Converting the ART/13 Transmitter

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For multi-frequency all-band operation the auto-tune ART/13 is an easily converted war surplus model.

THE ART/13 TRANSMITTER offers a refreshing variant from the present general run of war surplus equipment. Essentially, the ART/13 is a Collins product using the auto-tune selector. This allows any one of eleven preselected frequencies to be automatically chosen, tuned and operated from a remote position. As if this one feature were not sufficient to warrant further consideration, a *frequency meter type* v.f.o. allows the transmitter to be manually operated on any frequency between 2000 and 18,100 kc with a calibrated accuracy on the order of 1 kc. A Collins pi-network enables practically any type of antenna, excepting two wire balanced lines, to be matched to the final output.

Technical Description

The tube lineup consists of an 837 electron-coupled oscillator operating in the range from 1000 to 1500 kc. This oscillator has excellent frequency stabilization and is sufficiently shielded to rule out any possible broadcast-band interference. The oscillator tuning is broken into two ranges, the first range tuning from 1000 to 1200 kc and the second from 1200 to 1500 kc. Together these two ranges are spread over almost the entire 4000 possible dial divisions, thus a very high order of dial divisions per kc is obtained even on the 10-meter band. Setting up a frequency is much the same procedure as followed in using a frequency meter with calibrating charts and the results are of about the equivalent accuracy.

The 837 low frequency oscillator drives a 1625 (12 volt filament 807) operating as a doubler, tripler or quadrupler depending upon the output frequency. The second frequency multiplier is also a 1625 and is always operated as a tripler. The final amplifier is an 813 which is modulated by a pair of 811s. We have stepped the high voltages up to 1500 volts and a plate input, fully modulated, of about 225 to 250 watts may be reached without exceeding the commercial ratings of the tubes. The lower voltages have also been stepped up to about 450 volts, resulting in somewhat more excitation to the final amplifier in the 10 meter band.

The speech amplifier consists of a 12SJ7 followed by a 6V6G which drives the 811s. Also incorporated in the speech end of the ART/13 is another 6V6G which acts as a sidetone amplifier. The output of this amplifier is delivered to a phone jack labeled "Sidetone No. 1" on the front

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The ART/13 with a-c power supply. Equal in size to the average communications receiver, this aircraft transmitter is rated at 200 watts output on phone and c.w. with automatic selection of 11 frequencies on any band from 80 to 10 meters after conversion.

panel. The speech may be monitored by the side-tone amplifier or the keying may be monitored through a built-in audio oscillator when the emission switch is in the c-w position.

A carbon mike may be plugged directly into the mike jack with the modification shown in *Fig. 1*. Quality reports even with a carbon mike have been excellent and the designers claim that the frequency response of the transmitter is about plus or minus 2 db from 300 to 4000 cycles. C-W operation with a high speed key is not advisable, although ordinary hand key operation is satisfactory. The present keying relay appears too sluggish for rapid keying. If necessary, the relay may be removed and the 813 biased to cutoff of about 40 to 50 volts. No bias is necessary with the 1625s. The keying relay, however, permits the same antenna to be used on both the transmitter and receiver. A binding post marked "receive" is located near the antenna post and the receiver lead may be connected to it. The relay also grounds the receiver antenna input while transmitting.

Because of the compact size of the ART/13 after a period of continuous filament operation the transmitter becomes very hot. In fact, the pitch in the modulation transformer may become so warm that it will soften sufficiently to permit the unit to "talk" so loudly that acoustic feedback to the mike may occur. This difficulty was solved by obtaining a small automobile fan which works smoothly from a spare 5-volt filament winding. This forced air draft cools the entire transmitter down to a safe operating point and is practically a necessity. If brush noise results in the receiver from this fan, it may be circumvented by using shielded crystal mike cable and 0.1 μf by-pass condensers.

Generally the ART/13 is sold with a 30 wire cable and/or a power supply plug type U-7/U. The remote control head may also be for sale at the same time and this is especially valuable if remote operation from the living quarters of the house to the transmitter in the attic or cellar is desired. There are a few different models of the ART/13, but the following pointers may be applied to all.

