73

November 1961
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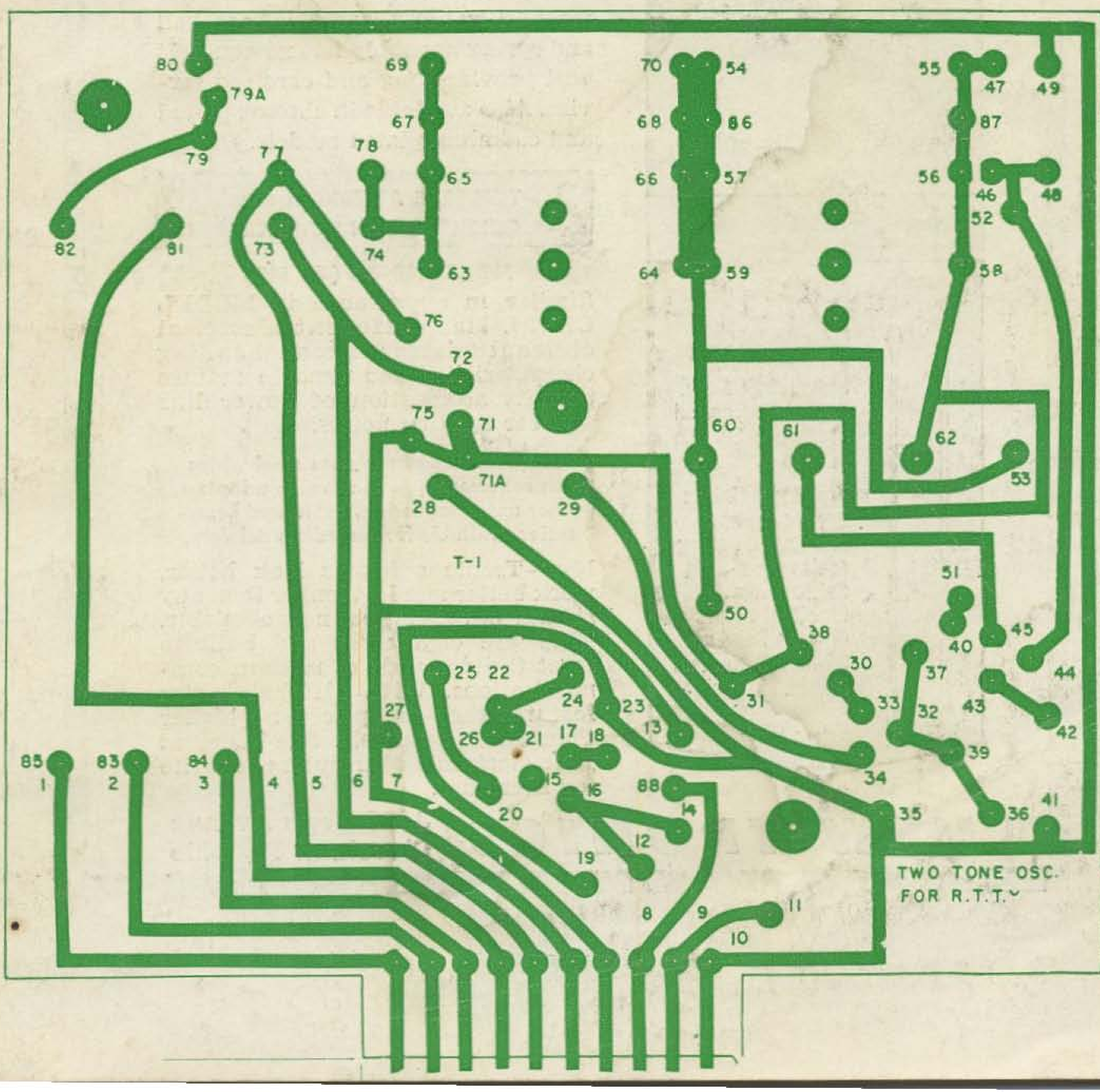

Watch for Mystery Antenna Contest

73 Magazine

1379 East 15th Street—Brooklyn 30, New York

Wayne Green W2NSD—Editor, etcetera November 1962 • Vol I, No. 14

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COVER: Actual Size P.C. Board for W5SFT Oscilator.

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. . . de W2NSD

(never say die)

Conventional

Many amateurs are naively surprised to learn that we cannot advertise 73 in other major ham magazines. Accepting this fact of life it is only reasonable that you should see my flashing smile guiling you into subscribing at every convention, hamfest and club meeting that I can manage to attend. After attending two highly touted abject failures in a row I began to ponder over what factors were present to keep the customers away in such droves. It didn't take much pondering for the whispers of dissent were loud and boistrous. It would seem that convention committees can assure themselves the best chance at the prizes by setting a $4.00 to $5.00 admission fee for the convention.

This astronomical fee is rationalized by the committee members who convince each other that the grand and glorious prizes they will buy with the proceeds will lure the ham out of his cellar and bring him eagerly to the convention, trailer in tow, in hope of going home with the complete kilowatt station. There seems to be a shortage of kilowatt station manufacturers who are willing to give these for door prizes, so the committee has to buy said gear and pass along the tab to the conventioneers. This thus becomes a giant raffle.

The committee agrees that, after all, $4 isn't very much these days. It is little enough to spend on that one glorious day a year when you go to a Ham Convention. Committee members, I have a news flash for you: $4.00 is still considered a *lot* of money by a *lot* of hams. You would be surprised how many of the lads don't have an extra $3 with them to subscribe to 73 at these conventions after they've been through the general admission ringer.

Why not apply reason to this business of buying prizes? Reason, in this case, as always, means that you should accept my views. One of the basic ingredients of the fabulously successful Dayton Hamvention is the welter of small prizes. A goodly percentage of those attending go home with something worth more than their admission fee. A chap who pays $2 to attend a convention feels wonderful when he wins a $3 prize. And these small prizes are a heck of a lot easier to pry from manufacturers than the $1,000 ones.

There are probably a lot of bargains around, if you take the time to look. For instance, if I were a Prize Chairman for a convention, I would get in touch with the Callbook Magazine and find out what kind of deal I could make for a hundred or so of a recent past issue. Or how about getting a price on a hundred or so 1961 ARRL Handbooks? With the 1962 issue coming or out they should be reasonable. Ham magazines should cooperate on a bulk subscription order of fifty or so. Manufacturers, if requested to send small items, would probably respond generously.

Now, with from 500 to 1,000 prizes, I would be able to distribute joy at the convention. I would have a list of prizes mimeographed and given at the door so the fellows could look over the list and see what they would most like to win. Numbers would be pulled every hour between technical sessions and the winners would have their choice of the remaining prizes as they came forward. The winning numbers could be posted on a bulletin board and sent to various parts of the convention floor via printers furnished by local RTTY'ers. Letting 'em make their own selection keeps the phone man from winning a bug and the DX man from going home not too gruntled with a mobile mount. And darned few fellows would be going home empty handed.

So much for the prizes and exorbitant admission fees.

The focal point of any convention is the exhibit area. This area could stand a lot more attention. Few manufacturers feel that a convention will do them enough good for them to spend $100 for a small booth plus the cost of shipping the equipment to be exhibited, travelling expenses for booth personnel, hotel expenses for same, and rentals of tables, chairs, curtains, tablecloths, etc., for the booth. When you add all this up it keeps most of 'em at home. This is why, out of over a hundred possible exhibitors, most conventions end up with a handful plus a couple local distributors and reps.

A little consideration and red carpet treatment would go a long way toward giving you a much fuller exhibition hall. Booth rentals should be kept as low as possible and not considered as a major source of income. $25 to $50 is reasonable for most shows of 1,000 to

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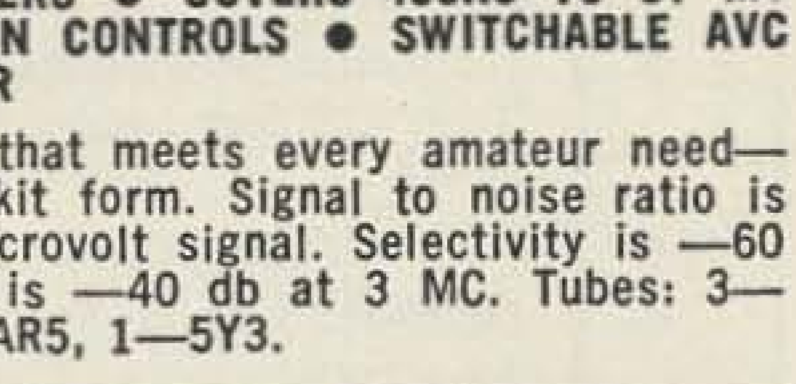

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2,000 actual ham registrants. Tables and chairs for the booth should be furnished at no extra cost, with rental units available if requested. Hotel reservations for exhibitors should be looked after. Badges should be prepared specially for them. Comes to mind the badges presented at the Swampscott Convention which were of the type made by K9TVA Enterprises, an engraved laminate. It doesn't take a lot of extra effort to meet the exhibitors at the airport and drive them into town, saving them the cost and confusion of the taxi or limousine ride. It also makes them feel a lot more wanted.

Once you have them delivered to the hotel, registered, and badged, then help them find their exhibit materials and set up their booth. Most manufacturers are experts on their particular type of equipment and it would be a nice gesture to allot them a few minutes of a technical session so they can extoll the virtues of their gear before an audience and answer questions. I assume that you will not be surprised to learn that they came to the convention with the idea that they might generate a few sales as a result. If they succeed in this you will find them a booster for your next convention.

Now, about those tickets to the grand banquet. Give a couple to each exhibitor. Manufacturers who frequent conventions rarely go to the dinners since they are already heavily out of pocket and an extra $5 to $10 per dinner doesn't make too much sense compared to the $2.50 he would have to pay outside. Even if he doesn't want to stay for the dinner he will appreciate the offer. You can further ingratiate your convention with him by reserving a good table for exhibitors and not just let him fend for himself if he does come to the banquet. If the convention is on such financially shaky ground that it is necessary to charge the exhibitors for the dinners, then the convention is being misrun. Some committees go as far as to charge their own members general admission and banquet fees. This is ridiculous.

To give you an idea of what lengths this sort of madness can go let me cite the case of the chap who spent months working hard on a convention. He sent out all of the promotion on it to exhibitors, possible program advertisers, and all of the radio clubs in the general area. He prepared the posters, the ticket order forms, the letterhead letters and envelopes, etc. He pinned down most of the exhibitors by phone and solicited most of the advertising for the program booklet by phone, then went on to publish the booklet, help manufacturers to set up their exhibits, and a hundred other small jobs. In addition to this he paid in full for his own booth. Came time for the banquet and though over $400 in the hole personally (never reimbursed) and in a very tight financial position with a new business of his own, the committe absolutely insisted that he and his wife

(Turn to page 77)

Six Meter KW Linear

for sunspot lows or do it yourself F2 layer

Bill Cronkhite K6QQN
1771 E. Mountain Street
Pasadena, California

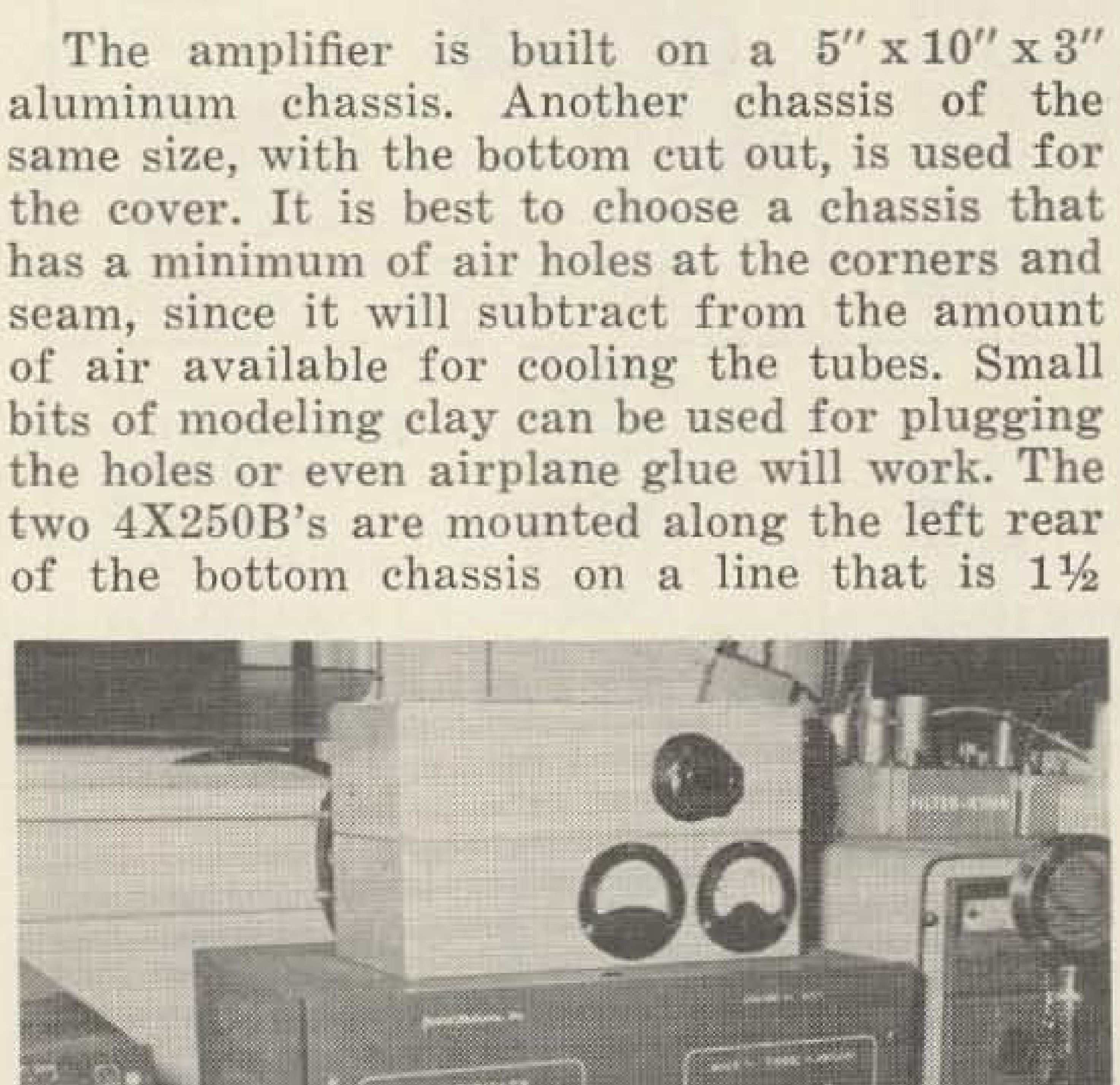
Bob Adams W6QMN
Box 4, San Fernando
California

WITH the decline of the last sunspot cycle, F2 layer skip is a thing of the past, at least until the next cycle comes around. It falls upon the serious VHF enthusiast to compensate for the loss of natural phenomenon by extending his reliable range with more effective equipment. The use of the less spectacular modes of propagation will still be available to us throughout the sunspot low, and there is no reason why they can't be used to their fullest extent. One way to extend your reliable range is with high power.

Described here is a really simple and compact six meter kilowatt amplifier. It is capable of one thousand watts on CW and SSB, and six hundred watts on AM, and a communicator will drive it into the *illegal region!*

Construction

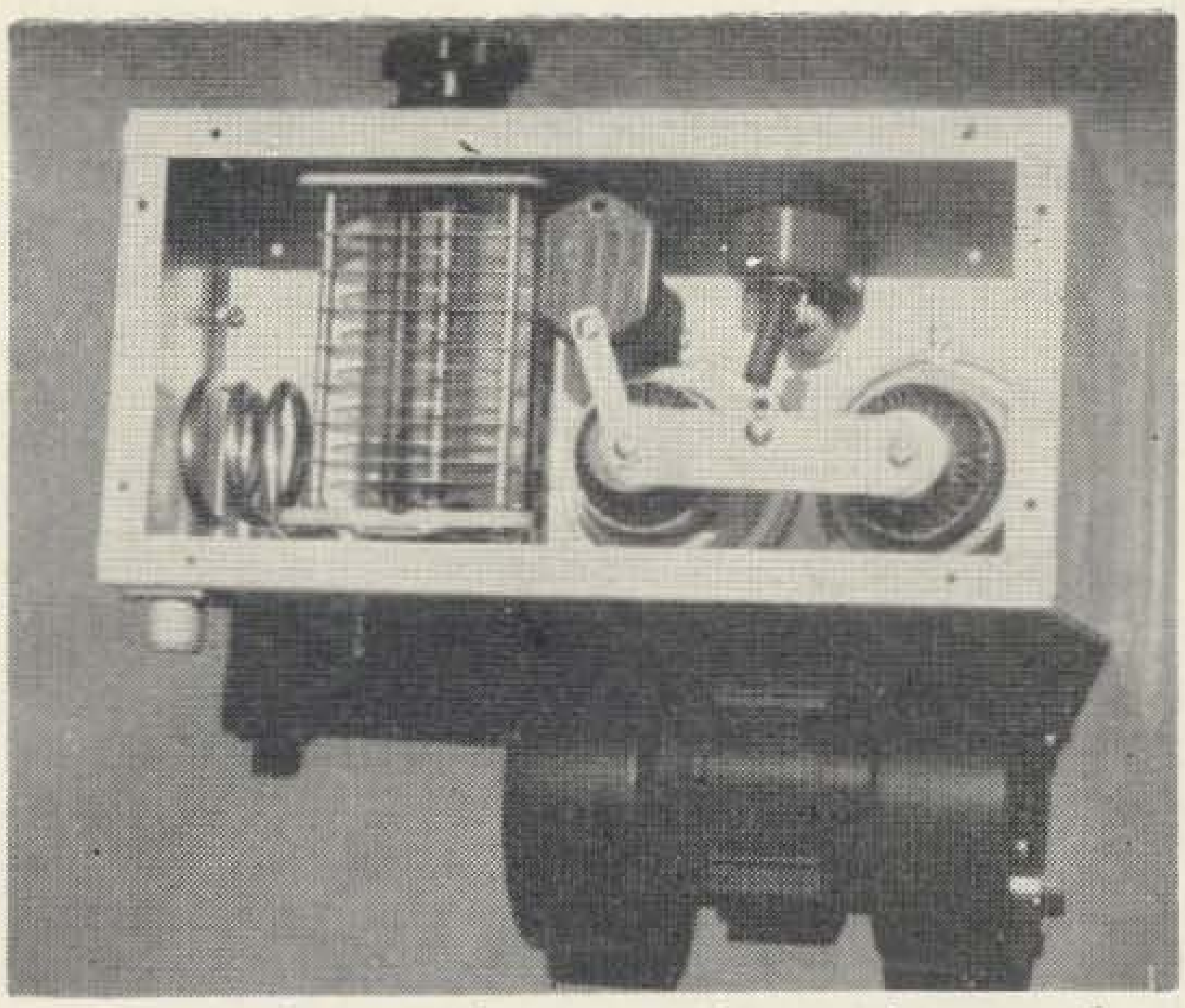
The amplifier is built on a 5" x 10" x 3" aluminum chassis. Another chassis of the same size, with the bottom cut out, is used for the cover. It is best to choose a chassis that has a minimum of air holes at the corners and seam, since it will subtract from the amount of air available for cooling the tubes. Small bits of modeling clay can be used for plugging the holes or even airplane glue will work. The two 4X250B's are mounted along the left rear of the bottom chassis on a line that is 1½



The author's amplifier fits nicely on the top of the Central Electronics 10A that drives it. Not much bigger than a VHF converter, it will fit almost anywhere in your operating area.

inches from the rear and 1⅝ inches and 4½ inches respectively from the left side. These dimensions depend somewhat on the size of the variable capacitor you use. (The parts list is for non-bargain hunters.) Actually any capacitor will do that has a maximum value of fifty micro - microfarads and whose spacing will handle the rf voltage. The capacitor from a BC-375 tuning unit will work fine. The variable capacitor in the author's unit is mounted on a line 3⅛ inches from the right side and centered between the front and back of the top chassis. Leave at least 2½ inches between the right side of the tuning capacitor and the right side of the box for the plate coil. You will need room here to adjust the antenna tap to the right spot.

The feedthru insulator for the plate supply is placed approximately 2 inches toward the front of the amplifier from the line on which the sockets are mounted. It is equidistant from each socket. These are available in most surplus houses. The plate caps should be cut off between the second and third fins and the hole retapped for a 6/32 screw. The author found the use of these plate caps easiest for fastening the copper strap between the tubes and mounting the tab that supports the coupling capacitor. If you are unable to find the specified coupling capacitor, they can be obtained from L-R Electronics, Pasadena, California. Be sure to get the kind that have the bushings threaded for easiest mounting. The plate coil, as in most amplifiers, is a cut-and-try affair. Nearly anything from #10 copper buss wire to ¼ inch tubing will do for the plate coil. The unit shown uses 3/16 inch automobile gas line. Caution should be used in winding the coil out of this material since it will collapse if bent too sharply. A nice smooth coil can be would if the tubing is first filled with fine sand and the ends crimped closed. The handle of a medium sized screw driver makes a good form to produce the required diameter. Make the coil about 3½ turns to start and trim off as required to obtain resonance. Note the direction in which the coil is wound in the photo. The proper portion of the coil will be opposite the antenna connector if this winding direction is followed. Don't worry about duplicating the coil exactly since there is more

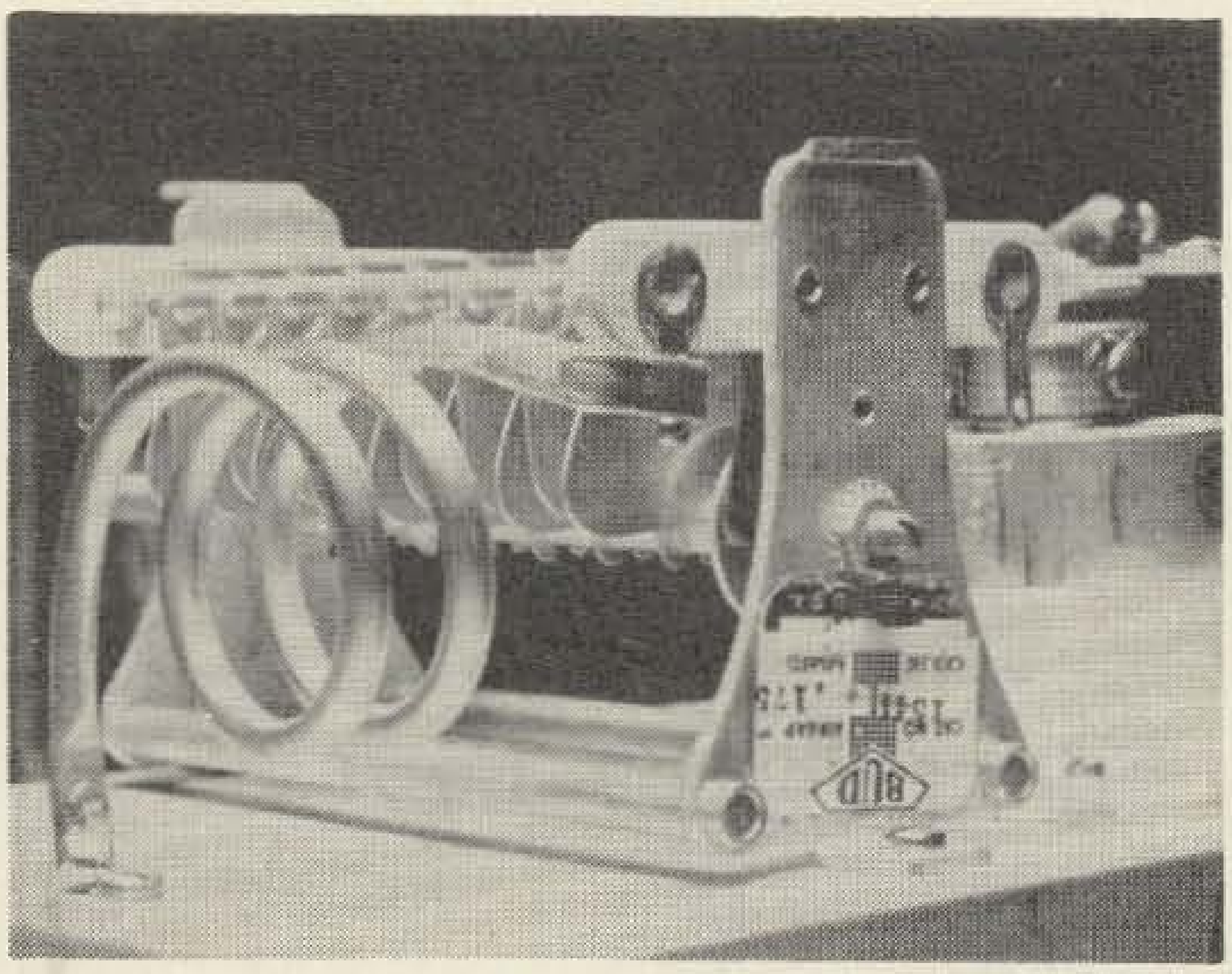


than enough capacity to make up for any loss in coil inductance if you happen to trim off a little too much. The author's units resonate with three, and two and a half turns respectively at about half capacity on the variable. There are a number of silver plating solutions that will increase efficiency slightly and give the coil a professional appearance. The other high voltage mica capacitor shown in the photographs is a bypass on the cold end of the plate choke, however it is only a refinement and is not needed for proper operation.

Under-chassis wiring is not critical and is left up to the discretion of the builder. It is advisable however, to keep the input capacitor leads as short as possible and not allow any components to block air flow from the blower.

Circuitry

The design represents probably the simplest circuit that is compatible with good performance. A passive grid circuit is employed since the idea was to build an amplifier with a minimum of parts yet obtain a superior quality signal on single sideband. The use of a passive grid circuit also eliminates the need for neutralization. The plate circuit is shunt fed so that no dc is on the tuned circuit, therefore the cold end of the plate coil may be grounded and the loading capacitor eliminated. This also permits closer spacing between the tuning capacitor plates. It is strongly recommended that the tube sockets be of the type with built-in screen bypass capacitors and grounded cathode pins. If you absolutely cannot get this type or have a garage full of the unbypassed kind, try at least .01 mfd to ground with the shortest possible leads. If the front end of your neighbor's TV set goes into orbit from one of your parasitics, don't say you weren't warned. The 20K resistor from the screen to ground is used to make the screen meter read upscale and will allow better observation of screen current fluctuations. After wiring, recheck for poor solder points and errors, it quite



Looking from the rear of the chassis, the plate coil is wound so that the part that is 1/2 to 3/4 of a turn from the ground end, is adjacent to the antenna connector.

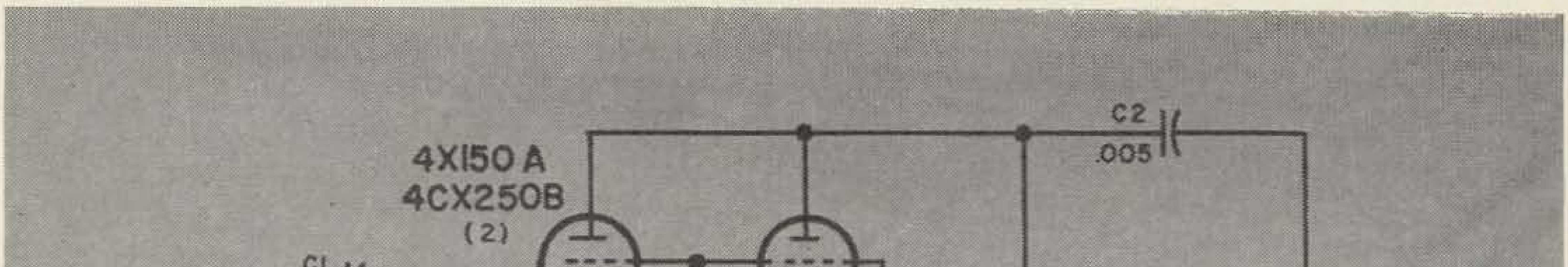
often pays off in a better unit.

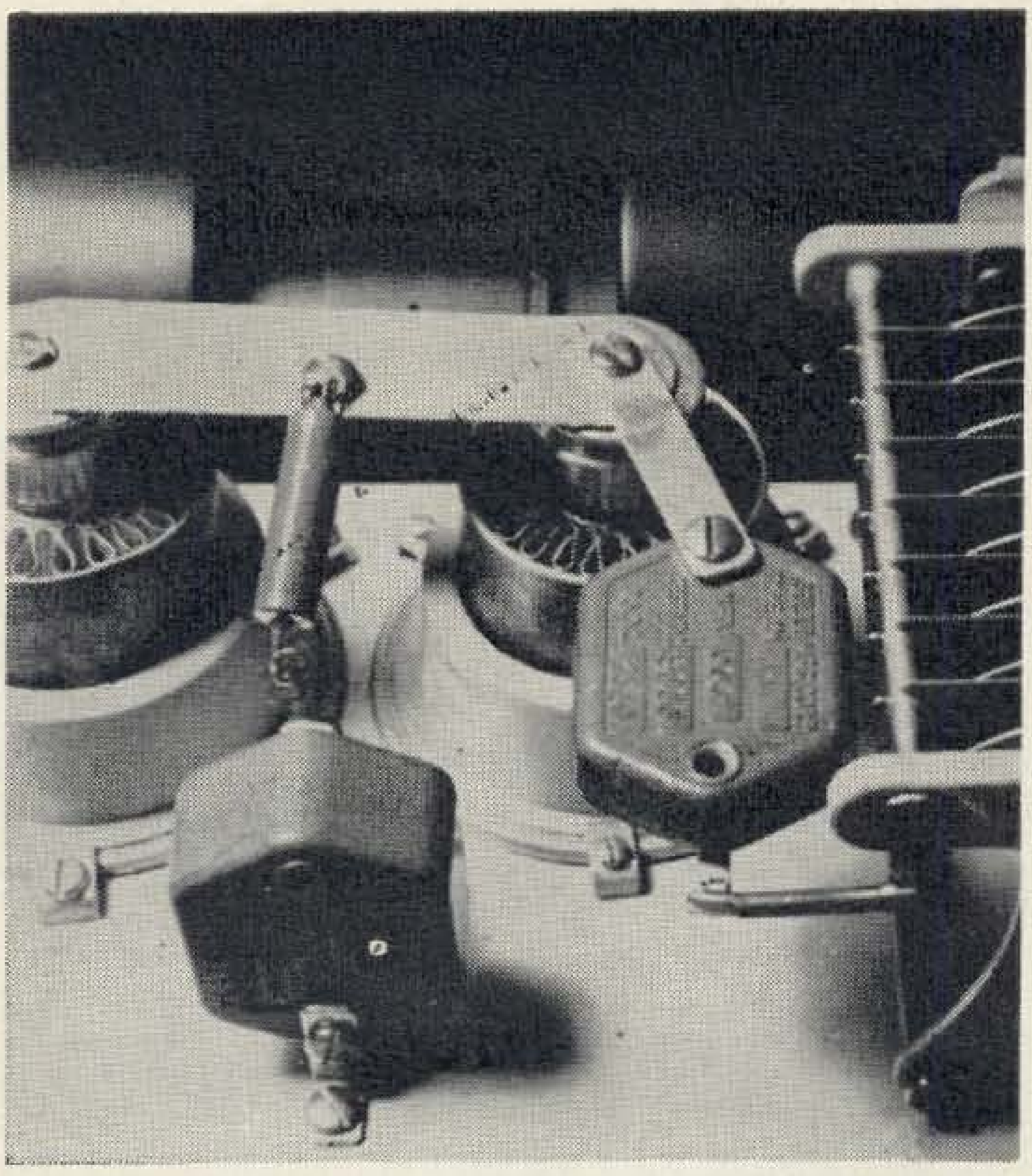
Adjustment Procedure
(CW and SSB modes)

The following adjustment procedure is for a plate voltage of 2000 volts and a screen voltage of 350 volts regulated. First set the bias for a resting plate current of 100 ma. This will mean about negative 50 volts or a little higher. Desired maximum values of plate, screen, and grid currents are as follows: Plate current, 500 ma., screen current, 50 ma. and grid current, O ma or a slight trace. Next connect the antenna or a suitable load to the output connector. Set the tap at ½ turn from the ground end of the plate coil. Now apply a small amount of drive from the exciter. As the drive is applied, the plate current will begin to rise. Immediately tune the plate circuit to resonance, as indicated by a dip in plate current. Continue to increase the drive, keeping a careful eye on the plate and screen currents. At this point it might be well to mention that with the value of 20K from the screen to ground, the no-drive screen current will be approximately 17 ma. As the drive is increased the screen current will probably go first below 17 ma and then will reverse and go above 17 ma. This is normal. If, as drive is increased, the screen current reaches 50 ma *before* grid current begins to show and the plate current reaches 500 ma. it is an indication of insufficient loading. If however the plate current exceeds 500 ma. before grid current shows, it indicated excessive loading. Adjust the antenna tap position to obtain 500 ma of plate current with just a trace of grid current. At this point the screen current will indicate somewhere between 17 and 50 ma. Under voice conditions, the screen current will kick around between 17 and 25 ma. The amplifier is now ready for operation on SSB and CW and will deliver approximately 600 watts output.

Adjustment for AM

If AM operation is desired, the amplifier should be adjusted as above. The drive is then





The plate coupling capacitor is supported by a heavy aluminum strap at one end, and a short length of copper tubing soldered to a lug, at the other. The plate bypass capacitor is mounted in front of the high voltage feed-thru insulator. Note positioning so that the choke leads can be short.

reduced until the plate current is about 275 ma. Modulation of the exciter will then be adjusted so that a trace of grid current is indicated on voice peaks. Plate current will remain constant if the amplifier is properly loaded. Output will be around 200 watts.

Screen Protection Circuit

In the interest of preserving the life of your tubes we present the simplest and most reliable screen protection circuits known (except perhaps for a fuse). Place a 50 ma. relay coil in series with its own normally closed contacts in the screen supply lead, with a 6K 25 watt resistor from the normally open contact to ground. If for any reason the screen current should rise above 50 ma, the relay will open and the 6K will hold it there until you can get things turned off.

Results

The unit is providing consistent and reliable communication on tropospheric scatter circuits from Los Angeles to Central California and the Bay Area. During the last VHF contest, 38 states were worked using the amplifier. Whatever mode of transmission you choose, you will be surprised with the performance obtained. The authors' are on single sideband, generally in the first 10 kc of the phone band. We'd be happy to QSO.

. . . K6QQN & W6QMN

Transistor Mike Preamp

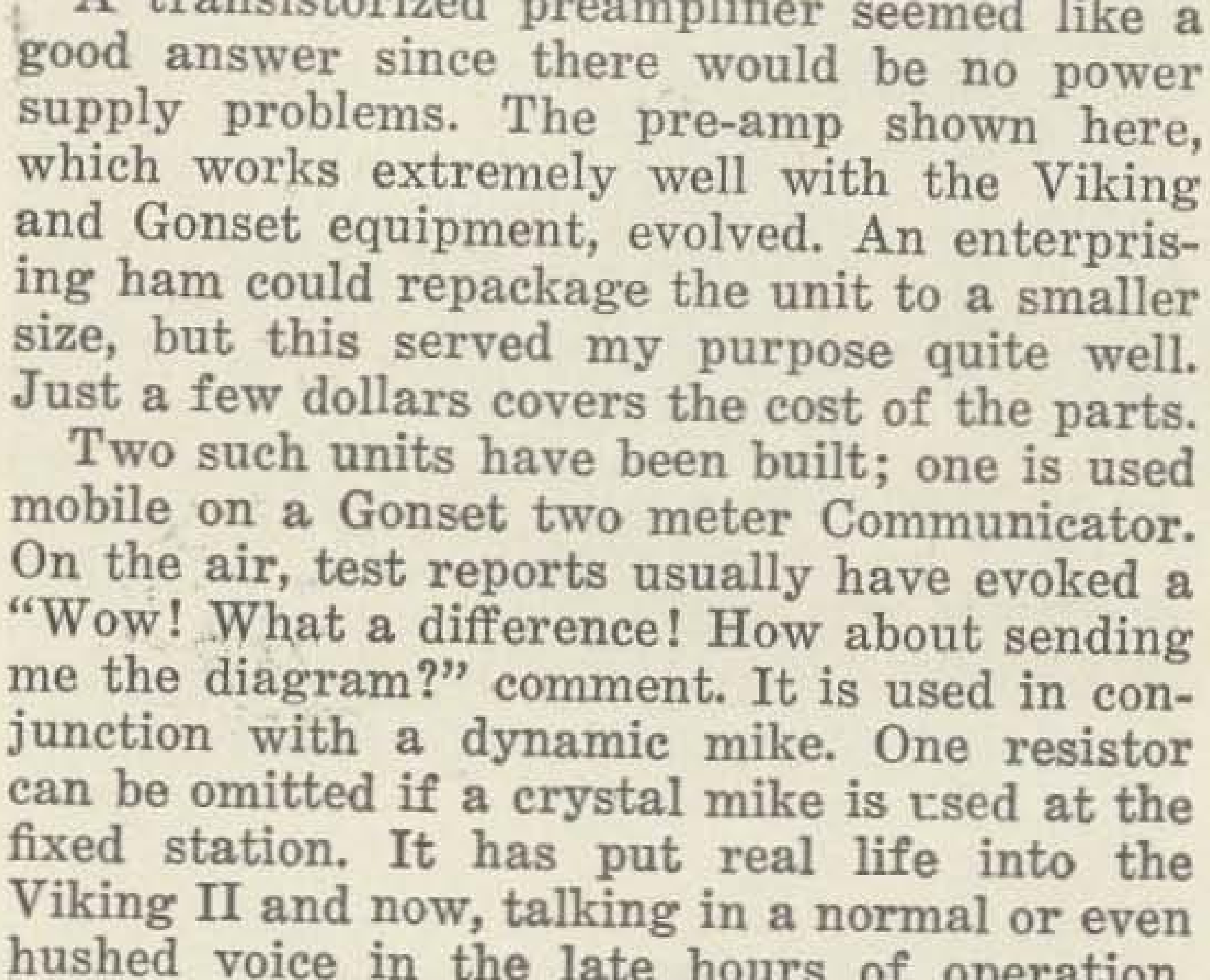
Glenn Malme, Jr., K6PZT
9337 Gotham Street
Downey, California

How many times have you wished that your transmitter might have just a bit more audio gain? Neither my Viking II nor my Gonset II had an overabundance of gain in the audio stages. Quite often, when conditions got rough, I found myself shouting into the mike in a subconscious effort to get more punch from the audio driver stages.

