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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[1]. 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.

1 Editorial, CQ, Feb. 1951

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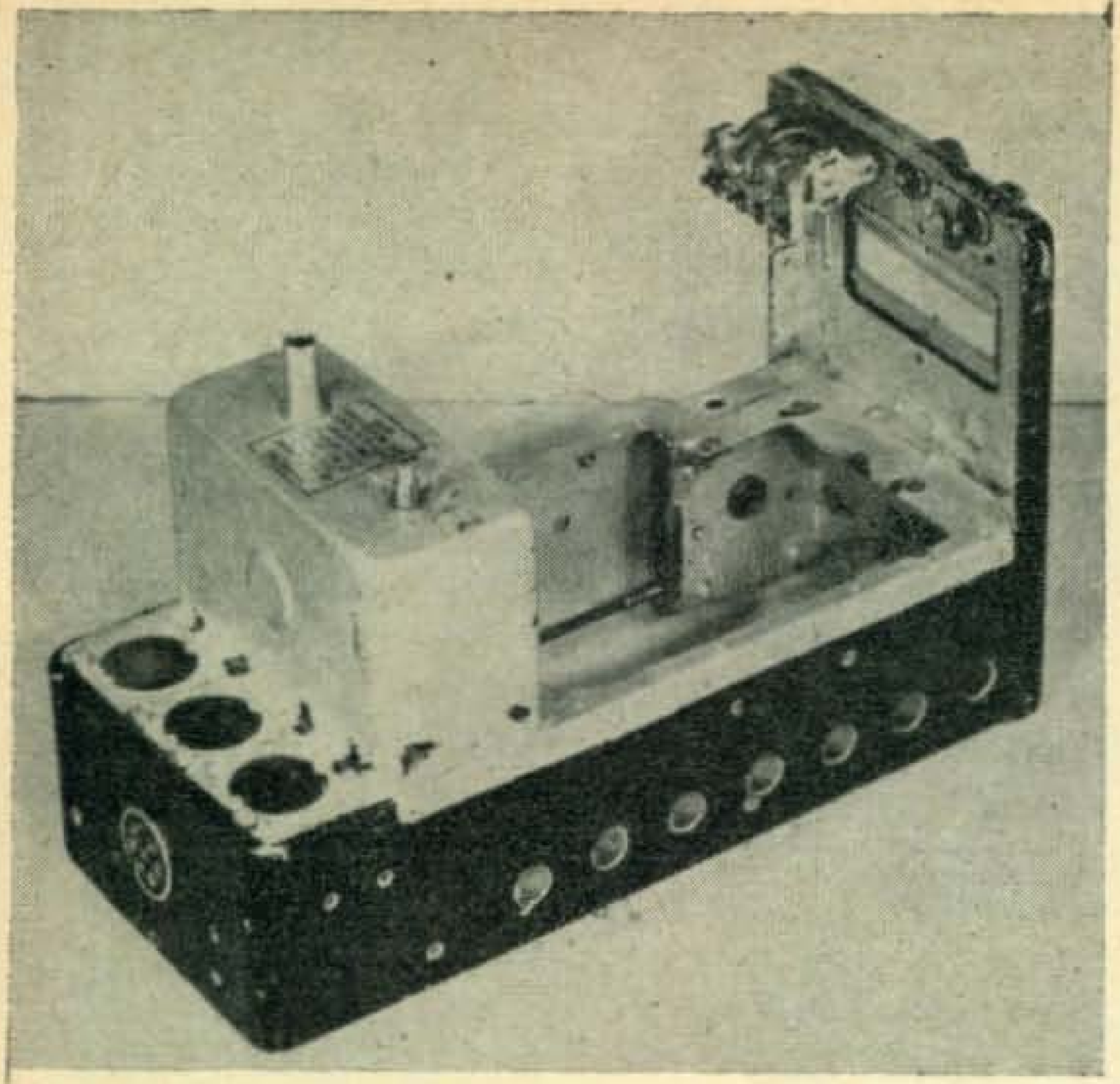
Circuit

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 1

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.

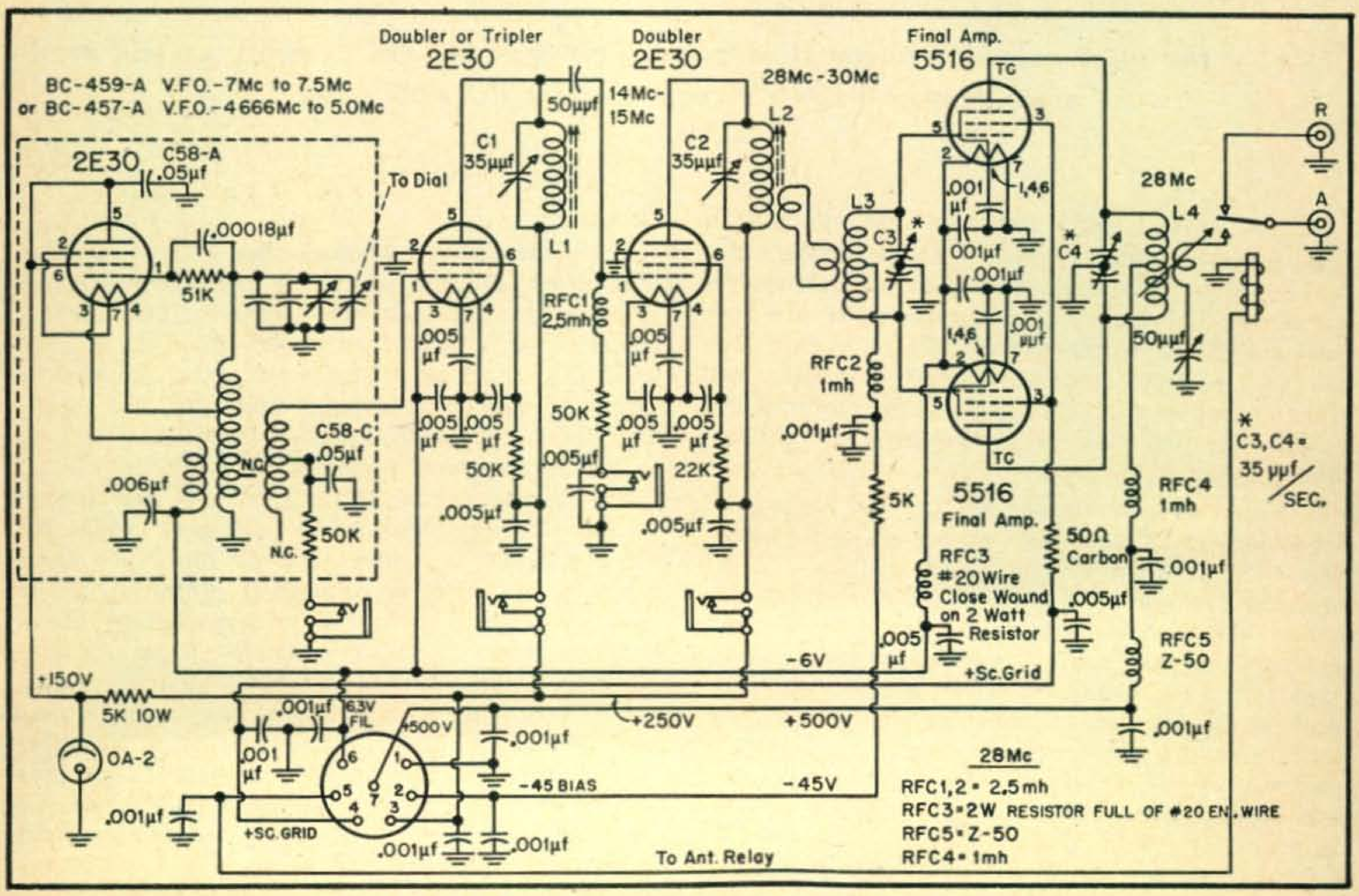


Fig. 1. Ten meter conversion circuit diagram.

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

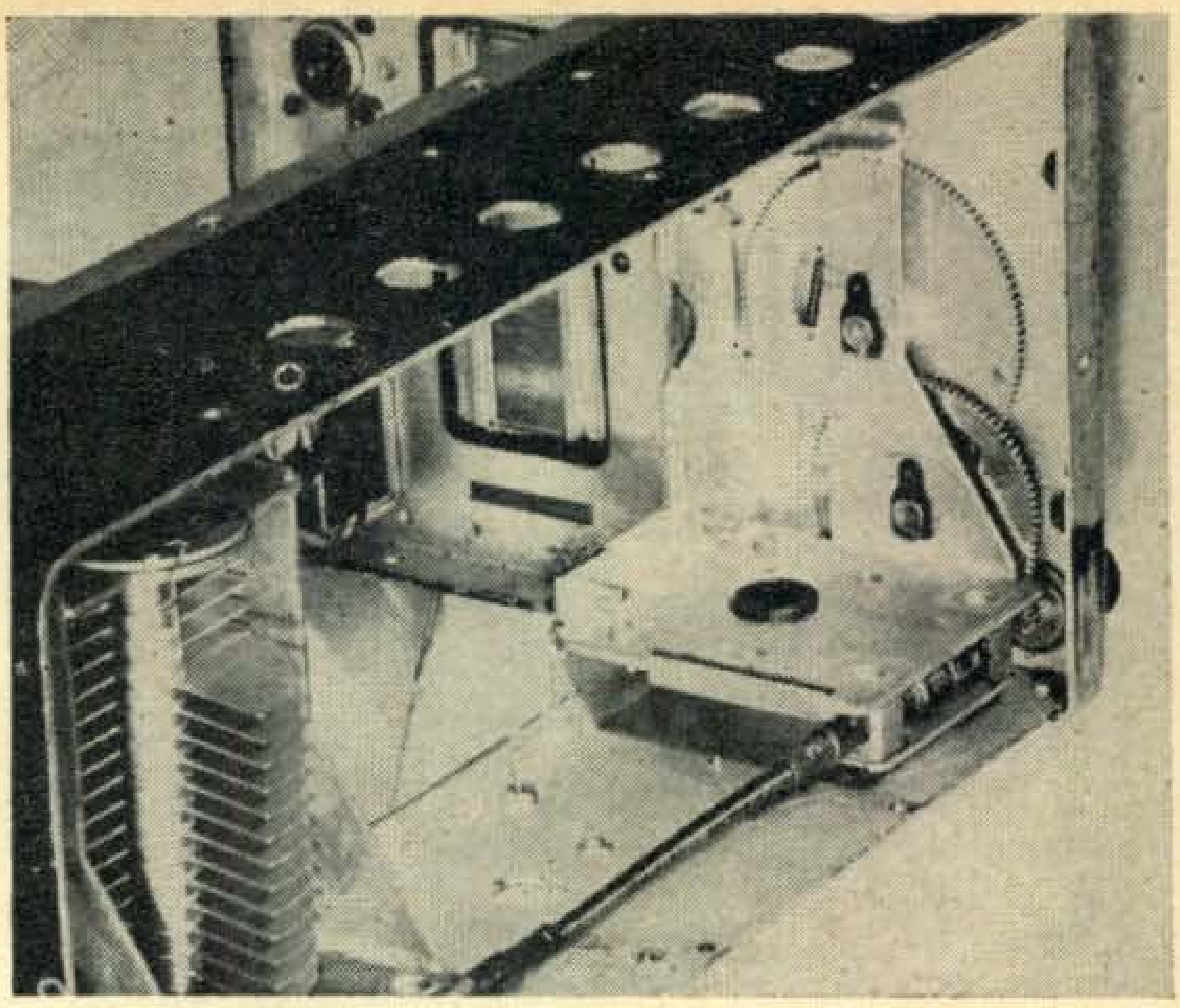
Operating voltages for 28 mc conversion. Transmitter and Modulator.

