

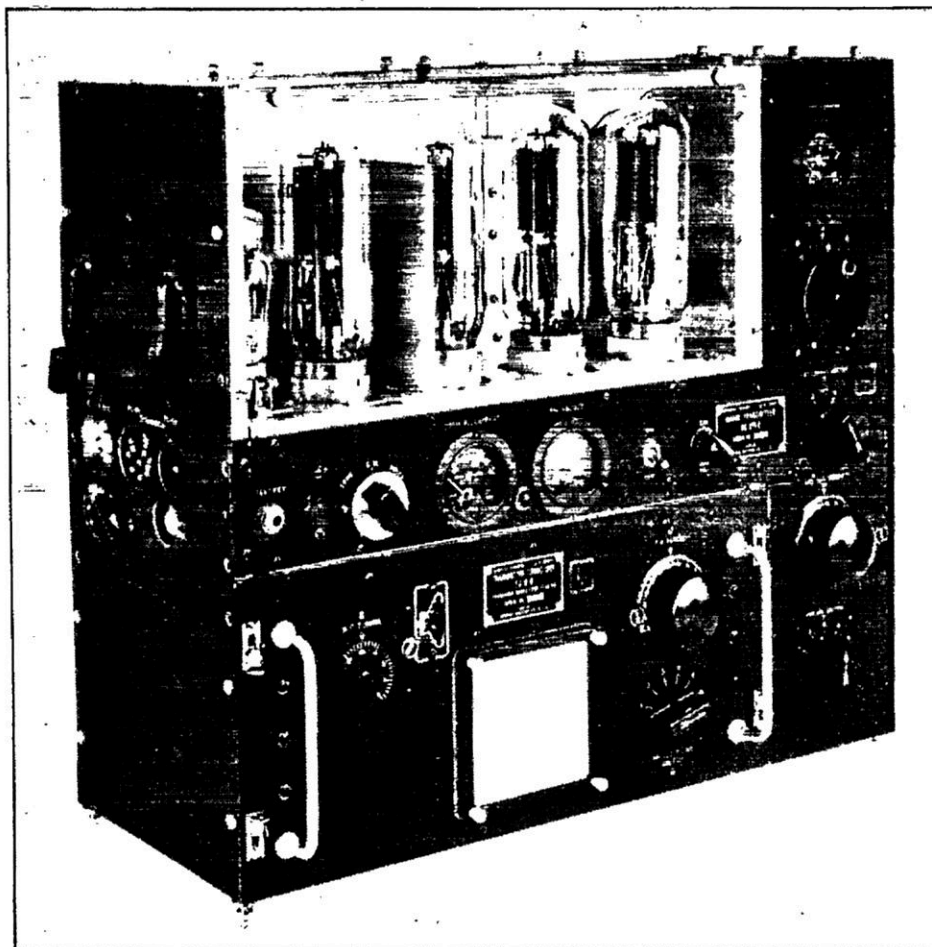
What About the BC-375-E?

WE'VE had a flood of questions about the BC-375-E, an Army transmitter that has appeared in large quantities on the present war-surplus market. "What is it?" — "Will it make a good transmitter for my home station?" — "Is it worth the price [about \$50, with tubes] being asked for it?" — "Is it easy to convert for a.c. operation?" These seem to be the questions most frequently asked. To get the answers to these and a few questions we had in our own minds, we bought one, took it into the lab, and went to work on it. The following may not answer all questions, but it should supply enough information to permit some evaluation of the situation.

The BC-375-E is an aircraft transmitter, using an MOPA circuit, with a 211 oscillator driving a 211 amplifier to produce 45 to 75 watts output over a wide range of frequencies, including the 3.5- and 7-Mc. amateur bands. A 210 speech amplifier driving Class B 211s is used for 'phone

operation. The equipment is designed for operation from a 24/28-volt d.c. source capable of supplying about 600 watts for c.w. operation, 840 watts for 'phone. A dynamotor rated at 28 volts at 20 amperes input furnishes the plate power required, while the filaments are supplied directly from the 24/28-volt batteries. Seven plug-in tuning units are used to cover the frequency range. The plug-in units, the dynamotor and, in some instances, an antenna tuning unit are included in the price.

