72, R75—51K	R77—390 ohms
C61—.006 μf	C67—Amp. padder	R68, R76—20 ohms	R78—51 ohms
C62—Fixed neut. cond.	C68—3μμf	R69—1 meg.	S1—Push button osc. test switch
C63—Osc. tuning	C69—See text		

covered with paper and a new scale inscribed thereon, or the dial may be removed and turned down on a lathe, repainted, new calibration lines painted on, and new numerals added. (A handy numeral set is included in most popular panel marking decal sets.) The same general procedure is used when tuning up the BC-458-A for operation in the 7-mc band, except that a 7.5-mc crystal is used.

If the adjustment of the iron core has been disturbed, the transmitter may be completely realigned by first adjusting the oscillator section for the desired frequency coverage by tuning the padder capacitor at the high frequency end of the tuning range, and by adjusting the iron core at the low frequency end of the tuning range. It may be necessary to repeat this several times to obtain the desired frequency spread or to obtain coincidence between the frequency and the calibration of the dial.

Having adjusted the oscillator, the P. A. tank tuning may be made to track with the oscillator by using a similar procedure. Adjust the capacitance trimmer at the high frequency end of the tuning range, and adjust the inductance trimmer at the low frequency end of the tuning range, repeating the two adjustments until perfect tracking is obtained. This is the same procedure as is used in adjusting the gang-tuned stages of a receiver.

If the SCR-274-N transmitter is to be used as a complete transmitter, or if it is to be used as a keyed VFO, it will be necessary to clean up the keying. Many systems suggested in the past include radical modifications, with the installation of vacuum tube keyers in some instances. Let us bear in mind that whenever we make changes in one of these units, we are modifying a piece of precision apparatus and should disturb it as little as possible.

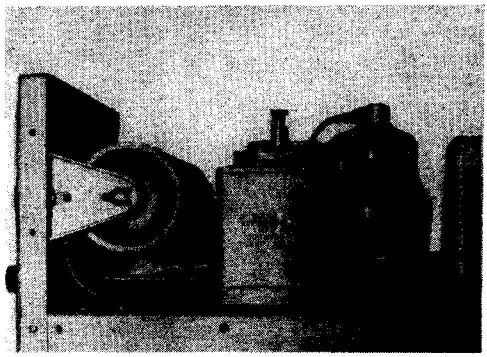


Fig. 5. Side view of the transmitter showing capacitor C69.

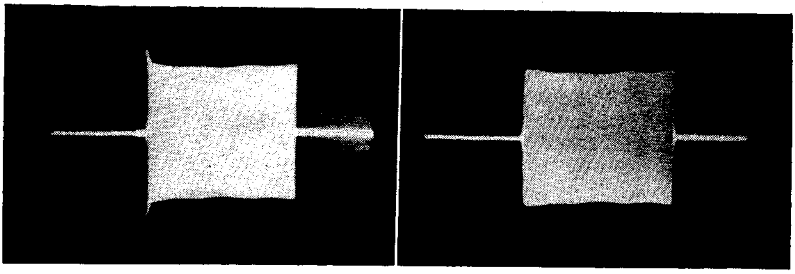


Fig. 6, L., the keying oscillogram before modification, and Fig. 7, showing the improvement attained.

Therefore, why not use the keying system included, after cleaning it up so that it is free from clicks, thumps, and chirps?

We have 12.6 volts available from the tube heater supply. From this we can get approximately 17.5 volts of d.c. for operating the keying relay by the simple addition of a low voltage senenium rectifier and a high capacity electrolytic capacitor. The keying relay will follow keying up to more than 40 words per minute with the power thus supplied if the relay armature and contacts are carefully adjusted.

The keying relay is quite noisy as it is. If this noise is objectionable, a short piece of small rubber tubing, soft plastic tubing, or "spaghetti" tubing may be placed over the armature arm stop. If this is done, the armature arm will require re-adjustment so that the relay contacts will open when the relay coil is de-energized. The contacts should be adjusted until the P. A. cathode circuit is closed just slightly before the relay armature comes to rest on the pole face of the relay coil. The contacts closing the circuit to the oscillator plate supply should be adjusted to close before the P. A. cathode circuit is closed. This is important if the operation is to be free from a keying "chirp." If the oscillator plate circuit is closed slightly ahead of the closing of the P. A. cathode circuit, the oscillator frequency will be stable before the power is actually applied to the P. A., and the "chirp" will not be present in the transmitter output.

The keying waveform before modification is shown in *Fig. 6.* Note the sharp spike just ahead of the main keying pulse, and the high amplitude of the start of the pulse. The sharp spike is caused by relay chatter, and the high amplitude at the start of the pulse is due to power supply regulation. Both of these faults are corrected very nicely by the addition of the time constant in the keying system, as is indicated in the oscillogram shown in *Fig. 7.*

The time constant which has been added to the keying circuit is a bit unusual in its operation. While the relay is open, the potential appearing in the cathode to ground circuit of the P.A. tubes will charge capacitor C_{60} through resistor R_{74}. When the relay closes, the terminal of C_{60}, which connects to the P.A. tube cathodes, is connected to ground. C_{60} then discharges through R_{74}, placing a negative potential upon the grids of the P.A. tubes, momentarily holding them at cutoff. As the charge is reduced in C_{60}, the potential across R_{74} is reduced, and the P.A. tubes start operating normally, until the full output is reached. This delaying action is just sufficient to produce a starting slope of approximately 2 milliseconds duration in the keying pulse, resulting in the desirable keying pulse shape shown in *Fig. 7.*

Figure 5 shows the location of C_{60}. This capacitor is a Solar No. XEMRBW6-1. This same type of capacitor is produced by several other manufacturers. (The JAN type designation is CP68B1EF105WK. These units are generally available in the surplus market at less than one dollar.) The mounting of this capacitor is rather simple. It involves the drilling of two one-half inch diameter holes and one small screw hole. One existing screw hole is used. This existing hole is used to fasten a wire clamp on the underneath side of the chassis. This wire connects to the antenna shorting relay. The antenna shorting relay is removed, and the wire is therefore no longer needed. The wire clamp bracket and the wire are both removed. The screw which originally held the clamp in place is now used to fasten one end of the capacitor bracket. The two ½-inch holes and the small screw hole are drilled in line with the wire clamp screw hole and spaced as shown in *Fig.* 3.

One very convenient arrangement when using a SCR-274N transmitter as a complete transmitter for phone-cw, work in the 3.5–4 mc band is shown in *Fig. 1.* The assembly pictured consists of a BC-457-A modified, as shown in *Fig.* 4, together with power supply and modulator units, all mounted on a standard 19-inch relay rack type of panel. The schematic diagram of the power supply, modulator, and the incidental connections between units and to the pilot light, switches, etc., is shown in *Fig.* 9. This arrangement includes a power switch and fuse, a pilot light, a plate current meter, an r.f. output ammeter, and a "phone"-"push-to-talk phone"-"c.w." selector switch. When operating "push-to-talk" phone, the push-to-talk switch connection is plugged into the telegraph keying jack.

An additional filter section is added to the P.A. plate power supply system when the unit is operating as a phone transmitter. This provides ample filtering to produce a hum-free signal for phone work. Type 1625 tubes are used in the modulator, since they are also used in the transmitter. Type 807 tubes could be used with identical results. Either type will provide sufficient power for producing 100% modulation of the power amplifier.

The panel used for mounting the entire system is made from 3/16-inch thick 24ST aluminum, 19 inches wide and 10½ inches high. A cutout is made in the center of the panel to accommodate the transmitter. The transmitter is mounted in place by means of two 5-inch lengths of ½-inch by ½-inch aluminum angle, screwed to the top and bottom of the transmitter and to the panel. The power supply and modulator units are built on 5″ by 10″ standard chassis and are mounted end-on to the panel, with standard chassis panel brackets, two to each unit. The rear view of the unit, *Fig. 8*, shows the appearance of the completed assembly.

The power supply described delivers 470 volts at 170 milliamperes. Under these conditions, the a.c. ripple voltage is 9 volts r.m.s., or 1.92%. The output of the transmitter on c.w. is 38.5 watts, with an input of 56.4 watts to the p.a., representing an efficiency of 68%. The r.f. current into a 52-ohm load is 0.86 amperes. The output when operated with telephone modulation is reduced slightly due to the additional load on the power supply by the modulator tubes. The output under these conditions is approximately 35 watts.

The values given in the parts list of *Fig. 4* are taken from the instruction book covering this particular equipment, with the exception of C_{69} and C_{70}, and are listed for the convenience of those who may not otherwise have access to this information.

The SCR-274-N transmitters will perform very satisfactorily if treated properly and if not altered unnecessarily. Make as few changes to the frequency determining portions of the circuit as possible; don't try to overload the output stage, regulate the plate supply to the oscillator and to the screen grids of the power amplifier, and you will have a signal that will be outstanding in quality and a joy to copy.

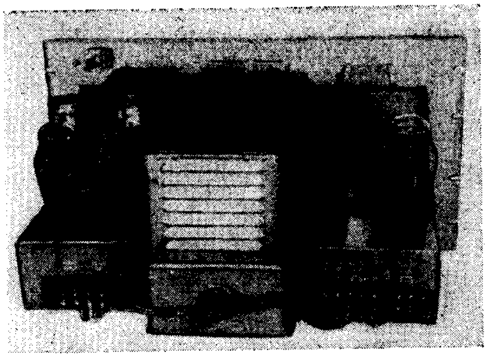


Fig. 8. Rear view of complete phone/c.w. transmitter.

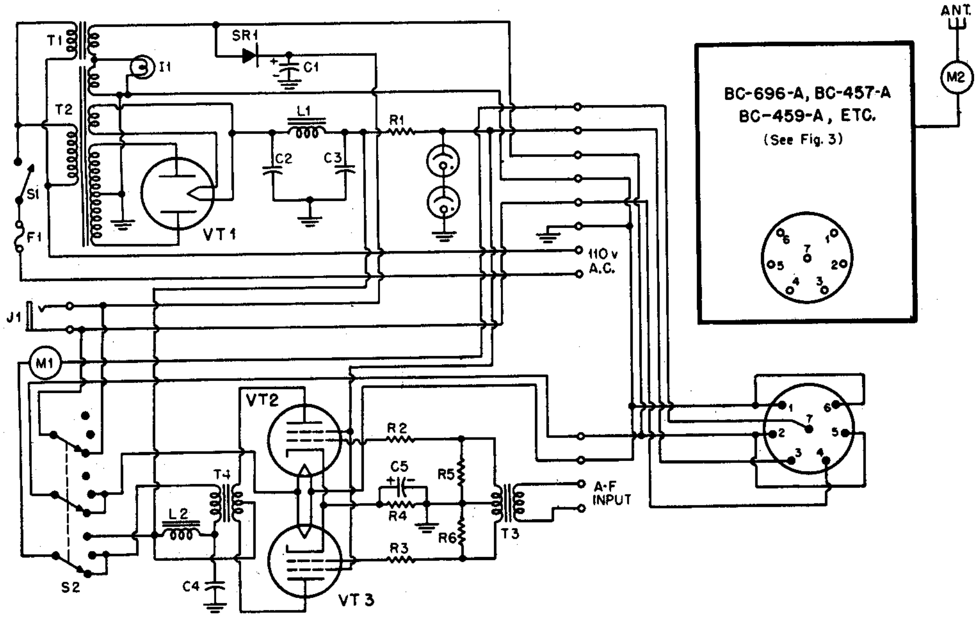


Fig. 9. The power supply, modulator, and interunit cabling.

C1—500 µf, 25-volt dry electrolytic
C2—1 µf, 600 v., oil filled
C3—10 µf, 600 v., oil filled
C4—4 µf, 600 v., oil filled
C5—40 µf, 150 v., dry electrolytic
L1, L2—Thordarson T-20C64 chokes
R1—5K, 20 w., wirewound
R2, R3—500 ohms, 1 w.
R4—250 ohms, 5 w., wirewound
T1—6.3 v. at 3 amp, fil. trans.
T2—Plate and filament transformer, 400 v. each side c.t. at 250 ma, with 6.3 and 5 v. windings
T3—Mike or line to grid trans.
T4—25-watt modulation transformer, select to match p.p. 807s to 3,000-5,000 ohm load
S1—S.p.s.t. toggel switch
S2—Three-pole, 3-position wafer switch
SR1—Seletron 1M1 selenium rectifier
F1—Bussman type 3AG 3-ampere fuse
I1—6.3-volt pilot lamp
J1—Single-circuit jack
M1—0-300 ma d.c. miliammeter
M2—0-3 amp r.f. ammeter

Variations in the Modification

For 80 and 40 Meters

E. B. McINTYRE, W3KHJ *

THE PURPOSE of this article is to describe one possible conversion of the ARC-5, or ATA and SCR-274N into a useful 40 and 80-meter v.f.o. Originally this unit was an aircraft command set and hence used the 24–28 volt d-c supply of the plane as its primary source of power. Unlike many other pieces of surplus equipment these units will operate efficiently with only a minimum of modification. As a matter of fact, so little time was spent in connecting them up that it was decided to rebuild them into a rack and panel unit. Thus, we have the foundation of a good ham station with very little encroachment on our time and expense account.

The Circuit

The ARC-5 transmitters are essentially m.o.p.a. A type 1626 (while the 1626 is a more stable oscillator tube, the 12J5 can be substituted) with the plate grounded for r-f is used as a modified Hartley master oscillator. A pair of 1625 tubes (807 with 12.6-volt filaments) are paralleled and form the final amplifier. Grid neutralization is used in this single-ended final stage with the out-of-phase voltage being fed back into the grid coil through a fixed-tune condenser.

The original aircraft antenna was loaded by a combination of rotary link and loading coil. The antenna connects directly to the loading coil through the relay *K54*. A rotary link is inserted in the final amplifier plate tank and is connected through to the loading coil with a moving tap. The tap on the loading coil is arranged to roll along the turns of the coils as it is turned by means of a gear system that extends through the front panel. This type of coupling is especially useful when loading up a Marconi or end-fed Hertz antenna.[1]

The maximum power output of the transmitter while in the plane is about 40 watts on c.w. and 15 watts output on phone with 100 per cent modulation. The model ATA, however, uses screen modulation and has only a power output of about 10 watts on phone. The modified transmitter uses much higher plate voltages and a maximum power input of between 100 and 150 watts may be expected.

These transmitters also incorporate a 1629 (magic eye tube) which is used as a crystal-controlled calibration oscillator. This oscillator does not control the frequency of the transmitter at any time, but simply acts as a check on the calibration of the master oscillator. Most of the units are supplied with a calibration crystal of 3500 kc (BC-456A unit) or one of 8870 kc (BC-459A unit).

Electrical Modifications

Certain modifications should be made before the transmitter is put into operation. These modifications are as follows:

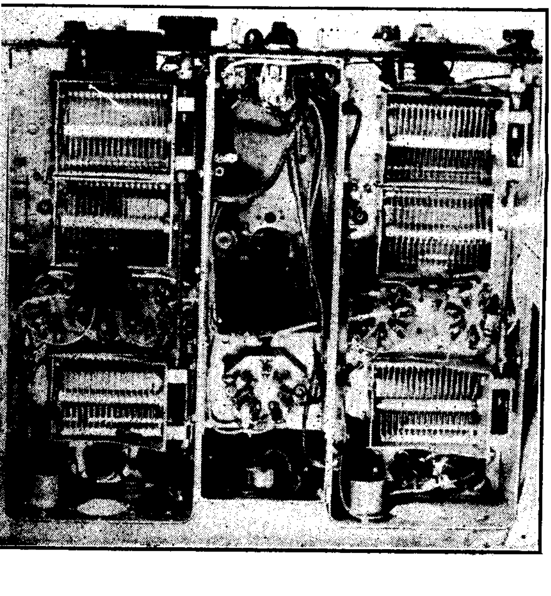
1. Remove *R71*.
2. Run lead on VT 138 *pin 7* to VT 138 *pin 2* and ground *pin 7*.
3. On one VT 136 *pin 7* is grounded, on the other VT 136 *pin 7* is ungrounded. Work with the ungrounded lead. Remove lead to VT 136 *pin 7* and run to *pin 1*. Ground *pin 7* (thus *pin 7* in both VT 136 tubes will be grounded and one side of the filament input circuit will go to ground).
4. Disconnect *K53* connection to plug terminal 5 and 6. Remove relay.
5. Disconnect *K54* and remove.
6. Remove *R70*.

The 390-ohm cathode resistor, *R77*, used with the 1629 should be replaced with a 1000-ohm ½-watt resistor. The cathodes of both of the 1625 tubes are then tied together and grounded through a SPST switch. This switch serves as a TUNE-TRANSMIT switch enabling the operator to open the cathode circuit of the final amplifier so that the oscillator may be zero-beat without undue interference. A power supply giving 12.6 v. a.c. (6.3 v. transformers in series are satisfactory) and d-c voltages from 500 to 750 at 200 ma and 150 to 250 v. at 50 ma is required.

In certain cases (ours included) it may be advisable to remove the loading coil in the antenna circuit completely. This coil will soak up quite a lot of the r-f that should be in the antenna. When using a coax line the center conductor may be tied into the rotary link in the final tank coil and the link used to load the antenna. The other side of the link is already grounded and it is only necessary to ground the outer braid of the coax line.[1]

* 220 Forest Glen Rd., Silver Spring, Md.

1 See footnote 1 in WØZJB conversion.



Bottom view of SCR-274Ns showing units rack-mounted with switching circuits in between.

of the SCR-274N Transmitters

Mechanical Modifications

The mechanical arrangement of the ARC-5 did not harmonize with the rest of our rig and it was decided to rebuild into a relay rack. After some thought we evolved the arrangement shown in *Fig. 1.* The 3.0 to 4.0-mc transmitter is on the left and the 7.0 to 9.1-mc transmitter is on the right in the illustration. Above the two v-f-o control dials. The dials are combination indicator and panel lights. They may be adjusted to throw a beam of light in any direction along the panel. A single meter with meter switching is employed in conjunction with a 2-pole 11-position switch and the oscillator plate, final grid, final screen, or final plate currents may be read. Positions are also used to show the oscillator and final plate voltages. The details of this arrangement are not shown here since they may be quite easily worked out and will vary according to the number of meters the reader may have at hand.

The transmitter filament, oscillator plate, and final amplifier circuits are switched by means of the 3-position 3-pole switch in the lower center of the panel. The key jack is directly below this switch. The toggle switch to the right of the key jack is for SEND-RECEIVE and the toggle to the left is for TUNE-TRANSMIT. A pair of indicator lights in the upper center of the panel show which transmitter is in use. The pilot lights may be operated from the 12.6-v. filament supply by inserting a separate 47-ohm 1-watt resistor in series with each 150-ma pilot lamp.

To rebuild the ARC-5 into this arrangement it is first necessary to remove the front panel of the transmitters. Removing the front panel may prove to be the most difficult part of this operation. First remove the dust cover, all of the tubes, the calibration crystal and all of the knobs and dials. The antenna tuner will also come off as it is mounted to the front panel and chassis with 3–48 screws.

Aluminum rivets fasten the front panel to the chassis, but the heads of these rivets (three on each side and one on top center of the chassis) may be cut off with a cold chisel or drilled out. This permits removal of the front panel from the transmitter unit. The front panel of the relay rack may now be marked.

When two of the transmitter units are placed side by side there is sufficient space to mount a narrow chassis between the two and still put them in a standard rack mounting. We decided to place the VR-150 voltage regulator on this small chassis along with the dropping resistors, switches and cable connectors from the power supply. The dimensions of this chassis are 11½" x 3½" x 3". As a matter of fact, a doubler stage could also be built into this chassis if it is desired.

The three units are laid out side by side and bolted together to form one complete unit. The front panel is a regular 19" x 7" plate of black crackle 1/16" inch steel. The layout for drilling the panel requires a little extra care, although bushings should be used where possible to allow for a much greater tolerance. The meter, switch and screw holes may be laid out and drilled without difficulty. When the front panel is completed it is secured to the transmitter unit with two standard chassis end brackets and the various switch shafts and screws through the front panels. Two extra brackets in the center will add considerably to the rigidity of the completed unit.

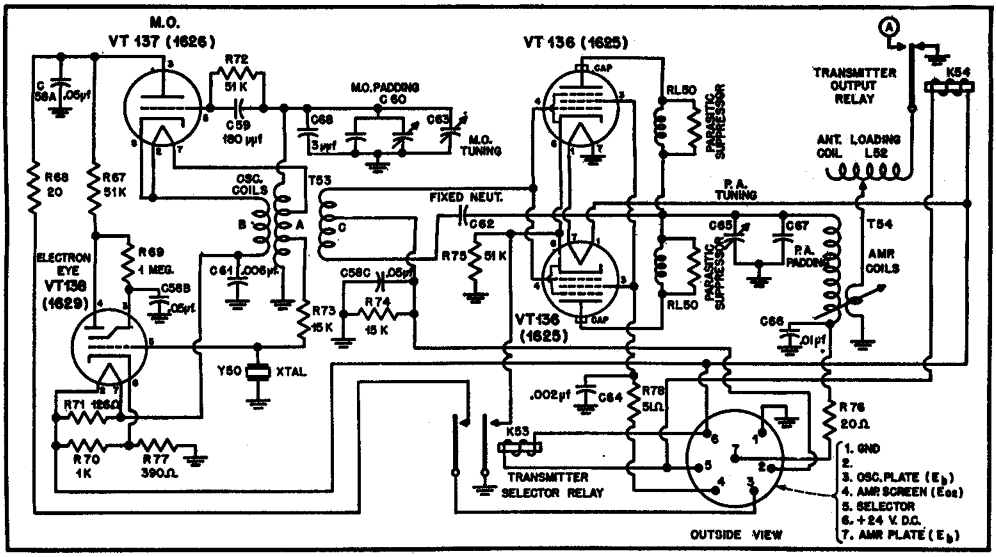


Diagram of the SCR-274N before any modifications have been made. All modifications described are based on this circuit.

We tried several different keying circuits and finally compromised on the simultaneous keying of the oscillator plate and the final screen voltages. This will allow break-in operation while keying the cathodes of the final amplifier will not. A keying relay is used which has been mounted on the rear of the small center chassis. The note sounds very good even though the oscillator is being keyed.

With a power input of about 100 watts we have found the performance of the ARC-5 excellent.

For 40 and 20 Meters

EDWIN W. HANNUM, W2VNU/8 †

By the simple expedient of switching the fixed air padder (across the PA coil) in and out of the circuit, efficient operation may be realized on both 20 and 40 meters. It is necessary to uncouple the PA tuning condenser from the drive and shaft mechanism and run its shaft out the side of the unit through a fixed or flexible coupling. This shaft is at ground potential. The oscillator tuning remains unchanged.

Only 20-meter operation was contemplated at W2VNU/8 so band switching was not incorporated. The "hot" end of the fixed air padder, *C67*, in the schematic was disconnected. There is, however, sufficient space along the side of the unit to mount a SPST switch for bandswitching.

For 11 and 10 Meters

VINCE DAWSON, WØZJB ††

As MIGHT BE EXPECTED, our particular interest is a v.f.o. combination capable of working from 11 to 2 meters. The SCR-274N series, particularly the BC-458A and BC-459A, provide a ready answer to the problem. The former unit tunes initially from 5.3 to 7 mc, and the latter unit covers the range 7.0 to 9.1 mc. On 11 meters we use the 4th harmonic of 6.79 to 6.85 mc, on 10 meters we use the 4th harmonic of 7.0 to 7.42 mc, on 6 meters the v.f.o. is between 8.33 and 9.0 mc, while for 2-meter operation we use the 18th harmonic of 8.0 to 8.2 mc.

A first inspection will confirm that little conversion work is necessary to get these v-f-o units on the air. After a clean up with a few drops of light oil mixed with some carbontet applied with a stiff brush, the top shield is taken off by removing the small screws holding it in place. Then, if the unit is to be used strictly for v-f-o operation take the coiled spring lead that is actuated by the antenna change-over relay and solder it to the antenna feed-through post. Note at the same time that variable link coupling is used from the 1625 plates to the variable inductance. By rolling the inductance to "0" on the dial it is effectively removed from the antenna circuit, making a straight lead from the link to the antenna relay.[1] A coax cable is then used from the antenna post to transmitter. An adaptor for coupling the v.f.o. to a crystal stage is shown in *Fig. 1a.*

The filaments of the 274N are wired in series-parallel for a 24-28 d-c volt input. Since 807s require different sockets than 1625s and since there is no 6.3 volt equivalent to the 1626, it is suggested that a 24-volt output transformer be obtained that is capable of supplying about 2 amps. These are now becoming fairly common and should be available from most jobbers.[2]

The next step is to remove the bottom plate and locate relay *K53* which is mounted in the middle of the unit on the left side. This midget relay switches the plate voltage to the *VT137* (1626) and shorts out the biasing resistor *R75* (51,000 ohms). Either remove this relay entirely from the unit or tie it down in the energized position. If the relay is removed, the cathode wires from the 1625s should be grounded to the chassis and the red lead carrying the oscillator plate voltage from socket *pin 3* to *R68* is resoldered directly, in place of running through the relay arms.

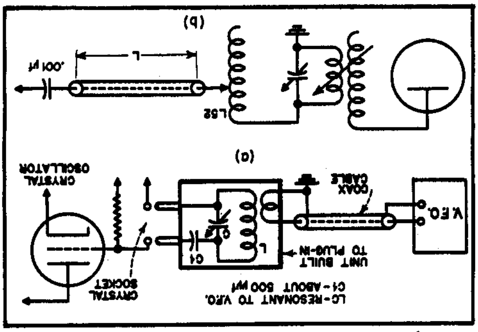


Fig. 1a. Adaptor for coupling v.f.o. to crystal stage
Fig. 1b. Alternate method for coupling to driver stage

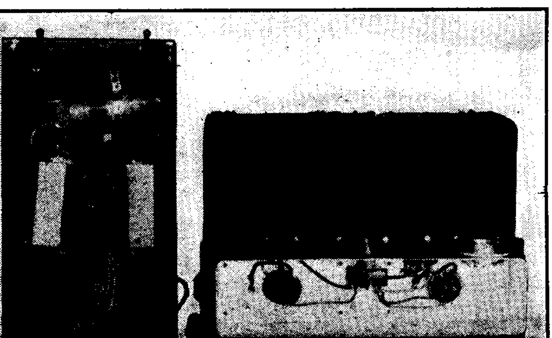
It is often worth while to use the magic-eye (1629) and crystal calibrator unit to check the v.f.o. in the absence of frequency standard. This unit normally would have used the 24-volt d-c filament voltage as the bias on the cathode of the 1629 through resistors *R77* and *R70*. To change this part of the circuit over to a-c operation disconnect the cathode lead of

(*Continued on page 87*)

† 44 James St., New Hyde Park, N. Y.
†† VHF Editor, *CQ*.

1 By choosing a reasonably small length of coaxial cable to connect to the transmitter the "antenna" coil of the 274N may be used as shown in *Fig. 1b*. The length of cable, L, multiplied by the capacity of the coax per foot (from the manufactures data this is usually equal to 20 to 30 $\mu\mu f$ per foot) resonates with L52 and its associated link provided L is short compared with a quarter-wave at output frequency.

2 The 1625 sockets can be modified in accordance with instructions given on page 27, January 1948, *CQ*, in the article by W2CVV, "Mobile With the SCR-274N." For 12.6-v. operation the filaments should be wired as outlined by W3KHJ.



Rear view showing voltage-regulated power supply and method for switching power between the two units.

the 1629 (pin 8) from the junction of these two resistors. Then solder a 2500-ohm 2-watt resistor between the cathode and chassis ground. The magic-eye now operates normally with the eye closing when the v-f-o frequency equals the frequency of the calibrating crystal.

Power Supply and Connections

We were able to obtain a dual rack for our two v-f-o units. These also have socket connections at the rear for the control and power plugs. By removing the screws at the back of the power receptacle box all the wiring becomes accessible. It is best to remove all of the wiring and start out fresh.

Remove the small socket and replace it with a 4-prong socket to handle the voltages coming from the power supply. In the center of the power receptacle box mount a DPDT toggle switch. This switch is to be used to switch the plate and screen voltages from one v.f.o. to the other. The filaments of the two units are wired in parallel.

and checks on the output and drift we arrived at these voltage and current ratings. For strictly stable v.f.o. operation, not more than 300 volts at 100 ma on the plates of the 1625 amplifiers, and 210 volts on the oscillator stage. If the unit is to be used on either 40 or 80 meters 500 volts at 200 ma can be used and still afford a reasonably clean-cut signal. The oscillator voltage must be well-regulated and a suggested power supply is shown in *Fig. 2*. Two VR 105 tubes in series keep the oscillator plate and amplifier screens down to a current drain of between 30 and 40 ma, by providing 210 v. of stabilized d.c. The double section filter in the power supply is worth while, thus keeping the ripple content down.

To set the v.f.o. to a spot frequency chosen on the receiver, a calibrating switch is included in the power supply proper. Since the two units are mounted side by side it enables the operator to set up without causing needless QRM by having the entire transmitter on the air.

Keying

Many types of keying circuits have been tried with this v.f.o. For the author the most satisfactory has been to use relay *K53* and key the cathodes of the 1625 amplifiers. This relay will operate nicely from a 22-volt battery, or through a 10-watt 17,000-ohm resistor from the 300-volt supply. The relay draws about 16 ma from either the battery or the dropping resistor.

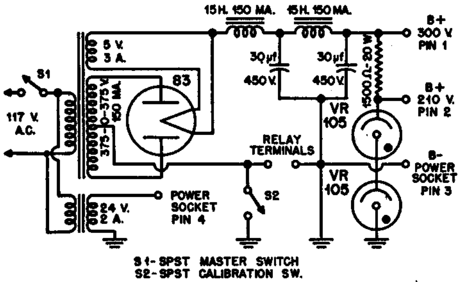


Fig. 2. Voltage regulated power supply recommended for use with the SCR-274N as a v.f.o.

A well-regulated power supply is the key to the stability of any v.f.o. After a number of experiments

160 Meters

Putting a Command-Set (*SCR-274N*) transmitter on 160 meters is quite simple, if the following method is employed. Although used specifically with the BC-457, it appears equally applicable to other models.

Oscillator

Remove the shield can covering the oscillator coil and padding condenser. Without dismounting the coil form, strip the wire from it; both the large winding and the small one connected in the filament circuit. Do not, however, disturb the 1625 grid coil which is inside the form.

Rewind the larger coil with thirty-six turns of No. 20, enamelled wire. Close wind the first thirty-three turns, starting at the bottom of the form and complete with the final three turns spaced in the grooves at the top of the form. The winding must be put on tightly to prevent the turns from slipping.

The cathode of the oscillator tube is tapped on the eighteenth turn from the bottom of the winding. Cut loose the oscillator tube filament terminals from all other circuits and connect them directly to the filament heating circuit. Set the oscillator padding condenser to maximum capacity. Then replace the shield and turn the oscillator slug halfway in.

Under the chassis, remove the black wire between the oscillator coil terminal strip and the neutralizing condenser. Move the 15,000-ohm, 1625 grid-bias resistor and its bypass condenser to the terminal previously occupied by the neutralizing condenser lead.

The magic eye assembly is not used, and the neutralizing condenser may also be removed if desired.

Amplifier

Remove the amplifier coil form from the chassis and strip off the old winding. Tightly rewind with 34½ turns of No. 18 enamelled wire. Close wind thirteen of them in the space at the bottom of the form. Continue close winding in the upper part of the form for 18½ turns. Finish off with three turns space wound in the grooves on the form. Replace the coil.

Remove the antenna loading coil and connect the variable link to a coaxial output connector. If later it is found that this does not give enough coupling between the antenna and amplifier, a few turns of insulated wire may be wound over the amplifier coil and connected in series with the variable link.

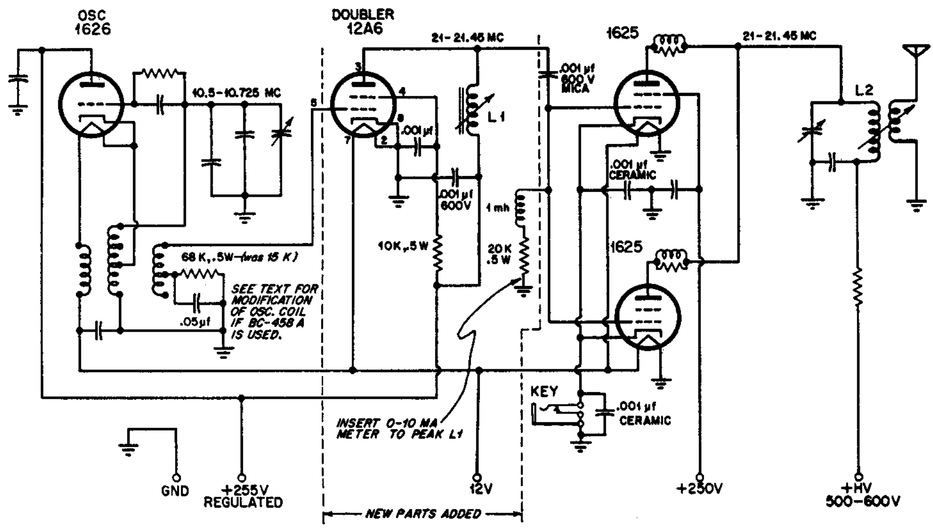
After the coils are modified, apply low voltage to the transmitter and tune the amplifier padding condenser for minimum plate current. Experimentally adjust amplifier and oscillator coil slugs for best tracking of the two circuits across the band.

On 15 Meters - Quick!

H. N. LEM, W2CTE*

Another of the apparently endless uses of the versatile BC-459—getting on 21 mc. with a minimum of fuss and bother. —Editor.

Command-Set transmitters can be converted to cover the new 21-mc band with a minimum of effort. Two conversions, applicable to the BC-459A (7-to-9.1 mc.), and the BC-458A (5.3-to-7 mc.) transmitters are described below. The simpler conversion consists of shifting the oscillator tuning range to cover 10.5 mc. to 10.725 mc. and operating the parallel 1625's as frequency doublers. To accomplish these objectives, do the following:



NOTE
UNLISTED PARTS ORIGINAL AND UNCHANGED.
L1— 7T #22 PE WIRE ½" LONG, ⅝" DIA CERAMIC SLUG-TUNED FORM.
L2— 5T, DOUBLE SPACED ON ORIGINAL AMPLIFIER COIL FORM.

Fig. 1. Modification schematic. The dotted lines enclose the optional doubler stage, which affords added output and stability.

BC-459A

Oscillator: Decrease the capacity of the padding condenser, located under the oscillator shield can; so that the oscillator tunes to 10.725 mc. when the dial is set to 9.1 mc. The shield must be in place while checking frequency.

Amplifier: First, disconnect both the amplifier tuning condenser (the one ganged with the oscillator condenser) and the neutralizing condenser. Next, remove three turns from the top of the amplifier tank coil.

The amplifier padder now becomes the main tuning condenser. Remove its shaft lock, and add a shaft extension, plus a knob, for easy adjustment. It may be necessary to dismount the padder from the chassis to remove the shaft lock and to enlarge the hole in the side of the chassis to accommodate the shaft extension.

Mount a midget phone jack in the lower left-hand corner of the panel, and connect it between the 1625 cathodes and ground. Bypass the cathodes to ground with a .001 µf. ceramic condenser.

Connect the power supply, plug a key in the jack, check your frequency, tune the 1625 plate tank to resonance, couple an antenna, and you are on 21 mc.

BC-458A

In addition to the above, putting the BC-458A on 21 mc. requires modifying the oscillator coil as well as the amplifier coil. Remove five turns from the top of the oscillator coil, and rewind the amplifier coil. The new winding consists of five turns of the original wire, wound to occupy every other groove

———

on the coil form.

(Using a conventional frequency doubler as an output stage always incurs the risk of radiating appreciable power at both the subharmonic and harmonics of the desired output frequency. A link-coupled antenna tuner will greatly reduce the possibility of such spurious outputs reaching the antenna. Another possibility is to divide the parallelled 1625 grids and excite one from the present point on the oscillator coil assembly and the other from the point previously connected to the neutralizing condenser. This will convert the 1625 stage to a push-push doubler, increasing doubling efficiency and decreasing the probability of output on other frequencies. Also, note W2TCE's improved conversion described below. —Editor.)

A More-Efficient Conversion

After the thrill of the first few contacts on the new band has worn off, you may desire to go a step further and add a 12A6 frequency doubler between the oscillator and the 1625's. The added stage will permit the 1625's to operate as straight amplifiers, resulting in increased 21-mc output. It will also improve stability, because of increased isolation between the oscillator and the 1625's.

The portion of the diagram *(Fig. 1)* between the dotted lines gives data on the new doubler stage. To accommodate it, strip all connections from the 1629 tube socket and the crystal socket. Reconnect power leads removed from them to the power plug at the rear. Replace the 1629 socket with a piece of scrap aluminum upon which L1, the slug-tuned 12A6 plate coil, is mounted. Rewire the former crystal socket for the 12A6.

Note that the connection from the oscillator coil that formerly went to the 1625 grids now goes to the 12A6 grid, while the 1625 grids are connected to the 12A6 plate through a .001 µf. condenser.

Connect the grids of the 1625's to ground through a one-milli-henry r-f choke and a 20,000-ohm, ½-watt resistor. Raise the value of the former 1625 grid resistor—now the 12A6 grid resistor—to 68,000 ohms.

Tuning The Doubler

Insert a 0-10 ma. meter between the amplifier grid resistor and ground. With the plate and screen voltage removed from the 1625's, tune the oscillator to the center of the 21-mc band (21,225 kc.), and adjust the slug in *L1* for maximum meter deflection. It should be about five milliamperes at the center of the band, dropping fifteen to twenty per cent at the ends of the band.

If the grid current exceeds five milliamperes, decrease the size of the coupling condenser between the 12A6 and the 1625's or increase the value of the 12A6 screen resistor.

Neutralization of the 1625's was not found necessary. If instability is noted, try different 1625's: they are still cheap on the *surplus* market.

20-Meter Operation of the BC-459A

This is an improvement over the method suggested by W2VNU/8 (July, 1948, *CQ*, page 44). Instead of switching out the padder (*C67*) switch out the main tuning condenser (*C65*). With this arrangement the tuning condenser does not need to be disconnected from its worm drive shaft, and hence will still track perfectly on 40 meters. When operated on 20 meters, one of the two condensers must be tuned and this is more easily facilitated by cutting another hole in the chassis and adding a shaft extension to *C67*. An ordinary SPST power toggle switch works very well as a band switch. I have also found that the tuning is quite broad and the final tank condenser need not be re-tuned over the whole 20-meter band.

Willem Van Aller, W2VIK

20 and 40 Meters With the BC-459A Transmitter

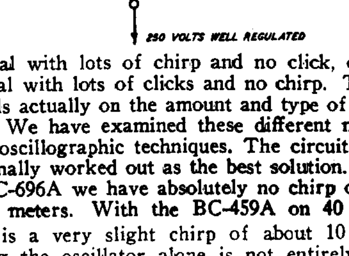
By the simple expedient of switching the fixed air padder (across the PA coil) in and out of the circuit, efficient operation may be realized on both 20 and 40 meters. It is necessary to uncouple the PA tuning condenser from the drive and shaft mechanism and run its shaft out the side of the unit through a fixed or flexible coupling. This shaft is at ground potential. The oscillator tuning remains unchanged.

Only 20-meter operation was contemplated at W2VNU/8 so band switching was not incorporated. The "hot" end of the fixed air padder, *C67*, in the schematic was disconnected. There is, however, sufficient space along the side of the unit to mount a SPST switch for bandswitching.

Edwin W. Hannum, W2VNU/8

SCR-274N Keying Filter

There seem to be thousands of different ways of keying the 274N transmitters, but judging from the number of chirpy and burpy notes on the air, a lot of them are pretty bad. Plate, cathode, or center-tap keying will give you two choices. One,



a signal with lots of chirp and no click, or two, a signal with lots of clicks and no chirp. This all depends actually on the amount and type of keying filter. We have examined these different methods using oscillographic techniques. The circuit shown was finally worked out as the best solution. Using the BC-696A we have absolutely no chirp or click on 80 meters. With the BC-459A on 40 meters there is a very slight chirp of about 10 cycles. Keying the oscillator alone is not entirely satisfactory as this will allow the final to break into parasitic oscillations.

Bill Orr, W6SAI

Break-in With the 274 N

FRANK A. MOHLER, W2IAZ

187 Broad St., Eatontown, N. J.

After converting an *ARC-5* "Command" transmitter by following standard procedures,* I first keyed it in the common B+ lead to the oscillator plate and amplifier screens. This arrangement produced a noticable keying chirp. Next, I tried straight cathode keying of the 1625 tubes. This system worked well, but the constantly-running oscillator prevented working "break-in."

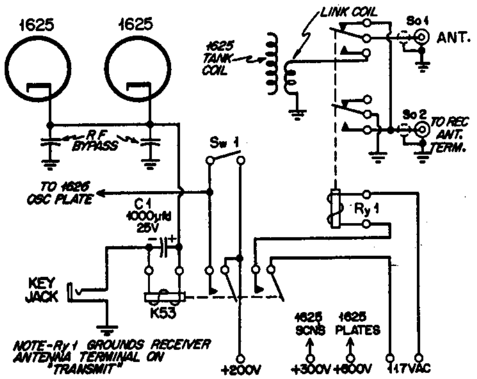
My next step was to combine the advantages of the two keying methods. This was done by the method sketched in *Fig. 1.* I connected the coil of the original transmitter selector relay, *K53,* between the cathode terminals of the 1625's and the key jack. I fed the oscillator plate current through the same set of relay contacts originally used for this purpose. The other pair of contacts control a 117-volt, a-c, antenna changeover relay, which is mounted near the amplifier plate coil. In addition, I connected a 1000 μfd., 25-volt, electrolytic condenser across the relay winding.