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, 2½" x 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.



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.

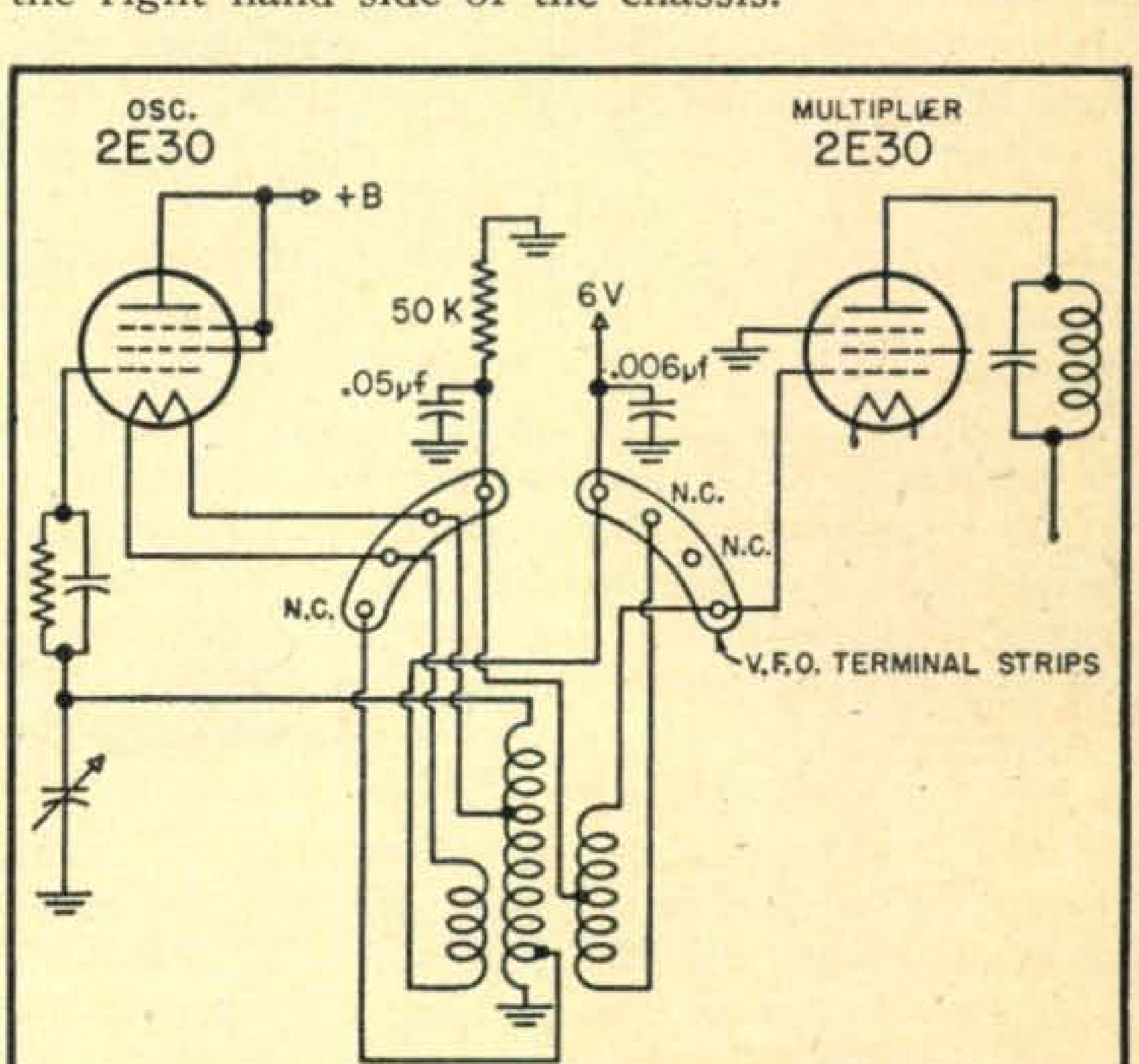


Fig. 2. V.F.O. coil connections.

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.

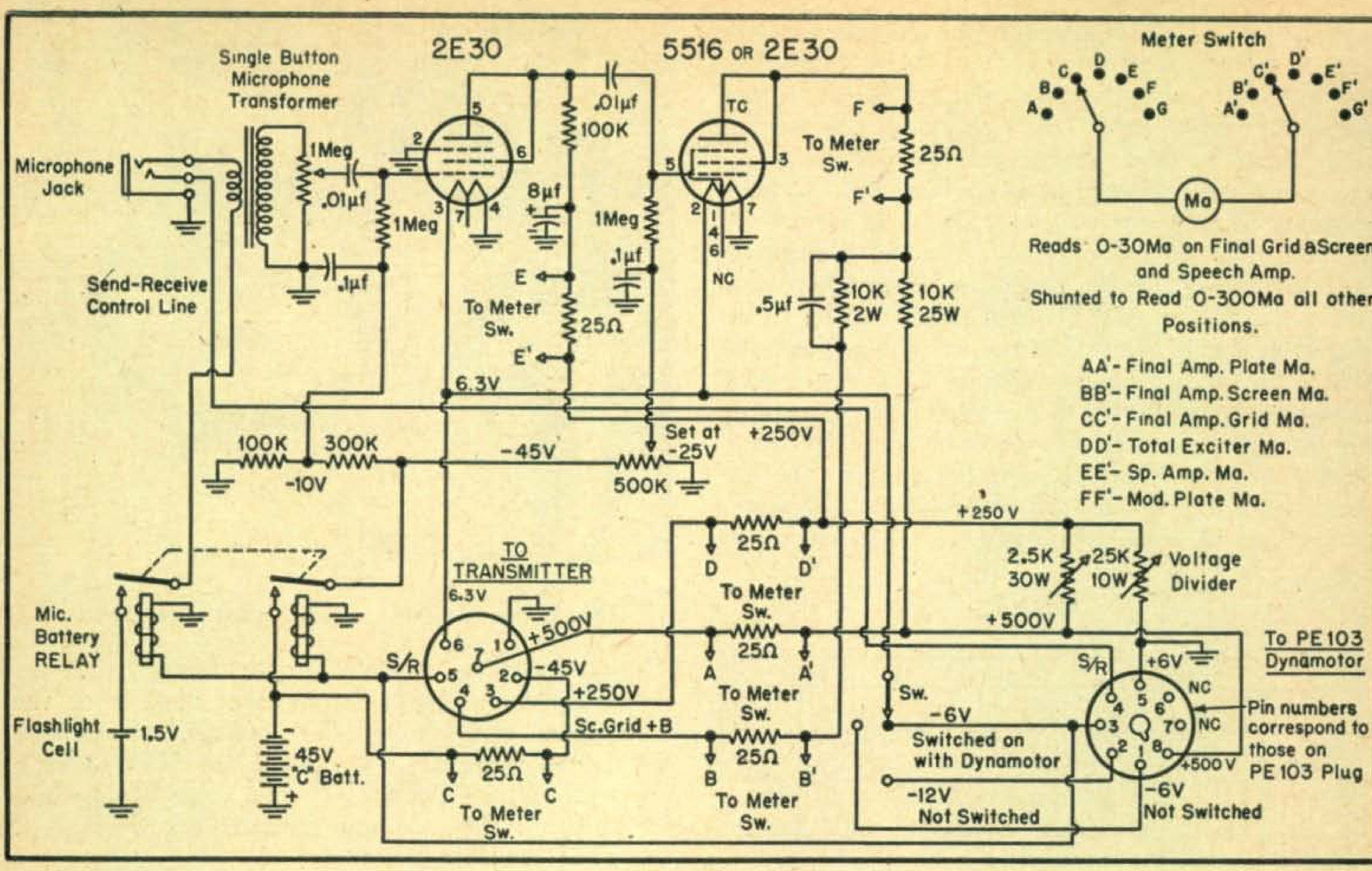


Fig. 3. Modulator circuit diagram.

Frequency Multipliers

The frequency multiplying strip is a small sub-assembly 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.)