The d.c. power-supply requirements present the first problem. Four 6-volt 100-ampere hour batteries would cost about \$30 at present market prices, and a suitable battery charger perhaps another \$8 or \$10. The cost, plus the inconvenience of having to recharge the batteries frequently because of the heavy drain, makes battery operation of the equipment a rather unattractive possibility. A few purchasers have shown some interest in using the dynamotor, driving it by



Front view of the "modified" BC-375-E. The tuning controls remain unaltered, but along the meter panel several changes have been made. At the extreme left is the new key jack, next to it the tuning control for the grid circuit of the first 211, which now operates as a buffer-doubler. Just to the left of the nameplate is the meter switch. On the left side of the case are an audio gain control, a bandswitch for the grid of the first 211, a power plug for the preamplifier, and a new microphone jack.

coupling its shaft to an a.c. motor. When you stop to consider that the motor required would have to be at least a 1-horsepower job, if 'phone operation was desired, and that it would be necessary to drive the dynamotor shaft by means of a V-belt and pulleys to obtain the rated 5000-r.p.m. shaft speed, this method also seems costly and impractical. The motor would cost \$40 or \$50, and would require a pretty husky power line to run if the usual single-phase 220-volt grounded-neutral house wiring circuit were to be used, and there aren't very many ham shacks that have 2- or 3-phase stuff available. The cost of a suitable selenium rectifier supply also seems prohibitive.

Converting for A.C.

Therefore, forgetting that a dynamotor had been included in the purchase price, we set about "converting" the transmitter for fixed-station use from rectifier power supplies. A look at the circuit diagram in the instruction book supplied with the equipment convinced us that it should not be a difficult job to unground one side of the filament circuits and rewire them in parallel for operation from a filament transformer. Perhaps we should say *transformers*, because the requirements are 10 volts at 13 amperes for the four 211s, to say nothing of the 7.5-volt 1.25-ampere needs for the 210 speech amplifier. Armed with the usual assortment of ham tools, we started the job. We had not gone far, however, before we began to learn things about the BC-375-E, things that were not apparent at first. The equipment was designed for a specific purpose, and we have no doubt that it fulfilled that purpose. But it was not, apparently, designed with any thought of making it easy to work on. Consequently, when we attempted to do what, on paper, seemed to be a simple rewiring job, we found that we had our hands full. Before we could reach the tube sockets, several parts had to be removed — including the modulation transformer, which is something in the nature of a major operation. Without detailing the steps here, let's say that the rewiring was accomplished, with difficulty, and with the aid of about every socket and open-end wrench we could find, plus a little old-fashioned brute force. In the course of these operations, the entire filament voltage-compensating circuit was removed, as it is not needed in a.c. filament operation. To avoid using a separate filament transformer for the 210 speech amplifier, Resistors 1191 and 1192 were wired in parallel instead of in series, resulting in about 7 volts at the socket of the tube, which is adequate for the sort of operation involved.

Some Other Changes

While the rig was still opened up, and before the modulation transformer was put back, we installed a meter-switching circuit to permit measurement of oscillator plate current, amplifier

grid current, amplifier plate current, and modulator plate current. The usual system of inserting 22-ohm resistors in the d.c. leads of the circuits to be measured, and switching the meter across each resistor in turn, was used. The meter switch was mounted on the front panel in the hole vacated by the toggle switch originally used for filament compensation. The keying relay was disabled by turning the contact-spacing adjustment screw all the way in, leaving the relay permanently in the transmit position. The relay will not operate on a.c. The keying lead was disconnected from the relay, and was brought out to a closed-circuit jack installed on the front panel in the hole formerly occupied by the "Test Key," which was not considered essential for ham use. The "On-Off" switch was rewired so that it would break the B- lead instead of actuating a relay in the dynamotor unit.

With these changes behind us, we were rapidly becoming familiar with the schematic diagram and the wiring diagram. The use of the latter is essential, because circuit tracing from the schematic alone is next to impossible.

Performance as an MOPA

We hooked up a d.c. power supply capable of giving 1000 volts at 250 ma., and with the tuning unit that covers the 3000-4500-ke. range plugged in, set the dials for 3500-ke. output in accordance with the calibration charts supplied with the unit. The "conversion" had not upset the calibration too much, but the fact remains that we did have to retune to hit the desired frequency. Using a 150-watt lamp bulb as a dummy load, we were able to load the final amplifier satisfactorily, obtaining about 60 watts output with 100 watts input. When keyed, however, the oscillator "yooped" badly, and nothing we could do in the nature of retuning seemed to help. In addition, tuning the antenna circuits pulled the oscillator frequency a good many kilocycles away from where we started, indicating that more isolation between the antenna circuits and the oscillator was needed. These faults convinced us that the stability of the BC-375-E as an MOPA rig is just not good enough to meet the FCC requirements for amateur stations, and it does not appear to be capable of improvement without extensive modification. The low-C oscillator circuit seems to be the main cause of this instability. It is another illustration of how Army requirements frequently have no relationship to ham requirements; what the Army needed was a transmitter that would put out a signal that would be within a small percentage of a specified frequency under some rather trying operating conditions. The *quality* of the signal as judged by amateur standards was of secondary importance. The result no doubt was just about what was desired, but the signal isn't the kind that a self-respecting ham would care to have on the air!