Operation

Upon pressing the key, the 1625 cathode current flowing causes *K53* to close. This, in turn, actuates the antenna changeover relay, which switches the antenna from the receiver to the transmitter, and applies plate voltage to the oscillator. The condenser across the relay coil quickly charges up, and its charge holds the relay closed during normal keying pauses, so that the keying is essentially cathode keying of the 1625's. However, a 2 to 4 second pause allows the condenser to discharge through the relay coil. The relay then opens, the oscillator ceases to function, and the antenna is automatically switched back to the receiver.

The "non-swish" *Spot-Tune* switch, *Swl* across the oscillator plate-voltage contacts of the relay permits checking the transmitter frequency and zero-beating a signal without putting a signal on the air. Also closing the switch allows operating the transmitter without the "break-in" feature.

A minimum cathode current of 100 milliamperes is required to operate *K53.* On the other hand, the cathode current should not exceed about 150 milliamperes; otherwise the voltage drop across the relay winding will exceed the 25-volt rating of *C1.* Note that the voltage drop acts as cathode bias on the 1625's; therefore it prevents the plate current from soaring when the key is pressed and the oscillator is not functioning.



C1—1000 μfd., 25v. electrolytic (Sprague TVL 1280 or equiv.)
K53—Original "selector" relay rewired as shown.
Ry1—DPDT antenna changeover relay, 117v. a-c winding (Advance K1504 or equiv.) installed in position previously occupied by old d-c antenna relay.
So1, 2—Coaxial chassis fittings mounted on panel near Ry1.
Sw1—SPST toggle switch mounted on side of transmitter near K53.
Other components normal for a "Command" transmitter converted for amateur use.

Fig. 1.—Simple circuit changes required to achieve chirpless, break-in keying with "Command" transmitters. Full details in text.

This keying system has been in operation for several months with entirely satisfactory results. At keying speeds of five words per minute and over, *K53* stays closed during normal spacing between letters and words, but a slightly longer pause automatically shuts off the oscillator and nects the antenna to the receiver, so that I n listen for "breaks."

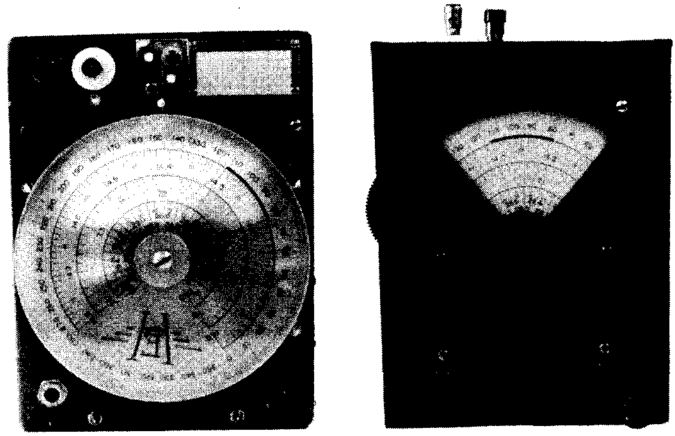


Fig. 4. The SCR-274N with the band-spread dial installed. The model on the right has a front plate exposing only the portion of the dial being read.

E. HENRICH, W8OVL*

Bandspreading the SCR-274N

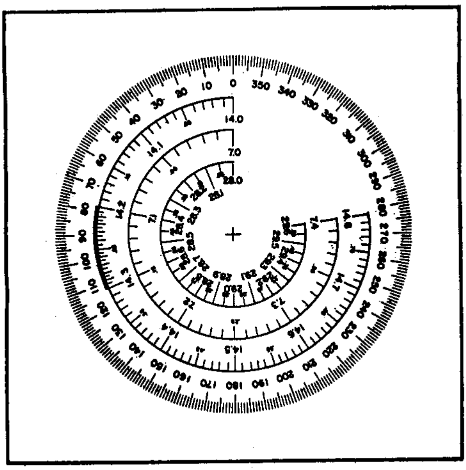
Improving the operating convenience of the command transmitter.

ALMOST EVERYONE speaks highly of the SCR-274N. When the transmitters are converted they make excellent units for v-f-o operation. Mechanically, the one prominent fault that is found with the transmitter is the lack of bandspread and direct calibration at the harmonic frequencies. Since these circuits are initially stabilized, the frequency reset accuracy with a regulated power supply is quite good. In view of these factors the writer decided to attach a bandspread dial to one of the units—thus providing direct readings on all the important amateur bands that are in harmonic relationship to 40 meters.

* *144 Edgar Ave., Dayton 10, Ohio.*

The converted transmitter is the BC-459A that in its original form covers 7.0 to 9.1 mc. The old dial is taken off and a gear substituted in its place to obtain a step-up ratio for the new dial. This gear is similar to the one now driving the frequency dial from behind the panel. It is a 48-pitch 110-tooth gear, and may be obtained from a stripped down BC-459A, or a gear supply house.

The pattern of the bandspread dial is shown in *Fig. 1.* This is the extent of the bandspread obtainable with the 110-tooth gear. Using another gear ratio will result in a change in the amount of bandspread and the calibration. A second pattern is shown in *Fig. 2,* which was obtained by using a gear



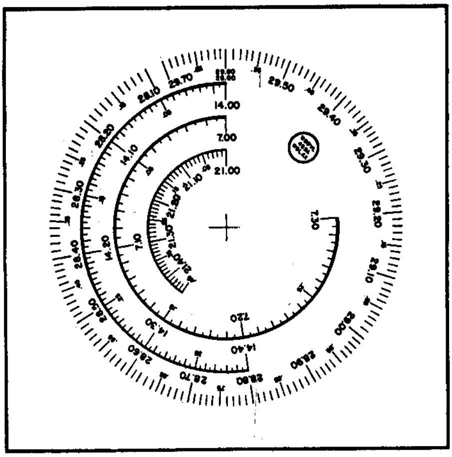


Fig. 1 (left). Bandspread dial pattern for the BC-459A using the 110-tooth gear, and Fig. 2 (right), using a 144-tooth driving gear. Enlarged photostats may be made from these drawings.

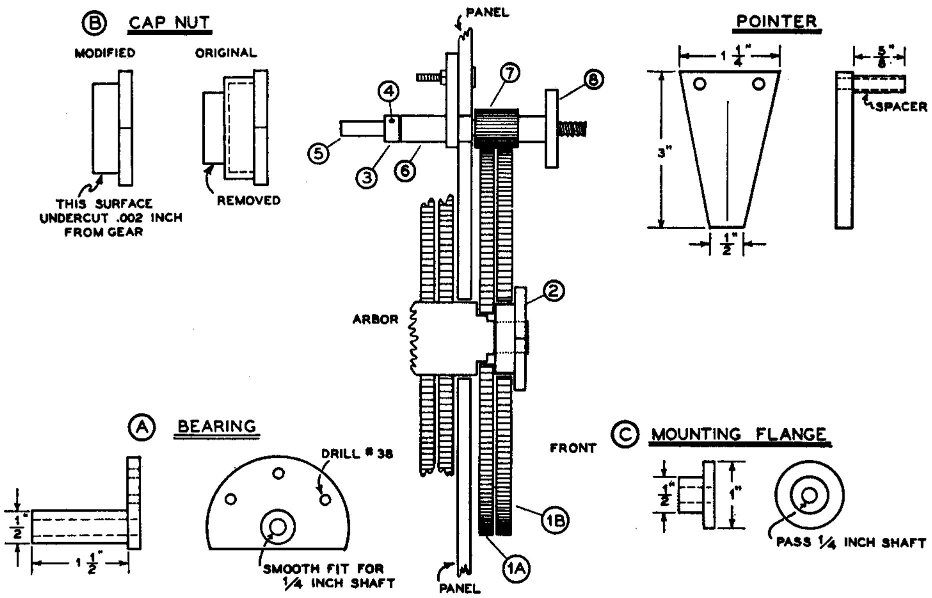


Fig. 3. Additional parts and mounting arrangement for installing a directly calibrated bandspread dial on the BC-459A.

having 144 teeth. In both instances, the calibration is based upon the gear ratio and should be sufficiently accurate for all practical purposes. The pattern may be copied from the page by photostat and enlarged to a diameter of between four to six inches.

Installation Instructions

1) In order to simplify the correct positioning of the tuning condenser and the bandspread dial after it has been installed, it is recommended that the present dial be set to exactly 7.0 mc. Secure the control knob in the lower right corner with adhesive tape to prevent accidental movement during the installation process.

2) Remove the old BC-459A frequency dial. This includes removing the dial, the index spring, rivets, and the locating pin for the dial on the arbor.

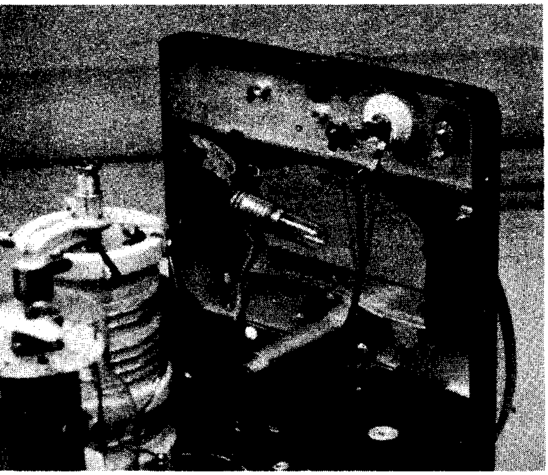
3) Remove the window that looks in on the antenna inductance above the frequency dial. Remove the present antenna coupling knob, shaft, gear and bearing in the upper left-hand side of the transmitter.

4) Set a pair of dividers to 1 7/16". Locate one point in the center of the dial arbor. Swing an arc to scribe a mark directly above and in the same vertical line as the dial arbor. This is the center of the 3/8" hole to be drilled for the bearing that will hold the new bandspread dial. This dimension applies only to the 110-tooth gear. Naturally, if the 144-tooth gear is used the diameter of the gear will be somewhat greater and the location of this hole slightly further (1 25/32") up the face of the panel.

5) Drill out the 3/8" hole in *step 4*. Take the bearing shown as *Part A*, *Fig. 3*, and position it at the back of the front panel in line with the 3/8" hole and with the cutoff flange section at the bottom. Scribe the three holes necessary to mount it to the panel. Drill out with a No. 38 drill. Mount the bearing with binding head 3-48 screws.

6) Set the dividers to 3 3/32". Locate one point in the center of the dial arbor. Swing an arc to

Fig. 5. Behind the panel view showing the location of the new window, pilot bulb and the bearing for holding the bandspread dial.



scribe a mark on the front panel near the lower left corner of the old inductance window. Reset the dividers to 2". Locate one point on the screw under the antenna binding post and intersect the previous scribe mark. At this intersection drill out for 3/16" clearance to pass the shaft of the new antenna coupling control.

7) Take the original cap nut used for securing the old frequency dial to the arbor and set it up in a lathe and undercut as shown in *Part B, Fig. 3.* Any local machine shop will do this for very little cost.

8) From another BC-459A unit (or from the local gear supply house) secure a split gear identical to the one that drives the frequency dial from behind the front panel. It is a 48-pitch 110-tooth gear. Unless this particular size gear is used the bandspread dial pattern shown in *Fig. 1* will not be to scale.

9) Disassemble the new gear by removing the tension spring. This leaves us with parts *1A* and *1B*. Ream the center hole of gear *1A* until it is a tight snug fit of the dial arbor. This reaming must be exact to hold the true center of the gear. Gear *1B* is reamed somewhat more than gear *1A* until it has a diameter allowing a 0.002" clearance between it and the cap nut.

10) Take a ¼" shaft about 2¼" long and thread one end for a distance of about ½". Use the most convenient thread for which you have nuts. This shaft should rotate smoothly in the bearing *Part A, Fig. 3.* It is retained on one end by a collar and pin, or set screw. Sometimes a shaft can be secured with the center pre-drilled and tapped. Such an arrangement is shown in *Fig. 7.* The small gear, part number *7* in *Fig. 7,* is the 26-tooth 48-pitch gear originally used for adjusting the link coupling, removed in *step 3.*

11) Make the small flange for spacing the bandspread dial. It is shown as *Part C, Fig. 3.* There are three possible means of attaching the bandspread dial to the shaft. Two are already described in *step 10,* a third is to drill three small holes in the flange of *Part C, Fig. 3,* and bolt the dial directly to the flange section.

12) Closely examine the cut-away assembly drawing in *Fig. 3.* Assemble the gears and shafts for the dial as shown. Note particularly, that gear *1A* is held tight against the dial arbor by the cap nut. Gear *1B* has been reamed sufficiently to float between the cap nut and gear *1A*. Don't forget to put the spring back between the gears *1A* and *1B* in the assembling process. The fiber washer under the original antenna coupling knob should be inserted on the shaft between the small gear, *Part 7,* and the new bearing, *Part A.* Mesh the two gears with sufficient tension to eliminate any back lash. Do not bottom the two gears as this would cause irregular dial motion.

13) There are several methods of recoupling the shafts of the antenna link from the front and side panels. Our method is shown in *Fig. 6.* We have put a 2" fiber gear on the shaft passing through the new 3/16" hole (*step 6*) and this hangs out beneath the new bandspread dial to give thumb control. The bearing is adjusted to make the two fiber gears mesh.

14) The dial pattern is secured between two thin sheets of plexiglas. The pointer is diagramed in *Fig. 3,* and is positioned as shown in *Fig. 4.*

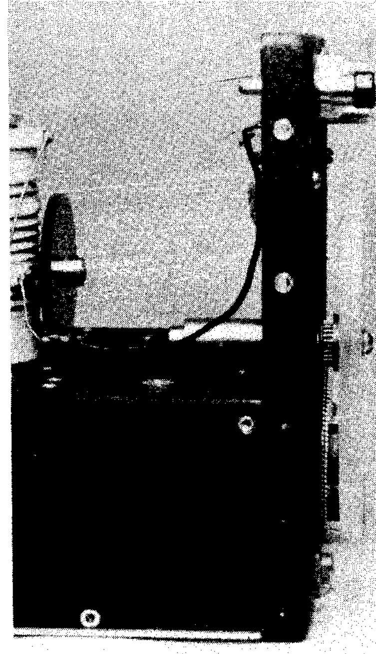


Fig. 7. Side view showing the arrangement of the new gear and bearing for the band spread dial.

Once the dial has been mounted and set to 7.0 mc the unit is ready to be put back into operation. If the tuning knob has not been turned the alignment and calibration should be relatively easy. Check the calibration with a 100-kc standard oscillator. Using the gears as shown, the calibration should be very close. Slight readjustments can be made with condenser *C60* in the BC-459A.

Beautifying may be left to individual taste. A dial light has been installed in most of our models and wired into the filament supply. A sheet of green celluloid may be mounted behind the dial to soften the light. A light metal cover or pan about 1¼" deep and the size of the front panel can be placed over the entire face. A fan shaped window will allow the dial to show.

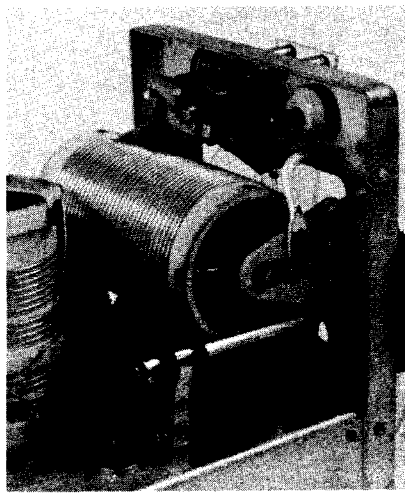


Fig. 6. Method of adjusting the link when the bandspread dial is installed. The fiber gear for thumb control and a new bearing have been used to mesh the gears at the link.

A Crystal-Control Adapter for the BC-696

HENRY R. GREEB, WØFVD

R.F.D. #1, Tecumseh, Nebraska

Many Novices possessing "Command" transmitters hesitate to dig into their oscillators to convert them to crystal control. By grounding an unused pin on the oscillator tube socket and using WØFVD's adapter, changing from variable-frequency to crystal control or vice versa takes less than a minute.—Editor.

Wishing to convert a BC-696 to crystal control for Novice operation, I hit upon a very novel way of doing so. A plug-in adapter, using parts costing less than $3.00, changes the 1626 from a variable-frequency to a crystal oscillator. As it requires no modification of the oscillator, v-f-o operation may be restored in a matter of seconds. *Figure 1* and the picture shows the simplicity of the adapter.

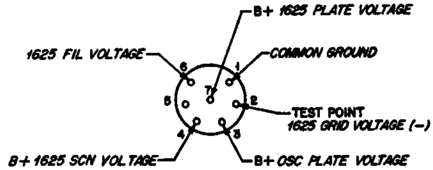
This unit was built in an FT-203A adapter from a BC-454. However, a U-bracket, about 1½ x 1½ x 2 inches, will work satisfactorily. The parts arrangement shown in the picture utilizes the available space to good advantage. One word of caution is in order. Do not apply too much pressure while drilling the holes, as the thin aluminum is easily bent.

Much of the wiring may be done before the parts are mounted. Mount the tube socket with the keying slot down and the plug P1, with its key to the front.

To prevent possible shorting, insulate the r-f choke, *RFC*, with a layer of tape before wiring it into the circuit.

The only modification required in the BC-696 itself, besides those usually made for amateur operation, is to connect *pin 1* of the 1626 socket to the nearest ground lug.

Remove the 1626 and 1629 tubes and the calibrating crystal from the transmitter. Plug the 1626 and a Novice-band crystal into the adapter, and plug the adapter into the 1626 socket. The unit is now ready for testing.



This view of the Command transmitter power plug is shown for reference purposes.

Testing

Apply filament voltage between *pin 2* of *V1* and ground and to the 1625 filaments. Connect a 100-volt, d-c meter between *pin 3* of the power plug on the transmitter, the positive meter terminal to ground and the negative one to the pin.

Set the transmitter dial approximately 100 kilocycles above the crystal frequency and apply a maximum of 250 volts, d.c., to *pin 4* of the power plug. Quickly tune the dial for maximum meter deflection, consistent with the crystal starting every time oscillator plate voltage is applied.

Now apply plate and screen voltage to the 1625's and adjust the amplifier padding condenser for minimum plate current. Antenna tuning and loading follow standard procedures described many times in *CQ* and other publications.*

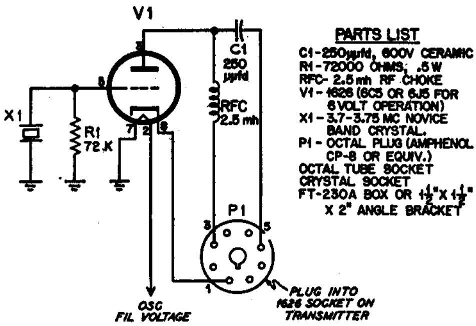
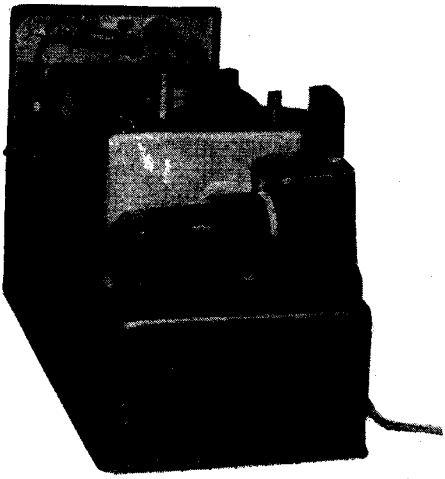


Fig. 1. The wiring schematic reveals that only a very few parts are required. The only circuit change in the Command transmitter is to ground pin #1 of the 1626 socket.



The plug-in adapter is simplicity in itself. The 1626 v-f-o oscillator tube is removed and the adapter with either a 6J5 or 6C5 (for 6-volt operation) is inserted. The calibrating crystal and the 1629 tube are also removed to make room for the adapter. In the above photograph the wire shown leading to the right is a special 6-volt lead used by the author.

Several methods of keying have been tried with this transmitter. The most foolproof method was cathode keying of the 1625's. Oscillator plate and amplifier screen keying also works fine, but oscillator tuning becomes rather critical.

* See especially "The Novice Conversion of a Command Transmitter," R. M. Smith, W1FTX, and W. E. Bradley, W1FWH. QST, November, 1951, page 22.

(This adapter should work equally well with a BC-459 and an appropriate crystal on the new 7.2-Mc Novice band. Also, the BC-457 will tune to the 3.5-4.0-Mc band by setting the oscillator and amplifier padding condensers to approximately maximum capacity. Similarly, the BC-458 will cover the 7-7.3 Mc band by decreasing the capacity of the padding condensers somewhat—Editor.)

Chapter III MOBILE

LT. PAUL H. LEE, W4RXO*

Mobile / ARC-5

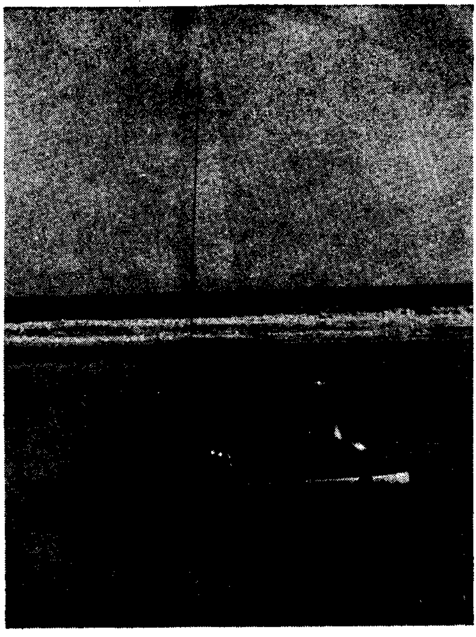
As the result of many requests for the conversion of war surplus gear. —Editor.

The writer has had the urge to "go mobile" for several years. However, lack of time for construction of homebuilt equipment, plus an unwillingness to spend the amount necessary for commercial gear have combined to prevent such action. However, the "bug" finally bit us very hard and we determined to work out a reasonable compromise. Conversion of the ARC-5/SCR274N series equipments offered an easy, extremely inexpensive, and neat looking installation.

In order to make the installation worthwhile from both the peacetime amateur and the Civilian Defense standpoint, an "all or nothing" approach was adopted, with phone operation on 3.9, 14, and 28 mc, by means of interchangeable units, as the goal. The purchase of three SCR-274N transmitters, three SCR-274N receivers, an MD7/ARC-5 plate modulator, a receiver rack, and a transmitter rack, gave us a good start. Included in the lot were one transmitter and receiver covering the 3.5-4.0 megacycle band, giving us the 3.9-mc phone band without the necessity of modifying the r.f. portions of these units. For the 14 and 28-mc bands, we used 4-5.3 mc transmitters, and 3-6 mc receivers. The latter were chosen because their i.f. frequency of 1415 kc offers a good amount of image rejection without sacrificing too much selectivity. The 4-5.3 mc transmitters were selected because of their lower cost.

The differences between the ARC-5 and SCR-274N transmitters should be noted here. The ARC-5's use shunt plate feed in the p.a. with an r.f. choke, while the SCR-274N's use series feed and no r.f. choke. This makes no difference in actual operation. Also, the size of the original power plugs at the rear of the chassis is different, as are the connections. Most racks on the surplus market fit the SCR-274N's, so if you happen to get an ARC-5 transmitter, it will be necessary to replace the larger power socket with a smaller one from an SCR-274N. These sockets are available on the surplus market. Of course, the best way is to get all ARC-5 equipment, or all SCR-274N equipment and racks to fit, and not attempt to mix the two.

Acquisition of circuit diagrams for these units is a necessity. Readily available sources of such information are the two volumes of the *Surplus Conversion Manuals,* and no attempt will be made to reproduce original circuit diagrams here. In all of the conversions we used as many of the original parts, and left as much of the original wiring undisturbed, as possible.



The author's Chevvy contains a three band installation using only war surplus materials. The antenna is the usual center loaded 75 meter whip.

*4 Oak St., Isle of Palms, S. C.

Power Source

The next matter for consideration was the source of power. After much careful thought it was decided to use 12 volts for several good reasons. First, the units are already equipped with 12 volt tubes, and require only the paralleling of filaments. Second, the low cost of 12 volt dynamotors outweighs the cost of an extra storage battery, and 12 volt dynamotors are easily obtainable from surplus. Third, use of an extra battery in series with the car battery places only half the drain on the car battery that would result from 6 volt operation. The extra battery can be located up under the hood in many cars. The writer obtained a battery mounting from a junkyard and installed it under the hood of his 1949 Chevrolet, on the left hand side, near the generator. Use of two extra batteries, with one out on charge while the other is in use, provides a reliable power source, and changing batteries has been reduced to a matter of but three or four minutes' time. Someone is sure to suggest the use of a 12 volt automobile generator at this point, but we did not wish to carry matters that far!

Basic Receiver Modifications

Now that the preliminaries are out of the way, let's get down to the actual conversion work. First of all, discard all the 28 volt receiver dynamotors, but save the mounting plates with attached snap fasteners. Mount DM-35 12 volt dynamotors on them, and replace them on the receivers. Then, make a short sleeve, slotted on both ends, out of 1/4" i.d. copper tubing, and use it as a coupling between the splined tuning shaft and a piece of 1/4" shafting to which a tuning knob may be attached. A spinner-type knob is very handy for this purpose. Fill the sleeve with some type of adhesive which dries hard, such as Duco cement, before fitting it snugly over the receiver tuning shaft. It will withstand rough usage without coming loose.

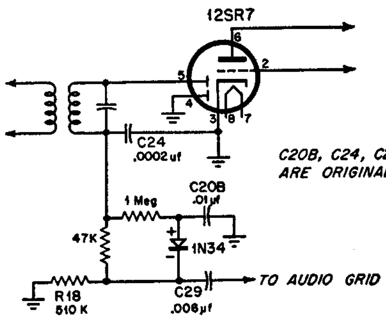


Fig. 1. The noise limiter circuit.

Remove the bottom shield and the front plug-in cover plate from each receiver. The latter may be thrown away, and a new cover plate made of scrap aluminum, for mounting the r.f. gain control and the BFO on-off switch. The r.f. gain control is a 50,000 ohm variable resistor. These two items may be connected to the proper pins of the recessed plug by merely soldering leads to the plug pins. The r.f. gain control should be connected between *pin 1* and *ground*, and the BFO switch between *pin 5* and *ground*. It will also be necessary to solder a jumper between *pins 6* and *7* to complete the filament circuit, as this was formerly accomplished through the plug-in cover that we threw away. Next, using care, clip all the leads from the power socket at the rear of the chassis except the following: *common ground, filament,* and *audio*. The red wires which formerly connected to *pin 4* of the old socket and which are the BFO "shut off" circuit, should be tied together and taped up. The remaining wires should be traced back to their origin and clipped out, as they will not be used. Next, trace the filament wiring, and connect the filaments of all tubes in parallel for 12 volt operation. Remove the bottom of r.f. stage grid resistor *R2* from the AVC circuit, and connect it to ground, to permit this stage to run wide open for increased gain. There are certain i.f. circuit differences between the ARC-5 and SCR-274N receivers, but they are of little consequence. In the ARC-5, the 2nd i.f. and a.v.c. tube is a 12SF7 instead of a 12SK7.

A word of caution is here in order. In any of the receivers, do not disturb the wiring between the 12K8 tube and the oscillator coil. In most sets these leads are fastened down with glyptal, and for a very good reason. Shifting these leads will greatly affect the oscillator frequency and stability. Hours of careful work can be ruined by movement of these leads.

A coaxial jack should be installed on the front panel in the place formerly occupied by the old antenna binding post. Merely drill a series of small holes around the circumference of a 5/8" diameter circle, and knock out the center. Use self-tapping screws to secure the jack to the panel.

Replace the 12SK7 r.f. and i.f. tubes with 12SG7's, to give greater sensitivity and gain. If you have an ARC-5, there is no replacement for the 12SF7 2nd i.f. tube, and you will have to be content with it.

At this point, we have completed the basic modifications for all receivers, and they are capable of operation from a d.c. power supply delivering 10-12 volts. Such a source of test voltage is a necessity for testing the receivers and transmitters on the work bench. The 3.9 megacycle receiver should now be tested and put aside.

Use of the station receiver during the conversion of the remaining receiver units is necessary, as it is a very simple matter to listen to the mobile receiver's h.f. oscillator in the station receiver and check its frequency as we make changes. Subtract 1415 from the h.f. oscillator frequency, and you will have the mobile receiver's operating frequency. To bandspread the 14 mc-band, the h.f. oscillator will have limits of 15,415 and 15,815 kc. For the 28 mc band, the limits will be 29,415 and 31,115 kc.

14 MC Receiver Conversion

Let's start on the 14 mc receiver. We have already performed the basic modifications. Remove the top cover and the shield can over the variable condenser. The receiver may operate without these shields for rough frequency calibration. With a pair of long-nose pliers, carefully remove rotor plates from the variable condenser until only one rotor plate is left in each section. This should be the slotted plate, for tracking adjustment. Now turn on the power, and locate the receiver's h.f. oscillator by listening on the station receiver. The frequency will be much higher than it was originally, but we will have to go still further. Remove the plug-in coil unit from the bottom of the receiver, noting that it is polarized by the pin arrangement of the three coil plugs. Remove the oscillator coil from its shield can, and carefully remove the core from the coil. This should be replaced after rewinding, and its position is not too critical. Remove only the large winding of the oscillator coil, and rewind it with about 10 turns as a start, spacewound. The wire size is not critical. We used number 24 enamelled wire. Put the coil back in its shield, replace the coil unit in the set, and turn on the power. The h.f. oscillator should now be somewhere around 15 mc on the station receiver. Check the bandspread for approximately the correct limits. If you are very "foxy", you can use the original dial markings, with new figures, for the new frequency calibration. Slight adjustment of the number of turns, and the oscillator trimmers and padder, will give proper bandspread.

Tracking may be improved if necessary by bending the slotted sections of the tuning condenser rotor plate. Remember our limits of 15,415 kc (14 mc) and 15,815 kc (14.4 mc). Rewind the mixer and r.f. coils, using about 11 turns on each, spacewound. Rewind the mixer coil primary, using 18 turns of number 30 d.s.c., interwinding part of it with the secondary, to give increased gain. With the coils back in the receiver, and power on, adjustment of the trimmers should now bring in signals, using a short wire antenna. Slight changes in turns may be necessary, and adjustment of the slotted sections of the tuning condenser rotor plates may have to be made, to secure tracking of these two stages. Now replace the shield over the condenser, and fasten the coil unit securely in place.

Install the noise limiter circuit as shown in *Fig. 1*, in the ground return of the 2nd detector diode circuit. Replace the bottom cover. Use the station v.f.o. or frequency meter for final receiver calibration with the shield in place. The top cover may now be replaced, and the 14 mc receiver is ready for use. It is an excellent six-tube superheterodyne, capable of pulling in even weak signals with ease.

28 Mc Receiver Conversion

The conversion of the remaining receiver for 28 mc is performed in a like manner, but with several additional improvements. First, remove the octal r.f. socket, and replace it with a 7 pin miniature socket, for a 6AG5. Replace the 620-ohm cathode resistor *R1* with a 220 ohm resistor. Remove *C6* and connect the small ceramic bypass condensers (as shown in *Fig. 2*) with as short leads as possible From the coaxial antenna jack on the front panel, run a short length of small coaxial cable to *terminals 1* and *6* of the oscillator coil socket, using *terminal 6* for the shield. Tie *terminal 6* to *terminal 3* to ground the shield. Connect the 6AG5 filament and the mixer stage filament in series and use a 6K8 as the mixer tube. Each tube draws 0.3 amps. filament current.

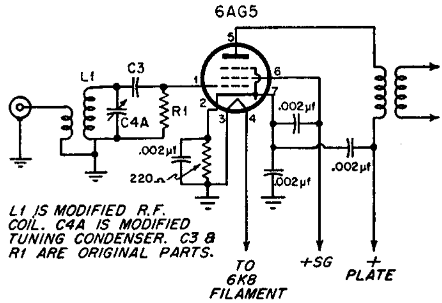


Fig. 2. The new r.f. stage.

Insert a 10,000 ohm 10 watt resistor between *R22* and *R23*, to increase the screen voltage to approximately 140 volts. Connect the filaments of the two i.f. tubes in series, and use two 6AC7's in place of the 12SK7's in these sockets. If you have an ARC-5, you will have to use the existing 12SF7 2nd i.f. with a 12SG7 1st i.f. The gain will be a bit lower than with 2 6AC7's. Install the noise limiter circuit as shown in *Fig. 1* in the ground return of the second detector diode circuit. Now, remove all but one rotor plate in each section of the tuning condenser, and use 6 turns on the r.f. coil, 5 turns on the mixer coil secondary, 9 turns on the interwound mixer primary, and 5 turns on the oscillator coil grid winding, all spacewound. Wind a one-turn link of insulated wire over the ground end of the r.f. coil, and connect it to *terminals 1* and *6* of the coil plug.

Using the station receiver, VFO and frequency meter as before, align the receiver for 28 - 29.7 mc coverage. In this case it will be easier to make a new dial plate than to attempt to make the receiver track to the old markings. As before, the final adjustment should be made with the condenser shield cover, and bottom cover, in place. The preceding paragraphs cover in a few words many hours of work, but the results are well worth the effort. We now have a receiver that is hard to beat for sensitivity and good signal-to-noise ratio on 28 mc.

3.9 Mc Transmitter Conversion

Conversion of the 3-4 mc transmitter for 3.9 mc phone is quite easy. This portion of the work is also the basic conversion for the other two units and it should be done simultaneously in all units.

Remove the top and bottom shield covers, and the oscillator cover. The common ground, filament, p.a. plate, oscillator plate, p.a. screen and antenna relay leads should be connected to the power socket at the rear of the chassis as shown in the diagram, *Fig. 3*.

Remove the old antenna relay, and the feed-thru insulator associated with it, and install two coaxial chassis-type connectors for the antenna connections. From the bottom of the unit, remove the ceramic-insulated keying relay, and by rearrangement and bending of the contacts, make it over into a new s.p.d.t. antenna relay, and mount it in the holes on the front panel where the old one was mounted. Rewinding is not necessary, as it will operate on 12 volts. Now, go back under the chassis and install a closed circuit jack for p.a. plate current measurement in the lower left corner of the front panel. Connect the ungrounded side of this jack to the cathodes of the 1625's, and bypass *both* ends of this lead to ground with 0.001 μf mica condensers. Rewire all tube filaments in parallel, and remove and discard the 126-ohm resistor mounted in clips on the rear of the chassis. The 20-ohm resistor may be removed from the oscillator plate voltage lead. The circuit diagram of the completed 3.9 mc. unit is shown in *Fig. 3.*

One word of caution is in order. Before replacing the oscillator shield in any of the transmitters, take a piece of transformer cloth or other suitable, good, insulating material, and pass it down between the secondary and primary windings of the oscillator coil. Occasionally, one of the primary leads, as it comes thru the coil form and passes down to the terminal block, may rest against the secondary winding and may break down intermittently after the unit heats up. This fault may be recognized by a very rough, off-frequency signal, and it caused the writer much consternation until the trouble was located after several hours of work.

The 3.9 mc unit may now be tested, after replacing the oscillator shield cover and the top and bottom shields. Use a source of 10-12 volts d.c. for the filaments and 250 volts for the plates, with a 5000 ohm dropping resistor for the p.a. screen voltage. If you are lucky enough to have a unit with the calibrating crystal still in it, you may use it and the magic eye tube for calibration. Without the crystal, the station receiver and frequency meter may be used.

The rotating antenna loading coil is left in the circuit, to permit use of the unit with a wire antenna should the occasion ever arise. However, it should be set at *zero* for operation into coaxial feedline.

14 Mc Transmitter Conversion

The conversion of the 4-5.3 mc transmitter for 14 mc is based upon retaining single dial control, using as many of the original parts as possible, and the use of only one doubler stage. The circuit shown in *Fig. 4* is the result.

First, perform all the basic modifications as described under the 3.9 mc portion of the conversion. Then, change the oscillator of this transmitter to bring it to 7 mc, with bandspread, using the existing dial calibration markings with new figures. The outside winding of the oscillator coil should be reduced to 12 turns by removing turns from the top only. The oscillator tuning condenser located under the chassis should have all but 2 rotor plates removed. One of these remaining plates should be the slotted one for tracking adjustment. Now, at the coil terminals under the chassis, move the grid leak tap from the center of the secondary to the bottom end. Disconnect and discard the p.a. neutralizing condenser. Strip out all wiring and small resistors associated with the crystal and 1629 magic eye tube sockets, and remove the 1629 socket.

The doubler coil is wound of 11 turns of number 24 enamelled wire, spaced to occupy ½" length, on a 5/8" diameter slug tuned form. The crystal

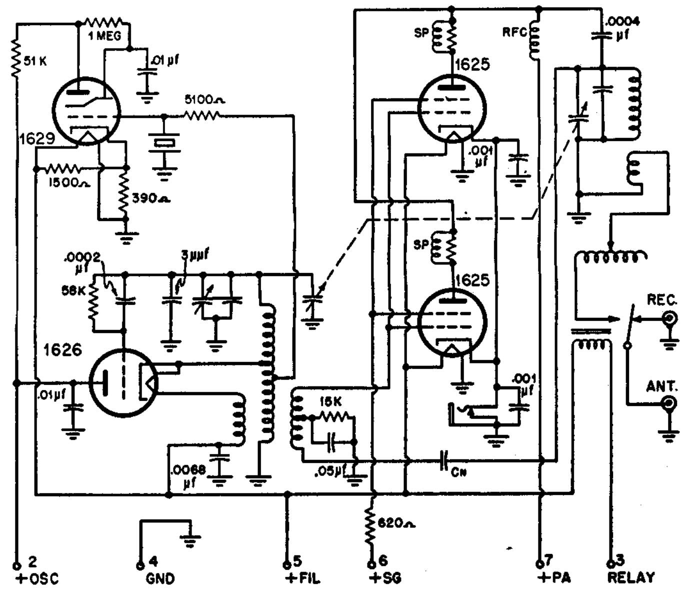


Fig. 3. The 3-4 mc ARC-5 Conversion. This particular transmitter is used on 75 meter phone with considerable success.

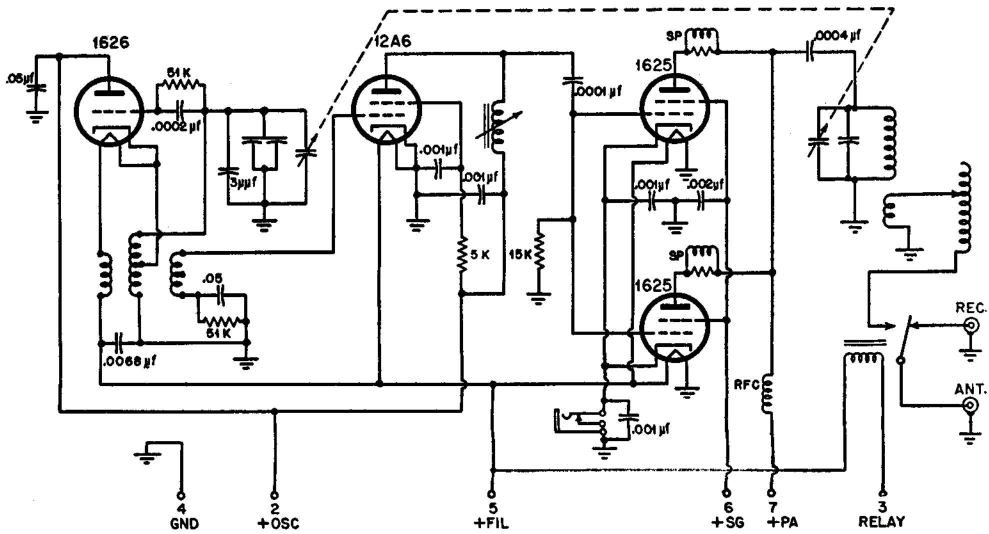


Fig. 4. The circuit of the 14 mc transmitter. The plan here was to use as many of the original parts as possible from a 4-5.3 mc unit.

socket is used for the 12A6 doubler, and the doubler coil is mounted by means of an "L" bracket under the chassis with its adjustment screw sticking up through the vacant socket hole. Wire the doubler stage as shown in the diagram. Now attack the p.a. plate tank circuit, and rewind the coil with its own wire, using only 5½ turns, double-spacing them in the existing grooves. Carefully pull out rotor plates from the p.a. variable tuning condenser until only two are left. Loosen the set screws holding the rotor of the fixed tank condenser, and remove all but two rotor plates. Now the p.a. plate tank on 14 mc will track with the oscillator on 7 mc, giving us our single dial control. The rotary antenna coil may be left in, for use with a wire antenna, or removed, as desired. It should be set at *zero* for coaxial feed, if it is retained.

The transmitter is now ready for test. With plate power applied to the oscillator and doubler only, set the transmitter dial to the desired frequency, say 14 mc, and adjust the fixed oscillator tank condenser under the shield can (it will be necessary to loosen the set screws holding the rotor, and then replace the shield) until the signal is heard in the station receiver on 7 mc. Its harmonic may be heard on 14 mc. Next, check the bandspread, and adjust the slotted rotor plate in the variable condenser under the chassis until proper dial tracking is secured. In the W4RXO transmitter, the new dial markings correspond to the old as follows: 14-4.0, 14.1-4.2, 14.2-4.4, 14.3-4.6, 14.4-4.8. A little painstaking work here will make it possible for you to read frequency directly, and may save you a "pink ticket" from the FCC later on. Slight adjustment of the tuning slug in the oscillator coil may be necessary for proper bandspread or tracking. Once the adjustments have been made, the oscillator should be perfectly stable and should give no trouble.

Now the p.a. may be adjusted. With 250 volts applied to the p.a. plates and the 5000-ohm series dropping resistor supplying the screen voltage, tune the p.a. to resonance by adjustment of the fixed tank condenser under the chassis. Some slight adjustment of the slug in the p.a. coil may be necessary for perfect tracking. Once this condenser is adjusted it may be locked and forgotten, and the p.a. will track with the oscillator over the whole band. Replace the top and bottom shield covers, peak up the doubler coil for maximum drive to the final, and make final frequency adjustments through the holes provided for that purpose. The job is now finished.