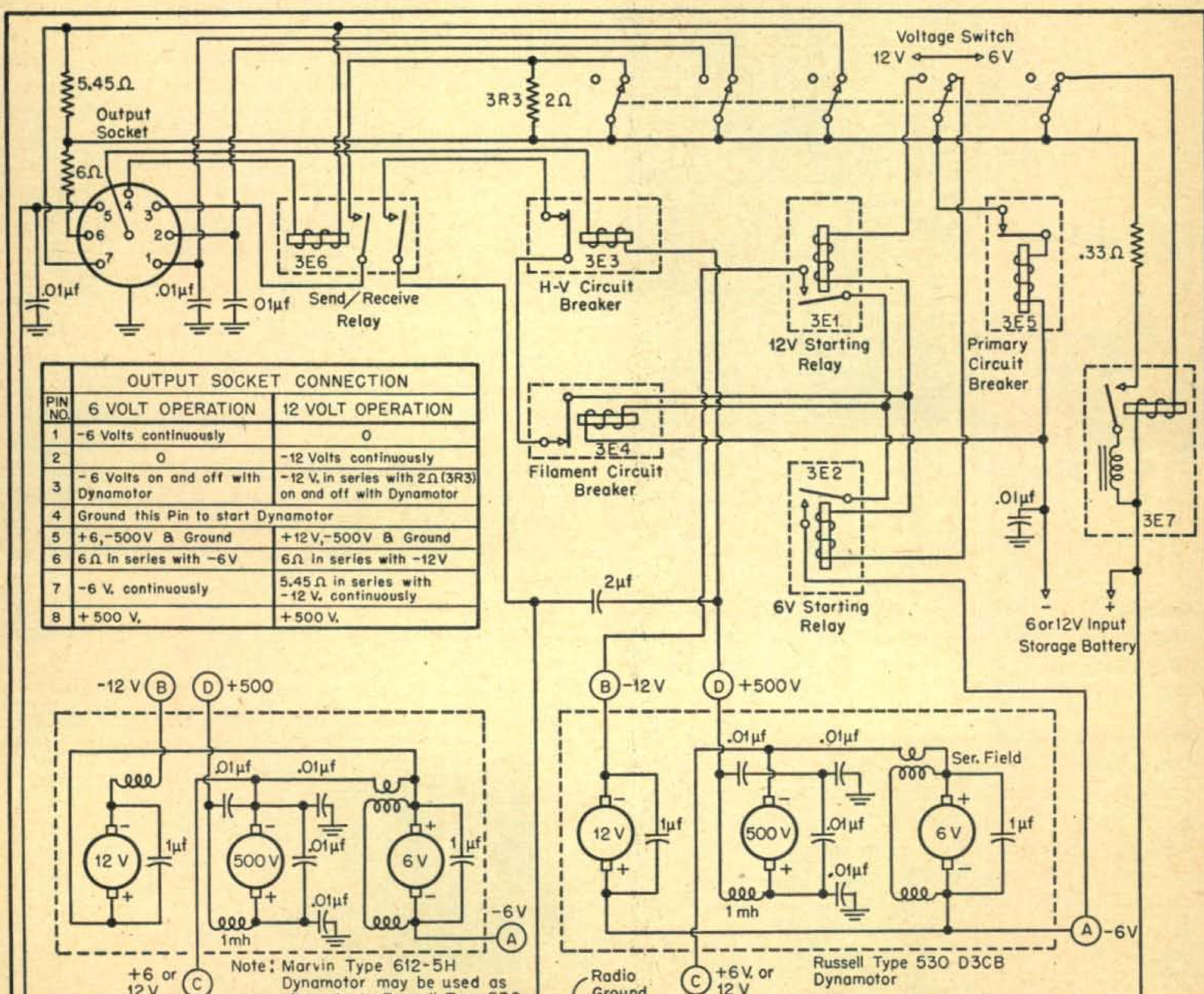
Modulator

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[5]; 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

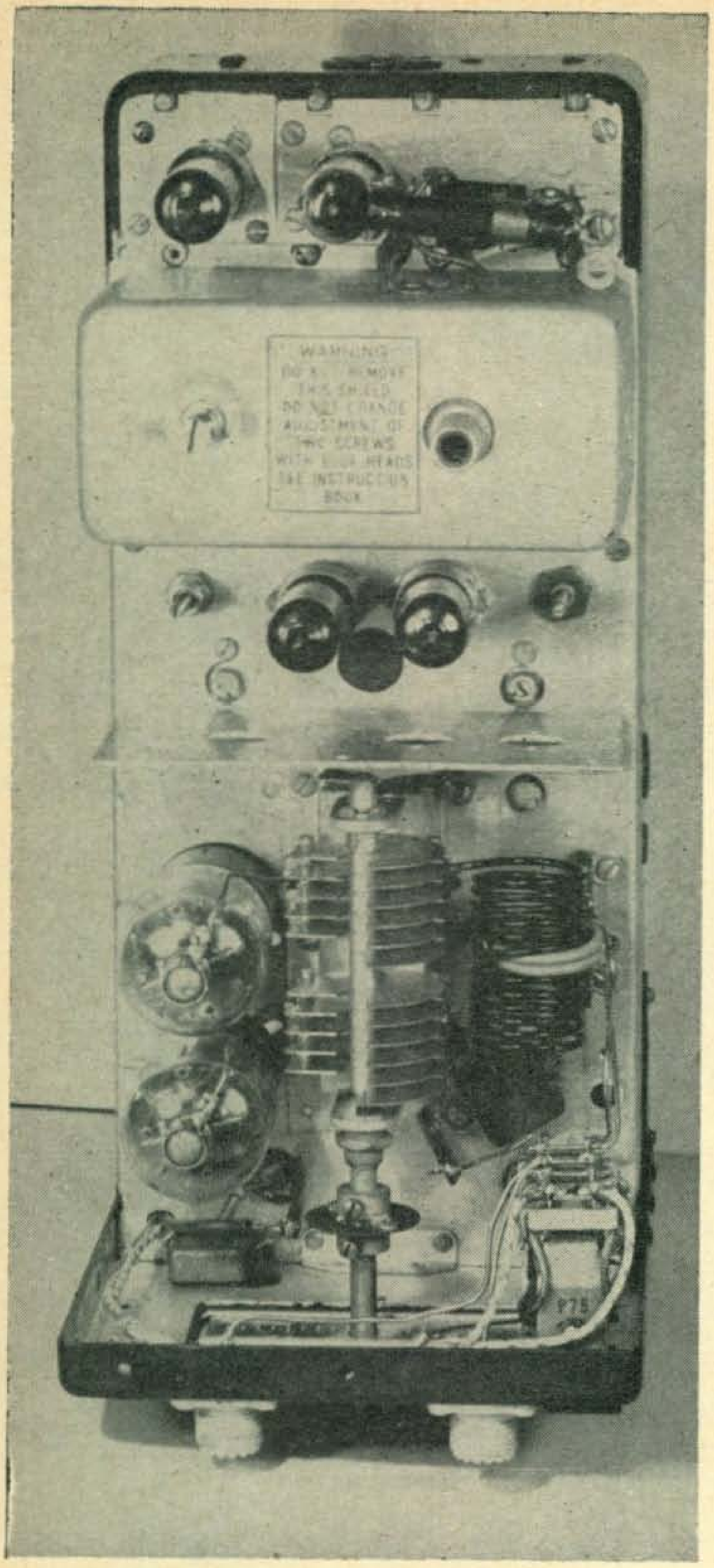
[5] Next month a plate modulator will be described that is interchangeable.

[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.

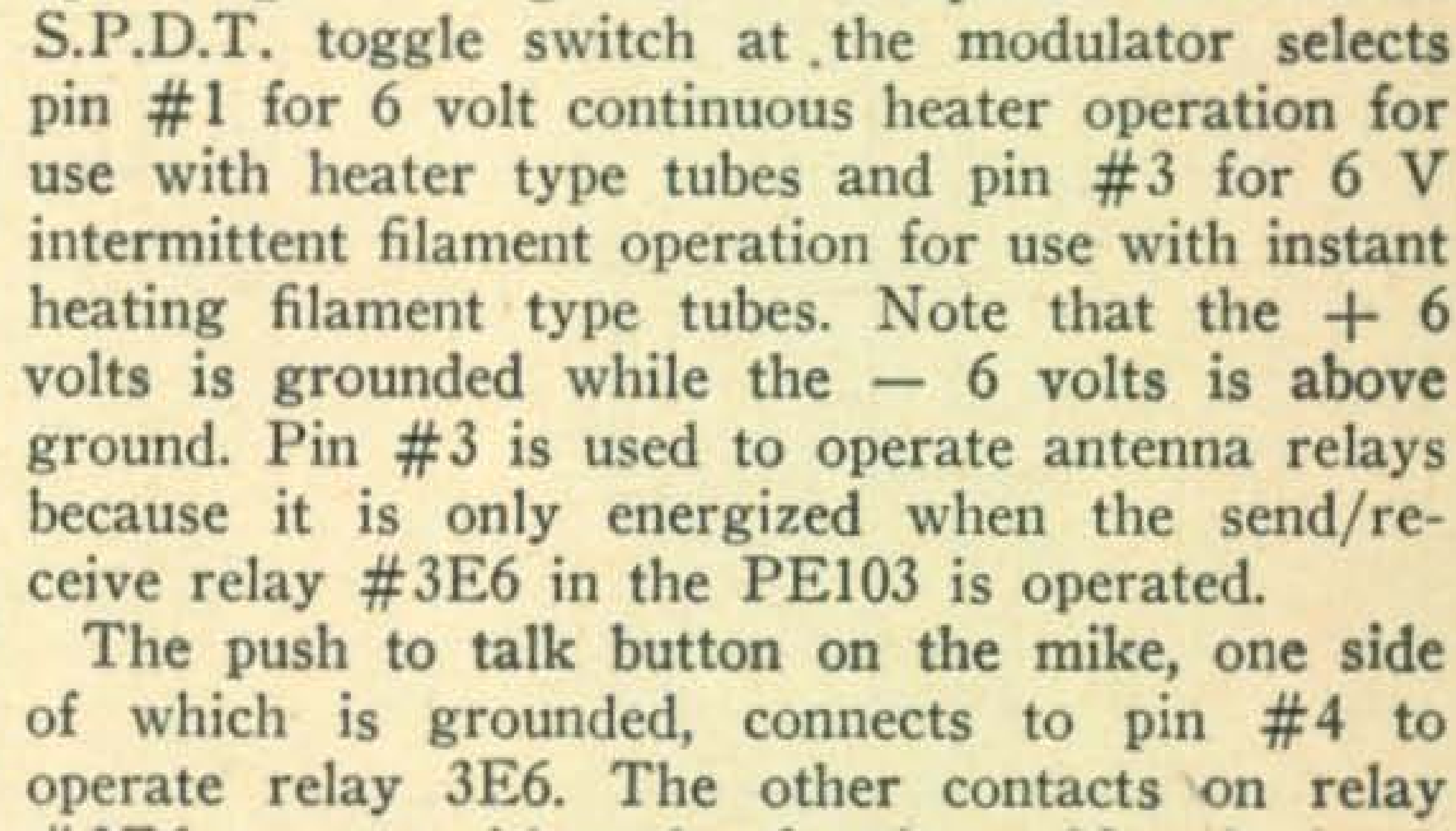
The switches shown in Figure 5 are mounted on the rear of the racks and are for breaking the filaments and plus 250V on the units that may be plugged into the additional racks, but which are not in use at the moment. This feature allows the operator to have up to three racks all connected in parallel, 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.