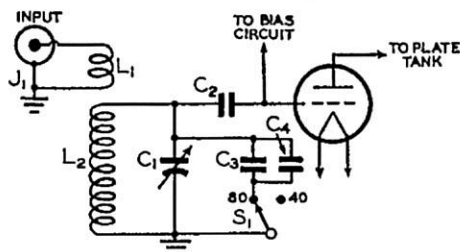


Fig. 1 — The tuned circuit used to permit link-coupling to the grid of the first 211 tube. Padding condensers are used to provide bandswitching.

- C₁ — 100- μ fd. receiving-type variable (Millen 22100).
 C₂ — 0.0022- μ fd. mica.
 C₃ — 22- μ fd. mica.
 C₄ — 47- μ fd. mica.
 L₁ — 3-turn link, part of L₂.
 L₂ — 22 turns No. 20 enameled, spaced to occupy 1 1/4 inches, 1 1/4 inches diam., air-wound. (National AR-16-40 E, with 4 turns and plug-in base removed.)
 J₁ — Coaxial connector (Jones S-101).
 S₁ — 5-position single-pole ceramic switch (4 positions not used). Centralab 2501.

Stabilization

The solution to the stability problem was found in using a separate oscillator, external to the equipment because of space limitations, and changing the first 211 from an oscillator to a neutralized amplifier. Therefore, a tuned circuit, shown in Fig. 1, was installed in the grid of the former oscillator, with a link terminating in a small coaxial connector mounted on a plate that covered the hole formerly occupied by the remote-control connector. The grid coil and its tuning condenser fit behind the front panel, the condenser shaft coming out of the hole in the panel from which the "Tone-C.W.-Voice" switch had been removed. A rotary switch was installed with its shaft coming out through the side of the transmitter to switch padding condensers into the circuit, permitting the same coil to be used for either the 3.5- or 7-Mc. bands.

The neutralizing circuit, shown in Fig. 2, was installed in the tuning unit. A 50- μ fd. transmitting-type variable condenser, mounted as shown in the photograph, with its shaft protruding out of the rear of the tuning unit, did the job nicely. A similar circuit was installed in the 6200-7700-kc. tuning unit, to permit operation in the 40-meter band. In this case it was possible to neutralize with the plates of the 50- μ fd. condenser at almost minimum capacitance, so it would be possible to use a smaller condenser if available.

Using the "Longfeller" 6F6-6L6 transmitter described in *QST* for July, 1946, as an exciter, we were able to

obtain an entirely stable signal from the transmitter. For 3.5-4-Mc. operation the first 211 works as a neutralized amplifier while output in the 7-Mc. range is obtained by using it either as a doubler from 3.5-Mc. excitation, or as a neutralized amplifier from 7-Mc. excitation. The doubling efficiency of the circuit is low, but can be improved materially by increasing the bias on the tube by adding a 50,000-ohm 10-watt resistor inside the tuning unit. It should be connected in the same manner shown in Fig. 3, the diagram of the 10-12.5-Mc. tuning unit.

To obtain output in the 14-Mc. band, it was necessary to modify the coils in the tuning unit supplied for the 10,000- to 12,500-kc. range, and to remove the grid condenser, C_x, shown in Fig. 3. The simplest way to change the coils is to short one turn at the "cold" end of each. Unless straight-through operation of the first 211 is desired, installation of the neutralizing circuit in this tuning unit is unnecessary. The efficiency of the doubler in this band is poor, even when the bias is increased by insertion of a 0.1-megohm 10-watt resistor in the same manner as in the 7-Mc. unit. The long r.f. leads apparently cause the loss of efficiency at these frequencies, because the tubes themselves are capable of reasonably efficient doubling, even up to 28 Mc. To get ade-