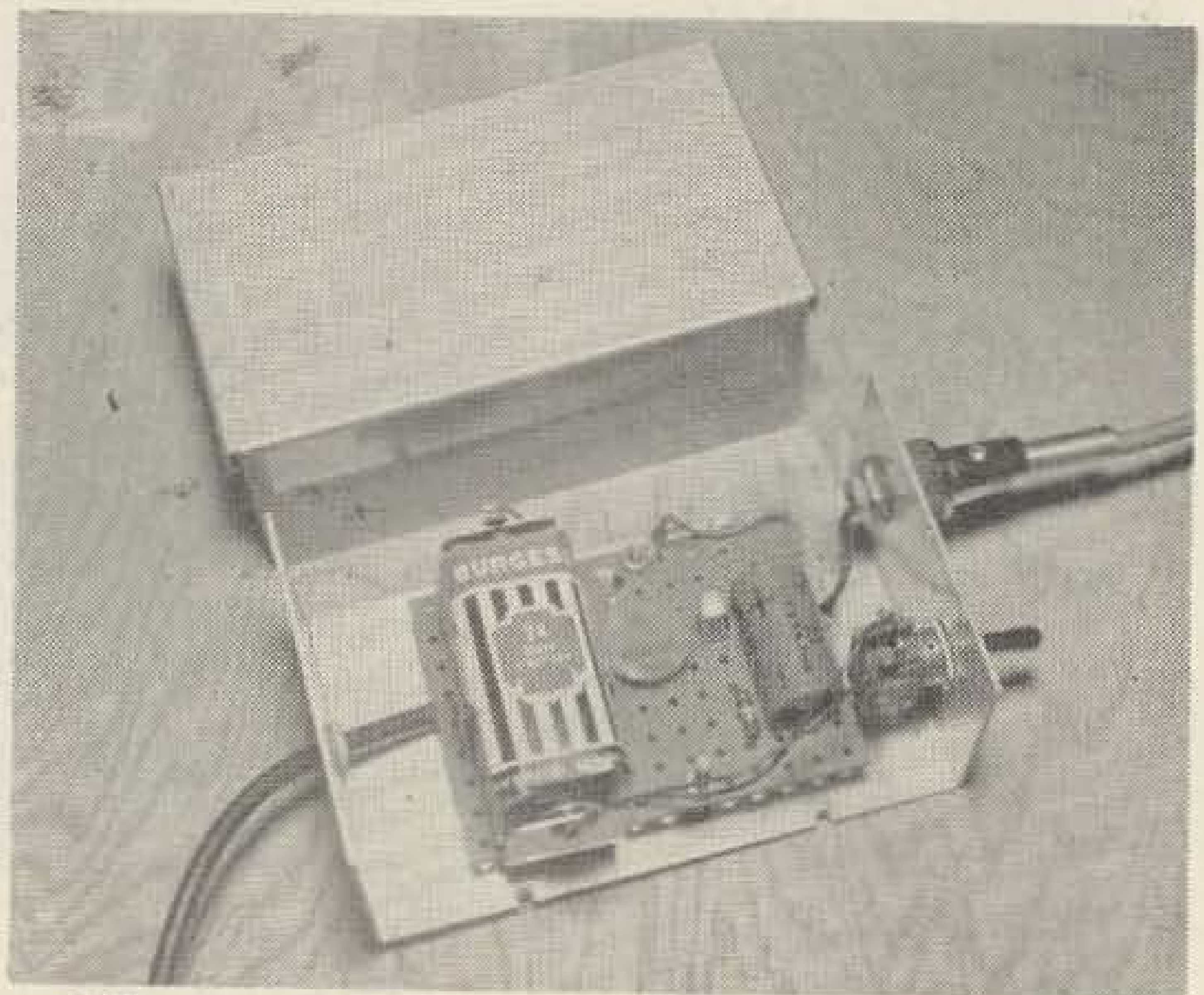
A transistorized preamplifier seemed like a good answer since there would be no power supply problems. The pre-amp shown here, which works extremely well with the Viking and Gonset equipment, evolved. An enterprising ham could repackage the unit to a smaller size, but this served my purpose quite well. Just a few dollars covers the cost of the parts.

Two such units have been built; one is used mobile on a Gonset two meter Communicator. On the air, test reports usually have evoked a "Wow! What a difference! How about sending me the diagram?" comment. It is used in conjunction with a dynamic mike. One resistor can be omitted if a crystal mike is used at the fixed station. It has put real life into the Viking II and now, talking in a normal or even hushed voice in the late hours of operation, still provides more than enough audio gain.

The CK722 transistor was selected because they are plentiful and cheap and do a more than adequate job. The fixed station unit was built into a standard 2" x 3" x 5" Mini-Box.



A toggle switch was mounted on the input side to cut off the six-volt battery required to operate the circuit. While the unit could be installed right at the mike, I left the mike cord unmodified and used a ten-inch length of shielded mike cord, found in the scrap box, for the output cord to the transmitter. The basic circuit is exceedingly simple, and the component values are not too critical.

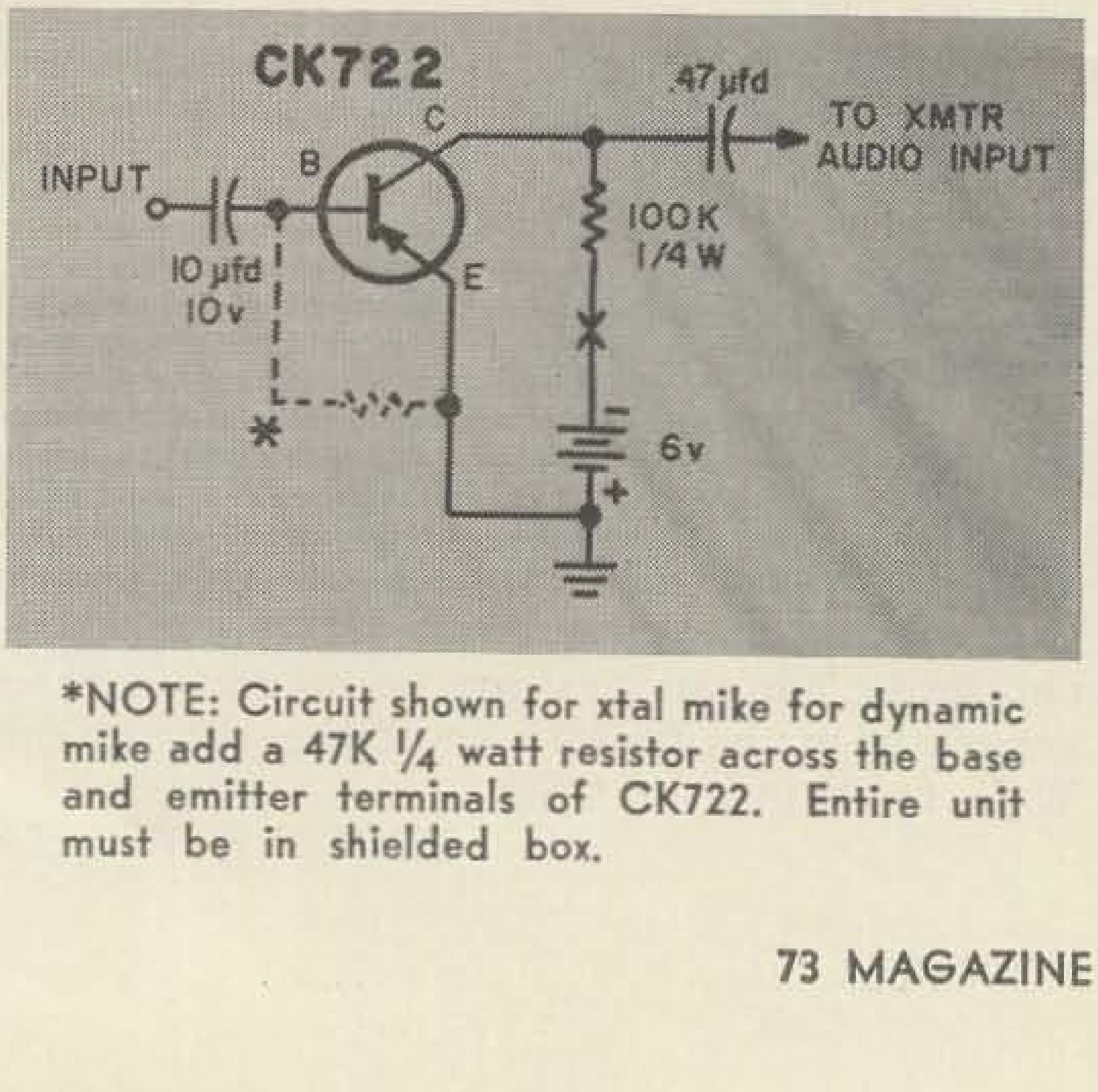


All parts were mounted on perforated mounting board cut to fit the inside of the Mini-Box, and a hole on each side was enlarged so that an 8/32 one-inch length bolt and nut serve as a standoff support. In operation you simply readjust your transmitter audio gain to suit your voice level. The metal box serves to shield the components quite satisfactorily; however, shielded mike cord for the input and output should be used. The unit can be built in less than an hour. Try it, and I'll bet that you too will say, "Wow! What a difference!" . . . K6PZT

Parts List

1—2 x 3 x 5 Mini-Box
2—Mike Jacks
1—.047 mfd 10 volt condensor
1—10 mfd 10 volt condensor
1—100,000 ohm ¼th watt resistor
1—47,000 ohm ¼th watt resistor
1—Z4 6 volt battery (Eveready)
1—Battery clip holder
1—CK722 transistor

(Note: 47,000 resistor required only if used with dynamic mike.)



*NOTE: Circuit shown for xtal mike for dynamic mike add a 47K ¼ watt resistor across the base and emitter terminals of CK722. Entire unit must be in shielded box.

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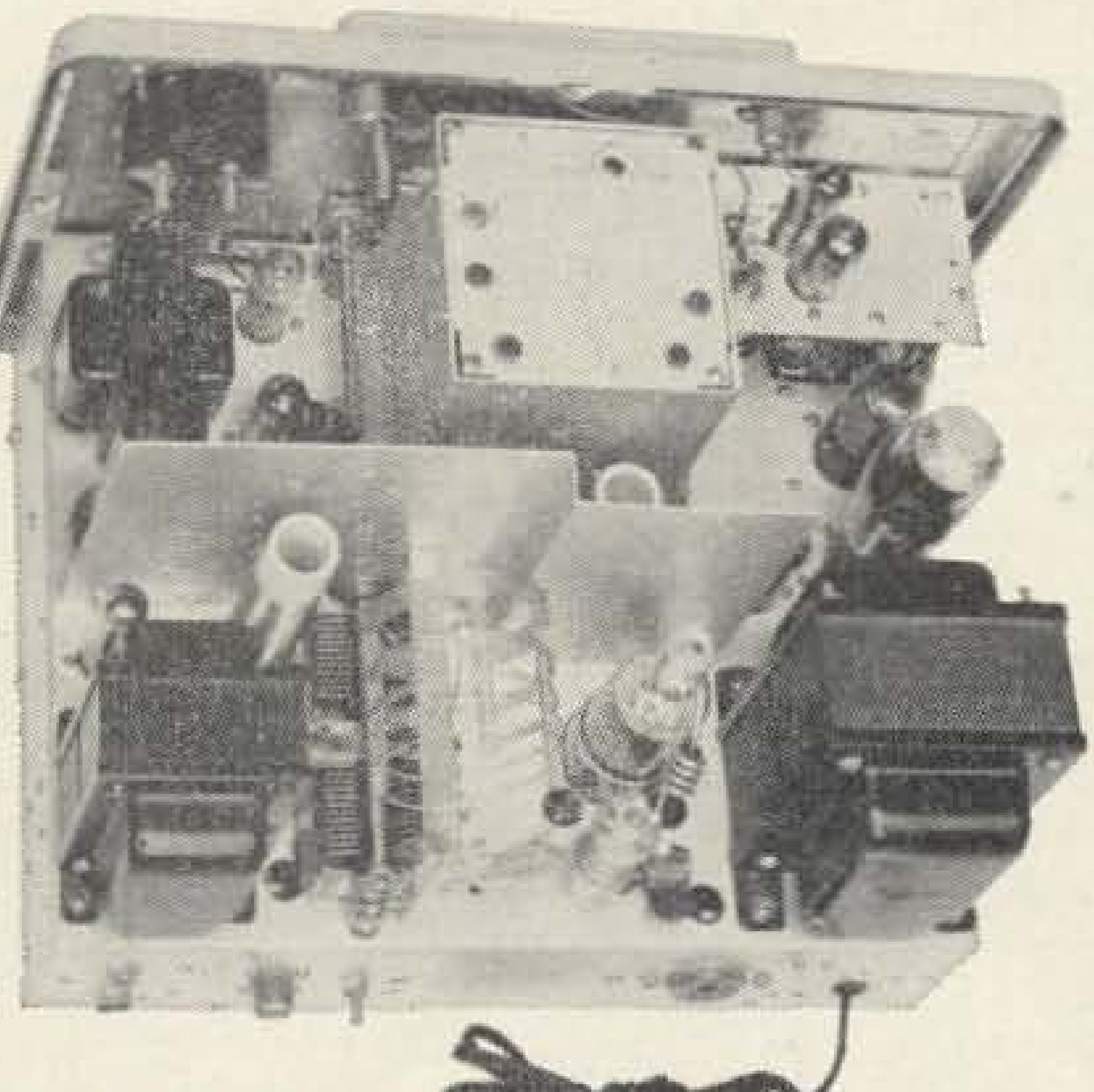
75 watts CW input ... 65 watts AM!



Now—a new version of the popular Viking "Ranger" . . . the "Ranger-II" Transmitter/Exciter! Completely self-contained in a handsome re-styled cabinet, the "Ranger II" now covers 6 meters! As a transmitter, the "Ranger II" is a rugged and compact 75 watt CW input or 65 watt phone unit. Pi-network coupling system will match antenna loads from 50 to 500 ohms and will tune out large amounts of reactance. Single-knob bandswitching on six amateur bands: 160, 80, 40, 20, 15, 10 and 6 meters—built-in VFO or crystal control. Timed sequence (grid block) keying provides ideal "make" or "break" on your keyed signal, yet the "break-in" advantages of a keyed VFO are retained.

As an exciter, the "Ranger II" will drive any of the popular kilowatt level tubes, provides a high quality speech driver system for high powered modulators. Control functions for the high powered stage may be handled right at the exciter—no modification required to shift from transmitter to exciter operation. Nine pin receptacle at the rear brings out TVI filtered control and audio leads for exciter operation. This receptacle also permits the "Ranger II" to be used as a filament and plate power source, and also as a modulator for auxiliary equipment such as the Viking "6N2" VHF transmitter. Unit is effectively TVI suppressed . . . extremely stable, temperature compensated built-in VFO gives you exceptional tuning accuracy and velvet smooth control. Complete with tubes, less crystals, key and microphone.

Cat. No. 240-162-1
Viking "Ranger II" Kit.......... **Amateur Net** **$249.50**

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Transistor Two-Tone RTTY Oscillator

J. R. "Bob" Barbay W5SFT
6811 Tolland Street
Dallas 27, Texas

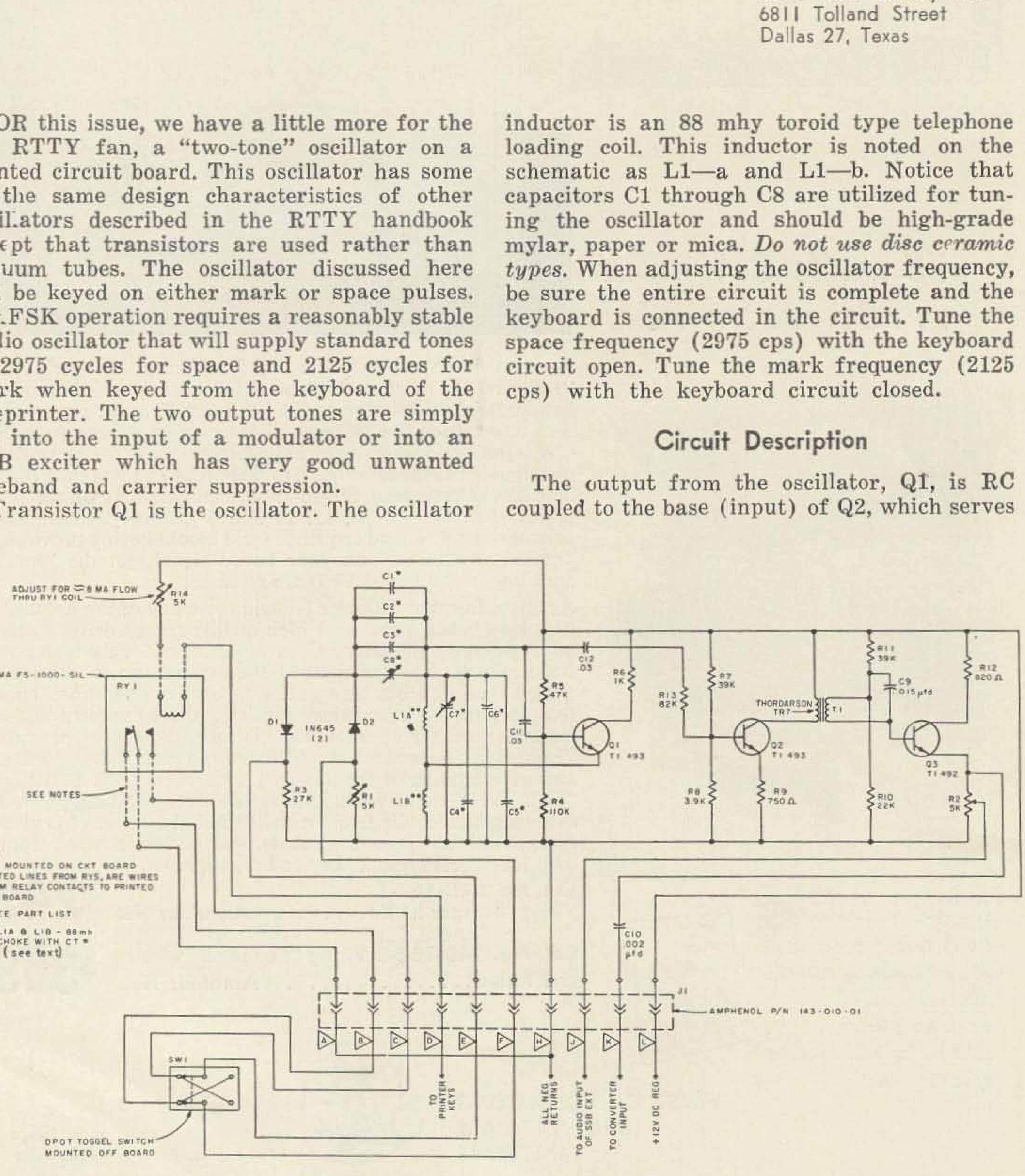
FOR this issue, we have a little more for the RTTY fan, a "two-tone" oscillator on a printed circuit board. This oscillator has some of the same design characteristics of other oscillators described in the RTTY handbook except that transistors are used rather than vacuum tubes. The oscillator discussed here can be keyed on either mark or space pulses.

AFSK operation requires a reasonably stable audio oscillator that will supply standard tones of 2975 cycles for space and 2125 cycles for mark when keyed from the keyboard of the teleprinter. The two output tones are simply fed into the input of a modulator or into an SSB exciter which has very good unwanted sideband and carrier suppression.

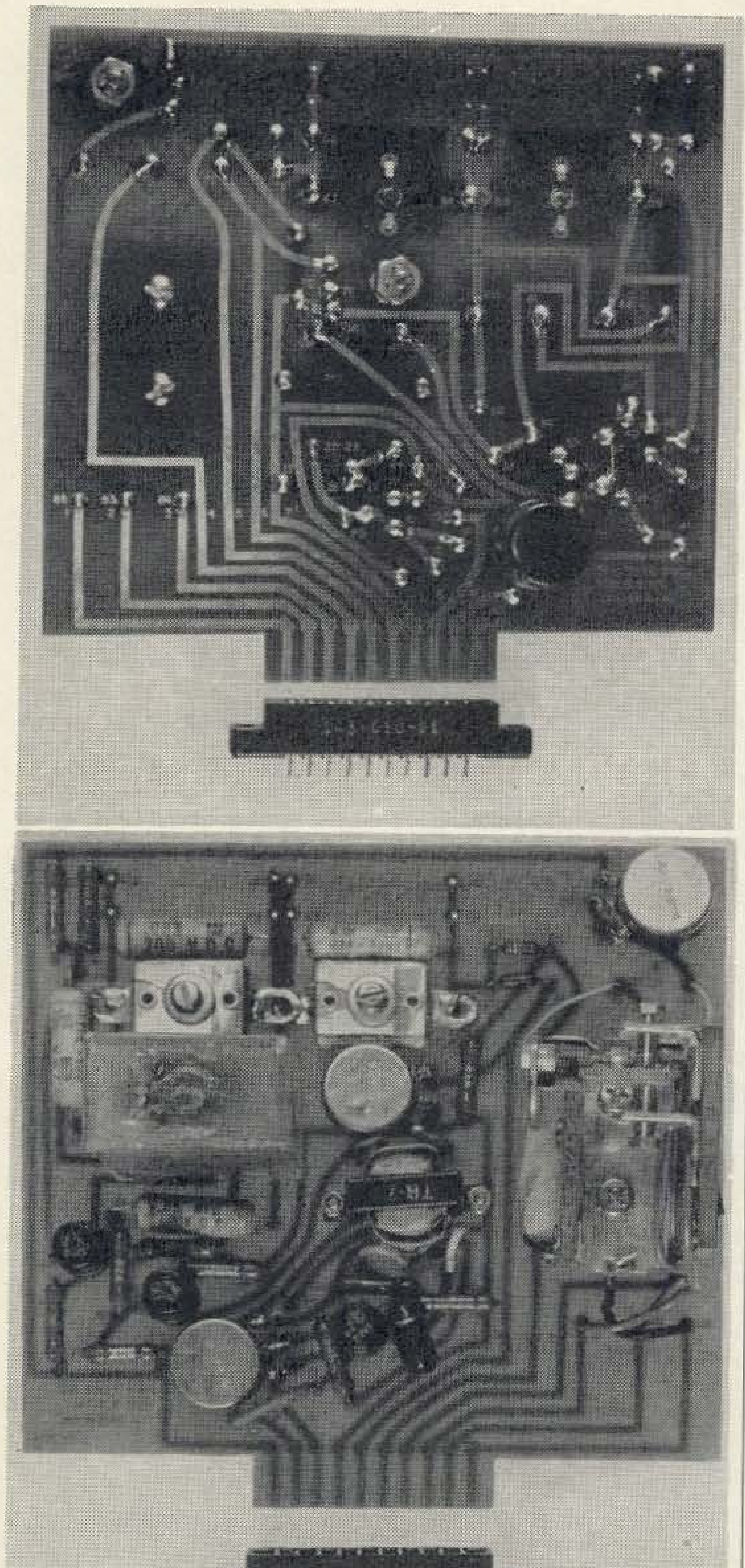
Transistor Q1 is the oscillator. The oscillator inductor is an 88 mhy toroid type telephone loading coil. This inductor is noted on the schematic as L1—a and L1—b. Notice that capacitors C1 through C8 are utilized for tuning the oscillator and should be high-grade mylar, paper or mica. *Do not use disc ceramic types.* When adjusting the oscillator frequency, be sure the entire circuit is complete and the keyboard is connected in the circuit. Tune the space frequency (2975 cps) with the keyboard circuit open. Tune the mark frequency (2125 cps) with the keyboard circuit closed.

Circuit Description

The output from the oscillator, Q1, is RC coupled to the base (input) of Q2, which serves



TWO TONE OSCILLATOR FOR RTTY (2125 & 2975 cps)
WITH KEYING RELAY FOR MARK OR SPACE



as both an amplifier and isolating stage. The output of Q2 is coupled through an interstage transformer to the base (input) of emitter follower Q3. From the output stage, Q3, the audio tones are fed into the converter, for local copy, and into the modulator or SSB exciter. Converter input is taken directly from the emitter of Q3, while the output level for the transmitter, may be adjusted and is coupled out from the arm of the emitter load resistor, R2.

Construction

The two-tone oscillator is quite simple to construct on the printed circuit board available from Tri-Tronics Lab. Inc. Only a small drill, small soldering iron and simple hand tools are needed. Provisions are made to mate the printed circuit board with an Amphenol P/N 143-010-01 connector for plugin use, or the circuit board may be wired directly into associated equipment.

Adjustment

The relay (Sigma F5-1000-SIL) is set for a pull-in current of approximately 8 ma. However, other relays with equal coil values may be used in this circuit. Relay current is adjusted by potentiometer R14. This adjustment is made by breaking the circuit between R14 and one side of the relay coil and inserting an appropriate meter.

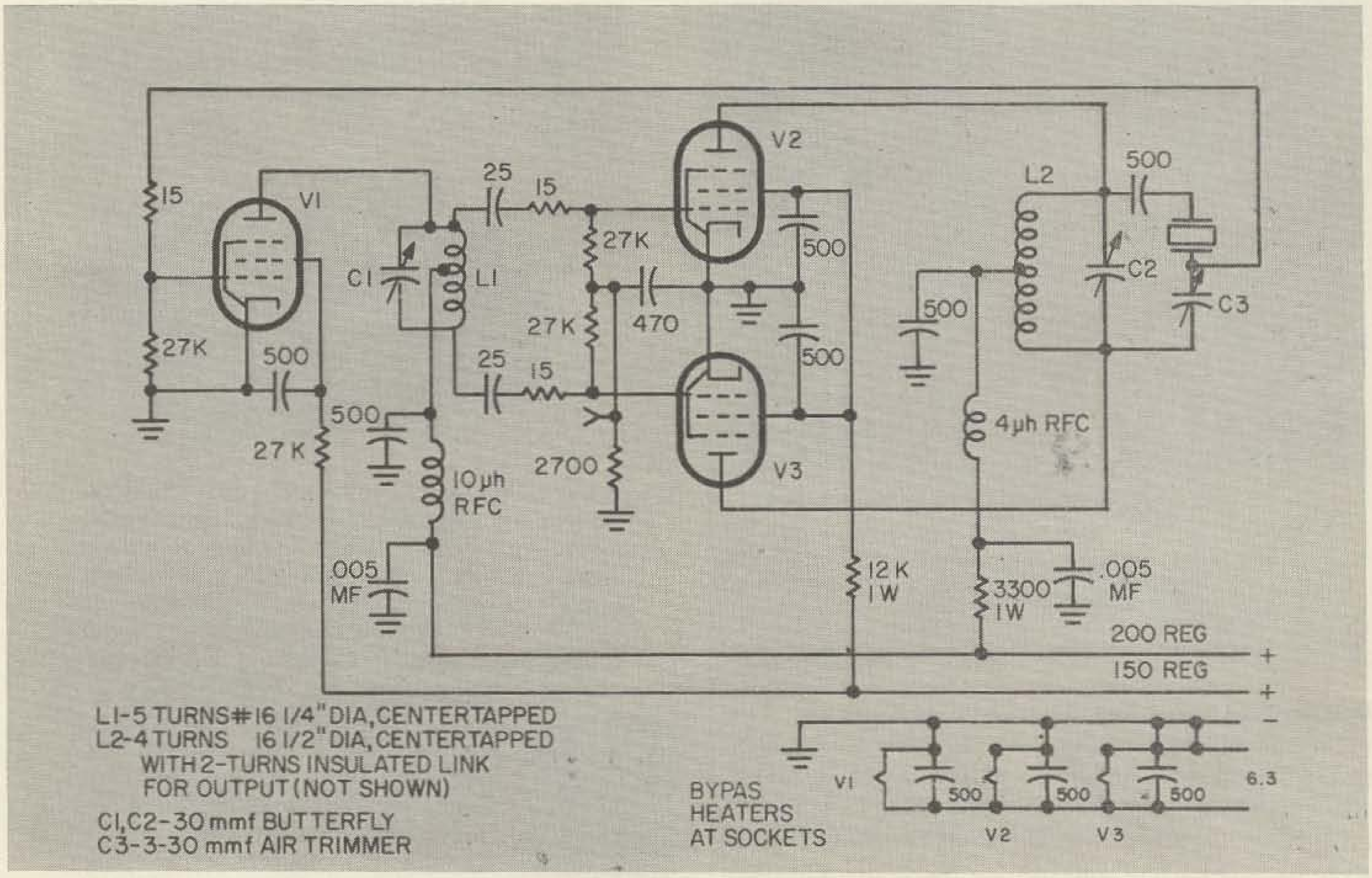
Oscillator output level is adjusted to obtain equal output amplitude for both tones. This is done by keying the printer and adjusting R1 until there is no difference in the transmitter plate current readings during mark and space times. When this adjustment is completed, tone output of the transmitter will be equal for both mark and space.

Conclusion

All parts listed for this project may be purchased from your local distributor. However, a well stocked junk box should produce most of the parts required to complete this circuit. The 88 mhy coil can be obtained from sources listed in the RTTY handbook or from Irving Electronics, Box 9222, San Antonio 4, Texas. The printed circuit board is available from Tri-Tronics Lab. Inc., Box 238, Euless, Texas, (Price $2.00 P.P.) and the transistors are available from any Texas Instruments Incorporated authorized distributor. It would be advisable to check surplus ads to find the required relay as many of this type can be found from surplus houses. . . . W5SFT

Parts List

All resistors ½ watt
All condensers 100 volts
C1, 2, 3 plus C8 equal approx. .0398 mfd (2125 cps tone)
C4, 5, 6 plus C7 equal approx. .0347 mfd (2975 cps tone)
L1A-L1B—see text



ADDENDUM FOR CRYSTAL OSCILLATORS

Please substitute the following diagram for the one marked (in error) as Figure 12 in the September issue, page 57. We have various lame excuses for this. At any rate we are maintaining our inadvertent policy of publishing all articles in three parts: the original article, the corrections, and the corrections on the corrections. This sort of lends a nice feeling of continuity to the magazine, don't you think?

Now, about this oscillator. This is a capacitance-bridge oscillator and it is capable of giving you the 73rd harmonic of a crystal, putting you on 219 mc with a 3 mc crystal! This should be great for a 220 mc converter.

D. L. Heller K3HNP
14 Darkleaf Lane
Levittown, Pennsylvania

Have you met these Characters?

THESE incidents in the work of a TVI committee are the calls we talk about. The majority of our complaints are bona-fide; most of the complainants are polite and reasonable, and their troubles are always (almost) completely cleared. The committee serves a useful purpose both for the amateur and his TV listeners. But have you met—

He quite indignantly insisted that K3—be kept off channel 8. I had no trouble convincing him the nearest channel 8 was several hundred miles away and hadn't yet been reported Q5—he knew that. But he was sure the ham had no right to be there calling CQ 20. I couldn't quite understand what he expected.

She reported excellent reception of W3—next door, which she couldn't understand since "I only have an indoor antenna."

She was happy to have the committee visit her, for the amateur interference was "quite upsetting" according to her letter. But a check of the TV showed no interception at all. Nor did the radio or phono. "What is the trouble?" I asked again.

"He's always on my telephone."

"The telephone company will clear it up—for free, no less."

"But you don't understand," she continued, almost crying. "I can't hear the one he's talking to."

The follow-up of a petition is often an unusual experience. One of these involved a six-meter operator running close to a half gallon—of course his own TV was clean, but we expected technical problems. We had none—just characters. But we were forewarned. The petition as sent back from FCC had several dozen signatures, but involved only eight TV sets.

A typical call was that at Mr. M's house. The check of the TV showed absolutely no amateur pickup even with the set detuned. I pointed this out to Mr. M. and asked when he had trouble.

"Three in the morning."

"He's running full power now, and we see no sign of him on the set."

"He runs more power at three in the morning."

"That's impossible," I had to say.

"How much can he run? I heard he's running 20 amps."

"Legally he can run 1000 watts. But his equipment can't go much over 300."

"I think he runs 1025 watts at 3 in the morning."

"When did you last hear him?"

"This is a whitewash. Last week." (his AF gain up a bit.)

"When was your TV last repaired?"

"This is a whitewash. Six months ago" (add 3 db audio.)

This continued a bit—he finally admitted having had no trouble since his set was fixed many months back. AF gain slowly advancing. I then asked why he had signed a false statement and submitted it to FCC—a government agency. Response was confused—the volume was up past the distortion point. On the report form I had a brief transcript of our conversation, and my findings, and at the bottom, "FRAUDULENT." I showed him the report and invited his signature. "I'm a businessman. I don't sign anything." As I left he was still yelling "whitewash."

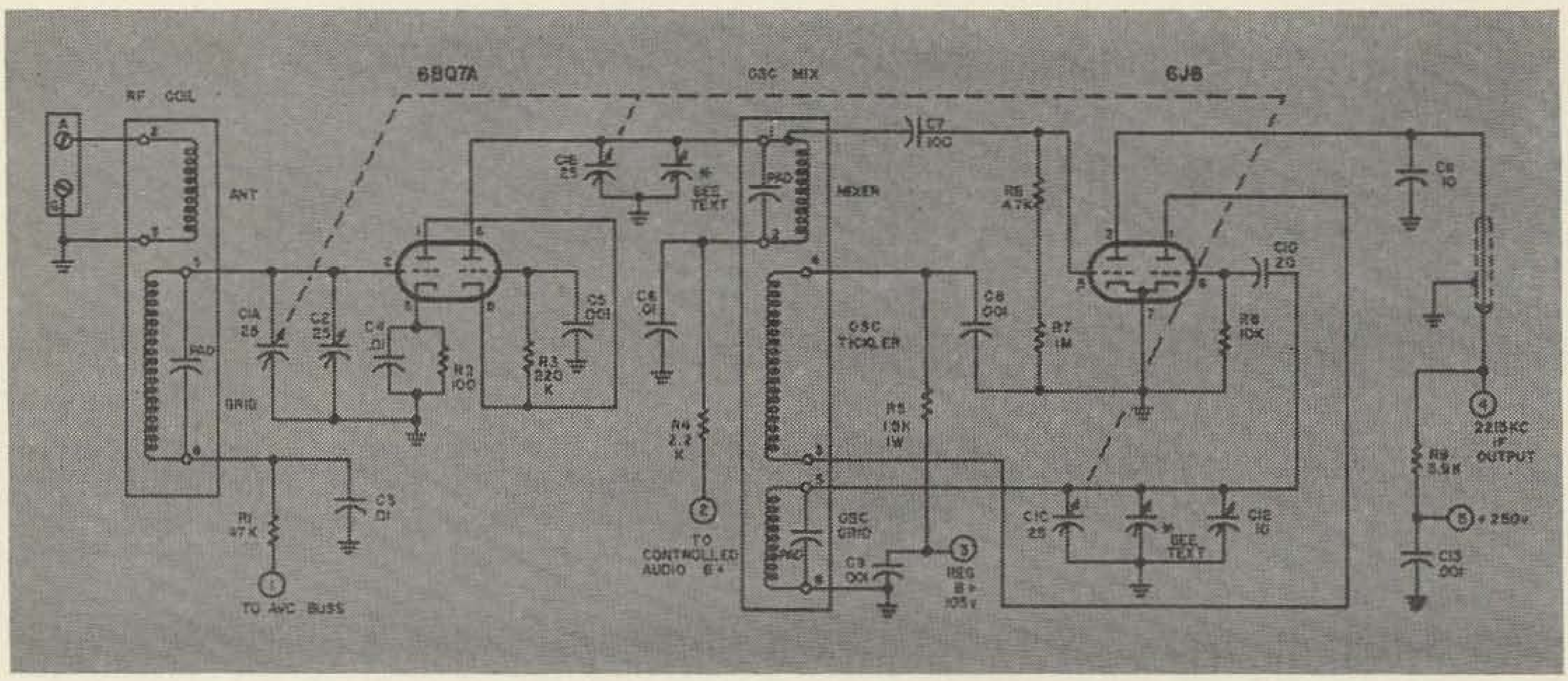
Then there was the case of Mrs. B. A severe case of TVI had been traced to an appliance in her house; since she was unwilling to repair it on her own, in due course she got a note from FCC. Unfortunately her TV was as sick as the appliance and the amateur who had traced the trouble was in on all channels. She refused to get a filter or to do anything but phone and complain. Finally she was insistent on relief for a special program—request denied. So she called FCC and gave them hell. Within several days an FCC engineer had visited the amateur and found him clean. He then went to Mrs. B., who was very pleased to see him—until he told her she should fix her TV. Then she had unkind words for him. The problem was compounded by the instructions regarding her TVI appliance: fix it, license it, or get it off the air.

Much of our trouble is caused by misinformed servicemen. A typical case was caused by one of the largest service organizations. A Drake filter was properly plugged into the set, but the filter was still ineffective. The recheck showed that the filter was grounded with a steel spring extending the width of the set. Perhaps the dc resistance was low, but the rf impedance of this several hundred turn coil figured to be several thousand ohms.

. . . K3HNP

T.V. Special Receiver

Louis Hutton WØRQF
2608 South Fern
Wichita 17, Kansas



THE equipment described in this article is a restricted coverage amateur communication receiver. It features 2.8 kc bandwidth, AM and SSB detectors, crystal controlled BFO, and S-Meter. Up to 12 individual frequency bands may be selected in the 3.5 to 60 mc range. The receiver's over-all performance is comparable to commercial products in the 150 dollar class, but will cost the constructor from one half to one third less, depending on the contents of the "junk-box."

I decided to build a receiver after having some sad experience with portable operation using a commercial ac-dc "communications" receiver. The decision to try my hand at receiver construction came when I listened to the home constructed receiver built by KøLZU. His receiver is a copy of the unit described on Page 540 of the Radio Handbook, 15th edition. My receiver is designed around that unit but is modified to fit my requirements and parts supply.

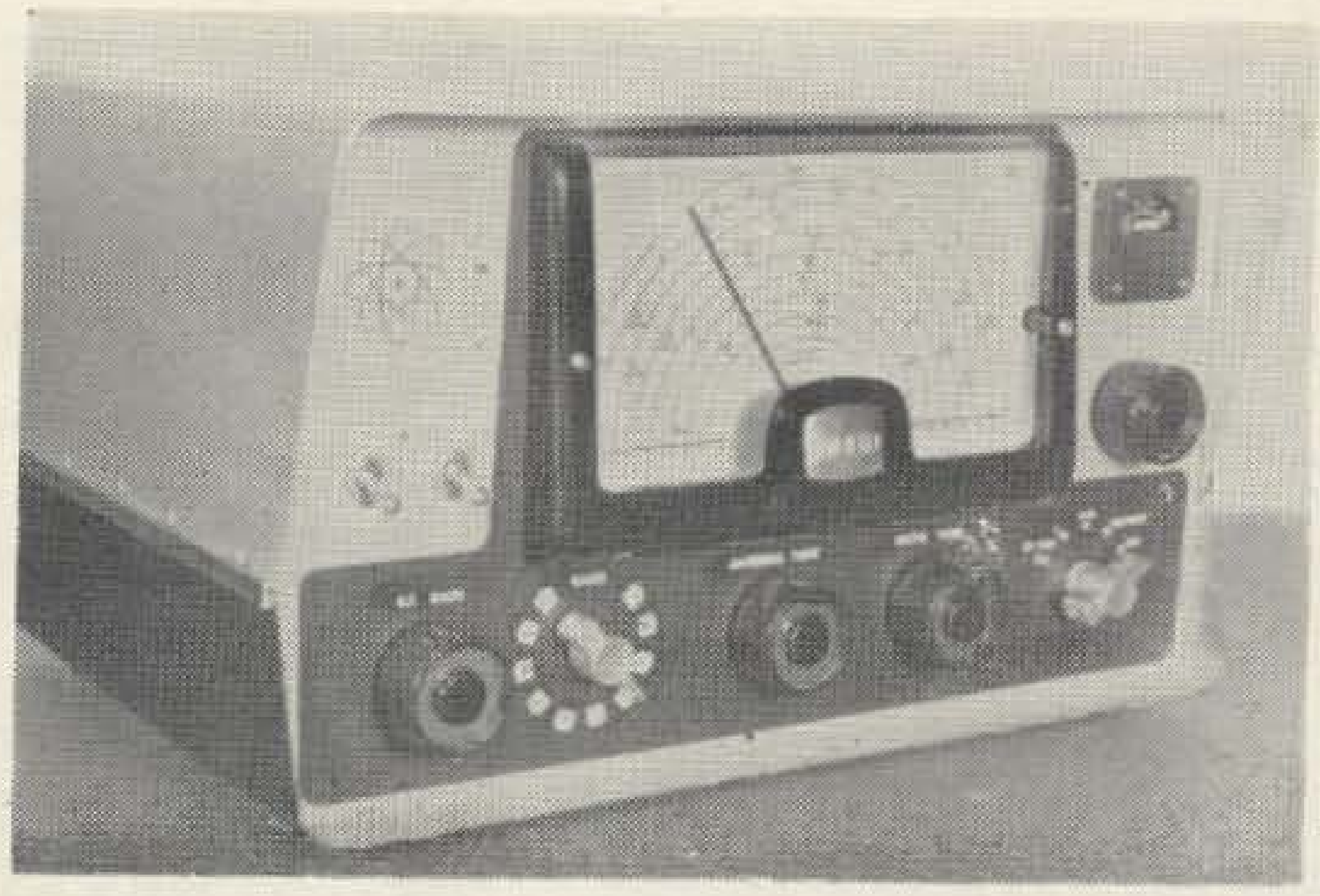
Tuner Modification

The surplus TV tuner used for the front end in this receiver is a *Standard Coil* cascode type removed from an old 1953 model Majestic TV. All of the wiring except the heater circuit was removed. The 21 mc *if* coil was discarded and the mounting tab hammered back flush with the chassis. New condensers and resistors were purchased and the tuner chassis was rewired as shown in the diagram. I removed the

Tuner

BAND	WIRE	ANT	GRID	PAD	MIXER	PAD	OSC TICKLER	OSC GRID	PAD
WWV	22	11T	34T	68mmf	21T	90mmf	12T	20T	50mmf NPO
80A	24	27T	90T	75mmf	60T	75mmf	30T	60T	50mmf NPO
80B	24	27T	90T	100mmf	60T	180mmf	30T	60T	56mmf NPO
40	22	17T	45T	33mmf	40T	75mmf	15T	26T	82mmf NPO
20	22	7T	19T	50mmf	25T	50mmf	9T	15T	82mmf NPO
15	22	7T	11T	50mmf	13T	47mmf	7T	10T	100mmf SM
CB	22	8T	10T	50mmf	17T	10mmf	11T	8T	100mmf SM
10	22	6T	8T	20mmf	8T	56mmf	8T	10T	25mmf NPO

Coil Table. All wire enameled and close spaced. Mixer padders either disc ceramic or silver mica, all other padders disc ceramic.