28 Mc Transmitter Conversion

This conversion is very similar to the 14 mc job, as may be seen from the diagram, *Fig. 5*. In this case, we bring the oscillator to 14 mc and use one doubler stage to go to 28 mc. For those who may have their doubts, let us state that the oscillator is as stable on 14 mc as it ever was, and also the p.a. operates perfectly on 28 mc, although unneutralized.

Make all the basic modifications as in the 3.9 mc unit. Then remove the 1629 socket, and all parts associated with the crystal calibrating circuit, as in the 14 mc set. The doubler coil in this case consists of 6 turns, spaced to ½" length, on a ⅝" slug tuned form. The doubler coil is mounted as in the 14 mc set, with its adjustment screw sticking up through the vacant socket hole. The oscillator coil is cut down as follows. Remove turns from the top of the coil, leaving 1⅔ turns above the cathode tap. Then remove turns from the bottom of the coil, leaving 4 turns below the cathode tap. Be careful not to damage the fine-wire filament winding which is interwound. Remove turns from the bottom of this winding, until 4 turns are left. This latter operation should be done by cutting a turn, removing turns, and splicing the wire ends together again, rather than by attempting to pass the wire through the hole in the form and down to the terminal block. It is impossible to take the coil apart without ruining it, so we do it the easy way. Next remove all but 3 plates from the oscillator tuning condenser rotor under the chassis, and all but 7 rotor plates from the fixed oscillator tuning condenser above the chassis.

Remove and discard the p.a. neutralizing condenser and leave the bottom of the oscillator coil secondary winding floating. Wire in the doubler circuit. Note that an r.f. choke is necessary in the p.a. grid leak lead. The p.a. circuit modifications are next. We made no attempt to make the p.a. tuning track with the oscillator, as the p.a. tuning under load is broad enough to give good results within several hundred kilocycles of the operating frequency. If it becomes necessary to retune, this is easily done with a screwdriver. With a little cussing and some carefully applied brute force, remove the gear from the p.a. tuning condenser shaft. Yes, it *can* be done! Remove both rotor and stator plates from the p.a. tuning condenser until a total of 11 plates are left. Then drill a ¼" hole in the side of the chassis so that the shaft may be turned with a screwdriver. The old p.a. fixed tank condenser is left unchanged, and is used as the antenna loading condenser, in series with the link. The small parasitic suppressors should be removed from the old tank coil and reused in the 1625 plate leads.

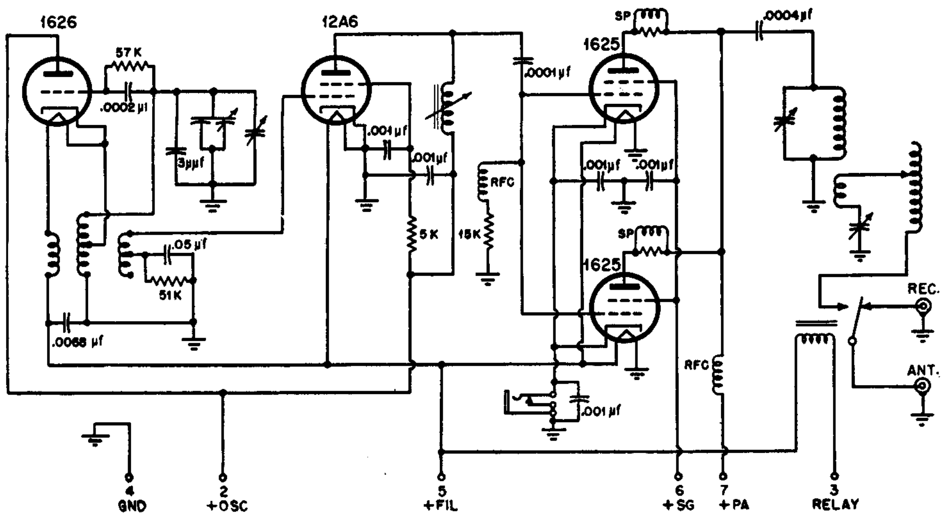
The new tank coil is airwound, consisting of five turns of #12, 1" long, and 1" diameter. The hot end of the coil connects to the tuning condenser stator thru a small feed-thru insulator on which it is mounted. The link consists of 3 turns of #12, ⅞" diameter, and should be mounted on another feed-thru insulator, near the ground end of the tank coil. Once adjusted for proper loading, it may be fixed in position and left alone. Note that shunt plate voltage feed is used.

Apply plate voltage to the oscillator and doubler only, and adjust the oscillator to 14.5 mc in conjunction with the station receiver. Its harmonic should be found on 29 mc. It is simpler in this case to disregard old dial markings and either paint them out, or make a new dial plate and calibrate it, than to attempt to align the oscillator to any of the old markings. Replace the oscillator shield can and again adjust the oscillator to 14.5 mc. Apply plate and screen voltage to the p.a., and tune the p.a. tank to resonance. The antenna loading condenser shaft should be left unlocked so that it may be adjusted in the final installation. Replace the top and bottom shields on the unit, peak up the doubler circuit, and again adjust the oscillator to frequency, and calibrate the tuning dial from 28 to 29.7 mc. The conversion is now complete.

Power Supply and Modulator

The original ARC-5 modulator also has the 575 volt dynamotor mounted on it. This is a 28 volt machine; it is useless to us and may be discarded. Save the mounting plate, however, and mount a DM-34-D 12 volt machine on it. The output of this dynamotor is 625 volts, which is just fine for our purpose. Strip out the tone oscillator, and install a VR-105 in the old 12J5 socket. Replace the two large 15,000-ohm resistors with two 5000-ohm resistors of the same size, and connect these in parallel. Remove all cable sockets except the one with 12 contacts. Cover the vacant holes, and mount a

Fig. 5. The 28 mc conversion is somewhat similar to the 14 mc transmitter.



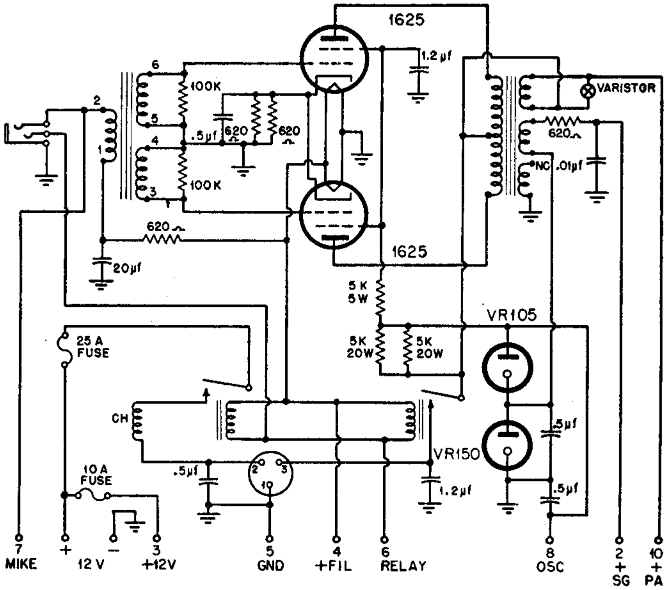


Fig. 6. The final modulator schematic. Note that this unit now supplies the power to the oscillator through the voltage regulator tubes.

heavy terminal block for the 12 volt leads from the battery. Rewire the 12 volt lines to the dynamotor plug with #12 wire. The relays will operate on 12 volts with slight adjustment of the contact springs. The final circuit of the modulator unit is shown in *Fig. 6.* Note that this unit supplies both plate and screen modulated voltage to the power amplifier, as well as unmodulated, regulated voltage to the oscillator. We chose plate and screen modulation rather than simple screen or clamp-tube modulation because we wanted to get the most out of our transmitter. With only 60 watts input, every watt of modulated output counts, especially in mobile operation.

The circuit of the remote control box is shown in *Fig. 7.* It contains the *receiver on-off* switch, which turns on all filaments and the receiver dynamotor, a transmitter *plate on-off* switch, a *phone-speaker* switch, a *volume control,* and a *loudspeaker.* All this is mounted in a metal box about 7" x 5" x 3" deep. The handset plugs into the two jacks. The handset has both microphone and receiver in it, together with a push-button for transmitter control. A loudspeaker silencing relay is also included in the control box, and it is connected so that it silences only the speaker. Thus the handset receiver may be used to monitor one's own signal if desired.

The control circuits are shown in *Fig. 8.* Terminal numbers are shown. It is best to purchase the plugs which fit the various cable sockets on the racks and modulator unit. They are listed here for those who do not have instruction manuals which give this information.

ARC-5 Modulator ——— *9589*
SCR-274N Receiver Rack — PL-152, PL-151
SCR-274N Transmitter Rack — PL-154, PL-156

If you are not able to find these plugs, the sockets may be removed and standard octal fittings substituted.

Installation

The W4RXO mobile instalation is in a 1949 Chevrolet sedan, with the modulator unit in the right rear fender cavity in the trunk. This saves most of the usable trunk space. The cables go through a hole behind the rear seat, which is thus concealed, and run under the front edge of the rear seat, under the floor mats alongside the hump in the floor, and up to the front bulkhead under the dashboard. The receiver and transmitter racks are bolted together and are mounted under the dashboard. This makes a very neat mounting and enables a quick change of units when changing bands. The control box mounts under the dashboard, on the driver's side. The handset is hung on the dashboard in a mounting bracket made of copper tubing. The transmitter plate current meter is plug-in, and is used only in tuning up and testing.

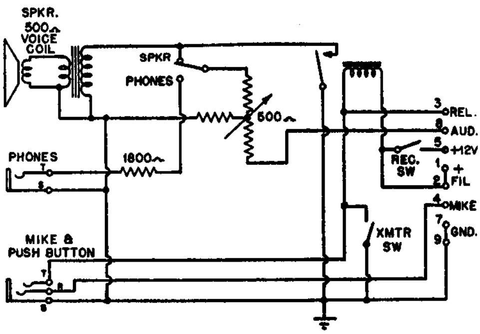
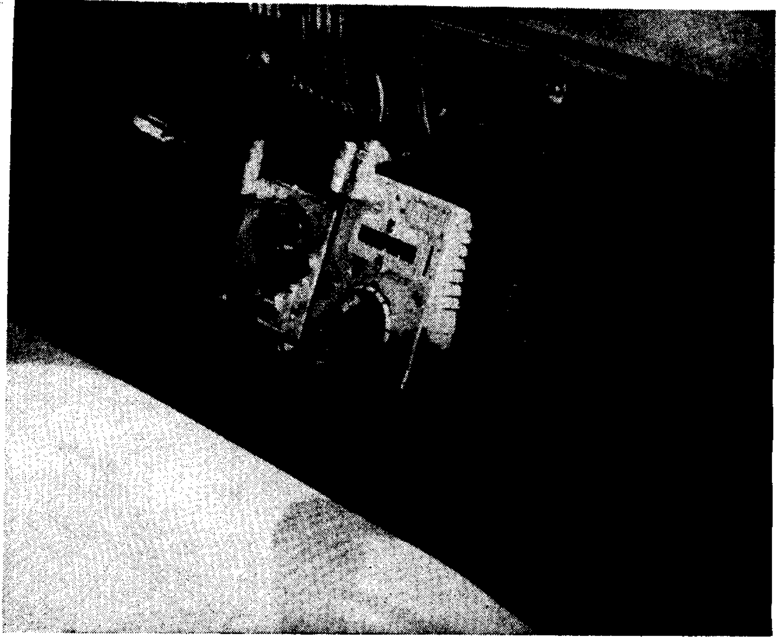


Fig. 7. The control unit is from TCS surplus.



The finished product — a sensitive receiver and a stable moderate power transmitter. Provisions for working on three bands by switching units.

Antenna

The writer decided to use a standard, manufactured, center-loaded whip, with replaceable loading coils, for quick band-change. It is mounted on the left rear fender, as high as possible, and is fed through RG8/U coaxial line with the shield grounded to the car body at the base of the antenna. Once the loading coils are cut to size with the aid of a grid-dip meter, no further adjustment is necessary. We found that removing the coil shield gave a stronger signal on 75 meters. If this is done it will be necessary to rewind the coil with smaller wire, because more turns will be required. Also, on 75 meters, cut the loading coil for maximum transmitter loading at 3970 kc. The drop-off in loading as you QSY to 3800 can be made up by running in about 5 or 6 turns of the variable loading coil in the transmitter. If you cut your antenna coil for 3900 kc, there is no way to make up the large drop in loading which occurs as you QSY to 4000 kc.

That completes our mobile installation. One final word of caution—use a heavy lead between the batteries, and from the batteries to the modulator unit, and a short heavy jumper from the modulator unit to the car frame, in order to keep voltage drop in the 12 volt circuit to a minimum. The loss should be no more than a fraction of a volt under full load, and this can be accomplished with sturdy, heavy, leads, plugs, and connectors. Suitable battery cable and connectors may be obtained at any automobile supply store. In our car, the negative terminal of the battery is grounded to the frame. Should your car have the positive grounded, it will merely be necessary to reverse the dynamotor's low-voltage leads. To make the connection to the car battery from the extra battery, drill and tap the positive (or negative, as the case may be) battery post to take a ¼-20 screw, about ½" long. The lug on the jumper cable may thus be securely bolted to the top of the battery post, without disturbing the car wiring in any way.

With the antenna described, each of the transmitters may be easily loaded up to 100 milliamperes plate current, at about 575 volts. A husky, well-modulated signal is put out by this installation, and results are limited only by band conditions and the amount of high-powered QRM that piles up on our frequency. We have worked 1000 miles on 75, and all U. S. districts and several foreign countries on 20 and 10 at the present writing.

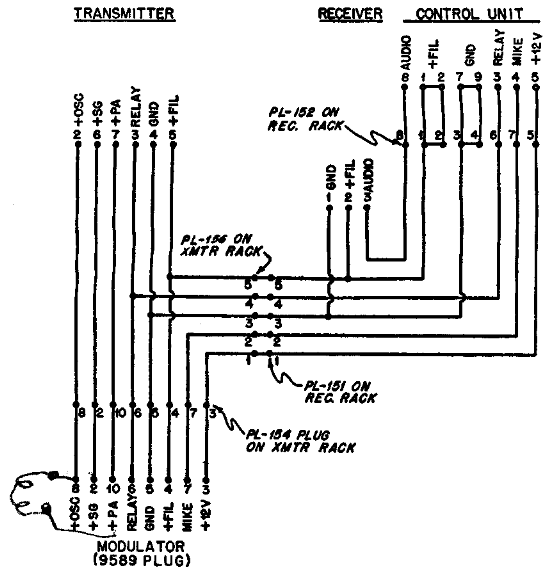


Fig. 8. The control circuits

Forty-Meter Mobile With Your ARC-5

Lt. Cdr. PAUL H. LEE, W4RXO

Box 116, Isle of Palms, S. C.

The two units described below are published in order to augment the ARC-5/SCR-274 mobile converion

Receiver (BC-445)

As the receiver already covers the desired frequency range, its' conversion is very simple. The basic modifications are very similar to those described in our original article. We added the tuning knob, the BFO switch, and the r-f gain control, as in the other units. However, in this unit we did not wire all the filaments in parallel, for operation on 12 volts. We merely substituted 6-volt tubes for the 12-volt tubes in the first four positions, as follows: 6SG7 r.f., 6K8 mixer, 6AC7 1st i.f., 6AC7 2nd i.f. We could find no simple substitute for the 12A6 which would work in series with a 6SR7. Therefore, we did connect these two filaments in parallel, and left the 12SR7 and 12A6 in place.

With the installation of the coaxial jack on the front panel, and the proper connections to the power plug on the rear, the modification is complete. We now have a very "hot" little receiver for forty meter phone or CW work. Even if you aren't interested in mobile work, it still is a valuable addition to a fixed staton.

Transmitter (BC-458)

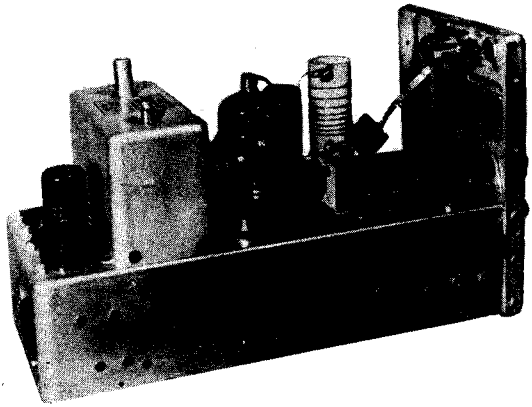
Now let's take a look at the transmtter. We could have made it very easy for ourselves and bought a 7-9.1 mc. transmitter in the first place. However, these units are more expensive for the obvious reason that they are useful for forty, so we purchased one of the 5.3-7 Mc units. With a very slight amount of work, in addition to the basic modifications, we can make this unit cover the desired frequency range and still make use of the calibrated dial.

The basic modifications, as in the 3.9-Mc unit previously described, consist of wiring the filaments in parallel for 12-volt operation, installation of two coaxial jacks on the front panel, removal of the old antenna relay and replacing it with the ceramic-insulated relay from below the chassis after modifying same, and installation of a plate current jack on the front panel. The final circuit diagram is the same as that of the 3.9-Mc unit, shown on page 58 of the May (1952) issue.

Now, for the frequency conversion. Remove the oscillator shield can, and loosen the set screws holding the rotor of the fixed padder condenser. Drill a ¼" hole through the shield can so that the shaft can be turned with a screwdriver when the shield is replaced. Now go under the chassis and loosen the set screws holding the rotor of the fixed p.a. padder condenser. Remove two rotor plates from the variable oscillator tuning condenser, and likewise two rotor plates from the variable p.a. tuning condenser. On the oscillator coil, short the last turn at the top, by soldering a short across it at the lug where it ends. Now go counterclockwise from the lug and solder another short across the top turn at this point. Solder a short across the top turn of the p.a. coil at the lug where it ends. Now replace the oscillator shield can, and plug the transmitter into the rack in the car, or apply power to it by other means. Set the tuning dial at 6.0, and by means of a screwdriver through the hole in the shield can, adjust the oscillator frequency to 7.0 Mc. Quickly tune the p.a. to resonance by adjustment of the padder condenser beneath the chassis with a screwdriver. Plate current at resonance should be about 40 milliamperes as read on the meter in the cathode lead. Now turn the tuning dial to 6.1. The frequency of the transmitter should be 7.1 Mc. With the dial set at 6.2, the frequency should be 7.2 Mc., and at 6.3 on the dial, the frequency should be 7.3 Mc. If the desired spread is not quite right, it can be adjusted by means of the variable slug in the oscillator inductance, adjustable from the top of the shield can, and by variation of the trimmer condenser, also reached through the top of the shield can. However, if these instructions have been followed, the calibration should be very close over over the whole 7.0-7.3-Mc. band.

The antenna loading coil is wound experimentally and checked for resonance on 7.2-Mc., by means of a grid dip meter. With the antenna connected to the transmitter, the p.a. plate current should be about 100 milliamperes at full coupling. Recheck the p.a. resonance, and the oscillator frequency, under full load, before tightening the set screws on the padder condensers. The rotating antenna loading coil is left at zero for operation into coaxial feedline.

If desired, the 6-Mc. markings on the dial may be painted out and 7-Mc. markings substituted. However, this is not necessary if you just remember to mentally add one megacycle to the dial readings to obtain your operating frequency.



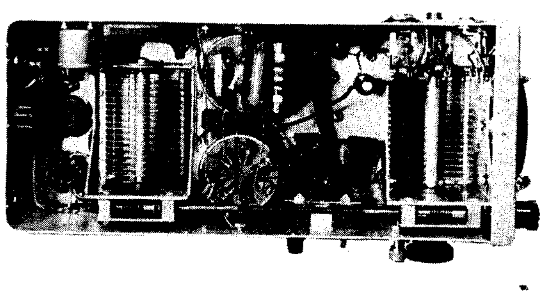


Fig. 4 (left). All components forward of the PA tubes are removed from the chassis top, and replaced by the frequency multiplier tubes, PA plate circuit, antenna relay and germanium crystal monitor. Fig. 5 (right). The frequency multiplier slug-tuned coils and other components, together with the plate feed choke, L7, are mounted in space made available by the removal of the original PA plate padding capacitor. The screen resistor and bypass condenser and the grid choke and resistor are mounted adjacent to the 807 socket.

Mobile with the SCR-274N

GEORGE M. BROWN, W2CVV*

The complete modification and installation of the SCR-274N 10-meter mobile station shown on the cover. It is equally well adapted to fixed station operation.

MOBILE OPERATION is an important phase of amateur radio, not only because it affords an opportunity to work under special conditions, but because it places the ham in a position to render valuable emergency service to his community. Mobile stations are the heart of any effective emergency network and ground coverage of a 10-meter mobile station provides effective short-haul communications. The chance to work skip DX under normal operating conditions makes 10 a fascinating band for mobile operation.

The principal obstacle to this type of operation seems to be that the necessary equipment occupies space which can ill be spared in the average family vehicle. Once the 10-meter mobile bug had bitten W2CVV, the least objectionable course to all members of the family seemed to be to work out a system involving the least possible dislocation of the normal space and functioning of the car. This resulted in the following list of desirable, or should we say essential, requirements. They apply particularly to the transmitter, since that is the subject of this paper. Reference to the associated broadcast receiver and converter are included herein only when necessary to the explanation of the transmitter design and operation.

1. The space required, particularly in frequently used locations such as the trunk, should be kept to a minimum.

2. The equipment should operate from the standard car battery and generator without frequent battery recharging being required. Item 1 effectively disposes of the possibility of extra batteries or a gas-engine-generator.

3. The transmitter should be amplitude modulated, with modulation capability of essentially 100% with low distortion. NBFM has possibilities and would certainly permit higher carrier output within the limitations imposed by item 2, but both experience and theory have firmly convinced the writer that until the time when at least a large proportion of amateurs are using receivers equipped with efficient limiters and discriminators or ratio

**14 Kingsland, N. Tarrytown, N. Y.*

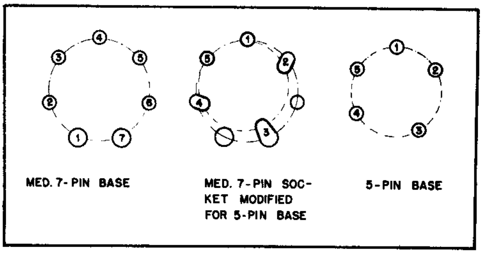


Fig. 1. 7-pin 1625 sockets may be modified to take 807s. In the scale drawing, the center illustration shows the 5-pin socket superimposed on the 7-pin, with the three holes filed to fit.

detectors, AM will do a better job, with less distortion and better signal-to-noise ratio.

4. Within battery and generator limitations, the maximum possible power output is essential. It seemed reasonable to expect that output in the order of 15 to 20 watts to the antenna would be obtainable.

5. Although crystal control is conventional with mobile transmitters, it is believed that a v.f.o. of sufficient stability, both electrical and mechanical, is highly desirable.

Although the approach of the purist to these requirements would probably involve the development and construction of a transmitter specifically designed to meet them, such a procedure would involve quite an extensive and time-consuming program. Consideration of the various suitably convertible pieces of equipment available on the surplus market resulted in the selection of the 4 to 5.3-mc transmitter of the SCR-274N or ARC-5 equipment. For those unfamiliar with this item it consists of an excellent and extremely stable v.f.o. with direct frequency calibration driving a pair of 1625s (12-volt 807s) as a power amplifier. Modulation, when used, was provided by an external unit. The power amplifier plate tuning is ganged to the oscillator by separate worm drives and a built-in loading coil is provided to permit operation into a short antenna.

The reason for the selection of this particular fundamental frequency range may seem a bit obscure, since it does not fall in any amateur band. However, the addition of a tripler and doubler with a total multiplication of 6 pushes the frequency range up to 24 to 31.8 mc, covering the 11 and 10-meter bands with adequate overlap at both ends. Although a similar transmitter having a fundamental range of 7 to 9.1 mc would have required a total multiplication of only 4 to provide 28 to 36.4-mc

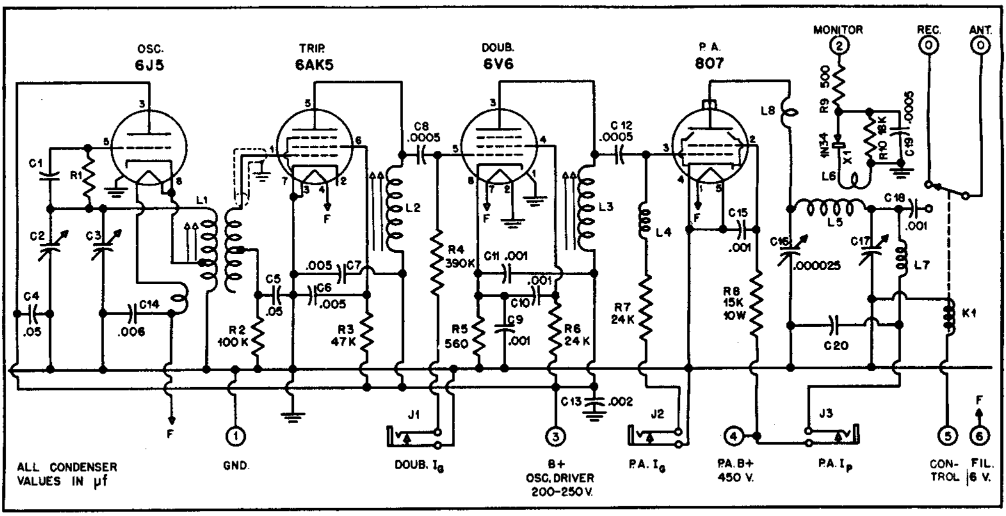


Fig. 2. Circuit of the SCR-274N 4-5.3 mc transmitter modified for 27-30 mc coverage.

C1—Oscillator grid coupling capacitor. (Unchanged)
C2—Oscillator tank circuit padder. (Unchanged)
C3—Oscillator tuning capacitor. (Unchanged)
C4—.05 µf. (Unchanged)
C5—.05 µf. Part of C4.
C6, C7—.005-µf mica.
C8, C12, C19—500-µµf mica.
C9, C10, C11—1000-µµf ceramic.
C13—.002-µf capacitor. (Use old PA screen bypass.)
C14—.006-µf capacitor. (Unchanged)
C15—1000-µµf ceramic.
C16—PA plate tuning capacitor, 25 µµf.
C17—Antenna loading capacitor. (Use old PA plate padder.)
C18—.001-µf mica.
C20—PA plate bypass capacitor. (Use original capacitor, mounted between two PA tubes under chassis.)
L1—Oscillator coil system. (Unchanged)
L2—Tripler plate coil. Iron core tuning. 34 turns No. 28 enameled wire, 3/8" diameter, 1/2" long.
L3—Doubler plate coil. Iron core tuning. 7 turns No. 22 enameled wire, 3/8" diameter, 3/8" long.
L4—PA grid choke, Millen 34-100.
L5—PA plate coil. 9 turns No. 16 tinned copper wire, 1" diameter, 1 1/2" long.
L6—Crystal monitor coil. One turn No. 14 wire, 1/2" from low end of L5.
L7—PA plate feed choke. Millen 34100.
L8—Parasitic choke. 5 turns hook-up wire, 3/8" diameter.
J1—Doubler grid current jack, closed circuit.
J2—Power amplifier grid current jack, closed circuit.
J3—Power amplifier plate current jack, closed circuit, mounted on insulating washers.
R1—Oscillator grid leak. (Unchanged)
R2—Tripler grid leak. 100,000 ohms, 1/2 watt. Mounted in same location as old PA grid leak.
R3—47,000 ohms, 1/2 watt.
R4—390,000 ohms, 1/2 watt.
R5—1000 ohms, 1/2 watt.
R6,R7—24,000 ohms, 1/2 watt.
R8—15,000 ohms, 10 watts.
R9—500 ohms, 1/2 watt.
R10—18,000 ohms, 1/2 watt.
K1—Antenna switching relay. See text.
X1—Germanium crystal, 1N34.

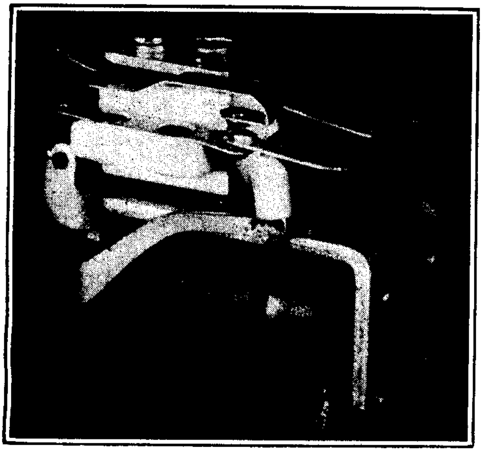


Fig. 6. Rearranging the contacts and rewinding the coil of the salvaged keying relay provides an excellent ceramic-insulated antenna switching relay.

output, the fact that the 11-meter band was not included in this range, together with the lower price usually asked for the 4 to 5.3-mc version, caused the selection of the lower frequency unit.

Tube Substitution

The original transmitter has the 12-volt tube heaters connected in series-parallel for 24-volt operation. Since 6-volt operation is required for most mobile applications, it will be necessary to substitute 6-volt for 12-volt tubes and to rewire for parallel heaters. A 6J5 is a suitable replacement for the 1626 oscillator and the 807 is electrically similar to the 1625s. Unfortunately, the 1625 sockets are of the large 7-pin variety and will not accept the 5-pin 807 base without modification. This modification is not difficult, however, and is much easier than replacing the tube sockets themselves since thay are spun into aluminum shields. It is made as follows:

Remove all connections from both tube sockets except the old lead running from grid to grid of the two tubes.

The spacing of the filament pins of the 807 is identical to the old spacing in the 1625 socket and these pins will not require modification. However, in the interest of short leads, it is desirable to rotate the connections and use old pins 3 and 4 for the 807 filaments. This will make old pin 7 the 807 grid, old pin 5 the 807 screen and old pin 2 the 807 cathode. These three socket holes will not quite match the corresponding 807 pins and it will be necessary to file the socket insulating material as shown in *Fig. 1* to permit them to enter. Before filing the holes, pull the steel "U" shaped spring of each socket contact back and spring the brass contact material apart to provide access for a small rat-tail file. After the holes have been filed correctly, the steel springs can be pushed back in place, restoring the original tension to the clips.

If external high level modulation is to be used as recommended, it is only necessary to modify one of the PA sockets in this way, since a single 807 will readily accept the 40-watts input. However, if screen modulation is contemplated, or higher power is required, two 807s should be used. The multiplier to be described will be capable of driving either one 807 or two in parallel.

Filament Connections

A filament voltage ballast resistor (125 ohms wire-wound) is mounted on the end of the chassis. This

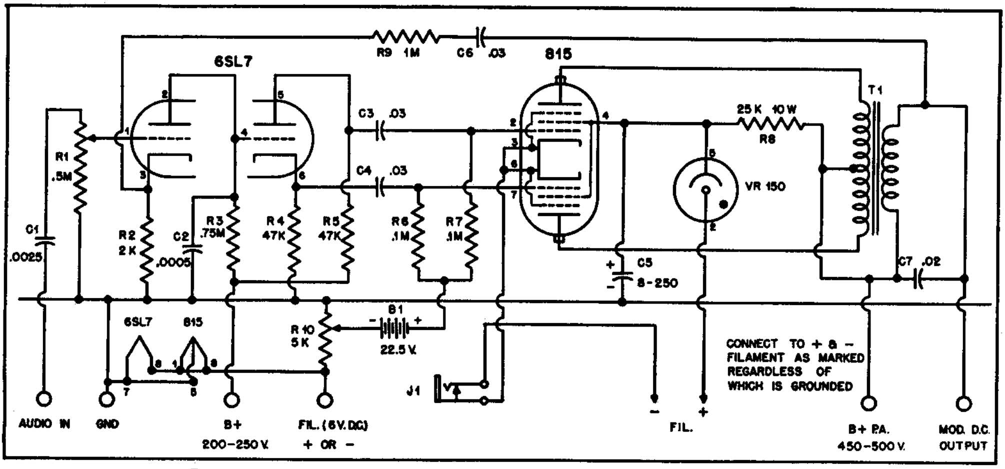


Fig. 7. Circuit of the 20-watt modulator used with the SCR-274N.

B1—22.5-volt small size "B" battery for bias.
C1—.0025-μf mica.
C2—500-$\mu\mu$f mica.
C3, C4, C6—.03 μf, 400 v.
C5—8-μf 250-volt electrolytic.
C7—.02 μf, 1000 v.
J1—Cathode current jack, closed circuit.
R1—500,000-ohm pot., gain control.
R2—2000 ohms, ½ watt.
R3—750,000 ohms, ½ watt.
R4, R5—47,000 ohms, ½ watt.
R6, R7—0.1 megohm, ½ watt.
R8—25,000 ohms, 10 watts.
R9—1 megohm, ½ watt.
R10—5000-ohm pot., bias control.
T1—Modulation transformer, 16,000/5000 ohms.

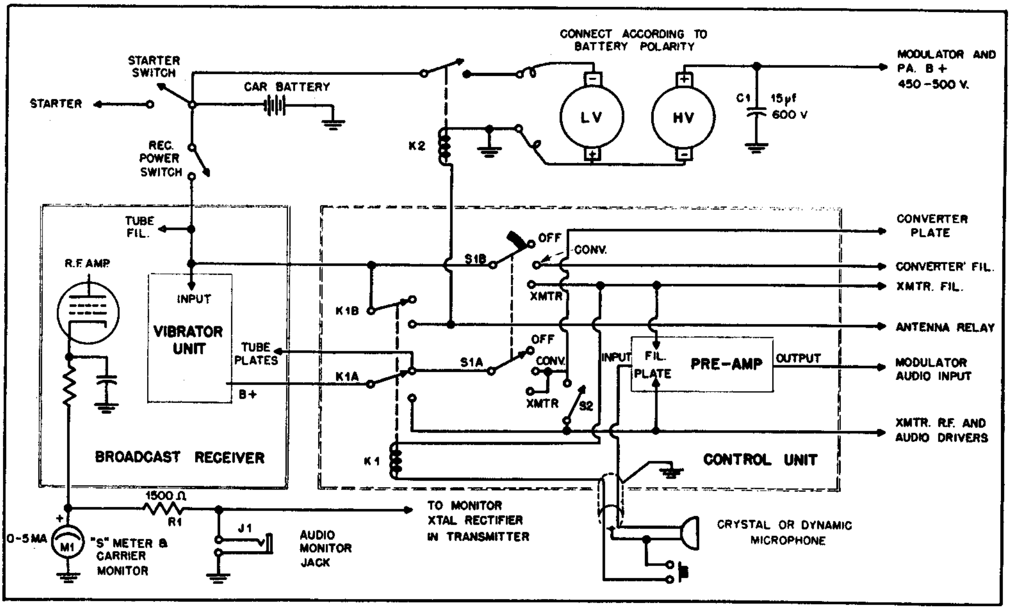


Fig. 8. Power and control circuits for the complete mobile installation.

C1—Filter capacitor, 15 µf, 600 volts.
J1—Audio monitor jack.
K1—Push-to-talk relay, DPDT, 6-volt d-c coil.
K2—Dynamotor relay, SPST, 6-volt d-c coil, heavy duty contacts.
M1—"S" meter and carrier monitor, 0-5 ma or more sensitive movement with adjustable shunt.
R1—1500 ohms, ½ watt.
S1—Control switch, 2-pole 3-position.
S2—Frequency check switch, SPST.

should be removed as it is no longer needed. The original chassis connector mounted beside this resistor can be retained for external connections if a suitable cable connector to match it can be obtained. If not, it is suggested that it be removed and replaced by a 6-pin tube socket. On the unit shown in the photographs, the original connector was retained and an additional one connected in parallel with it mounted beside it. This is not recommended since it congests the chassis and one of them serves no useful purpose.

The filament voltage for the oscillator tube is fed through two sections of *L1*, the oscillator coil, to avoid frequency instability resulting from the conventional oscillator circuit having r-f voltage between cathode and heater. One side of the tube heater is grounded through the tuning coil itself and this connection can remain unchanged. The "hot" heater connection is made by means of a white wire running from one of the oscillator terminals to the ungrounded end of *C14*. *C14* is a 0.006-µf mica capacitor, the smaller of two mounted on the chassis skirt at the end of the oscillator tuning capacitor. Two white leads actually connect to this point on the capacitor, the second one going to the 1629 tuning indicator. The 6-volt heater supply for the 6J5 oscillator tube should be connected to this point.

Since all the old wires have been removed from the PA tube sockets, no difficulty should be involved in rewiring the heaters.

Addition of Multiplier Stages

In order that the transmitter may operate on the 10-meter band a total multiplication of oscillator frequency of 6 is required. This is attained by the use of a 6AK5 tripler and by a 6V6 doubler which in turn drives the 807 amplifier, as shown on the schematic diagram, *Fig. 2.*

Slug-tuned coils are used for tuning the tripler and the doubler plates to obtain maximum band width and gain. No tuning capacity other than the tube and circuit strays is necessary. Since the antenna circuit loads the PA plate tank and consequently broadens it, it is possible to shift frequency over a range of several hundred kilocycles by means of the oscillator control only, without serious detuning.

The first step in the addition of the multiplier stages consists of stripping the top of the chassis from the 807 tube forward. None of the components originally mounted in this space will be used. Beneath the chassis the large air padder adjacent to the PA tuning capacitor, the small fixed neutralizing capacitor and the small relay mounted on the chassis skirt should be removed. Be sure to save this small relay since it will be used later for antenna switching. The neutralizing capacitor leads should be clipped off short and removed.

Before mounting any of the new components, the tuning capacitor originally used for the PA plate should be removed and the gear mounted on its shaft removed. Since this capacitor will be used as the antenna loading control its shaft should be provided with an extension sufficiently long to extend through the chassis skirt to permit mounting a dial. It is suggested that a metal dial and a Millen type 10050 shaft lock be used on this control, as shown in *Figure 3* (front cover center), to avoid accidental movement.

After reinstalling this capacitor, sockets for the 6V6 doubler and the 6AK5 tripler should be mounted along the same edge of the chassis as the worm drives, spaced between the 807 PA socket and the capacitor. The 6V6 should be nearest the PA.

The tripler and doubler coils should be mounted on the chassis skirt approximately in line with their respective tubes and with their slug controls accessible through the chassis skirt. The coils used in the original model were obtained from surplus and probably cannot be duplicated. They happen to have an outside diameter of 3/8″ and the coil winding data are given for this diameter. If it is necessary to use coil forms having slightly different diameters, the number of turns should be changed to correspond accordingly. In any case, adjusting these coils is not difficult providing an absorption wavemeter is available to check the harmonic on which they are operating. It was found convenient to mount the doubler coil in the hole in the chassis skirt originally providing access to the lock on the PA padder condenser. The knob from a telephone type key switch tightly screwed on the end of the tuning slug shaft makes a convenient tuning knob. Any of the commercially manufactured slug-tuned forms, such as the National XR-50, will do a good job.

The various bypass and coupling capacitors and resistors associated with the multiplier tubes should be mounted in such a way that lead length is kept to a minimum. The grid of the 6AK5 should be driven from the same terminal of the oscillator as originally drove the grids of the two 1625s. Since this requires a rather long lead, a piece of shielded

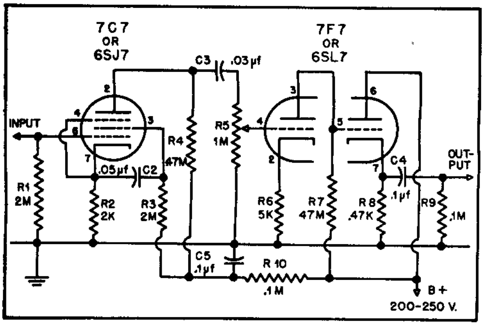


Fig. 9. Circuit of the preamplifier. The preamplifier can be mounted with the receiver or converter, the output connecting to the modulator in the trunk.

C2—.05 µf, 400 v.
C3—.03 µf, 400 v.
C4, C5—.1 µf, 400 v.
R1, R3—2 megohms, ½ watt.
R2—2000 ohms, ½ watt.
R4, R7—0.47 megohm, ½ watt.
R5—1-megohm pot.
R6—4700 ohms, ½ watt.
R8—47,000 ohms, ½ watt.
R9, R10—0.1 - megohm, ½ watt.

microphone cable was used for the connection.

The original grid leak for the PA is a 15,000-ohm resistor mounted between pins 5 and 7 on the crystal socket. Since the same circuit is used to feed the 6AK5 tripler grid, the 15,000-ohm resistor should be replaced by 100,000 ohms (*R2*).

Tuning Jacks

Three tuning jacks should be mounted along the chassis skirt as shown in the photographs, *Fig. 4* and *5*, directly below the old PA tuning capacitor. Be sure that the one for metering PA plate current is well insulated since it will be connected in the hot side of the plate supply. The reason for this is that it is possible to tune and load a pentode or tetrode amplifier much more accurately by means of plate current only, than if plate, screen and grid current are all read, as would be the case if the jack were in the cathode circuit.

PA Plate Circuit

The PA tuning capacitor *C16* should be mounted as near the 807 power amplifier as possible and directly in line with the original loading control. The old loading control shaft should be extended or a new shaft turned out to permit tuning this capacitor from the original front panel loading control location and using the old shaft lock.

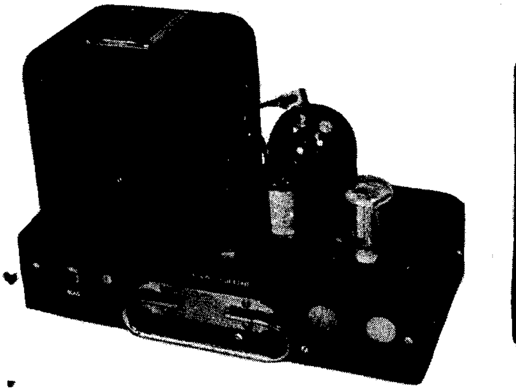
The power amplifier tank coil should be mounted beside the tuning capacitor approximately in the location shown in the photographs, *Fig. 3* and *4*. The bottom of this coil should connect to the stator of the old PA tuning capacitor, now the loading capacitor *C17*, through the mica-insulated feed-through button originally used to connect to this same capacitor. The PA tuning capacitor should connect to the top of the PA tank coil and to the PA plate through the small parasitic choke *L8*. This produces a pi network, which is particularly desirable at high frequencies since it permits low circulating current, good harmonic attenuation and readily adjustable loading. The coil *L5* and the capacitor *C17* have essentially constant r-f current flowing in them, so that the voltage across *C17*, and thus that applied to the antenna circuit is a minimum when *C17* is at maximum. Decreasing the capacity of *C17* increases the voltage and the loading.