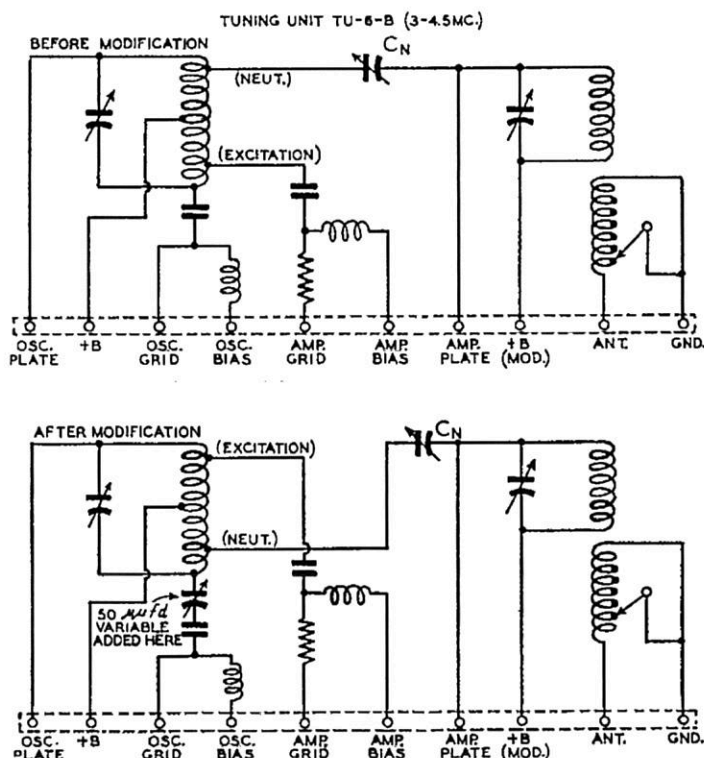


Fig. 2 — Simplified circuit diagram of the tuning unit used to cover the 3000-4500-kc. range. The addition of a 50- μ fd. variable condenser as shown in the after-modification portion of the sketch permits use of the unit as a neutralized amplifier. Output of the transmitter can be increased substantially by rearrangement of the excitation and neutralization taps on the oscillator coil as shown. The keyed terminals at the bottom of each sketch connect the tuning unit to the tube circuits.

quate drive for the final amplifier at 14 Mc. (35 to 40 ma.) it was necessary to use an 807 running at about 50 watts input as the exciter in place of the 6L6 used in the lower-frequency bands.

Boosting the Output

With the changes outlined so far, we were able to get about 60 watts output in the 3.5- and 7-Mc. bands and somewhat less at 14 Mc., in each case running about 100 watts input to the final. This output can be increased to something over 100 watts, however, by rearrangement of the taps on the "oscillator" coils in the various tuning units. As originally designed, the drive at the grid of the final amplifier is low — too low to permit full utilization of the power capabilities of the 211 tubes used. The excitation taps on the coils are placed near the "cold" end of the tank, a desirable situation when the first tube was used as a self-excited oscillator, but no longer necessary for stability when the tube is used as an amplifier-doubler. By shifting this tap to the plate end of the coil, as shown in the after-modification sketches of Figs. 2 and 3, and at the same time placing the tap from which the neutralizing voltage is obtained near the cold end, several times as much driving power can be obtained. For example, with the taps in their original positions the grid current to the final (using the 7-Mc. coils) was measured at 15 ma. When the taps were shifted, this figure was increased to 45 ma. While 15 ma. might be adequate for c.w. work, it is insufficient for true Class C operation of the tube, a requirement if satisfactory 'phone operation is to be obtained.