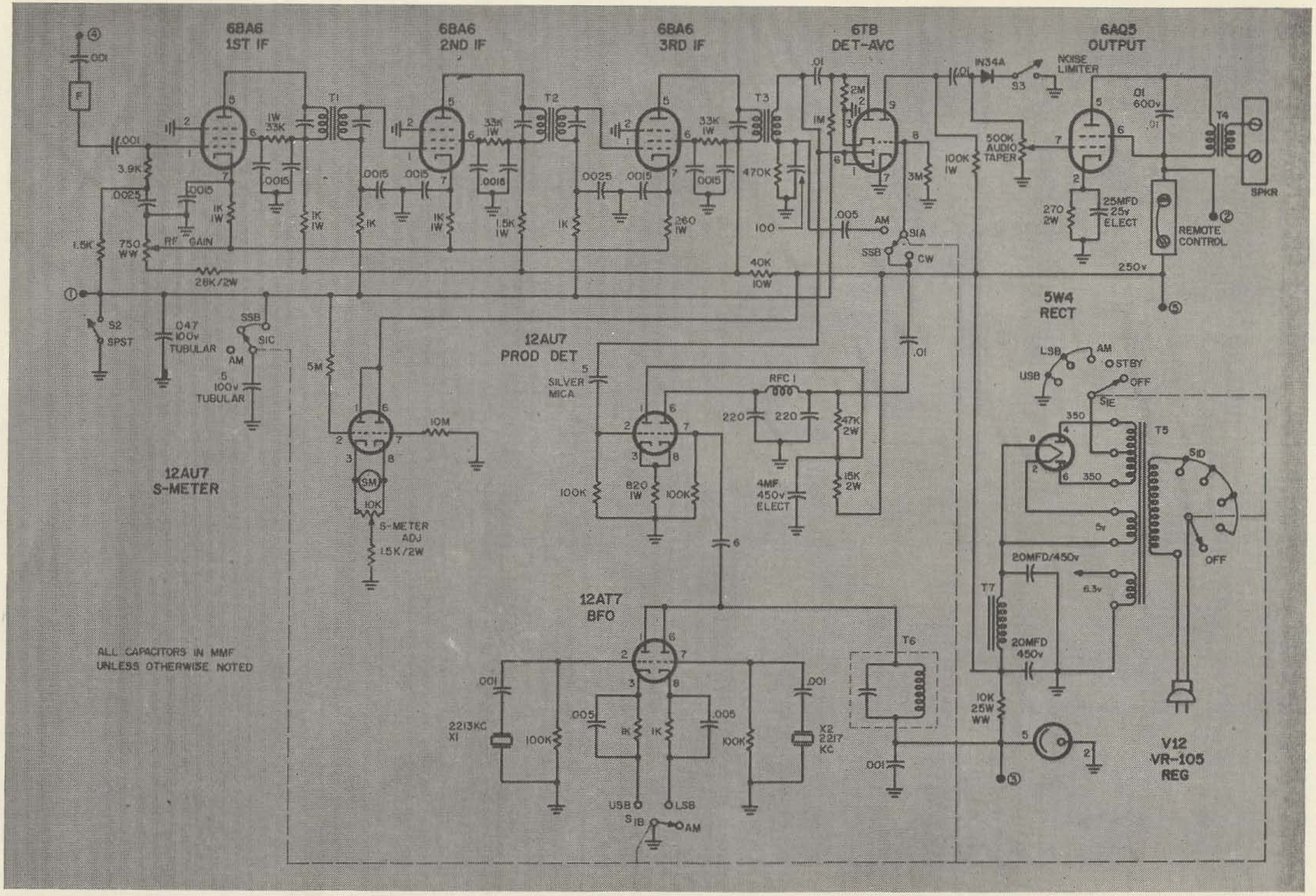
metal side cover plate, fine tuning control and capacitor. The coils and the fibre coil forms were removed from the clip-in coil strips. Coils were rewound as listed in the coil table.

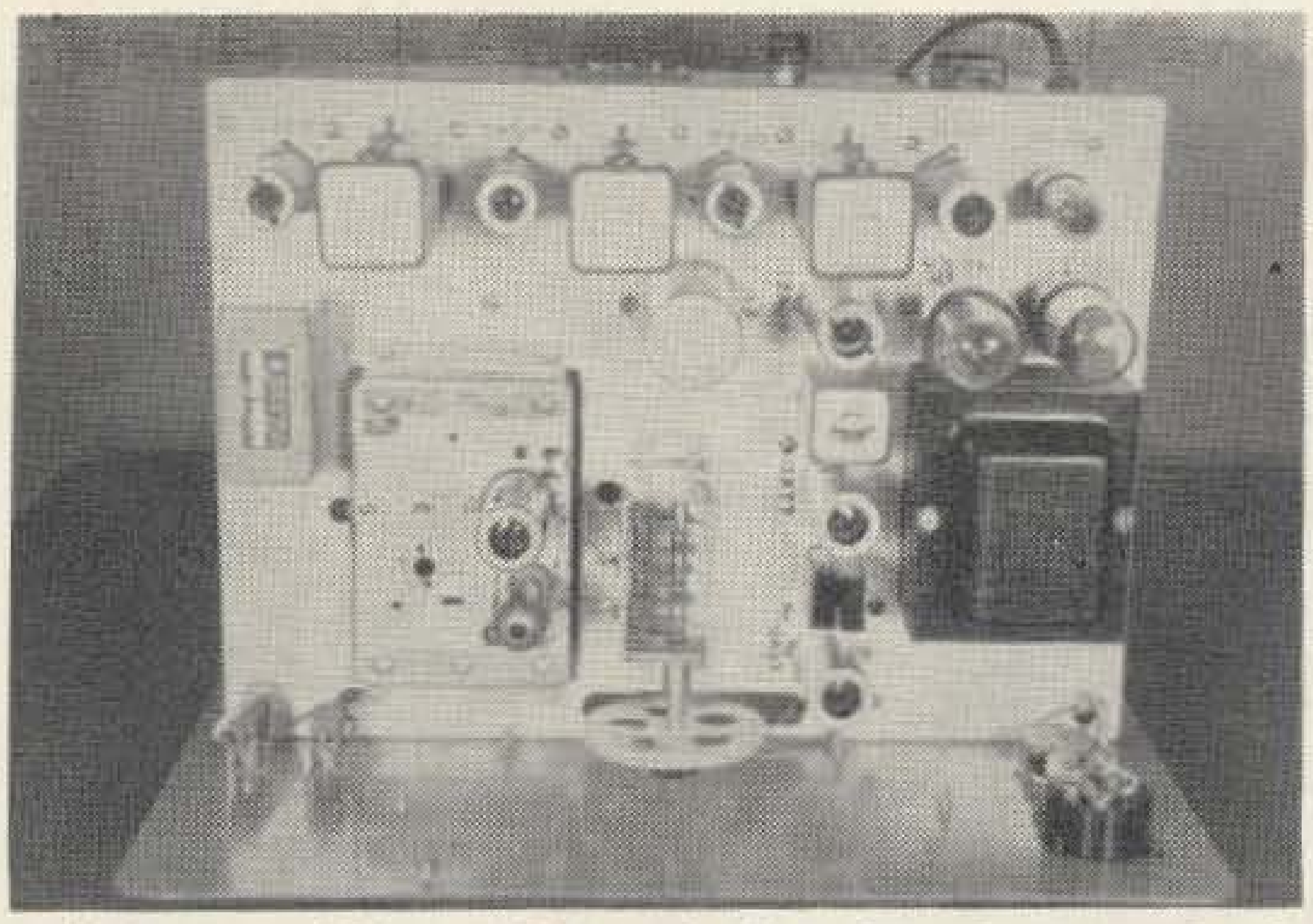
Construction

The major components were laid out on the 11 by 14 by 3 inch chassis as shown in the photograph. Since my operation is predominantly AM and SSB, I used the 2215 kc crystal lattice *if* filter (2.8 kc bandwidth) made by *Hermes*. The receiver made by KøLZU used a homemade filter at a much lower frequency (455 kc). His receiver was dual conversion, whereas mine is single conversion. The *if* transformers are designed for 1650 kc *if* operation, but I modified them to 2215 kc by replacing the padder condensers across the coils with 20 mmfd silver mica condensers. After the major components were mounted the tube heaters were wired and power applied to make sure of no errors or omissions. The power supply and audio circuits were wired and given a quick check by connecting the output from an audio signal generator to the grid of the triode section of the 6T8.

The *if* stages, AVC detector, noise limiter and the AM detector circuits were then wired. A 2215 kc rf signal was fed to the input of the filter to align the *if* stages. The *if* stages promptly broke into oscillation and no amount of stagger tuning or cathode resistor value juggling would completely cure the trouble. I finally traced it to the noise limiter wire which was routed too near the plate and grid circuits of the *if* strip. This wire was rerouted away from the *if* circuitry and the feedback stopped. The S-meter circuit wiring was completed and connected to the AVC buss. The original 1.25 millampere meter was replaced by a 500 microampere unit to provide for a greater swing to the S-meter indicator on weak signals. The meter was carefully removed from its case, and the lettering blanked out with black dope. Decals were used to mark the new calibrations, converting it to an S-meter.

The product detector and crystal controlled BFO circuit were wired next, and each BFO crystal frequency was adjusted to the proper

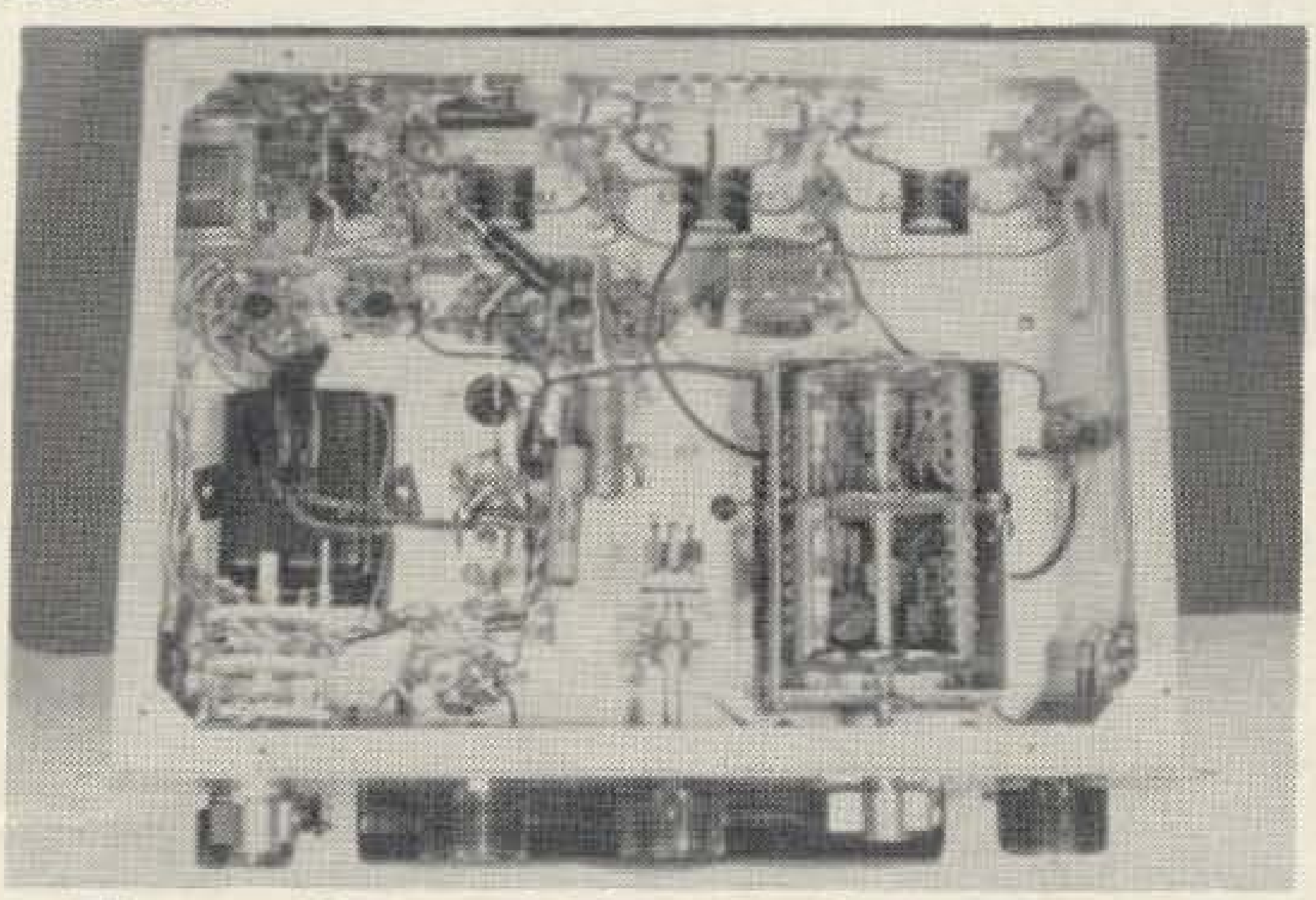

6BA6
1ST IF
6BA6
2ND IF
6BA6
3RD IF
6T8
DET-AVC
6AQ5
OUTPUT
IN34A
NOISE
LIMITER
S3
T1
T2
T3
T4
SPKR
500K
AUDIO
TAPER
100K
1W
REMOTE
CONTROL
250v
RF GAIN
750
WW
28K/2W
40K
10W
S2
SPST
.047
100v
TUBULAR
.5
100v
TUBULAR
SSB
S1C
AM
S1A
CW
12AU7
PROD DET
SILVER
MICA
RFC 1
4MF
450v
ELECT
5W4
RECT
LSB
USB
STBY
OFF
S1E
S1D
T5
T7
20MFD/450v
20MFD
450v
6.3v
5v
12AU7
S-METER
10M
5M
SM
S-METER
ADJ
1.5K/2W
12AT7
BFO
2213KC
X1
X2
2217
KC
T6
USB
LSB
S1B
AM
10K
25W
WW
V12
VR-105
REG
ALL CAPACITORS IN MMF
UNLESS OTHERWISE NOTED



point on either side of the bandpass of the *if* filter. One crystal appeared to be on frequency, but the other required a small amount of capacitive padding to bring it on frequency. The tuner sub-chassis was now connected to the *if*, AVC, and power supply circuitry. Now begins the most trying part of building a receiver of this type, the front end alignment.

Tuner Adjustment

Whereas most modern communication receivers provide for coil frequency adjustment by padding and trimming condenser on slugs, this tuner is adjusted by removing turns from the coil or by squeezing or spreading the coils. The grid dipper is used to check the rf coil frequency. Sufficient turns are supplied on the coil so that resonance at the desired frequency is found with the antenna trimmer half meshed.



The oscillator tickler winding is wound in reverse rotation to the oscillator grid coil so that it will oscillate.

The coil and tuning condenser combination that I used requires two coil banks to cover the 75 meter phone band. Only the phone portion of 40, 20, 15 and 10 meters are covered in this receiver. The entire 11 meter citizens' band and the 10 MC WWV bands are provided on two more coil strips.

Cabinet

The cabinet is formed from two pieces of aluminum. The bottom half is painted a dull black, and the top half silver grey hammertone. A chrome trim strip salvaged from the dash of a 56 Buick was used to cover the joint where the two pieces were joined. Sheet metal screws through rubber feet are used to hold the chassis in the cabinet. The dial scale was calibrated on a piece of white cardboard, then redrawn in twice size. This was photographed and enlarged to full size. The dial cover was swapped from another amateur and was originally part of a two meter Geloso VFO dial assembly. A speaker assembly was manufactured from a dime store plastic flower pot.

Connections are provided in the rear of the chassis for the speaker, and remote control of the receiver B plus. The S-meter adjustment is also located on the rear apron.

. . . WøRQF

Parts List

T1-3—1650 kc if transformers modified to 2215 kc as in text. 912-W1, W2, W3.
T4—Stancor A3877 (5000 to 4 ohms).
T5—Stancor PM8409 (700 vct/90 ma; 5v/2A; 6.3v/3A).
T6—Miller 012-W1.
T7—Stancor C1709 (8 Hy - 85 ma).
F—2215 kc filter; HERMES ELECTRONICS CO., 75 Cambridge Pkwy, Cambridge, Mass.
S-meter—500 microamp; Burstein-Applebee 18A916.

Jim Kyle K5JKX/6
1851 Stanford Avenue
Santa Susana, California

Solid Power, OM!

WE'VE said it so often, it's hardly worn while to say again that semiconductors are here to stay. And it's no news that one of the most obvious applications of semiconductors in a ham rig is in the power-supply department. Therefore, we won't give you any sales pitch for siliconizing your power supply except to point out that solid-state rectifiers run cooler, last longer, take up less space, and in the long run cost less than do their vacuum-tube counterparts.

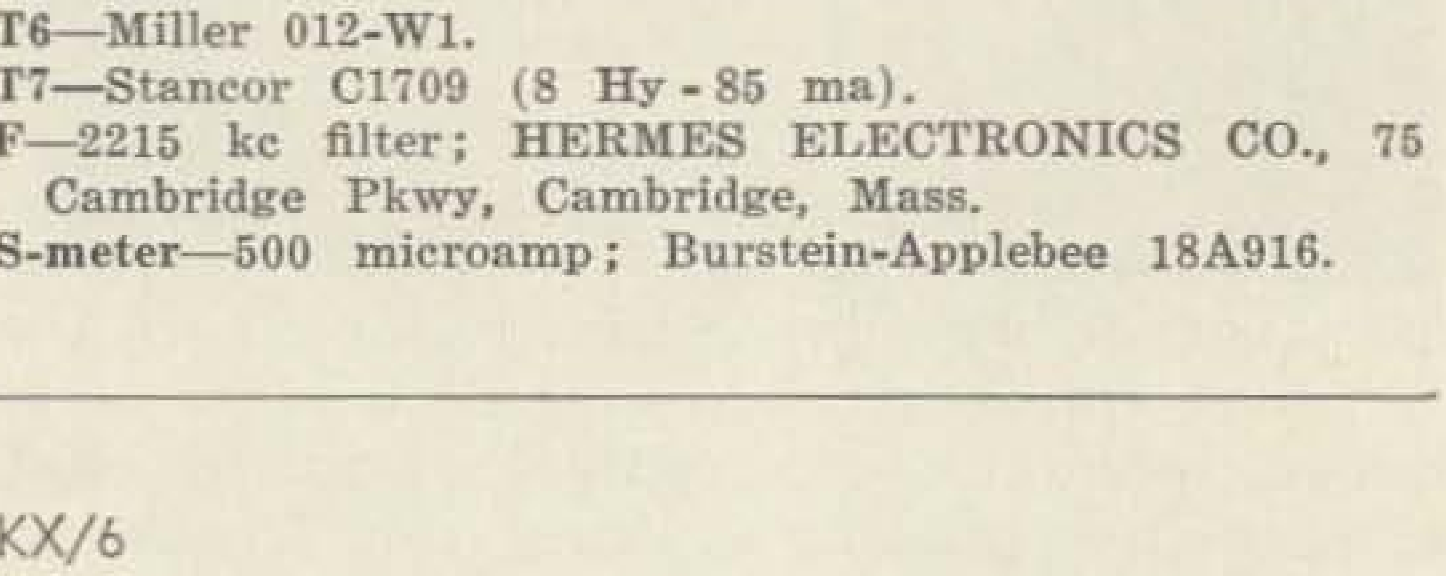
Designing (or haywiring, whichever term you prefer) a low- or medium-voltage power supply around silicon rectifiers is a pretty simple affair; however, when you get into the neighborhood of 100 watts' worth or so the job can get rather hairy, since unlike the vacuum tube the silicon rectifier is a bit weak in the department of reverse voltage. The kind you're most likely to find at the corner parts emporium is rated to take only about 130 volts of ac, which isnt' much help when you want 750 volts dc output.

Connecting a number of the little gems in series easily overcomes the reverse-voltage problem. Just one small question arises then—and confusion reigns around the answer. That question is: "How many in series for what voltages?"

MANUFACTURER	PEAK INVERSE VOLTAGE RATINGS				
	400	500	600	800	1000
Amperex	OA210	–	–	–	–
Diodes, Inc.	DI -54	–	DI -56	DI- 58	DI -510
General Electric	1N604	1N605	1N606	1N560	1N561
Mallory	1N2094/T400	1N2095/T500	–	–	–
Motorola	1N540	1N1095	1N1096	–	–
Raytheon	1N540	1N1095	1N547	–	–
Sarkes-Tarzian	M-500	50M	60M	–	–
Sylvania	SR-500	–	–	–	–

Table II. Type Numbers VS P.I.V. ratings for readily available 500-750 ma diodes.

You can write the manufacturer (tell them you saw it in 73) but if you write to more than one at a time you'll discover, as we did, that each manufacturer inserts a different safety factor in his ratings. The result will be that you still won't know how many diodes to hook together for your 2500-volt supply.



We've compiled a chart listing the number of diodes needed, according to various voltage ratings, for a number of commonly used transformer voltages; a companion chart translates the PIV ratings back to diode type numbers to make it easy to obtain the proper diode. But before we explain the chart, let's look at the two circuits most used for medium- to high-power supplies: The full-wave center-tapped, and the bridge.

The full-wave center-tapped circuit, shown in Fig. 1, is the conventional vacuum-tube power supply circuit. If this is the circuit you're going to use, measure the output voltage of the transformer from one side of the high-voltage winding to the center tap, and read the "full-wave" column of our chart.

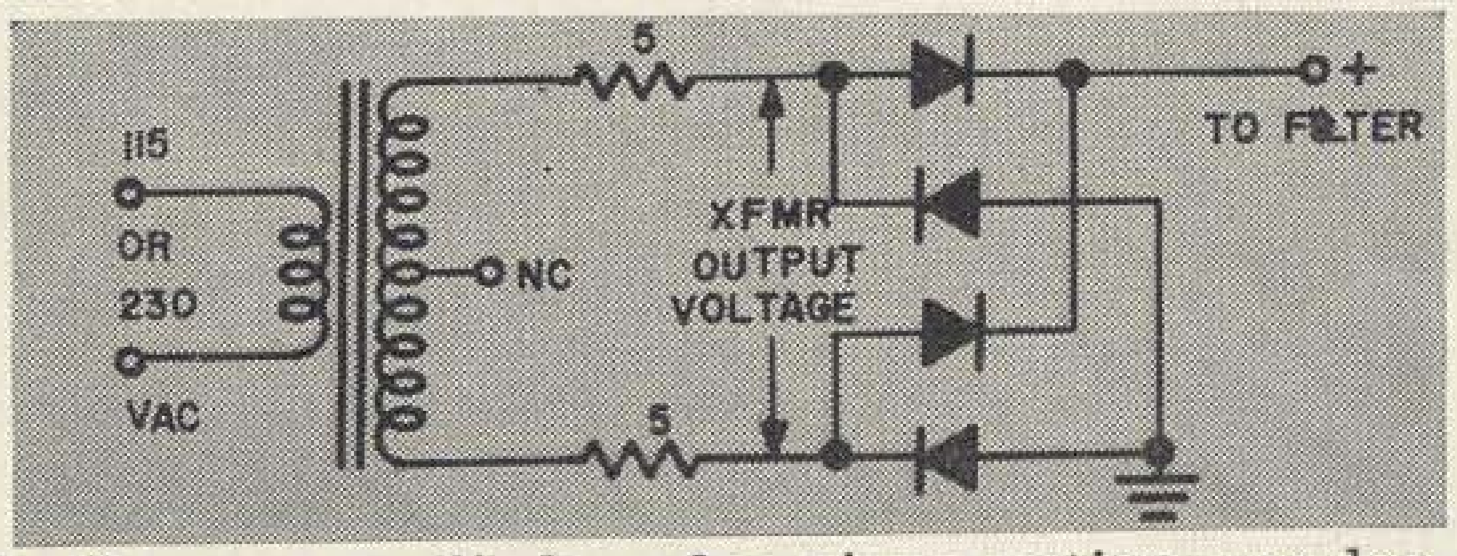
The bridge circuit of Fig. 2 isn't so common with vacuum tubes, since supplying filament current for all the rectifiers poses a problem. However, with semiconductor rectifiers the filament-power problem disappears, and the bridge circuit becomes more attractive because it allows approximately double the output

Transformer Output Voltage	FULL WAVE CIRCUIT PIV rating of each diode	Number per leg	BRIDGE CIRCUIT PIV rating of each diode	Number per leg
130	400	1		
260	800	1	400	1
260	400	2		
375	600	2	600	1
375	400	3		
520	800	2	800	1
520	400	4	400	2
650	1000	2	1000	1
650	500	4	500	2
650	400	5		
750	600	4	600	2
750			400	3
975	1000	3	500	3
975	600	5		
1040	800	4	800	2
1040			400	4
1300	1000	4	1000	2
1300	800	5	500	4
1300			400	5
1500	1000	5	800	3
1500			600	4
1950	1000	6	1000	3
1950			600	5
2600	1000	8	1000	4
2600			800	5

TABLE I. Number of diodes required per leg.

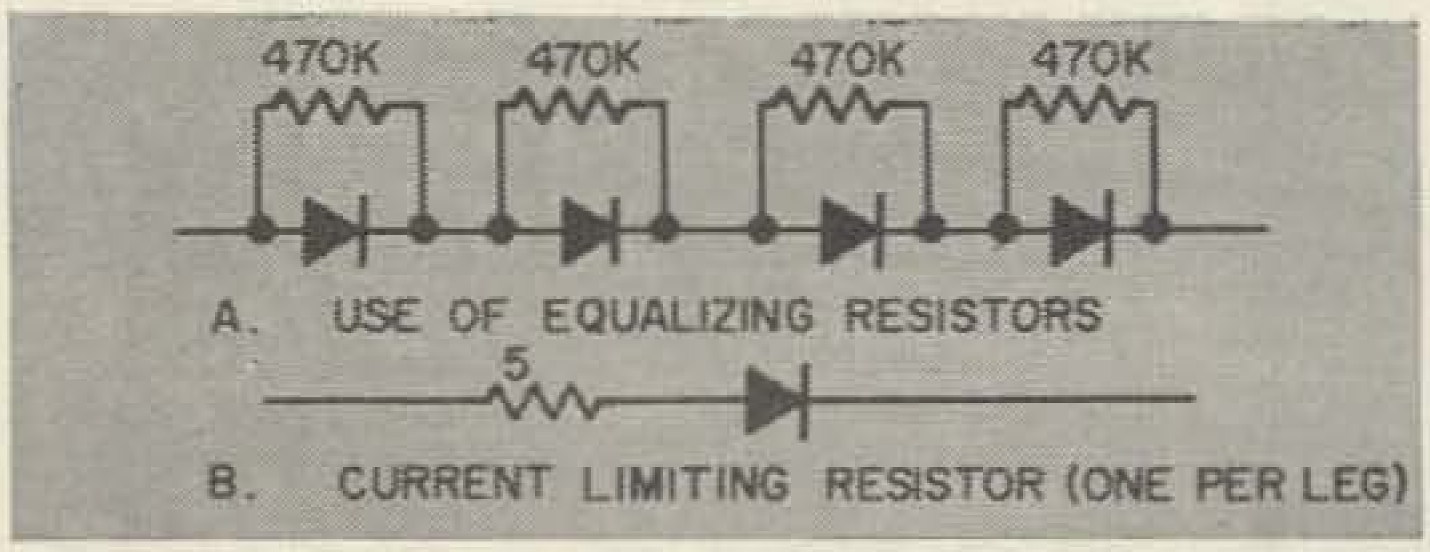
voltage from the same transformer. For the bridge circuit, measure the transformer output voltage across the full high-voltage winding, and read the "bridge" column of our chart.

You'll note that the rectifiers are apparently able to stand twice the voltage in the bridge circuit that they can handle in the full-wave circuit. This happens because, in the bridge circuit, two of the four bridge legs are always in a series at any instant. You'll also note that, for the same transformer voltage, the same *total* number of diodes are used with either circuit. While the bridge circuit requires only



half as many diodes of a given rating per leg, the bridge circuit contains four legs while the full-wave circuit has only two. Therefore, the transformer output voltage should be the deciding factor in choosing the circuit.

Semiconductor rectifiers are unlike vacuum tubes in another way, too; they can't stand much overload. The voltage ratings given in our chart include a 10 percent safety factor to allow for line voltage surges; if possible, you should increase this safety factor by designing for a voltage slightly higher than that actually present. If you need the figures for a voltage not included on the chart, you can calculate it easily. First multiply the transformer output voltage by 3.08 (for the full-wave circuit) or 1.54 (for the bridge circuit) to find the total PIV rating you must have. Then divide this figure by the PIV rating of the diode type you intend to use. Naturally, the answer must



be rounded off to the next higher digit—where are you going to get half a diode? For instance, a 1500-volt transformer voltage would require a total PIV rating of 4620. Using 1000-PIV rated diodes, we get 4.26 as the answer. Our chart lists 5 diodes.

To make sure that the voltage divides properly between the various diodes in the string, connect equalizing resistors in parallel with the diodes as shown in Fig. 3A. The high-valued resistors won't degrade diode performance, but they will make certain that no individual diode is overloaded due to failure of the voltage to divide properly down the string. Omission of these resistors has caused failure of a number of experimental power supplies.

The final point has been said so often it seems almost unnecessary, but forgetting it can also cause monetary grief (32 diodes represent nearly a third of a centibuck, anytime!). That is that a semiconductor diode must have a current-limiting resistor in series with it as shown in Fig. 3B. The value of this resistor need not be over 5 ohms, and a 2-watt 4.7-ohm unit will do the job nicely. Its function is to protect the rectifier against over-current in case the supply is switched on when the AC voltage is at its positive peak and the filter capacitors are discharged. Under these conditions, the entire power-supply circuit looks like a dead short across the line, and the diode plays the role of a fuse (the fuse itself won't blow out in 1/120 second, but the diodes will in considerably less time than that).

Letters

Simple as A-B-C1

Dear Editor:

The thought provoking discussion of classes of amplifiers in your August issue has indeed provoked me—according to information in one statement in the discussion, my mobile rig has been operating in a "self-contradictory" mode for the last year!

The statement I take exception to is ". . . a class C1 amplifier is self-contradictory; to operate class C, grid current must flow." Frankly, I find this statement 'self-contradictory.' To explain. . . .

Author Kyle correctly identified the class C mode as that mode where plate current flow occurs in less than half the cycle. However, it is not necessary for grid current to flow in order that plate current flows. For example, a tube could be biased at, say, 30 volts beyond plate current cut-off, cut-off bias being, say, —50 volts. Thus, the d-c bias is —80 volts. Any signal having a peak swing of more than 30 volts would cause the tube to conduct plate current for that time in the cycle where the signal voltage overcame the cut-off level.

Admittedly, most power tubes won't operate very efficiently or near their power capabilities with such slight excitation. However, some modern beam pentodes have so high a gm that they exceed their d-c plate power ratings at zero bias. There is no need to drive such a tube into the positive grid current region, thus consuming driving power.

To be sure, my 5 band 400 watt carrier-control mobile rig could not have been built into its 5" x 6" x 9" enclosure without the feature of class C1 operation of the two 6DQ5's in the final; with negligible drive requirements the VFO-exciter was reduced to a two tube affair.

I hope that these comments will save the class C1 mode from an undeserved fate of 'self-contradiction'!

John Dannenberg W6HBF

You're right, now how about an article on that rig?

MARS Broadcasts

Sundays: 2-4 PM EST 3295-7540-15, 715 kc

Nov. 5—Introduction to Sonar
Nov. 12—Underwater Communications
Nov. 19—Modern Submarines
Nov. 26—Oceanography

Dear Big Daddy:

Well, it's a wonder some cat hasn't come up with a real crazy answer to this license fee bit. So here's my monumental answer to a lot of things—this will really solve the whole problem:

C. B.	$5 per application and renewal
Novice	$5 per application
Technician	$3 per application and renewal
General, Advanced, etc.	$1 per application and renewal
Extra Class	$1 per application
Ladies	Free, God Bless 'em.

Can you think of a better incentive for Novices and Techs to bone up for the General exam? And assuming 300,000 amateur licensees in the near future, 300 KBUCKS should fill the pot nicely down there in Direct Current Land. Like, man, this plan is way out! Like, man, cats with 365 DX contacts per year entitled to 3% reduction in fees upon submission of QSL's. Like, additional 1% reduction for cats with cool homebrew linears. Man! Like, end of fiscal year surplus to be used for Giant Bang and Smash Hamfest and Surplus Prize Drawing. Yeh!

I realize it takes really brilliant people like you and me with the crystal clear keen perceptability to reach the logical solutions unattainable by those W3-clods; and opposition will rear its ugly head supported by the dunces of the rest of this stupid world who are too cheap to contribute to the support and furtherance of the glorious hobby of Amateur Radio and 73 Rag. Let's face it. You and I are in the minority, and I have the greatest respect and admiration for you.

Please excuse the crayon—they don't let me have anything sharp here.

Lou W3DVB

Dear Wayne,

I read with interest the article on "Zero Shift Keying" by Jim Kyle in the September, 1961 issue of "73." Both you and Jim should be complimented on bringing to the attention of the amateur fraternity new techniques which can be tried and evaluated by interested experimenters.

Perhaps a few footnotes to Jim's article, elaborating on some of the characteristics of zero shift keying might be of interest to your readers.

The modulation scheme described in the article is a type of phase modulation. It is sometimes referred to as 180° phase shift modulation and has been used in various commercial and military communication systems. Considering first the bandwidth requirements, it should be noted that this type of keying, when the bits have a nominal length of 20 milliseconds, will produce side bands every 25 cycles from the original carrier frequency. For any intelligence to be transmitted, at least the first pair of side bands must be transmitted and for good keying characteristics the first and third side bands should be transmitted. This means that for the example chosen, a minimum bandwidth of 150 cycles per second would be required. As the author points out, the 850 cycle frequency shift is a legacy from land line work and creates an artificially broad channel requirement when applied to RTTY work. The 180° phase shift type of modulation should, therefore, be referred to as a minimum bandwidth system. The concept of zero frequency shift is not truly accurate. It is, further, interesting to note that when equal numbers of marks and spaces are being sent, the actual power transmitted on the original carrier frequency is zero—all power appearing in the generated side bands.

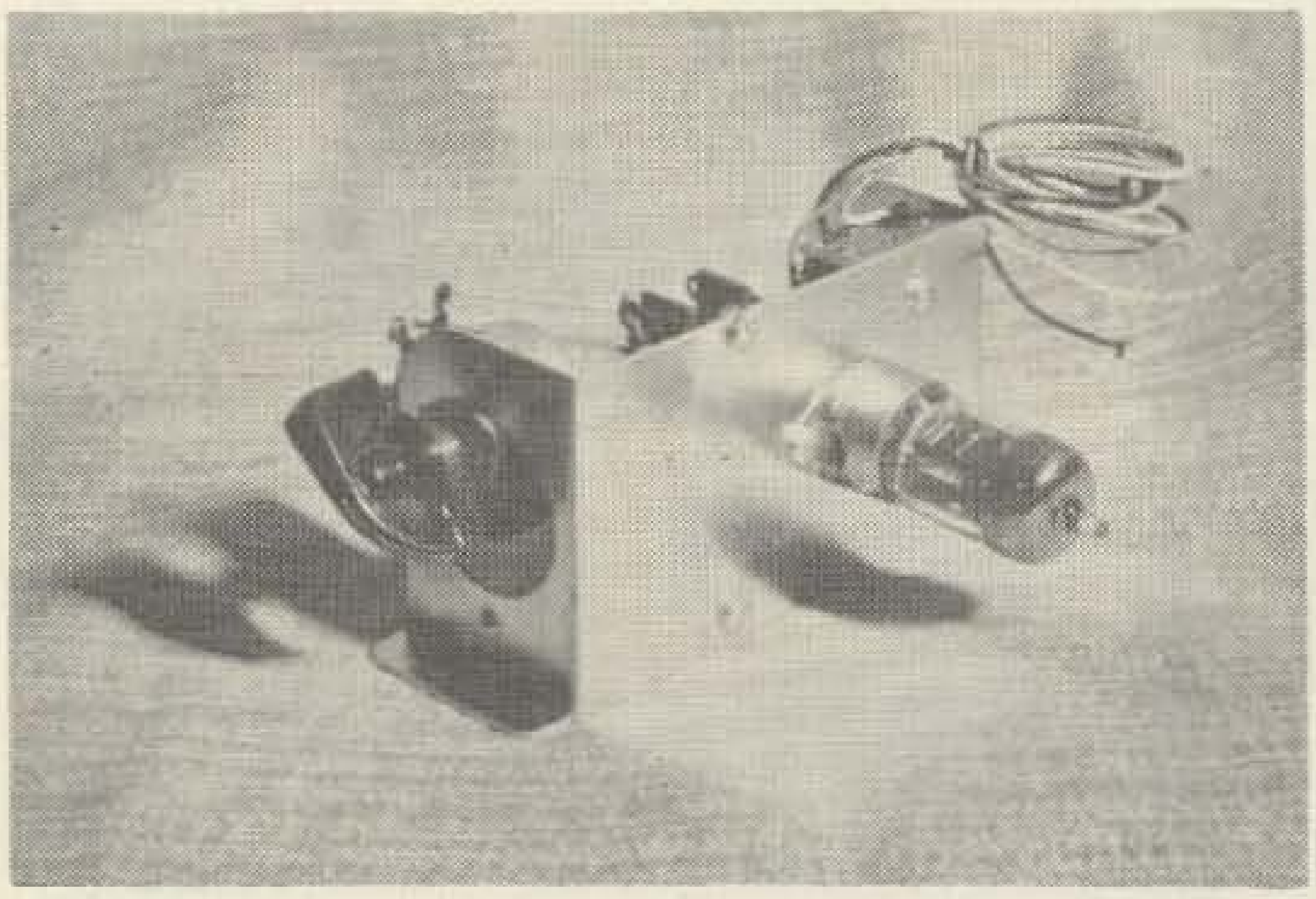
Inasmuch as the modulation scheme results in minimum occupied bandwidth, it should not be difficult to obtain an interpretation or ruling from the FCC to permit amateur use of this technique in any of the bands currently allocated to CW or RTTY work.

The technique of 180° phase shift keying relieves the user of the requirement of re-establishing the two audio tones required in the standard RTTY used by amateurs at the present time. This is, as Jim points out, probably its chief advantage. Its chief disadvantage was apparently overlooked in the original article, however. If a CW signal is transmitted on an HF band by reflection from the ionosphere, quite commonly more than one transmission path will exist between transmitter and receiver. Under such conditions, multipath fading will occur. It is characteristic of multipath fading that frequent 180° reversals of phase will occur in the carrier during the fading periods. If a phase reference is generated at the receiver as suggested in the article, and adjusted to give the proper mark and space sequence at any given instant, the spaces and marks may be reversed a short time later due to this fading phenomenon. There are many ways of meeting this problem; the most common being to associate a mark with a change of phase between two successive bits and a space with the absence of a change of phase between two successive bits. If this is done, only one bit is lost when propagation causes a 180° phase reversal of the signal. This technique will, of course, slightly complicate the circuitry required, but still does not produce a particularly complicated system.

Another type of keying which should be called to the attention of an amateur interested in improved radio teletype systems, is the baud synchronous system. This scheme, sometimes referred to as "integrate and dump" or "predicted wave signalling" goes even farther than phase reversal keying and nearly approaches maximum information transfer in minimum bandwidth. Systems have been built in which up to 40 teletype channels have been compressed into a single 3 kc bandwidth.

This system has been incorporated by the Collins Radio Company into its Kineplex data system and by other groups into various commercial and military systems. A description of this system was given in the book, "Fundamentals of Single Side Band" published by the Collins Radio Company, Cedar Rapids, Iowa.