Antenna Circuit

The original antenna connector on the panel should be removed, and replaced by a coaxial fitting such as an Amphenol type 83. A similar one should be mounted on the other side of the panel for the antenna connection to the receiver.

The rather fancy relay originally used for antenna grounding on the transmitter is not very well suited for antenna switching. Fortunately, the small relay removed from beneath the chassis can be readily modified to produce an excellent low-power antenna switching relay complete with ceramic insulation. Reference should be made to the photograph of the modified relay, *Fig. 6*. The modification is accomplished as follows:

1. Spring the lower movable contact (the "J" shaped one) by its mate to make them normally closed instead of normally open. There is enough of the silver contact extending through the spring to the wrong side to provide a satisfactory contact.



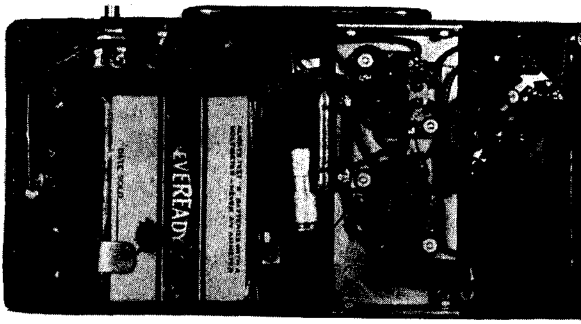


Fig. 10 (left). The 815 modulator, with 815, VR-150 screen regulator and 6SL7 amplifier-phase inverter-driver mounted in recessed sockets. The modulation transformer shown has at least twice the required rating but was used because it was available. The screwdriver-controlled gain potentiometer is just visible behind the 6SL7. Fig. 11 (right): Bottom view of the modulator. The number of components is kept to a minimum by the use of a simple phase inverter and direct coupling between it and the tube that drives it.

2. Remove the contact assembly and discard the small fibre spacer used to operate the top set of contacts.

3. Remove or clip off the top "L" shaped contact spring.

4. Bend the remaining top contact (the straight one) doubling it under itself to make it match up with the movable contact. This provides the normally open connection.

5. Reassemble and adjust. It will be necessary to bend the operating arm of the relay and the stop below it to get the contacts to operate properly.

6. To make the relay operate on 6 volts d.c. instead of its rated 24 volts, remove the wire from the coil and rewind it full of No. 30 or No. 32 enameled wire. Either size will be satisfactory but No. 32 is preferred since there will be less current consumption and less heating of the coil than if the larger size is used. Random winding is satisfactory.

The relay when modified should be mounted on the front panel between the antenna and receiver connectors using the same mounting holes and mounting screws as the old antenna relay. Be sure to make the connections from it to the antenna and receiver connector and to the PA tank coil of substantial conductor to minimize losses.

Monitor Circuit

In order to provide some sort of visual or aural indication of normal functioning of the transmitter, it is suggested that a simple monitor circuit be included. This may readily be done by adding a one-turn coil, *L6*, to the bottom end of the PA tank coil and rectifying the voltage induced in it with a 1N34 crystal. The constants shown on the schematic, *Fig. 2*, will produce suitable level for feeding a pair of phones for aural monitoring or, if desired, operating a carrier indicator meter.

Modulator

The first attempt at applying modulation to the modified transmitter consisted of the installation of a 6V6 in the socket originally occupied by the 1629 tuning indicator and arranged to modulate the screens of two 807s. This system worked fairly well and it was possible to obtain approximately 12 watts of r-f output with total amplifier plate, screen and modulator plate current of 130 ma at 450 volts. Under this condition the maximum positive modulation was between 60% and 70%.

The reports obtained with the screen modulation too frequently were something like: "Your carrier is strong here but your modulation seems a little low." Presumably this was caused by the maximum positive limitation of 60% to 70%. This could have been increased to a full 100%, but with a serious reduction in carrier power output. Accordingly, it was decided that the best expedient would be to build a small external modulator unit capable of modulating some 40 watts of input to the plate and screen of the power amplifier.

It was decided to use an 815. Its maximum plate voltage rating is 500 volts and under Class AB_2 conditions it can deliver a power output of 54 watts. Its zero-signal plate and screen current are low. Although no AB_1 operating conditions are specified in the tube book an experimental setup showed that 20 watts of audio power could be obtained with 450 volts on the plate, 150 volts on the screen and zero grid current. Under this condition the maximum plate current was 80 ma and maximum screen current 10 ma. Static plate and screen current totaled only 30 ma.

Two minor disadvantages appeared, one being that it was necessary to regulate the screen voltage closely between its static value of approximately 2 ma and its full output value of approximately 10 ma in order to obtain high audio output with low static plate current. The other was that this low static plate current prohibited the use of cathode grid bias.

A VR150 regulator was provided for the screen voltage and a 22.5-volt midget B battery was used to supply bias. Since the correct grid voltage to produce the optimum value of static plate and screen current was somewhat less than 22.5 volts, an interesting expedient was employed to use the 6 volts

Continued

available from the automobile battery to buck the bias battery down to the correct value. *Fig. 7* shows how this is done with either positive or negative ground on the car battery. In either case *R10* is used to provide continuously variable grid voltage from 22.5 volts to 16.5 volts.

Since the cathode of the modulator tube is returned to the negative of the car battery, when the positive is grounded this same connection provides an additional 6 volts on the plate of the modulator tube. If the negative of the car battery is grounded, returning the negative of the high voltage winding of the dynamotor to the positive of the battery will produce the same result. In both cases the plate voltage on the modulator tube is 6 volts higher than the dynamotor output. The negative (pin 2) of the VR150 regulator is also connected to the positive of the car battery, regardless of battery ground polarity to provide an additional 6 volts on the 815 screen. It was found that this slight increase in screen voltage provided greater audio output.

Approximately 24 volts grid-to-grid audio is required to drive the 815 modulator to 20 watts output. A 6SL7, with one triode connected as a voltage amplifier and the other as a phase inverter was used to supply this driving voltage. Sufficient gain was available to permit full output with 0.4-volt input. This was somewhat more sensitive than was required and an inverse feed-back circuit consisting of *R9* and *C6* from the secondary of the modulator transformer back to the cathode of the voltage amplifier was used to reduce the gain by a factor of 4 and at the same time reduce distortion.

With this driver, the output of the modulator is rather sharply limited at 20 watts of audio, with the grids of the 815 acting as a peak clipper above this level. In order to minimize splatter resulting from this clipping, *C7* was used to "build out" the leakage reactance of the modulation transformer into a low-pass filter. The value of .02 μf was selected for *C7* because it was found that this gave good response to approximately 3000 cycles and then reasonably rapid attenuation. *C1* was selected to produce low-frequency attenuation beginning at about 200 cycles.

Although a preamplifier and dynamic microphone were used to drive this speech amplifier, it produces adequate gain for direct operation from a carbon microphone.

Top and bottom views of the final modulator are shown in the photographs, *Fig. 10 and 11*.

A similar modulator has been built by W2QJZ around a surplus ART/13 speech amplifier. He removed the 6V6 side-tone amplifier and transformer, making room to mount the 815 in the enlarged transformer mounting hole and an OA2 regulator in the space vacated by the 6V6. Heaters were rewired to take a 6SJ7 speech amplifier and a 6V6 driver. The cathode resistor of the 6V6 can be increased to about 2000 ohms to reduce plate current, since only a small portion of its available power is needed to drive the 815. Sufficient gain is available to permit the use of a low-impedance dynamic microphone without a preamplifier. With this unit, it is necessary to mount the modulation transformer and bias battery outboard at the end of the chassis.

Control and Power Circuits

Fig. 8 shows in detail the control and power circuits. With the switch *S1* in the first or OFF position as shown on the drawing the converter and transmitter circuits are dead and the broadcast receiver functions normally. Plate voltage from the vibrator power supply in the broadcast receiver is disconnected internally from the plates of the broadcast receiver tubes and is brought out to the blade of the push-to-talk relay, *K1*. During reception it returns to the broadcast receiver plates through the back contact of the relay.

When *S1* is advanced to the No. 2 or CONVERTER position, filament voltage is applied to the converter by one set of contacts and plate voltage by the other. An additional switch associated with the converter but not shown is used to take care of the antenna and r-f switching between broadcast reception and high frequency reception through the converter.

When *S1* in the third or TRANSMITTER position, filament voltage is applied to speech amplifier tubes in the control unit, to the transmitter and modulator tubes and to the coil of the push-to-talk relay, *K1*. Under this condition, operating the push-to-talk button on the microphone switches the broadcast receiver B+ from the receiver and converter circuits over to the speech amplifier and audio and r-f driver circuits. This feature is particularly valuable since it saves 40 to 50 ma of plate current which would be required from the high-voltage dynamotor if it were used to supply these low-level stages. The same relay operation applies 6-volt operating voltage to the coils of the dynamotor relay, *K2*, and to the antenna switching relay in the transmitter.

Note that the negative brush of the high voltage commutator of the dynamotor is connected to the positive brush of the low-voltage commutator rather than to ground. The reason for this is that when a battery with negative ground is used, the battery voltage is added to the dynamotor output voltage producing an extra 6 volts for the modulator and PA plates.

The only filter found necessary for the transmitter high-voltage supply was a 15-μf capacitor, *C1*, connected across the high-voltage output. No filter choke is needed since the internal inductance of the dynamotor itself serves as an effective choke.

In order to save space in the trunk and to keep the high-current leads from battery to dynamotor as short as possible, the high-voltage dynamotor (450 volts at 175 ma) with its associated relay and filter capacitor is mounted on the bulkhead under the hood.

On the control circuit diagram, *Fig. 8*, are shown the "S" meter connections used to provide carrier monitoring during transmitting periods as well as normal "S" meter functioning. The "S" meter is connected in the cathode circuit of the r-f amplifier of the broadcast receiver. With no signal being received, the meter sensitivity is adjusted by means of a variable shunt, not shown, to provide full scale deflection. When a signal is received, the a.v.c. of the receiver reduces the r-f amplifier plate current causing a corresponding reduction in meter reading.

During transmitting periods, the r-f amplifier plate current is zero since plate voltage is removed from the receiver circuits. Rectified r-f supplied by the monitor circuit shown in the transmitter takes its place in the meter. With the constants shown (500 ohms in series with crystal in the transmitter and 1500 ohms, *R1*, in the control unit) and with the coupling to the PA tank coil provided by one turn approximately ½" from the low end of the coil, the rectified current is 2 ma.

J1 on the panel of the control unit provides a strong signal in a pair of phones for aural monitoring of modulation. *R1*, in addition to limiting the crystal current to a safe value, prevents the "S" meter from shortening out the monitor jack.

An additional switch *S2* is provided for checking transmitter frequency in the receiver. When *S1* is in the transmitter position and the PUSH-TO-TALK button is not pressed, closing *S2* applies plate voltage to the oscillator and frequency multiplier stages of the transmitter without de-energizing the receiver. This permits checking the point on the converter dial where the transmitter signal is located or even setting the transmitter frequency to zero beat with an incoming signal. Since the transmitter v.f.o. frequency calibration is highly accurate, it also permits obtaining an accurate calibration on the converter.

A preamplifier to permit the use of a low-level microphone is included in the control unit. A detail of its circuits is shown in *Fig. 9.* It operates in straight-forward fashion with two stages of amplification direct-coupled to a third stage used as a cathode follower to provide a low-impedance source for feeding the line back to the modulator. It provides sufficient gain to permit operating from a 50-ohm dynamic microphone (salvaged from a surplus B19 tank set). Its maximum output is 8 to 10 volts. Although this may seem like an excessive amount of speech amplification, the total plate current consumption by this preamplifier is only 2 ma and the additional speech amplifier included in the modulator unit requires only 2 ma more. It is believed that the improvement in audio quality resulting from the use of the dynamic microphone justifies the additional circuit complexity.

Lock-in type tubes were used in the preamplifier since they were mounted in an inverted position.

Antenna

The antenna used is of the type normally encountered on police installations and includes a coil spring at the base to provide flexibility in going under low obstructions. It was found important to include a flexible connection between the upper and lower spring fitting since depending on a connection through the spring itself gives rise to inductance variation and detuning as the antenna sways.

Although the antenna could be mounted on the rear bumper as is frequently done, experience with previous police installations has shown that a higher mounting point produces much greater radiation efficiency. Accordingly, the antenna was placed at as high a point on the body as was possible. In order to avoid drilling holes in the car body, a special bracket was fabricated of ⅛" sheet steel curved to fit the body and bolted to the flange inside the trunk cover. It extends through the crack between the trunk cover and the body and provides a sturdy and sufficiently rigid mount. This mounting is shown in the photographs on the cover. Note that four bolts are used to secure the bracket to the car body and that it was made in the form of a gusset in the corner of the trunk opening thus providing much more strength than if it had been mounted at one edge only.

The small loading coil shown in the photographs was found to provide a somewhat better match and better loading since the antenna itself is slighly shorter than a quarter wave.

Due to the proximity of the trunk cover to the base of the antenna, it has been found that opening the cover has a slight effect on antenna loading and PA tuning. Accordingly, the final loading and PA tuning adjustments are made with the trunk closed except for a crack wide enough to permit reaching in to the controls and to peek in at the PA plate current meter.

Adjustment

Because the substitution of the 6J5 oscillator for the 1626 and the change in the circuit which the oscillator drives will have a slight effect on the frequency calibration, it will be necessary to recalibrate the oscillator to make the indications on the dial correct. This may be done by any convenient means and using any signal of known frequency in the oscillator range. WWV on 5 mc is suggested. The compensation should be accomplished by adjusting the oscillator padding condenser trimmer, accessible through the top of the oscillator shield, until the oscillator is on frequency at one point. Since the oscillator inductance is not disturbed during the modification this should provide correct calibration at all dial settings. If the oscillator coil inductance is found to be off, it may be easily corrected by the slug adjustment provided.

During adjustment of the low-level stages, plate and screen voltage should be kept off the power amplifier. When the oscillator is on calibration, set it so that its sixth harmonic is at the desired point in the 10-meter band, and adjust the tripler tuning coil, *L2*, for maximum grid current on the 6V6 doubler. It should be possible to obtain 300 to 500 microamperes. After tuning for maximum grid current, check the frequency with a wavemeter to be sure that the third harmonic of the oscillator has been selected.

The doubler plate coil, *L3*, should next be adjusted for maximum grid current on the power amplifier and the frequency checked with a wavemeter to be sure that it is tuned to the sixth harmonic of the crystal. Grid current of from 2 to 3 ma should be obtainable.

With the antenna connected to the transmitter, the loading capacitor, *C17*, should be set for its maximum capacity. Plate voltage and excitation should be applied to the 807 and its plate tuned for minumum by means of *C16*. The capacity of *C17* should now be decreased and after each change *C16* reresonated until correct loading is obtained. With 450 volts on the plate of the 807 it was found that 90 ma was optimum loading since the efficiency dropped off rapidly with heavier loading.

Care should be used in adjusting the power amplifier, since it is provided with grid leak bias only. This is not as dangerous as it is with a crystal-controlled transmitter, since there is little chance of the v.f.o. failing to oscillate. The addition of a cathode resistor large enough to protect the 807 in case of loss of excitation would dissipate an appreciable portion of the plate voltage with consequent reduction in power output.

After all adjustments have been made to the transmitter, the oscillator frequency control, the loading control and the PA plate tuning should all be locked to prevent their shifting under vibration.

It will be found that small changes of frequency may be made when desired without readjusting the multiplier and power amplifier tuning controls All that is necessary is to set the oscillator frequency control to the correct point.

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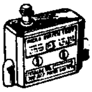

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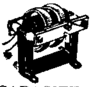

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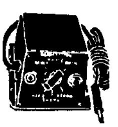
75 Carbon Resistors*	250 ft. Hookup Wire
36 Panel Lamps	100 Fuses
10 Electrolytic Cond's	35 Ceramic Cond
15 Volume Controls	10 Rotary Switches
25 Tube Sockets	6 Crystals
50 Tubular Cond's	60 Inductors & Coils
300 Lugs & Eyelets*	5 Microswitches
10 Bathtub Oil Cond's	10 Wheat Lamps
5 lbs. Surprise Kit	40 Insulators
10 Xmit Mica Cond's	* In Plastic Box

ONE KIT EACH .... only **99¢**

NEW Q-5er FILTER



Navy Mfgr. U.T.C. Chop off QRM by turning knob to pass only 1000 cycle with enough width for code or speech, rejects all else. Or turn knob to pass everything. With phone plug & jack, plugs into receiver.
Special $2.98 @ ; 4 for $10
FILTER FL-5, Range or Voice. Filters 1020 cy audio, excellent for CW...59c; 2/$1

TOP $$$$ PAID FOR LAB TEST EQUIPMENT Kay, G.R., H.P., L&N, G.E., RCA, DuMont, Tektronix, Weston, Boonton, Measurements, Ballentine & others.

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TUBES

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OA2	$ .74	2K29	28.85	6BL7	Q	245A	15.00	717A	.29
OA3/VR75	.89	2K30	100.00	6C4	.35	250TL	12.00	723AB	8.00
OB2	.60	2K33	120.00	6F4	2.99	252A	7.95	726B	25.00
OB3/VR90	.84	2K39	100.00	6H6	.49	254A	4.00	726C	21.75
OC3/VR105	.59	2K41	95.00	6J7	.85	259A	Q	807	1.19
OD3/VR150	.57	2K45	50 00	6L6	1.55	274B	1.95	808	1.75
1AD4	1.00	2K50	165.00	6Q5G	3.65	275A	3.45	809	2.75
1AH4	1.00	2K55	15.00	6SL7GT	.76	276A	8.45	811	3.85
1B3GT	.69	2V3G	.98	6SN7GT	.72	303A	6.75	812	3.85
1B23	5.00	3A4	.58	6SU7GT	2.75	304TH	11.00	813	10.00
1B24	4.95	3A5	.39	6Y6GT	.59	304TL	18.00	814	2.98
1B26	1.00	3B4	2.00	6X4	1.00	307A	.59	815	2.25
1B27	10.00	3B22	1.50	6Y6	.79	310	4.50	828	4.85
1B29	9.95	3B24W	5.00	7C4	.07	BL315	Q	829B	8.49
1B35	4.50	3B28	5.00	8D21	150.00	322	6.90	832A	5.00
1B37	6.00	3C22	72.00	12AL5	.60	323	10.50	837	1.95
1B41	50.00	3C33	7.50	12A6	.39	324A	Q	866A	1.25
1B42	4.00	3C34	4.95	12AU7	.50	348A	6.90	872A	1.29
1B46	1.25	3C45	8.00	12AX7	.72	349A	10.00	875A	18.00
1B56	30.00	3D21A	3.95	12AY7	.65	350	3.00	889A	75.15
1B63	19.00	3D23	4.98	12H6	.63	353	3.75	931A	4.50
1D21	4.95	3K23	150.00	12K8	.69	354	15.00	991	.20
1L4	.58	4B27	2.50	SRC12	200.00	355	12.00	1005	.35
1T4	.65	4B36	4.75	15E	1.25	356	4.00	1620	3.00
1Z2	1.95	4J31	215.00	NE16	.25	359	1.70	1625	.30
2A3	.98	4J51	215.00	SRX16	125.00	366	Q	1629	.30
2A4G	1.98	4J52	50 00	FG17	2.60	368AS	3 95	2050	.95
2C43	9.00	4J53	Q	24G	3.00	371B	.85	5517	2.10
2C44	.30	4X150A	22.50	25A6	1.65	380A	.80	5844	.85
2C51	3.95	4X500A	65.00	25T	3.35	387A	4.00	5870	98.00
2C52	2.75	5AW4	1.17	28D7	.75	388A	1.15	5875	2.05
2D21	.75	5C22	19.10	35T	3.00	394A	1.85	5879	1.50
2E22	1.89	C5B	1.00	HK54	4.00	395A	4.25	5881	2.95
2E30	1.95	5D21	7.95	RK59	1.88	399A	4.50	5965	1.85
2E31	1.75	5R4WGY	3.00	FG67	12.00	403B	2.65	8008	3.90
2E32	1.00	5T4	1.45	QK81	50.00	421A	6.90	8011	1.50
2E35	1 95	C6A	6.59	82	1.20	460	17.00	8013A	3.95
2E36	2.15	6AG7	1.14	83	2.25	WE417A	15.00	9001	.80
2E43	1.50	6AH6	1.29	83V	1.25	CK502	1.70	9003	1.25
2G21	1.75	6AK5	.75	FG105	11 00	CK503	1.00	9004	.28
2J21	2.95	6AK6	.55	FG166	6.75	CK525	2.95	5BP1	2.49
2J27	5.99	6AN5	2.25	FG172	19.50	CK526	1 75	5BP4	2.95
2J34	14.50	6AQ5	.45	FG190	7.00	CK531	1.89	5CP1A	9.00
2J48	10.00	6AQ5W	1.95	HF200	12.50	CK532	2.50	5JP7A	39.00
2J50	35.00	6AQ6	1.10	203A	2.50	CK536	1.55	5LP1	16.50
2J55	35.00	6AS6	1.20	204A	25.00	538DX	.98	5LP2	27.50
2J56	40.00	6AS7G	2.50	RX215	27.00	539DX	2.50	5LP7A	45.00
2K22	14.00	6B4G	.95	RX233A	.70	707B	3.95	5SP7A	95.00
2K23	12.50	6BD4A	8.73	242C	12.50	715B	3.85	7BP7	9.00
2K25	15.00	6BL6	31.00	244A	15.00	715C	12.00	10KP7	39.50

"TAB"

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New 5-Way Binding POSTS

Similar to Superior DF30*, takes plugs, tips, lugs, wire, 1/16" to ¼" panels.
BP30*, 30 Amp, 30c @ .... 100/$27
BP10*, 10 Amp, 18c @ .... 100/$15
BP60*, 60 Amp, 75c @ .... 50/$30
BP100, 100 Amp, $1 @ .... 24/$18

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Portable Units—AC & Battery Inbuilt

Uses new lo cost lo voltage super circuit constant bright light output; light duration 1/600 sec'd; color K 6800-; cost per flash less than ¼ c. 1000 to 2000 flashes per set of batteries. All kits with inbuilt AC pack. (Kits do not include batteries*.)

Model 400B,60W Sec color 75 +; B&W 225 +. Recycles 2 sec'd, less than 4 lbs. $24.95
Model 600B, 120W Sec, color 100 +; B & W 300 +. Recycles 5 sec'd, less than 5 lbs. $34.95
Kits ASSEMBLED, additional .... @ $10
***Two (2) 240V BATTERIES** .... @ $10
SOLD WITH "TAB" MONEY BACK GTD

MA408 MicAssoc/VIDEO DIODE Spl. $9
CK569/CK570A X Sub min Elctrmtr Triode .... @ $2
Millen #1007 1-⅝"/Chrome Knob 39¢ @ 3 for $1
Voltmeter AN Type 2½"/0-30VDC $3 @

TRIGGER COIL LO VOLT FLASH ... $1.67
COND-525MFD/450VDC/53.1WATTSECONDS NEW low leakage famous mfgr..$8; 2/$12, 6 $36
Send 50c for "TAB" Photoflash Data

PRECISION RESISTORS

1% ACCURACY GTD
SPECIAL 18c EA
10 OF ONE VALUE 15c ea.
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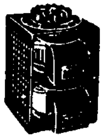
REGULATED POWER SUPPLY

LAB & HIFI, LAB Built & ready to work. HIFI uses "SOLA" constant voltage Filament & Power Xfmr w/rectifier tubes. Low Resistance Brute Force Filter. Furnishes 400VDC @ 250 ma from filter system & 3% regulated & 12V @ 5A filtered DC for filaments. 45 lbs. "TAB" **$39.00**

New Variable Voltage X-fmrs



SUPERIOR-GR-STACO

0-132V-1.25A	$7.23
0-135V/3A	10.63
Cased 0-135V/7.5A	19.55
Uncased 0-135V 7.5A	15.30
Cased/0-270V/3A	22.10
Uncased/0-270V-3A	17.00
Cased 0-135V 15A	39.10
Cased/0-270/9A	39.10
Uncased 0-27V/7.5A	51.64
Cased 0-270V/9A	81.60
Cased 0-270V/12A	107.10
Cased 0-270V 15A	124.95
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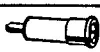
NEW MICA CONDENSERS GTD.

MFD	WVDC	Price
.003	600	45c: 100 $35
.01	1200	35c: 100 $25
.001	1200	20c: 100 $15
.002	1200	35c: 100 $30
.015	2500	75c: 100 $50
.002	2500	45c: 100 $35

CIRCUIT BREAKER

Heinman El. Mag. Bkr. Amps: 3, 5, 9, 10, 12, 35, 80 @ **$1.50 EACH; 12 FOR $16** .... **50 FOR $50**
SQ'D & CH Toggle Bkrs. 5, 10, 15, 25, 70 Amps. @ **50c EA; 12 $5**
Klixon Therma Push Button Bkrs. Amps: 5, 10, 15, 25, 30, 35 **@ 59c EA; 8/$4; 25 FOR $10**

IN23B NEW *Crystal Diode*



"TAB" SPECIAL **89¢ ea; 10 FOR $5**
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FOR YOUR TRANSMITTER —

ONE BALUN FOR 1.5 to 30 mc

Full Kilowatt Rating When SWR is 2 to 1 or Better

One balun for 1.5 to 30 mc. True broadband operation. No switching or complicated circuitry. Full kilowatt when SWR is 2 to 1 or better. Three types are available.

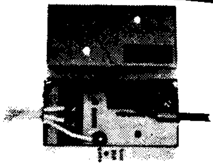
Type TB-2 Matches between 75 ohms unbalanced, and 300 ohms balanced...Price $16.95
Type TB-3 Matches between 50 ohms unbalanced, and 200 ohms balanced...Price $17.50
Type TB-4 Matches between 75 ohms unbalanced, and 75 ohms balanced....Price $17.50

These baluns are a natural for feeding dipoles, beams, trap antennas, twinlead, etc., etc. They allow transmitters designed for coaxial cable output, to drive balanced circuits without any strain or pain. Completely weather-proofed, they may be mounted on a pole, suspended by a rope, or mounted in your shack.

Specifications: 3½" wide, 3" deep, 4½" long (less mounting bracket), 8" long (with bracket). Weight 2½ lb.

FOR YOUR RECEIVER —

A MATCHING BALUN FOR 1.5 mc to 150 mc



Of course, a transmitting balun may also be used for receiving but it is certainly uneconomical. The Lynmar type RB-1 Receiving balun is designed to match between 75 ohms unbalanced and 300 ohms balanced from 1.5 mc to 150 mc. It may be used between unbalanced circuits of 50 to 100 ohms and balanced circuits of 200 to 600 ohms when the upper frequency limit is restricted to 30 mc.

Some communication receivers have a high impedance input. In such cases, use of the RB-1 balun between a coaxial feed line and the receiver may result in a definite increase in signal and a better signal to noise ratio. Similarly, it can be used to efficiently feed twinlead into receivers designed for coax input. It may be used for transforming from twinlead to coax to decrease noise pickup and then back to twinlead if necessary. It is a flexible piece of gear with a variety of uses.

Type RB-1 $2.95
Soecifications: 3½" long, 2" wide, 1" deep. Weight 3 oz.
Also Available: Type RB-2 Matches between 75 ohms unbalanced and 300 ohms balanced . . . 50 mc to 1000 mc ....Price $2.95

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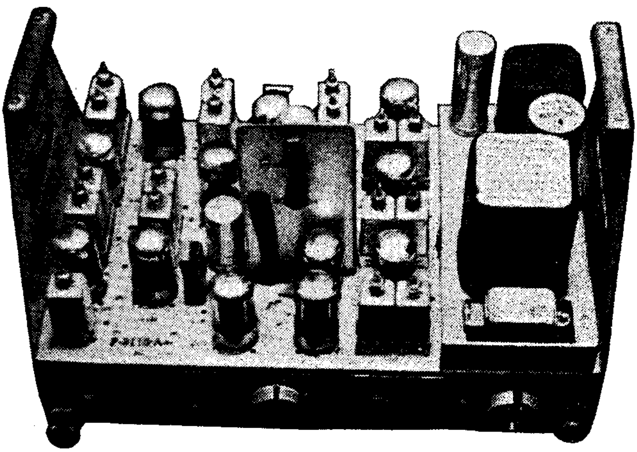

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(FMR13VA OR FRM16V)

MOTOROLA, R.C.A., G.E., LINK, etc. 30-50 Mc., 152-172 Mc. Used Commercial F.M. Communications Equipment Bought & Sold. Complete Two-way sets meetingF.C.C. Licensing Requirements for taxicabs, Police, Fire, etc. $169.00 and up.

Motorola F.M. Receivers, Double Conversion.......... $55.00 each
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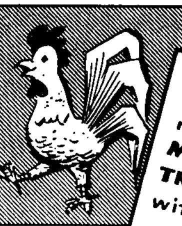
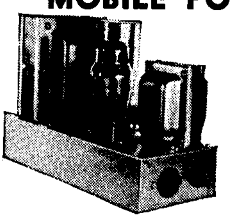
HERE 'TIS!

The PALCO BANTAM 65



The smallest, most compact **MOBILE TRANSMITTER** with 65W-Phone 90W-CW

MOBILE POWER



NEW SAFETY FUSING

- 500 V.D.C. at 225 MA. Perfectly filtered.
- Instant Start—No Waiting.
- No battery drain when on standby.
- Low current—low voltage switching.
- Heavy duty components for dependable, long life operation.
- No ventilation problems. Mount on fire-wall near battery.

MODEL 606—6 V.D.C. Kit $32.50
MODEL 612—12 V.D.C. Kit $35.50
FACTORY WIRED, either model $7.50 extra
Combination 6 and 12 V.D.C.—115 V. AC Model also available. We can supply power cables of any required length.

The PALCO BANTAM 65 is only 4" high, 8" wide, 8¾" deep—leaves you lots of leg room. The separate modulator section on a 2" x 2⅝" x 11" chassis may be mounted in any convenient location. The exclusive new "tune up" meter was designed with highway safety in mind. No more stooping, no more squinting—you'll like this new idea!

OTHER OUTSTANDING FEATURES

- Built-in VFO with 2 xtal positions.
- Either 6 or 12 volt filament supply plate supply 450-600 volts @ 250 MA.
- Complete bandswitching 10 thru 80 meters.
- Gang tuned VFO and exciter stages.
- Efficient pi-section output.
- Provisions for mounting standard coax relay.
- Separate inputs for high impedance or carbon mikes.
- Break-in CW operation.
- AB_1 modulation employing negative peak clipping.

NOVICES! Use the BANTAM 65 as a fixed rig now—as a mobile when you get your "General".

BANTAM 65, complete with tubes and power connectors $159.50

For additional information, see your distributor, or write to . . .

PALCO ENGINEERING • FRANKFORT, INDIANA

COMMUNICATIONS EQUIPMENT CO

420-500 MC TRANSCEIVER
BC645 — NAVY ABA-1

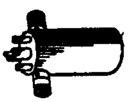
Two-way rig for mobile or fixed station covering the VHF band for amateur or CITIZENS radio. (See complete conversion details in Dec. issue '56 of CQ magazine) Brand New, in original factory cartons. Complete with 12-volt dynamotor, PE101, shock mounting, and control box. Original government cost was over 1,000 $$. Now you can get this super value for only **$32.50**

ARC-4 2 METER RIG. Transmitter-receiver unit is xtal controlled for 144-148 mc, phone or CW. 832 in Final. Makes a beaut of a rig for mobile or home station. Used, excellent, but less tubes and dynamotor. With conversion info for use on 110 vac, or battery **$14.50**

ARC-5 EQUIPMENT

T-19/ARC-5, 3-4 mc, used, exc., all tubes $4.95
T-15/ARC-5, 500-820 KC, New $7.49

MICROWAVE CAVITY



Receiver front end cavity resonator: Tunes 2700 to 3400 mc with a loaded Q of 3000 50-ohm, type N input. Video output from 1N27 crystal. May be used at quarter wave (1.1 to 1.4 kmc) **$22.50**

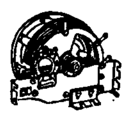
DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR83	14	..	375	.150	$6.50
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.110	6.95
DA-3A*	28	10	500 300 150 14.5	.050 .260 .010 5.	3.95
PE 73 CM	28	19	1000	350	10.50

BC 929 OSCILLOSCOPE

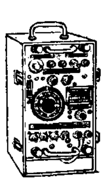
Here's a 3" radar scope that's a natural for conversion to a sweet general purpose scope for the shack. Ideal for on-the-air checks, modulation monitor, etc. Brand new, complete with all tubes including 3BP1, original schematic and conversion data **$7.50**

VHF BUTTERFLY TANK



Butterfly tank unit: Tunes 60-300 mc. Ideal for frequency meter, grid-dipper, signal source, etc. New, complete with acorn tube socket.... **$5.75**

VHF TEST SET



Model OAP equipment is a versatile test instrument which can be used in all phases of VHF work. The unit is portable and operates from 115v /50-70 cy or 115v/400 cy. The test set consists of the following main units: 1/ A wavemeter (accurate to .25%) composed of: a low-loss tuned circuit covering the frequency range of 150-230 mc*, a detector/amplifier equipped with an electric eye indicator tube which shows when the tuned circuit is in resonance with the applied signal. The entire band covers approx. 600 divisions 2/ A high-frequency local oscillator adjustable from 140-230 mc. The output of this oscillator is modulated at 60 cycles. 3/ A dummy antenna, diode detector, and cathode-loaded amplifier. This unit furnishes an output for use with an oscillo-scope to determine a transmitter's power output and pulse shape. Input imp. is 50 ohms. 4/ An untuned VTVM INPUT connection for the detector amplifier, so that the equipment will serve as a tube voltmeter. The model OAP sets are in used, but excellent operating condition $42.50

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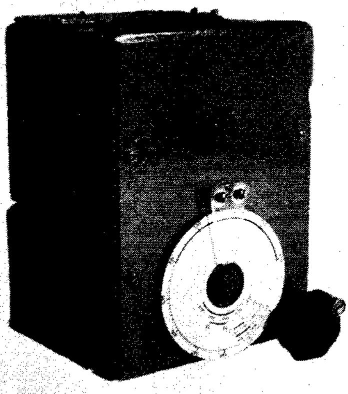
Chapter IV VFO's

Here is a VFO that is a real dandy for st… is reasonably compact, is easy to build, and si… it is made primarily from the ARC-5 is certainly economical.

low cost VFO



Paul Lee, W2EWP
252 Genessee Park Drive
Syracuse, New York

A kilowatt transmitter is a mighty handy thing to have around the ham bands. Around the house it is not quite so handy, and if you happen to be in the armed forces it is a half-ton liability. After several moves from one duty station to another the old behemoth was traded in for one of the lower power commercial rigs, one that was considerably more portable, but which was crystal-controlled.

Crystal controlled operation may be alright for some people, but after having used a VFO for several years this "frequency-binding" was distinctly uncomfortable and seemed to be a serious limiting factor in making contacts. A VFO was definitely in order.

Commercial VFO's come through at commercial prices and this fact led to the decision to home-brew the VFO. Since the most important part of any VFO is the coil, with the use of an inferior coil or coil-form resulting in drift and instability in general, the logical solution was to use some sort of commercially manufactured unit for this purpose. Most Hams by now have one or more of the ARC-5/SCR-274N transmitters around. The VFO coil in this unit was well known to us for its stability (see *CQ* May 1952).

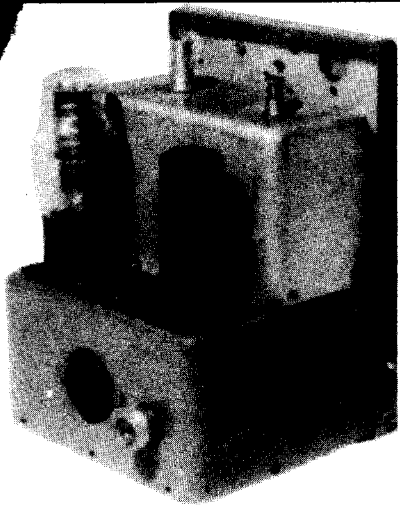
Since no operation was contemplated on 160 meters the 3 to 4 Mc. version of the ARC-5 was selected. These units can still be obtained as surplus at a reasonable price. Even the units marked "as is" seem to have the VFO unit still intact, and that is all that is needed for our purposes. If you have a choice try to pick out a unit with the dial in good shape so you can use it in this conversion.

The Conversion

The first operation is a bit brutal and may be painful until you get used to it: Remove the top and bottom covers, the oscillator cover, and ALL THE WIRING BELOW THE CHASSIS. Next remove the two power amplifier tube sockets, the flexible tuning shaft, the power amplifier padder condenser (the one not attached to the tuning shaft) the power amplifier tank coil, and the r-f choke. Remove the dial, window frame, and all projecting hardware and knobs from the front panel. Grind or drill the heads of the rivets which hold the front panel to the chassis down to where they can be punched out with a center punch.

Remove the front panel and cut a piece of 1/16" sheet aluminum to fit over it as a false front. In this false front cut a 2" diameter hole to clear the tuning dial hub, and a hole in the lower right corner just large enough to clear the tuning shaft. Mount the false front on the front panel by means of 6-32 screws.

The oscillator tuning condenser (from below the chassis) can be removed and added to your junk box. Remove the p.a. tuning con-



Rear view, "Collapsed" ARC-5

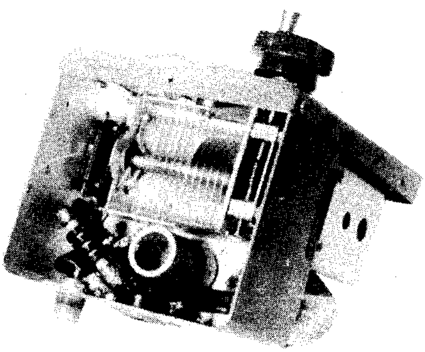
denser with its associated gears. Use care, for this condenser will be used to replace the oscillator tuning condenser.

With a husky pair of tin snips or a hacksaw you can now cut the chassis down to 4½" depth. The cut will come about ⅛" ahead of the rear edges of the two p.a. socket holes. Remember, you are using the rear part of the chassis, not the front.

Mount the former p.a. tuning condenser in the space left vacant by removal of the oscillator condenser. Try the front panel on for fit. There should be sufficient clearance between the front panel and the gears to permit them to turn freely. Once this clearance has been established the panel can be secured to the sides of the chassis by means of "C" clamps. Drill and tap through the rivet holes, then mount the panel on the chassis with ¼" 6-32 screws. Top and bottom covers should be cut to size.

The former crystal socket should be removed, and the hole covered by a 1⅛" square piece of 1/16" sheet aluminum. The power socket on

Economy VFO, bottom view



the rear of the chassis should be replaced with an octal socket. A coaxial chassis-type connector should be installed beside the octal socket. Using the oscillator tube socket for the 6AG7, and the "magic-eye" socket for the VR-150, wire up the unit as shown in the schematic.

The output coil is mounted in the former crystal socket space with the adjustment screw upward, as shown in the photographs. Use solid No. 14 wire for all leads between the 6AG7 and the oscillator tank circuit. The 6800 $\mu\mu$fd bypass condenser, the 51,000 ohm grid leak, and the 200 $\mu\mu$fd. grid condenser, are original parts. Use short direct leads, especially on the 1000 $\mu\mu$fd. ceramic bypasses.

When all connections have been made, the unit is ready for test. A 24" 4-conductor power cable should be made up to connect the VFO to the transmitter. A source of 300 volts plate power and 6.3 volts filament power will be required. A 24" piece of RG-59/U coaxial cable is used as the r.f. connection to the transmitter.

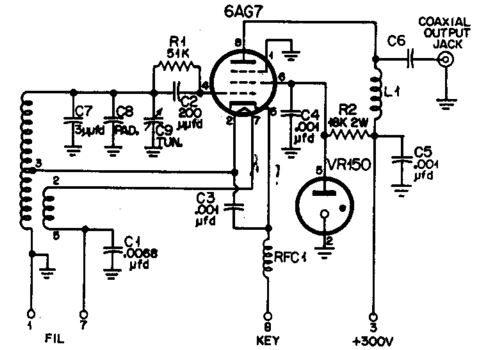
Put back the old dial, and the tuning shaft knob. Set the dial at 4.0 Mc., and loosen the screws which hold the shaft of the oscillator padding condenser on top of the chassis. Replace the oscillator cover and fasten it down with several screws.

Turn on the power, and after warm-up, adjust the oscillator padder until the signal is heard in the station receiver at 4.0 Mc. Set the v-f-o dial at 3.5 Mc. and check the calibration. The band-spread may be adjusted by means of the oscillator tank coil slug and the padder condenser. When the tuning tracks satisfactorily, the padder shaft can be locked in position, and the covers replaced and secured with all screws. Fine adjustment may now be made with the trimmer at the top of the condenser, and the slug.

For those who are interested only in the 3.5- to 4.0-Mc. band, the unit may now be considered complete. The slug-tuned output coil *L1* may now be peaked for maximum grid drive to the transmitter. The capacity of the co-ax cable forms a part of the output circuit. Should a different length of cable be used, it will be necessary to adjust the number of turns in *L1* accordingly, to assure resonance in the 3.5 to 4 Mc. band.

In our case, we use 14- and 21-Mc. 'phone most of the time, so it was deemed desirable to make a new dial, and to spread the 3.5- to 4.0-Mc. band over about 330 degrees of rotation, to avoid cramped readings at the higher frequencies.