Power Supply

Because the ART/13 is an aircraft transmitter, the question of a power supply is extremely important. There are several models that might be adopted for converting the unit to a.c., but we decided that the best procedure would be to separate the 24-28 volt filament circuits from the relay coil circuits and the auto-tune motor channeling-operate the filaments of the tubes from a 26 volt a-c supply and the d-c circuits from a 26-volt source. This reduces rewiring to a bare

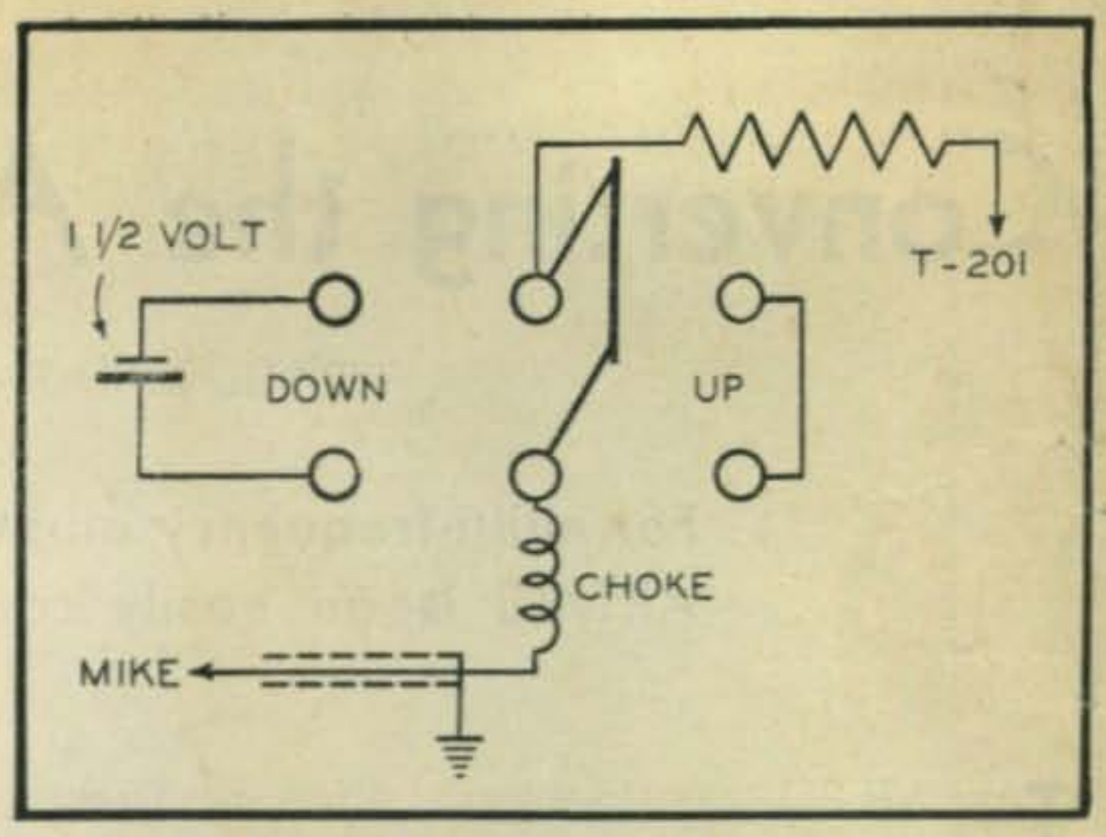

Fig. 1. First modification of the ART/13 is changing the microphone supply to a high level carbon mike by adding a pen-lite battery on the down terminals of the mike switch.

minimum and requires only a low amperage d-c source. The separation is the only obvious solution since it does not appear practical to build a d-c supply capable of delivering 10 amps when the tubes may be operated on a.c. The a-c requirement is 8 amps. Direct current is provided by a 30-volt, 2 amp. transformer, and rectified by two 1-amp. selenium rectifiers operated in parallel. The voltage is filtered by two 100 μf 25 w.v. condensers. Other arrangements, equally as good, could be employed, especially certain types of variable voltage battery chargers.