Jim Green K5WUT



Jim Kyle K5JKX/6
1851 Stanford Ave.
Santa Susana, Calif.

Phasing for Audio Selectivity

RALLY round, those of you who have tried and abandoned range filters, resonant audio circuits, and all the other conventional methods of obtaining narrow-band audio selectivity for CW operation.

Here's a gadget based on a little-known approach to filter theory which can make the 80-meter Novice band sound as vacant as the lower end of the 3500 mc region—yet won't smash your pocketbook or your patience to build.

Most CW operators agree that something is needed to weed out the other 437 signals from the passband of the receiver, and many of us have settled on some form of audio filter. One of the most popular is the surplus range filter, with a 1020-cycle center frequency.

However, after an extended period of listening, it's hard to tell if a signal is there or not—the note seems to persist, even with the receiver turned off!

This gadget avoids that, by allowing you to choose the center frequency you want—50 cycles (as some veteran CW men prefer) or 5000 cycles, it's all the same to the filter. Only three capacitors must be changed to vary the frequency at any time.

Here are the complete specifications:

Passband at 6 db point: Continually adjustable from 10 cps to more than 5 kc while in operation.

Center Frequency: chosen by constructor; can be changed at will.

Rejection outside passband: Continually adjustable from approximately 50 db to ø db by selectivity control.

Maximum input: approximately 1 volt rms.

Output at maximum selectivity: approximately 10 volts rms.

Cost if all parts purchased new: approximately $5.

Time to build: approximately 45 minutes.

Time to place in operation after completion: approximately 90 seconds.

Interested? Let's look at how it works first, then get to the construction and hookup details.

While most audio filters of the bandpass variety (which is the only kind we're interested in at the moment) are based on resonant circuits, this one works on the phase-shift principle.

As you know, an ordinary vacuum-tube amplifier shifts the phase of the signal 180 degrees between grid and plate circuits.

As you probably also know, an RC-network will shift the phase of any signal applied to it.

Three RC networks connected in cascade can be made to shift the phase anywhere between almost zero degrees and almost 270 degrees between input and output, depending on the frequency and the values of R and C employed.

For any given values of R and C, at some point in the frequency spectrum the phase shift through the triple network will be 180 degrees. To determine the exact frequency for any values of R and C, use this formula: $R \times C \times F = 65$ if R is in ohms, C in microfarads, and F in kilocycles.

Now, if you take a conventional amplifier and connect its output to the input of such a phase-shift network, then connect the output of the phasing network back to the input of the amplifier tube, at the predetermined frequency the phasing network will add its 180-degree shift to the 180-degree shift inherent in the tube. As a result, the feedback signal will be in phase with the input signal and will reinforce it. Figure 1 shows a block diagram of such a circuit, with an isolation amplifier ahead of the active circuitry.

So far, we have the exact circuit of a con-

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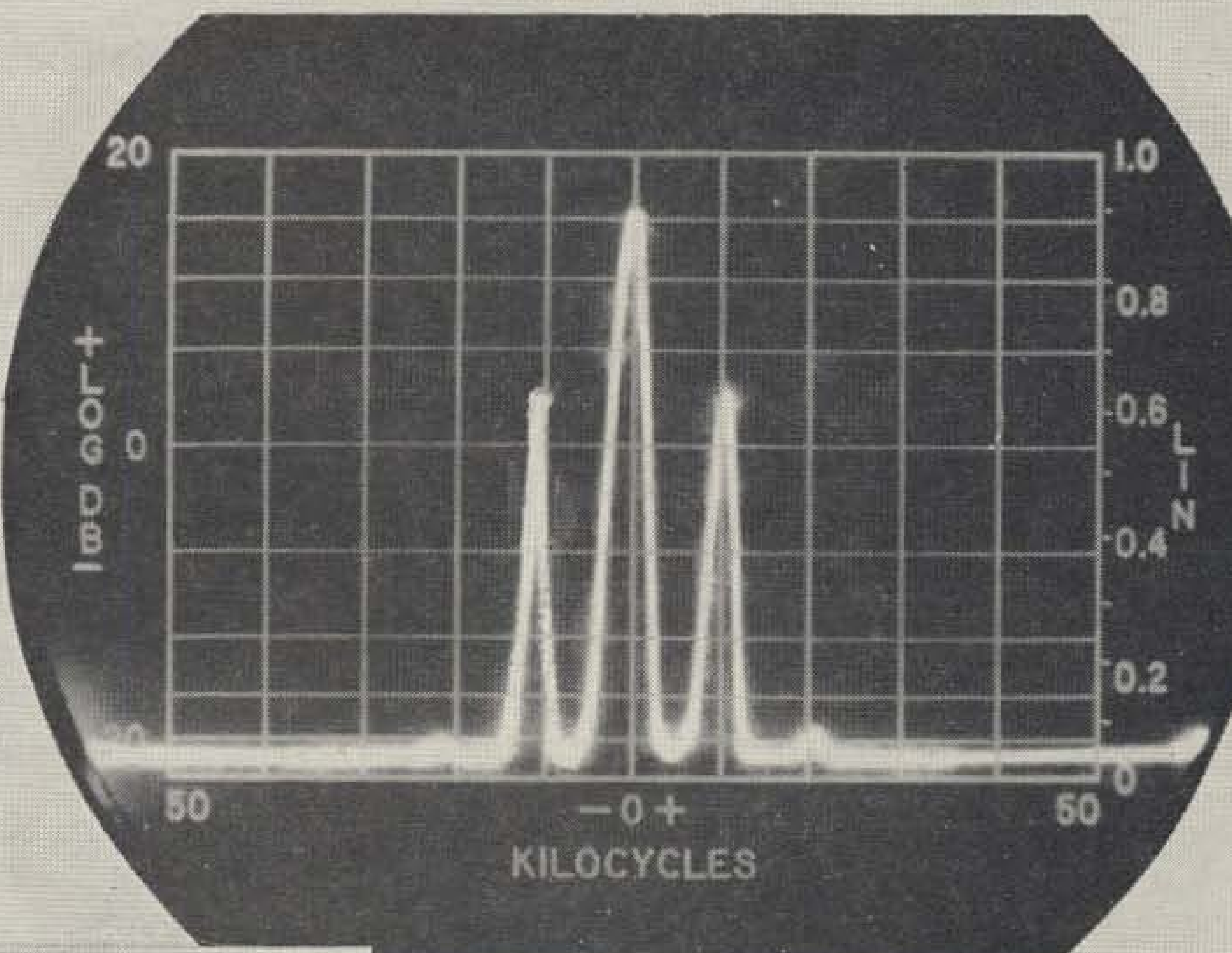

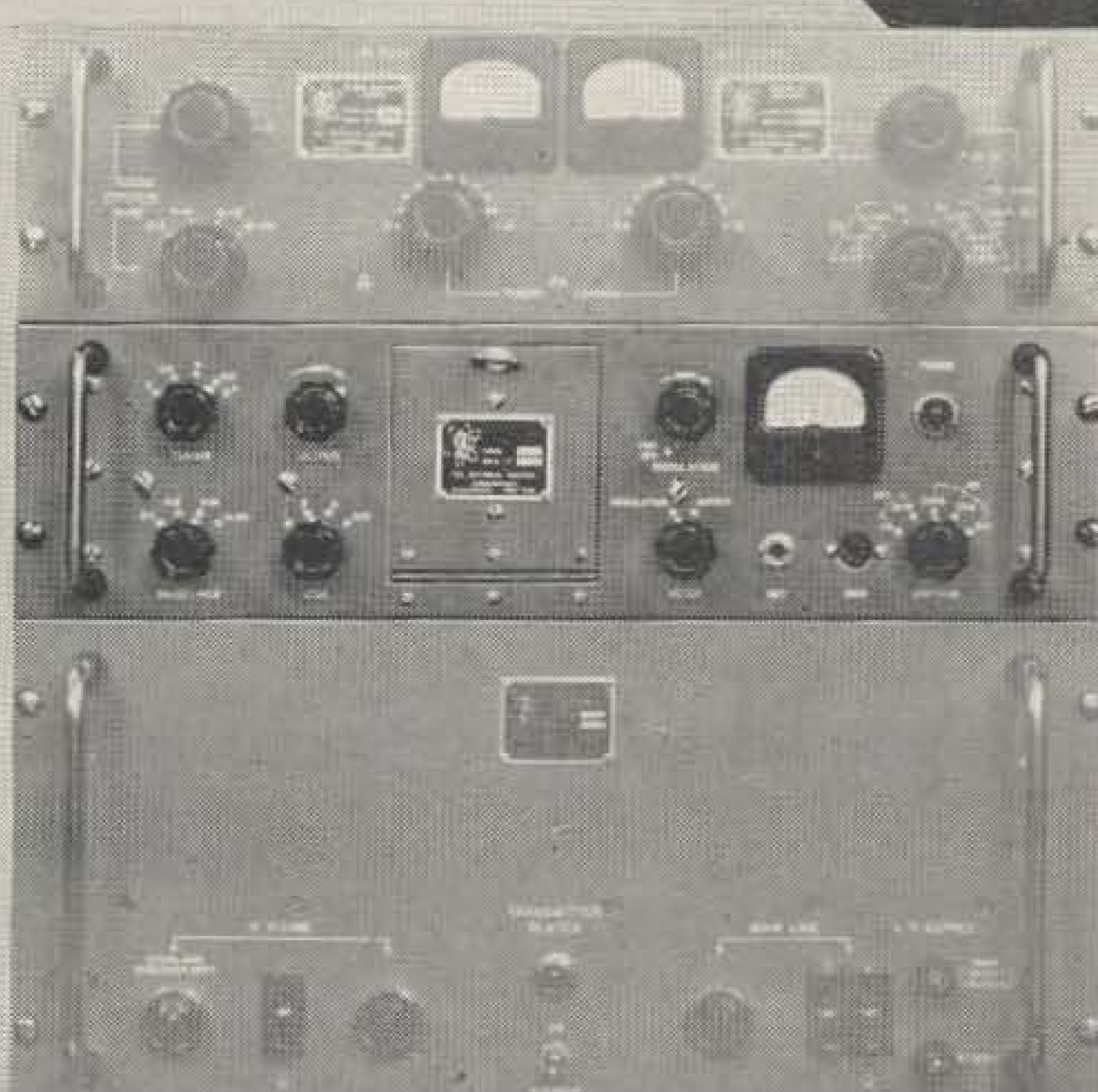

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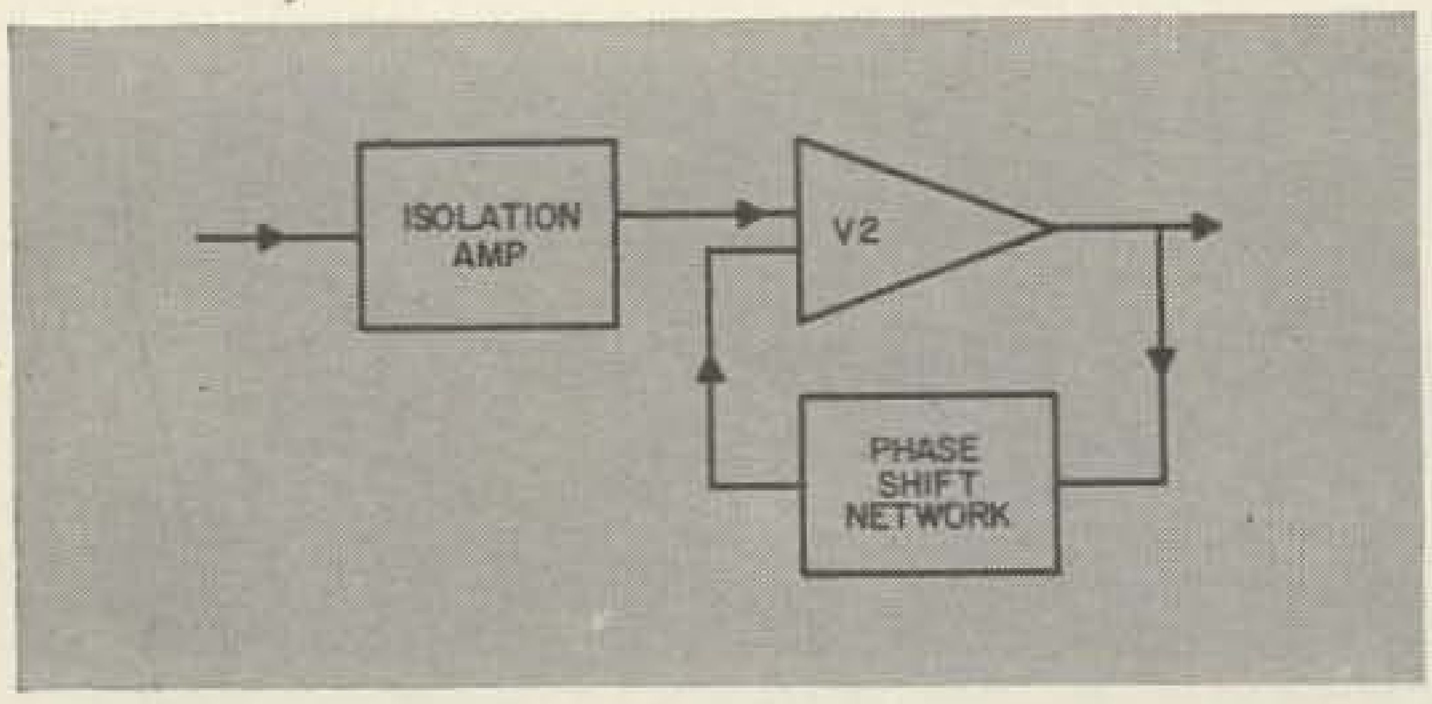

Figure 1. Block diagram of phasing filter.

ventional phase-shift oscillator, and you're probably thinking that the positive feedback we've caused will make the amplifier take off wildly at this one particular frequency.

This would be true, except for one thing. The triple RC phase-shifting network has a rather high loss. To be exact, only 1/29 of the signal applied to its input gets through to the output. Oscillation can occur *only* when the gain around the loop is equal to one or more.

Thus, by keeping the gain of the amplifier tube lower than 29, it can't oscillate. However, the positive feedback does increase the tube's gain drastically. And at any frequency other than that for 180-degree phase shift, the feedback signal will be partially or completely out-of-phase with the normal input signal.

For instance, if the frequency is such that phase shift through the feedback loop is only a few degrees, the feedback voltage will be almost completely out-of-phase with the input. In addition, if the tube gain is adjusted for maximum selectivity (more about this later) the feedback will be almost equal in amplitude to the normal input. The two will then almost completely cancel each other out, leaving a null point in the response.

As mentioned earlier, if the tube gain is 29 or more, the total loop gain will be 29 (tube gain) times 1/29 (phasing-network loss) or one—which allows oscillation. Another way of putting it is that gain goes to infinity and bandwidth to zero at the oscillation frequency.

However, if tube gain is, say, 28, then the gain around the loop will be only 28/29. Since this is less than one, the thing won't oscillate—but its gain will be high at the center frequency (812, as a matter of fact) and the bandwidth will be on the order of 100 cps at the 6 db points.

Now, if tube gain is reduced to unity, the loop gain will be only 1/29, which will produce only a bare bump on the response curve. At this point, bandwidth is at a maximum and selectivity at a minimum. You can see that selectivity is directly influenced by the tube's gain.

This effect is illustrated graphically in Fig. 2 for various values of tube gain. You can see that, no matter what the tube gain, the gadget also acts as a low-pass filter. Here's why:

Forgetting the phase-shifting action of the network for a moment, you can see that it's also a high-pass filter. Standard filter theory tells us that it will have 9 db attenuation at the frequency which makes capacitor reactance equal to resistor resistance—which is somewhat higher than the phase-shift-design frequency. From that point downward its attenuation becomes greater with frequency at the rate of 18 db per octave. Above that point its attenuation approaches zero.

Since attenuation at the higher frequencies is low, naturally there will be greater feedback through the network at the upper end of the frequency range. Except for the phase-shift properties, which are for the most part concentrated in a rather narrow region, this feedback will be negative. This, then, reduces the amplifier's gain tremendously, without regard for the selectivity-control setting.

As an example, the unit shown in the photos—which has a 480-cps center frequency as a CW filter—cuts off most frequencies above 2500 cps in the wide-band setting.

This is no disadvantage for most purposes—but it does bear mentioning.

Before going into construction details, here is the detailed design theory if you're interested; it will save you six weeks of research, because it has never been published previously:

Gain of the total filter stage is calculated by the standard feedback-amplifier formula:

$$Kf = K/(1 - KB)$$

where KF = gain of the stage with feedback
K = gain of the stage without feedback
and B = transfer function of the feedback network.

The only difficult thing about this filter circuit is calculation of B for this formula—the transfer function of the feedback network. By use of standard circuit theory, it was eventually found to be:

$$B = 1/\ (5X^2 - 1) + j/\ (6X - X^3)$$

where X = ratio of reactance to resistance at particular frequency
and j = square root of −1

It was found easiest to calculate B separately for various values of X, then substitute back these values against definite values of R and C to determine frequency, simultaneously taking the values of B thus calculated into the feedback formula, to determine the response of the amplifier for various values of tube gain and input frequency. The result was the curves of Fig. 2, which have been approximated by straight lines in the drawing.

The formula for choosing C, given R and F, is derived from the transfer function by determining that the second term must disappear for phase shift to be exactly 180 degrees. The only real value of X which will cause this term to reduce to zero is the square root of six, and substituting this value into the standard capacitive-reactance formula results in the FRC = 65 equation given earlier.

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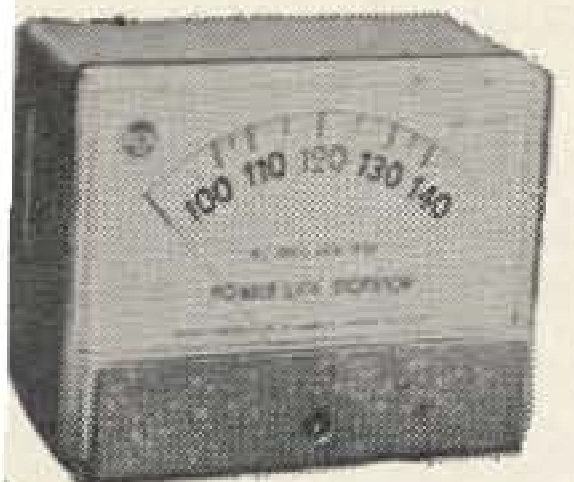

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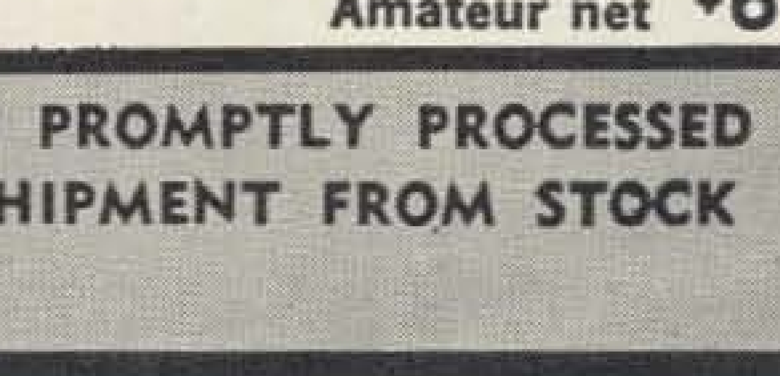

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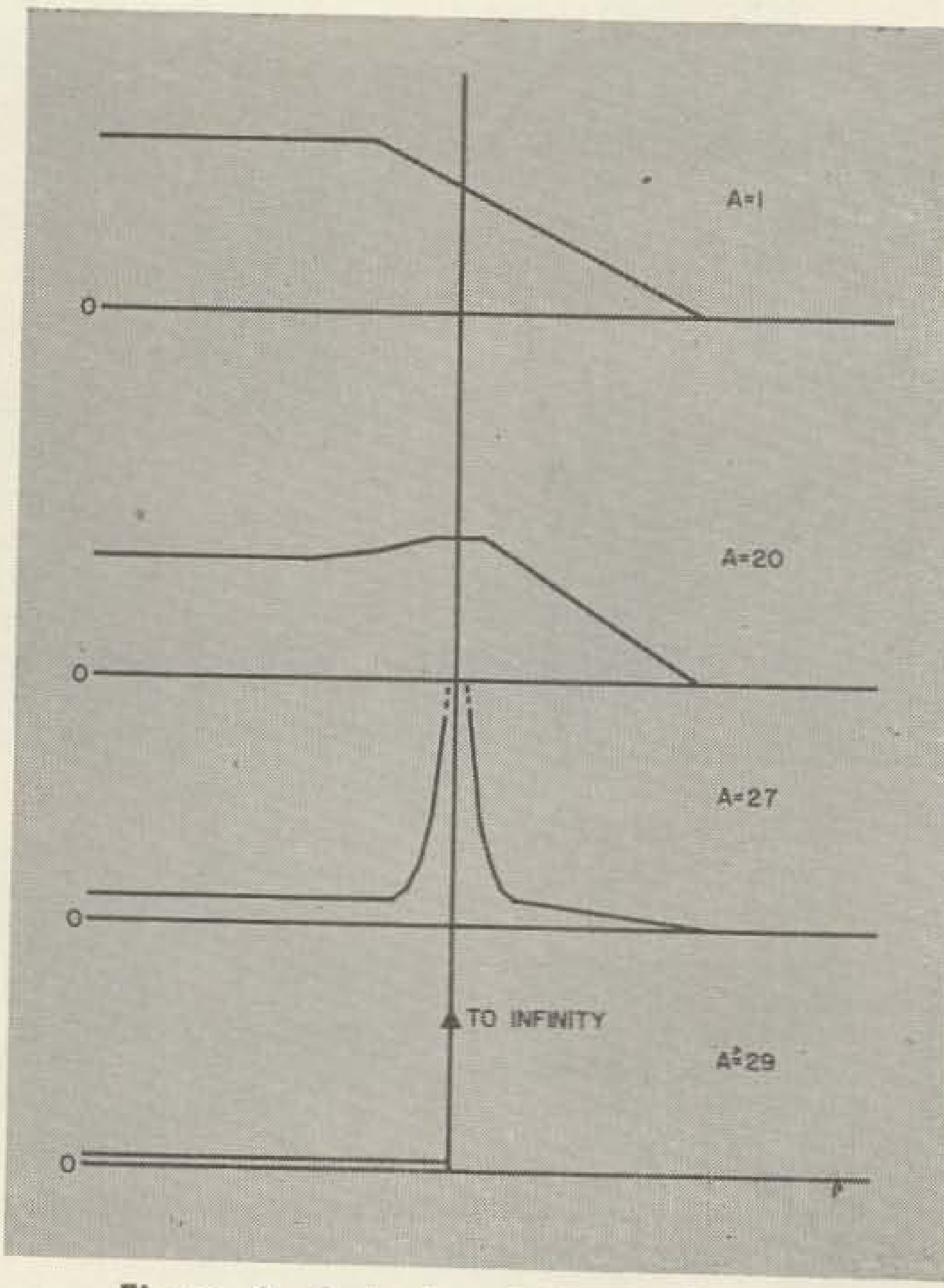


Figure 2. Output variation with frequency as a function of V2 Gain.

Enough engineering talk. Let's get on with building the filter.

Constructionally speaking, there's no critical wiring. You can build it as an outboard unit, like the one shown, or—if you can find room for a 12AX7 you can put it inside the receiver. Since the selectivity control is in a cathode circuit at low impedance to ground, its leads can be relatively long with no hum problems.

Parts values, likewise, are relatively uncritical. The common cathode resistor can be anything from 100 to 1000 ohms, and the phasing-network resistors can be anywhere from 22,000 to 100,000 ohms (with proper adjustment of the capacitance values). Only the plate load resistor has definite requirements—it should be within 20 percent of the 220K value specified, to get tube gain up to 28 for maximum selectivity.

Power requirements are 6.3 volts at 600 ma for filaments, and 250-300 volts at approximately 15 ma for plate supply.

When completed, the filter must be hooked into the receiver. This is best done by breaking the present connection at the upper end of the volume control and inserting the filter at this point, adding an input capacitor if necessary to isolate dc from the tube grid. Since this is an active rather than a passive filter, it *must* be placed ahead of the volume control. Otherwise, the set's output will probably run you out of the room.

With the filter inserted, set it for minimum selectivity (5K pot in maximum-resistance position) and turn on the receiver. Tune to one of the Novice bands and adjust for proper reception of a signal with a beat note of about the pitch you built the filter to pass.

Now crank up the selectivity control slightly. If the signal doesn't get louder, tune carefully to vary the pitch a bit and see if it peaks. If you still get no effect, crank up the selectivity some more.

Somewhere in the process, you'll discover the peak point of the filter. Leave the tuning alone from here on in, but adjust selectivity slowly until you reach maximum. You'll probably have to turn the volume down a bit as you proceed. Now, listen for the other signals you undoubtedly heard all around the desired one when you started this process. You can still find them, if you listen closely, but they're way, way down. This is the ideal situation for CW reception, since you can still tell how bad the interference is but the signal you want is in the clear for copying.

The reason for interaction between the selectivity and volume is implied a few paragraphs back—gain of the filter tube, at center frequency, varies from approximately one to more than 800 as you adjust the selectivity control. This means that you must cut back the audio to keep the same signal output level.

At about this point, you may be multiplying that gain figure of 812 times the 1-volt maximum input and trying to reconcile the theoritical 812-volt output with the 10-volt figure quoted.

Here's what happens: The tube can deliver only so much output, no matter what its gain. As overall gain goes up, the tube runs into saturation, thereby clipping all signals at a 10-volt level.

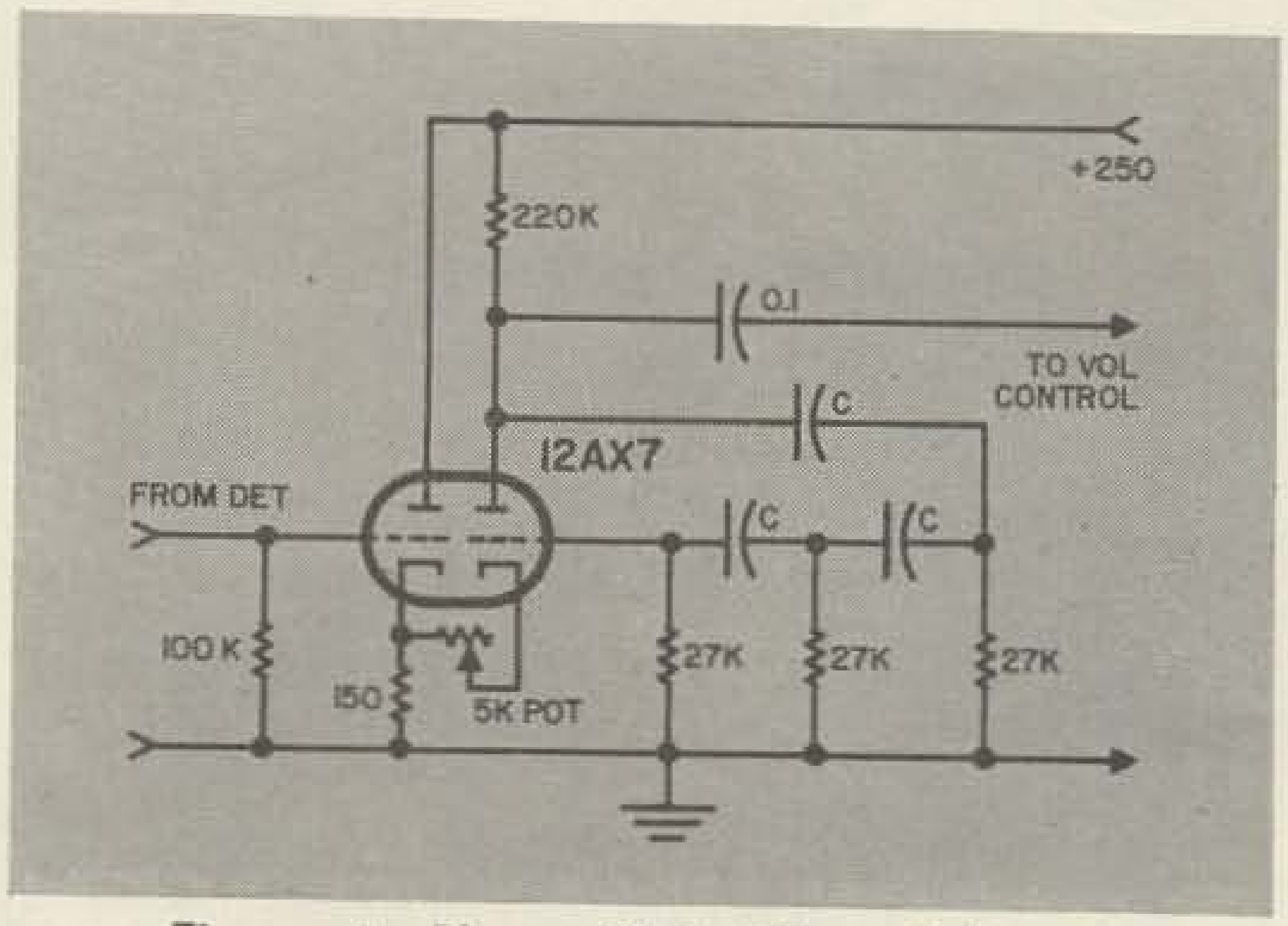
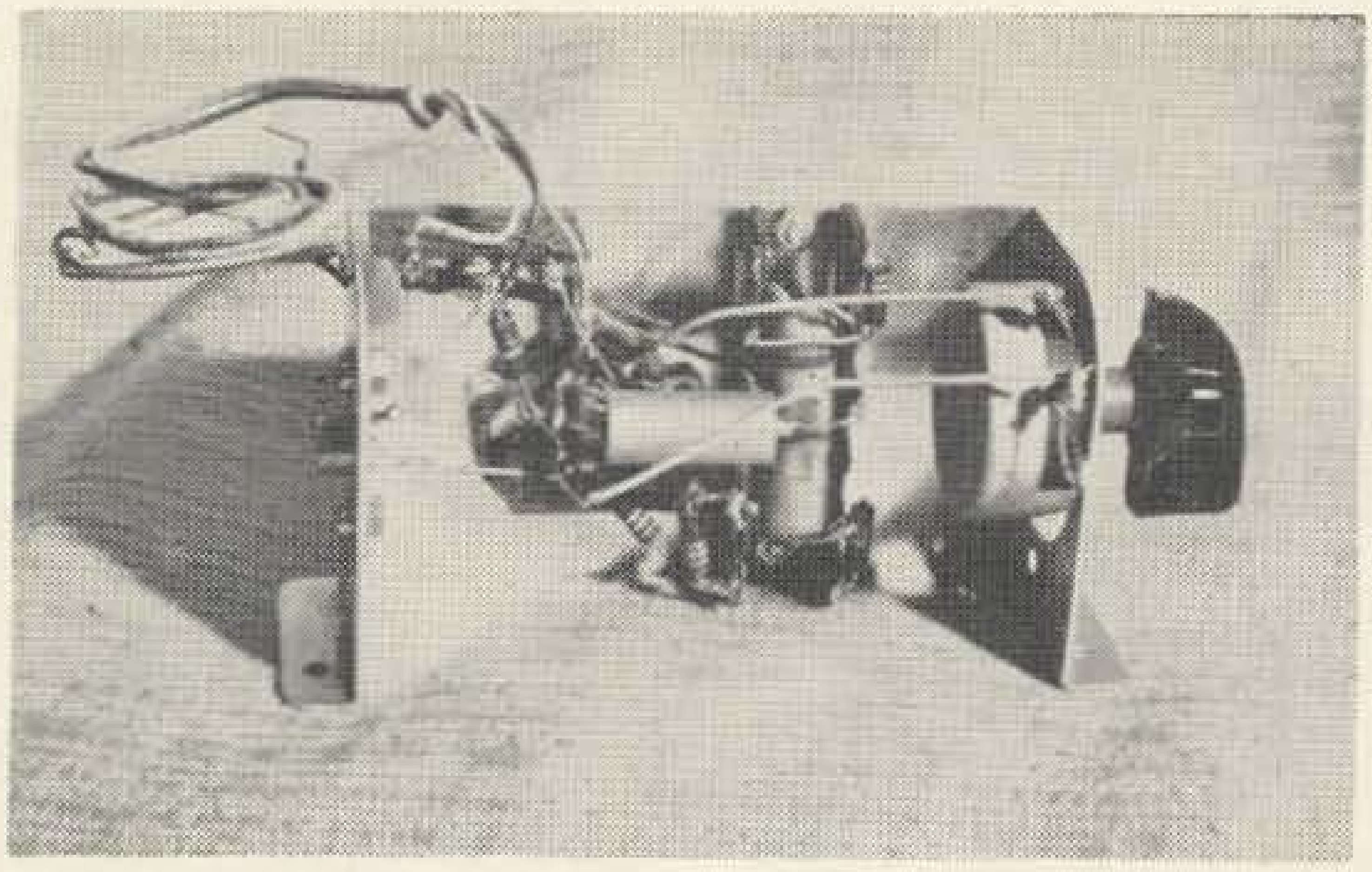


Figure 3. Phase Shift Filter. Values of three capacitors (C) are determined by frequency desired. Formula is:

C=0.0024/F where F is frequency in kc.

However, the feedback process cleans up the clipped signal to the point that no distortion is noticed. Bandwidth remains narrow, and the result is a clean, in-the-clear signal to copy. As an additional benefit, noise pulses are clipped off also, making an additional noise-limiter unnecessary.

This filter has even been used to copy 80-



meter signals through hash from a nearby TV receiver's horizontal oscillator, complicated by a washing-machine motor, an electric fan, and the neighbor's power saw. No better testimonial can be written—without the filter, the signal couldn't even be found in that mess!

. . . K5JKX/6

An xyl's Lament

The dishes are done, the chillun's abed,
The cat is out, and the dog is fed.
The house is quiet, the day is complete,
And I am practically out on my feet.

There is the bed, so snug and warm,
I've longed for it since early morn.
But, do I go, now that all is done?
Of course not, now's the time for fun!

For mine is the hobby of grid dip and load
Of learning some theory, and practicing code.
Of checking the meter and logging the call.
What am I? A radio amateur, that's all.

I tune up the rig, (I'm starting to smile)
Turn the beam to the north (we'll try there for awhile).
And amid all the calls of CQ, CQ,
I clean forget I'm tired and blue.

There's that VE4 I've been trying to get,
And the happy voices of the Clam Diggers Net.
I'm a mother, yes, and proud of it too.
But I'm also an amateur, a ham like you!

Muriel Joan Smith, WA2GXT

Jim Kyle K5JKX/6
1851 Stanford Avenue
Santa Susana, California

A Quick and Simple Mobile Rig

Conversion of a Citizens Band Unit

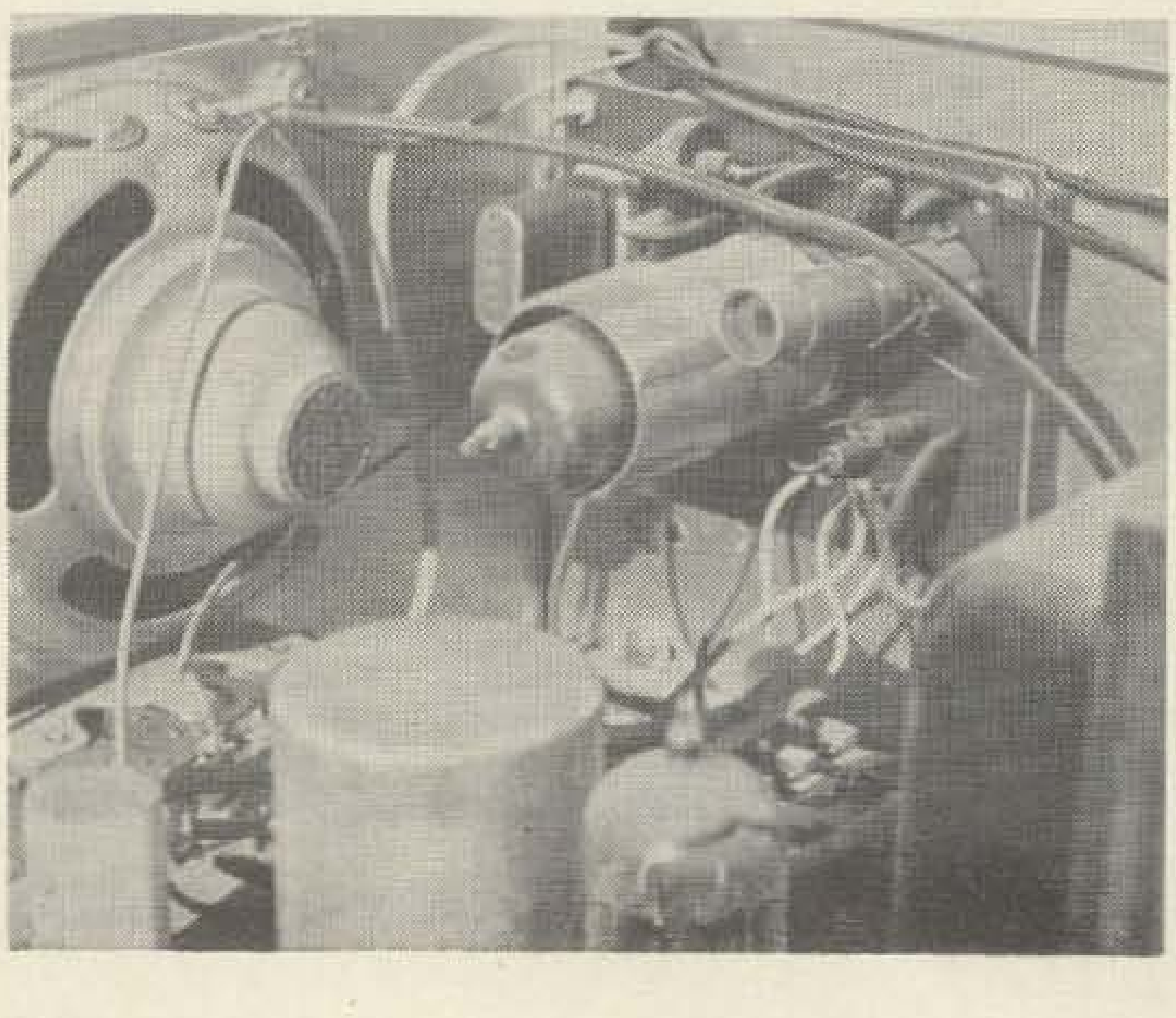
Discussion still rages about the Class D citizens band, and since we ain't mad at nobody we aren't taking any sides—but it's true that many persons are getting an introduction to radio communication through CB activity, and some of them are becoming hams.

Naturally, since ham-type operation is prohibited on 27 mc, they find they have an item of equipment which is unusable in their ham efforts.

Change of subject briefly. With sunspots on the rapid wane and the low expected some time early in 1964, the higher-frequency bands are going to become as dead as the VHF regions are now. The DX chasers are going to be forced to come down to 40 and 80, thus crowding the rag-chew gang and the mobiles to other bands.

The conversion procedure described here provides one answer to both the situations mentioned above. For the CBer-turned-ham, it's a way to use his existing equipment. For the mobileer crowded off the high end of 75, it's a fast way to get on another band which won't be so crowded.

The starting point is a CB transceiver in working order. We used an International KB-1, but similar principles apply to all of them and we'll take some time to show a few direct applications to other rigs.



Like many other CB rigs, the KB-1 is a superhet receiver combined with a 5-watt plate-input transmitter. Power supply and audio are shared by both transmitter and receiver. The conversion to ham-band usage consists of two steps: converting the receiver, and converting the transmitter.

Before we start converting, though, let's pick the band we're going to use. In this conversion, we're moving to 20 meters, on the assumption that 20 will be dead for DX within a year. Similar procedures would be used to go to any other band desired.

The KB-1 receiver is a double conversion type, with a crystal-controlled-converter assembly feeding a tunable *if* strip. This part of the conversion is simplicity itself, since International makes converter boards for the KB-1 covering 20, 15, 10, and 6 meters in addition to the CB board. Just get the replacement board, remove the original (unsoldering seven connections), replace it with the new one, and reconnect the seven leads. Receiver conversion is now complete.