To accomplish this band spread, first remove 9 rotor plates from the bearing end, and 1 rotor plate from the gear end of the oscillator condenser. This leaves 6 rotor plates. This can be done with a pair of long-nose pliers. Be careful not to disturb the stator or to dislodge the pyrex bead insulators. Adjust the padder condenser until 3.5 Mc. appears at the low end of



NOTE: C1, C2, C7, C8, C9, & R1 ARE ORIGINAL ARC-5 PARTS. .001 CONDENSERS ARE 600V CERAMIC.

Figure 1

R1—51,000 ohms.
R2—18,000 ohms, 2w.
RFC1—2.5 mh. r-f choke.
L1—3.5 mc., 20 turns #28 enam. closewound on National XR-62 form.

C1—6800 μμfd.
C2—200 μμfd.
C3, C4, C5—1000 μμfd.
C6—1000 μμfd. 600v. mica.
C7—3 μμfd.
C8—Oscillator padder.
C9—Former p.a. tuning condenser.

the tuning dial, and 4.0 Mc. at the high end. The exact location of these points relative to the old dial scale is not important, as we have to make a new dial scale.

Remove the old dial. Using a piece of 1/8"

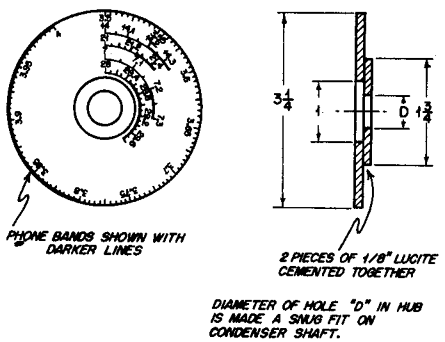
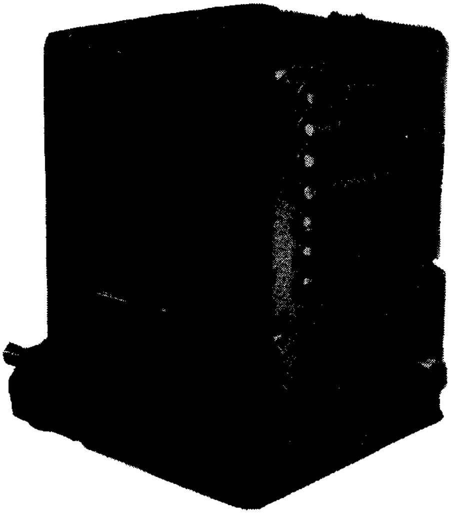


Fig. 2. VFO dial. Note harmonic relationships of bands.

lucite, cut a circular piece 3¼" in diameter, and another one 1¾" in diameter. The larger piece is the dial face, and the smaller one the hub. Cut a 1" hole in the dial face, and using the old dial as a template, cut a hole in the center of the hub to fit the dial mounting. Drill the hole for the alignment pin. Try the hub for size on the dial mounting. The face may be cemented to the hub at this time, using Duco cement.

Using small spots of rubber cement, secure a piece of heavy white paper or cardboard to the dial for a scale, and calibrate the new scale using the station receiver and frequency meter, marking the calibration right on the paper. Begin at 3.5 Mc. and make a small mark every 5 kc. The 50 kc. points should be marked with figures, such as 3.50, 3.55, 3.60,



etc. Mark the 3.5-Mc. and 4.0-Mc. points on the edge of the lucite. With the aid of a draftsman, the marks and figures may be neatly inked in, with the paper scale removed from the dial.

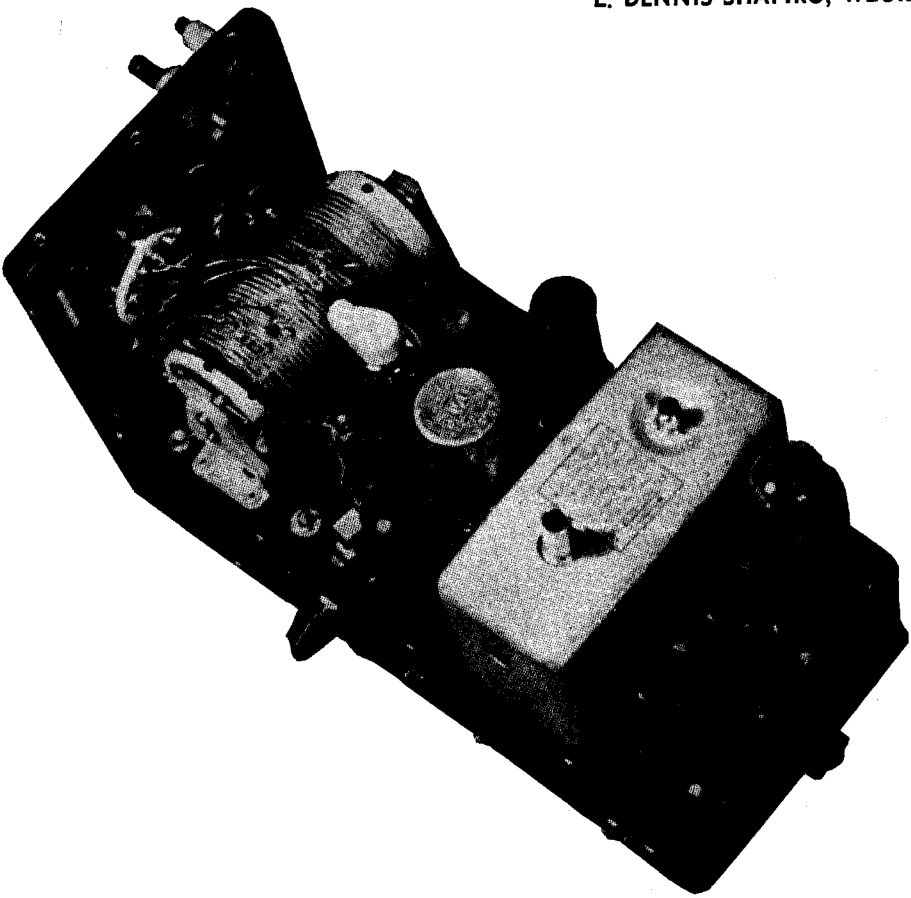
The other amateur bands may be shown in the proper harmonic relationship, as shown in *Fig. 2.* The 'phone bands may be shown by heavy inked lines. This figure is not intended to be an accurate calibration but is merely included as a guide to the reader. After the inking is done, the scale may be cemented to the dial face by means of Duco cement, and the whole dial should be sprayed with Krylon clear plastic spray to protect it.

The calibration should be rechecked, with the oscillator padder locked and the covers in place and secured with all screws. Slight variations in calibration can be made with the slug and trimmer.

The VFO unit, from its 3.5- to 4.0-Mc. output, will give sufficient excitation to drive most transmitters on all bands from 3.5 to 28 Mc. Its frequency stability is exceptionally good, due to the use of the electron-coupled circuit and the retention of the original temperature compensating condenser, *C7.* It represents quite a saving over the cost of the commercial model. Besides, it gave us the enjoyment of making it and the pride of workmanship, which makes it even more valuable to us.

Rubber feet under the bottom cover give it sufficient clearance from the table top to permit use of a spinner knob for ease in tuning. We painted the unit gray to match the receiver, and it makes a very attractive little companion.

L. DENNIS SHAPIRO, W2URX*



HAVING USED THE ARC-5 SERIES OF VFOS for some time, I became thoroughly disgusted at the futility of getting them to key well on the higher bands—ten and twenty meters, while using full breakin.

There and then I decided to build a VFO of my own design that would have the following features:

1. T9x keying on all bands while using full breakin
2. Commercial appearance
3. Bandswitching—80, 40, 20, 15, 11–10 meters with enough output to drive my push-pull 807s.
4. A compact unit that would easily fit on top of the receiver.
5. Direct calibration in frequency with provision for easily resetting dial reading.
6. LOW COST

* *4 Elizabeth St., Glen Cove, N. Y.*

Looking over VFO designs, I found that the heterodyne type of frequency generator, which uses two oscillators and a mixer, was the best bet. This unit was designed similarly to the "T9-er" which was featured in the April, 1948, issue of *CQ,* with changes made to suit the particular application.

Upon searching the surplus market, I found the ideal unit to convert into this exciter. It is a T-20/ARC-5 transmitter which has a range of from 4 to 5.3 mc. The oscillator covered the desired range and the unit looked neat and matched the black crackle of my HRO receiver. Any other of the ARC-5 series or the SCR-274N series should work just as well, needing only a revision of the oscillator range.

The Circuit

The original oscillator is used as the VFO. The 1626 works quite well with six volts on the heater,

A PRACTICAL ALL-BAND HETERODYNE V. F. O.

and eliminates the expense of a six-volt tube. The oscillator covers a range of from 4765 to 4290 kc, which, after being mixed with the crystal oscillator, beats to give output from 3375 to 3850 kc.

The fixed oscillator is crystal controlled on 8140 kc. A 6J5 works quite well in the conventional Pierce circuit. Using this range of frequencies no trouble should be experienced due to beat notes on the conventional communications receiver with an i.f. at or near 456 kc.

The two oscillator signals are fed into a 6SA7 mixer which extracts the difference frequency and sends it to the next stage. The 6SA7 is not used as an oscillator in itself so does not cause any chirp when it is keyed.

A 6AG7 is used as a buffer in the next stage. It is keyed along with the 6SA7 so as to keep the signal leakage at a minimum.

The next stage, a 6AG7, is used as either a quadrupler or a tripler, raising the frequency to either 10.5 or 14 mc. This stage may be switched either in or out by a switch on the side of the chassis, so as to allow excitation to the PA on 3.5 mc, whenever 80- or 40-meter output is desired.

A 2E26 is used either straight-through or as a doubler in the final stage. Considering the cost of turrets and the space available, I decided to use the ARC-5 antenna coil as my final coil. Although it may not be as efficient as a turret, the output is more than enough on all bands and the extra cost of a turret did not warrant its use. The silver plated wire makes it more efficient than it would seem.

Two band switches are used, one switching the final coil and the link, and the other switching the quadrupler in and out.

Special attention is called to the link output circuit. In order to get good output, a small link was needed for the higher bands and a big link for the lower bands. A two-turn link is used for 10-11, 15, and 20 meters, and one wire from that link plus one wire of a four turn link half way up the coil gives good output on 80 and 40 meters. The circuit is unorthodox but it works very well.

The 500-ohm resistors on the wire from the link of the VFO coil to the 6SA7 are used to cut down signal leakage with key up so as to be able to work full breakin. They also serve to keep a constant load on the oscillator which cuts down chirp.

Small size coax should be used in the wire from the link to the grid of the 6SA7 to insure against signal leakage.

A tune-up switch has been incorporated in the exciter since the pictures were taken. It is inserted in the hole in the front panel which originally housed the link control. It allows swishless zero beating and the VFO puts out a weak signal which does not overload the receiver. The switch cuts off screen voltage from the quadrupler-tripler and the 2E26.

Construction

There are a lot of parts that are unused in the ARC-5 that must be removed. Remove all tubes. Remove the 1625 sockets by slipping a screwdriver around the rim and prying the lip up. Disconnect the wires from these sockets and put them aside. Remove the neutralizing condenser and all parts of the amplifier and antenna coils and the tuning assembly for the antenna coil. Leave the mounting bracket on the antenna coil and put it aside for later use. Remove the r.f.c. and all the knobs on the front panel except the tuning knob and lock. Use a Bristol screwdriver for this purpose. If one is not available, take a six-inch screwdriver with a ¼ inch blade and file the blade on the edges so as to fit into the Bristol screw heads. Then jam it into the screws, with a hammer if necessary, and it will unscrew easily. This screwdriver will be of much use later on. Make sure to use a 6-inch one, for you will need the length.

Remove the p.a. padding condenser. Remove both relays and the plug in back of the unit. Cut the wires at the connection points to the parts, for they will be used to carry filament and plate voltages later on.

Remove the crystal and resonance indicator tube assembly and all connected parts. Remove all parts on tube sockets except the group on both #1 pins and the filament connection on the #2 pin of the resonance indicator socket. Follow the diagrams and make the necessary changes. Use as many parts from the original transmitter circuit as possible in wiring the new circuit.

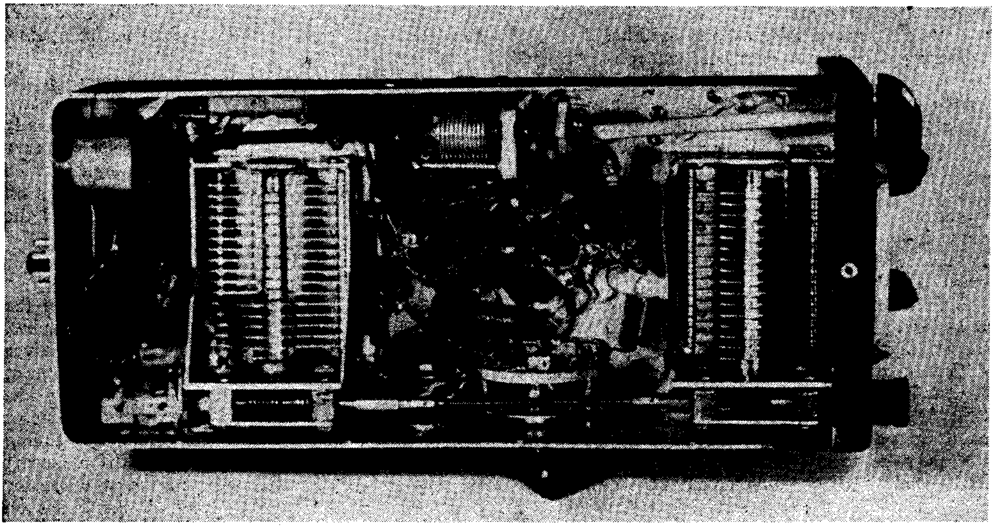
You should now have a clean chassis between the oscillator coil shield on top of the chassis and the front of the cabinet with the exception of the feed-through insulator. On the underside, all should be clean between the oscillator tuning condenser and the amplifier tuning condenser except for the relay wires which will be used for power wires later on.

The connector on the back is an 8-pin male plug. It may be bought commercially but it is very simple to make. Take a metal octal tube that has gone west and remove the octal plug from the bottom. Remove the wires from the plug and clean out the pins. File out the hole in the back of the chassis with a rattail file until the plug fits snugly. Then file two pips in the hole on the top and bottom. Place the plug in the hole and fasten it with two small screws through the pips. It makes an inexpensive substitute that works very well. If a commercial plug is used, the lock ring or screws should be put into place in the usual way.

Before assembling any parts on the chassis, the filaments should be wired. Use the original filament wires whenever possible. Remember, do not wire filament voltage to the coil socket! Allow these wires to go around the edge of the chassis so as not to interfere with the r.f. wiring.

The wiring should be done starting from the oscillators and finishing with the 2E26 stage.

The wiring is very crowded in the oscillator and mixer compartment. The 3×.05 condenser should be unscrewed and left hanging over the side to gain access to the sockets. The 6SA7 transformer should be installed last. The easiest way to assemble the crystal oscillator is to connect all the parts to be connected to the crystal socket first without soldering them. Solder the socket to pins #4 and #6 of the 6J5 socket after connecting pin #4 to pin #5 and the necessary connections to pin #6. If this is followed it will greatly simplify the job of assembly. The other wiring of the unit is routine stuff. The



Bottom view of the finished unit. The placement of major components should follow this model rather closely. The switch mounted on the side is the "multiplier in-out" control, SW_1.

The tube sockets should be punched next. The three sockets in the rear are ideal for the two oscillators and the mixer. The other sockets must be punched. The removal of the 1625 tube sockets leaves a problem because of the wide holes in the chassis. The 6AG7 sockets are mounted on the outer edge of these holes. They are made the right curve at the edge with a socket punch and the sockets are held by one screw which seems to be sufficient, for tube changing does not come often. The 6AG7 buffer coil socket is mounted in a hole punched exactly between the 1625 socket holes. Two screws should be used in this case.

The 2E26 socket is placed in the center of the chassis, being careful that the 2E26 tube, when inserted, will not interfere with its coil assembly. Follow the pictures in laying out the chassis as closely as possible.

3×.05 μf condenser is used as the 6SA7 cathode bypass, and the 105-volt bypass, and the 6SA7 screen bypass condenser.

The mixer plate transformer is made from a 456-kc cartwheel i.f. transformer that was lying idle in the junk box. This transformer may be easily obtained at any radio establishment. Both of the coils are removed and the transformer is built on one of the forms. The windings are wound with maximum coupling to get the widest bandpass without resorting to much resistor loading. Any small gauge cotton-covered, stranded, or solid wire may be used. The type that I used was stranded cotton-covered wire from an old i.f. coil of about a 34 gauge. The transformer consists of about 25 turns, closewound, on one of the forms. A piece of scotch tape should be inserted between the two windings of the transformer to take care of the difference in potential. The windings don't have to be wound in an orderly fashion and the specifications are not critical, for the wide range of the trimmers take care of any slight variations.

The transformer is mounted right below the 6SA7 tube on the right side of the cabinet. Two holes should be drilled in the side of the chassis to allow screwdriver adjustment of the trimmers.

The "quadrupler in-out" switch is located in the larger hole on the right side of the chassis. The cover for this hole and for the smaller hole is used to cover up the holes in front left by the removal of the knobs. The key jack is right next to the switch further back on the chassis.

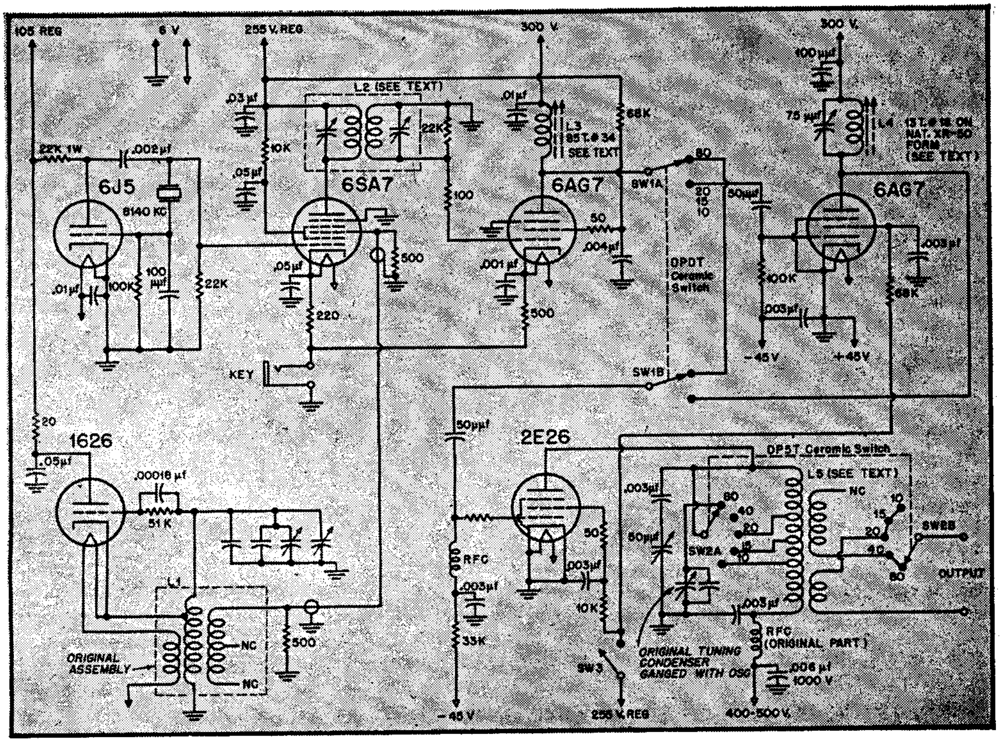
The quadrupler plate coil is located midway between the 6AG7 quadrupler and the 2E26. It is made up of 13 turns of 22 gauge enamelled wire spaced over the length of the XR-50 coil form. The 75 μμf variable condenser is mounted on a bracket made of copper sheeting. A lip is bent in the copper to allow it to be bolted to the side of the chassis and extend out at right angles.

Four holes should be drilled in the copper plate; one to hold it to the side of the chassis; two to hold the condenser to the plate; one for the rotor control that is large enough to prevent it from shorting to ground. The rotor is connected through a ¼″ insulated flexible coupling to a ¼″ rod extending through a bearing out the front of the cabinet to a knob. This circuit tunes either to 14.0 or 10.5 mc.

The buffer coil consists of about 80 turns, close wound, of #30 or smaller wire. Any wire from an old r.f. or i.f. coil would work fine. The coil should be about ¾ inches long, starting ½ inch down from the top of the form. Slight variations may be necessary in different coils. The turns can be easily removed, so I suggest that you start with about 85 or 90 turns and prune it down to size.

The 2E26 band switch and tuning condenser are placed on the front plastic window in holes drilled to fit. Make sure that your condenser is the right size and will not interfere with the coil directly behind it. The coil is the original antenna coil tapped for the different bands. It is screwed to the top of the chassis using the original brackets. The holes in the brackets are tapped so the screws, inserted from the bottom, need no nuts. The entire coil is used for 80 and 40 meters. It is tapped between the 15th and 16th turn for 20 meters, between the 10th and 11th turn for 15 meters, and between the 6th and 7th for 10–11 meters. The counting of the turns should be done from the high-voltage end of the coil. The taps are made by laying the tapping wire between the two turns and soldering them. These connections should not be made permanent until the unit is operating efficiently, for a bit of cut and try may be necessary to find the correct points for maximum output on the higher frequency bands.

The original p.a. condenser which is ganged with the oscillator condenser is used to provide a good



The circuit of the v.f.o. exciter. The original ARC-5 parts should be used wherever possible.

degree of gang tuning on 80 meters. A copper shield should be placed between this condenser and the 2E26 to insure stability. It is placed right over the side of the condenser, as seen in the pictures.

The parts layout in the pictures should be followed closely in order that all components be fitted into such a small space. The tolerances of the components are not close, and any makeshift parts will work, such as parallel or series resistors to reach a certain value.

Power Supply

Four plate voltages are necessary to operate the unit besides the six-volt filaments. You need 105 volts regulated, 255 volts regulated, 300 volts and 400–500 volts. Two supplies were used in our installation. One supply had an output of 105 volts, regulated, at about 30 ma for the oscillators. The other supply supplied all the other voltages by means of taps on the bleeder resistor. A 500-volt 200-ma transformer was used and seems to be bearing the load very nicely. Separate power supplies were necessary to take out the slight chirp that was introduced by the voltage shift if the same supply was used for the keyed stage and the oscillators. A VR-105 was used for the 105-volt supply and a VR-150 and a VR-105 were used in series for the 255-volt supply. Good filtering should be used throughout to insure a good clean note. A 45-volt "B" battery is used to supply bias. The one here has been in use for over 6 months and still going strong. It is placed on the power supply chassis.

Tuning up

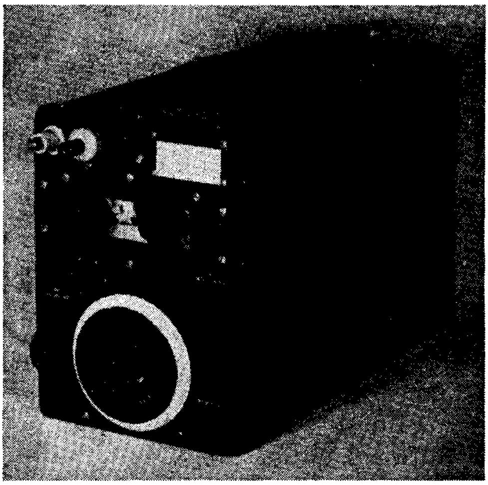
This job forms the nucleus of the unit, for if done incorrectly, it will give no end of trouble, but if done the right way, it will do wonders.

In this type of VFO circuit, as the oscillator frequency gets higher the output frequency gets lower, thus making the dial read "backwards." This condition was rectified by loosening the bristol screws on the rotor shaft of the oscillator condenser and rotating the condenser 180 degrees so that it moves into mesh as the dial reading is increased. Remove ten plates from this condenser, starting from the rear of the shaft, leaving the six remaining plates closest to the worm drive mechanism in place. This is done to get maximum bandspread. Make sure that you do not disturb the drive mechanism for it might introduce some backlash.

Remove the two 6AG7s and the 2E26 tubes and apply voltage to the unit. Tune your receiver to 3.6 mc. Adjust the oscillator tuning condenser so that it is a little less than half mesh, by turning the knob on the front panel. Short the key terminals and adjust the oscillator padder located in the shield on top of the chassis until you get a signal from the oscillator on the receiver. Make sure that you don't pick up an image instead of the fundamental. The oscillator padder is adjusted by unscrewing the locking screw through the hole on the side of the shield and pushing the adjusting arm toward the right with a screwdriver. The shield does not have to be removed for the arm only has to be moved about ½ inch. Move it slowly for it is very critical and a hair this way or that will get you off frequency. When you get the signal near 3.6 mc it may be adjusted by turning the top blue screw in or out, as the case may be. The original oscillator adjusting screw is used to reset calibration in this unit. It should be set at about half scale and all the fine adjusting should be done with the blue screw on the top during the original tuning up process.

Put a pencil mark on the dial at the 3.6 point for easy reference. Check the range of the unit by turning the VFO dial from one extreme to the other. It should cover from 3.375 to 3.85 mc. If this range cannot be covered, adjust the cut end plate on the condenser so that a lower frequency will be produced when it is out of mesh, and a higher frequency will be produced when it is in mesh. It should just cover the desired range.

Adjust the 6SA7 transformer to peak at 3.6 mc and insert the 6AG7 buffer. Adjust its coil for 3.6 peak. The output should be able to light up a neon



Front view of the heterodyne v.f.o., showing the 2E26 tuning control and the band switch mounted on the plastic window.

bulb. Those of you who are anxious to get on the air might want to put a link around this coil and connect it to an 80-meter antenna or to your final grids, if using 807s or the like. You will really be thrilled by its performance.

Insert the 2E26 and, making sure that the band switches are in order, tune it to 3.6 mc with the tuning condenser. In order to obtain gang tuning over the 80-meter band, the original p.a. condenser is used to tune the 2E26. It was found that the range of the condenser was too much for the coil and padder combination to allow it to track perfectly over the range so the ganged condenser should be set at half mesh at 3.5 mc. This is an unorthodox condition but the front condenser dial only has to be touched three or four times during the whole range on 80 meters.

The 80-meter band should be set first before going to the higher frequency bands. The easiest way to tune the unit for uniform output over the range is to connect the output link to the grid circuit of the next stage in your rig and tune for uniform output, or grid current. The 6AG7 coil should be left at 3.6 mc and the 6SA7 transformer should be stagger-tuned until the correct range is covered. A little adjustment of the 6AG7 coil may be necessary in some installations. There will be more drive in the middle of the band, but that is to be expected from circuits not using elaborate loading resistors and the like. Your main consideration is getting enough excitation over the range, and if you get more than enough at some frequencies it will do no harm. Adjust this from 3.5 to 3.85. Do not worry about 3.4–3.5 output for this is not necessary on 80 meters.

Once you have it working on 80 meters the other bands are quite simple to get going except ten meters. You will find that you will get good output on 40, 20, and 15 meters with no trouble at all.

The 6AG7 quadrupler should work fb from the start. A wavemeter would come in quite handy to make sure that you have the right harmonics but you can get along ok without it. With the constants shown, the circuit should only tune the third and fourth harmonics of the 80-meter input. The circuit works quite efficiently on both tripling and quadrupling.

Ten meters may give you a bit of trouble in getting good output from the doubling 2E26. As the frequency gets higher, the taps on the 2E26 coil get more critical so that on ten meters you may have to adjust the tap a bit on the coil to get maximum output. The link should be coupled loosely to the coil to obtain good output. Experimentation with your particular application is the best condition under which to adjust the unit. Once the unit is adjusted correctly it will work with no trouble for a long period of time. The 2E26 tube plate should not get red under any condition if the unit is operating properly. Short overloads are permissable in tuning up, however.

The 6SA7 transformer may need a little adjustment when you are initially tuning for good output on the 11-meter band. By tuning it a little, a happy medium can be struck that will be good for both 80 and 11.

Calibration

To calibrate this unit so that it will be accurate in frequency readings, all that is necessary is a 100-c crystal oscillator and a receiver. If your particular installation does not require accurate calibration, you may calibrate it with the receiver alone if your receiver calibration is fairly accurate.

Since the original dial readings are discarded, a mask made from stiff paper was cut out to fit over the dial. Tune the receiver to 3.5 mc and tune the VFO to this spot. Make a mark on the new VFO dial at this spot. Now put the receiver on ten meters and find the harmonic on 28.0 mc. Keep the VFO tuned to 80 or 40 meters so as to get a weak harmonic to beat with the weak 100-kc harmonic at that frequency. Adjust the VFO trimmer to set the 3.5-mc point exactly at 28 mc, for any bit you were off on the adjustment on 3.5 mc will be multiplied 8 times on this band. After this is set, make a mark at every 100-kc point from 27 to 30 mc.

This procedure will make your unit a pretty good frequency meter, but remember, when using it near band edges, join it with a 100-kc crystal oscillator to make an unbeatable team. In time, the VFO will tend to get off calibration. An adjustment of the original oscillator trimmer will put it right on the beam.

Results

I have been using this exciter to drive pp 807s on all bands for about a year now and have found nothing lacking in its capability of T9x c.w. I have never gotten a report below T9.

Because I can now use breakin on the higher bands and still retain a good note, my scores in the DX and CD contests have been vastly improved.

I find that this exciter retains its calibration over long periods of time and is quite accurate as to band edges.

Although I spent quite some time taking the bugs out of this unit, it is repaid a millionfold when I can say during a QSO, "Exciter hr OM is a *home-made* bandswitching job and I am using Bk in," after receiving a T9x report.

EASY WAY HETERODYNE

Anyone who has tried to build a variable-frequency exciter that produces a T9 signal, keys well, and is stable enough to drive an SSB transmitter appreciates the difficulties involved. W6TZB, however, shows how to let someone else do most of the sweating.—Editor

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While working on a single-sideband rig recently, the writer developed a simple method of converting 3 to 6-Mc and 6 to 9-Mc "Command" receivers *(BC-454* and *BC-455)* into heterodyne-type, variable-frequency exciters, covering the same frequency ranges. The stability of the converted units is outstanding, they key beautifully, and have sufficient output to drive a Class AB 807, a 6AG7, etc.

Heterodyne exciters have been described in the radio magazines for quite a few years; Their manifold virtues include good keying, excellent stability, and high reset accuracy. However, they are rather complicated and expensive to build. In addition, many are difficult to adjust and their

The Easy Way Heterodyne~Exciter

MAJOR R. H. MITCHELL, W6TZB

2442 A St., Lincoln, Neb.

output is full of "birdies." The conversion of a "Command" receiver into one, however, retains the advantages and eliminates the disadvantages. Besides the *surplus* receiver, a small handful of fixed condensers and resistors and an optional crystal are the only parts required. Unless you are unfortunate enough to possess nothing but thumbs, the entire job should take only an hour or two.

What Must Be Done

To accomplish our purpose, we change the receiver wiring around, so that, instead of high-frequency input to the antenna terminal being converted to intermediate-frequency output from the mixer plate, intermediate-frequency input to the mixer grid is converted to high-frequency output at the antenna terminal. *Figure 1* shows essentials of the high-frequency section of the receiver, where most of the simple, though necessary, changes are made. *Figure 2* shows the revised circuit.

Starting at the antenna terminal, change the present coupling condenser to 100 $\mu\mu$fd. and remove the small neon bulb. Disconnect *C3* and *R1* from the control grid (*pin No. 4*) of the 12SK7. Remove and save *R1*. Now, transfer the plate connection (*pin No. 8*) to the grid, and connect *C3* to the plate terminal. Feed plate voltage to the terminal through a 2.5 mh. r-f choke and a 200-ohm resistor in series, bypassing the resistor to ground through a 0.002-$\mu\mu$fd mica or ceramic condenser. Disconnect the bottom of *L2* from the *B* plus line, and ground. Believe me, this is important.

Proceeding to the 12K8 mixer stage, disconnect *L3* from the 12K8 grid cap. Also disconnect the wire between the 12K8 plate (*pin No. 3*) and the first i-f transformer. Then connect the plate terminal through a 0.002-μfd midget mica or ceramic condenser. Feed plate voltage to the tube through another 2.5-mh, r-f choke. Connect the 2-megohm resistor (*R1*) salvaged from the r-f stage between grid and ground, and feed i-f energy into the grid through *Cc*, a 0.002-μfd midget mica condenser.

Obtaining Intermediate-Frequency Energy

In the first receiver (a BC-454) I converted, the input signal for the 12K8 control grid was provided by a single-sideband exciter ending up on 1415 kc. In the next one, the first i-f stage was changed into a crystal oscillator. (See *Fig. 3.*)

The grid lead of the first i-f tube was removed from the first i-f transformer, and the crystal connected between grid and ground. A 47,000-ohm resistor in series with a 2.5-mh, r-f choke across the crystal furnished operating bias. Output from

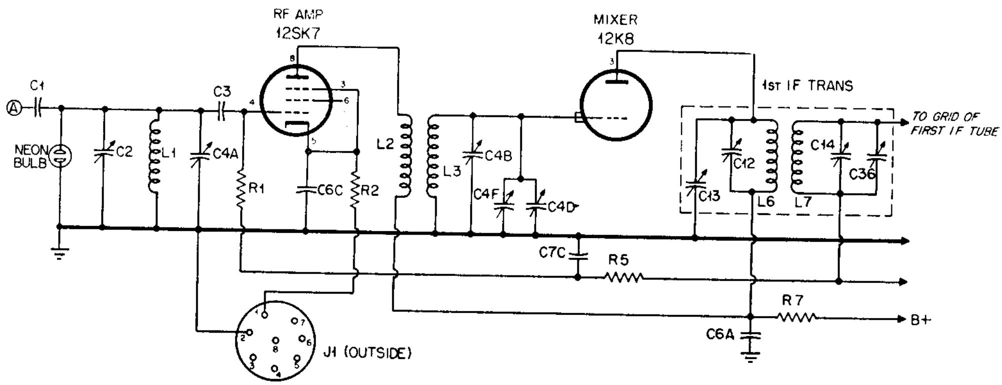


Fig. 1. Skeleton diagram of the r-f amplifier and mixer stages in either a BC-454 or BC-455, before modification to a variable frequency exciter.

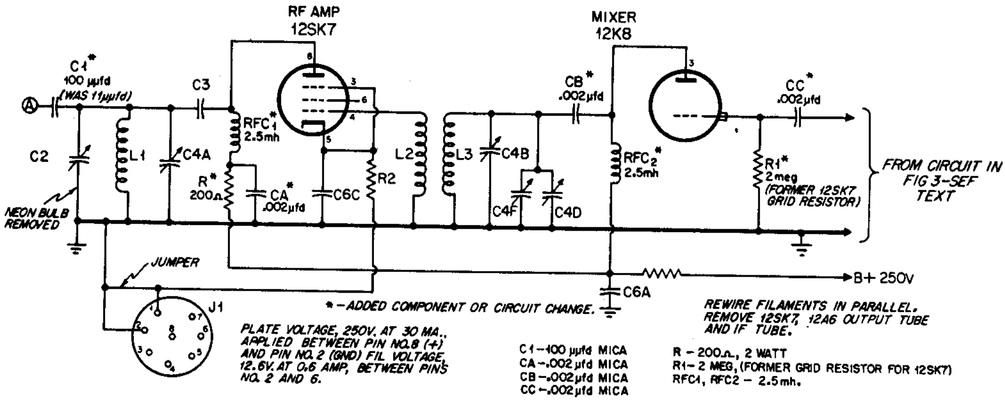


Fig. 2. The r-f stage and mixer, after modification.

the oscillator was obtained by disconnecting the secondary of the second i-f transformer from the grid of the second i-f tube and connecting it to *Cc* of *Fig. 2.* The double-tuned i-f transformer knocks out virtually all spurious "birdies" from the oscillator output. Incidentally, the crystal will not oscillate without the 10-μμfd condenser between grid and plate terminals of the 12SK7.

If a crystal of the proper frequency is not available, the receiver beat oscillator may be used instead. Referring to *Fig. 3,* disconnect the feedback condenser from the 12SK7 plate and use it to couple the beat oscillator to the 12SK7 control grid. To do so, connect the free end of the condenser to the control grid. (*pin No. 2*) of the 12SR7.

I have fed the output of the beat oscillator directly into the control grid of the 12K8. Results appeared satisfactory, however, the isolation provided by the 12SK7 stage is worth having, especially as it is already there, waiting to be used.

Two keying methods have been used. The first was screen keying of the 12K8 screen. No chirp was noticeable on either 3.5 or 7 Mc., but I was worried about the possible effect of the varying load on the oscillator section of the tube. Next I tried screen keying of the 12SK7 crystal oscillator (or isolation) tube. Keying was beautiful; so this system was retained.

Adjustment

As I said earlier, adjustment of the exciter is simple. First, get the low-frequency oscillator to work. Next, tune in the exciter output signal on a communications receiver. Then reduce the low-frequency output by decreasing the 12SK7 screen or plate voltage until the exciter output drops off a db. or two—a reduction barely noticeable to the ear or on the receiver *S*-meter.

This adjustment produces maximum output at the desired frequency, commensurate with minimum spurious outputs.

After the low-frequency output is adjusted, adjust the padders across *L3* and the antenna trimmer for maximum output. If necessary, the padders on the high-frequency oscillator should also be adjusted for accurate dial calibration. This completes the conversion.

Operating Notes

The impedance at the output terminal of the exciter is high, being suitable for direct coupling into the grid of the next stage. Keep the length of the coupling lead reasonably short.

The diagram of the 6 to 9 Mc. BC-455 differs from the one shown, in that the i-f transformers are single tuned; however, conversion is exactly as described. *(Some of the ARC5 equivalents of the BC-454's and BC-455's use a somewhat different i-f tube lineup; consequently, it would be wise to study a circuit diagram of them before starting to convert one into an exciter.—Editor.)*

In operation, greatest frequency stability is obtained by leaving d-c voltages on all tubes and opening the keyed circuit during "standby" periods.

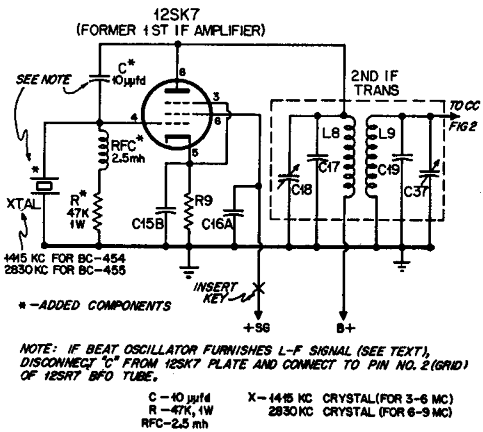
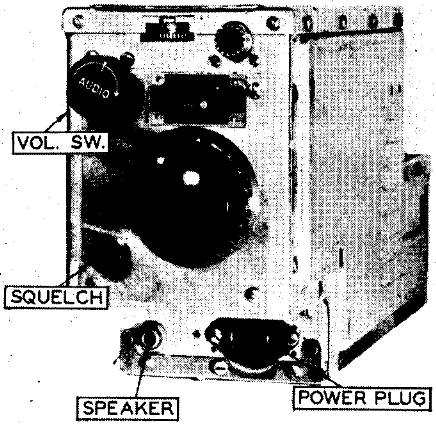


Fig. 3. This is how the first i-f stage is converted to a crystal controlled oscillator.



Front view of the converted R-28/ARC-5 v-h-f receiver. A new power input socket has been mounted on the under-deck.

Converting the R-28/ARC-5 V.H.F. Receiver

Starting with this issue of the column I am pleased to turn over a portion of it each month to writers who will discuss various topics of interest to the gang. This month the space goes to Mr. Mack Spizer of Los Angeles who brings us some data on the conversion of the R-28/ARC-5 v-h-f receiver.

This unit was designed by the Western Electric Co. for operation on 24-28 volts. It fits into an FT 220-A mounting rack. The line-up is a 717A in the r-f stage, 717A as a mixer, 12SH7 oscillator and two more 717A's as multipliers, two i-f stages with 12SH7's, two 12SL7's in the detector, a.v.c., squelch and 1st audio stages and a 12A6 2nd audio output. Motor tuning to set the receiver on four channels is provided.

The first step in the conversion process is to replace the 12-volt tubes with their 6-volt equivalents (a 6V6 will replace the 12A6). Then remove the side and end plates of the receiver, and separate the receiver housing from the front end containing the motor. Remove the motor, but be sure to save all the gears. Leave the motor drive shaft in place. Note that two pieces of pressed iron constitute the frame that held the motor. As you take these apart notice that on the front of the larger piece is a raised portion that must be flattened out—otherwise it will interfere with the dial drive mechanism that is to be mounted.

Vernier tuning can be obtained through the use of the discarded parts from the motor drive mechanism. Remove the bronze gear and one worm gear from the shaft that has two worm gears. Be careful not to bend or spring this shaft. Enlarge the hole in this gear to ¼ inch and then drill and pin it about 11/16 inch from the bottom plate on the main drive shaft for the gear train. Make a bushing for the new dial drive (see photo) by forcing the 3/16-inch shaft into a short length of ¼-inch O.D. tubing and then trim the whole shaft to about 2-3/16 inches. Put the worm gear on this shaft and mount it at right angles to the bronze gear (again see photo) by making up an end bearing. The latter can be cut from a piece of square bar (or equivalent) that is 1 inch long and 5/16 or ⅜ inch on a side. Drill and tap one end for an 8-32 thread to mount it to the bottom plate (see photo). About ¾ inch from the tapped end drill a 3/16-inch hole for the worm gear shaft. Drill additional holes in the ¼-inch main drive shaft and put in pins to hold it in place.

From the aluminum cabinet, remove the door by drilling out the rivets in the hinges. Remove the two steel pins by twisting them out with pliers. Bolt a piece of aluminum (4⅛ x 4⅜ inches) to the front of the unit and cut out a 2¼-inch hole for the dial drive (centered about 2⅜ inches from the left side and 2½ inches from the bottom). Bolt the dial unit in place.