The general power supply in use at W2GQM is shown in *Fig. 2*. The only unconventional arrangement in the power supply is the resistor in series with the center-tap lead of the 1550-volt transformer. It will be noted that the side of the resistor away from the center tap is grounded. The plate current meter is placed across this resistor and actually measures the entire current being drawn from the power supply. This is not usually considered a very desirable feature as the grid currents and screen and modulator currents are also being measured at the same time. This system was employed by the original designers and it was decided to retain it rather than place the meter elsewhere. If the transmitter is tuned in the c-w position, fairly accurate readings may be taken. The exact position of the sliding contact on this resistor must be obtained by experiment and it is suggested that a 25-ohm unit first be tried. The milliammeter is calibrated from 0 to 200 ma, but with the increased plate current from the higher voltages it is necessary to adjust the resistor until the full scale meter reading is actually 400 ma.

Transmitter Conversion to A-C Filaments

The rewiring of the ART/13 to incorporate a-c filament voltages is fairly simple. The first step

is to remove the bottom and lower front panels, exposing the autotune mechanisms and the bottom of the transmitter. Remove the screws from the jack mounting strip which is fastened to the lower part of the autotune units *C*, *D*, and *E*. This will allow removal of autotune unit *C*. Unscrew the autotune locking bar on unit *C* and remove it so that the knob and disc may be removed. Unscrewing the locking bar may have to be done with pliers. Remove the knob by unscrewing with one of the special wrenches that are mounted inside the chassis. This knob will not slip off easily and some force must be used. Observe the reading indicated by the knob before removal. If it is not replaced exactly the same way, it will be necessary to experiment after the transmitter is placed in operation, to show what the proper reading of the knob for a given switch setting should be.

Remove the disc behind the knob so that the three screws holding the autotune are accessible. Take out these screws and remove the autotune unit from the chassis. The autotune unit will come loose if pulled forward with a medium amount of pressure. Notice that the coupling between the autotune unit and the switch is composed of a short shaft with a keyed cog on each end. These cogs fit snugly into both the autotune units and switches. When the autotunes are replaced these keyed cogs will automatically align the autotune with the switch. Removal of the autotune *C* allows access to the 1-ohm resistor *R-116* which is shown in *Fig. 3* and is located above and to one side of the motor relay. Remove autotune unit *A* in the same manner. This exposes the speech amplifier power plug which is also shown in the bottom view photo.