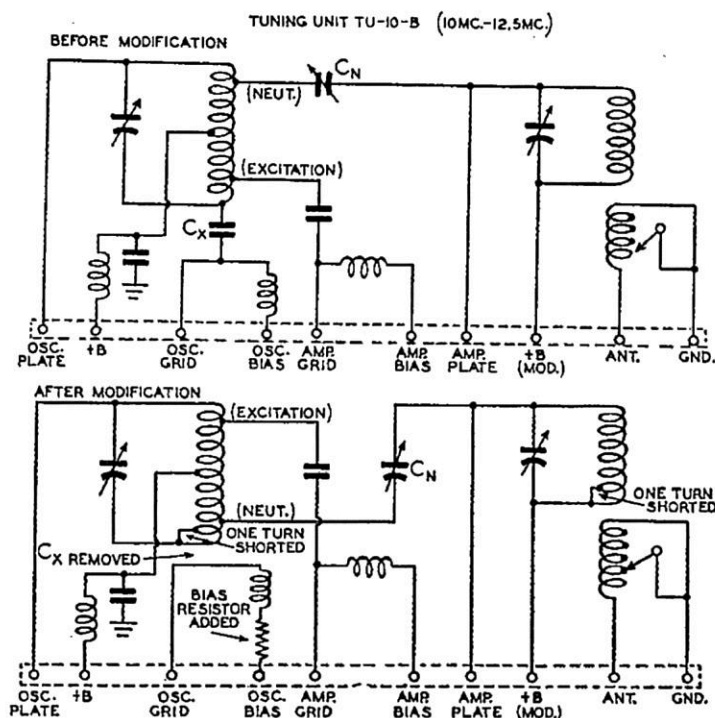


Fig. 3 — Circuit changes needed for modification of the 10,000-12,500-kc. tuning unit to permit coverage of the 14-Mc. band. One turn at the cold end of each coil is shorted, the grid condenser C_x is removed, and the excitation and neutralization taps on the oscillator coil are rearranged as shown in the "after" sketch. Unless operation as a neutralized amplifier in the 14-Mc. band is desired, addition of a neutralizing condenser is not required.

Shifting the taps is not a difficult operation, the main consideration being that the excitation tap and the neutralizing tap must always be kept an equal number of turns on either side of the "center-tap." The exact location of the taps must be determined by trial. The location that gives maximum amplifier grid current with minimum detuning of the buffer, when the final is tuned to resonance, is best.

Inside view of one of the tuning units after modification. The neutralizing condenser, mounted on small ceramic stand-off insulators, is in the center. The taps on the former oscillator coil are relocated as described in the text.

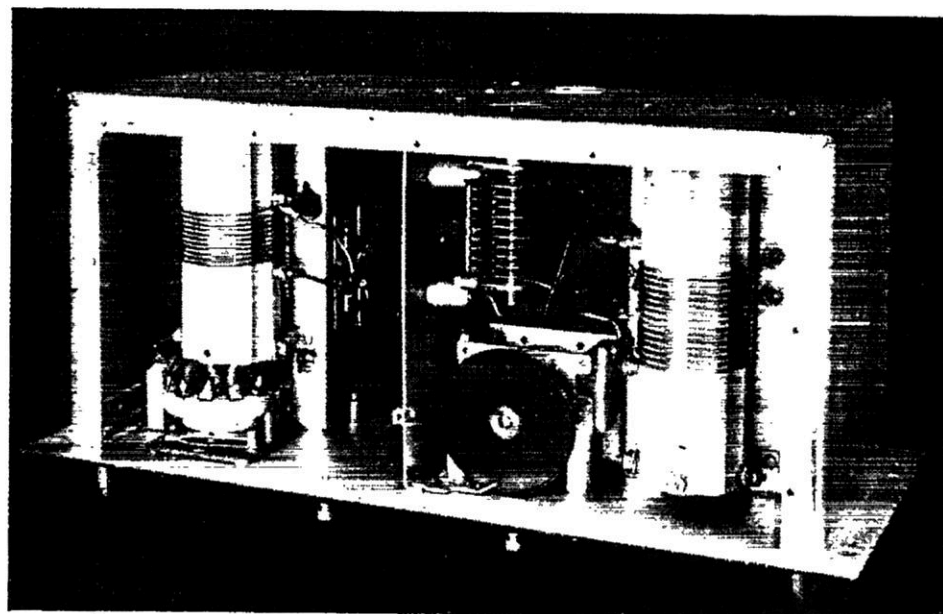
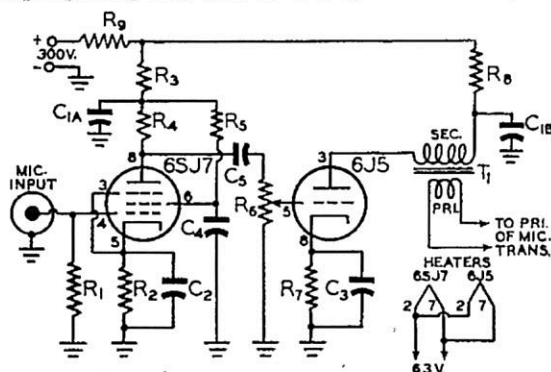


Fig. 4 — Circuit of the preamplifier used with the BC-375-E to permit use of a crystal microphone. If desired the transformer could be omitted, with normal resistance coupling being used between the 6J5 and the 210.