Remove all of the crystal sockets and relays. In opening up the bundle of wire going over the top of the unit be careful not to disturb the two wires going to the squelch and the one wire to the r-f stage.

Convert the oscillator stage by removing the grid by-pass condenser (*C163*) from *pin 4* of *V108*. Add a 0.0001 μfd. from *pin 4* of *V108* to the cold side of *L111* at the junction of *R152* (1000 ohms). The 6SH7 should now take off on its own and be tuneable.

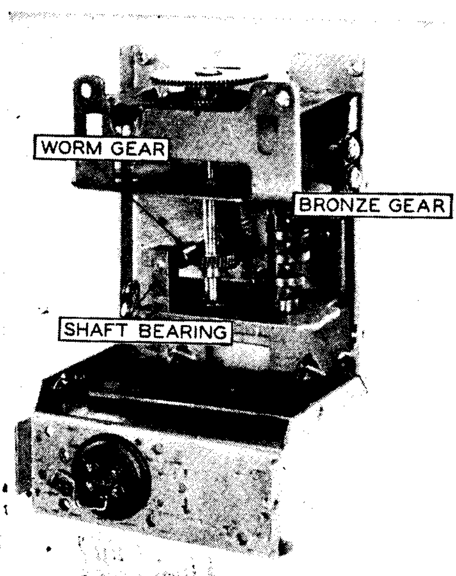
Remove coupling resistor *R136* (1.0 megohm) and coupling condenser *C149* (0.006 μfd.) from *pin 1* of the 6SL7 *(V106)* squelch amplifier. Replace with a single 0.01 μfd. Now remove *R143* (1.0 megohm) and coupling condenser *C154* (0.006 μfd.) from *pin 5* of the 6V6. Replace with a single 0.01 μfd. Remove the 47,000-ohm grid resistor *(R144)* from *pin 5* of the 6V6 and replace with a suitably connected volume control (450,000 ohms with switch). For more audio remove *C157* and *R168* across the audio output transformer primary (*terminals 1* and *2*).

The impedance of the output can be changed from 600 to 8000 ohms by switching the connection from *terminal 6* to *terminal 3.*

Receptacle *J102* on the rear of the receiver should have *pins 3* and *4* connected to ground *(pin 1).* Since the original squelch control has a short slotted shaft, use the control 6488 Type J from either a control box BC-496-A or from a C-25/ARC-4. A new speaker output jack was mounted in the front of the unit.

For simplicity, compactness and selectivity this unit is head and shoulders above many other war surplus equipments including the popular SCR-522 and BC-1068A.

This photo shows the stripped down motor drive and tuning assembly. See the text for details on converting the original mechanism.



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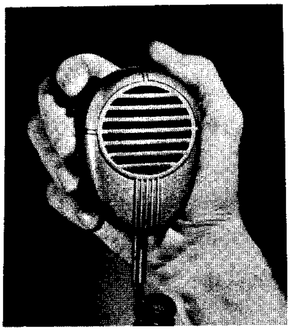

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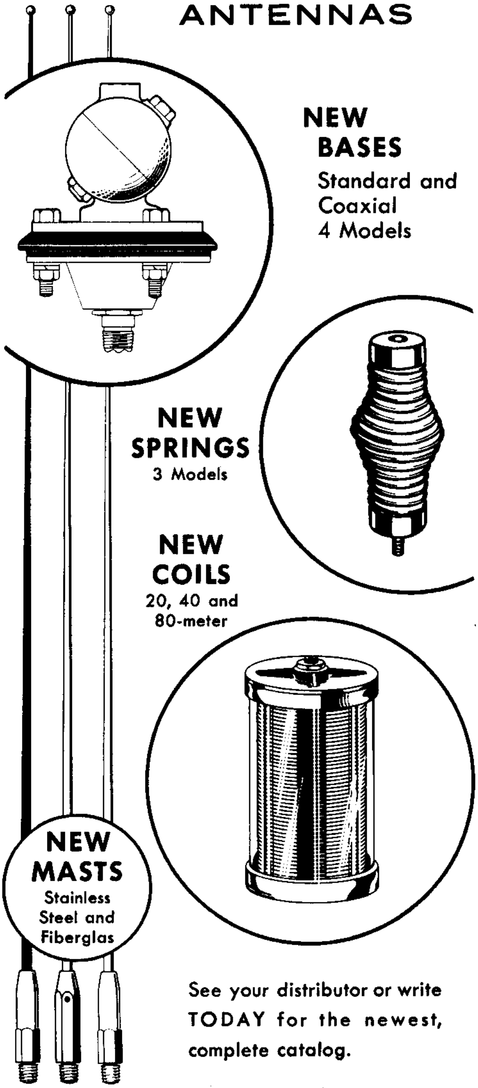

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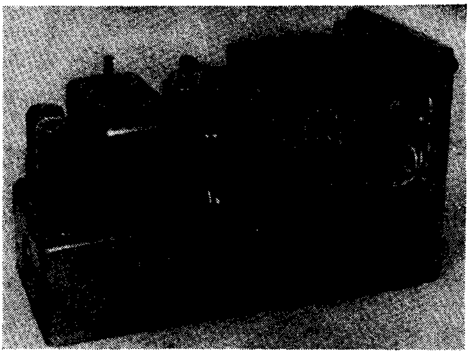
Chapter V MODULATORS

A High-Power Mobile Modulator

GEORGE M. BROWN, W2CVV

A pair of 807s in Class B makes an excellent modulator for use with your converted 274-N transmitter. The low idling plate current of the Class B connection is just the thing for mobile operation where battery drain is a factor.

THE MOST COMMON FAULT with amateur mobile phone installations (and many home stations) is probably the lack of sufficient high-quality audio power for adequate modulation without overload. This is a perfectly understandable situation, since plate power is precious, and the desire to put as much of it as possible into the final, even at some sacrifice in modulation capability, is part of human nature, regardless of the effect it may have on the readability of the signal. The modulator to be described herein, and the complete high-



The modulation transformer fits nicely between the 807s and the meter and leaves plenty of room for the cover.

power mobile installation built around it, provides about the highest level of fully-modulated power that can be handled by a standard automobile battery and generator without excessive auxiliary charging. It is capable of as much as 60 watts input to the final, with 100% modulation, using a PE-103 for plate power and can be readily removed from the car for use as a fixed or portable station, using a rectifier power supply, and operated with as much as 120 watts input.

In spite of this high power capability, the modulator is economical for transmitters of as low as 30 or 40 watts input, since the static plate current is lower than that of a 6N7, with 10 watts rated output, and about one third the static plate and screen current of a pair of 6L6s, Class AB_1 with 24.5 watts rated output. Higher plate voltage is required, but in general this is obtained from a 450- to 600-volt dynamotor used for the r.f. also and is readily available.

The Driver

One of the most unique features of the modulator, *Fig. 1,* is the use of a push-pull cathode follower driver stage direct coupled to the grids of the 807 modulators. The 807s are operated with their "zero bias" Class B connection, in which their screens and control grids are both driven, the screens somewhat harder than the grids. With zero voltage on both grids and screens, the static plate current is reduced to a very low value, of the order of 5 or 10 ma. Actually, the direct-coupled cathode followers supply approximately 10 volts of positive bias with resultant total static plate current on the 807s of 30 ma. Of course, with tone modulation this plate current increases to 80 to 150 ma, depending on the output required, but on voice, although peaks of the same magnitude are present, the average is far lower. This means that a PE-103, rated at 160 ma at 500 volts, can be loaded to 120 ma into the p.a. and still be within its average rating with voice modulation.

One of the penalties incurred by operating 807s in this fashion is that considerable driving voltage, accompanied by as much as 20 ma peak grid current, must be supplied. Conventional methods of producing this driving power would involve power consumption largely cancelling the power-economy advantages of the Class B operation. Since power need be supplied to each grid only on its positive half of the cycle, however, the cathode follower driver is a natural. Note there is no connection from the 6SN7 cathodes to ground except through the grids and screens

The bottom view illustrates its simplicity.

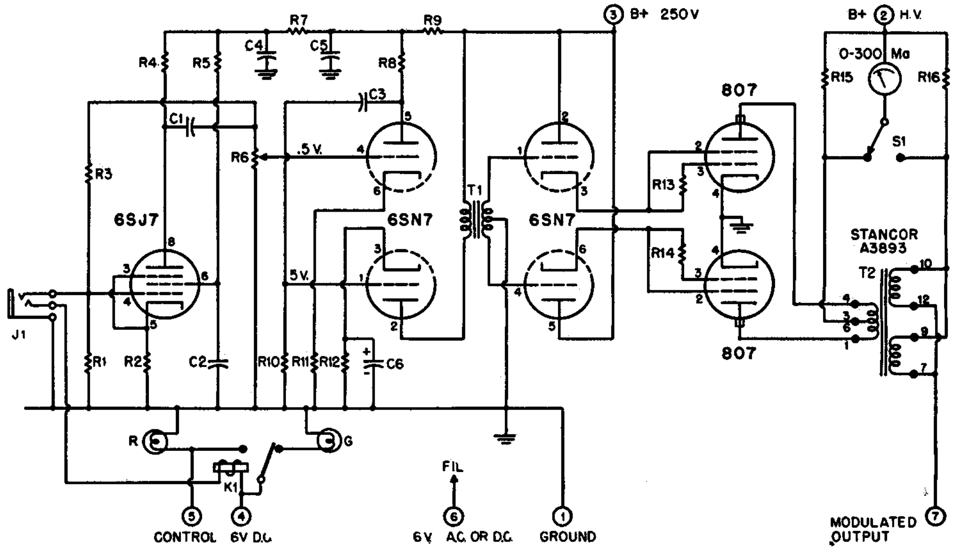


Fig. 1. The circuit diagram of the modulator.

C1, C3—.006 µf
C2, C4, C5—.05 µf
C6—5-µf audio bypass
R1—3 meg, ½w.
R2—1K, ½w.
R3—10 meg, ½w.
R4—220K, ½w.
R5, R10—1 meg, ½w.
R6—0.5-meg pot.
R7, R8—100 K, 1w.
R9—33K, 1w.
R11, R12—3.3K, 1w.
R13, R14—22K, ½w.
R15, R16—10 ohms, ½w.
T1—push-pull input transformer
T2—modulation transformer (Stancor A3893 or equivalent)
K1—push-to-talk relay, 6v. d.c. coil, s.p.d.t.

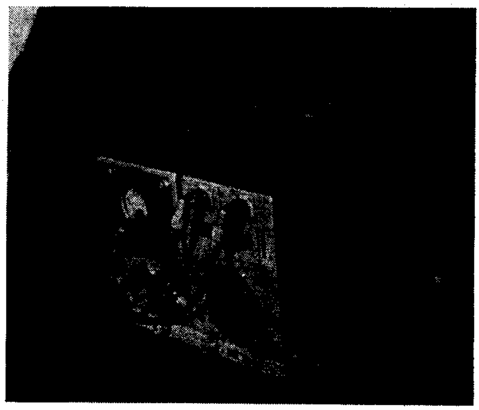
of the 807s. Thus the plate current flowing in the 6SN7s is equal to the grid and screen current of the 807s, and varies from less than 1 ma to peaks of 20 ma with voice modulation. Actually the total plate current consumption of the entire driver, up to the 807 grids, is less than 10 ma under static conditions. Since this driver section works on 200 to 250 volts, its plate power as well as that of the r.f. driver stages is obtained from the receiver plate supply to save all the output of the high-voltage dynamotor for the final and the modulator. The receiver plate power supply is switched from the receiver to the transmitter during transmitting periods.

Speech Amplifier

The early stages of the speech amplifier section are conventional in design. Transformer coupling is used to the grids of the cathode follower stage, using a conventional step-up interstage transformer, since they require higher voltage that can readily be obtained by resistance coupling. Of course the cathode follower draws no grid current, so the usual heavy-duty driver transformer and power stage are not required, but be sure the transformer is step-up, about 2 to 1 from primary to each grid. The type usually used between a 6J5 and a pair of 2A3s is okay.

The 10 megohm resistor R_3 is included to provide inverse feedback around the 6SJ7 preamplifier tube, since somewhat more gain than necessary was available. It may be omitted or increased if more gain is desired.

The optimum load on the modulator is ap-



The modulator sits on the right of the r.f. unit in the 274-N dual-transmitter rack. The whole assembly can be slipped out of the trunk for fixed-station operation.

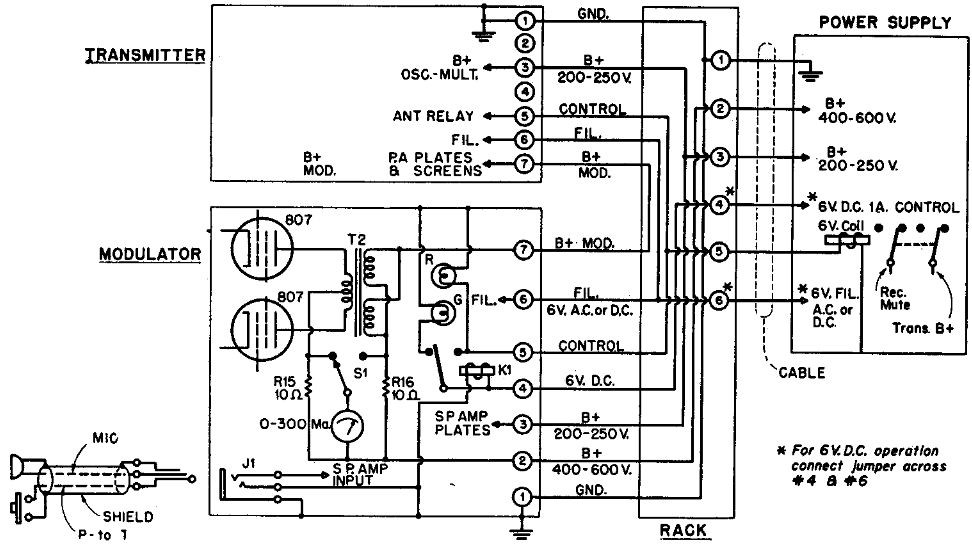


Fig. 2. The interconnections as used at W2CVV. The numbered connections correspond to the connectors on the 274-N chasses and the mounting rack.

proximately 12,000 ohms, plate-to-plate. With the transformer and connections shown in *Fig. 1,* and the same plate voltage on the final and on the modulator, a load of any reasonable impedance down to 3500 ohms can be fully modulated. No changes are required to operate with any supply voltage within the rating of the tubes. In one test, the entire modulator was operated from a 150-volt receiver supply, and, although the power was redueed, the modulation level and quality were satisfactory.

As shown in the photographs, the entire modulator was built into a stripped-down 274-N chassis. The 1625 sockets were filed to fit the 807s and the three other tubes are mounted in the three sockets on the rear of the chassis. The interstage transformer was mounted under the original VFO shield can, and the can used to cover both it and the large holes in that section of the chassis. One of the adjustment screws was left protruding from the shield can to form a rest when the unit is inverted on the bench.

The meter may be connected, selectively, to the modulator or to the final at the flick of the panel switch.

A patch-plate was cut to cover the top portion of the front panel, and drilled for mounting the various components. The two receptacles in the lower corners are provided to permit the use of two different types of microphone plugs and are simply wired in parallel.

The metering circuit permits monitoring either the modulator plate current or the final plate and screen current by means of S_1. The two 10-ohm resistors, R_{15} and R_{16} are large enough so that they will not appreciably affect the calibration of the meter.

Note that the gain control R_6 is provided with a long extension shaft to permit keeping it near its associated components and still be accessible from the front panel. A tapered knob, protruding only a little way through the front panel, was selected in order that the gain would not be accidentally disturbed by the knob being bumped.

Choosing the Microphone

As originally built, the speech amplifier was intended to provide sufficient gain for a dynamic microphone, and a low-impedance microphone-to-grid transformer was incorporated. This transformer is shown in the photograph of the bottom of the chassis mounted near the tube sockets and is shielded by a section of iron pipe to reduce magnetic hum pickup. A crystal microphone would have eliminated the need for this transformer with its associated hum-pickup troubles, but the sensitivity of that type to temperature and humidity renders it unsuitable for mobile use. The recent availability of ceramic microphones, however, has changed this situation. They are essentially impervious to temperature and humidity conditions, and, having electrical characteristics similar to the crystal type, require no transformer. An Astatic CC1S, equipped with a ceramic cartridge, was modified to permit operating the push-to-talk relay, K_1 with the conventional microphone switch. The additional lead was obtained by replacing the single-conductor cord with a double-conductor one. The microphone transformer was removed and the microphone jack wired directly to the 6SJ7 grid as shown in *Fig. 2*.

Results with the ceramic microphone have been very gratifying. Reports from stations familiar with the previous dynamic unit (and it was a good one of standard make, not surplus) have invariably included reference to the greatly improved quality and intelligibility. A slight persistent vibrator hum, originally magnetically induced by the push-to-talk relay into the dynamic microphone transformer, has completely disappeared. A CC1S similarly modified and used by W2DZV has been equally successful.

A modulator such as this, on a 274-N chassis, mounted beside a converted 274-N transmitter on a dual transmitter rack as shown in the photographs, makes a very convenient installation for either fixed or mobile operation. All interunit connections may be made via the plugs on the rear of the chassis, with cross-connections made in the shielded compartment which comes on the rear of the rack. By means of a plug connector on the rack, the entire assembly may be plugged into either the mobile power supply cable or removed from the car and used with an a.c. power supply as a fixed or portable station. Perhaps even better, separate racks may be used for mobile and fixed operation, and the modulator and transmitter units only transferred.

The transmitter shown in the photographs is a 4- to 5.3-mc, BC 457, converted for 10 and 11 meters, essentially as described in January, 1948, *CQ*. The two grid current jacks are at the rear of the chassis, on the right, since they would not be accessible on the left as shown in that article. Note that the rack must have clearance holes to permit access to the jacks. No plate current jack is included since plate current may be read on the meter on the modulator. Because of the relatively high power level at which this installation is intended to run, two 807s in parallel are used in the final. The exciter shown in the January, 1948, article is capable of driving them.

By providing other 274-N transmitters, converted as necessary for the desired bands, bandchange can be reduced to the simple process of plugging in the proper transmitter and making such antenna modifications as are required. Since each can then be set on a preselected frequency, and completely pretuned, one to two minutes are all that are required for a complete band change, including adding or removing an antenna loading coil as may be required for lower frequency bands.

Screen Grid Modulating the Command Rigs

ROBERT R. HALL, WØCRO*

Complete modulator and power supply. Controls are, from left to right: Adjustable screen dropping resistor; c.w.-phone switch (to lower power input from 200 to 100 watts); mike input, and audio gain control.

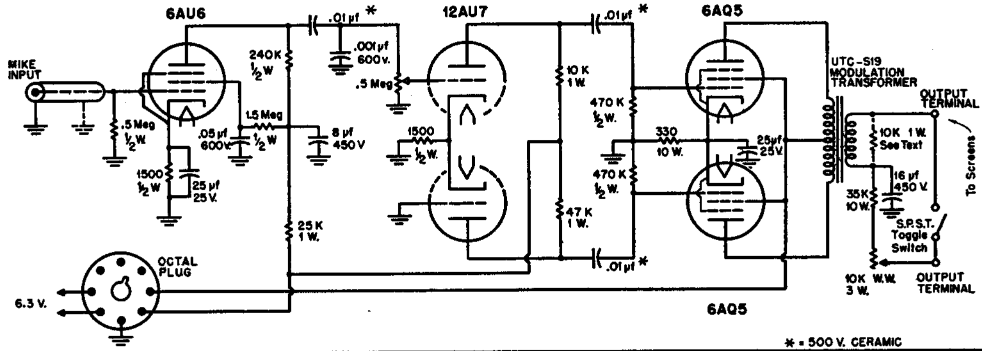


Fig. 2. The screen grid modulator is built on a 5 x 7 chassis which is mounted on the front of the power supply chassis. A cable with an octal plug comes out of the rear of the chassis and plugs into the octal socket on the back of the power supply. The audio output of the modulator, which is terminated with two feed-through insulators, is connected in series with the screen voltage feeding the transmitter.

There seems to be no end to the uses that may be made of the popular command transmitters. But one obvious application seems to have been overlooked and that is operation of the BC-696 or converted BC-457 as a screen grid modulated phone.

Screen grid modulation can be accomplished with very low audio power and with a very simple modulation transformer. Furthermore, adjustment of the circuits is simple. Examination of the accompanying circuit diagrams will show that the components are small and relatively inexpensive and can be easily obtained. Any speech amplifier that will deliver two and one half watts or more of audio can be used and matched to the screens with a suitable transformer.

The modulator shown in the photographs is the one now in use at WØCRO. It has a 6AU6 input tube, a 12AU7 phase inverter feeding into a pair

**3340 39th Ave. S., Minneapolis 6, Minn.*

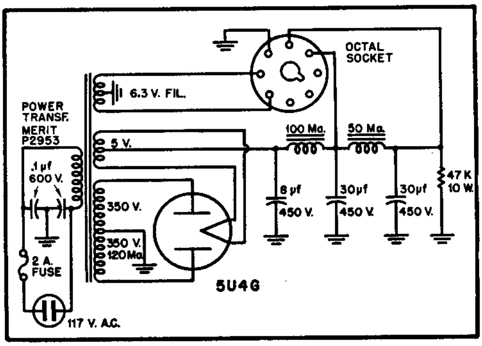


Fig. 1. Modulator power supply is built on a 7 x 9 inch steel chassis. The rectifier tube and power transformer are mounted toward the rear of the chassis to leave a clear space on the front to accommodate the 5 x 7 modulator chassis. There is an octal socket on back for output voltages. The chokes, condensers, etc., are mounted under the chassis.

of Class A 6AQ5s. In the original setup a factory built PA amplifier was used which had an 8-ohm output. It was coupled to the transmitter with a universal output transformer and a load resistor placed across the 8-ohm line. In this modulator a small universal modulation transformer was used and matched with its highest ratio (10,000 ohm primary to 14,000 ohm secondary). This impedance is not critical.

Since we know a number of hams using the BC-696 for 100-watt phone rigs, modulating them with Class B modulators, conditions in this article have been set up to duplicate this performance.

Instead of the usual 400-volt power supply as used with the BC-696 when Class B modulated, a supply capable of delivering 800 volts under load was chosen. The supply must be capable of delivering 250 ma average power to the final, plus bleeder and screen current. The transformer in this particular installation has a rating of 1040 volts a.c. each side of center at 400 ma and is used with a 16-µf single-section filter. The screen voltage is obtained from this supply through a suitable dropping resistor to develop 450 volts of regulated supply across three VR150s in series. This 450 volts is used on c.w. and when tuning up on phone, but is further reduced in the modulator before modulation is applied. A separate oscillator supply delivering 300 volts is regulated by two VR150s in series. With 300 volts on the oscillator it will deliver the 7 ma of drive required.

Modulation is accomplished by reducing the screen voltage to about one half of the value used on c.w. and then applying suitable audio voltage to swing the screen between zero and the 450 volts applied on the average peak c.w. condition.

Tuning Up

To accomplish the proper modulation of the carrier and to adjust the screen voltage to the proper portion of its operating curve a definite tuning up and adjusting procedure is used. Referring to the diagram of the modulator the control switch is closed for the initial tune up. The transmitter is then loaded up to 200 watts input or 800 volts at 250 mills which is an average carrier wattage whose instantaneous peak power is 400 watts. The switch is then opened and without changing anything else, the screen voltage is reduced so the plate current drops to one half, or 125 mills, which is 100 watts and is the phone carrier average power. Then apply enough modulation to cause the plate meter to move slightly; if the meter kicks upward it indicates the screen voltage is a little too low, if the meter kicks downward the screen voltage is a little too high. Attempt to adjust the screen voltage for minimum kick in either direction as a final adjustment. Just enough modulation to make the meter barely move is close to 100% modulation.

As an added refinement the d.c. was removed from the modulation transformer winding as shown in *Fig. 2* requiring the use of the choke and condenser, although the modulator works nicely without this modification.

With screen grid modulation and 100 watts power there has been no sign of BCI. An a.c.-d.c. midget can be operated right alongside the transmitter or within inches of my vertical antenna without any sign of blasting or signals beyond those characteristic points where a signal can be heard as a function of the receiver oscillator harmonics producing 455 kc i.f. beats.

A standard type 47 pilot lamp can be connected across about a foot of the antenna wire at a current point for a modulation indicator. Using this method of tuning and by making suitable changes there should be no reason why other rigs employing screen grid tubes cannot be similiarly modulated with excellent results.

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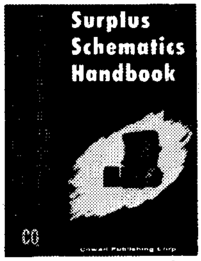

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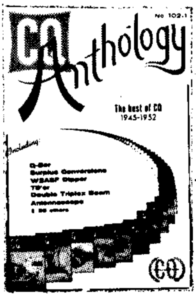

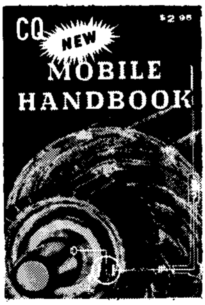

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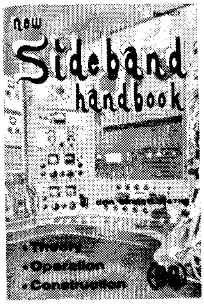

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Modifying for TVI-Free Operation

HERBERT S. BRIER, W9EGQ

Curing TVI and cleaning up the keying go hand in hand when we're working with the BC-459 and others of the Command Set series. If you want to clean up your pebble crusher, here's a complete course.

THE THOUSANDS of "war surplus," Army 274-N transmitters (BC-459, BC-696, etc.), and the ARC-5 equivalents, used by amateurs speak highly for them. Unfortunately, as does most "surplus" equipment, they have their faults. Two of them are their propensity to cause television interference and their less-than-perfect keying characteristics. This article will outline methods for eliminating one and improving the other.

There is a good reason for discussing together such apparently unrelated subjects as television interference and keying. There is often an unsuspected relationship between the two. TVI is usually caused by harmonic or spurious-signal output from the offending transmitter in or near locally-assigned television channels, overloading of the input stages of the television receiver by the strength of the fundamental signal, or undesired signals bypassing the input stages to appear directly in the receiver i.f. channels, or keying transients or "clicks." Any of the above may be radiated directly from the transmitter or power supply, as well as by the antenna.

The 274-N series of transmitters have caused interference in every manner listed, although not every one does so. One does, and another does not, depending on the separation between transmitter and receiver, strength of the television signals, the design of the television receiver, and dozens of other variables.

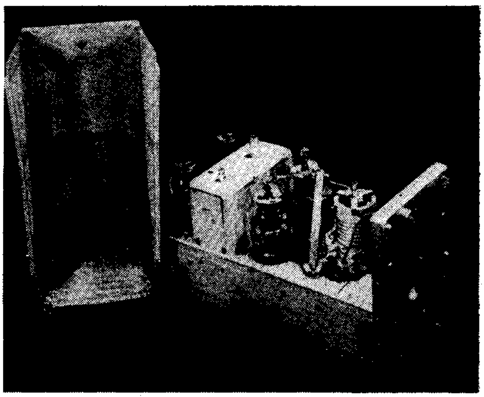
It is the variables that make the problem difficult, making it impossible to say, "Do this, and your TVI troubles are over." Instead, it is necessary to list remedies for as many of the probable causes as possible and offer the hope that only in the most severe cases will it be necessary to incorporate all of them. This is the procedure followed in this article, although all modifications can be made in a single evening. The modifications suggested refer specifically to the BC-459 (7 to 9.1 mc) unit, but apply to the other transmitters in the series as well.

The Original Layout

Looking at the original diagram, *Fig. 1,* and the physical layout of the BC-459, it is obvious that little effort was made to design a transmitter with low harmonic output. Tubes like 1625s generate parasitic oscillations at the slightest provocation, and putting a pair of them in parallel is a gilt-edged invitation for them to do so. Then to place the tuning capacitors below the chassis, necessitating long leads, unrolls the velvet carpet for parasitics in the v.h.f. region. The parasitic suppressors in each plate lead are mute evidence that the 1625s took advantage of the opportunities presented.

If the suppressors actually eliminated the v.h.f. output, all would be well, but they do not. Several local amateurs who can operate on ten and twenty meters with several hundred watts input to their regular transmitters without television interference report that a BC-459, with 250 volts on the 1625 plates and no antenna connected, blanks out one or more of the lower-frequency television channels on nearby receivers. The havoc created when an antenna is connected and higher voltages are applied can easily be visualized.

Parasitic suppressors in tube plate leads often eliminate high-frequency oscillations only to increase output at other equally-undesirable frequencies, which is what is apparently happening in the BC-459; therefore, we will remove the suppressors and attempt to eliminate the parasitics and harmonics through the methods shown in the



The placement of the vacuum condenser and the use of wide copper strap for plate circuit leads to achieve maximum attenuation of all but fundamental frequency output from the 1625s is clearly shown. Also visible is the piece of aluminum to cover the holes in the front panel. Output is from the "mike" connector in the upper corner of the panel.

photographs and the revised diagram (*Fig. 2*).

The most obvious difference between the two diagrams is the 50-$\mu\mu$f vacuum condenser in *Fig. 2*. Obtained from a BC-442 antenna unit, another part of the 274-N, and still available at "surplus" prices, its purpose is to bypass the plates of the 1625s directly to ground for frequencies in the television region. In order to mount it in the most effective spot, the unused antenna loading coil is removed and the amplifier plate coil moved forward.

The screws that fasten the coil to the chassis also support one side of a variable condenser below the chassis. By moving the center of the coil in line with the screws supporting the other side of the condenser, one of them will fasten one side of the coil in its new position. Rather than removing the condenser to drill a hole to fasten the other side, a small strip of metal clamps the coil bracket to the chassis with aid of a nearby screw.

Moving the coil forward requires a slight modification of the control for the variable link. With the antenna loading coil removed, it is no longer necessary to "offset" the link control; I therefore removed the gears and brought it to the front panel through an insulated coupling. Not having a spline wrench to remove the knob, I first sawed it with a hacksaw and then split it with a screw driver. A knob with a conventional set screw later replaced it.

Again, to avoid dismantling part of the transmitter to drill a hole, one end of the vacuum condenser is fastened to the chassis by bolting its mounting clip to the center of a three-quarter inch wide strip of stiff aluminum. Holes near the ends of the strip serve to fasten it to the chassis with the original coil-mounting screws. The head of the screw in the center of the strip is thus pressed firmly against the chassis, making a firm, low-resistance, electrical connection.

One-half inch wide strips of flexible copper strap connect the other side of the vacuum condenser to the 1625 plate caps. Another strip of the same material connects the condenser to the insulated stud, which is connected to the variable condensers under the chassis. A wire between the top of the coil and the vacuum condenser and another from the bottom of the coil to the stud, bringing the plate voltage through the chassis, completes this phase of the conversion.

Before these changes were made, the plate-circuit wiring, plus the parasitic suppressors, resonated in the low-frequency television channels. After they were completed, this secondary resonant frequency was raised beyond the range of my grid-dip meter.

Adding the 50-$\mu\mu$f capacity of the vacuum condenser to the plate tank circuit requires that the capacity of the amplifier padding condenser be reduced accordingly. Originally, it requires slightly less than half capacity on the padder to achieve resonance. With the vacuum condenser added, resonance is achieved with the padder condenser plates meshed about fifteen per cent.

For maximum harmonic attenuation, it would be better to remove the slug from the amplifier

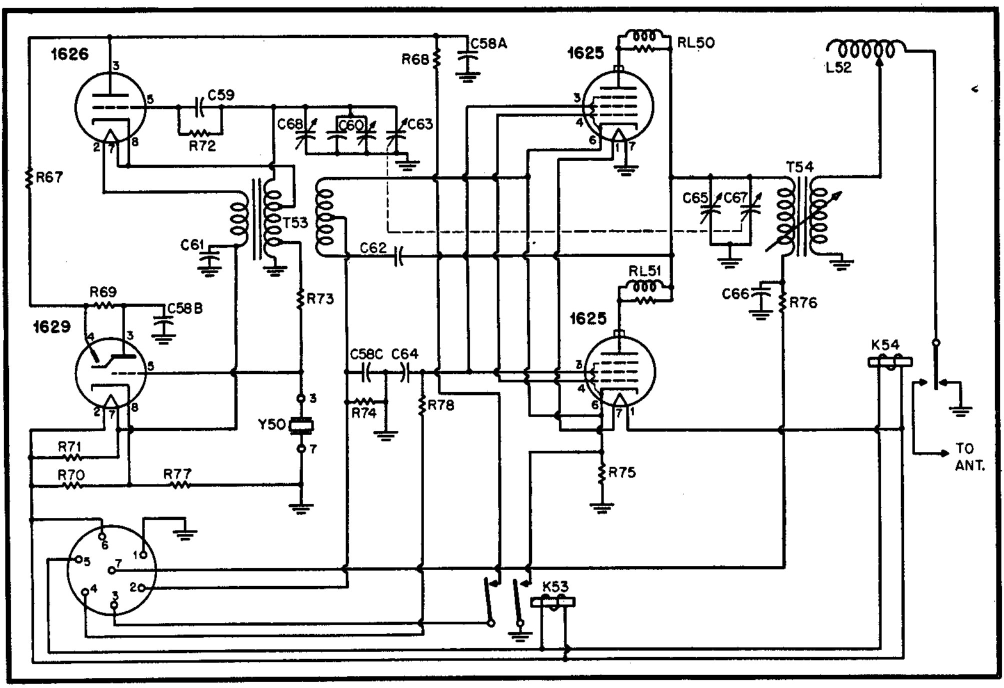


Fig. 1. The original circuit diagram of the BC-459.

coil and/or remove a turn or two from the coil so that the capacity required to achieve resonance is increased. Such a move may be desirable when it is suspected that third-harmonic (21 mc) energy is getting into the i.f. channels of nearby receivers. If either is done, it may be necessary to readjust the padder whenever the operating frequency is shifted appreciably. This should be done anyway in the interest of minimum harmonic output; therefore, it is not too much of a handicap.

Should the vacuum condenser be unavailable, either a mica or a ceramic condenser, with a d.c. voltage rating equal to four times the plate supply voltage, may be substituted with almost equal results if leads are kept short.

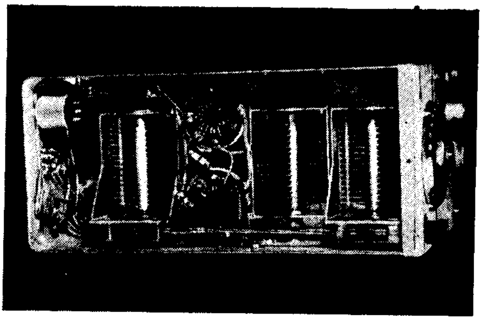
Below the Chassis

Below the chassis, the first thing noticed is that bypassing and grounding the 1625 cathodes and screens is done at one tube socket, with a jumper several inches long to the corresponding terminal on the other socket. Such construction leaves the second terminal floating for high frequencies. The photograph of the bottom clearly shows the placement of the added bypass condensers to bring them to zero r.f. potential. Also seen are the shielded wires replacing the jumpers between the cathode and screen terminals respectively, the shielded key lead, and those replacing the old leads between the power plug and the 1625 sockets. Each shield on these leads should be grounded at each end and wherever possible throughout its length. Although not necessary in this unit, it may be advisable to bypass each terminal of the power plug by 500-$\mu\mu$f condensers, and continue shielding of the power leads right to the power supply.

It would have been even better to ground the cathodes directly through wide copper strips, had it not been desired to key the cathodes. As said before, clicks can cause television interference, thereby nullifying efforts to remove other causes. Stabilizing the 1625s and shielding keying and power leads help in eliminating clicks, but whenever electrical circuits are suddenly broken, a power surge is developed which can cause a click independent of what is connected to the switch. (For example, turning on a nearby light often makes a click, causing a momentary loss of picture "sync.")

B-negative keying of the entire transmitter is particularly bad from this standpoint, and a filter sufficiently large to remove the click usually greatly accentuates the chirp accompanying this type of keying. Keying the B-plus supply for the oscillator plate and the amplifier screens is better, because the current and voltage keyed are less; however, the same difficulty with chirps is found. In addition, a keying relay is required to protect the operator.

Cathode keying of the amplifier permits using enough "lag" to eliminate clicks without increasing the chirp. The constantly running oscillator does prevent working "break-in;" therefore an alternate system permitting keying the amplifier alone, or with the oscillator by snapping a switch, is included in *Fig. 2*.



Shielded leads and the additional mica bypass condensers to stabilize the 1625s are clearly seen. Amplifier padding condenser (second from front) is still set at its original capacity. With the vacuum condenser in place, resonance is achieved with the padder near minimum capacity. The neutralizing condenser is mounted on the wall of chassis behind the padding condenser.

Photo by S. J. Kozan

Shielding

Although the shielding of the BC-459 looks quite complete, there is much room for improvement. Lining the cover with copper screening makes it more nearly r.f.-proof than before, while still retaining ventilation. The fine-mesh screening designed for strainers, etc., is best, but ordinary copper (or bronze) window screening is satisfactory and much cheaper.

Bend a piece about twelve by fifteen inches into a long trough to fit against the sides and top. Then solder another piece across the open back of the trough. The screening should extend to the edges of the cover on all sides, and when the cover is screwed to the chassis, it is firmly clamped between the two.

Covering the openings in the top of the cover makes it necessary to remove it completely to change tubes. This is not much of a handicap, because tubes are changed so infrequently.

A small piece of aluminum, with a cutout at the bottom to accommodate the dial, covers the holes in the front panel. To remove the two "locks," drive out the pins fastening the knobs to the shafts with a small finishing nail.

Tuning

Tune up the transmitter in normal fashion and check the neutralization of the 1625s. The easiest way to do so is to connect a 50- or 100-volt, high-resistance voltmeter between the chassis and pin number *2* of the power plug to measure amplifier d.c. grid bias. Carefully tune the amplifier plate padding condenser slightly each side of resonance while observing amplifier plate current and grid voltage. If neutralizing is complete, minimum plate current and maximum grid voltage will occur at the same setting of the condenser. If this does not occur, attempt to reneutralize the 1625s by squeezing together or spreading apart the plates of the two-plate condenser mounted on the side of the chassis behind the amplifier padding condenser. (Caution! The condenser is "hot.")

If television interference persists after these changes have been made, your fundamental signal is probably overloading the input channels of the affected receivers. This very common receiver fault is a problem for the television receiver technician. Suggest to him that a pair of traps tuned to your operating frequency or a high-pass filter inserted in the television receiver feed line right at the receiver antenna terminals is an almost positive cure, *if the television receiver is in good operating condition.*

To be as pessimistic as possible, let us assume that one receiver still has interference, even with antenna traps installed. Substitute a dummy antenna for the transmitting antenna—an ordinary 115-volt bulb will do, preferably shielded—and load the 1625s to their normal input. If interference disappears, your greatly-reduced harmonic radiation is still sufficient to cause interference. An antenna tuner, if not already used, connected to the BC-459 through a shielded line, may be sufficient to eliminate the interference, or a low-pass filter or "harmoniker" in the feed line to the antenna or tuner may be necessary. If the interference persists, even with a dummy load on the transmitter, direct radiation or r.f. energy feeding back into the power lines is probably occurring. Sprague, 0.1-$\mu\mu$f, high-pass condensers in the 115-volt supply line at the power

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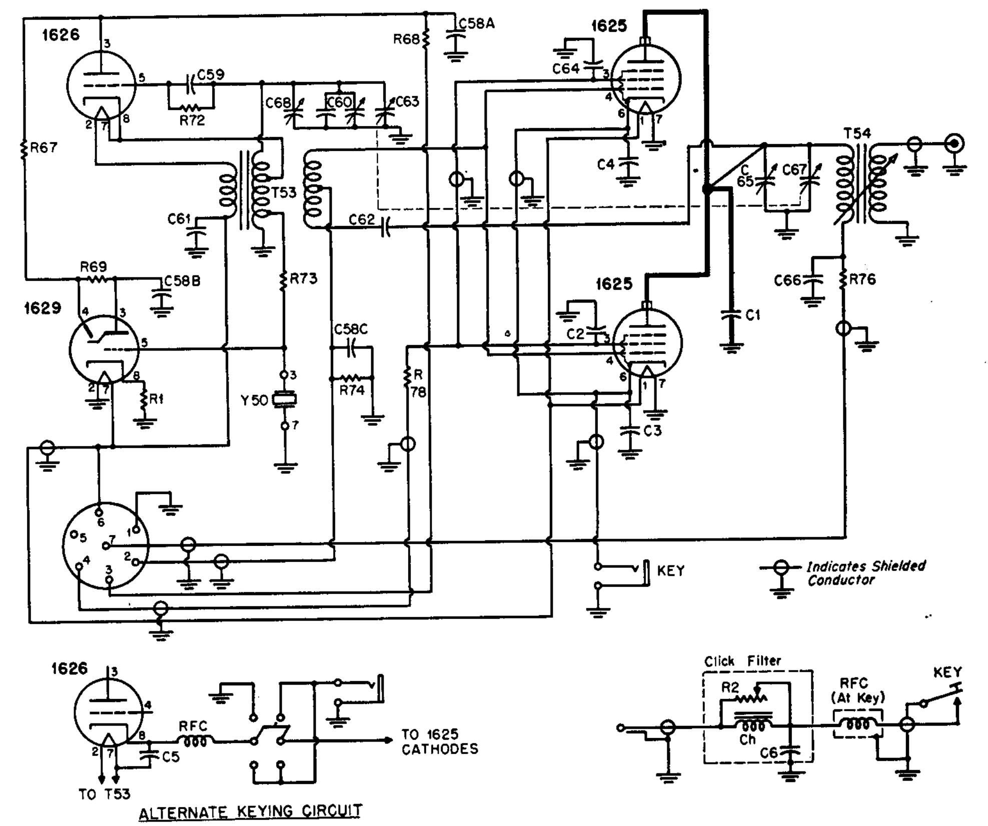


Fig. 2. Diagram of modified BC-459. Filaments have been rewired for 12-volt operation, and unused parts have been removed. Power requirements: 500-600 volts at 150 ma (pin 7), 250-275 volts at 20 ma (pin 4), 200 volts at 20 ma, regulated (pin 3), and 12 volts at 2 amp (pin 6).