Observe that there are three leads connected

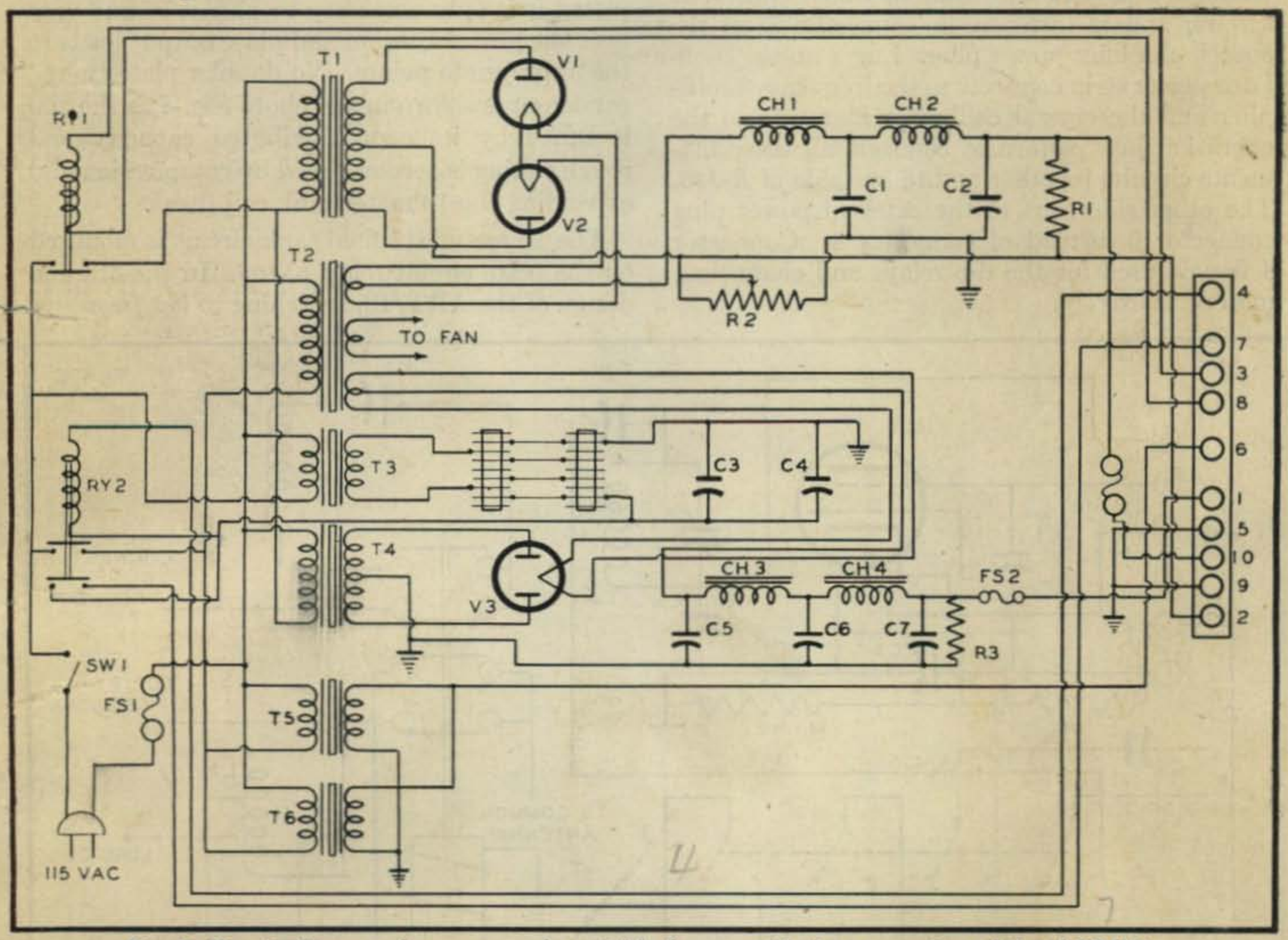

Fig. 2. Circuit diagram of power supply suitable for use with the a-c version of the ART/13.

C1, C2—2 μf, 2000 volt working
C3, C4—100 μf, 25 volt working
C5, C6, C7—8.0 μf at 600 volts working
CH1—300 ma swinging choke
CH2—15 h 300 ma choke
CH3, CH4—15 h 200 ma choke
R1—150,000 ohms, 25 watts
R2—see text
R3—50,000 ohms, 10 watts
FS1—10 amp. fuse
FS2, FS3—500 ma fuse
T1—plate transformer, 3500 volts, c.t.
T2—filament transformer, three 5.0 volt windings at 4.0 amps.
T3—step-down transformer, 30 volt secondary
T4—plate transformer, 600 volts, c.t.
T5, T6—filament transformer, 25 volts at 4.0 amps. each
RY1—relay, plate circuit
RY2—relay, four pole single throw, 26 volt coil
V1, V2—866 rectifiers
V3—5Z3 rectifier
SW1—heavy duty line swing or circuit breaker
Selenium rectifiers, 1 amp. rating each, in parallel

to one side of *R-116* and two leads to the other side. Remove all of them and solder the three leads together and insulate. These leads are on the power side of *R-116*. The other two leads are on the filament side of this resistor and one connects to contact 7 on the speech amplifier power socket while the other runs around through the transmitter and fastens to lug 2 on the oscillator power supply terminal strip.

In our modification, the two leads are fastened one to each side of *R-116*. The lead going to the oscillator is cut where it leaves the bakelite tube mounted at the rear of the transmitter. This wire is then pulled back through the tube and is fastened to the power side of the 0.8 ohm resistor *R-121* which is the filament dropping resistor for these tubes. The other half of the wire is pulled out of the cabling from the oscillator end, run through a hole in the wall, to which control *A* screws, and is fastened to connector 7 on the speech amplifier power plug. Lug 2 on the oscillator power strip connects to the frequency multiplier and the crystal calibrator filaments so the operation just performed connects all these filaments circuits together and to one side of *R-116*. The other side runs to the external power plug connector 6 instead of connector 4. Connector 4 is now used for the d-c relays and channeling motor exclusively.