C_{1A-B} — Dual filter condenser, 2 × 8 μfd., 450 volts.
 C₂, C₃ — 10-μfd. 25-volt electrolytic.
 C₄ — 0.1-μfd. 600-volt paper.
 C₅ — 0.01-μfd. 600-volt paper.
 R₁ — 2.2 megohms, ½ watt.
 R₂ — 1000 ohms, ½ watt.
 R₃ — 15,000 ohms, ½ watt.
 R₄ — 0.1 megohm, ½ watt.
 R₅ — 0.22 megohm, ½ watt.
 R₆ — 1-megohm potentiometer.
 R₇ — 2200 ohms, ½ watt.
 R₈ — 5000 ohms, ½ watt.
 R₉ — 10,000 ohms, 10 watts.
 T₁ — Microphone transformer, s.b.-to-single-grid type.



'Phone Considerations

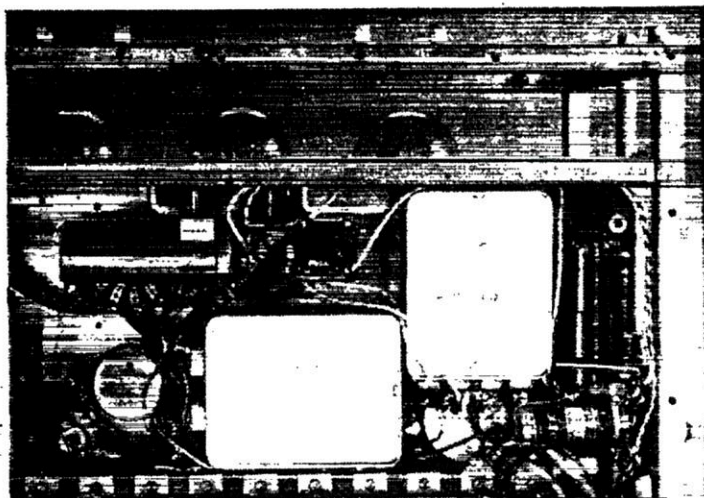
In considering the audio system of the transmitter, it would seem that the set was not designed to operate at high modulation percentages, nor does it seem possible that linearity could be obtained with the low r.f. drive available for the amplifier. Using a carbon microphone, we were unable to approach 100-per-cent modulation, even with the transmitter running at 100 watts input, without shouting; in fact, the percentage seemed to be closer to 50. The trouble lies in the fact that there just isn't enough amplification ahead of the modulator grids to drive them the way they should be driven if anywhere near full output is to be obtained.

To get around this problem, we built a small two-stage preamplifier comprising a 6SJ7, resistance-coupled to a 6J5, with the output of the 6J5 arranged to feed the low-impedance primary winding of the microphone transformer. The circuit is shown in Fig. 4. If desired, the preamplifier can be external to the transmitter, but there is sufficient room for mounting it inside if the choke and condenser used to filter the microphone voltage in the original set-up are removed. To obtain an approximate match between the output of the 6J5 and the primary of the micro-

phone transformer, an old microphone transformer was used with its high-impedance secondary connected as the plate load for the 6J5 and its primary directly connected to the primary of the transformer in the set. With this preamplifier sufficient drive can be obtained from a crystal microphone.

Best results in 'phone operation can be obtained, however, only after revision of the biasing circuits of the Class B stage and the 210 speech amplifier. In the original circuit, biasing voltages are obtained by tapping on the grid leak of the final amplifier tube. Thus, bias on both stages changes with the amplifier grid current. To eliminate this possible source of trouble, a small 75-volt bias supply was used for the 211, and a 45-volt battery for the 210. Under these conditions, we were able to obtain 108 watts of audio from the secondary of the modulation transformer — enough to modulate a Class C input of 200 watts. We didn't attempt to get more than this, because the transformer just doesn't look large enough to handle more. (Ratings for the transformer are not included in the instruction book, but at 108 watts output with a 400-cycle sine wave, the transformer did not heat appreciably.) The audio quality of the rig, with the

(Continued on page 148)



View of the upper right-hand corner of the rear of the transmitter chassis. The 2-stage preamplifier is crowded into the space formerly occupied by the microphone filter components in the upper right corner, with some of the "overflow" mounted on the shield partition just above the driver transformer. The audio gain control comes out of the right-hand side of the chassis.