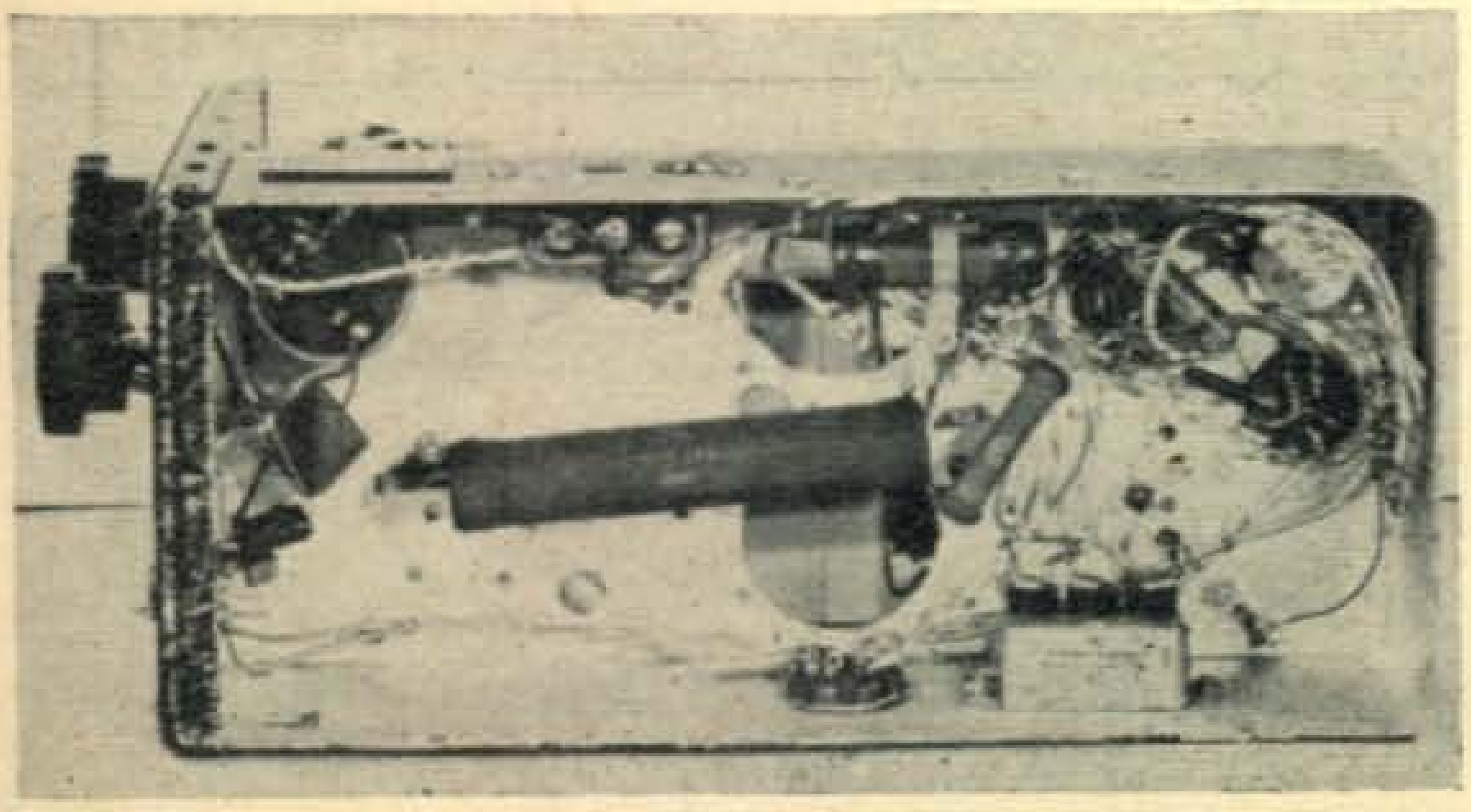
If trouble is experienced with the H.V. circuit breaker #3E3 kicking out too easily, it may be corrected by soldering a 10 ohm 1 watt resistor in parallel with the coil. This will increase its current handling ability, but will still allow it to kick out on a H.V. short circuit.

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

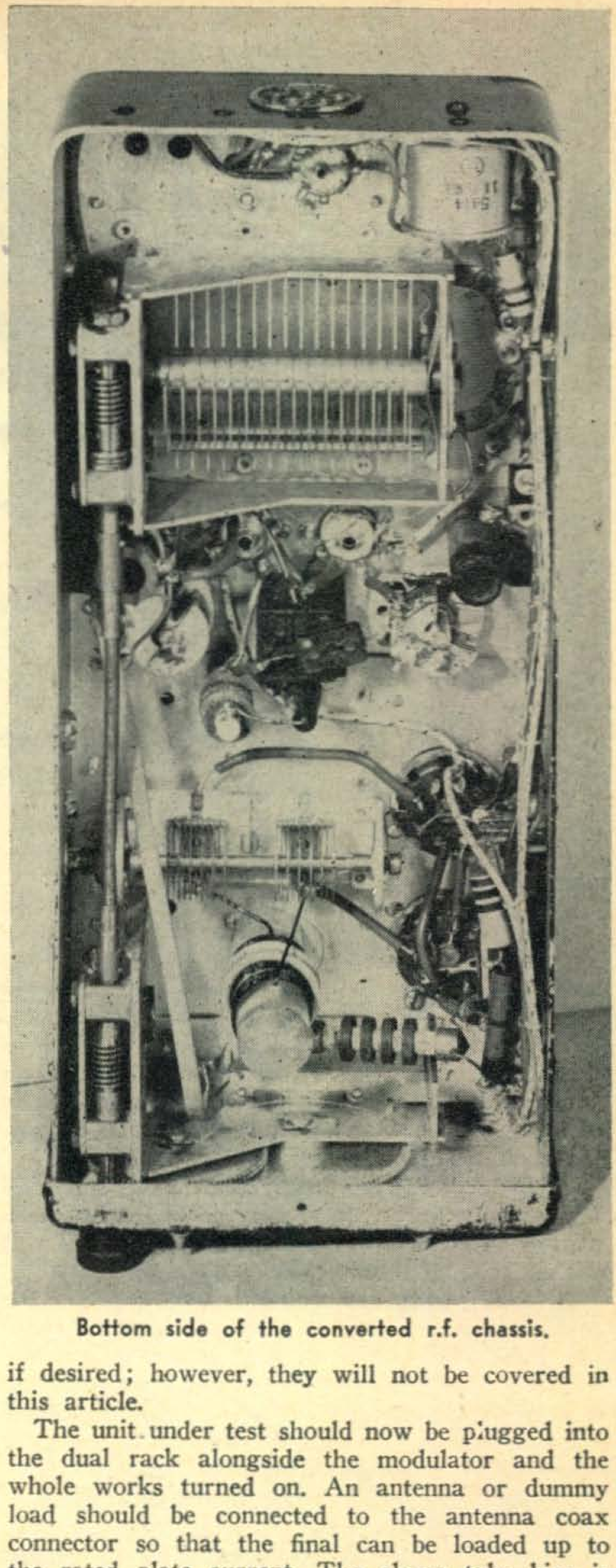
Tuning Up

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



Bottom view of the modulator unit.



Bottom side of the converted r.f. chassis.

if desired; however, they will not be covered in this article.

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.

(Continued on page 44)

ARC-5 FOR CD

(from page 17)

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

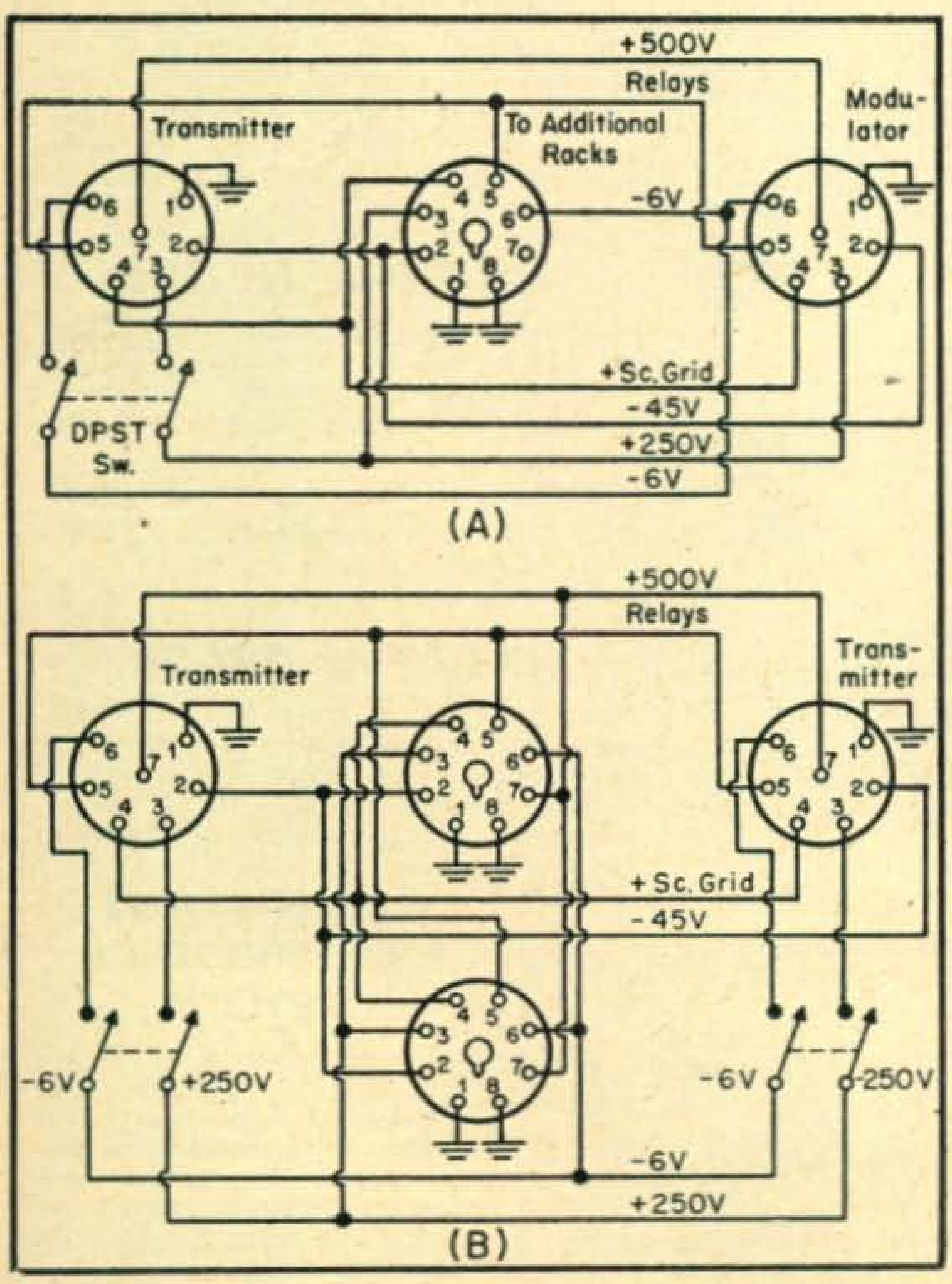


Fig. 5. Shock mounted rack connections.