The transmitter board of the KB-1 consists of one printed circuit board, bearing a crystal, two coils, some resistors and capacitors, and a 6AU8 tube. As shipped from the factory, the board is pre-tuned for operation at crystal frequency into a 52-ohm load at a power input of 5 watts.

For most efficient operation, some surgery was required on the 20-meter board installed here. Values of two resistors and one capacitor were changed, and three turns were removed from the plate winding of coil L2. Power output was raised from less than a watt to about 1.5 watts at the same input, and linearity of modulation was increased greatly. The changes are shown in detail on the schematic diagram. Since they will prob-

ably improve operation of the 15, 10, and 6 meter transmitter boards as well, let's examine the reasoning behind the changes.

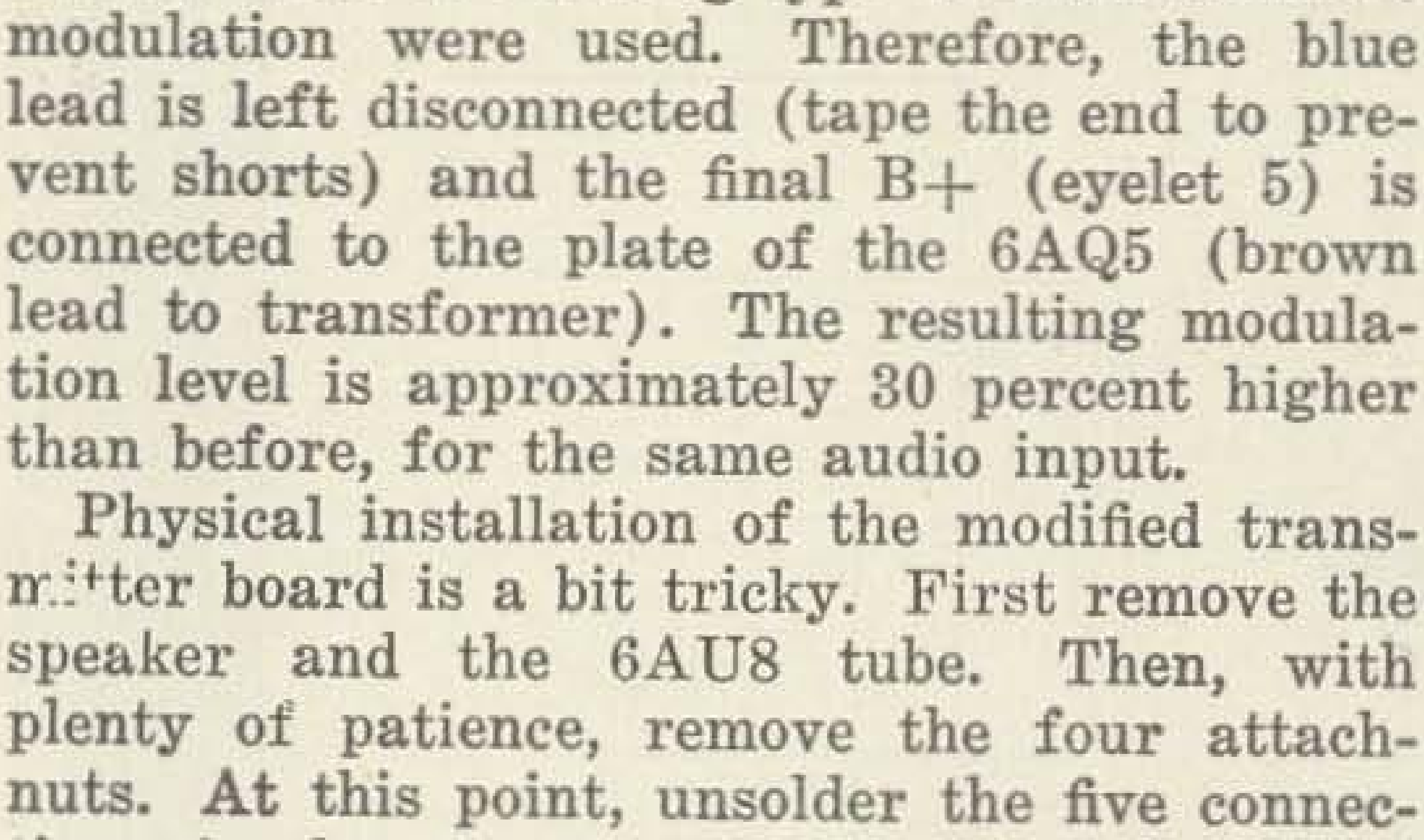
Capacitor C4 was increased in value to improve the Q of the output tank circuit; if an antenna of other than 50 ohms impedance is used, it might be well to leave C4 unchanged. The coil change increased output by increasing coil Q for the same amount of capacitance.

Resistors R1 and R3 were both originally 47K ohms, since in CB service the KB-1 output stage is operated as a frequency doubler. In this type of operation, high bias (obtained from large grid resistors) is essential to get any kind of efficiency in the doubling process. However, when the unit is operated straight through a crystal frequency, both resistors must be reduced to 15K ohms to increase the tube's conduction angle and thus improve power output.

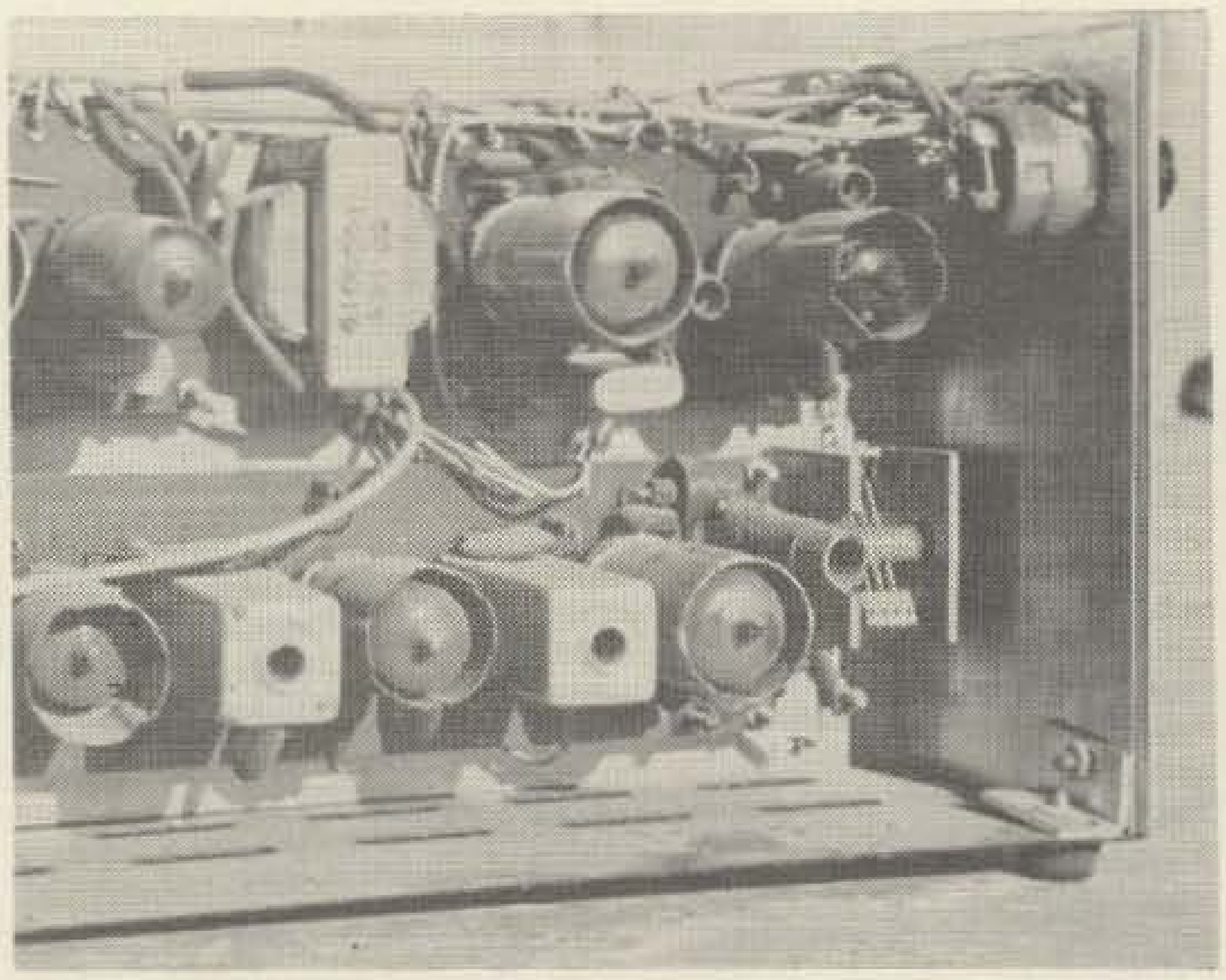
One other change is made in the transmitter-board installation. Originally, the blue lead of combination modulation-output transformer T1 supplied modulated B+ to the final. Tests showed that the mismatch introduced to the transformer resulted in less effective modulation than if Heising-type constant-current modulation were used. Therefore, the blue lead is left disconnected (tape the end to prevent shorts) and the final B+ (eyelet 5) is connected to the plate of the 6AQ5 (brown lead to transformer). The resulting modulation level is approximately 30 percent higher than before, for the same audio input.

Physical installation of the modified transmitter board is a bit tricky. First remove the speaker and the 6AU8 tube. Then, with plenty of patience, remove the four attachnuts. At this point, unsolder the five connections (eyelet 2 is blank) to the board and lift the board free. Install the new board, tighten the four nuts, and resolder the five connections, being sure to modify the final B+ connection as described above. Replace the tube, and finally mount the speaker back in place.

This completes the conversion, and you're ready to go on the air. Keep in mind that 1½ watts of output into the antenna isn't much on 20 at the moment, and don't expect to slam



Conversion to 20M: Change R1 to 15K, R3 to 15K, C4 from 36 mmfd (not 5 as marked) to 51 mmfd, and remove three turns from L2 primary. A 14,250 kc crystal will put you in the AM part of the phone band.



through over he California kilowatts! However, when the activity drops off a bit this unit should give an effective 10-mile working radius, adequate for local mobiling.

The receiver, rated at 0.2 microvolt sensitivity, is one of the hottest this writer has ever seen on 20. Its selectivity (10 kc at —30 db) could stand improvement, but when the band is relatively quiet this unit digs in and pulls the weak ones through. Even under marginal conditions, if the signal is present at all this receiver will make Q5 copy out of it. The squelch takes a couple of microvolts to operate, making it a bit of a luxury on 20, but when signals are strong enough to trigger it properly it works just like the book says.

Earlier, we said we'd show direct applications of this gimmick to other CB rigs. The modified KB-1 transmitter board (designated as unit D) is available from International, and may be used to replace the transmitter section of any CB rig which operates at 250-300 volts on the plates. The receiver boards are only applicable to double-conversion superhets with a 6-mc tunable *if*, though.

If your CB rig uses single conversion, or is a superregen, the best bet is to retune the front end and oscillator. Using a grid-dip meter, remove turns from the appropriate coils until the signal-frequency circuits tune to the ham band you want and the oscillator tank circuit tunes to the ham frequency *plus* the amount of the *if*. In other words, to tune 20 meters, adjust signal-frequency circuits to cover 14.2 to 14.35 mc and the oscillator circuit (if your *if* is 455 kc) to conver 14.655 to 14.9 mc.

Since the CB rigs do not include circuitry, and addition of a BFO would play havoc with the noise limiter and squelch, modification to cover CW bands or to receive SSB is not too practical. However, for low-power AM use, such a conversion makes a quick and simple mobile rig. The only thing lacking is power—and we're working on that. Look for a later article on a 50-watt outboard amplifier for the converted citizens bander. . . . K5JKX/6

Wm. W. Goldsworthy
W6BUV
41 La Encinal
Orinda, Calif.

Very

Portable,

All Band,

Single Sideband Transceiver

THE single sideband transceiver to be described was built mainly from war surplus parts but has the features, versatility, and performance found only in the best single sideband equipment. With a little bit of sweat, a lot of patience, plenty of time and a certain amount of scrutinizing at the local surplus stores, this entire rig should easily be built for under a hundred dollars.

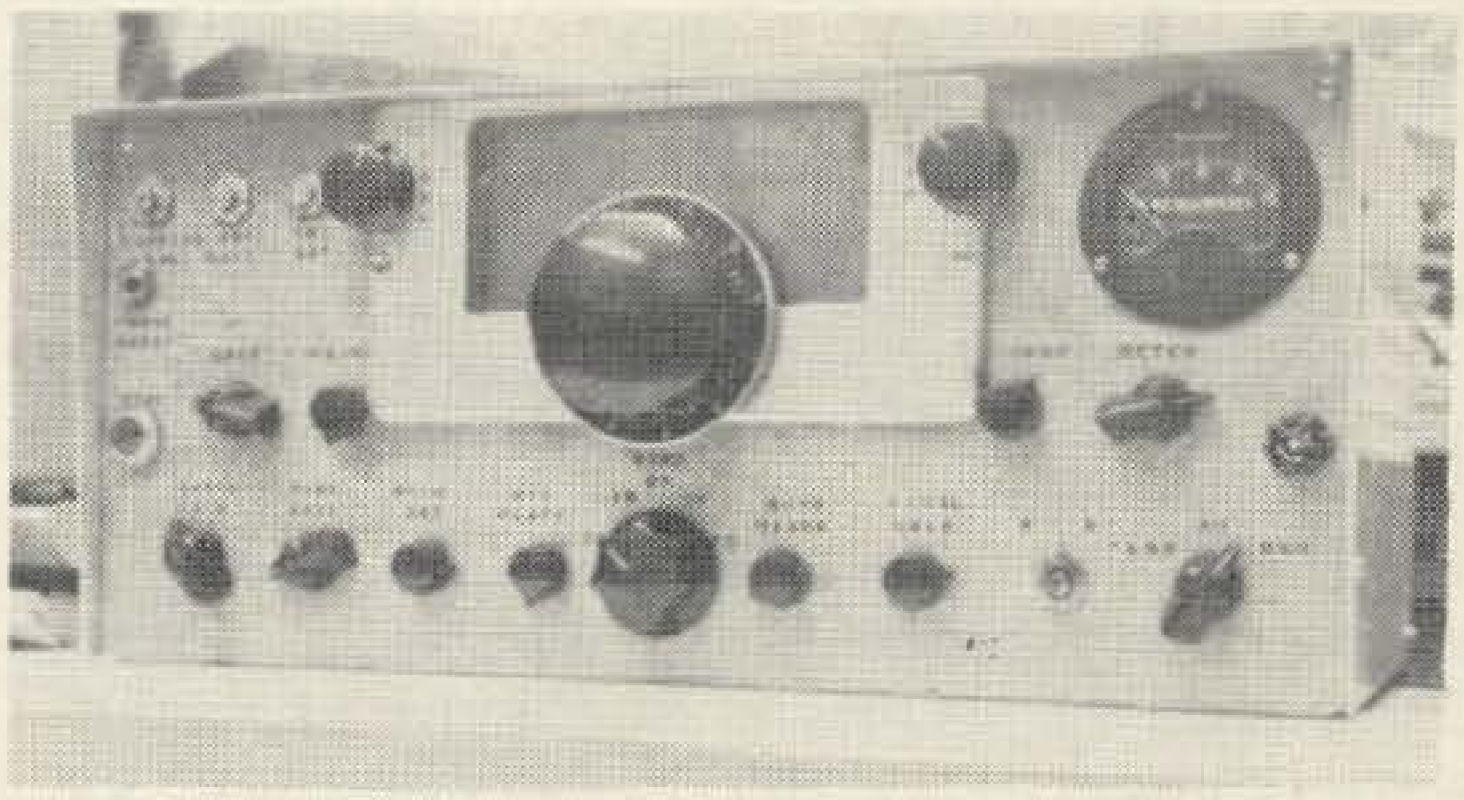
This single sideband transceiver covers all of the amateur phone bands from 10 through 75 meters. It will operate on upper sideband, lower sideband, or AM, has a peak power input capacity in excess of 200 watts, can be either manually or VOX operated, switches antennas when changing bands, has phone patch provisions, provides for the monitoring of final plate current, antenna current and external field strength, and is completely contained in a cabinet measuring only 15¾" long, 9" deep and 7" high.

To those of the ham fraternity who have operated SSB transceivers little need be said regarding their merits, especially when SSB mobile operation is contemplated.

Basically this transceiver is of quite straightforward design, using the filter method for suppression of the unwanted sideband and for providing an extremely high degree of receiver selectivity. Fig. 1, showing the block diagram, shows both transmitting and receiving sections of the transceiver sharing a common VFO, a common master osc. and a common *if* amplifier circuit.

An easy concept to understanding SSB transmitters is to think of them as a superheterodyne receiver in reverse, starting with an audio signal and ending with an rf signal.

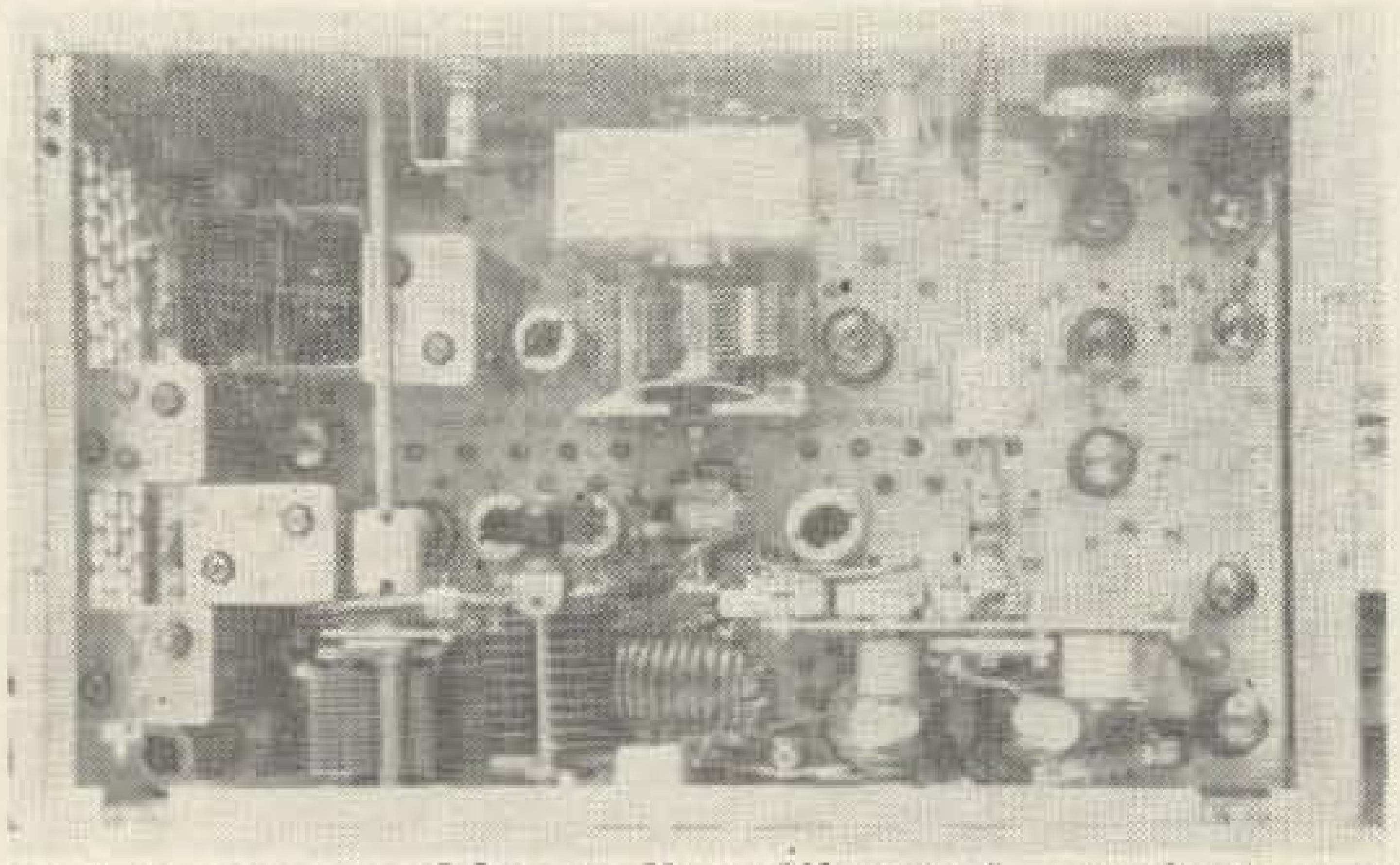
The use of a high frequency, high selectivity lattice filter eliminates the need for double conversion both in the transmit and receive



sections of the transceiver, since the high frequency of the *if* amplifier eliminates the problems of image rejection and the high selectivity of the lattice filter provides the degree of selectivity normally obtained only at low frequencies. This greatly simplifies both band switching and send-receive switching and greatly reduces the number of tubes and tuned circuits required without reducing performance. One of those high frequency lattice filters can be purchased for around $40 or can be readily assembled from surplus components for a couple of dollars and a little time.

In talking with many hams on the air, the mere mention of building a "filter rig" petrifies them and for the heck of it I cannot understand why. In reality, the filter rig takes less equipment for its alignment and construction than the phasing job, is just as easy to construct, and I am sure that most experienced SSB hams will agree with me that it is the preferable way to build a SSB rig. The performance of a transceiver using one of these high frequency half lattice filters compares very favorably with that obtained from the better quality sideband gear at a fraction of the cost of these commercially built units.

The ability to grind or etch crystals and wind coils, and the access to a VOM, a VTVM,



and a reasonably well calibrated receiver are the only prerequisites necessary to build this SSB transceiver.

To facilitate convenience of operation of this transceiver many features have been incorporated into its design, such as VOX operation, bandswitching, good selectivity, good bandspread, good stability, both SSB and AM operation, monitoring of antenna current as well as final plate current, and antenna switching with band switching. Also the rig had to be equal in quality to the better quality SSB gear, and be relatively easy to construct and service.

There are several circuits used in this transceiver that do not follow usual amateur SSB design. These are the use of a fully balanced modulator, a fully balanced product detector and a fully balanced mixer, the use of a high level mixer to directly drive the final amplifier, the use of proper matching between receiver mixer and the lattice filter to obtain higher receiver performance, the use of a built-in antenna current meter to facilitate tune-up, the use of a final amplifier screen regulator not using VR tubes, and the use of a coupling driver between the output of the *if* strip and the high level mixer or product detector to improve linearity.

Basically the transmitter rf section is quite simple and straightforward. A crystal controlled master oscillator develops the original signal at either a frequency of 5.438 mc or 5.442 mc, being either slightly lower or slightly above the *if* pass band, and as in most filter type SSB rigs, passes into a balanced modulator followed by a 2 section cascaded high frequency half lattice filter having a pass band of approximately 3 kc at 5.440 mc. The output of this filter is then amplified through 2 *if* amplifier stages operating at 5.44 mc and fed to the grids of a high level balanced mixer through a push-pull coupling follower. The cathodes of this high level balanced mixer are driven directly from the VFO plate tank through balanced coupling links and the output of this balanced mixer drives the parallel connected 6146's in the final amplifier.

The *if* amplifier, the VFO and the master oscillator are common for both the receive and transmit operations and all send-receive switching circuits with the exception of the antenna relay, are electronically switched to avoid the use of special relays in the send-receive switching operation.

The receiver section is also quite straightforward, consisting of an rf stage using a cascode connected 6BQ7, a mixer stage using a 12BE6, two *if* stages, an AM detector, a balanced product detector and two stages of audio amplification.

Very conventional audio, VOX, and anti-VOX circuits are included which provide for VOX operation, push-to-talk operation, manual operation and loudspeaker operation using VOX.

Use of High Frequency Lattice Filters

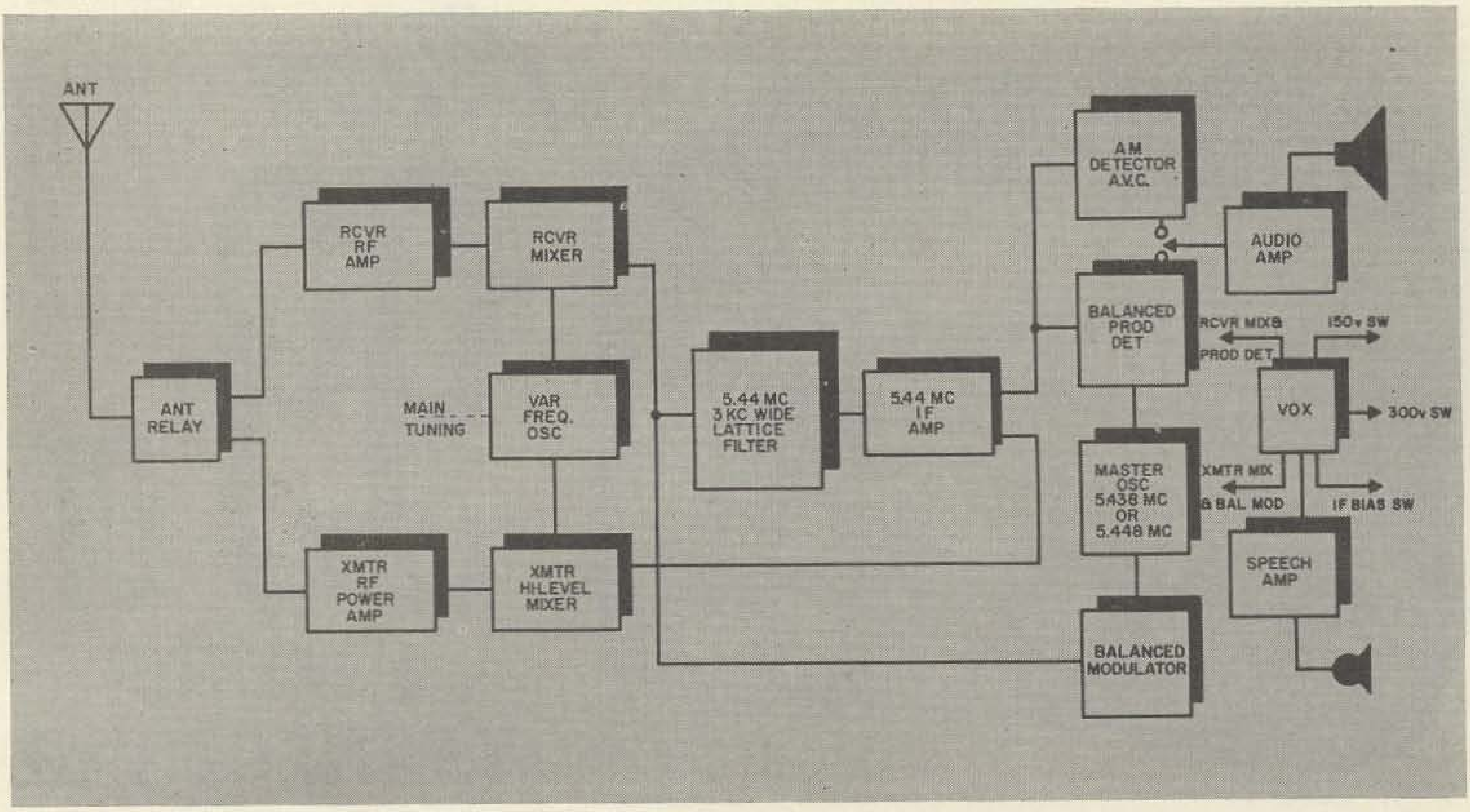
As more hams are experimenting with high frequency lattice filters, many of the techniques necessary for the proper adjustment and construction of these units are being determined. There have been a number of articles written regarding the construction of these filters as well as ways to improve their performance.[1]

Like most other experimenters, I dug into the problem of constructing a cascaded half lattice filter by reading the existing articles available and then doing the construction and testing. I was somewhat disappointed at first in the performance of these filters in that they exhibited too much dip in their pass bands and too low an impedance to match correctly with the output of a receiver mixer stage. Both of these shortcomings were finally overcome by the installation of a proper impedance matching network between the mixer output and the filter input, which greatly reduced filter insertion loss and produced flat topped band pass response. The impedance matching transformer used to couple into the lattice filter accomplishes an impedance transformation of about 10 to 1 to more properly match the lattice filter to the output of the mixer.

In constructing the cascaded half lattice filter it is important to have excellent isolation between its input and output terminals. This can be achieved easily by simple shielding procedures. The coupling transformer (T2) is constructed by bi-filar winding two lengths of #28 gauge wire on a ¾" toroid form.[1]

Use was made of surplus FT243 crystals in the 5.4 mc region for the elements of the lattice filter. These crystals, when properly aligned and used, will produce a flat band pass characteristic for about 3 kc with extremely sharp skirt selectivity and transmitter adjacent sideband rejection equal to the more expensive SSB commercial units on the market.

The first step in the construction of the lattice filter, which is the most important single unit in the transceiver, is to obtain several surplus FT243 crystals in the 5.5 mc region. These can be obtained reasonably at most surplus stores. Crystals in the frequency ranges between approximately 5.2 and 5.8 mc can be used, keeping in mind that these fre-



Block Diagram: SSB Filter Transceiver. Send-Receive switching is accomplished by: 1) Relay switching antenna circuits; 2) Electronically muting the receiver mixer and product detector in the transmit mode and muting the transmitter mixer and balanced modulator in the receive mode; 3) Switching if bias; 4) Switching 300 volts to receiver audio or final screen.

quencies are approximately halfway between the 7 and 3.5 mc bands, allowing for a reasonable separation between *if* and signal frequencies when operating these two bands. Grinding or etching of the crystals in the lattice filter should be done with enough accuracy to provide a separation of 1500 cycles between the crystal pairs.

When choosing the proper crystals at the surplus store, it is wiser to select those of a single make and frequency to insure similar crystal and holder dimensions. This will result in a minimum amount of crystal shifting. Once the crystals are ground and assembled, they can be soldered permanently into place in their shield can. Care should be taken in selecting crystals to insure that there are no spurious crystal responses of consequence within a 100 kc of the *if* pass band on either side.

Mixer Muting and Design

One source of difficulty experienced in the design of a transceiver is the problem of regenerative feedback occurring back through the unused mixer where the *if* amplifier is common is both receive and transmit modes. Unwanted oscillations will occur if means are not taken to insure that the transmitter mixers are completely muted in the receive condition, or if the receiver mixers are not muted completely during the transmit condition. The usual means of inactivating the mixers is to short one of the mixer inputs and remove the input signal from it, but this requires relay switching of the high frequency rf circuits. Another approach which is employed in this transceiver is to mute the unused mixers electronically by applying the correct bias to cut off the unused mixers. (The term "mixer" applies to mixers, balanced modulator and product detector, which are all forms of mixers.)

In order to keep the distortion products and spurious responses to a minimum, the high level mixer, the balanced modulator and the product detector are all of double balanced input design. The use of a double balanced mixer for driving the final amplifier stage allows for moderate power handling capability with fewer undesirable mixer products, greater attenuation of the VFO signal which is cancelled by the push-push arrangement of this stage and greater attenuation of the even harmonics of the *if* frequency, one of which appears near the edge of the 21 mc band.

The balanced product detector used in this transceiver has the advantage over the single ended variety in producing fewer undesirable mixer products. A true product detector should produce only products between the incoming signals and the local oscillator and not those between various incoming signals. The methods used here to accomplish this is to apply large oscillator signal level, low input signal level and to provide a push-push arrangement for cancelling the beats developed between various incoming signals in its audio output. Sideband quality comparable with AM is obtained by using a product detector of this design. This should really appeal to the died-in-the-wool AM boys.

The product detector circuit uses one double triode (V13). The grids of this tube are driven

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in push-pull from the attenuated output of transmitter mixer driver, applying only a small fraction of the *if* output signal to its grids. The cathodes are also driven in push-pull from one of the bi-filar wound link coils on the master oscillator (BFO) plate transformer (T5). The cathode resistor R79 has been selected to provide proper bias for good mixer operation. Grid signals which mix with each other due to the non-linearity existing in two tube halves of the product detector cancell in the anode circuit since the generated signals are 180° out of phase from each half.

The above reasoning about balanced product detectors was also applied to the balanced modulator stage which is also completely balanced with respect to both circuits.

VFO Circuit

Good oscillator stability is one of the most important considerations when dealing with SSB since a small amount of drift will require frequent retuning to reestablish intelligibility. This can be quite a nusiance to all concerned and can easily be avoided by careful planning. There have been numerous articles written regarding VFO's, VXO's and heterodyning oscillators. The VFO, of all of these types, takes the least amount of space and circuitry for the amount of flexibility and stability desired and with moderate care, excellent stability can be obtained on all bands. The simple variety VXO circuits were also considered with the conclusion that these were less stable than a good VFO.

All of the frequency determining elements in the transceiver have been placed where they will be away from heat. The Clapp type oscillator was chosen for the VFO circuit since its ability to isolate the effects of tube change on the oscillator frequency is extremely good. All components in the frequency determining circuits have been rigidly mounted and placed so that heating from other components is kept to a minimum. In the frequency determining circuits, good quality low temperature coefficient inductors and capacitors are used. Silver mica capacitors and low negative temperature coefficient ceramic capacitors are used along with good quality, HI-Q low temperature coeffcient B&W Miniductor stock.

In order to reduce frequency dependence upon the contact condition of the band switch, all frequency switching is accomplished only across low impedance parts of the frequency determining circuits. Capacitor C12 in the VFO grid circuit is used to prevent parasitic oscillation from occurring.

If the oscillator is properly built, stability in presence of plate loading changes, voltage changes, and temperature changes should be excellent, being more than adequate for good SSB operation on all ham bands from 75 through 10 M. Actually the largest effect of frequency change in a properly built Clapp oscillator comes from filament voltage change. This being a considerably larger effect than from plate and screen changes. This constitutes no problem when ac line operation is used, but does when an automobile electrical system is used with its inherently poor voltage regulation. If mobile operation is contemplated, the power supply should contain provisions for regulating the VFO filament, such as a shunt zener diode or a series transistor regulator.

Miscellaneous Considerations

In dealing with any transmitter using linear amplifiers, it is of utmost importance to provide good neutralization. Anyone who thinks he can get away with neutralizing a class AB1 linear without providing a large amount of grid swamping, is in for a shock when he tries it. A quick calculation of the amount of rf feedback through the inter-electrode capacities of a beam power tetrode such as a 6146 into a high impedance grid circuit, is certainly a great convincer. Balanced bridge neutralization, which is a convenient way of providing grid neutralization for a tetrode amplifier stage, was used mainly for its compatability with simple band switching circuits. Since the final amplifier driver is a mixer stage, there is no need for its neutralization since all inputs and outputs are on widely separated frequencies. There is also less need for circuit isolation from input to output of this stage for the identical reason.

Tuning Controls

Front panel adjustment of all bandswitched rf circuits is provided by front panel controls to insure the ability to tune all circuits accurately. Each of the individual tuned circuits has an individual trimmer placed across it to allow preset alignment for each band, thereby reducing tune-up time when changing bands.

The main tuning dial which controls the VFO frequency provides a frequency coverage only across the amateur phone bands from 10 through 75 in five bands. This provides the high degree of band spread desirable for SSB operation. Normally, controls other than the main dial need not be realigned with band switching when proper alignment of each band has been once attained.

A control is also provided on the front panel for carrier injection when talking to hams using ancient modulation.

The transceiver was also well tested for TVI with excellent results. Without any additional filtering of the antenna output, no difficulty was encountered with a TV set located two feet away from the rig with feedline closely paralleling for at least 10 feet.

Construction Details

Above all, in a unit of this size and com-

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plexity, a certain amount of care must be exercised in its layout. To facilitate easy duplication of the unit as far as general, layout Fig. 2 shows the basic chassis layout that should be followed to prevent unwanted feedback. This layout is the result of a very careful study of all problems concerned and represents one of the best possible parts layouts for ease of assembly, ease of servicing and freedom from unwanted circuit coupling.

Most of the wiring is all point-to-point with the aid of terminal strips, with the exception of filament wiring, control wiring, power wiring and some audio circuit wiring. All rf wiring is kept short to prevent circuit interaction, and a minimum amount of shielding is used to reduce the number of chassis fabrications needed.

Since many hams wishing to duplicate this transceiver will undoubtedly wish to use as much junk box and surplus components as possible, I will attempt to point out what should or should not be used in certain cases.

VFO Construction

All of the VFO components should be rigidly mounted to avoid shift of frequency from shock or vibration and should be mounted away from heat generating components such as vacuum tubes, power resistors, VR tubes, etc. If the proposed chassis layout is followed, this will occur automatically.