Conversion to 10 Meters

It is not possible to reach the 10 meter band, using the frequency multipliers in the ART/13. Provision has been made in the transmitter for the addition of a low frequency oscillator if so desired. This arrangement makes it convenient to add a frequency multiplier using another 1625. A chassis may be built around *panel MX-128* to fit very nicely into the space allotted. Without the l-f oscillator the 28-ohm resistor *R-402* is connected across the power input plug and is used to take the place of the 1625 filament drain. This may be removed and the new 1625 doubler filaments connected across the plug. This plug also provides plate and screen voltages, thus greatly simplifying the problem of wiring up the doubler stage for 10 meters. The schematic of the new doubler appears in *Fig. 4*. When completed it is only necessary to plug it in and connect the grid excitation and plate output leads to the appropriate points. No doubler plate tuning condenser is shown in the photo *Fig. 5* as the coil is tuned by its own distributed capacity and rough tuning is accomplished by compressing and expanding the 10 meter tank coil turns.

The 10 meter 813 final tank circuit is mounted on the plate circuit relay *K-105*. In the original design of the ART/13, switching to *low frequency*

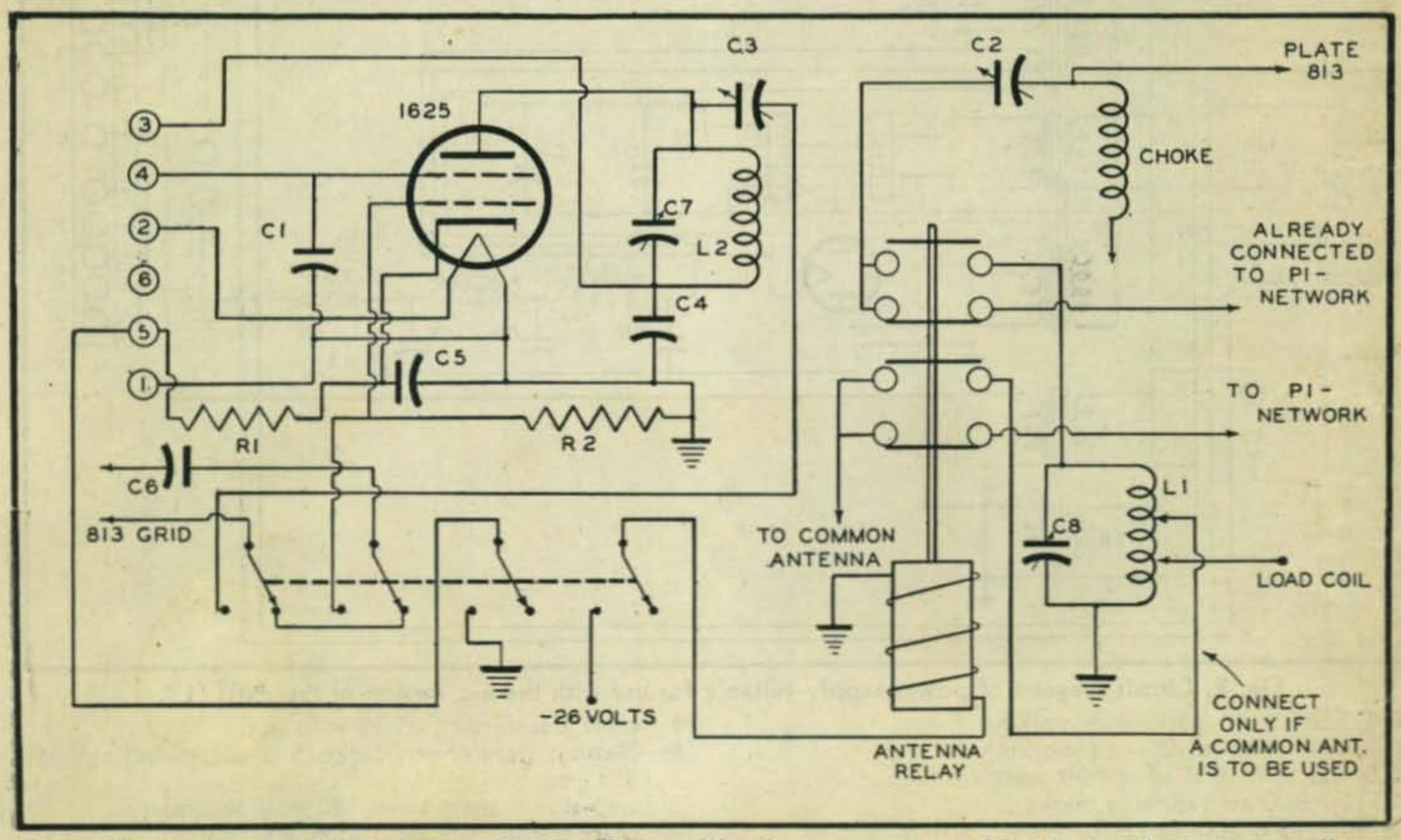

Fig. 4. Circuit diagram of the 10 meter doubler designed for the space occupied by the low frequency oscillator MX-128 before conversion.

C1, C4, C5—.001 μf mica
C2, C6—.002 μf mica
C3—4-40 μμf trimmer
C7—10 or 15 μμf variable
C8—35 μμf variable
R1—1000 ohms 2 watts
R2—100,000 ohms, 1 watt
L1—4 t. No. 10 enamel, 1½" I.D.
L2—4 t. No. 14 enamel, 1½" I.D.