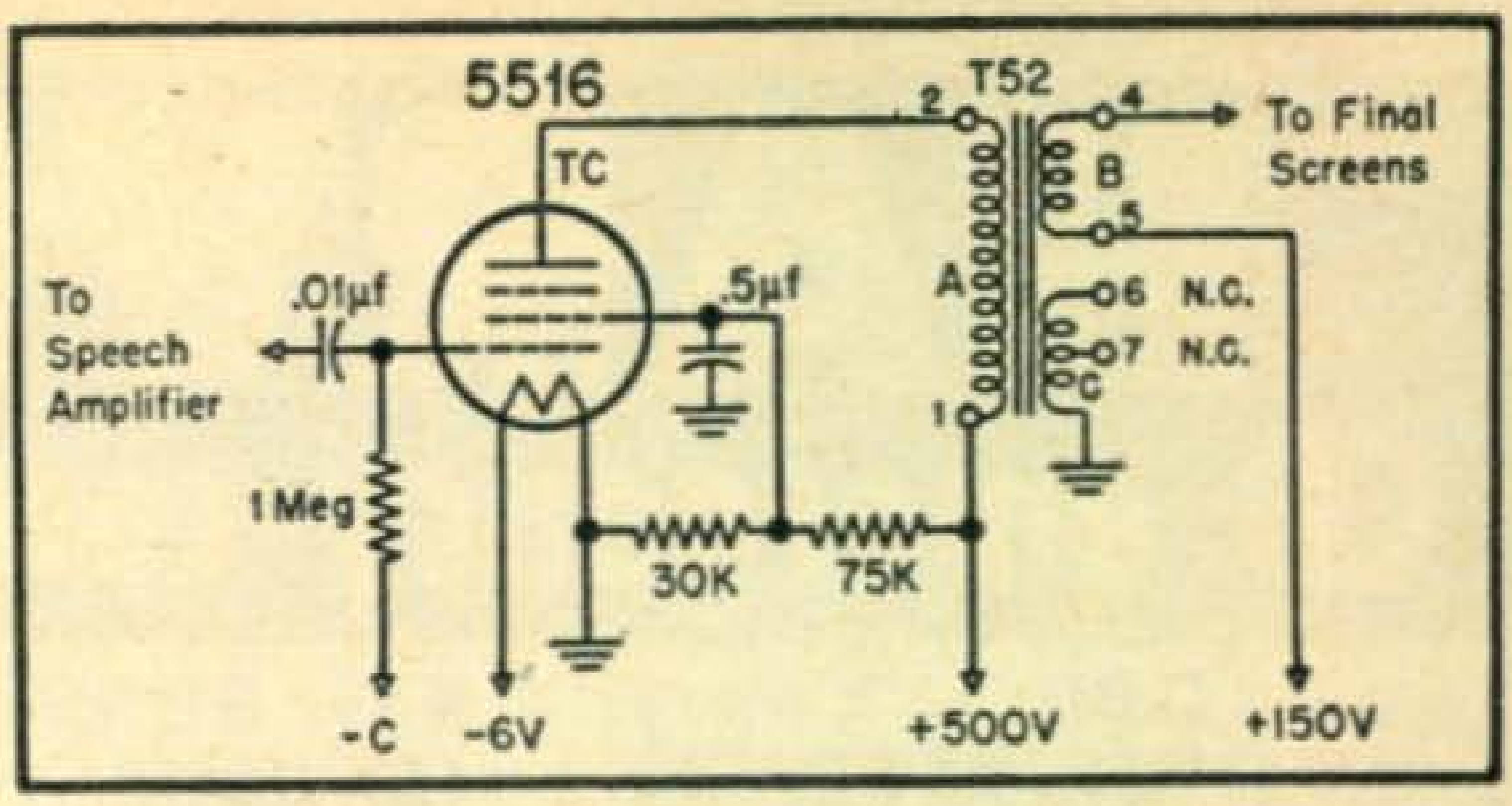


Fig. 6. Optional modulator, using transformer T-52.

more like a class B linear amplifier with the decreased efficiency of such an amplifier.

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.

Part 2, next month, will cover additional r.f. units converted to Civil Defense frequencies that may be plugged into the shock-mounted rack interchangably with this 28 mc unit, as well as a Class AB_1 plate modulator.

WALLET RIG

(from page 30)

Coils Easy To Wind

The coils are all air wound and W1KWU, whose finger size we do not know, says L1, L3 and L4 are "wound scramble, on the end of the little finger, slipped-off and laced with thread to hold its form". Coil L2 is wound on the end of a pencil, slipped-off and similarly laced. L2 fits inside L1. The wire lengths are critical and are given in the parts list.

Batieries Are External

W1KWU's construction is shown in Figure 1 with heavy-duty type batteries. For greater transportability, it is recommended that the miniature hearing-aid type of battery be used. The battery leads from the "billfold shack" terminate at a screw-terminal strip. By bringing out the oscillator, power amplifiers and receiver plate voltage leads as separate lines, a milliameter can be inserted in series for tuning-up.

Space can be saved by mounting the chokes with polystyrene cement after removing the ceramic forms they are wound on. This is best done with a vise and patience; the vise to hold the ceramic, and the patience to give you caution not to break the choke wire.

QSO Report

W1KWU reports that he operated this rig for a week at Boscawen, New Hampshire, last August, 1950. The antenna was a 133 feet long wire with the far end atop a flood light pole about 30 feet above the ground. Running 1 watt input on 7105 kc after midnight, he worked a thousand miles into the W4 and WØ zones. Maybe this again proves that good operating, the right band conditions and patience are just as essential to working-out as is high power.

PARTS LIST

R1, R6, R8, R11,—4700 ohms.
R2—1 megohm.
R3—1,000 ohms.
R4, R9—10,000 ohms.
R5—470,000 ohms.
R7—270,000 ohms.
R10—47,000 ohms.
R12—22,000 ohms.
C1, C10, C12, C15,—5-20 uuf Ceramicon Variable trimmer.
C2, C4—7-45 uuf Ceramicon variable trimmer.
C3, C5, C11—100 uuf (disc type).
C6, C7, C8, C9, C13, C14, C17, C18—.005 uf (disc type).
RFC1, RFC2—3 mh rf chokes with ceramic forms removed (see text).
L1—36 in. Tap 12 in. from ground end.
L2—24 in. All coils wound with $30 dsc. See text for winding instructions.
L3—48 in.
L4—54 in. Tap 12 in. from plate
SW—4p2t flat type switch (Centralab).
Antenna—133 ft. long flexible #14. Wind on spool when not in use.

YL'S FREQUENCY

(from page 36)

radio. Their dog (a "sausage dog"), says Louise, is called DX because of the long distance between her head and tail. For other hobbies besides radio Louise likes stamp collecting and gardening.

We've had the pleasure of doing it many times in this column for other YLs—now we're mighty happy to be able to make such an announcement for ourselves. That's right, W5RZJ and OM are the happy parents of a jr. YL. She arrived on February 16th and will answer to the name of Deryn.

Also on the personal side, we have a new QTH (again!), as you may have noticed at the beginning of this column. One highlight, of course, in moving to town is to have current —and two days after we got here we were on the air, courtesy of W5CA and W5FVO. CUL.