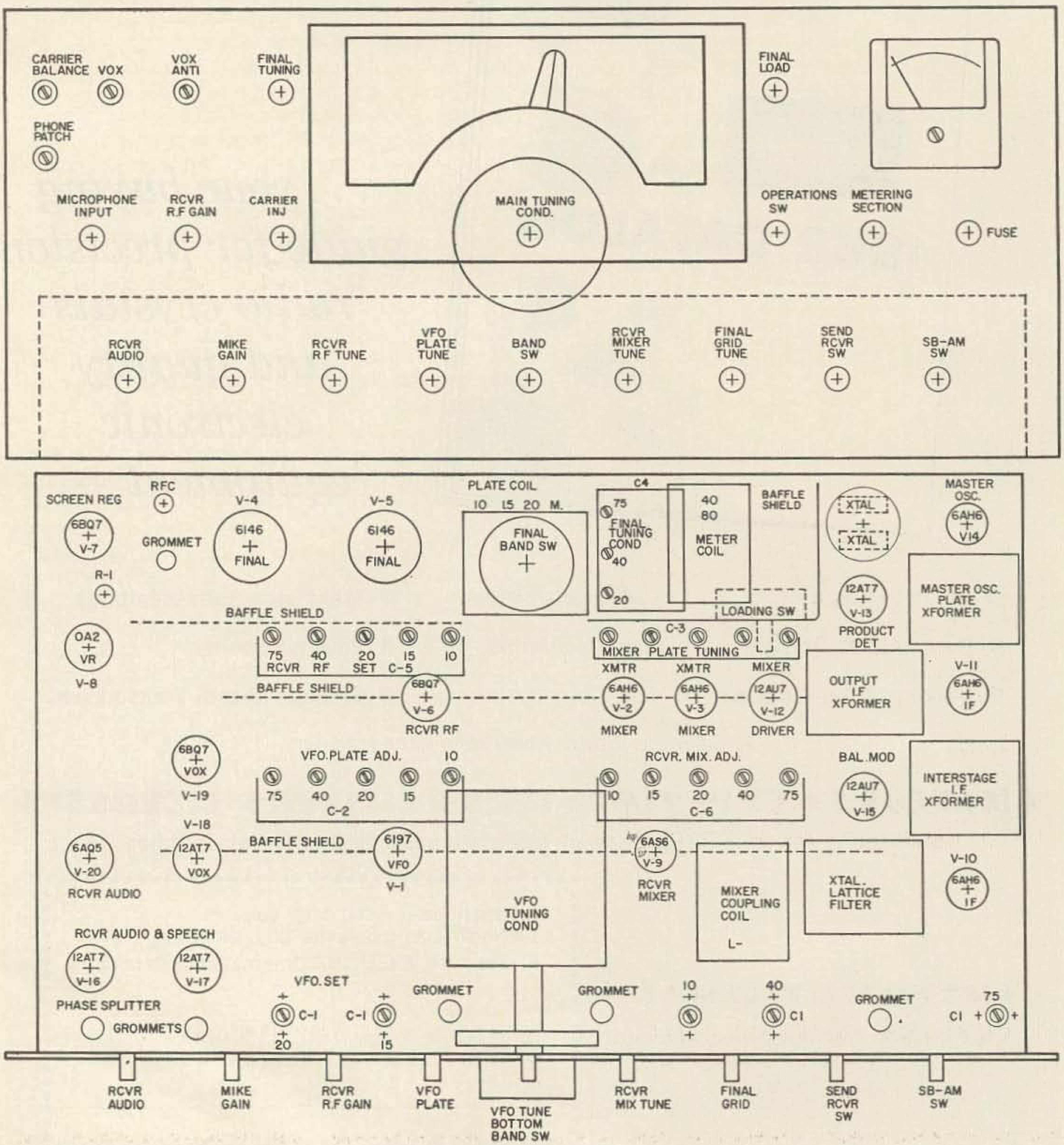
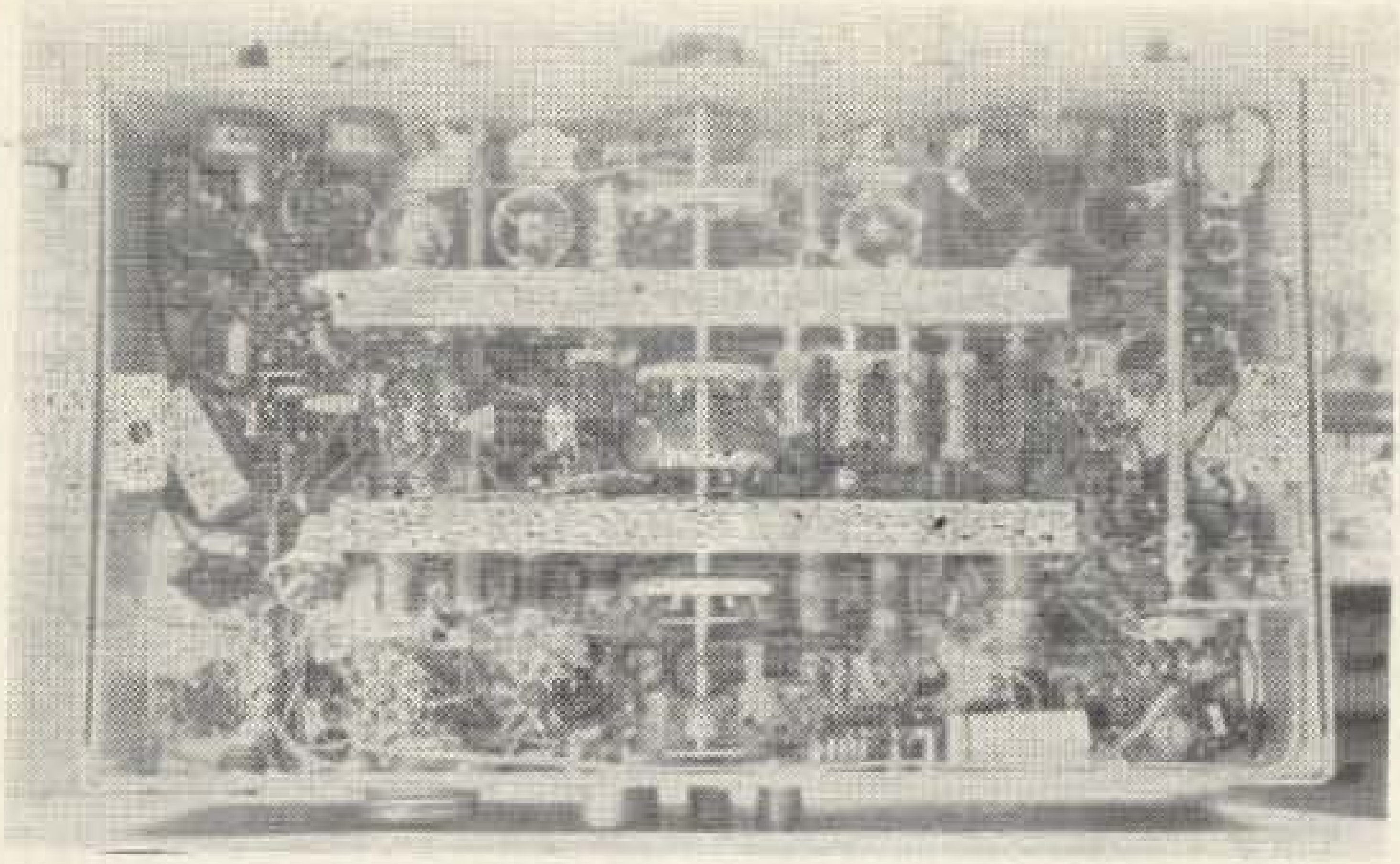


Fig. 2



As has been pointed out earlier in this article, excellent frequency stability can be easily obtained from a Clapp oscillator if a few simple precautions are followed. These are: to rigidly mount all components, to use inductors having high Q and high thermal stability, to use a good grade of low temperature coefficient capacitor for the frequency determining circuits, to provide band switching in only the low impedance parts of the frequency determining circuits, to apply regulated voltage at least to the screen of the oscillator, and to place the oscillator tube's grid-cathode circuit across as low impedance part of the oscillator grid tank as possible.

Some temperature compensation may be desirable and can be placed into the tuned circuits of the oscillator upon final alignment. Almost all of the compensation that is finally needed to provide a minimum of frequency drift on warm up will be necessary because of the positive coefficient of drift of the oscillator tank circuit inductors, and the better the choice of inductors, the less need there will be for temperature compensation. Also, these inductors should have as high a Q as possible, since higher values of Q permit a looser coupling of the frequency determining tanks to the oscillator tube, thereby reducing frequency shifts caused by tube parameter variations, such as filament and anode voltage shifts. The commercially available B&W Miniductors are one of the best choices for oscillator tank inductors as these units have extremely high Q's and exceptional temperature stability. Filament voltage shift is the more serious of the above mentioned tube parameter variations, and causes a shift not only in the operating transconductance of the oscillator tube, but also a much larger effect, the shift in the oscillator tube's grid input capacity by thermal effects.

A good quality dial and condenser assembly should be used to provide stable and convenient SSB operation. The dial should preferably have a high reduction ratio for smooth SSB tuning, and the condenser should preferably be one in which the rotor grounding is accomplished through wipers rather than through ball bearings, as ball bearing ground returns can cause considerable frequency instability. There are a number of good dial condenser combinations on the surplus market, and the one used in this transceiver was one designed for use in the National RAO surplus navy receivers. This particular condenser had to be cut down from three to one section to fit in the available space, and a condenser was employed in series with this condenser in order to reduce its tuning capacitance from 240 to 100 mmfd and to improve its tuning linearity.

Placement of the various oscillator grid tanks where they have adequate spacing from ground is desirable and no difficulty should be encountered in running fairly long leads from these tank circuits, through the bandswitch and to the oscillator's grid and cathode, if a single precaution is taken. This precaution is to place a capacitor of about 40 mmfd directly from the grid of the oscillator tube to ground at the oscillator tube's socket. This capacitor will prevent the oscillator from going into parasitic oscillation because of the lead inductance in the wiring between the oscillator tube and the frequency determining tank circuits.

Care should also be used in adjusting the Clapp oscillator to prevent squeezing, which may occur if the grid resistor is too high in value or if too much feedback is used. Feedback in the Clapp oscillator is easily controlled by varying the ratios of the grid-cathode capacitors with respect to the other series capacitors in the oscillator tank circuit. Unfortunately, a change in these ratios will also produce a change in frequency coverage provided by the main tuning condenser, which is in parallel with the grid-cathode capacitors, but with a little juggling of the coil inductance, the proper amount of band spread for the main tuning dial can be easily obtained on each amateur band. The oscillator tuning condenser is the only one connected to the main tuning dial, and readjustment of the other tuned circuits which are pre-aligned for each amateur band is only necessary when covering the entire ranges of the 75 and 10 meter bands. These other tuning adjustments, which are receiver mixer tuning, oscillator plate tuning, receiver rf tuning and final grid tuning are conveniently grouped on each side of the band switch knob for easy retuning.

In order to reduce the effects of frequency pulling when tuning the plate of the oscillator or when changing its load, as in the case of switching the final driving mixer on and off during the transmit and receive switching, frequency doubling is done in the oscillator on all bands.

A single inductor is used in the plate circuit of the VFO for all amateur bands. This is done for two good reasons. The first being that fewer band switching positions are needed on the main band switch, and secondly, only one balance adjustment need be made on the links coupling to the final amplifier driving mixers cathodes for all bands. Voltage drives to the cathodes of this mixer must be well balanced to prevent the oscillator signal and the even harmonics of the *if* frequency from appearing in the final amplifier's grid circuit. One pole of the band switch is used to switch the various size capacitors needed across the oscillator's plate tank for proper resonance on each band and to also switch in the appropriate tank loading resistors, whose function it is to equalize oscillator output with band changing in order to maintain uniform mixer drive on all bands. The various oscillator plate trimming capacitors should be adjusted so the oscillator plate circuit resonates in the center of each band with the front panel oscillator plate control set at mid-range. This procedure also applies to the tuning of the receiver mixer, the receiver rf, and the final amplifier grid tuning circuits.

There are a few more words of caution in regards to frequency stability of the VFO. Make sure that grounds made with any bare wire, like the return leads of one of the VFO frequency determining capacitors, be not allowed to rest against the chassis except at the point of intended connection, as the change in lead inductance will have effect on the frequency. It is also advised that all shafting in the vicinity of the oscillator coils be non-metallic, since those metallic shafts can cause shorted, unstable coupling circuits with the oscillator tanks. Even the two shafts driving the final tuning and final loading capacitor should be broken with insulators to avoid any undesirable coupling with the oscillator. Both of the above causes of instability were actually encountered and had to be corrected.

Balanced Final Amplifier Driving Mixer

This stage is driven by the VFO output in a push-pull cathode drive arrangement and by the output of the *if* strip in a push-pull grid drive arrangement. A double push-pull drive parallel plate arrangement was chosen to provide a great deal more attenuation to oscillator frequency, *if* frequency and even harmonics of the *if* frequency than can be obtained from single ended mixer arrangements. Fewer additional tuned circuits are therefore required to suppress the unwanted mixer products to a desired low level.

A grid driver consisting of a push-pull cathode follower is used to provide low distortion drive to the current drawing grids of the mixer and a small portion of these signals are also tapped off to drive the product detector grids. Because of the proximity of the mixer drive circuits to the receiver mixer, ground returns from both of these stages should be separated as widely as possible to prevent feedback at the *if* frequency. To further reduce the tendency for regeneration at *if* frequency, the grid cathode circuit of the balanced mixer is neutralized to prevent feeding of the *if* output through the grid cathode capacitance of the mixer into the oscillator circuit, back through the receiver mixer, and then into the *if* amplifier again.

Actual balancing of the mixer drive from the oscillator is accomplished by shifting the position of the three turn link coils mounted at each end of the oscillator plate tank. The outputs of these link coils must be phased and adjusted properly so as to produce two equal potential out of phase voltages of approximately 7 to 10 volts on all bands.

Receiver Mixer

The receiver mixer is of quite conventional design using a 12BE6 pentagrid converter tube. Some care is, however, needed in preventing the over-driving of the signal input grid of this mixer from unwanted oscillator coupling. A reasonable amount of judement in the placement of the VFO plate coil and the mixer grid coils will produce the desired degree of isolation without additional shielding. The oscillator plate coil should be placed at right angles to the mixer coils at a reasonable distance away. Over-drive with oscillator signal at the mixer's grid will produce a loss in conversion transconductance, and will be noticeable, if present, by a decrease in gain accompanying the proper resonating of the oscillator plate tuning. The actual loss in conversion transconductance occurs when grid circuit rectification produces large bias changes.

IF Amplifier

This amplifier, operating at approximately 5440 kc, uses two stages; the first being driven by the low impedance output of the lattice filter, therefore requiring no neutralization, and the second one being driven from the high impedance output of the first *if* amplifier and requiring neutralization. To anyone who does not believe in neutralizing high frequency *if* stages, a quick calculation of the amount of signal fed back through the low value of grid plate capacitance of a pentode to its high impedance grid circuit should be the only argument needed. Of course, it is possible to load the grid circuit with a resistor to prevent oscillation, but only at the expense of *if* gain and selectivity. At first glance, selectivity seems unimportant because of the lattice filter, but the greater the *if* selectivity after the filter, the better will be the rejection of any unwanted spurious crystal responses in the vicinity of the *if* frequency.

Neutralization of the last *if* stage is by balanced bridge neutralization and requires only the addition of two small condensers and a resistor.

Detectors

There are two detectors provided; one for AM reception and one for SSB reception. The AM detector which also provides AVC voltages, is a full wave diode rectifier circuit, and the SSB detector is a balanced product detector. AVC action on AM is of the normal type, while AVC action on SSB is of the fast charge, slow discharge type. AVC action on SSB delivers the proper signal level to the input of the product detector for all signal levels, thereby producing distortion free SSB reception.

Audio circuits in the receiver section are quite conventional and the audio output stage is muted during the transmit phase to prevent driving from the AM detector which is active on both transmit and receive conditions. Muting is accomplished in the audio output amplifier circuit by removing the screen voltage from this stage and placing a small amount of negative voltage to this screen.

Master Oscillator

This oscillator, which is crystal controlled and operates slightly below or above the lattice filter's pass band for upper sideband, AM and lower side band operation, provides the BFO injection signal to the product detector in the receive condition and the master oscillator signal to the balanced modulator in the transmit condition. The two frequency determining crystals are switched in by the USB-LSB-AM selector switch with one of the crystals being used also for AM, and this switch also selects the type of AVC action desired automatically, provides detector audio output switching automatically, and allows the oscillator screen voltage to be switched off in the AM receive conditions to eliminate the local injection signal.

Coupled to the master oscillator's plate tank are two link coils, one going to the product detector cathodes and one to the balanced modulator cathodes, respectively. Both of these link coils are bi-filar wound so as to produce balanced push-pull voltages for good balance in the product detector and the balanced modulator. The placement of the product detector and balanced modulator in close proximity to the master oscillator plate coil was carefully planned, so that as short a run possible is made with oscillator signal leads. An excess amount of radiation from the master oscillator signal will seriously impair the operation of the *if* amplifier by over driving the *if* amplifier with oscillator signal, thereby reducing the signal *if* gain by allowing amplified oscillator signals to be fed into the AVC rectifier circuit.

Balanced Modulator

This modulator is one in which both audio and master oscillator are fed in push pull, and the outputs are parallel connected. Further improvement in carrier balance is accomplished by the cathode plate capacitor balance adjustment provided. This adjustment is made for a minimum of carrier feed-through during final alignment.

Receiver RF Stage

This stage is a cascode connected amplifier of standard design. Muting of this stage is necessary on the transmit condition to prevent unwanted feedback; this being accomplished by applying positive bias to the cathode of this stage during the transmit cycle.

Final Amplifier

The final amplifier uses a pair of parallel connected 6146's. This amplifier is operated in class AB1 and will handle in excess of 200 watts PEP input on SSB. Neutralization is provided by balanced bridge grid neutralization which is absolutely necessary.

The output of the 6146's is fed into the Pi network output circuit which has provision for pre-alignment of the loading for each band. Provisions are also made for switching of all antennas with the main bandswitch, if desired. The usual plate parasitic chokes are included, and screen and cathode by-passing is made with .01 disc. capacitors directly from socket pins to ground. No trouble was encountered with the final amplifier once neutralization was performed. A slight departure is made from the usual VR tube screen regulator, and in its place is used a cathode follower screen regulator. This regulator has the advantages over the VR tube types in that low regulator idling current is maintained, the operating voltage of the regulator can be easily changed, and only one tube is required in comparison to at least two VR tubes.

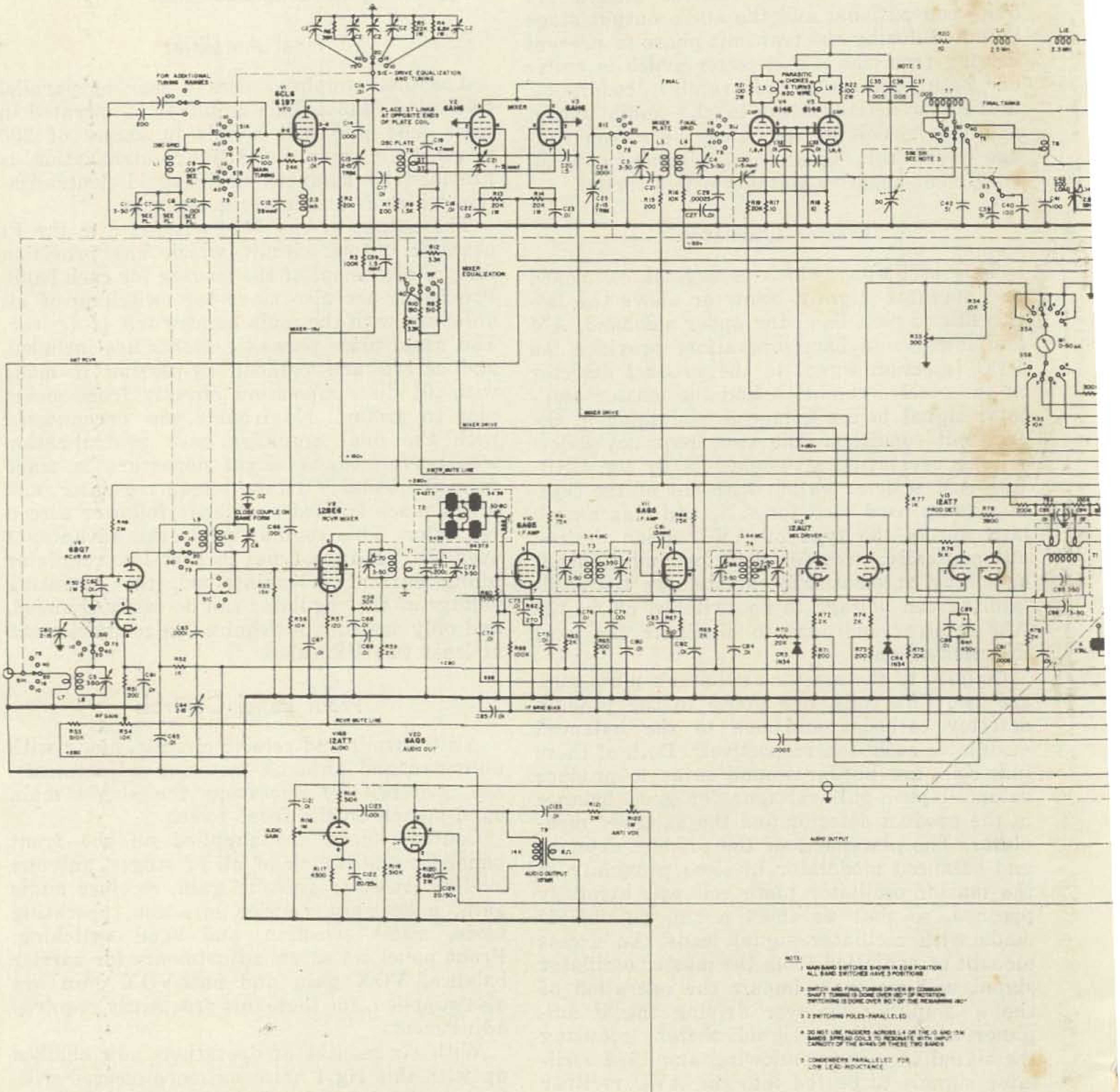
Front Panel Controls

All transmit and receive circuits, along with antennas and antenna metering adjustments, are switched by operating the single main band switch on the front panel.

Control knobs are supplied on the front panel for the tuning of all rf stages, antenna loading, receiver gain, rf gain, receiver audio gain, mike gain, carrier injection, operating mode, meter selection, and band switching. Front panel set screw adjustments for carrier balance, VOX gain and anti-VOX gain are also supplied, for these less frequently required adjustments.

With six months of operations now chalked up with this rig I am even more pleased with it than the day I first put it on the air. Operating it has been a real pleasure and using it as a portable has been effortless. I won't make the usual claims of the large amount of DX worked but I will say that the rig has as much punch as any of the SSB exciters or mobile transceivers, is more compact and is the first complete radio station I have had that can be carried to the car in only one trip.

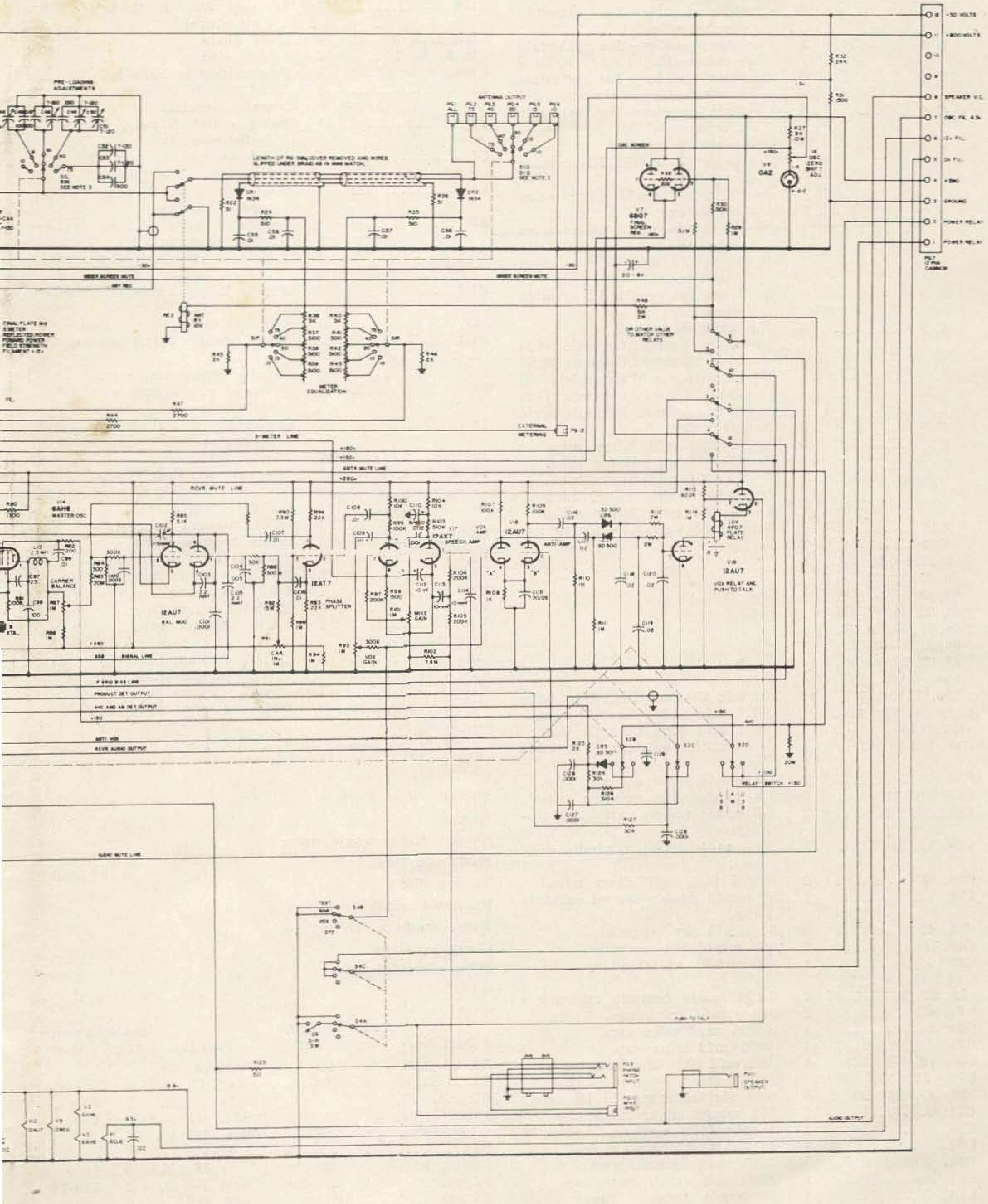
1. Vesper, Surplus High Frequency Crystal Filters, QST Jan. '59.
2. Vesper, Mobile SSB Transceiver, QST June '59



BAND	RANGE L1 MUST TUNE IN MC	
10M	11.580	11.680
15M	7.880	7.980
20M	4.380	4.450
40M	6.320	6.380
75M	4.620	4.720

BAND	RANGE T8 MUST TUNE IN MC		TUNES
10M	23.160	23.760	28.800 29.200
15M	15.760	15.960	21.200 21.450
20M	8.660	8.840	14.150 14.350
40M	12.840	12.740	7.200 7.300
75M	9.240	9.440	3.800 4.000

C2 C3 C4 C5 C6	
10M	15-7mmf
15M	15-7mmf
20M	3-30 mmf
40M	7-45mmf
75M	7-45mmf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PARTS LIST

Part Number	Quantity	Description
C 1	5	Ceramic padder—See schedule on schematic
C 2	5	Ceramic padder—See schedule on schematic
C 3	5	Ceramic padder—See schedule on schematic
C 4	5	Ceramic padder—See schedule on schematic
C 5	5	Ceramic padder—See schedule on schematic
C 6	5	Ceramic padder—See schedule on schematic
C 7	5	Approximate values B—10 m 175 mmfd Silver mica capacitor A—15 m 85 mmfd Silver mica capacitor N—20 m 100 mmfd Silver mica capacitor D—40 m 225 mmfd Silver mica capacitor S—75 m 100 mmfd Silver mica capacitor
C 8	5	Approximate values B—10 m 30 mmfd Ceramic N080 A—15 m 15 mmfd Ceramic N080 N—20 m 15 mmfd Ceramic N080 D—40 m 30 mmfd Ceramic N080 S—75 m 15 mmfd Ceramic N080
C 9	5	Actual values
C10	5	B—10 .001 mfd Silver mica A—15 .001 mfd Silver mica N—20 .001 mfd Silver mica D—40 .0015 mfd Silver mica S—75 .001 mfd Silver mica
C11		100 mmfd variable—See text
C12		
C13, 17, 18, 22, 23, 26, 27, 31, 32, 33, 34, 55, 56, 57, 58, 61, 62, 65, 67, 68, 69, 73, 74, 75, 76, 80, 82, 83, 84, 85, 88, 92, 93, 94, 99, 106, 107, 108, 109, 121, 125	41	.01 mfd Ceramic Disc. Cap. 600v
C14, 24, 63, 126,		.0001 mfd 600v Ceramic Cap.
127, 128	6	.0001 mfd 600v Ceramic Cap.
C15, 25, 60, 64	4	2-12 mmfd miniature variable cap.
C19	1	4.7 mmfd 600v ceramic cap.
C20, 59, 81	3	1.5 mmfd 600v ceramic cap.
C21, 30, 102	3	1-5 mmfd piston variable (miniature)
C28, 35, 36, 37	4	.005 mfd 2000v ceramic disc. cap.
C29, 97	2	.00025 mfd 600v silver mica
C38	1	50 mmfd double spaced variable cap.
C39, 42	2	51 mmfd 3kv ceramic
C40, 41	2	100 mmfd 3kv ceramic
C43	1	200 mmfd variable cap.
C44, 45, 48, 50, 51, 52, 53	7	7-120 mmfd ceramic trimmer
C46, 47	2	100 mmfd mica cap.
C49	1	.00025 mfd mica cap.
C59	1	.0005 mfd mica cap.
C66, 79, 111, 123	4	.001 mfd 600v disc. ceramic cap.
C70, 72, 77, 78, 86, 87, 95, 96	8	3-50 air trimmers—in IF cans
C71	1	200 mmfd silver mica cap.
C89	1	8 mfd 450v electrolytic cap.
C90	1	.00025 mmfd ceramic cap.
C91, 100, 104	3	.0005 mfd ceramic cap.
C98	1	.0001 mfd silver mica cap.
C101	1	50 mmfd ceramic cap.
C103, 105	2	2.2 mmfd ceramic cap.
C110	1	2 mfd 450v Electrolytic cap.
C112	1	10 mfd 6v Electrolytic cap. (miniature)

Part Number	Quantity	Description
C113, 114	2	10 mmfd ceramic cap.
C115, 122	2	20 mfd 25v Electrolytic cap. (miniature)
C116, 117, 118, 119, 120	5	.02 mfd ceramic disc cap.
C124	1	20 mfd 50v Electrolytic cap. (miniature)
CR1, 2, 3, 4	4	IN34 diode
CR 5, 6, 7	3	SD500 diode
Crystals	6	Approximately 5500 kc
S1	1	Band switch 10 pole, 5 pos., 5 wafer ceramic
S2	1	Band switch 8 pole, 5 pos., 4 wafer ceramic
S3	1	Band switch 1 pole, 3 pos., Ceramic
S4	1	Switch 2 pole, 4 pos., miniature (shorting)
S5	1	Switch 2 pole, 6 pos., miniature (shorting)
RE1	1	4 pole, 2 pos., miniature relay (10 ma coil)
RE2	1	2 pole 2 pos., miniature relay (6 ma coil)
M1	1	0-50 ma meter
PG1, 2, 3, 4, 5, 6, 7	7	coax female (831R amphenol)
PG8	1	12 pin female connector
PG9	1	3 sleeve phone jack-with extra circuit leaves
PG10	1	Amphenol 2 pin female mike connector
PG11	1	Phone jack
T1, 2, 3, 4, 5, 6, 7, 8, 9	9	See coil winding charts
S6	1	S.P.S.T. toggle sw.
V1	1	6CL6 vacuum tube
V2, 3, 14	3	6AH6 vacuum tube
V4, 5	2	6146 vacuum tube
V6, 7	2	6BQ7A vacuum tube
V8	1	OA2 Regulator
V9	1	12BE6 Vacuum tube
V10, 11	2	6AG5 vacuum tube
V12, 13, 15, 18, 19	5	12AU7 vacuum tube
V16	1	12AT7 vacuum tube
V17	1	12AX7 vacuum tube
V20	1	6AQ5 vacuum tube
L1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	14	See coil schedule

Miscellaneous Parts

Knobs

Shafts, Right angle drive

Shaft couplings

Tuning dial

Insulated shaft couplings

Nuts, washers, bolts

Chassis—cabinet

Wire—Shielded wire

Resistors

Part No.	Quantity	Description	Part No.	Quantity	Description
R2, 32	2	24K	R37, 38, 39, 41, 42, 43, 85	7	5.1k
R2, 7, 82, 15	4	200	R44, 47	2	2700
R3, 64, 65, 66, 81, 99, 107, 109	8	100k	R45, 59, 46, 63, 69, 72, 74, 78, 125	9	2000
R4	1	6.8k-1w	R48, 76	2	51k-2w
R5, 93, 96	3	22k-1w	R49, 112, 113, 121	4	2M
R6	1	39k-1w	R51	1	200
R8, 60	2	1500	R52, 77, 123, 79	4	1k
R9, 10, 24, 25, 67, 73	6	510			
R11	1	3.3k			
R12	1	3.9k			

R13, 14 ...	2	20k-1w
R16, 34, 35, 56, 100, 104	6	10k
R17, 18....	2	10
R19, 70, 75	3	20k
R20	1	10-1w
R21, 22 ...	2	100-2w
R27	1	10k 10w
R28	1	200
R54	1	10k pot.
R57	1	120
R58	1	30k-2w
R61, 68 ...	2	75k-1w
R62	1	270
R71	1	510
R80	1	1300
R83	1	20M
R84, 88 ...	2	300k
R30, 53, 103, 118, 119, 126	6	510k
R29, 50, 86, 89, 94, 110, 111, 114 .	8	1M
R31, 98 ...	2	1500
R33	1	500 ohm pot.
R36, 40 ...	2	3k
R87, 91, 95, 101, 116, 122	6	1M pot.
R90	1	7.5M
R92	1	15M
R93, 96 ...	2	22k-1w
R97, 105, 106	3	200k
R108	1	1k
R117	1	4300
R120	1	680-1w
R124, 127..	2	30k

Ed. Note: All resistors ½ watt, uniess otherwise stated.

Transformers	Pri	Sec 1	Sec 2	Pri-Sec Spacing
T1 Mixer Coupling 5.4 mc	65t #30 ⅝" dia. Close wound	20t #30 ⅝" dia. Close wound		Close wound
T2 Xtal Coupling 5.4 mc	2-25 turn bi filar wound on 1" dia. Toroid. #24 gr.		Total winding 80μh	
T3 Interstage IF 5.4 mc	50t #30 ⅝" dia. Close wound	50t #30 ⅝" dia. Close wound		½"
T4 Output IF 5.4 mc	50t #30 ⅝" dia. Close wound	50t c.t. #30 ⅝" dia. Close wound		½"
T5 Master Osc. Plate 5.4 mc	40t #30 ⅝" dia. Close wound	10t c.t. #30 Bifilar Wound	10t c.t. Bifilar Wound	
T6	13t #20 ½" dia. Close wound	3t #20 Insulated wire Close wound	3t #20 Insulated wire Close wound	Adjust to Supply 7-10v to cathodes of mixer
T7	10t #12 Air Wound 1⅛" dia. 1⅝" Long-tapped 4t and 6t			
T8	16t #14 on 1½" dia. form close wound—tap 11t			
T9	Output Audio transformer 14000—8 ohms			

Coil Winding Data

Band		L1	L3	L7	L8	L9	L10
10M	Turns Winding length Diameter	7½t 8t per inch 1" Miniduc- tor	8t #20 ⅝" Air wound ⅝"	2t #20 Close wound ½"	9t #20 ⅜" ½"	9t #20 Close wound ½"	9t #20 ⅜" ½"
15M	Turns Winding length Diameter	13½t 16t per inch 1" Miniduc- tor	12t #20 ⅞" Air wound ⅝"	3½t #20 Close wound ½"	11t #20 ½" ½"	11t #20 Close wound ½"	12t #20 ⅜" ½"
20M	Turns Winding length Diameter	26t 32t per inch 1" Miniduc- tor	12t #24 ¼" ⅝"	4t #22 Close wound ½"	19t #22 ½" ½"	17t #22 Close wound ½"	19t #22 ½" ½"
40M	Turns Winding length Diameter	14½t 16t per inch 1" Miniduc- tor	20t #24 ¼" ⅝"	7t #26 Close wound ½"	35t #28 ½" ½"	30t #28 Close wound ½"	35t #28 ½" ½"
75M	Turns Winding length Diameter	26t 32t per inch 1" Miniduc- tor	35t #28 ½" ⅝"	11t #28 Close wound ½"	55t #28 ¾" ½"	50t #28 Close wound ½"	55t #28 ¾" ½"

L2—2.5 mh RF Choke
L4—Same as L3, ⅜" spacing between coils
L5, 6—6t #20 wound on 100Ω 2w Resistor
L7, 8—Close spacing between coils
L11, 12, 13, 14—2.5 mh RF Chokes

$6 Quad for Six

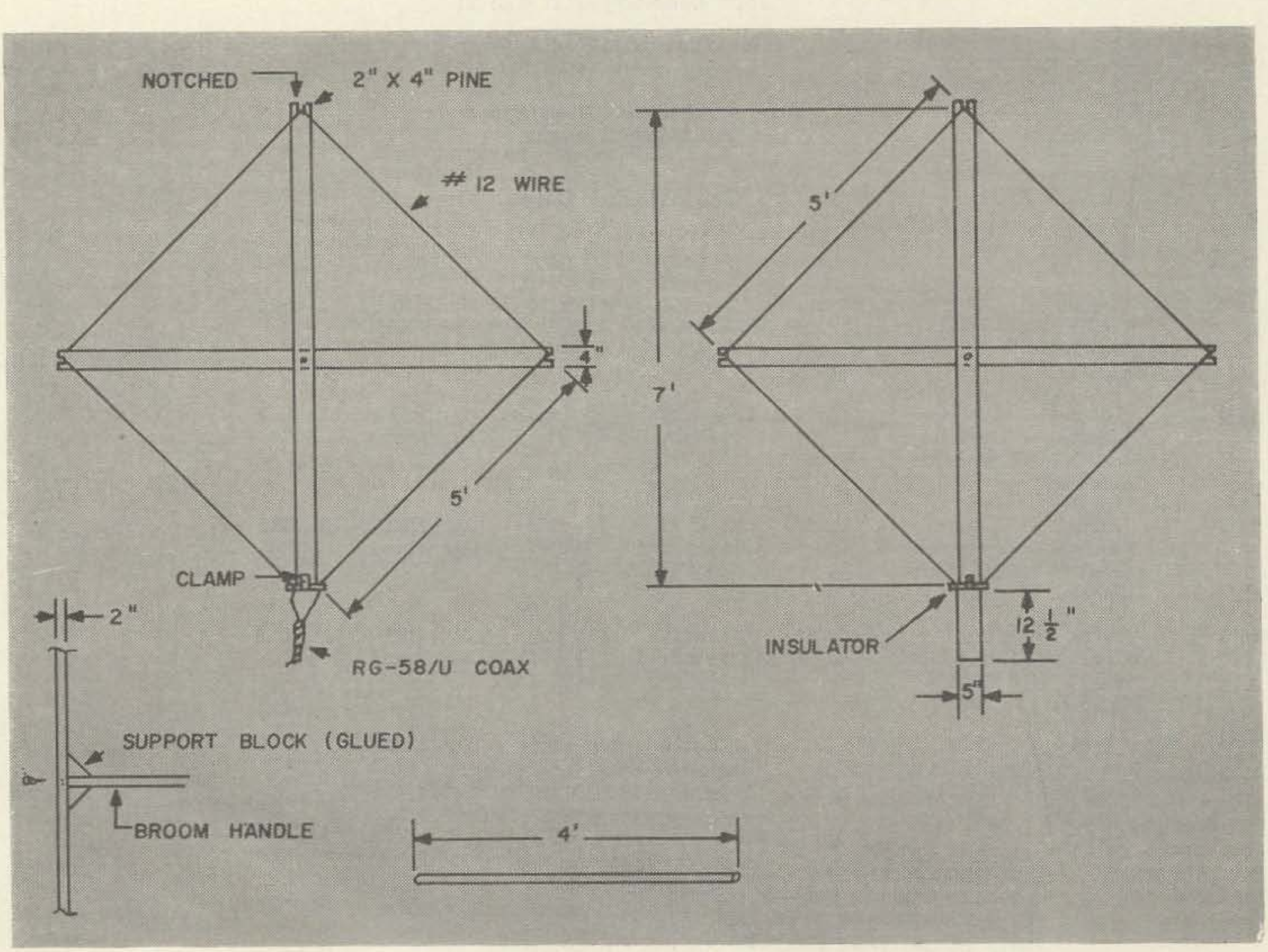
highly directive, high gain

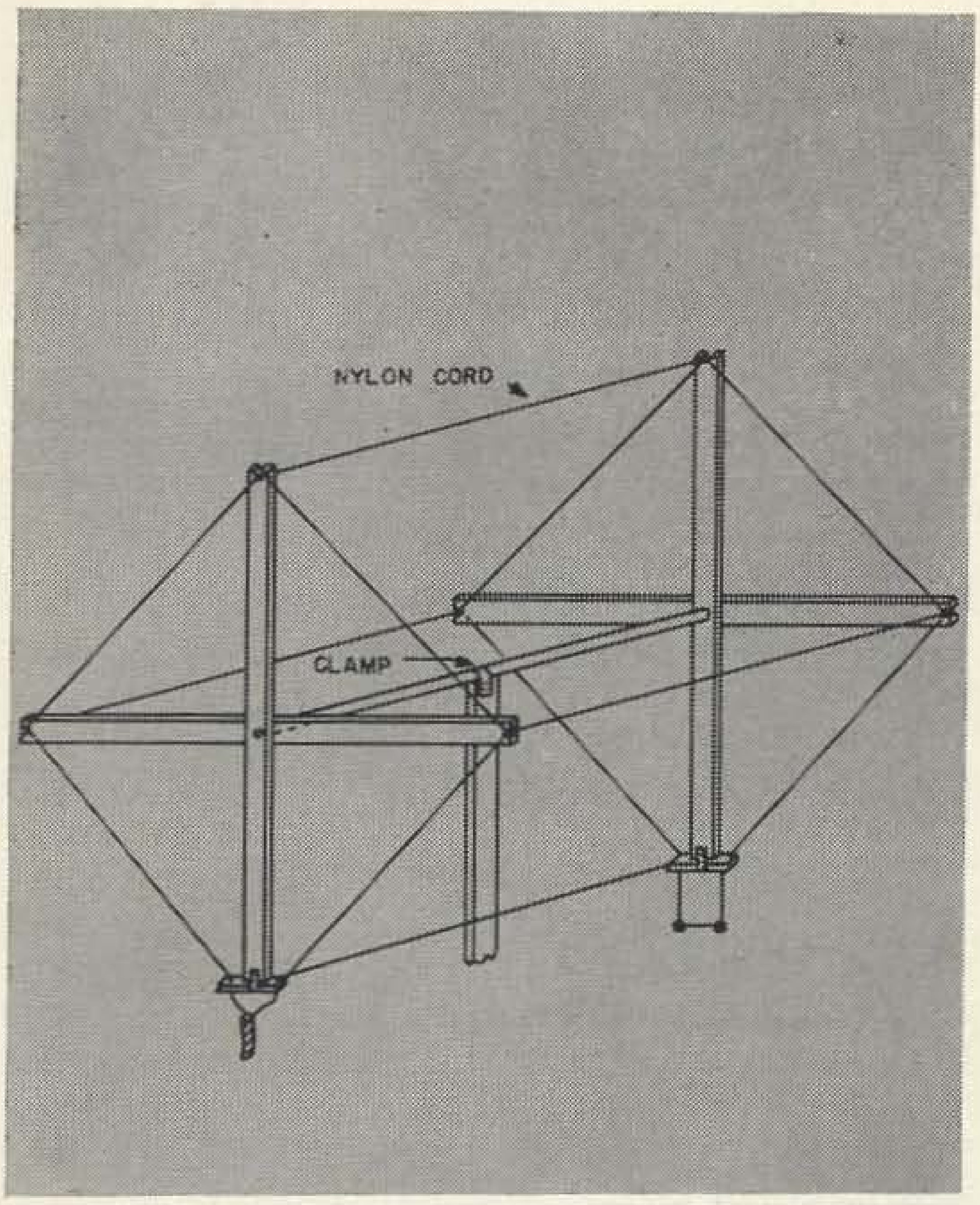
Karl Brownstein W3TBF/ø
1363 W. Maynard Drive
St. Paul 16, Minnesota

When operating on 6 meters I have always relied on a beam antenna. In Philadelphia I used a 9 element home brewed beam with excellent results. Lately I have been hearing a lot about the Quad. Being always interested in new types of antennas, I decided to build one. After building the Quad, I installed it and connected it to my rig (HT-40 and SX-140). The Quad performed beyond expectations and was therefore cause for this article.