C1—50-$\mu\mu$f vacuum condenser, see text.
C2-C5—.001 μf, mica.
C6—0.5 μf, 1,000 volts, paper.
R1—2.5K, ½ w.
R2—2K, 10 w., with slider.
RFC—2.5 mhy. r.f. choke.
Ch—150-ma filter choke (between 1 and 10 hy.)
Sw—D.p.d.t. toggle switch.
Other parts same as Fig. 1.

supply will eliminate the latter, and a little judicious juggling of bypass condensers at the BC-459 power plug will cool off the lead that is radiating.

If this article makes it appear that eliminating television interference from the BC-459 is an almost hopeless task, this is not so. In the majority of cases, stabilizing the 1625s and eliminating key clicks is all that is necessary. To be complete, however, it was necessary to discuss the more difficult cases. Besides, the changes suggested will improve the unit as an amateur transmitter, even where television interference is not a problem.

TVI-Proofing the Command Transmitter

SAMUEL J. LANZALOTTI, W2DVX*

The Command-type transmitters are frequently a source of TVI when they are used "as-is." Here is a detailed description of how, by the application of the principles previously published in CQ, you can clean up yours.

THE CHANCES ARE you're having trouble with TVI if you're using an SCR-274N Command-type transmitter. Not that this unit isn't a first-rate performer on the amateur bands. It is, but unfortunately its major component, the BC-457, unaltered and by itself is capable of producing a spectrum of harmonics so strong that television receivers, even a considerable distance from the 457, may be completely blanketed.

This occurred at W2DVX and required a step-by-step procedure which, when completed, proved so effective that it is now possible to couple the BC-457 running at 70 watts on 75-meter phone into the input of a television receiver with no audible or visual signs of interference.

If you own an SCR-274N, here are the requirements.

1. Complete shielding.
2. Insert chokes and by-pass all power and other leads.
3. Feed the antenna with coax through a low-pass filter.

The cover of the BC-457, regardless of the louvres, must be made to function as a complete shield. This is done by using one layer of ordinary window screening, preferably copper, cut to size and installed over the louvres on the inner side of the cover and fastened down with 4–40 screws, as illustrated in *Fig. 1*. It is also necessary to cover the openings that are located in the back between the cover and the chassis with screening, as shown in *Fig. 1*. All other holes, if larger than 1/8 inch in diameter, should be screened or filled in with blind machine screws. This is necessary to keep all the r.f. confined within the BC-457. To further the shielding, cut out two pieces of copper or aluminum (approximately 3 to 10 mils thick) that will fit neatly under the two small felt padded covers located on top of the large over-all cover.

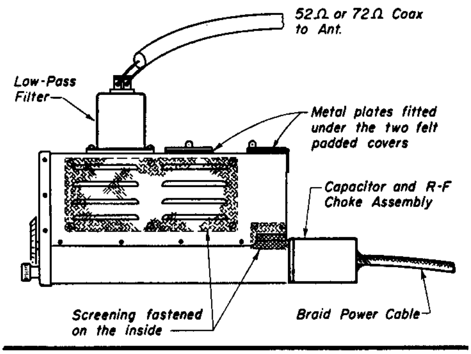


Fig. 1 illustrates the side view of the TVI-proof Command transmitter. The penthouse on the top holds the low-pass filter for the coax output line, the doghouse at the back houses the filter components for the shielded power-supply cable.

Filtering the Power Leads

The next and most critical step is the fabrication and assembly of the r.f. chokes and their shields. It isn't necessary to purchase r.f. chokes if a stock of enamel wire is available. All chokes are wound with No. 20 enamel wire, close-wound on a 3/8-inch form to a coil of approximately 2 inches. The chokes are then fully covered with electrical tape (adhesive tape is satisfactory) to hold the coil firm and also to serve as an insulat-

* *Alfred Vail Apts., Eatontown, N. J.*

ing medium between the shield and the coil. All the r.f. chokes are shielded individually in a ⅝-inch dia. (or larger) metal tube made of either copper, brass, or aluminum, as shown in *Fig. 2*. The choke coils had an inductance of 3.9 µh and a *Q* of 135; however, by covering the choke with tape and a tubular shield of ⅝-inch dia., the inductance dropped to 2.2 µh with a *Q* of 60, which was still satisfactory. It is best to use chokes with the highest *Q* possible, but in this particular case, space was also an important factor, and since some sacrifice in inductance and *Q* could be tolerated, it was decided to make the assembly as small as possible and still get results. It is very important that every choke coil be shielded individually. The r.f. chokes mounted in their shields were arranged in a turret-like

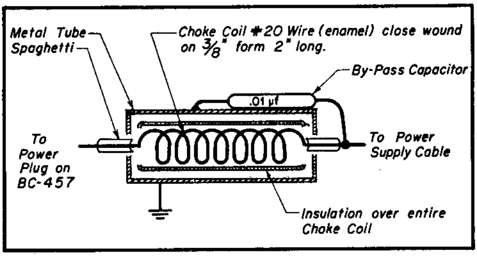


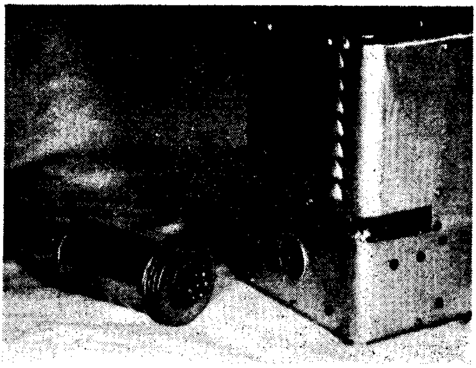
Fig. 2. Each of the individual power leads is filtered by its own LC network, as illustrated above. A "bundle" of these filter units fits into the rear doghouse.

manner, strapped together with tape and slid into a No. 8 tin can, thereby shielding the entire choke assembly. It is very important that this shield cover the entire choke and bypass assembly and be firmly bonded to the chassis of the BC-457. It was found necessary to strap the entire assembly to the chassis of the BC-457 with a heavy bracket.

All the coils are bypassed with .0033 and .01 µf capacitors. The power cable is shielded with heavy braid over its entire length, which, in this case, measured approximately three feet. The power supply need not be shielded; a breadboard supply is satisfactory.

The Antenna Filter

The low-pass filter used in the antenna circuit completes the isolation of all harmonics. The filter is similar to the Harmoniker described in the November issue of *Ham News*. The coils *L* are self-supporting and therefore need no form except for winding (*see Fig. 4*). The coils are close-wound on a ¾-inch form, 14 turns, with No. 14 enamel wire. It is best to wind a few extra turns because of the spring-back effect of the coiled wire when slid off the winding form. This will also increase the inside diameter of the coil from ¾ inch to approximately 13/16 inch diameter. Cut off all excessive wire except 14 turns and a sufficient amount of lead length. A large shield can should be used to house the filters. The coils should be mounted so that the distance be-



The doghouse containing the line filters plugs into the connector at the rear of the transmitter. The screening covering the slot at the rear corner of the chassis can be seen in this view.

tween any part of the shield and coil should be not less than ¾ inch.

The capacitors *C* are 840 µµf; however, a value falling between 830 µµf and 840 µµf is satisfactory. A shield is located between the two filter sections. This shield is so placed as to prevent any opening between the two sections, as shown in *Fig. 4*. The capacitors *C* are terminated as close to the molded portion of the capacitors as possible to minimize lead inductance. Silvered mica or silvered ceramic capacitors having a zero temperature coefficient and a 500-volt working voltage rating should be used. The filter as described here should be used only with transmitters operating between 3.5 mc and 4.0 mc. No. 8 tin cans were used very effectively as shields for the low-pass filter and the choke assembly. No circuit changes were made except to add .0033

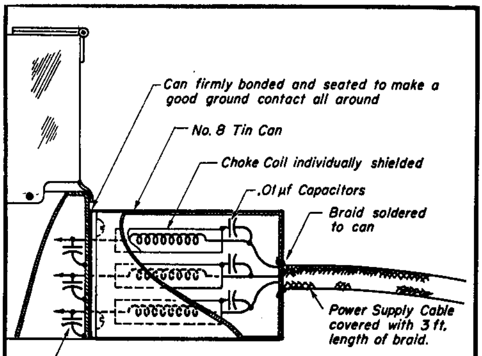


Fig. 3. A bundle of the Fig. 2 filter units is secured to the back of the transmitter and shielded as illustrated here. The .0033-µf condensers installed in the transmitter chassis as shown help out with the filtering job. A good electrical connection at each joint is essential.

capacitors on the inner side of the power plug, as shown in *Fig. 3*.

The BC-457 now shows no sign of TVI regardless of the operating frequency in the 3.5–4.0 mc band.

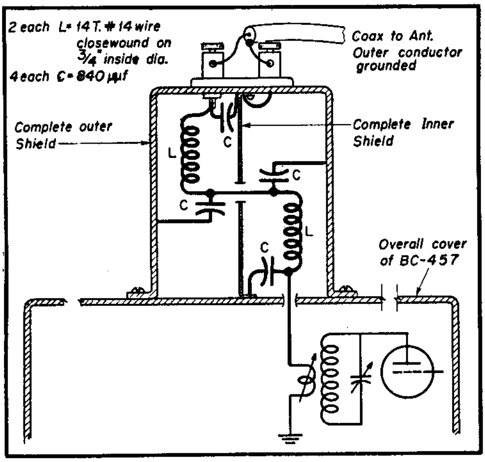


Fig. 4, showing what lives in the penthouse. The low-pass filter is a "must" for almost every 274N rig.

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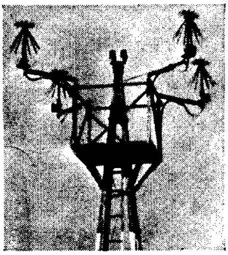

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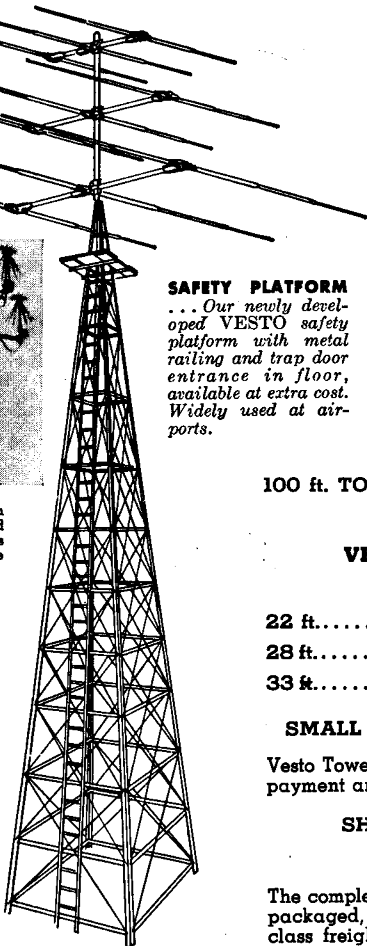

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Converting the SCR-274N Receiver

RUSSELL F. SIEVERT, W8OZA*

One of the top buys in surplus, modification of the 274N receiver series for a-c or d-c operation is extremely simple.

During the past few years the conscientious radio amateur has turned his attention more and more to the construction of portable-emergency equipment, which could be easily transported from one location to another at a moment's notice. Unfortunately, the attention given this type of equipment has been heavily lopsided in favor of the transmitter and those among us with a truly portable receiver are rare indeed. We are not entirely to blame; constructing a decent superhetrodyne receiver is by no means a simple job and since the manufacturers started building receivers with provisions for an external power source it has been easier to take along the home station receiver.

However, we can now all have a really portable job for a cost of from ten to twelve dollars. The "break" comes in the form of the BC-454-A and the BC-455-A government surplus receivers which form a part of the SCR-274N aircraft equipment. The two models available cover the tuning ranges of 3 to 6 mc and 6 to 9.1 mc respectively, and the circuits of both are nearly identical. The receivers are six-tube superheterodynes employing a 12SK7 t-r-f stage, a 12K8 mixer, two 12SK7s as i.f.s, a 12SR7 second detector and b.f.o. and a 12A6 audio amplifier. In the case of the 3 to 6-mc unit the i-f frequency is 1415 kc and in the higher-frequency model the i-f frequency is 2830 kc. The conversion data discussed can be applied to either unit without change, except for one item which will be described in detail further on in the article.

Built for the government, these receivers were designed to operate from a 24-volt d-c source which powered a small dynamotor mounted on the rear shelf of the chassis. The revamped job can be operated from either 110 volts a.c. or an external 6 or 12-volt a.c.-d.c. filament supply and 250-volt d-c plate supply. This is accomplished by means of a small a-c transformerless power supply and a six-pole two-position rotary switch. The power supply uses a 25Z5 in a conventional voltage doubler circuit but the whole secret to the receiver's versatility is centered around the aforementioned rotary switch. As

1345 E. 66 St., Cleveland, Ohio.

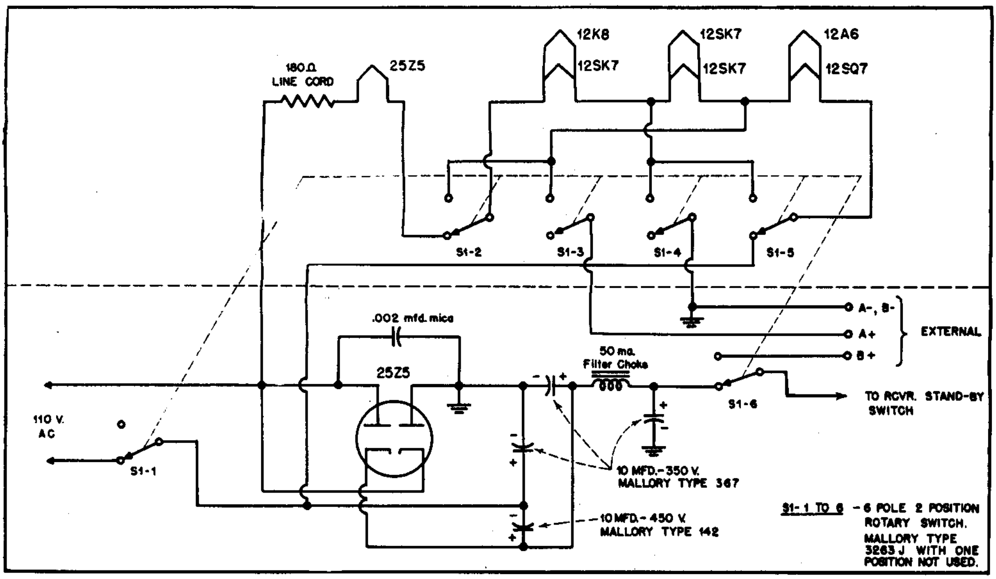
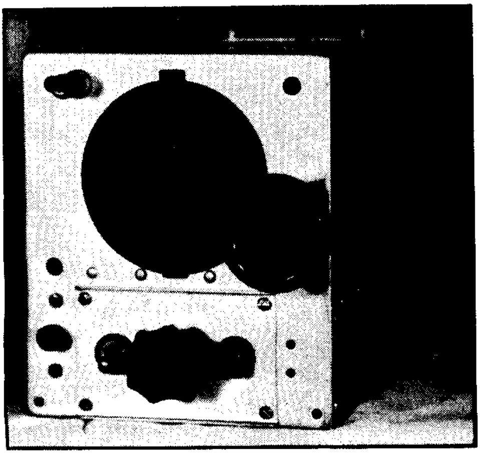


Fig. 1. Circuit diagram showing changes required for a-c or d-c operation. Part A is top, B is bottom.

will be seen from a study of the circuit diagram, this switch actually makes a complete change in the filament circuit. When it is in the position shown in the diagram the filaments are connected in a series-parallel circuit, with the 25Z5 voltage doubler cut in to supply power. It is necessary to have the tubes in the receiver proper wired so that two tubes will be in parallel in order to balance the filament current at .3 of an ampere. This seemed more desirable than using a .15 - ampere filament tube such as a 35Z5 in the power supply and having to sacrifice the extra voltage gained by using a voltage doubler.[1] When the switch is thrown to its second position the 25Z5 is completely removed from the circuit, all other filaments are connected in parallel and the leads for supplying filament and plate voltage are extended through to a set of terminals on the rear of the power supply shelf.

The first step in the modification is the preparation of the chassis for the addition of the power suply, plus the removal of the unnecessary parts. Remove the bottom cover plate and the large shield can which encloses the tubes and i-f transformers. Unscrew all of the metal-cased condensers, chokes, etc., from the sides of the chassis and remove the two screws holding the antenna, oscillator and mixer coils in place. With the exception of the square b-f-o transformer there is sufficient slack in the wiring to permit these units to be laid out over the sides of the chassis. The b-f-o transformer can be shifted far enough to be out of the way but care should be exercised to prevent breaking off the lugs to which its connections are made. The coils are of the plug-in type and may be entirely removed until the conversion is completed. The tubes and plug-in type i-f transformers should be taken out similarly and placed aside. Completely remove the metal-cased condenser mounted directly over the dynamotor connecting plug, the small mica condenser going from ground to one of the pins on the socket on the rear of the chassis and the dynamotor plug and its associated wires. Between the beat oscillator transformer and the 3 x .22-μf condenser across from it are two upright mounted black resistors. These were



Front view showing addition of tuning knob, gain control, stand-by switch, and b-f-o switch.

originally provided to furnish a dividing network for obtaining screen voltage. Since the power supply now being installed will give only about 210 volts this network is no longer required and the resistor nearest the b-f-o transformer is removed, leaving only a series resistor in the screen circuit and thereby giving an increased voltage. The four dynamotor mounting cushions are taken off by unscrewing the nut on the bottom of the chassis. All of the remaining leads going to the socket on the rear of the chassis are now completely removed and the socket itself is taken out. This completes the dismantling at the rear of the chassis and we can now begin to prepare the front end for the necessary revisions.

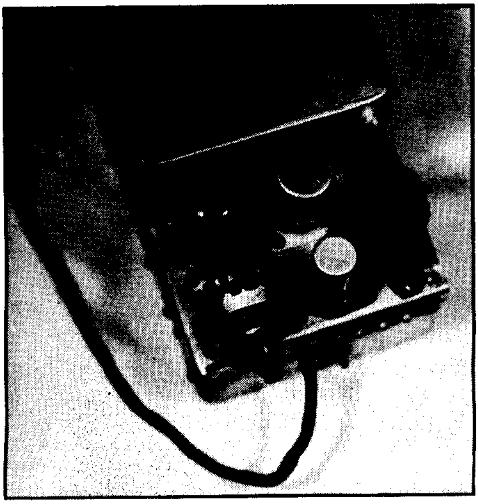
The first item to be removed is the 3-μf condenser fastened to the front panel alongside the remote control box. Remove the remote control box and the leads going to its socket with the exception of the black lead and the one remaining green lead, which should be cut only at the control box socket and left in place for further use.

Now that all of the "surplus" surplus has been removed we can go to work and put it together the way we want it. The first job of course is to rewire the filaments in accordance with the diagram shown in *Fig. 1*. The leads going from the tube sockets to the switch should be soldered in place at the socket end and fed through the left rear hole in the chassis which has been provided by the removal of the dynamotor mountings. These leads should preferably be color-coded so as to facilitate their later being connected to the six-pole two-position rotary switch. The next step is the installation of the controls on the front panel. These include a SPST toggle switch to be used as a stand-by switch, a 50,000-ohm potentiometer for a gain control and a second SPST toggle switch to control the beat oscillator. The controls are all mounted on the front plate of the remote control box which is completely dismantled for this purpose. The three holes left in the center of this plate, after the knob and socket supports

[1]It would, of course, be possible to construct a voltage doubler supply utilizing selenium rectifiers. Then the heaters could be connected in series and operated directly from the 117-volt a-c input if a 50L6 were substituted for the 12A6 (VT134). Screen voltage for the 50L6 would have to be limited to 110-volt d.c. requiring the addition of a screen dropping resistance, or bleeder and the inclusion of an audio bypass connected between screen and ground.

If a half-wave supply were used in place of the voltage doubler, no modification in screen wiring would be required in substituting the 50L6 for the 12A6. By the use of a half-wave supply, the receiver can be used on either 117 volts a.c. or d.c.

In either case, the substitution of the 50L6 for the 12A6 requires a 150-ohm cathode resistance in place of the 1500 ohms (R_{21}) used with the 12A6. The substitution of a 50L6 in place of the 25Z5 permits full series operation of filaments and elimination of line cord filament dropping resistance.



The power supply fits in the place formerly occupied by the dynamotor. The rotary switch is S1.

have been removed, are used as the centers for mounting the three items. The green lead which previously went to the remote control socket goes to the gain control and the arm of the gain control goes to ground. The switch used for the b.f.o. has one connection going to ground and the other to the 3 x .05-μf condenser mounted alongside the b-f-o transformer. This lead connects to the terminal on the condenser to which is already fastened a 5100-ohm resistor. One of the stand-by switch leads goes to the terminal nearest the chassis of the remaining large black resistor and to the terminal on the rotary control switch shown in part *S1* of *Fig. 1*. The output jack is mounted on the side of the chassis next to the b-f-o switch and can be installed without insulating washers. The only connection necessary is the black lead previously removed from the remote control socket.

The final job is the construction of the power supply, the circuit diagram for which is shown in part *B* of *Fig. 1.* This supply is built on an aluminum shelf measuring 3″ x 4½″ with a rear drop of 1″. Once the power supply has been completed the receiver shield can may be reinstalled, the power supply bolted in place on the receiver proper using four 1″ spacers, and the remaining filament and output connections soldered in place. When soldering these last leads in place it may be wise to leave a small amount of slack in the wires to provide for future servicing.

Installation of a Tuning Control

Two methods of installing a tuning knob may be used. One is to remove completely the threaded bushing over the geared shaft to give sufficient clearance for a ¼″ solid coupling and the other is to use a short section of ¼″ copper tubing adjusted to fit snugly on the geared shaft without removing the bushing. The author chose the first method, but only because the coupling was more readily available. The first system involves the complete removal of the tuning condenser and is therefore not recommended. If the first method is chosen the bushing should be removed before the power supply is bolted in place, since the receiver shield cans cannot be removed with the power supply securely fastened.

That about winds up the conversion of the receiver as far as necessary changes are concerned, but there is one thing more that can be done to make it still more adaptable for ham use. Like most equipment designed for military service, this unit is long on performance but short on bandspread. The particular unit the author converted was one that tuned from 6 to 9.1 mc and by removing all but two rotor plates from each section of the tuning condenser and adding small trimmer condensers to compensate for the loss of capacity, it was possible to spread out the 40-meter band to occupy a total of fifteen divisions on the dial, or 20 kc per division instead of the original 100 kc per division. No information is available on the number of plates to be removed from the 3 to 6-mc model, but this can be easily determined by removing the plates one at a time until the desired coverage is obtained. On the 6 to 9.1-mc model, trimmer condensers with a maximum capacity of 45 $\mu\mu f$ were found to give excellent range since the maximum capacity of the original tuning condensers is 66 $\mu\mu f$. On the 3 to 6-mc model the maximum capacity of the tuning condensers is 147 $\mu\mu f$. This would indicate a trimmer condenser with a maximum capacity of about 125 $\mu\mu f$.

To operate the completed receiver merely throw the rotary switch to the desired position, either series or parallel and connect the proper supply voltage. With the switch thrown so that the filaments are all in parallel the operator can substitute 6-volt type tubes and run the whole works from a single storage battery with a vibropack furnishing the high voltage. When using 6-volt tubes a 6K6 should be used in place of the 12A6. If *only* earphone output is desired, a 12J5 can be plugged in place of the 12A6 (with 6-volt tubes, substitute a 6J5 or 6C5) with saving in power supply drain.

Considering its cost, this little unit leaves nothing to be desired and makes a useful adjunct to any station. W8AZ has even mounted a small 3″ speaker on the top of his receiver and uses it as a monitor for his home rig when he is not operating in the field.

the ARC-5 repackaged

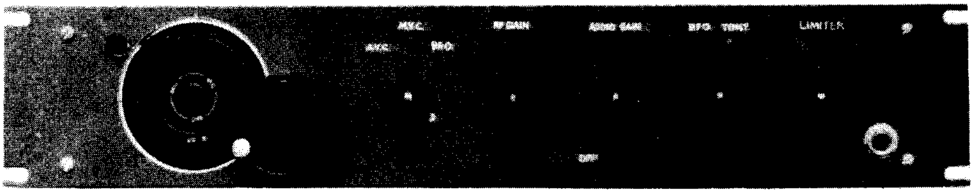


Fig. 1. The ***Commercial Look*** for inexpensive surplus receivers.

W. B. Bernard, CDR., ED, USN, K6EUS

The ARC-5 receiver units are extremely handy around any ham shack. They are inexpensive, plentiful and require so little power for operation that they can be used as standby receivers, monitors for net channels, autocall service, and dozens of other purposes.

Most of us admire the neatness of commercial communications installations and their ability to stack a large quantity of the essential gear in "package" form by relay rack style of construction. More and more amateur stations are adopting this space-saving feature. The reworking of the popular ARC-5 series of receivers into the form shown here permits realization of that dream of all amateurs: a separate receiver, optimized for each band worked.

The ARC-5 units are, as originally packaged, fairly unhandy from many aspects: they clash with the decor of the shack, are difficult to hold in place while tuning, and require an external power supply. For many uses it is desirable to add another audio stage and a noise limiter. At any rate, the solution is one of repackaging.

The receiver repackaged in this case was the one which covers the .19-.55 Mc. band. Since it was to be used as a Q-5'er it was considered very desirable to add an additional audio stage and a noise limiter so that once the i-f signal was removed from the communications receiver it did not need to be returned for either audio amplification or noise limiting. These changes are useful even if the receiver is only used as a stand-by receiver.

If you do not have available a Handbook of Maintenance Instructions for the receiver it is strongly recommended that wiring diagrams be made of all the coil sockets before the old receiver is disassembled.

Fig. 1 is the front view of the repackaged ARC-5. It is mounted back of a 3½-inch rack panel. The components are mounted on a 4x17x3-inch chassis as shown in *Fig. 2.* A 5x17x3-inch chassis would have been preferable in some ways but no chassis of this size was available on the local market at the time the conversion was done so we just squeezed things up a little bit more. Even so, it did not turn out to be unduly crowded.

The components of the ARC-5 were removed from the original chassis and then the chassis was cut into parts which held the coil sockets and the mounting studs for the coils. The r-f, mixer and oscillator coil sockets were removed

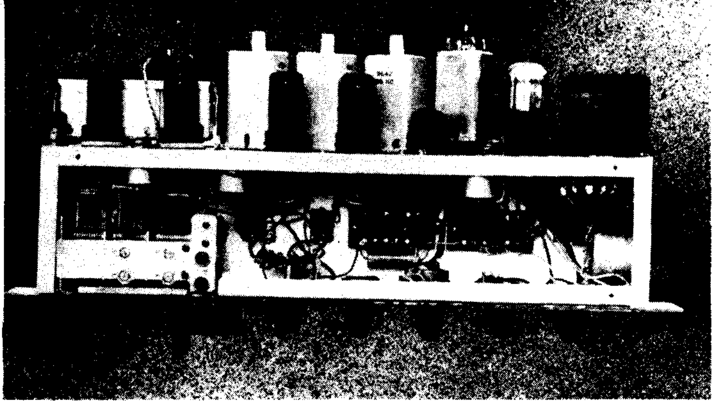


Fig. 2. Wiring under the chassis is kept simple if a parts layout like this is followed.

as a group of three and enough of the sides of the chassis was retained to allow the coils to be held by the screws, as was the case in the original instruction. Each of the i-f coil sockets was cut out along with enough of the chassis to hold the mounting studs and to permit the mounting of the socket to the chassis with four screws. An octal socket was placed next in line to hold the b-f-o coil which in the original receiver was not of plug-in construction. *Fig. 3* shows the back view of the new chassis with all the coil sockets mounted.

Fig. 4 shows the back of the chassis with all the coil installed. All the coils are from the original ARC-5 except the b-f-o coil which was missing from the receiver when it was purchased.

The circuit of the receiver was revised slightly to permit operation from a 120-volt d.c. plate supply. 6 volt tubes are used in this receiver since it had already been converted to 6-volt operation; however 12 volt tubes may be used if a power transformer with a 12-volt heater winding is installed or if a 6.3-volt filament transformer is connected in series with the heater winding of the type transformer used in this conversion. The revised circuit of the receiver is given in *Fig. 6*. The ARC-5 components which are re-used are not numbered on the diagram, making it a simple matter to distinguish the new parts needed. Since the second i-f amplifier operates at a fixed gain a 6SJ7 was substituted for the 6SF7 in order to save plate current. This made it necessary to get the a-v-c voltage from the second detector load resistor. This receiver was not designed for high-fidelity so there is no disadvantage to this change; however, after completing the conversion it was found that a reserve of plate current was available so the original second IF amplifier tube and the original AVC circuit could have been maintained.

The early stages of the receiver are little changed. In order to operate a 120-volt d.c. supply the screens and plates are fed from a single source, thus saving some decoupling resistors and associated by-pass capacitors. It was of course necessary to provide an RF gain control and it was also considered desirable to

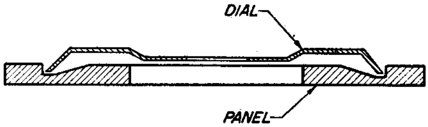
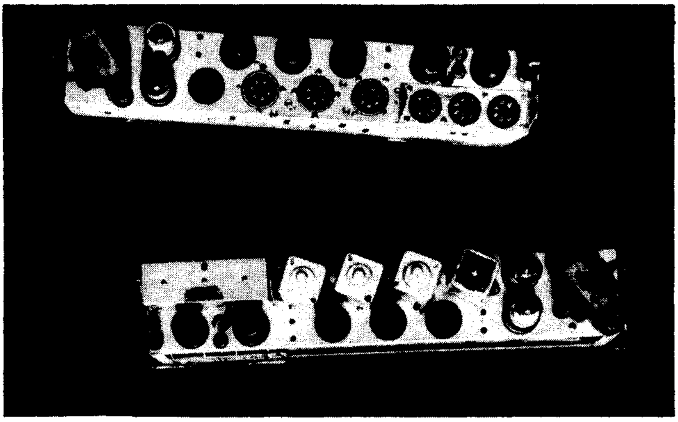


Fig. 5. Cross section of the recessed panel cut back to fit ARC-5 dial. Panel may be cut all the way through if you want to save some energy.

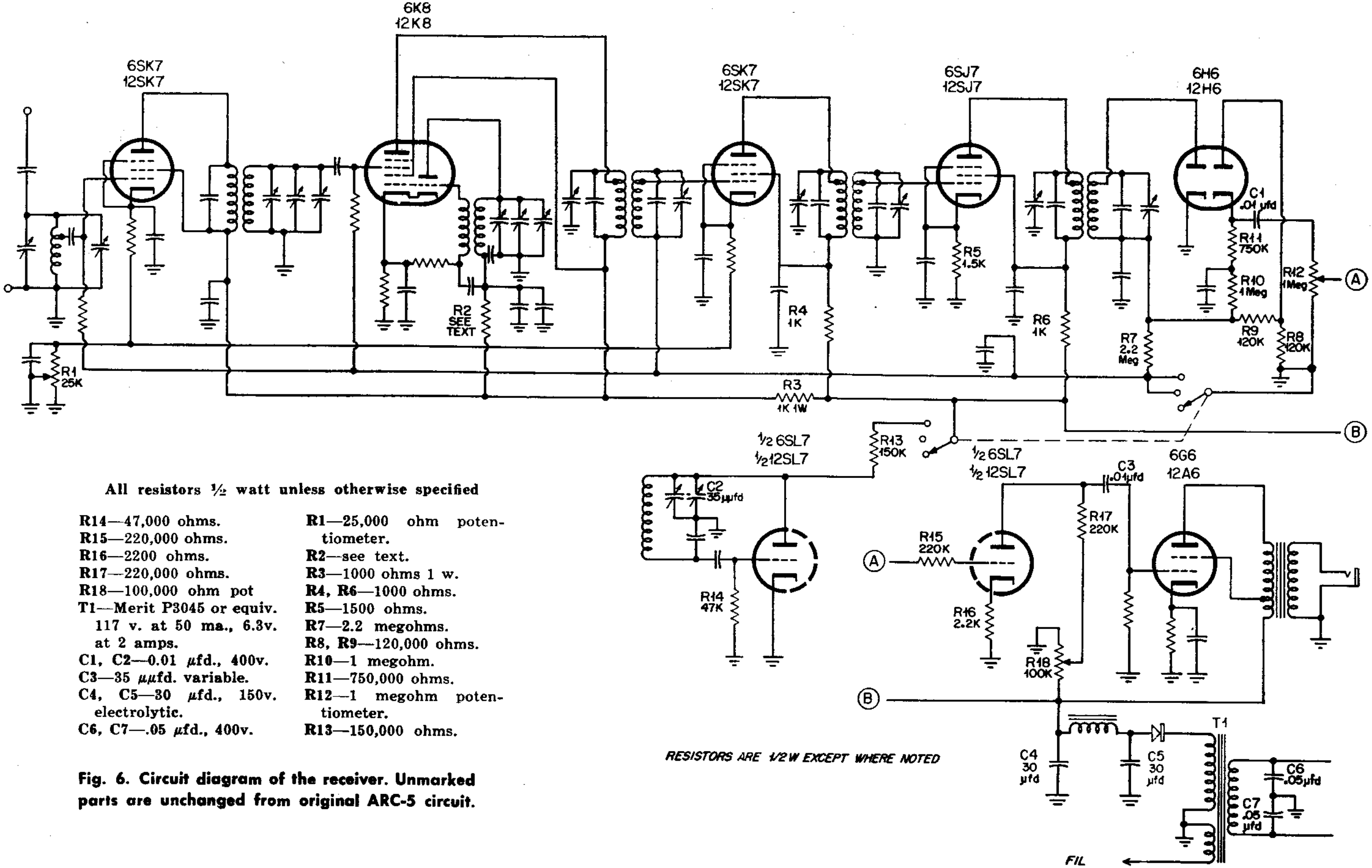
parallel the oscillator plate dropping resistor inside the coil shield with another one *(R2)* across the coil socket terminals. *R2* should be half the value of the resistor inside the coil shield.

One-half a 6H6 is used for the second detector and a-v-c rectifier and the other half is used for a series noise limiter diode. A 6SL7 is used as the first a-f amplifier and the b.f.o. The plate voltage of the audio section of the

[*Continued on page 16*]



Figs. 3 & 4. The position of the i-f and r-f plug-in strip sockets can be seen here.



All resistors ½ watt unless otherwise specified

R14—47,000 ohms.
R15—220,000 ohms.
R16—2200 ohms.
R17—220,000 ohms.
R18—100,000 ohm pot
T1—Merit P3045 or equiv. 117 v. at 50 ma., 6.3v. at 2 amps.
C1, C2—0.01 µfd., 400v.
C3—35 µµfd. variable.
C4, C5—30 µfd., 150v. electrolytic.
C6, C7—.05 µfd., 400v.
R1—25,000 ohm potentiometer.
R2—see text.
R3—1000 ohms 1 w.
R4, R6—1000 ohms.
R5—1500 ohms.
R7—2.2 megohms.
R8, R9—120,000 ohms.
R10—1 megohm.
R11—750,000 ohms.
R12—1 megohm potentiometer.
R13—150,000 ohms.

Fig. 6. Circuit diagram of the receiver. Unmarked parts are unchanged from original ARC-5 circuit.

6SL7 is made variable so that the tube may be operated as a saturated amplifier and thus act as an additional noise limiter. A 6G6 is used as a second audio amplifier. This tube was selected for its low heater current. A 6AK6 miniature output pentode could have been used or, if 12-volt tubes are used, the original 12A6 could be used. The screen of the 6G6 is fed from the tap on the primary of the output transformer to give some inverse feedback which reduces the output impedance of this stage and limits the voltage developed across the output transformer.

The power supply is a conventional half wave rectifier system employing a small transformer of the type used in audio pre-amplifiers or television boosters.

A few tricks were resorted to in order to use the 4-inch wide chassis instead of the 5-inch wide chassis for which the design was originally planned. It was originally planned to mount the tuning capacitor about ¾ inch behind the panel with the dial to be viewed through a window in the panel. Using the 4-inch chassis it was necessary to mount the capacitor right against the panel so the chassis flange had to be cut away as shown in *Fig. 2*. The panel had to be machined away to allow room for the dial as shown in *Fig. 5*. This machine work was done with a circle cutter the tool of which was ground to a slighter angle.[1] As may be seen from *Fig. 2*, the by-pass capacitor directly behind the tuning capacitor had to be mounted with its mounting studs sticking through the rear of the chassis. The antenna trimmer capacitor was mounted inside the first section of the tuning capacitor. The space there was a little crowded also so it was necessary to file off the bottom rear corners of the trimmer stator rods. Once these little mechanical details were arranged the project went forward at a good pace.

After the receiver was tuned up it was found to overload on strong stations when using avc and maximum r-f gain. An investigation showed that we were "fortunate" enough to have selected leaky 0.05 μfd sections for both of the avc line capacitors so they were replaced with a tubular capacitor alongside one of the terminal boards. Other constructors may profit by this easily avoided mistake and reserve the leakiest capacitors for the cathode by-pass function where a leakage resistance of 2 or 3 megohms is of no importance.

As stated previously, this conversion was planned to use the original ARC-5 parts wherever possible. A relaxation of this policy would have permitted further saving of space, for instance most of the bypass capacitors could have been located directly on the tube sockets and the remaining ones could have been terminal boarded. Miniature tubes could have been substituted for the metal tubes in which case the IF transformers could have been mounted square with the chassis and moved further to the left leaving more room for the power supply components at the right hand end of the chassis.

Regardless of whether the constructor wishes to follow exactly the instructions given in this article or wishes to give a more complete or less complete treatment to his receiver, the ARC-5 need not remain an ugly duckling. Repackage it!

1. Editor's note: The use of an aluminum panel instead of steel should materially ease the job of recessing the dial into the panel. Some may consider it simpler to merely cut out a circular opening in the panel slightly larger than the dial itself.

Bandspread Dial For The Command Receivers

JESSE O. BOSTWICK, W7LDT

835 S.E. 187th Ave., Portland 16, Ore.

Figure 1 illustrates how a dial scale may be added to the tuning knob of a "Command-Set" receiver *(BC-454, BC-455, etc.)* to provide a bandspread calibration for the amateur band it covers. The scale shown is a typical 7 to 7.3-Mc calibration for a *BC-455.*

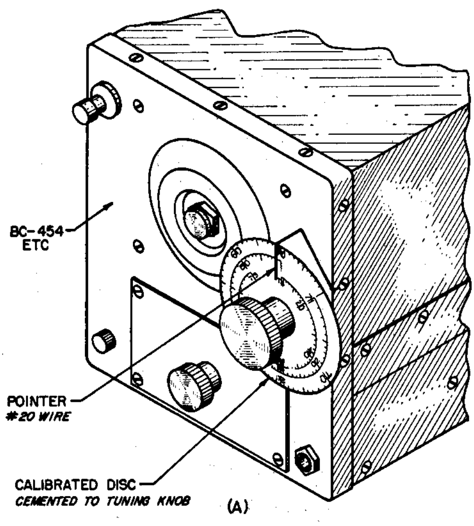


Fig. 1. Method of mounting bandspread scale.

To construct the scale, draw three concentric circles on a piece of stiff white cardboard. The first circle should be 2½ inches in diameter, and each of the others should be 3/16 inches smaller than the preceding one. Carefully cut out the disc around the outer circle, punch out a ¼-inch hole in its center, and cement it to the tuning knob.

Form a two-inch length of No. 20 tinned copper wire into a pointer. Fasten it by means of the screw on the side of the receiver nearest the knob. The pointer should extend vertically in front of the scale and about ¼ inch beyond the inner circle.

With the aid of a calibrated oscillator, set the main dial to exactly 7000 kc., and put a light pencil mark on the outer circle of the disc directly under the pointer. Tune the receiver to 7020 kc. and make another mark. Repeat every twenty kilocycles, until 7100 kc. is reached.

Mark the 7100 kc point and subsequent twenty kilocycle points on the second circle until 7200 kc is reached. Then drop to the inner circle and continue to 7300 kc.

Remove the disc from the knob and ink in the circles and calibration lines. Make the 100-kc lines slightly heavier and longer than the others. Next bisect the twenty kilocycle divisions with short lines. Finally, put four equally-spaced dots between each pair of marks.

Identify the calibration points thusly: Number the 100 kc. points 7.0, 7.1, 7.2, 7.3. Then number the intermediate twenty kilocycle points 20, 40, 60, and 80. Re-cement the disc firmly to the tuning knob, taking care to see that the 7000 kc. points on it and the main dial correspond.

In operation, a glance at the main dial shows in which 100-kilocycle segment the receiver is tuned, and the auxillary scale indicates the exact frequency. If the work is done carefully, frequencies can be read to two kilocycles and estimated to one kilocycle with good accuracy.

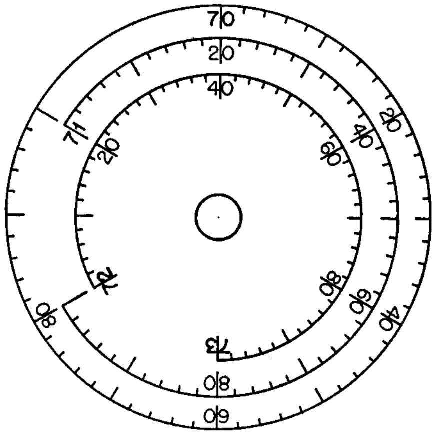
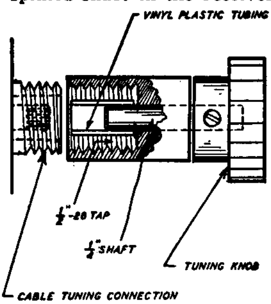


Fig. 2. Typical 40-meter band disc for the BC-455.