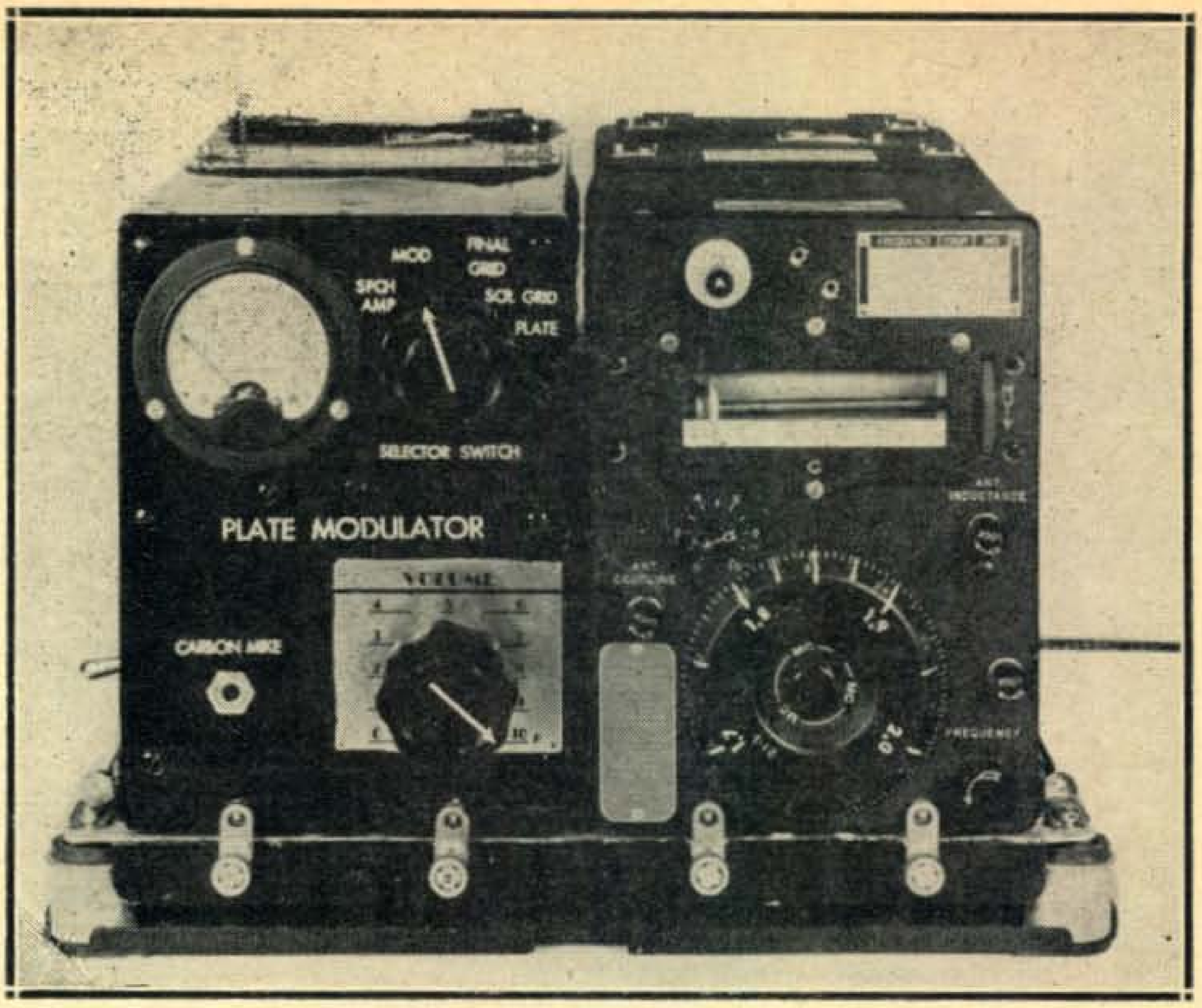
AMATEURS AND CD

(from page 27)

to make do with what you have. If men are needed, they can be recruited, trained, and assigned. If equipment is needed, it can be built. Here again a basic principle is involved, that of standardization and interchangeability. If you're building, build them alike. Quick repairs may mean the difference between the success or failure of an important mission. Standardization is also a term that can be profitably applied to operator training. Think in terms of uniform procedures. Back them up with drills. And keep the drills interesting, so that interest does not lag. In the setting up period, one big problem will be the allotment of frequencies. From what is available, it seems that the

P. S. RAND, W1DBM*

WAR SURPLUS for CIVIL DEFENSE



This is the concluding installment of W1DBM's ARC-5 conversion series, the first part of which appeared in our April issue. Since these two articles contain the original circuits for the unmodified units, they form a handy reference.

In part I of this article we described the conversion of a BC 457-A or 459-A command transmitter[8] to the new Civil Defense frequencies in the 10 meter band. This month we will describe a 50-54 mc conversion of a BC-458-A or BC 459-A, which is interchangeable with the transmitter described last month, as well as an 80 and 160 meter conversion, all of which may be used with the same modulator and power supply. A Class "B" plate modulator will also be described.

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

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8 CQ, April 1951, p. 11

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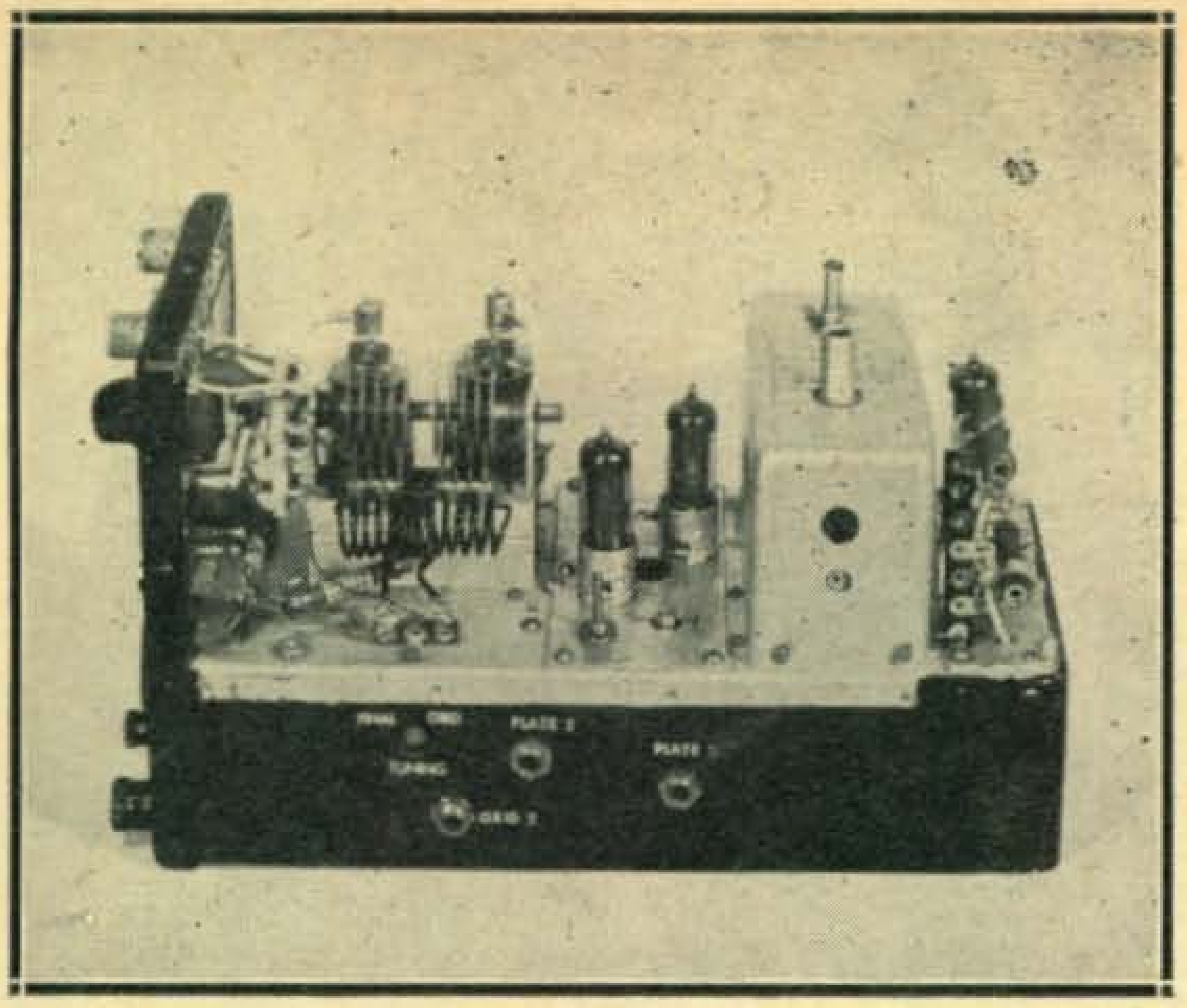


Right hand view of the converted 50 mc transmitter. The remaining grid current jack is on the left hand side of the chassis.

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 $\mu\mu$f, the plate-to-filament capacity, plus 10 $\mu\mu$f, the grid-to-filament capacity of the following 2E30, plus strays of about 5 $\mu\mu$f. This makes a total of around 20 $\mu\mu$f 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	uh
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 $\mu\mu$f 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

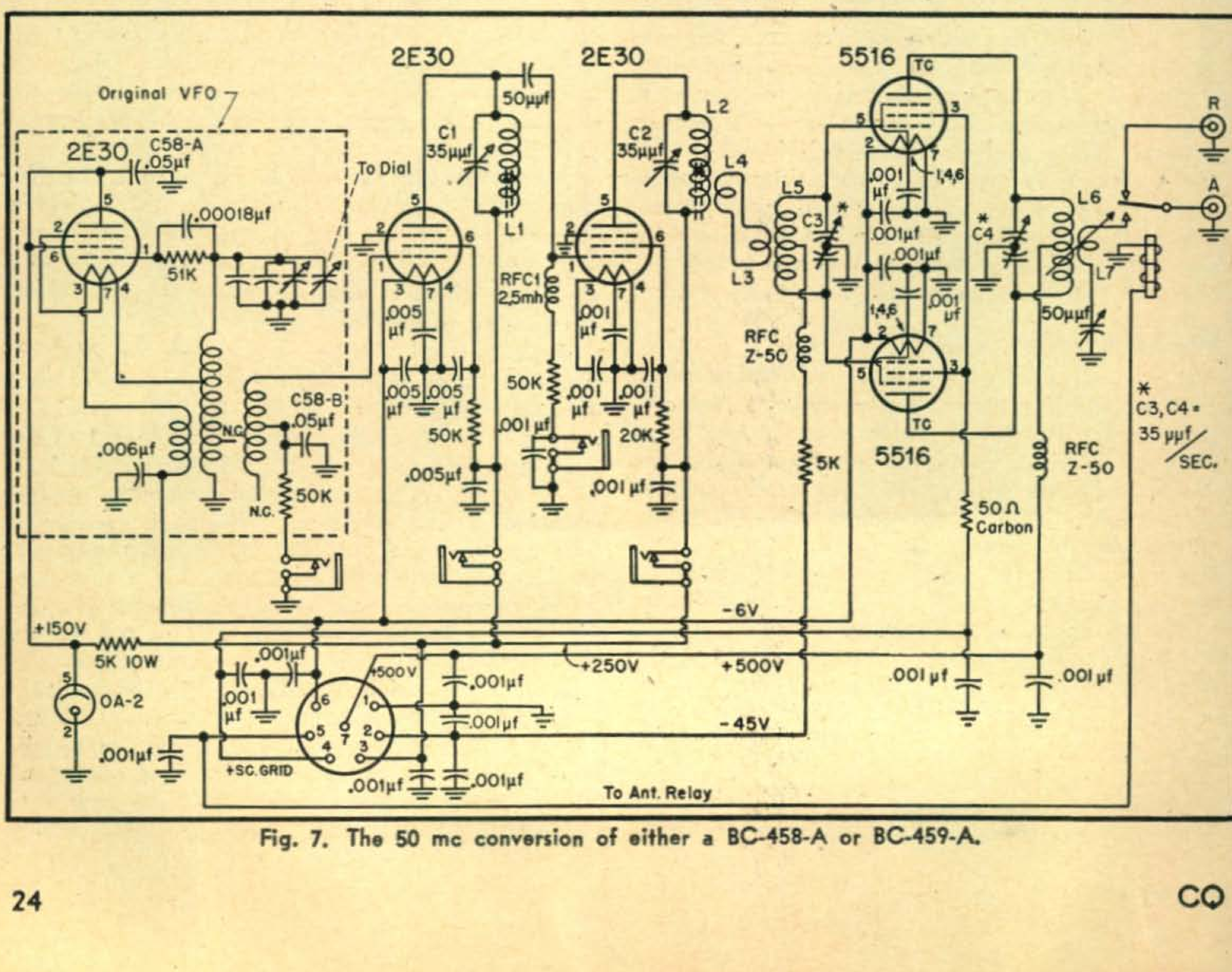


Fig. 7. The 50 mc conversion of either a BC-458-A or BC-459-A.