This quad can be assembled from materials in the shack and some cheap lumber from the nearest yard. Before proceding with the construction of the Quad, it was necessary to work out some mathematical details. First I calculated the size of each side of the Quad using the following formula: $L \text{ (in feet)} = \frac{251}{F \text{ (in mc)}}$

Since my crystal frequency is 50.2 mc, my length for each side came out to 5 feet. Using high school math to find the hypotenuse, I was able to determine the size of the cross supports. Each side squared $\$^2 = 25$, $25 + 25 = 50$, the square root of 50 is approximately 7. Therefore, 7 feet was chosen as the cross support. At the lumber yard I obtained four 7 foot 2 x 4 pine. I decided to space the ends of the Quad 1/20th of a wavelength or 4 feet. A broom handle was chosen and cut to size. Having some #12 enameled wire, I decided to string the Quad with it. Placing the 4 inch side of the pine flat and crossing it with the other piece, I measured the point of crossing, which at center is 3½ feet. Upon marking this point I drilled a ¼ hole through both pine pieces. I then inserted a nut and bolt to hold them together while stringing.





I notched the ends with a file to receive the wire. Upon stringing the wire, I placed a 5 inch insulator at the bottom of the quad, and terminated the wire as shown. At this point I connected my 52 ohm coax line and soldered it. I completed the same operation with the reflector side, but extended the wire to 12½ inches on either side of the insulator. At this point adjustment may be necessary for the placing of the shorting bar. This bar may have to be varied depending on the SWR.

The antenna is now ready for assembly. Taking one side at a time, I removed the nut and bolt from the center of the crossed pines and inserted a 6 inch wood screw. I then screwed the cross onto the broom handle. This was repeated for the other side also. For rigidity I tied the cross pines to each other using nylon cord. Do not pull the cross pines any tighter than snug as they may snap. At this point the Quad is ready to be mounted on the mast. If desired a two meter Quad may be strung inside the 6 meter Quad and separately terminated for two band operation.

As I swing my Quad south from Minnesota and make contact with Dallas, Texas, I wish you one and all, "Good DX hunting with your Quad." . . . W3TBF/ø

Diode Polarity?

Connect one end of the mysterious diode to a 6.3vac source and the other to a VOM set on 10 volt scale dc. If the meter reads up then that is the positive end of the diode.

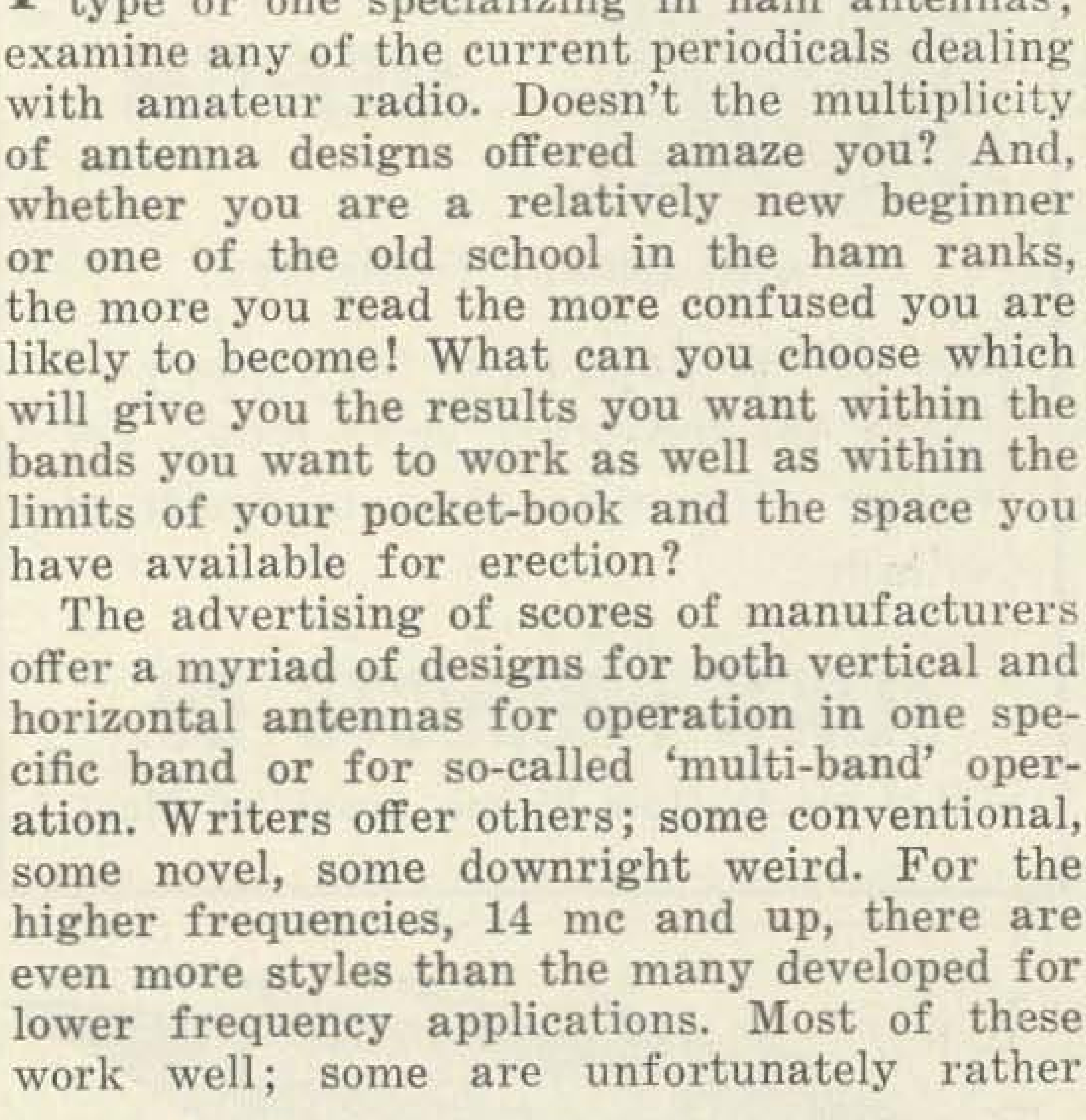
. . . K8BYO

Howard S. Pyle W7OE
3434 74th Avenue, S. E.
Mercer Island, Washington

Evolution of the Ham Antenna

PICK up any handbook, be it of the general type or one specializing in ham antennas; examine any of the current periodicals dealing with amateur radio. Doesn't the multiplicity of antenna designs offered amaze you? And, whether you are a relatively new beginner or one of the old school in the ham ranks, the more you read the more confused you are likely to become! What can you choose which will give you the results you want within the bands you want to work as well as within the limits of your pocket-book and the space you have available for erection?

The advertising of scores of manufacturers offer a myriad of designs for both vertical and horizontal antennas for operation in one specific band or for so-called 'multi-band' operation. Writers offer others; some conventional, some novel, some downright weird. For the higher frequencies, 14 mc and up, there are even more styles than the many developed for lower frequency applications. Most of these work well; some are unfortunately rather mediocre but on the basis that 'anything metallic will radiate,' they all will work to a greater or lesser extent.



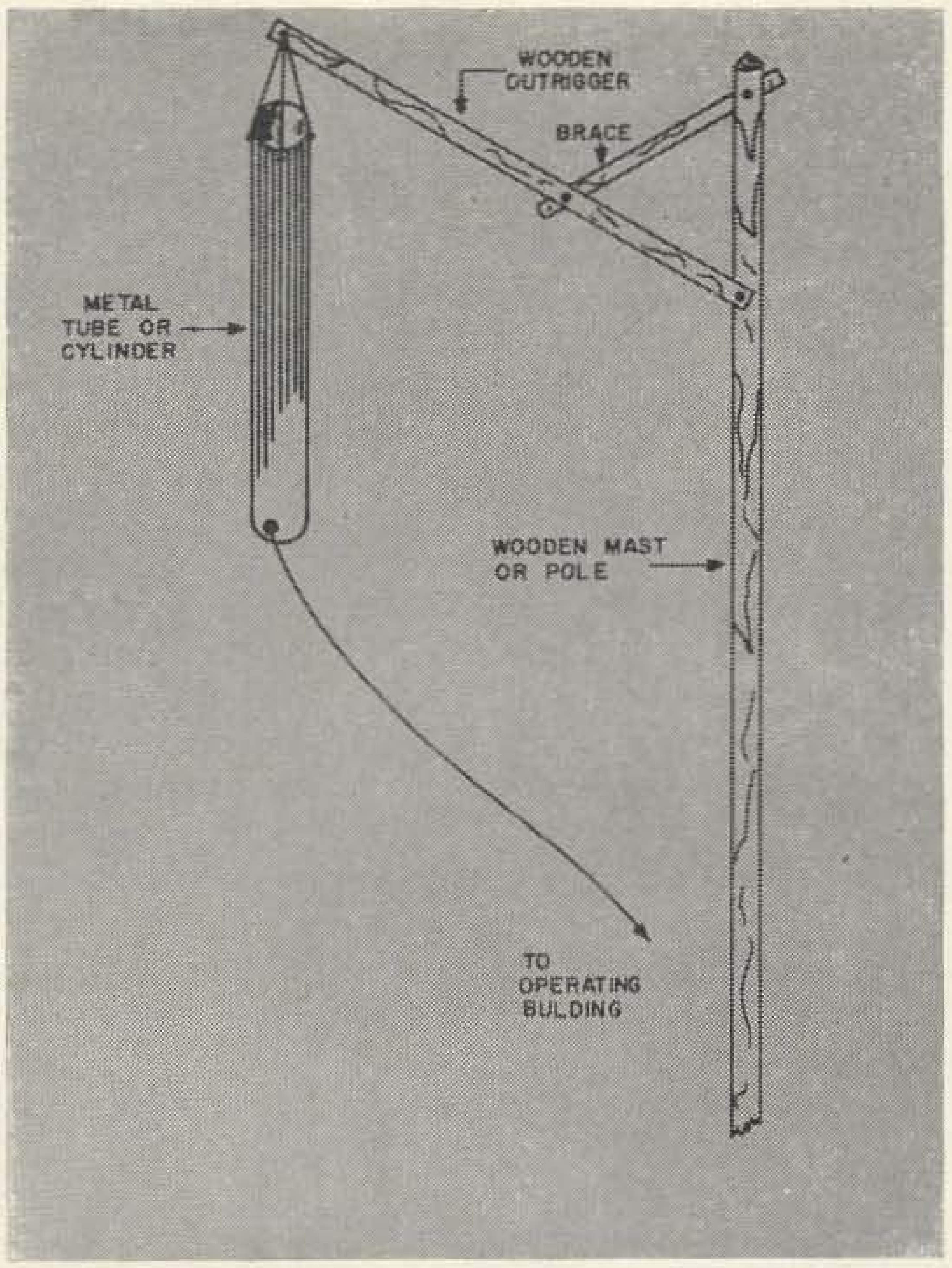
Prof. Hertz's transmitter. The spark between the two electrodes was transmitted to the small metal balls. The short wires served as antennas.

Remember that Prof. Clerk Maxwell and Prof. Heinrich Hertz, in the late 1800's, did not at first deliberately employ an 'antenna' with their spark coil experimental equipment. Initially it so happened that the short rods which they used between supporting posts for their spark gaps acted as 'radiators.' And too, their radiation with these antennas, which were not much more than a few inches long, must have been in the ultra-high frequencies; you figure it out if you like working some of the handbook formulas backwards! The inherent broadness of the wave generated by a spark discharge won't make it easy to determine however!

Hertz discovered this radiation phenomena through space when he found that he could pick up a minute spark between small closely spaced metal balls supported by a loop of wire. He also discovered that by making the electrical length of the loop equal to that of the rods of the spark gap the small spark picked up in the loop was considerably intensified . . . they were in "resonance." Hence, the name "resonator" which he gave to the loop and why we now know the radiation phenomena as "Hertzian wave propagation."

A few years later, Guglielmo Marconi devised a practical use for this radiation which, he reasoned, although confined to a most limited area with the crude equipment of Maxwell and Hertz, could be used to communicate *without* wires by using a code similar to that developed by Samuel Morse for his wired telegraph. Marconi's first concern was improvement of the radiating system. One of his earliest antennas resembled very closely a couple of lengths of what we know as 'stovepipe' suspended from a yard-arm on as high a mast as he could manage! It worked too, up to about 100 miles, even with the extremely crude and insensitive receiving equipment of that time! The down-lead perhaps did most of the radiating!

Later progress developed helical type tuning coils and similar 'refinements' (?), all of which apparently assisted in performance. Wavelengths, as such, were of little concern then, but with the addition of such coils and the development of increasingly longer and higher

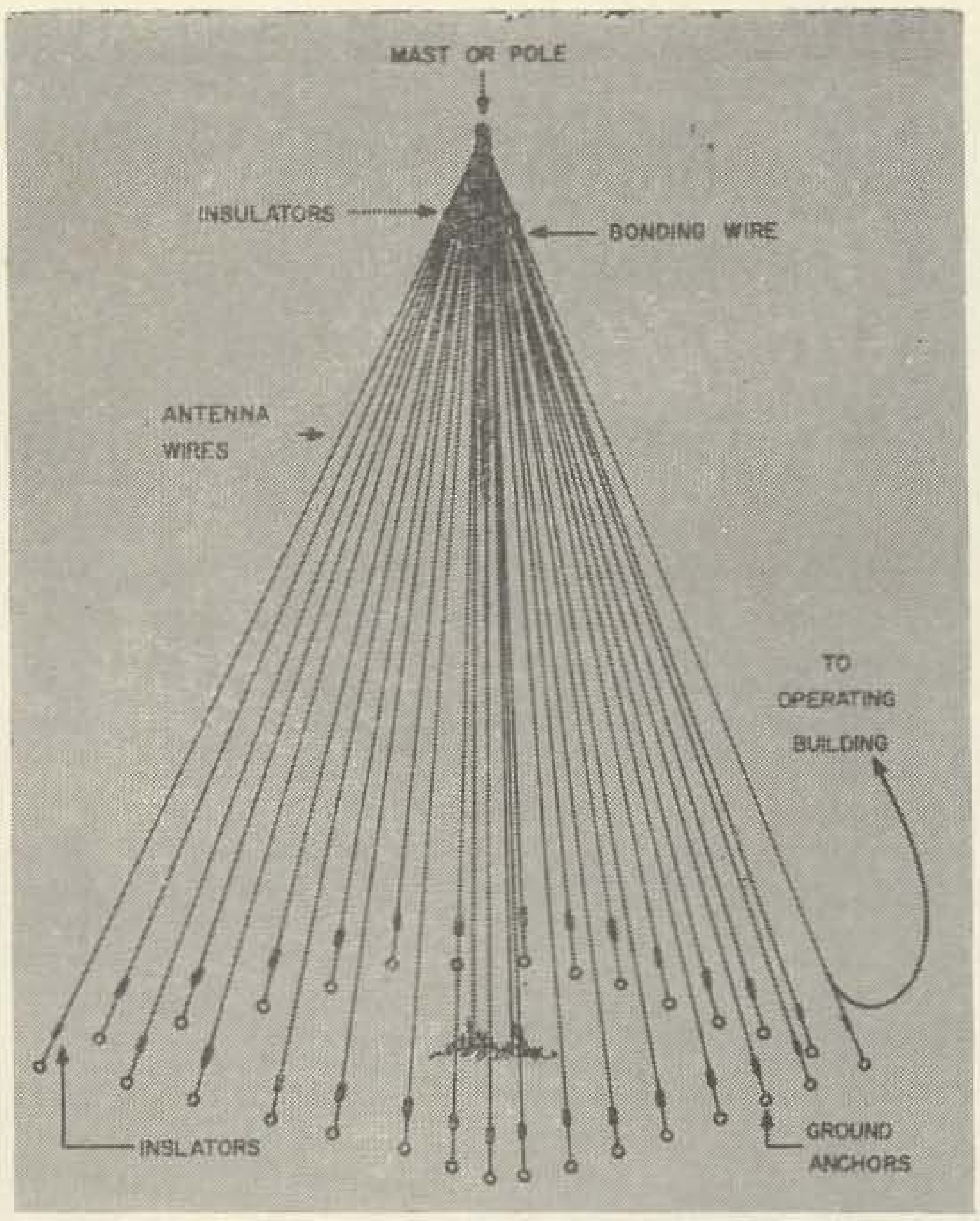


One of Marconi's original antennas used at some of his stations at the turn of the century. Anything metallic will radiate, but obviously the lead-in wire made a pretty good antenna by itself!

wire antennas with resultant increase in both inductance and capacity, wave-lengths could creep but one way . . . up!

So successful were the later multi-wire antennas of Marconi that pioneer amateurs, then beginning to enter this fascinating field, followed suit. Four, six and even eight wire antennas of as great a length as available space permitted, were suspended horizontally between trees, roof gables or masts. The four wire antenna proved most popular in commercial ship and shore station installations as with the amateur, for many years. A trend then developed toward reduction in the number of suspended wires and many amateurs were soon using but *two* parallel wires. Commercial companies were somewhat slower to follow, but within a few years two-wire antennas were becoming increasingly popular on merchant vessels.

It is difficult to say just when the adoption of a single horizontal wire for both transmission and reception occurred. Very probably with the amateur directly after he was permitted to resume operation some two years after the World War I armistice. In almost every case, such antennas were of the 'random length' type with little attention paid to length versus frequency. It was not long however, with the increasing popularity of vacuum tube over spark transmission, before it was discovered that if the radiating system was so made as to be resonant at the frequency on



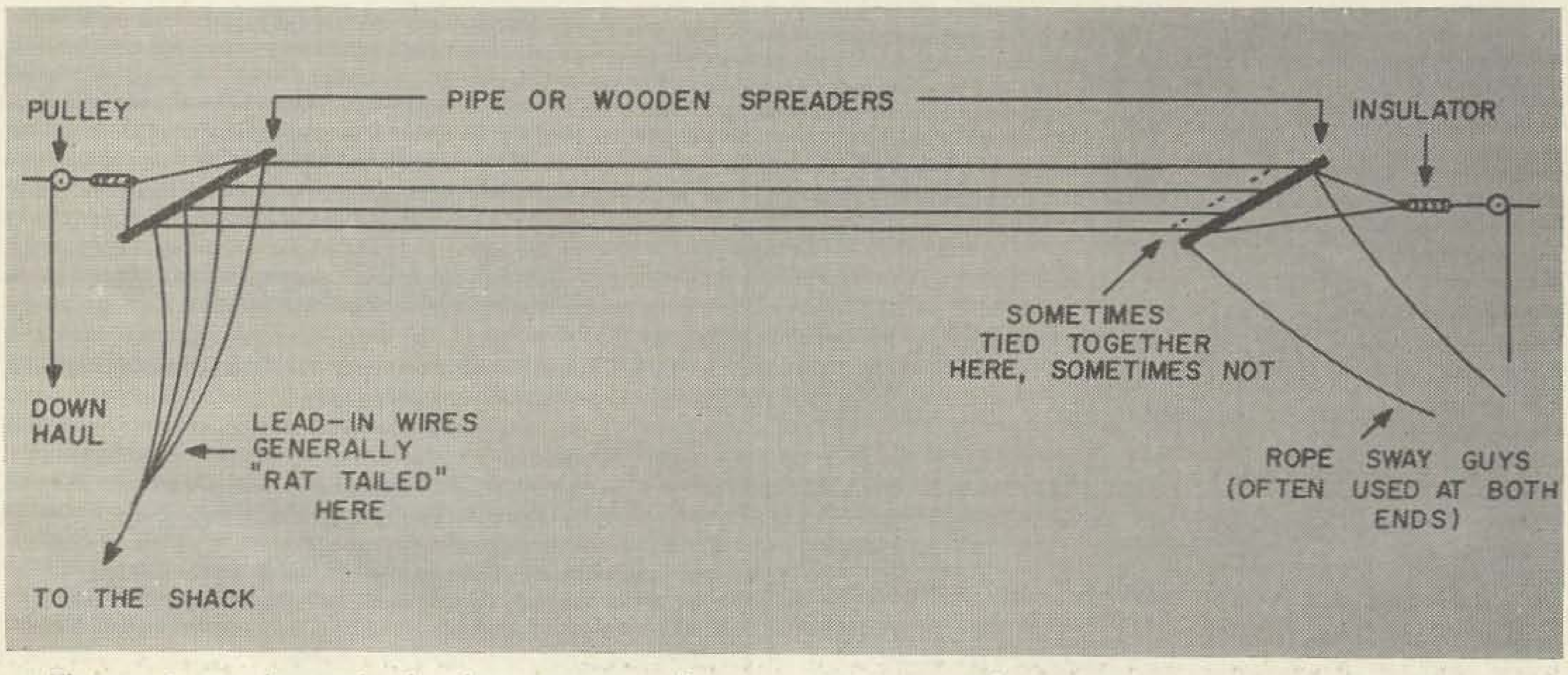
U.S. Army Signal Corps antenna used in the early 1900's. It was dubbed the "Umbrella" antenna, but found little favor with hams due to the large number of wires, insulators and ground anchors. The more wires the better was the motto. Some of these were still around during WWI.

which it was desired to work, results improved considerably. First 'full wave,' then half, later quarter-wave single horizontal wires came into being. Transmission lines or 'feeders' as they were initially termed, soon came within the scrutiny of the amateur. One of the earliest antenna systems using such a feeder system was the so-called "Zepp" antenna employing two wires, spaced by insulators, to supply rf power to the antenna. These were patterned after those used by the Germans on their Zeppelin dirigibles, hence the name, "Zepp" antenna. They proved very efficient in ham service and a large number are still in use today.

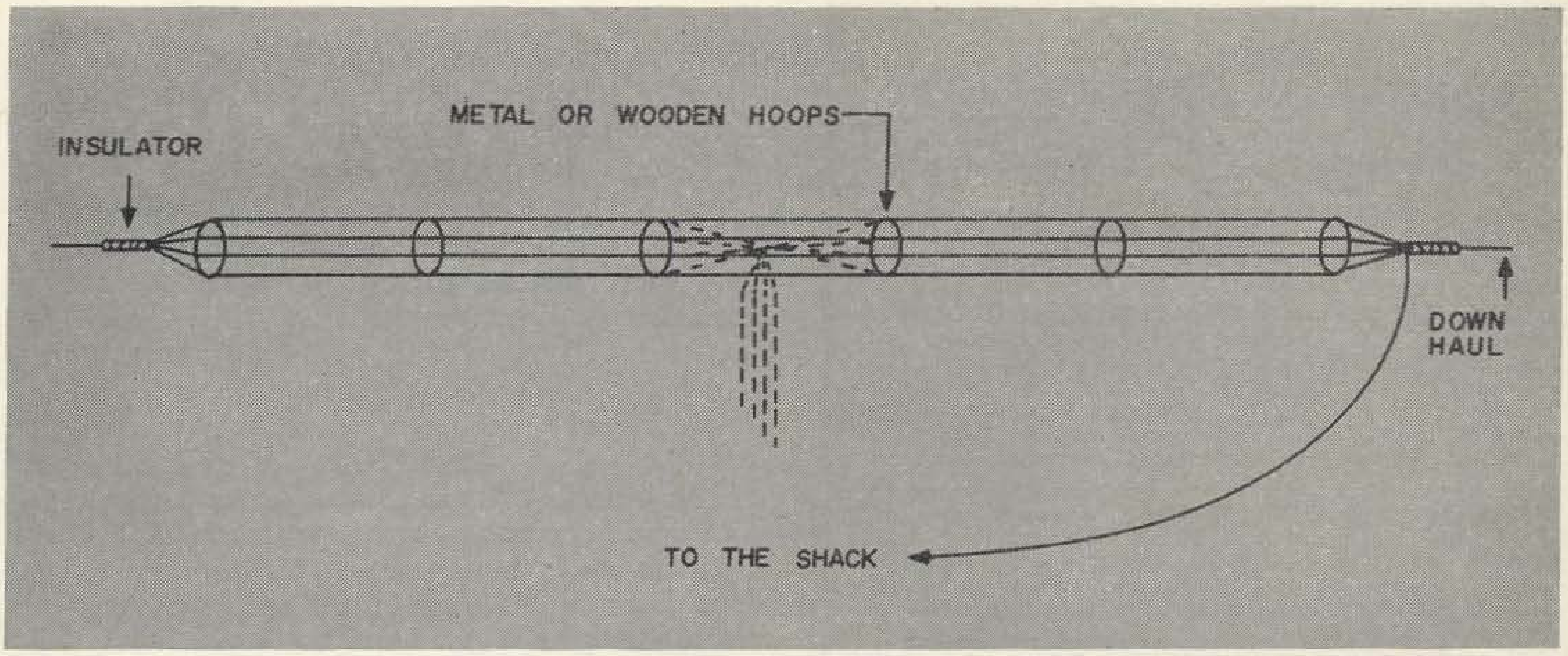
Equipment development had progressed meanwhile and unbelievable efficiency was being realized from both factory-built and 'home-brewed' transmitters. Thoughts again turned to antenna development both by the individual ham as well as manufacturers of amateur equipment. "Package" antennas soon appeared on the market; the radiating portion cut to proper length for the desired frequency band and insulators and similar accessory doodads supplied. To meet varying conditions, amateurs commenced to devise what were considered more or less as 'trick' antennas; descriptions of such with some pretty optimistic claims were appearing with increasing frequency in ham journals and handbooks. As a number of these had definite merit and lent themselves well to manufacturing production, a number of factories commenced fabrication.

It was not long before the problem of space in which to erect the popular horizontal wire antenna, preferably a half wave in length, became rather acute. Apartment dwellers and those living on small city lots were frequently unable to put up the length of span required by the then very popular 160 and 80 meter bands. Quarter wave antennas, calling for half the wire length, began to catch on and delivered rather well.

The eager and insatiable curiosity of the experimental ham was not so easily appeased however. Standard broadcast stations had discovered that a vertical tower with an insulated base, performed rather well for them. True, such towers were high and costly but their frequencies were relatively low in comparison to those used by the ham. Why not try it? A metal tower, mast or similar structure considered in the light of a half or even a quarter wave length in the ham bands, didn't seem too much of a problem. For the 80 meter band calling for some 130 feet for a half wave, a bit of structural as well as economic difficulty

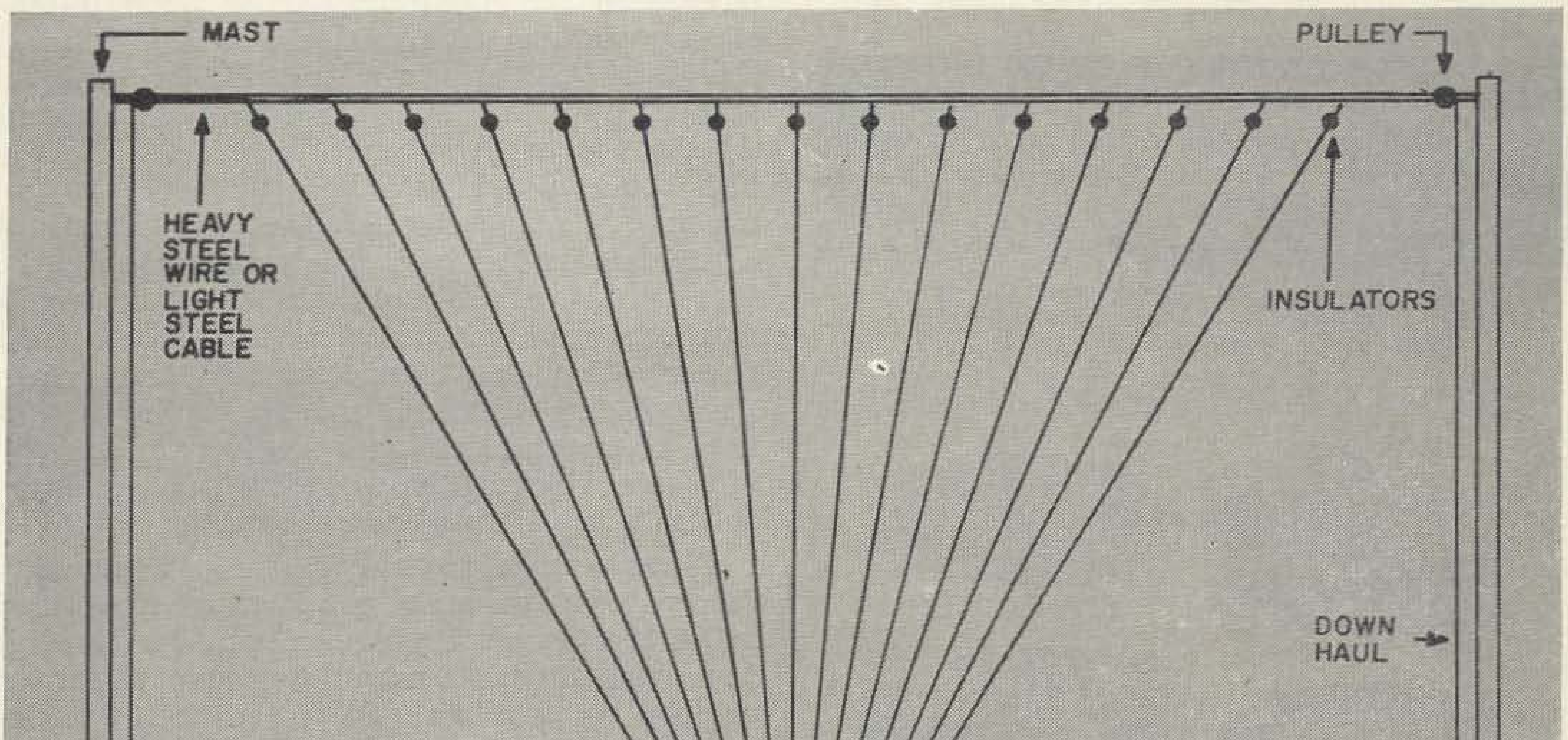


The most popular early day ham antenna, the Flat-Top was of random length. The wires were connected various ways, some put them in parallel, others in series, etc.



The Cage antenna was popular with hams just before WWI. Metal or wooden hoops from barrels were used as spreaders. When IBCG put the first ham signal across the Atlantic in late 1921 using a "T" Cage antenna with a Cage lead-in this type immediately became popular. These were popular until someone discovered that a single wire was just as effective as the multi-wire system.

was naturally encountered. However, a *quarter* wave vertical radiator for the 80 meter band would only require *half* of this height or about 65 feet. Still a bit on the costly and structurally precarious side, but quite a few hams managed it and such antennas performed very well. For the 40 meter band, the problem was greatly lessened as a quarter wave there was only some 33 feet in height. The 65 foot structures for a quarter wave on 80 also performed well on 40; the 33 foot radiators used at a quarter wave length for 40, didn't do bad at all on 80, particularly with a base loading coil. Both heights showed good results on 20 as well. Hundreds were built and may be seen throughout the country today. Factories again took hold and as current advertising will indicate, it is possible to buy a commercially made



Vertical Fan antenna of post WWI vintage. It worked well, but was expensive. As many wires were used as you could afford . . . eight was par.

tower, mast or similar radiating structure in almost any practical height and within a wide range of prices. Many have refinements such as 'traps,' base or center 'load coils' and/or 'capacity hats' at the top.

Next in line came the 'antenna tuner' which had already demonstrated its value to a considerable extent in connection with horizontal antennas. Even more so was it desirable on the vertical type of radiator. A combination of inductance and capacity, properly proportioned and installed between the transmitter and the antenna, did the trick. Many hams built (and still do) their own antenna tuner (or coupler as it has been more correctly termed). Manufacturer again kept pace and there are today, a number of factory built antenna couplers available on the market.

As operating frequencies increased to embrace the 15, 10 and 6 meter bands (and later even 2 meters), special antennas for these bands were devised. "Beaming" the signal for greatest radiation in the desired direction became highly popular; it proved phenomenal in working DX on these frequencies. Soon some of the more ambitious hams designed and erected such beams for use on 20 meters as well although their physical size became a bit awkward and unweildy. This problem was pretty well solved by ingenious design and it was not long before these too were being offered to the amateur market by a number of manufacturers. Rotation of these beams to the desired direction was initially accomplished manually; many hams used old auto steering wheels procured at wrecking yards. Not too bad either, fitted with a suitable pointer and a compass rose although they did offer quite a problem in the way of a watertight bearing through the roof! It wasn't long however before *electrical* rotators were fitted to the mast and rotation was then controlled from within the shack by a dial and pointer similar to those used on transmitters and receivers. Thousands of these electrically rotated beams are now in daily use throughout the world.

What next is anybody's guess. Today, in a fairly populous area, you can see practically all of the current types of popular ham antennas. Beams, in many respects, closely resemble conventional TV antennas. You can retty well tell by the physical size of them, which band the ham owner favors. Horizontal wire antennas are all more or less of the same general type; a half or a quarter wave horizontal wire between two supports; these may be fed in various ways but are all basically the same. A single wire feed as in the 'Windom' type; two open wires at the center, spaced throughout their length with insulators; the 'Zepp' with a similar pair of wires at one end; either center or end fed with coaxial cable or two-wire ribbon resembling TV lead-in. Even

(Turn to page 57)

Christmas Cheer and All That

While there is still considerable discussion going on as to whether subscriptions to 73 should be given to friends or to particularly despised enemies, there is no question about the fact that you should be giving them. Please fill out the below blanks and mail immediately. If we get 'em in time we'll send out a special Christmas gift card to the recipient which should arrive a day or two before the holiday which comes, I believe, sometime late in December. We'll start the sub with the January 1962 issue which will be mailed December 20th and should get there at about the same time.

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73 Magazine; 1379 East 15th St., Brooklyn 30, N. Y.

(Antennas from page 54)

the more modest random length wire with a similar single wire lead-in or down lead from one end or some random length along the antenna proper, will frequently be found.

And, the vertical antenna in popular use by thousands, will either be mounted on a roof top with appropriate guy wires or perhaps on the ground iteself. It may or may not be insulated at the base depending upon its feeder system; it may or may not have a 'capacity hat' of some sort at the top. Perhaps it's an elaborate tower, maybe only a simple mobile whip, roof or mast mounted. Water pipe, electrical conduit, rain-pipe and even a series of beer cans soldered together end to end, often serve as a radiator! Some are even a single wire suspended from a yard-arm and run down the pole on insulators; frequently copper tubing is used in this manner.

So, there you have it. Antennas have come a long way since the simple rods of Maxwell and Hertz and the 'stove pipes' of Marconi. What will *you* use? The choice is strictly yours and is dependent upon several factors. Available space, the band you want to work mostly and your checkbook. Talk to other hams; if they have been in the game any length of time at all they have no doubt tried a number of the more conventional antenna types. Find out what they think of those which they have used. Then make up your mind what you want to do; study antenna chapters in handbooks and read the many articles in the periodicals, check your bank balance and measure your available space, then go to it! "73" and 'happy hamming'! . . . W7OE

Letter

Dear Wayne,

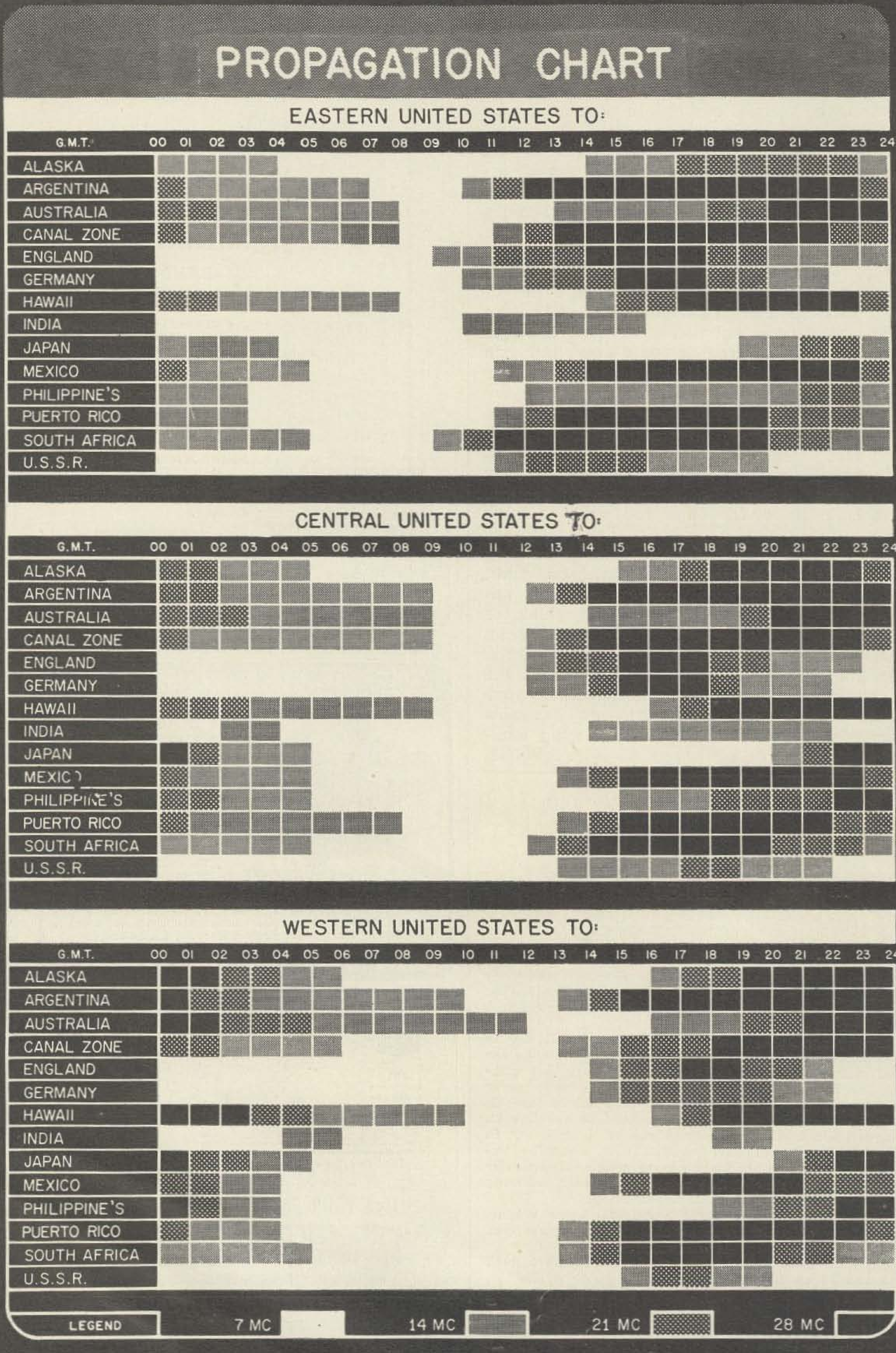
Please find enclosed a check for $5.00 to renew my subscription for the next 2 years; I feel that having survived the first year you should be worth risking 5 bucks for the next 2.