The procedure for making a 3.5-to 4-Mc calibration disc for a *BC-454* is similar, except that the circles are required.

274N Receiver Tuning Knob

This is a homemade tuning adaptor for the 274 N series receivers. The shaft and tuning knob are standard items. The only special parts are a piece of vinyl plastic tubing, the inside of which should be slightly smaller than ¼ inch, and the adaptor fitting itself which is machined out of ordinary brass, or even aluminum. This adaptor is ¾ inch in diameter and ¾-inch long. One end is tapped to a depth of ⅜ inch with a ½ inch, No. 28 tap. A ¼-inch diameter hole is reamed on through to the other end. The length of the ¼-inch shaft should be such that the end of the shaft butts against the end of the splined shaft in the receiver tuning fitting and the plastic tubing fits evenly over both shafts when the adaptor is screwed onto the receiver fitting.

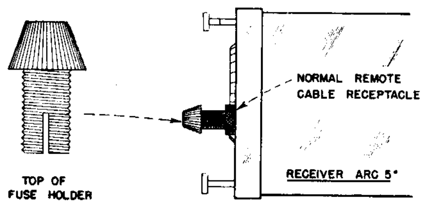


The plastic tubing retains its elasticity indefinitely and there is no noticeable backlash in tuning the receiver. For convenience a crank may be added to the tuning knob if desired.

T. C. Freedom, W8HVE

Tuning Device for ARC-5

Probably a good many amateurs purchased SCR-274N receivers (ARC-5) without the tuning cables necessary for remote control. The mechanical construction of these receivers is such that they are difficult to tune locally without a key for the purpose.



This situation was solved at W2RAC by using the removable part of a fuse holder. The fuse holder is partially filled with Duco cement, and inserted in the receptacle for the tuning cable, making a convenient knob. The Duco cement must be allowed to dry overnight.

George Nelson, W2RAC

Bandspreading the BC-455

GEORGE E. BIDWELL, W9FIS

Overcoming the greatest deficiency of this popular surplus receiver.

THE 6-9 mc receiver of the SCR-274N radio set is an inexpensive but efficient receiver for the 40-meter band. This article shows through a step-by-step process how the utility may be further enhanced by bandspreading the tuning range across the whole 7-mc band. This is done by removing portions of the main tuning condenser and substituting an adjustable padder and two negative coefficient condensers.

Step-by-Step Procedure

1. Remove the cabinet shield and all the tubes. It may also make it easier to work with the receiver if the i-f transformers are also removed. They should be clearly marked beforehand, as they cannot be interchanged. Remove the small shield from the front of the top chassis which houses the condenser gang assembly.
2. Turn the receiver right side up with the rear chassis wall facing you. Take a pair of diagonals and cut in two all the mica rotor stops on the ends of the three rotor sections. However, be sure to leave as much as possible of the stop on the last rotor plate on the right-hand side of each rotor.
3. Remove all rotor plates in each section starting from the left side with the exception of the last main rotor plate on the opposite end. Twist the rotor plates free, do not pull out. The shaft is floating on ball bearing which may be set free if caution is not exercised.
4. Remove the rotor phasing plates on each end of the rotor. These are the small plates with slots that are used to gang up or phase the main tuning condenser.
5. Mechanically line up the three remaining rotor plates, one in each section, if they have been bent while the other rotor plates were being removed.
6. Bend the right hand end stator plate about half way over towards the right side of the frame. This is done to further decrease the tuning capacity. Do not remove this plate, as it will be used to adjust the bandspread tuning range.
7. Solder a 50-$\mu\mu$f ceramic adjustable padder across the r-f tuning condenser section. This is done by mounting the padder as low as possible onto the top of the gang frame. Solder the adjusting screw lug to the frame. Then take a piece of #12 wire and run it directly between the top of the stator section and the other side of the padder. This wire should be heavy as it will also serve as the mechanical support for the padder. Drill a hole in the top of the gang shield can so that this padder may be adjusted with the shield in place.
8. Solder a 20-$\mu\mu$f CRL negative coefficient capacitor across the detector gang and another 20-$\mu\mu$f CRL negative coefficient capacitor across the oscillator gang. Both connections are made at the bottom of the gang on the top of the coil sockets. Do not attempt to use ceramic or bakelite adjustable padders across the oscillator or detector gangs as these will upset the stability of the receiver.
9. If the i-f transformers have been removed they should be carefully replaced and the receiver made ready to be brought back into the 40-meter band. With a known signal at either end of the band adjust the two midget air padders on the gang as well as the additional padder soldered across the r-f gang. Tune all three in the normal alignment procedure; no trouble should be experienced in tuning in the 40-meter band. By slightly bending each of the three stator plates, more or less bandspread may be obtained. Of course, after bending these plates the padders must be readjusted.

The entire band should extend from nearly one end of the dial to the other. As a matter of fact, it will probably be found necessary to use a spinner type knob, as the vernier and bandspread action are both so great as to make tuning a little slow.

Increasing the Bandspread on SCR-274 Receivers

A bandspread of 42 kc per division instead of the normal 100 kc may be obtained (on the 3–6 mc receiver) by removing five of the eight rotor plates on the tuning gang. Additional padding condensers must be added across the r-f and oscillator portions of the circuit. I found 33-$\mu\mu$f NPO Ceramicons did the job.

Ready-made 274N Tuning Knob

After reading several articles about the 274N series receivers, all of which required tuning knobs, I would like to offer this foolproof suggestion. An ordinary plastic push-on type knob that fits a one-quarter inch shaft and has a one-half inch sub-panel extension will work very nicely. This type of knob is in common use on many popular portable broadcast sets. The depth and diameter of the extension is just right and looks like it was made for the job.

David H. Schick, W4KPH

Putting the BC-455 on 10

EVERETT J. GILBERT, W9MSP*

A simple conversion for the phone man of a popular surplus receiver.

Many articles have been written on the conversion for amateur use of war surplus receivers and transmitters. To them should certainly be added the conversion of the BC-455B receiver for 27 to 30-mc operation. Very few additional components are needed and the antenna input may be adapted for either single-wire or doublet lead-in.

The parts required are a power supply furnishing either 6.3, 12.6, or 28 volts for the filaments and 250 volts for the plates. Also, a phone jack, plate switch, midget 25,000-ohm potentiometer, a five-prong socket with male plug to match power connections at the rear of the chassis, and several small resistors and condensers.

The first step is to take out the small can insert at the bottom front of the panel. This can contains male and female plugs which are clipped free of all wires close to the plug terminals. This will allow room for the controls which are mounted on the front plate. The midget potentiometer which is to serve as an r-f gain control is mounted in the center with the B− control switch on one side and the phone jack mounted on the other side.

The filament circuit is then rewired to match the new power supply. The BC-455B is initially designed for a 24–28 volt supply using 12.6-volt tubes. With a 12.6-volt supply the filaments will need to be rewired for parallel connections. 6-volt equivalents may be substituted while again rewiring for parallel operation.[1]

At this point the biggest job in the conversion is to reduce the capacity of the tuning condensers. This will be a much easier task if the condenser section is completely removed temporarily from the chassis. By heating the point of mounting of the plates, they can be readily removed. Care should be exercised to avoid bending or misaligning those plates which are to be left in the gang. Leave only one rotor plate and this one should be the middle one. Leave only two stator plates—the ones on either side of the single rotor plate. Also remove the front rotor sections of the trimmers on the mixer and oscillator variables, and all but three rotor plates of the remaining trimmers on the three sections. Do not touch the oscillator series padder condenser. Center the tuning plates by adjusting the centering screws on the sides of the condensers, remount the condenser and resolder the connecting wires.

The next step is to rewind the coils. The oscillator grid coil is changed to a double-spaced five-turn winding using the same wire and the same spacing for coupling to the adjacent winding. Take the mixer coil and remove the large winding of fine wire at the top of the form and replace it with four turns of No. 24 enamel wire. Change the grid winding to a double-spaced six-turn coil leaving a space of approximately one-eighth inch from the smaller one, being sure that both windings are in the same direction. Rewind the r-f form to duplicate the mixer grid winding and wind the two-turn antenna coupling coil of covered buss wire (No. 18) on top of the six-turn coil at its center. If a single-wire antenna is to be used, ground one end of this winding at the plug on the chassis, connect the other terminal to the antenna post, first removing the small condenser in series with the former antenna lead-in. Another antenna binding post may be mounted and both leads brought out for use with a doublet antenna.

Prior to starting the *realignment* process it is best to drill out the rivets in the coil shield cans. Enlarge the holes to one-quarter inch in both the can and the mounting bracket. This provides access to the slugs for alignment.

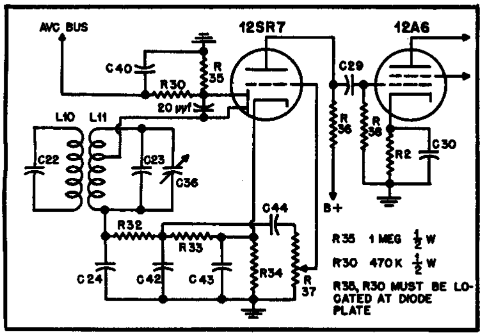


Fig. 1. Necessary changes for rewiring the BC-455B circuit for an additional audio stage and a.v.c.

C40, C42—100 μμf, midget mica.
C41—20 μμf midget mica or ceramic.
C43—25.0 μf, electrolytic.
C44—0.1 μf, paper.
R30, R38—470,000 ohms, ½ w.
R31, R32—100,000 ohms, ½ w.
R33—510,000 ohms (was R18 in original circuit).
R34—2200 ohms, 1 w.
R35—1.0 megohm, ½ w.
R36—220,000 ohm, ½ w.
R37—500,000 ohm, pot.

* *235-34 St. Dr., S. E. Cedar Rapids Iowa.*

[1] Sievert, "Converting the SCR-274N Receiver," *CQ*, Nov., 1947.

Preferably a signal generator feeding a 28-mc signal into the mixer grid should be used to start the realignment. Set the dial to 6.5 mc and adjust the oscillator trimmer and slug until a signal is heard. Next feed the 28-mc signal into the r-f stage through the antenna post and tune the mixer and r-f slugs for maximum signal output. An output meter should be used rather than tuning solely by ear. Now tune the signal generator to 30 mc and pick up the signal by rotating the receiver tuning dial. At this point tune the r-f and mixer trimmers for maximum signal output. Do not retune the slugs at the high end, nor the trimmers at the low end, as this will upset the tracking of the mixer and oscillator. Repeat the two settings until the tracking is accurate. Then remove the shield cans and replace the slug locking tabs. If care has been exercised in replacing the locking tabs the tuning should still be correct. Sometimes it may be advantageous to align the i-f transformers with the 28-mc input as the last step.

An a-v-c circuit has been added to our receiver and the detailed changes are shown in *Fig. 1.* The 25,000-ohm midget potentiometer is wired into the circuit to replace the external gain control of the BC-455B. The arm and one side of the potentiometer are grounded and the other side is connected to *pin 1* on *J-1*, or *pin 3* (outside view) on *J-3*.

Conversion of the BC-453 to the Broadcast Band

After recently buying a new car and finding that a factory model BC radio for the same would set me back an additional $90, I decided to call war surplus to the rescue. So we converted a BC-453 to do the job. The selectivity is very good and the sensitivity adequate. The audio quality is somewhat down, but can be modified to suit individual tastes.

The following coil information was obtained experimentally from a regular BC-946, and comparisons on an inductance bridge with the stripped down BC-453 coils. The nomenclature is the same as that appearing on the original BC-453 circuit diagrams.

L1—Remove 132 turns below the tap and then add 25 turns after the tap.

L2, L3—The top coil on this form is left alone (i.e., the coil farthest from the base). The lower coil should have 195 turns removed.

L4, L5—Remove 147 turns from the top coil and remove 38 turns from the bottom coil.

1st i.f.—Remove 800 turns from both coils.

2nd i.f.—Use the existing tap for the outside end of the coil, making sure to reconnect the tap to the end of the coil. No tap connection was used.

3rd i.f.—Same as the 2nd i.f.

The i.f. transformers should now tune very close to 239 kc, which is the frequency used in the BC-946 models. I would suggest removing the b.f.o. and reconnecting as the first audio stage. Let the r.f. end run wide open, and wire a volume control into the grid of the first audio tube.

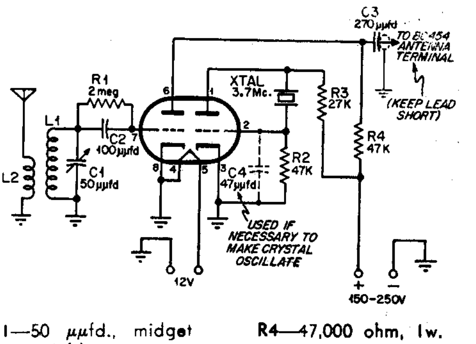
John R. Immel, W6ZKJ

Some *surplus* receivers, such as the BC-454, whose frequency coverage is 3 to 6 Mc, will not cover the 7-Mc band. *Figure 1* is the diagram of a simple crystal-controlled, 7-Mc converter for such receivers. It uses a 12AU7, dual-triode tube and a 3.7-Mc band crystal from your transmitter (you won't be using it in the transmitter, while you are on the 7.2-Mc band), plus a couple of resistors and condensers.

The converter may be built in a small aluminum utility box and mounted on top of the receiver near the antenna terminal. It obtains its power from the receiver. The combination becomes a dual-conversion superheterodyne, and all tuning is done on the BC-454.

The frequency to which the converter responds is equal to the sum of the crystal frequency and the BC-454 frequency. For example, with a 3700-kc crystal, to receive a 7175-kc signal, the BC-454 is tuned to 3475 kc. And to tune to 7200 kc., the BC-454 is tuned to 3500 kc. Similarly, to cover the entire 7-Mc amateur band, the BC-454 is tuned between 3300 and 3600 kc. *C1* is merely tuned for the loudest signal. For the Novice band, it may be peaked up in the center of the band and forgotten.

Other crystal frequencies will work equally well, but, as the 3.7-Mc Novice-band crystal is available, it might as well be used.



C1—50 μμfd., midget variable	R4—47,000 ohm, 1w.
C2—100 μμfd., midget mica	L1—18 t. #22 enam., close wound on 1" form.
C3—270 μμfd., midget mica	
C4—47 μμfd., midget mica	L2—4 t. #22 enam., close wound, 1/4" below L1.
R1—2 megohm, 1/2w.	
R2—47,000 ohm, 1/2w.	
R3—27,000 ohm, 1/2w.	Tube—12AU7

Fig. 1. The schematic and parts list for a simple 7-Mc crystal-control converter for BC-454 (3-6 Mc.) receiver. Build in small aluminum box and mount on top or side of receiver near antenna terminal.

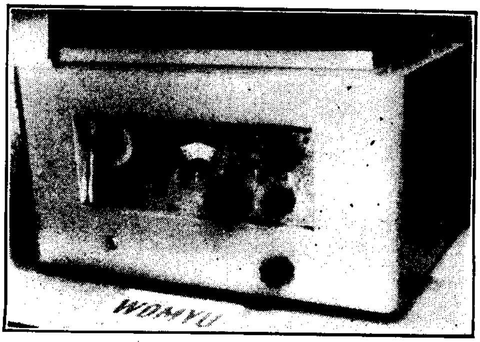


Fig. 1. The completely assembled double conversion receiver. Dial calibrations start at 0 above the line and 500 below the line. The 0 represents 7000 kc and 14,000 kc, while 500 represents 3500 kc. 50 kc is visible in the window. The BC-453 receiver is located in the center, tuned by the large knob. The r-f gain control and a-c switch is below the inset panel. The b-f-o switch is in the upper right corner.

A Double-Conversion Receiver for $30!

ALLEN A. ENGLEMAN, WØMYU*

You'll never know how good the BC-453 receiver is until you try this idea.

HERE is a relatively simple method of constructing a communications receiver, the performance of which is comparable to a far more expensive unit. Application of the fixed converter principle permits use of crystal-controlled high-frequency oscillators which provide stability that is unsurpassed. Combining fixed crystal-controlled converters with the BC-453 low frequency receiver results in exceptional stability and selectivity with an excellent degree of bandspread.

The circuit in *Fig. 2.* shows a converter which gives excellent results when used in conjunction with the BC-453 receiver. This converter uses a crystal oscillator which is 200 kilocycles lower in frequency than the low frequency end of the amateur band desired. Tuning is accomplished with the BC-453 functioning as a tunable intermediate frequency. The BC-453 tunes from 190 kilocycles to 550 kilocycles, a range which is sufficient to cover the 3.5 mc, 7 mc and 14-mc bands. The 3.85 to 4-mc phone band may be covered by plugging in another crystal which is 150 kc higher in frequency than the 3.5-mc band crystal.

The converter tube, a 6AC7, gives excellent gain and signal-to-noise ratio. The oscillator is an untuned Pierce which adds to the simplicity. If plug-in coils were used, one converter could be used to cover the 3.5-mc, 7-mc and 14-mc bands. The crystals could be either switched or plugged in. The image ratio would be good on the two lower frequency bands and fair on the 14-mc band.[1] However, because of the low cost of the individual converters our receiver employs a separate unit for each band.

A Simple Super

Using these principles the author has developed a receiver which gives extraordinary performance considering the investment involved. The unit pictured in *Fig. 1* costs approximately $30.00 to assemble. It incorporates a converter for each of the three bands covered, 3.5 mc, 7 mc and 14 mc. The 7-mc and 3.5-mc units are identical except for the coils. The 14-mc converter uses a stage of tuned preselection and a converter tube which gives better selectivity than the 6AC7 in order to reduce the image response. This arrangement will give reasonable image rejection ratio on this band.

Bandswitching is accomplished by switching the output of each converter to the antenna circuit of the BC-453 receiver and simultaneously switching the positive plate voltage to the converter units. The addition of a new dial, calibrated from 0 to 350 above the center line and from 500 to 850 below the

**3324 Woodland Ave., Kansas City, Mo.*

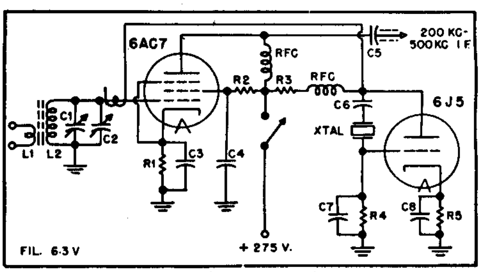


Fig. 2. Crystal controlled 3.5 and 7-mc converter.

C1, C7—50 μμf
C2—30 μμf
C3, C8—.01 μf
C4—.05 μf
C5—.005 μf
C6—.001 μf
R1—620 ohms
R2—150,000 ohms
R3—10 megohms
R4—25,000—50,000 ohms
R5—1000 ohms
RFC—2.5 mh
Coils—3.5 mc: L1, 8 turns; L2, 50 turns; 7 mc: L1, 5 turns; L2, 30 turns
Xtals—3.5-mc converter, 3300 kc. 7-mc converter, 6800 kc.

[1] The image ratio will be quite poor on all bands. It may be inferior to a conventional receiver with no r-f stage.

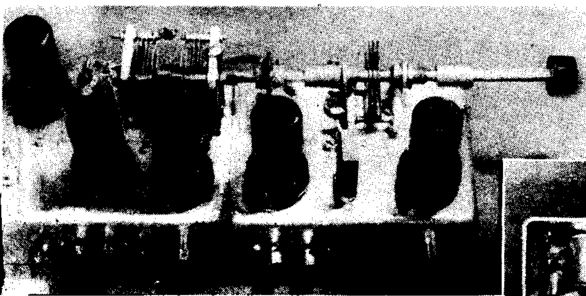


Fig. 3 (left). 7 and 14-mc converters. The tuning of both units is ganged to reduce the number of controls. The 7-mc converter with the trimmer condensers removed is on the right. The crystals are plug-in and different crystals may be used to cover other frequencies than the amateur bands. The individual chassis measures 3½" by 5".

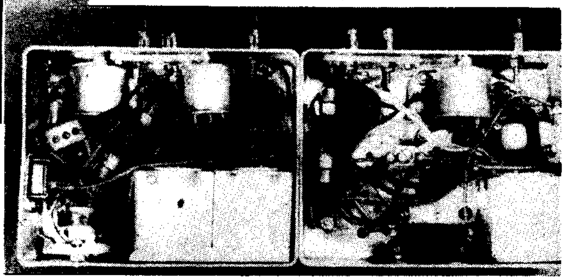


Fig. 4 (right). Under chassis view. The by-pass condensers, resistors, resistor holders and iron core coil forms, including shields, were obtained from surplus BC-453 receivers. A common power receptacle located on the extreme left supplies power to both units.

center line allows direct reading of frequency on all bands. Zero on the dial represents either 7,000 kc or 14,000 kc and 500 represents 3,500 kc. The dial is constructed by cutting an aluminum disk 3⅜" in diameter. Draw the new scale on a good grade of writing paper so that "0" corresponds to 200 on the original dial and 50 corresponds to 250, etc. This will provide accurate calibration provided the crystals are carefully chosen for the proper frequencies. Crystals may be obtained for less than one dollar on the surplus market. But if surplus crystals are used, purchase frequencies somewhat lower than those desired and carefully grind the crystals to the exact frequencies.[2]

The type of construction used for the converters is patterned after the BC-453 and most of the parts were obtained largely from two of these receivers that were "cannibalized." These receivers can be purchased for around $2.00 to $3.00 less tubes. One caution—do not attempt to use the radio frequency chokes found in this type of receiver because their inductance is much too low for successful use in the converters.

The conversion of the BC-453 receiver is not difficult. The filaments are wired in parallel instead of series parallel as is required for 28-volt operation. A 50,000-ohm variable resistor is added between pins number *3* and *1* (see *Fig. 7*) on the rear power socket and serves as a gain control. An OFF-ON switch for 117-volt a.c. may be added to this control. A switch for b.f.o. is added between pins number *4* and *1*. The headphone jack is wired to pins number *2* and *1*. Filament voltage is connected to pins number *6* and *1*. The plate voltage is connected to pin number *7*. Loudspeaker operation is obtained by connecting an output transformer with an 8000-ohm impedance primary to pins number *2* and *1*. Make sure that number *2* is connected to lug number *3* on the output transformer of the BC-453, as this is the 8000-ohm tap. Power supply requirements are 250 to 300 volts at 60 ma, and either 6.3 volts or 12.6 volts for the filaments, depending on the tubes used.

Receiver Alignment

Adjustment of the receiver for initial operation is as simple as the modifications. With the bandswitch set for the band desired, turn up the gain control on the BC-453 and set the alignment tuning condenser on the converter at half scale. Next tune the associated trimmer condenser for a distinct increase in noise level. This will be either the frequency desired or, possibly, the image frequency. The image frequency can be easily checked because it falls outside of the amateur band.

[2] Johnson, "Crystal Grinding Simplified," *CQ*, Jan. 1949.

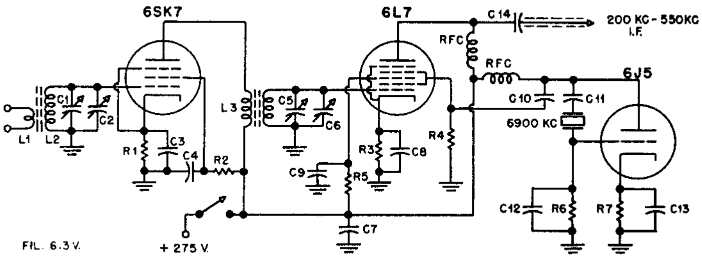


Fig. 5. Crystal controlled 14-mc converter for the BC-453.

C1, C5—15 μμf
C2, C6—40 μμf
C3, C8, C13—.01 μf
C4, C7, C9—.05 μf
C10—30-50 μμf
C11—.001 μf
C12—50 μμf
C14—.005 μf
R1, R3—620 ohms
R2, R4—50,000 ohms
R5—15,000 ohms
R6—25,000—50,000 ohms
R7—1000 ohms
RFC—2.5 mh
L1—3 turns
L2—15 turns
L3—10 turns
L4—15 turns

Now tune in a signal and adjust the trimmer for maximum signal strength. Once this setting is found it will need changing very little during complete band tuning. Repeat this process for each converter unit.

If the receiver does not operate check the appropriate crystal for oscillation. If it is oscillating sufficiently for adequate voltage injection to the converter the noise level will decrease noticeably when it is removed. Very little oscillator injection

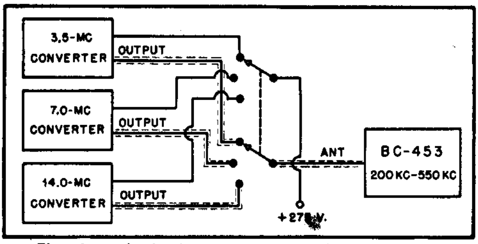


Fig. 6. Block diagram of receiver-converter arrangement.

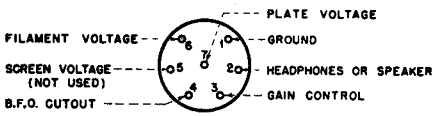


Fig. 7. Rear view of power receptacle connections.

voltage is actually required for the proper operation of the 6AC7 converters. For this reason the crystal oscillator plate voltage should be limited to 35 or 40 volts.

The over-all selectivity of this receiver is excellent. Single-signal reception is almost realized, one side of zero beat being very low. Additional selectivity would make intelligibility of phone signals poor. The substantial "skirt" selectivity offered in this receiver makes copying of weak signals possible right up to that kilowatt signal a few blocks away. As an interesting application of surplus and a good receiver at a modest investment this little super is a worthwhile shop project.

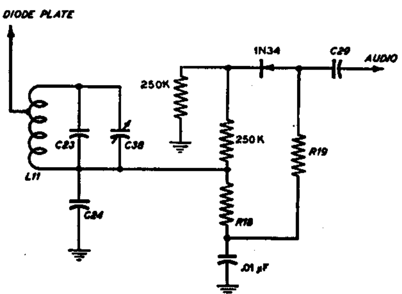
Output Plug for a 274N Receiver

Here is a quick and effective way to obtain the output from one of the 274 type receivers, when used as a converter. Remove the 12SR7 tube and plug a PL-291 (obtainable from the cord on a throat mike) into pins number 4 and 5. The plug fits nicely. into these pins, and the line from the plug is fed into the input of your regular receiver.

Noise Limiter for the SCR-274N Receivers

This is the simplest and most effective noise limiter I have used with 274N command receivers. The circuit calls for the addition of two resistors, a 1N34 crystal diode and a paper condenser. The noise limiter is of the self-adjusting series type and does not require a removal switch from the circuit since the quality and signal loss are negligible. The noise limiter may be wired into the receiver in about five to ten minutes.

Don Jeppesen, WØQFZ

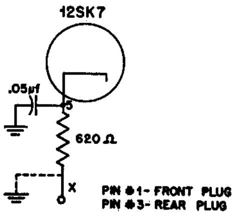


Coupling the 453 as a Q-fiver

In most receivers a comparatively large amount of i-f voltage is fed to the second detector. Because of the proximity of the wiring, etc. it is usually possible to obtain sufficient signal to operate the BC-453 by connecting its antenna post through a shielded line to the tip of a phone plug. Insert this plug in the phone jack of the receiver and pick the i-f signal while at the same time cutting off the main receiver audio. Of course, it is necessary to tune the BC-453 to the intermediate frequency of the communications receiver.

Herbert S. Brier, W9EGQ

Another 274 trick is to lift the opposite end of the 620-ohm resistor connected to pin 5 of the r-f am-



plifier tube and ground this resistor, thus removing the r-f amplifier from the gain control line. This will improve the signal-to-noise ratio. The diagram shows the modification required to obtain this increased performance.

Arthur Larky, Sommerville, N. J.

Chapter VIII POWER SUPPLIES

Selenium Supply

LLOYD V. BRODERSON, W6CLV*

HIGH ON THE popularity list of surplus equipment are the command set receivers. Few changes are necessary for conversion to amateur requirements and their cost per unit is but a fraction of the original contract price.

Unfortunately, a power supply is not included and the purchaser is confronted with the problem of designing his own. Inasmuch as there are several methods whereby one can obtain the necessary heater and plate voltages this is often a problem. Conversion to a.c.-d.c. operation was described by W8OZA in an early issue of *CQ*.[1]

The selenium power supply described is designed especially to keep these receivers as compact as possible. Ease of construction, low cost and efficent operation characterize this midget plug-in unit.

Selenium Rectifiers

Contrary to popular belief, selenium rectifiers have been in use for many years. Until recently, however, their general use has been prohibited by high cost and physical size. Seleniums are now available to the amateur at prices comparable to rectifier tubes and sockets which they replace. Their small size, low voltage drop and nominal cost class as the logical solution to a trouble-free power source.

Figure 1 shows a standard half-wave circuit with a 100-ma selenium rectifier replacing the usual half-wave rectifier tube. Capacitor C_1 across the input acts as a small filter absorbing any stray line "hash." A limiting resistor, R_1, protects the rectifier from peak voltages. Capacitors C_2 and C_3, together with resistor R_2, comprise an effective resistance/capacity output filter. Two small replacement type filament transformers, rated at 6.3 volts, 2.0 amperes, furnish heater current to the 12.6-volt tubes.

Assuming 117 volts a.c. input with values approximating those shown, the resultant d.c. output will be 100 volts. The values shown represent the best compromise between d.c. output voltage and a.c. ripple. Inasmuch as condensers C_2 and C_3 are not subjected to large peak voltages, a rated working voltage of 150 d.c. is safe. No appreciable improvement will be realized by using capacitors in excess of 40 μf.

Construction

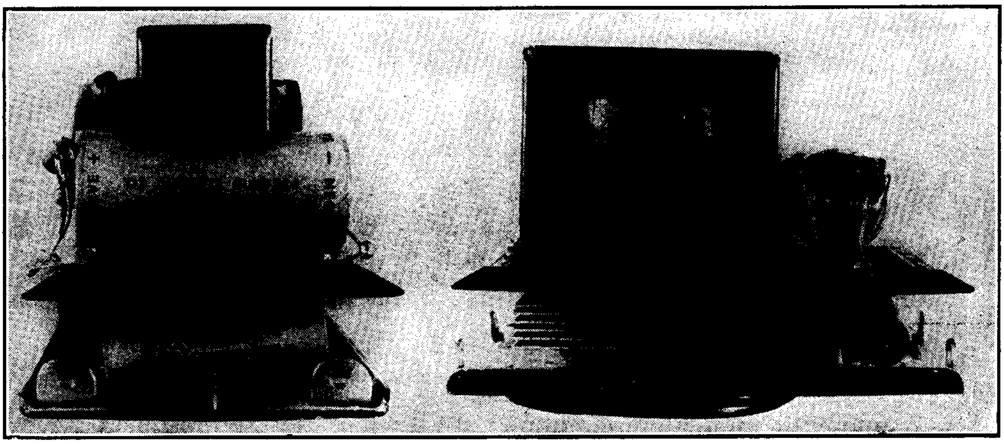
As may be seen from the photographs, the unit's foundation is the plug-in base removed from the dynamotor which originally powered the command set receiver. These bases (model D-32) may be purchased separately at some surplus outlets. If not procurable locally, one may fabricate a base plate from sheet aluminum and a modified wafer socket.

The top deck consists of an ordinary bakelite wall switch plate, obtainable at most "dime" stores. It so happens that these plates are the exact size of the dynamotor base plate which measures 2¾" wide by 4½" long.

All components are midget sized and leads consequently are short. A 6-32 machine screw through the rectifier eyelet serves to support the top

*State Dept. of Agriculture, State Office Bldg. #1, Sacramento, Calif.

1 Sievert, "Converting the SCR-274N Receiver," *CQ*, Nov. 1947.



Top and bottom view of the complete selenium rectifier power supply. Note the "sandwich" type construction permitting compact design. This supply uses a single filament transformer, the receiver filaments operating at half voltage.

deck at one end, while the remaining edge is supported by small bushings. The a.c. lead is brought through a rubber grommet mounted on the bottom front of the base plate. An on-off line cord switch is connected in series with one side of the a.c. line before its entry into the base plate.

Guide holes are drilled in both plates and all wiring is completed before the "sandwich" is assembled. Filter condenser and transformer leads should be readied with soldering lugs and guided into place after assembly. Parts placement and wiring is not critical. A good portion of those components at ground potential are easily taken care of by connections to the metal base plate.

For those contemplating a higher voltage utilizing standard voltage doubling circuits, several precautions should be considered. In any voltage doubling circuit, two selenium rectifiers will be required in addition to an extra filter condenser. This condenser must withstand the sum of the voltages across the doubling condensers and therefore should be rated at least 250 volts, d.c. working.

Where space is at a premium, these added components present a difficult problem. Furthermore, the total cost of a voltage doubling power supply employing selenium rectifiers, is almost twice that of a half-wave circuit. For headphone reception, of command receivers, the increase in signal strength at higher plate voltages is very little above that at normal rectified line voltages.

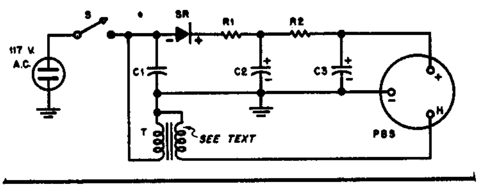
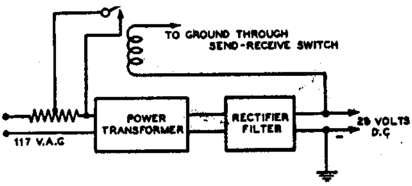


Fig. 1. Circuit diagram of 100-volt 100-ma supply.

C1—.02 μf paper tubular condenser, 400 volts d.c. working (Aerovox.)
C2, C3—Double 40 μf electrolytic condenser, 150 volts d.c. working, (Pyramid).
PBS—Plug-in base, Type D-32.
R1—30-ohm ½-watt resistor. (IRC).
R2—1,000-ohm 1-watt resistor. (IRC).
SR—Federal selenium rectifier, 100 ma.
S—SPST switch.
T—Replacement type filament transformer, 6.3 v., 2.0 amp.
1—Wall switch plate (bakelite or composition).
1—Rubber grommet.
Miscellaneous: Pushback Wire, Spaghetti Tubing, 6-32 Hardware, A.C. Line Cord.

Voltage Regulator for Command Sets

When using the command sets as v-f-o exciters the send-receive switching reflects a large load variation back to the low-voltage power supply, the load being much greater when transmitting. This results in a change of the heater voltages and subsequent drifting as the oscillator cathode changes temperature. In time, it will also damage the tubes.



Since the power supply transformer has a slightly higher output voltage than is required, my solution has been to insert a resistance in the power transformer primary circuit with a relay arranged to short out a portion of that resistance when transmitting. In this way the heater voltage can be easily maintained at the correct value. The proper resistance value depends on the load and your particular power supply regulation characteristics. Using the extra relay is quite feasible in view of the availability of low-priced surplus 28-volt relays of all kinds.

F. C. Breeden, W2SIJ

"Well—the advertisement did say 'Assorted Volume Controls.' "

Chapter IX MONITORS

Stay Out of Jail

FORD L. McGRAW, W6STS*

For some unacccountable reason the use of a monitor has gone out of style. Frankly, we wouldn't try to get on the air without one. If you're tired of RST-prevaricators among those you QSO, build this simple unit and be sure.

OF THE MANY CONVERSIONS and adaptations to which the 274-N command receivers have been put, we believe our conversion of a BC-454-B as a station monitor to be one of the easiest, most useful, and economical. Every amateur phone station should be monitored by its operator when first going on the air, and, at least periodically, during an evening of QSOs. Even the most experienced code operator likes to monitor his sending at times, while the beginning c.w. man will probably want to, or at least should, monitor continually. The BC-454-B is a natural for this purpose. About two hours of your time and the price of the receiver, plus the cost of one open circuit jack, one 20,000-ohm pot (with switch), one s.p.s.t. (BFO) switch, and one d.p.d.t. (B+) switch, are all that's required. It was found that by tuning the receiver to a transmitter sub-harmonic, it could be used on 80 through 10. It will usually be found unnecessary to use any antenna on the monitor. When using the BC-454 on the 80-meter band, the antenna post may be tied directly to the chassis to reduce pickup.

Conversion Procedure

Remove all hardware from the adapter panel and mount the pot, phone jack, and BFO switch, as shown in *Fig.* 1. Ground one side of the pot to the panel and connect the center tap to *pin 1* on J_1. Use stranded wire about 4 inches long for these panel connections. Wire the phone jack to *pin 4* on J_1. Ground one side of the BFO switch and connect the other side to *pin 5* on J_1. These connections may be soldered directly to the pin tips on J_1. Solder two wires to the switch on the volume control pot and connect to *pins 6* and *7* on J_1 This completes the front-end changes, and the adapter panel may now be replaced on the front panel.

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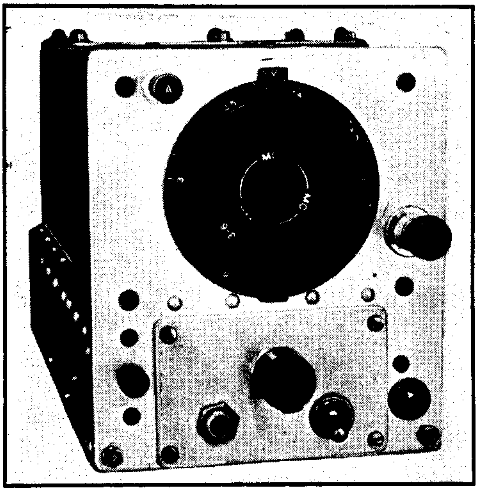


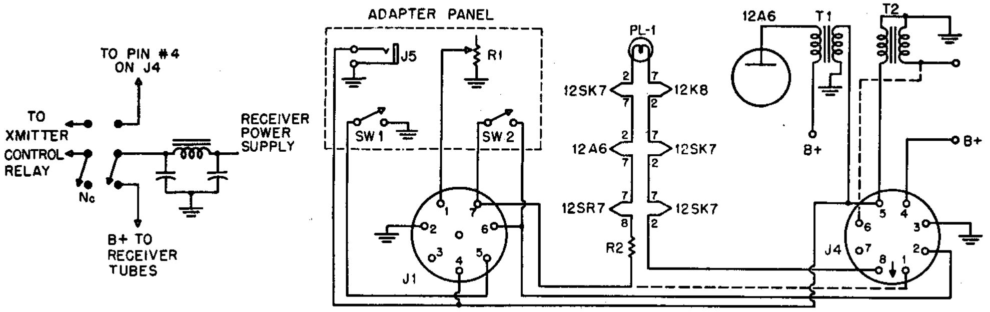
Fig. 1. From the front it looks like any other SCR-274N conversion.

Next, remove the bottom cover. Remove the two side screws that hold the coil assembly in place. Pulling out the coil assembly is necessary in order to permit working on the rear side of J_1. Unsolder the two white wires attached to *pins 6* and *7* on the rear side of J_1, and remove completely from the set. Remove the small r.f. choke L_{14} and the audio choke L_{15}. A couple of tie-points are bolted to the chassis for mounting the filament-dropping resistor in the space vacated by L_{15}. As we were unable to secure any male plugs to fit J_3, it was decided to remove it and replace with a standard Amphenol 86-PM8. Slight reaming of the hole with a pocket knife is necessary to admit the Amphenol plug. All leads unsoldered from J_3 may be removed to their nearest point of contact except the long red lead from *pin 4* on J_3. This lead is clipped just long enough to reach the point where the short red lead is removed. This is the point where the 5100-ohm resistor is tied to C15-C. As may be seen on the diagram *Fig. 2*, the audio output is brought to *pin 5* on J_4, the B+ to *pin 4* on J_4, and *pin 3* is grounded to the chassis.

The next step is to rewire the filaments, as shown on the diagram, *Fig. 2*. In rewiring the filaments it will be found easiest to start with *pin 7* on the 12SR7 and proceed around the circuit as shown. In this manner the original filament wires may be used to the best advantage. The a.c. wires running to the filament switch should be a shielded twisted pair with the shield grounded to prevent possible hum induction to the receiver.

Use as a C.W. Monitor

When the receiver is being used to monitor c.w., the output may be connected to a small speaker by placing a 4000-ohm-to-voice coil transformer between the speaker output on *pin 5* and the voice coil, as shown on the diagram. A switch must be added in series with the transformer to kill the speaker when monitoring with the phones. This speaker transformer may be mounted on the dynamotor deck or at the speaker.



J4—Amphenol 86-PM8.
J5—open ckt. jack for phones.
PL1—6 v., 250-ma series pilot light.
R1—20K volume control.
R2—250 ohms, 10 w.
SW1—b.f.o. control switch.
SW2—filament switch (on R1).
SW3—d.p.d.t. monitor B+ switch (see text).
T1—output transformer in monitor.
T2—speaker trans. (50L6-to v.c. trans.)

To prevent leaving the filaments turned on by mistake when using the monitor, a pilot light must be added. The small 3-μfd. condenser mounted on the front panel may be moved far enough up to make room for a small pilot light. If the pilot light is wired in series with the filaments as shown on the diagram, a 250-mil 6-volt bulb should be used. The 150-mil bulbs will not stand the current surge which occurs when the filaments are first turned on. The 250-mil bulbs will last many months and give plenty of light for the purpose. Some may prefer to use a 110-volt neon pilot light instead.

As the writer has several of the 274-N receivers around the shack used in various manners, the output plugs were standardized with the Amphenol 8-pin plugs. The wires shown by the dotted lines were incorporated to permit turning on the receiver B supply with the filament switch when individual power supplies are used on the various receivers. It was shown here with the thought in mind that some operators might prefer to use a small power supply for the monitor, or it may be utilized to control the transmitter filament relay from the operating desk, as we are using it here.

The B+ for the monitor is taken from the station communications receiver B supply, as shown by the diagram. The other half of the d.p.d.t. switch is used to control the transmitter high voltage relay. Thus the station receiver is killed and the monitor and transmitter are turned on with one switch. This switch may be located at any spot handy to the operating position.

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