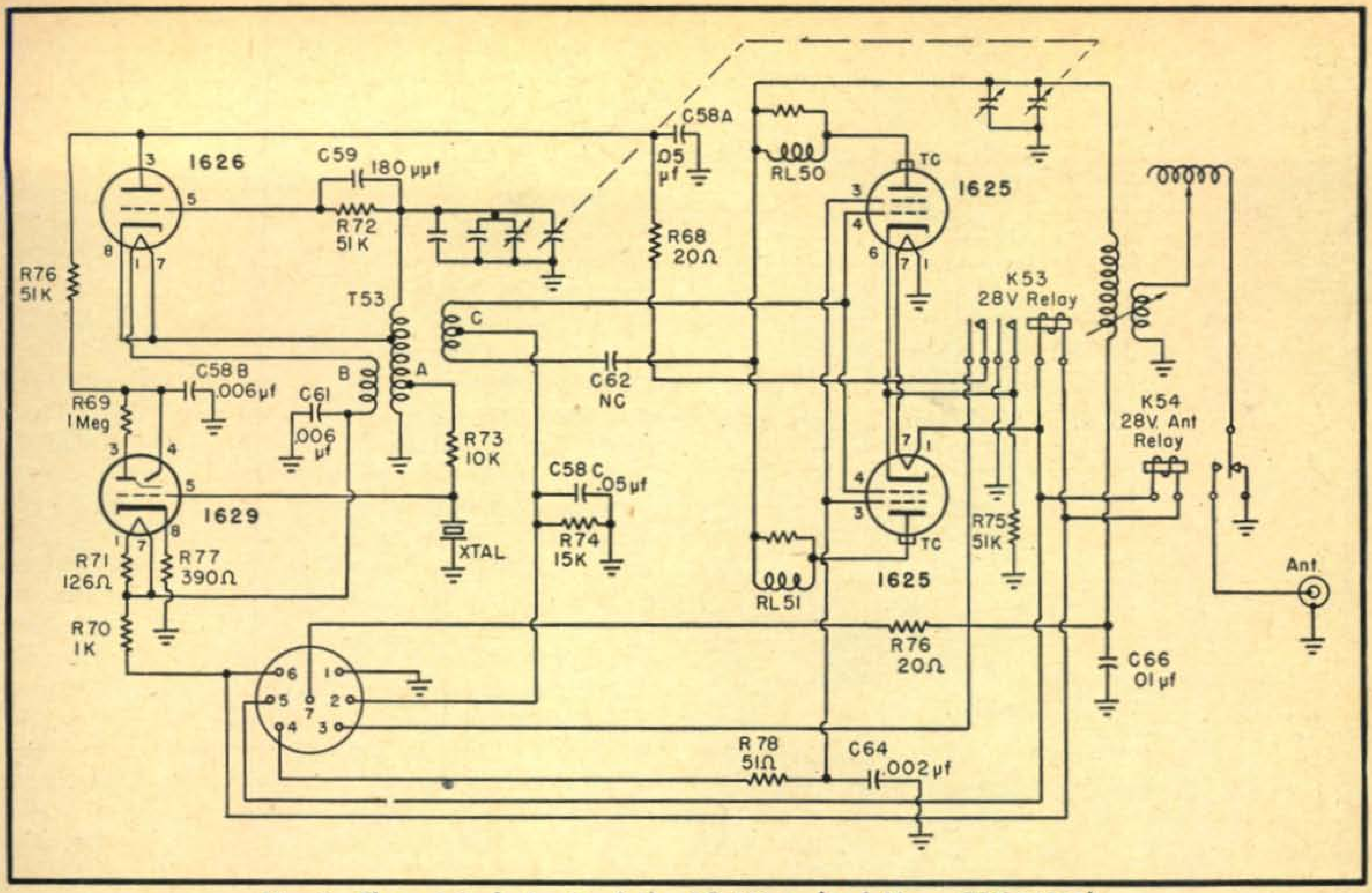


Fig. 8. The original circuit of the BC-696-A (and Navy CBY-52232).

winding data if parallel condensers are used to tune the coils.

Final Amplifier

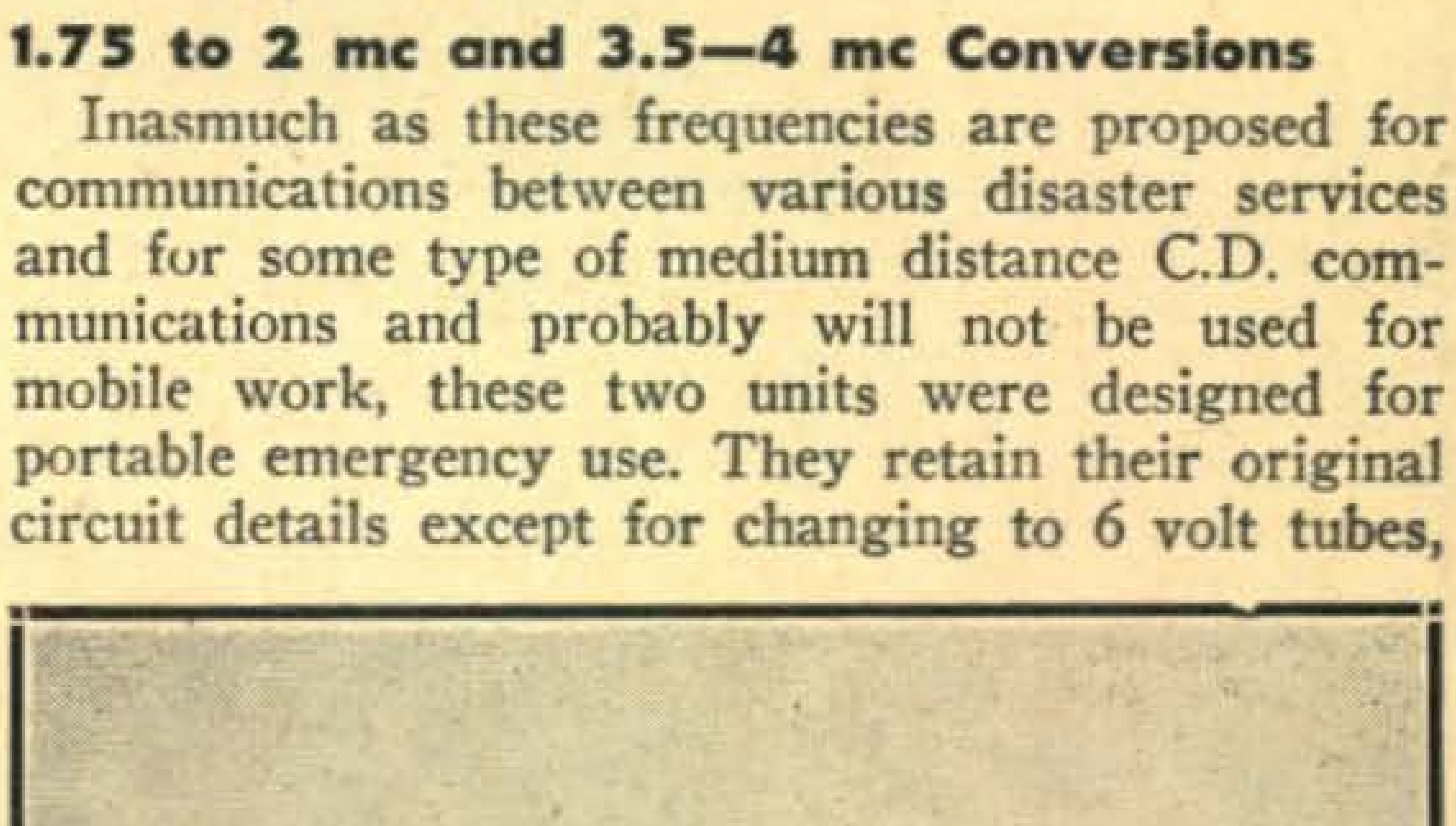
The components for the push-pull 5516 final amplifier are mounted in much the same fashion as for the 28 mc transmitter. The reader is referred to the photographs which show the general layout. The final tank condenser is raised off the chassis by means of a small aluminum bracket so that the plate leads 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.

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.

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

9 "Mobile with the SCR-274N." George M. Brown, W2CVV, CQ, Jan. 1948, p. 22.