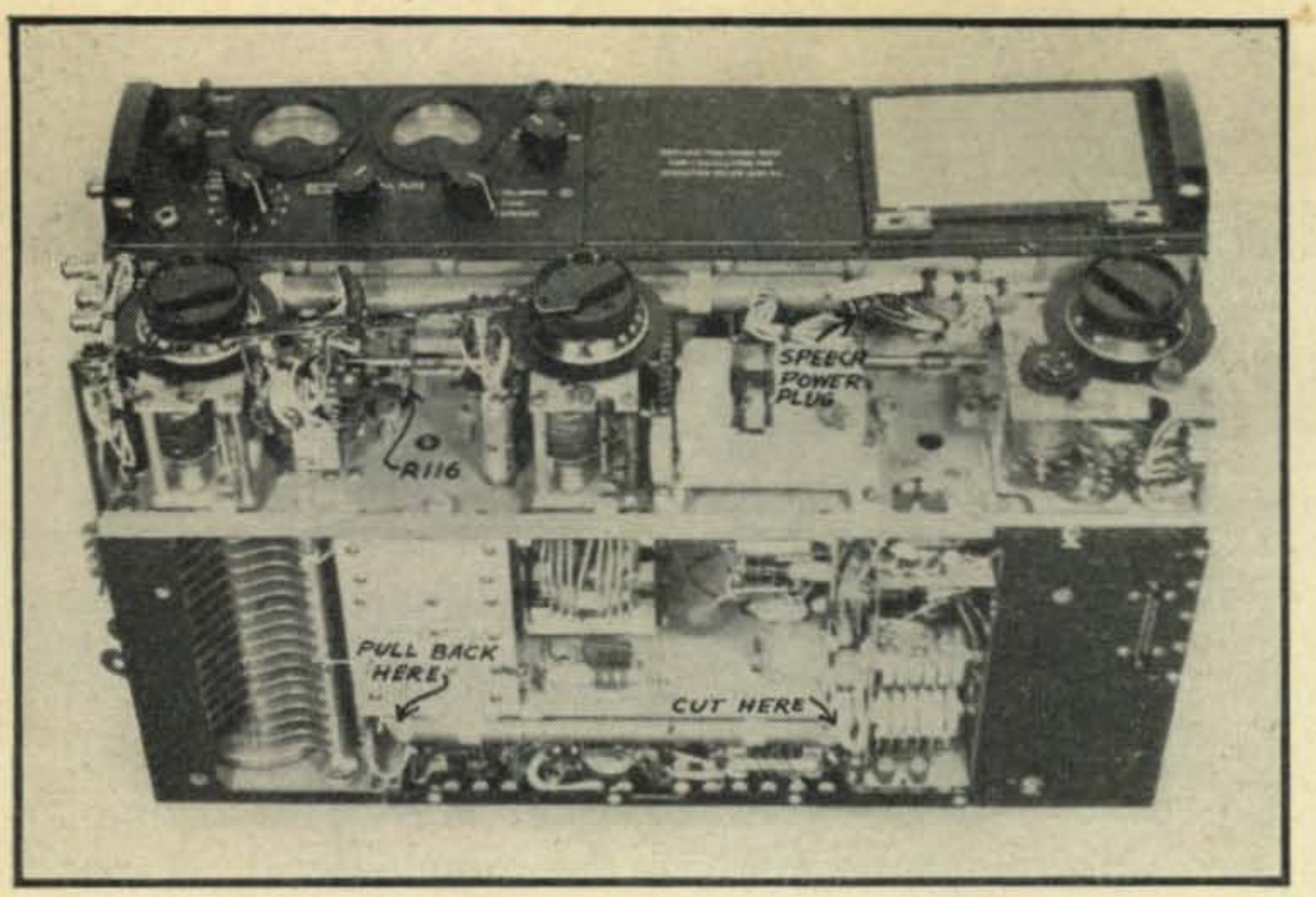

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Fig. 3. Bottom view showing location of the low voltage resistor R-116.

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causes this relay to close, which disconnects the antenna coupling system from the 813 plate and transfers it directly to the *load coil* post on the side of the transmitter. External antenna loading is normally used on the low frequencies. Here again, the original low frequency design lends itself readily to 10-meter conversion. The relay contact that provided output for the low frequencies is connected to the *hot* side of the 10 meter tank circuit and the other side is grounded with as short a lead as possible.

The 10 meter tank circuit is composed of a 35 $\mu\mu$f double-spaced condenser and a coil made of No. 10 solid copper wire. It is recommended that the low frequency r-f choke, *L-109*, be removed from the circuit. The .002 μf by-pass condenser *C-128* is then mounted in the same spot, the bottom end of the high frequency r-f choke and the B+ lead connected to one side of it, and the other side grounded. Eliminating the l-f choke and moving the by-pass condenser closer to the high frequency r-f choke shortens the circuit leads and reduces unwanted plate circuit capacities and circulating currents. It also allows the relay contacts, formerly used to short the large choke, to be used for switching the main antenna over to 10 meters. The external load coil is now available for use as a connection for the 10-meter antenna. Simply run a lead from it to the experimentally selected tap on the 10 meter tank coil. This tap is the spot on the coil selected as the one giving the proper loading of the final for the antenna in use.

Although the frequency multiplier unit may be converted to fully automatic 10 meter operation, a much simpler method is shown in *Fig. 4*. This conversion consists of breaking the lead between the 813 grid and its coupling condenser. A four-pole double-throw switch, insulated for r.f., is mounted on the lower rear panel of the transmitter as close to the 813 grid as possible. Connec-

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Fig. 5. Top view showing installation of 10 meter doubler and 813 10-meter tank circuit. No tuning condenser is used in the plate circuit of the doubler; the stage is tuned with its own distributed capacity.

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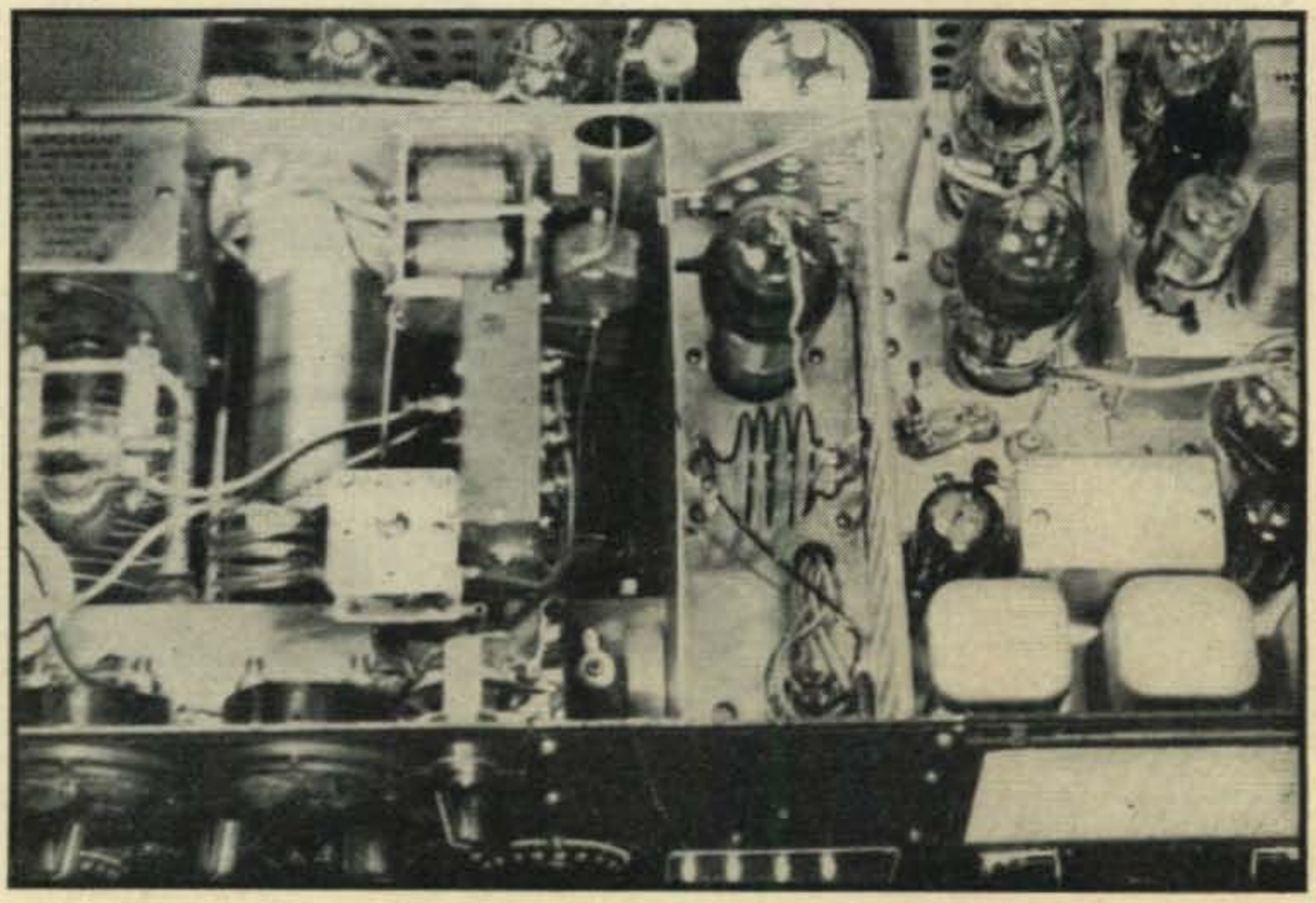

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ons are then made according to the schematic. hen operating on 10 meters, the transmitter ntrols *A* and *B* are tuned in the normal fashion one-half the required 10 meter frequency. The tting of controls *C*, *D*, and *E* are otherwise im- aterial, although *C* should be placed on a num- er that closes the internal switch in series with he key.

After throwing the four-pole switch to 10- eter operation the transmitter is turned on. une the doubler for maximum 813 grid current ith the function switch in "Tune" and the emis- on switch in the c-w position. Tune the 813 10- eter tank circuit for minimum plate current. he antenna or feeder may then be tapped on for he proper loading, about 180 ma. If the 813 id current is lower than its value on the other ands, a slightly reduced loading should be used. emember that the meter indicates the total athode current to the tube and not the plate urrent alone. It may be necessary to retune the ank after the feeder is connected, but the an- enna system detuning should not be too great, ince this is an indication that the antenna system ill not resonate.

General Operating Notes

When the emission switch is placed in the n-c-w position, when keyed, the transmitter will e modulated by the built-in audio oscillator. This type *of emission* is illegal for all but the igher amateur frequencies and the new 11 meter and.

Operators will find that it is very possible to une the ART/13 on a harmonic of the desired perating frequency. Quite likely this will only happen in the 80 meter and 40 meter bands. How- ever, if the readings of the numbers indicated by dial *C* are in proportion to the output frequency, his will probably never happen. For example, uning the transmitter up on 80 meters should ring dial *C* somewhere between readings 2 and 6. If a reading around 12 is obtained, the transmitter is tuned on a harmonic. The antenna current readings are not too reliable as the meter is operated by inductive coupling to the antenna lead.

The antenna used at W2GQM for all band operation consists of a 118-foot flat top tapped with a single wire feeder 17 feet from the center. On 75-meter phone, it acts as a single wire feed matched impedance half wave. On 40 and 20 meters it operates as a large T type Marconi, while on 10 meters it is used as matched im- pedance of seven half waves.