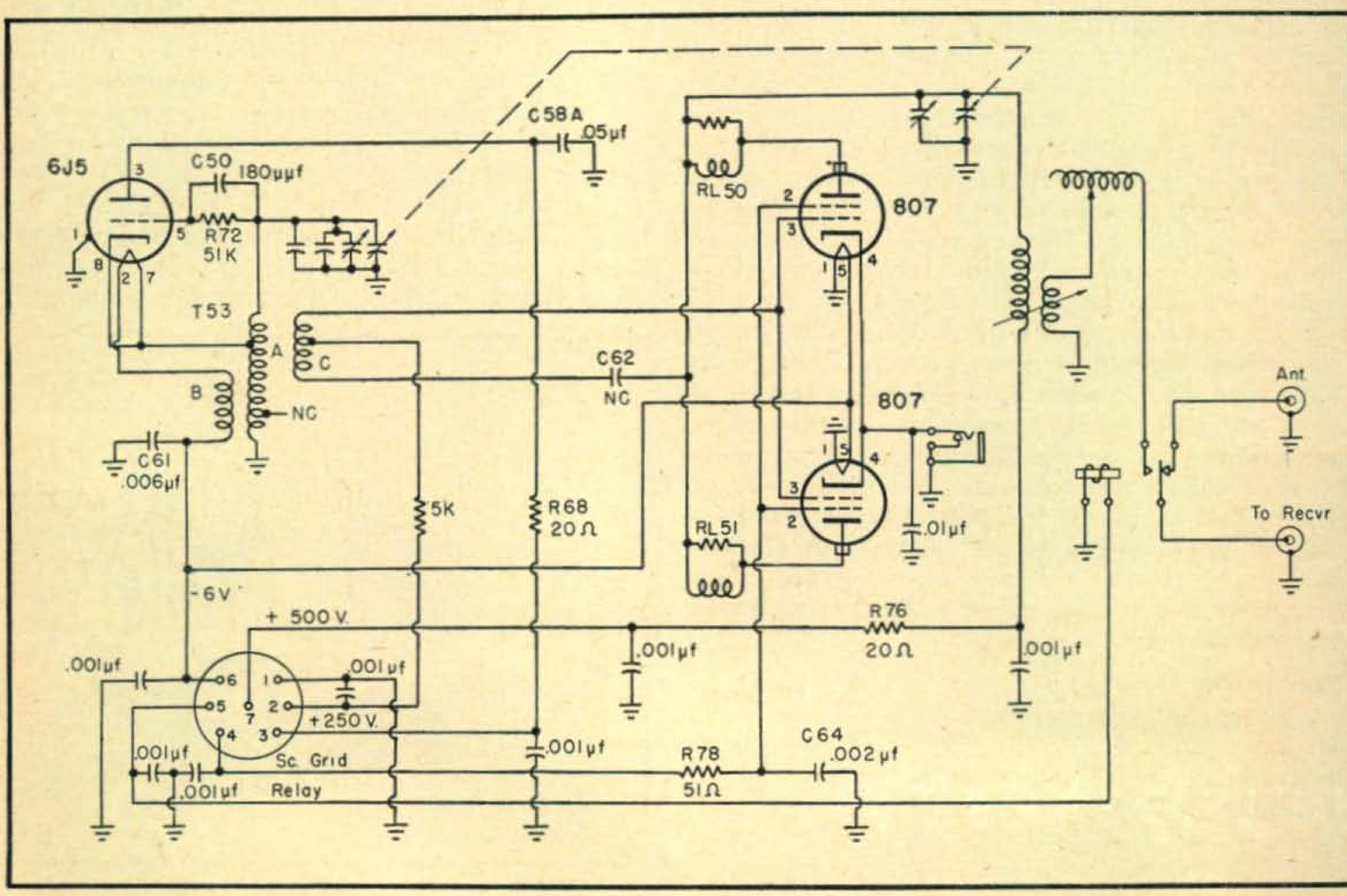


Fig. 9. WIDBM's 80 and 160-meter conversion from the circuit of Fig. 8.

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.

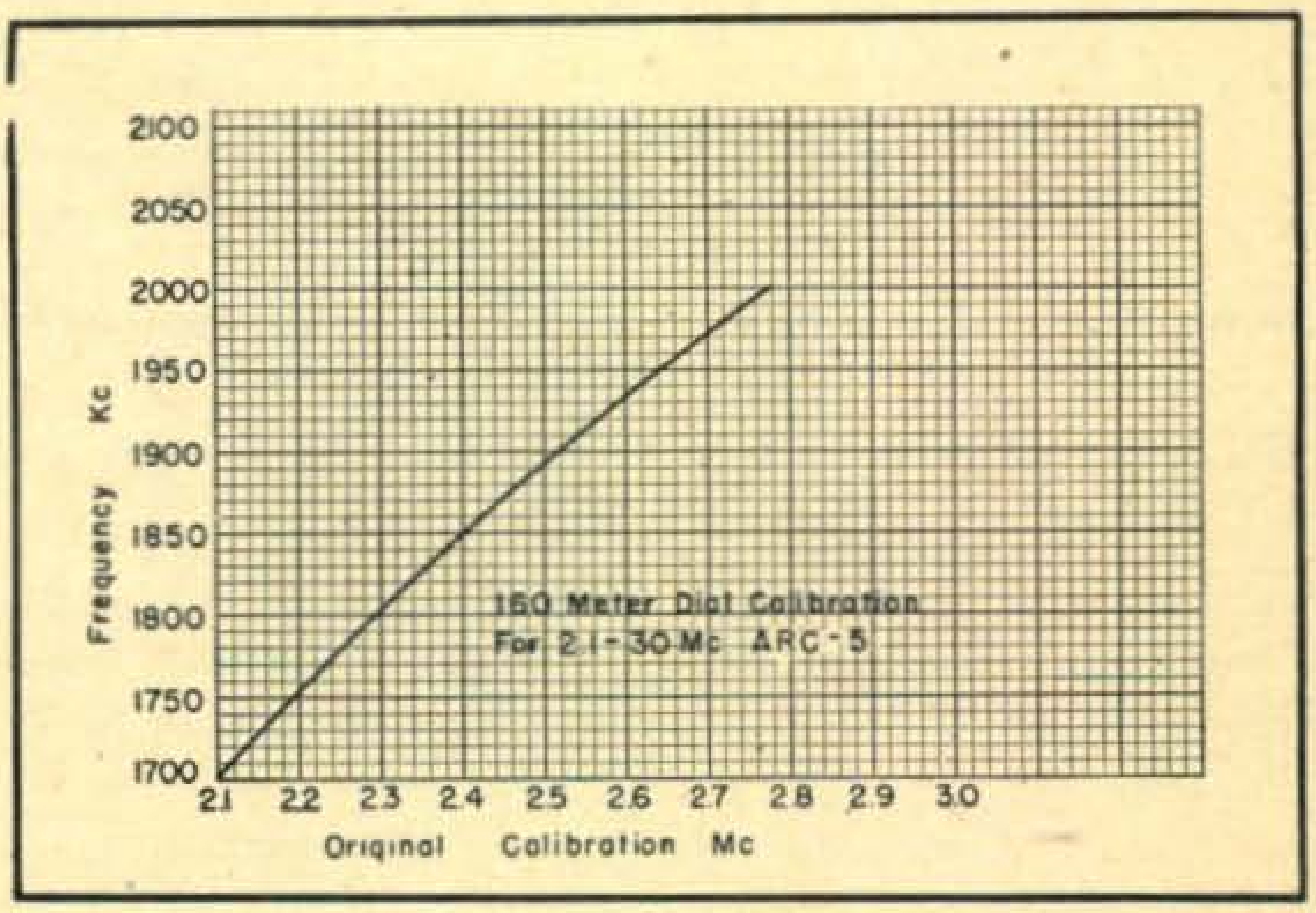
C. W.

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 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.



Figures 10.

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 multi-match 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

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10 "Modification of the SCR-274N," E. B. McIntyre, W3KHJ, CQ, July 1948, p. 43.

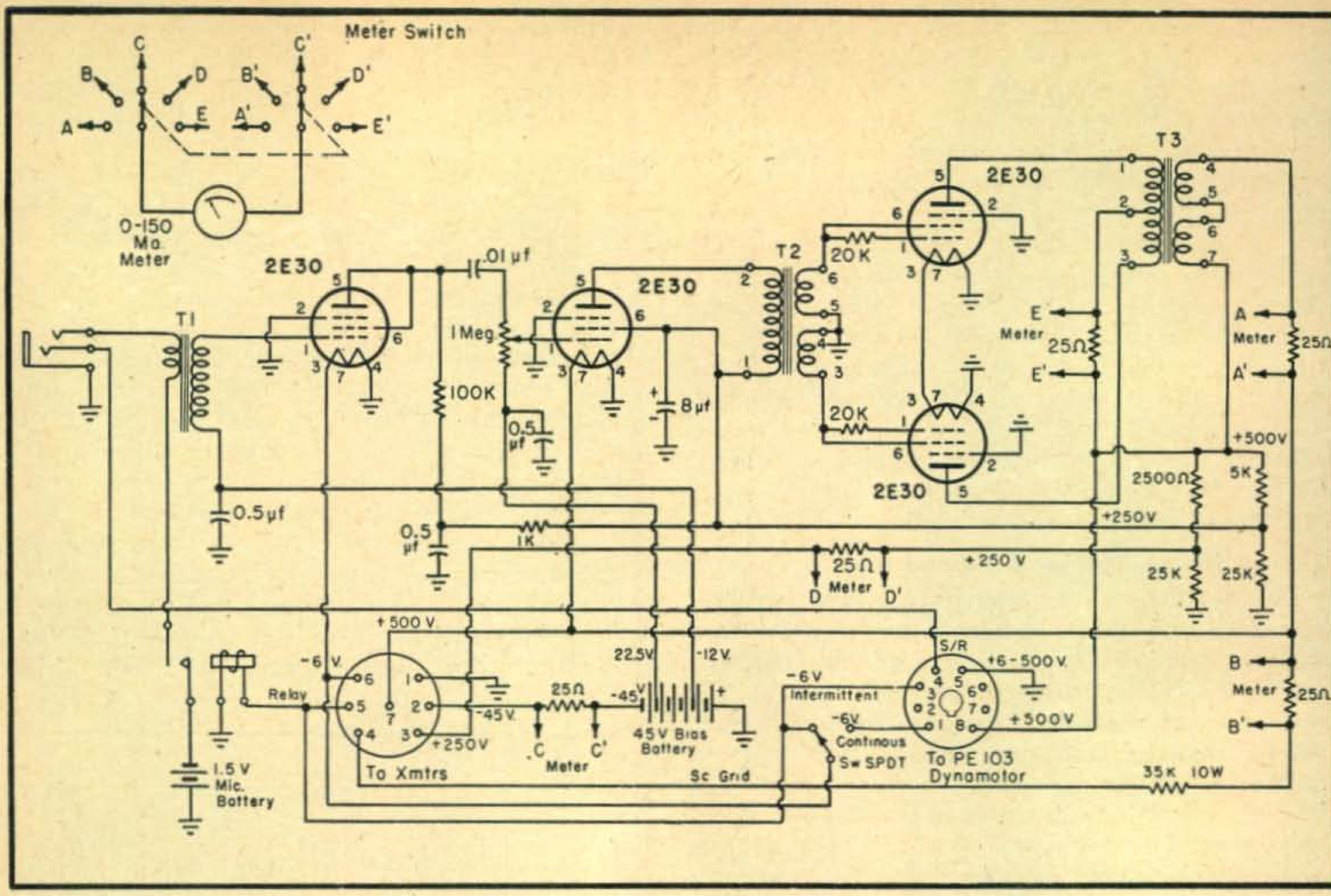

Fig. 11. The speech amplifier and class B modulator.

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.[9] 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.

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11 RCA "Ham Tips," Vol. VII, No. 2, May-June 1947.
12 "A High-Power Modulator for Mobile Operation," George M. Brown, W2CVV, CQ, Feb. 1950, p. 20.