Having run the gamut from Neophyte to Novice to Technician and finally at long last to General during the first year of 73 Magazine I would like to say that without the help of its informative articles I could never have gotten my General Ticket. I would like to say this but of course you know that this would be a helluv an exaggeration and a damn lie. However, I must say in all sincerity that I have enjoyed your magazine immensely and while not finding every article of particular interest at the time I find myself frequently referring to these back issues of 73 for information.

Hope you keep the general format the same Wayne, with plenty of construction articles and leaving the club news and contests to the other magazines.

Continued good luck and success in the future to both you and 73 on its first anniversary.

Bob Tanner K3ONQ


PROPAGATION CHART
EASTERN UNITED STATES TO:
CENTRAL UNITED STATES TO:
WESTERN UNITED STATES TO:
G.M.T.
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
ALASKA
ARGENTINA
AUSTRALIA
CANAL ZONE
ENGLAND
GERMANY
HAWAII
INDIA
JAPAN
MEXICO
PHILIPPINE'S
PUERTO RICO
SOUTH AFRICA
U.S.S.R.
LEGEND
7 MC
14 MC
21 MC
28 MC

Propagation Charts

David A. Brown K2IGY
30 Lambert Avenue
Farmingdale, N. Y.

For the DX propagation chart, I have listed the HBF which is the best Ham Band Frequency to be used for the time periods given. A higher HBF will not work and a lower HBF sometimes will work, but not nearly as well. The time is in GMT, not local time.

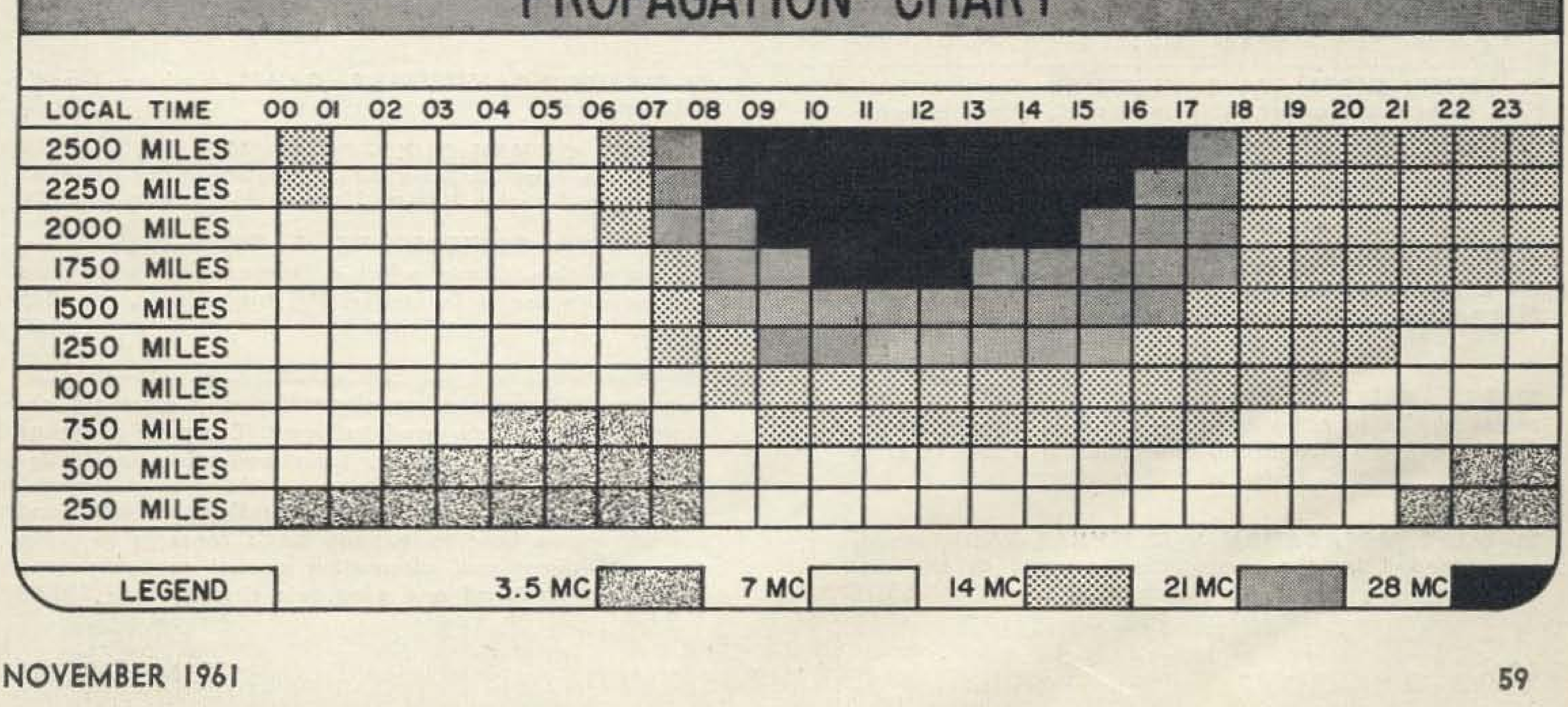
Advanced Forecast, November 1961

Good: 7-8, 10-25

Fair: 1-2, 6, 9, 26, 29-30

Bad: 3-5, 27-28

The Short Path propagation chart has been set up to show what HBF to use for coverage between the 48 states. Alaska and Hawaii are covered in the DX chart. The use of this chart is somewhat different than the DX chart. First, the time is the local time centered on the mid-point of the path. Second, the distance given in miles is the Great Circle path distance because of the Earth's curvature. Here are a couple of examples of how to use the chart. A.) To work the path Boston to Miami (1250 miles), the local time centered on the mid-point of the path is the same in Boston as in Miami. Looking up the HBF's next to the 1250 ile listings will give the HBF to use and the time periods given will be the same at each end of the circuit. B.) To work the path New York to San Francisco (2,600 miles), the local time centered on the mid-point of the path will be 1½ hours later than at San Francisco and 1½ hours earlier than in New York (the time difference between New York and San Francisco is 3 hours). Looking up the HBF's next to the 2,500 mile listings will give the HB to use. In San Francisco subtract 1½ hours from the time periods listed for local time and in New York add 1½ hours to the time periods listed for local time.



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Two Uses for a Birdie

Jim Kyle K5JKX/6
1851 Stanford Avenue
Santa Susana, Calif.

BIRDIES are familiar problems to nearly every VHF addict—and on occasion plague the rest of us as well, producing spurious signals at certain points within the tuning range of our receivers.

Those VHF men who have been forced for one reason or another to live with the birdies produced by their own pet converter-receiver combination usually have managed to find some use for them. One of the simplest is to use the birdie as a marker signal to ensure that the proper position for accurate frequency readout.

However, that's neither the kind of or use for a birdie we're going to discuss here. The particular genus under the spotlight today is the BFO birdie, that annoying whistle or tweet that may occasionally show up at multiples of your BFO frequency whenever the beat oscillator is turned on.

In case you don't recognize the term, incidentally, a birdie is a spurious signal produced by unwanted harmonics, their sum, and their difference. The difference between birdies and other spurious signals is that the name "birdie" is applied only to signals resulting from oscillators within the equipment. That is, the BFO and the receiver oscillator may produce birdies, as can the BFO alone. VHF birdies are usually caused by harmonics of the converter oscillator and the receiver oscillator, etc.

The usual cause of a BFO birdie is radiation of harmonics from beat-oscillator circuitry into the front-end portion of the receiver. These birdies can sometimes be heard as far up in the spectrum as 9.1 mc—which is the 20th harmonic of the signal. The cure, naturally, is to isolate the BFO to a greater extent through shielding, bypassing, and all other harmonic-reduction measures usually applied to a TVI-producing transmitter.

But this article isn't about the cure and defeating of BFO birdies—it's about two ways to make good use of them. If you don't have a birdie in *your* set, you'll have to put one in (temporarily only) to make use of these tricks.

Possibly the more useful of the tricks is the use of the birdie to determine the exact response frequency of the crystal in your crystal filter. With only a little care, you can locate this frequency accurate to ± 1 cycle or less. Here's how:

Disconnect the receiver's regular antenna and attach a short length of wire (insulated variety) to the BFO plate terminal. Route the other end of the wire into the front end portion of the receiver to let the birdies be picked up by radiation. Attach a VTVM to the second-detector load resistor, and turn on the set and the BFO.

With the crystal filter set to the OFF or equivalent position, tune in the neighborhood of the lowest multiple of your *if* frequency (910 KC, 1820 KC, 2275 KC, etc.) which you can reach. If your set tunes the BC band, the second harmonic is best at this point because it is the strongest.

When you find the birdie, set the crystal filter to its broadest position. While watching the VTVM, adjust in turn the BFO tuning and the receiver tuning until the VTVM indication reaches a peak at the same time the audio signal goes through zero beat. These two adjustments interact strongly, and this is the most critical part of the procedure, so take your time.

Now, without touching either adjustment, set the crystal filter to its sharpest position. You'll probably have to touch up the tuning adjustment to restore the VTVM peak reading. If an audio note is audible at the new peak reading, repeat the dual adjustments made in the previous step until the zero-beat and VTVM peaks coincide again.

Read the frequency from the receivers tuning dial and divide by the number of the harmonic used. That is, if the adjustment was made at the second harmonic, divide by two. If at the fourth harmonic, divide by four, etc.

At this stage, you know the crystal's response frequency only within 25 to 30 cycles, since the combined response of your ear and the receivers audio system cuts off at about 100 cycles. To check more closely, leave the

BFO adjustment alone and tune to successively higher harmonics with the tuning dial. At each birdie, zero-beat should coincide with the VTVM peak. If not, readjust the BFO ever so slightly. Remember, a 10-cycle adjustment monitored on the 20th harmonic will move the signal 200 cycles, which can well be outside the passband of the crystal filter in the sharp position. However, if you're on the nose at the 20th harmonic, you're within less than 5 cycles of the exact setting at the fundamental.

With the BFO adjusted exactly to the crystal response peak, it can now be used as a signal generator to align the receiver *if* stages for maximum performance at this frequency. Simply touch up each adjustment on each *if* transformer for maximum indication on the VTVM, taking care not to disturb the BFO setting. This simple procedure will frequently improve a receivers apparent gain by 10 times or more, since alignment is not permanent and an error of only a few cycles in each transformer adjustment can result in a large over-all loss of received signal.

The other use for a BFO birdie is as a substitute for an accurate 100-kc standard in calibration of equipment at frequencies other than the WWV standard transmissions. The BFO can be used to inject a signal every 450 kc or so, and this signal can be made accurate to approximately ± 10 cycles at the fundamental frequency. Here's how:

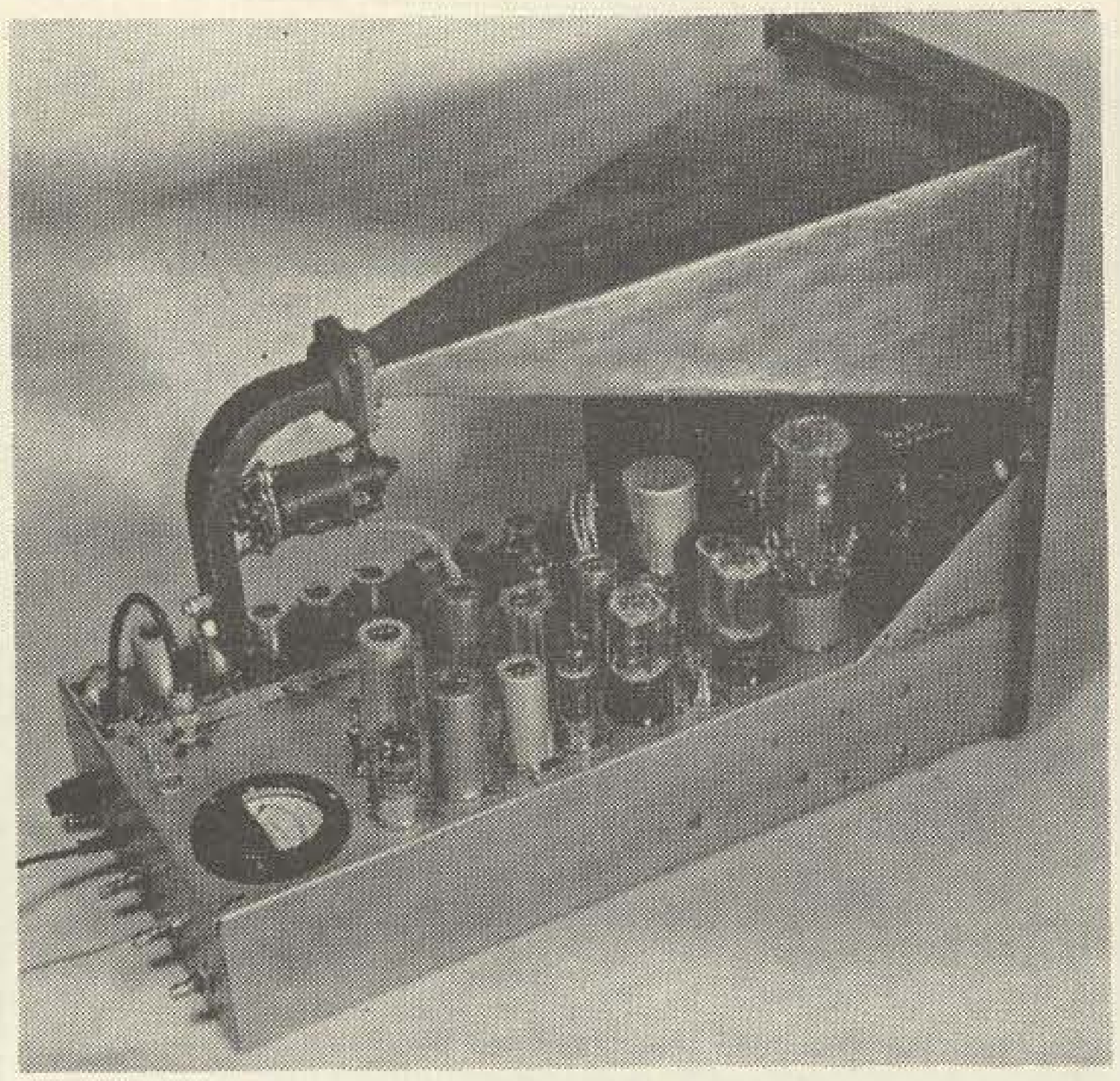
Set up the "birdie generator" antenna as described earlier and turn on the BFO. Tune the receiver to the broadcast band, and select a station in the 900-950 kc range.

Adjust the BFO setting until you get not one, but *two* beat notes. One will change pitch twice as rapidly as the other, and will be less strong; the fast-moving, weaker one is the one you're interested in. Ignore the strong one.

Continue adjusting the BFO until the weaker note is in zero-beat with the BC station. You have now adjusted the birdie to zero-beat, and the BFO is set to exactly (± the lower audio cutoff frequency mentioned earlier) one-half the frequency of the BC station.

Look up in a log the frequency of the BC station and divide by two. This will tell you the frequency to which the BFO is tuned. CAUTION: If you zero-beat the BFO with the birdie, instead of zeroing the birdie on the BC station, results will be inaccurate.

Now all you need to do is to tune to the third, 4th, 5th, etc., harmonics of this frequency and zero-beat the birdie *by adjusting the main tuning only* (don't move the BFO setting.) Zero-beat will mark the exact spot on the dial at which the harmonic falls, and pencil-and-paper calculations will tell you the virtually-exact frequency of the harmonic. With these checkpoints every 455 kc across the lower bands, it's not too difficult to interpolate other calibrations accurately.



Get That Last DB From Your Parabolic Dish

Horn Antennas

Erik Roy TI2NA
1616 Tibbits
Troy, New York

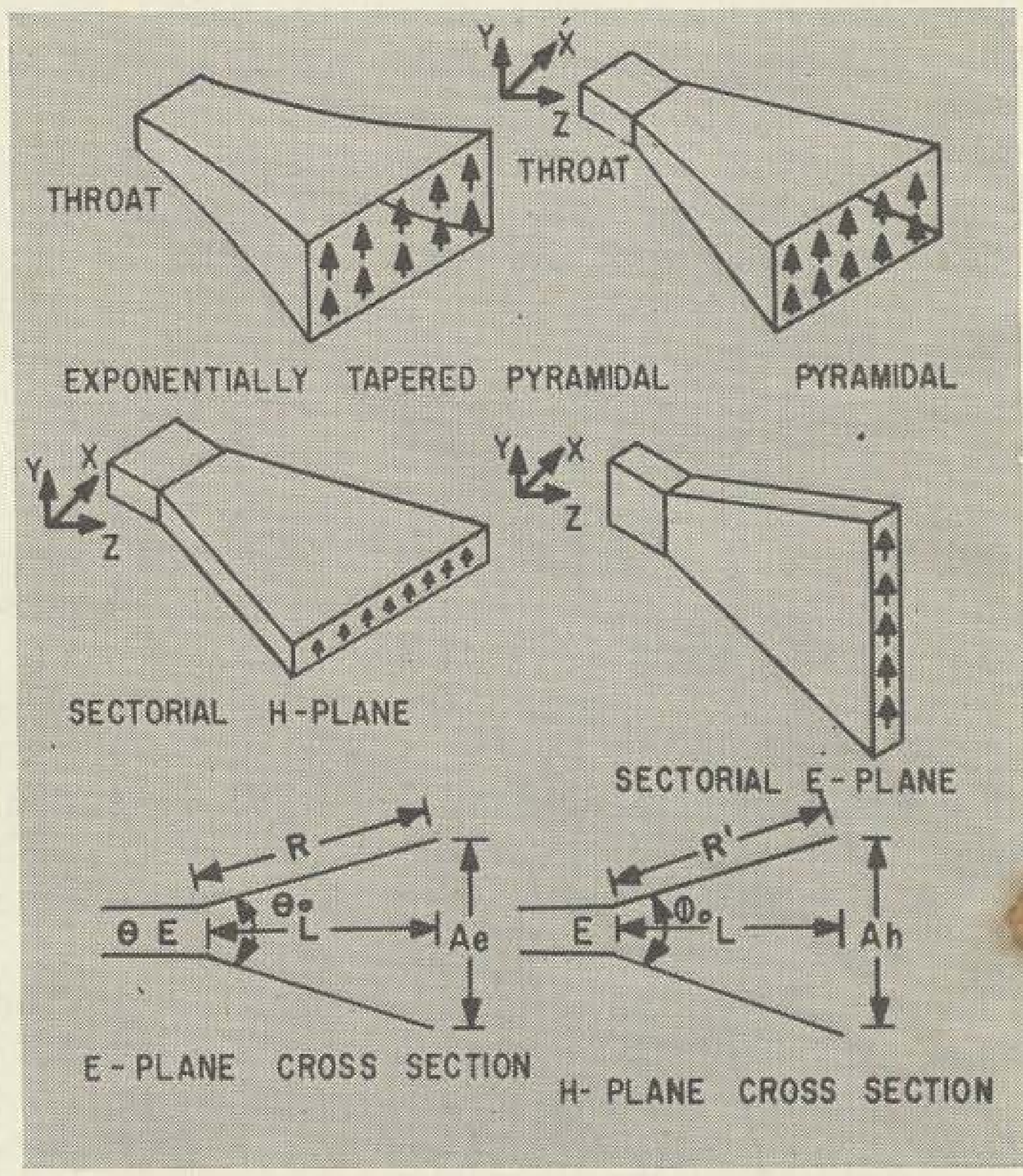
A HORN antenna can be used as a feed for a dish. If the dish is fed by a dipole or a dipole and a reflector it will not have optimum gain and bandwidth. It will be 2 to 4 db short of optimum gain, sometimes more. This extra gain doesn't come from the higher gain a horn has over the original feed, but it comes from the better illumination of the dish and the lack of side lobes and back lobe of the horn as a feed. With a dipole or a dipole and reflector, there is a back lobe and side lobes, all of which fall outside the dish, causing a loss in gain. In addition, spill over, which is caused when the beam width of the antenna illuminating the dish is greater than the angle of illumination of the dish, reduces the optimum gain. Sometimes the opposite can happen. This is very unusual and it happens when a poorly designed horn with too small a beam width is used.

Horns alone are not useful as antennas until the frequency is 10 cm or less because they are too large and cumbersome for the gain available. They are easy to design and build if you follow carefully the charts in this article. But before we do any constructing, a little theory may not do us any harm.

A rectangular horn with flare in both planes, as discussed in this article, is called a pyramidal horn. Other types include the exponentially tapered pyramid, sectorial H-plane and sectorial E-plane horns. (See Fig. 1)

To obtain as uniform an aperture distribution as possible a very long horn with a small flare angle is required. However, from a practical standpoint, the horn should be as short as possible. An optimum horn is between these extremes and has minimum beam width without excessive side lobes for a given length.

If the aperture in the two planes of a rectangular horn exceeds one wavelength, the pattern in one plane is almost independent of the aperture in the other. So, a horn can be designed as an antenna or as a feed for a parabolic antenna. The only frequency dependent parameters of a horn are the dimensions such as length which affects the gain and the type of waveguide feed at the throat. For the most uniform aperture illumination, the higher modes of transmission must be suppressed. Therefore, the width of the waveguide at the throat of the horn must be between ½ and 1 wavelength. If the excitation of the system is symmetrical, so that the even modes are not energized, the width must be between ½ and 3/2 wavelengths.



Figs. 1 and 2.

Referring to Fig. 2, the total flare angle in the E plane is Θ_o and the total flare angle in the H plane is Φ_o. The axial length of the horn from throat to aperture is L, and the radial length is R. A_e is the E plane aperture, and A_h is the H plane aperture.

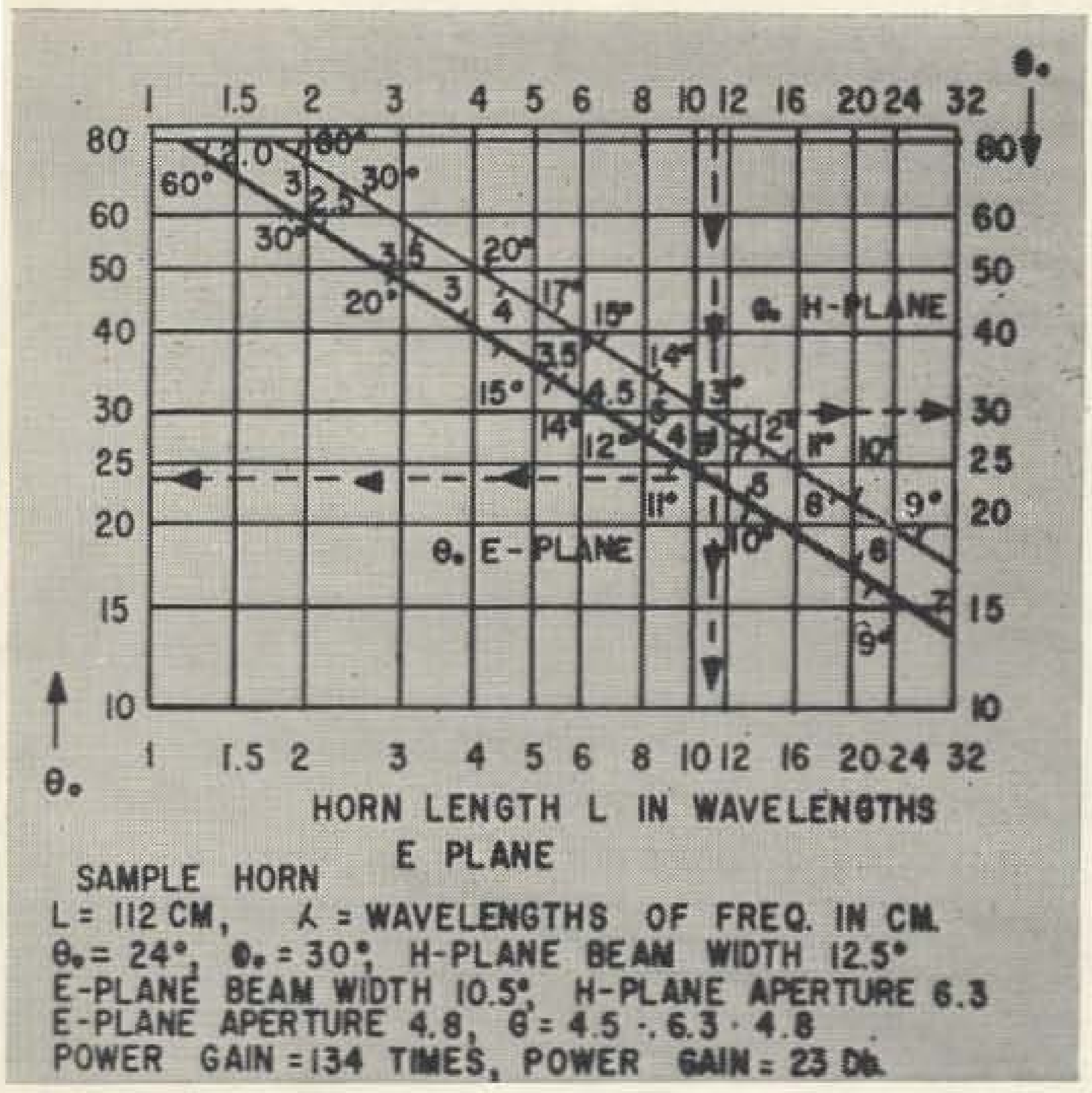


Fig. 3.

When building a horn, care should be taken so that the thrust fits the waveguide that feeds it. The corners don't have to be perfectly square, and, if the joints are made at the corners, they should be braced. If they are made on the middle of the H plane, they can be soldered because good conductivity is not necessary at this point as it is a voltage antinode. The chart in Fig. 3 is designed to give maximum gain which is needed in horns used as antennas.

When a horn is used as a feed for a parabola, the most important consideration is the illumination pattern. Therefore, if we know the feed angle necessary for feeding the parabolic reflector, a horn can be designed to do a fairly good job of illuminating it as the beam width of a horn is dependent to the aperture of its respective plane. For best results in feeding the parabola, the 10 db power points are used in figuring the horn. The chart in Fig. 4 gives this beam widths with respect to the other possible variables.

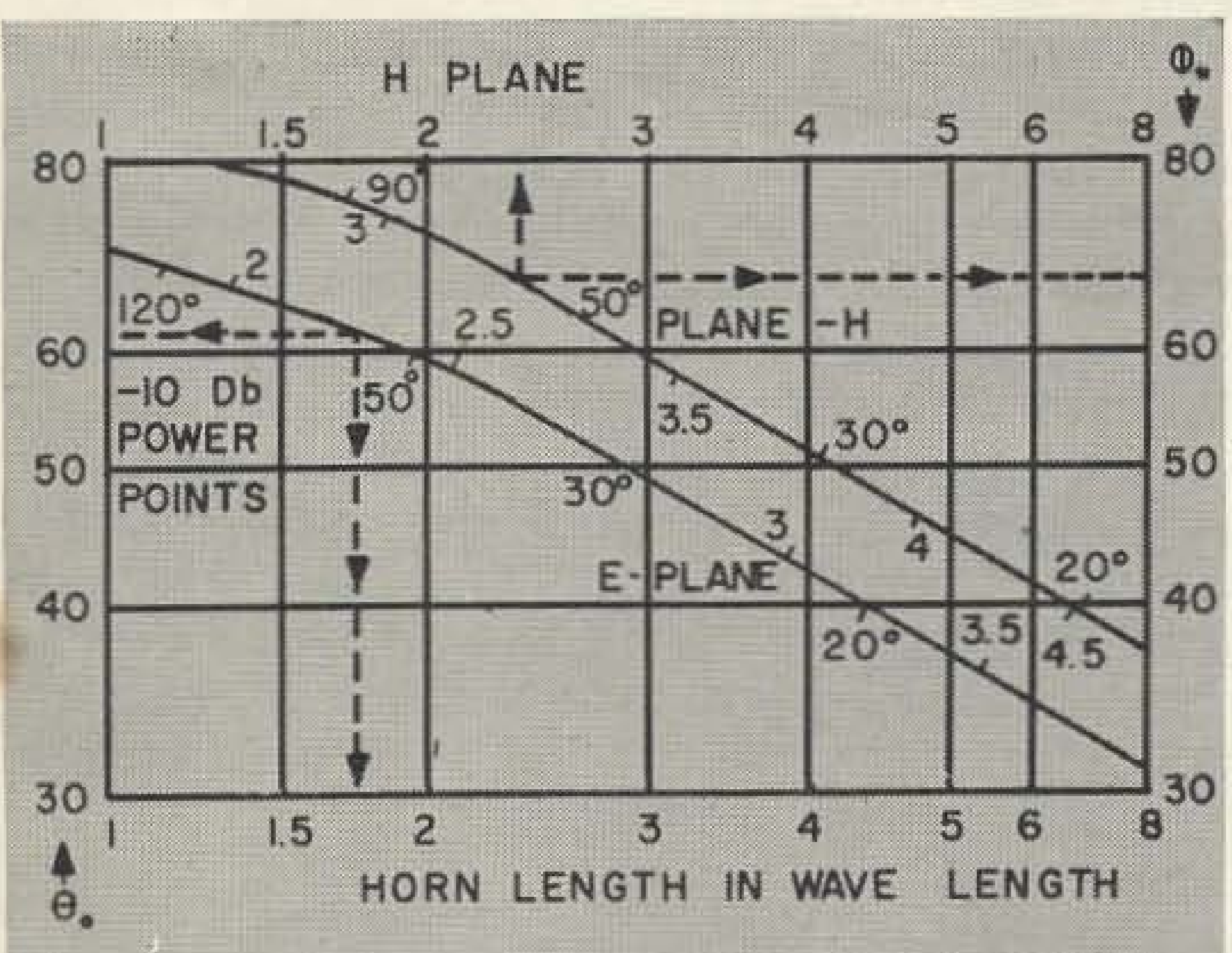


Fig. 4.

If the parabolic dish is round, the vertical and horizontal feed angles are equal. If it is another shape, oval, rectangular, etc., it has two separate feed angles. With equal or different feed angles, the design of the horn is simple if you have the chart in Fig. 4. A feed horn is not recommended if it figures out to be shorter than 1.5 wavelengths long. This is because the aperture illumination is not uniform and the side lobes tend to increase in strength. When the lengths are found in the chart, they may be different, so the average of the two Ls are taken as the length of the horn. If the difference is more than 2:1, the larger dimension should be taken as L. The thickness of the material is not critical and it should be a good conductor. A silver coating will help if the horn has been soldered.

A horn for 1296 mc is not difficult to build and the gain in performance will warrant the use of one as a feed for a parabolic dish. The one shown in the picture is a 10 kmc horn 11 wavelengths long with a measured gain of 22 db over a dipole.

. . . TI2NA

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J. D. Kraus, "Antennas," McGraw-Hill Book Co., Inc.

Audio, Hither and Thither

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Philadelphia 50, Penna.

AFTER an absence of ten years from amateur radio (ten years absolutely wasted acquiring a wife and four kids) I again got the bug. As my code speed was run down at the key I settled for a Technicians ticket and promptly got on six meters with the aid of a Gonset G-50 and a friendly bank loan.

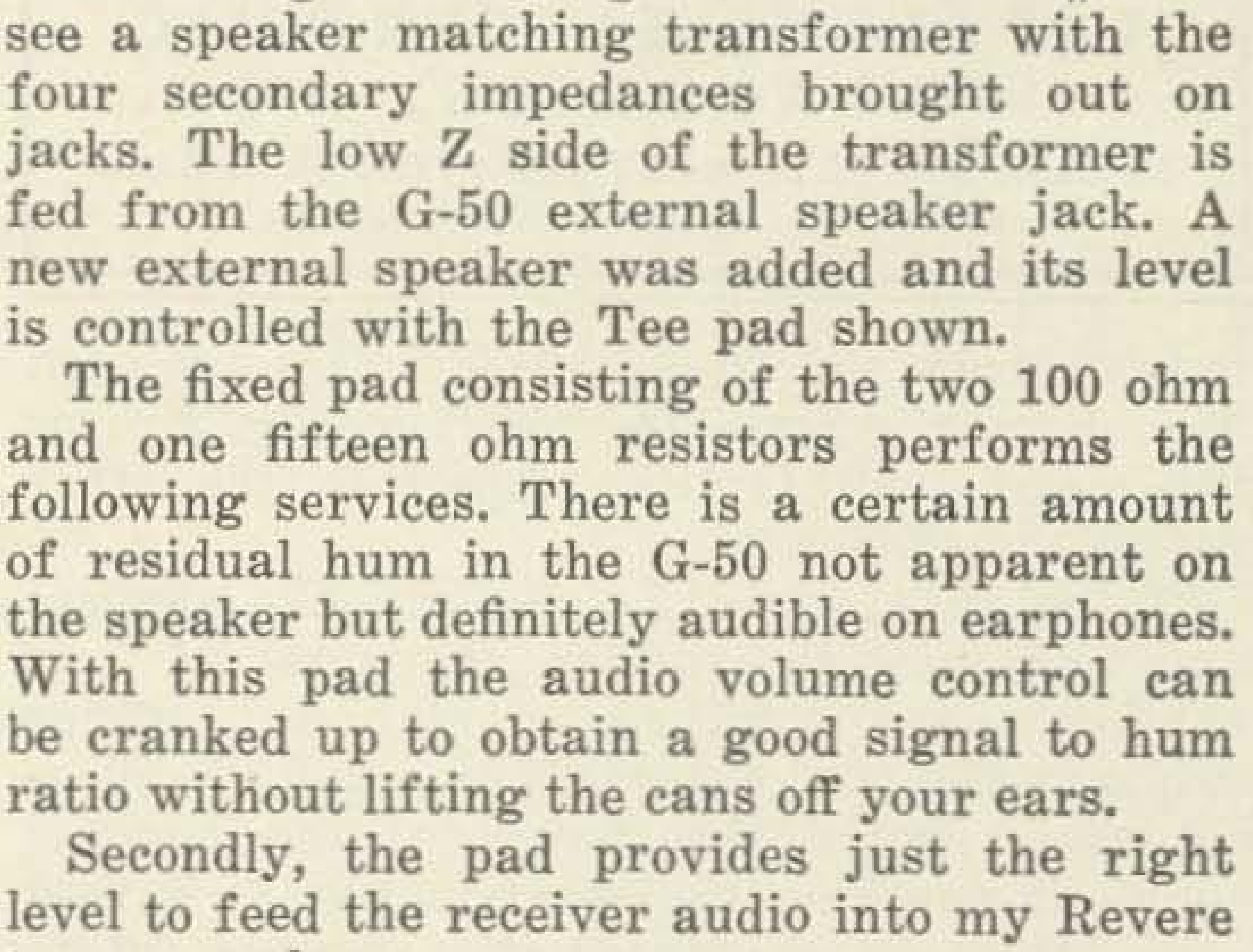
The fact that the G-50 did not have a phone jack suitable to my needs is where hereby hangs a tale. As much of my prior ham work had been on cw, I was used to headphones rather than a speaker and had to originate a headphone connection.

Referring to the diagram for UNIT #1 we see a speaker matching transformer with the four secondary impedances brought out on jacks. The low Z side of the transformer is fed from the G-50 external speaker jack. A new external speaker was added and its level is controlled with the Tee pad shown.

The fixed pad consisting of the two 100 ohm and one fifteen ohm resistors performs the following services. There is a certain amount of residual hum in the G-50 not apparent on the speaker but definitely audible on earphones. With this pad the audio volume control can be cranked up to obtain a good signal to hum ratio without lifting the cans off your ears.

Secondly, the pad provides just the right level to feed the receiver audio into my Revere tape recorder.

Notice that for reasons to be spelled out in just a bit, the jack feeding the new external speaker must NOT be grounded to the metal case the unit is built into. Putting it another way, there must be *no* dc connection between any part of the primary and secondary circuits of the matching transformer.



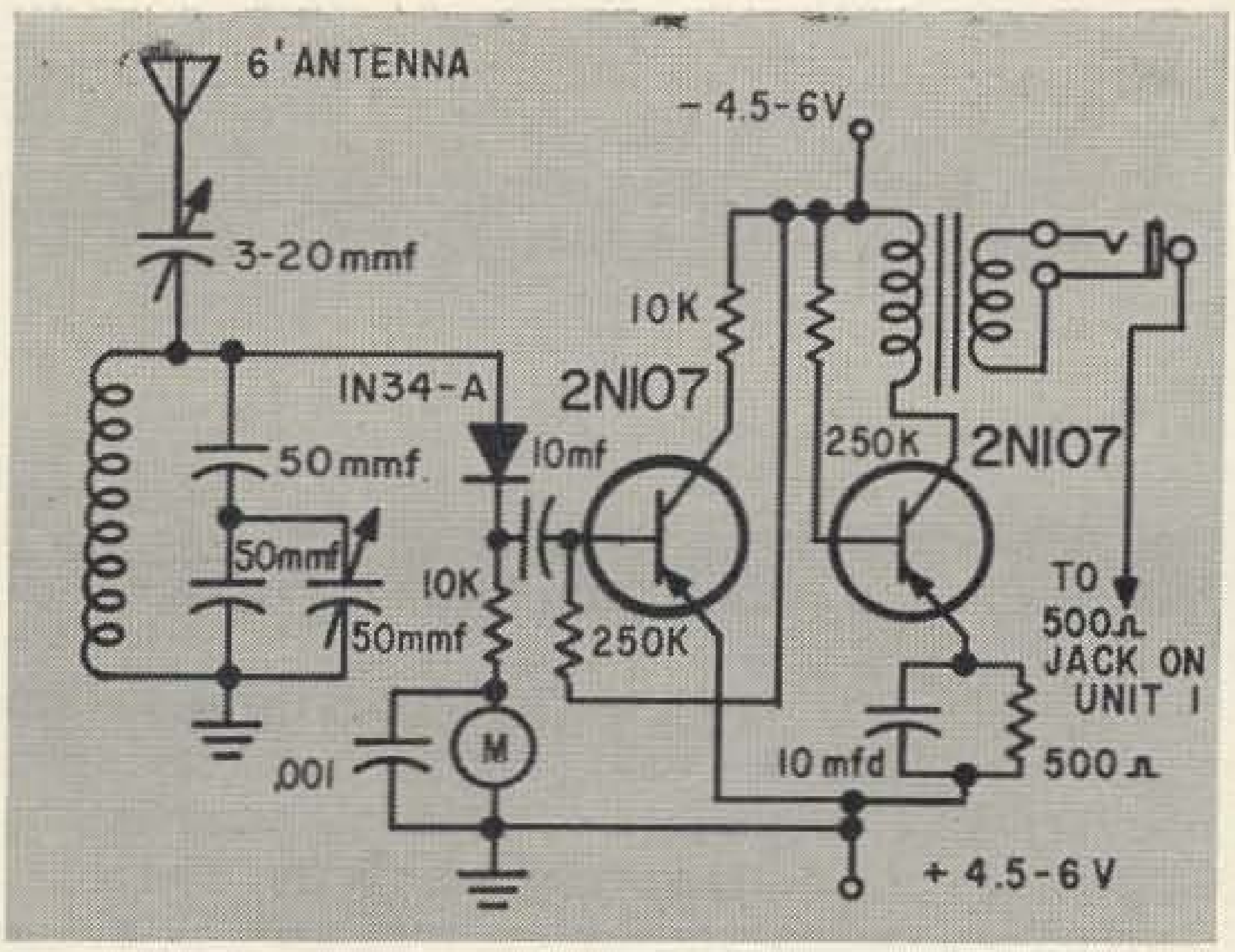
Now that I have established the fact that I own and use a tape recorder in connection with my shack to record QSO's and let the guy with the good audio (or bad) know just how he sounds, you can see a good reason for *no grounds* on the matching transformer secondary. By patching the audio from my tape recorder into the external speaker jack and patching the 500 ohm winding into my telephone I can play the tape back to any local ham who wants to hear his own signal. When it comes to a telephone, no grounds means no troubles which means good clean relations with Mother Bell.

There still semed to be a void in my life. When I recorded a QSO, my own glorious voice, my wonderful ideas and tremendous contributions to the general QRM never made the tape. In desperation was born Unit #2.

My QSO completer turned out to be a combination field strength meter, transistor radio and ego flatterer. Notice the charming simplicity of the little monster, born of a union of the junk box and the Lafayette Catalog.

Basically Unit #2 is a six meter tuned circuit, followed by a crystal detector feeding a two stage PNP transistor amplifier. The meter reads rectified crystal current providing an indication of signal strength. A pair of phones can be plugged into the output jack if you wish to use the unit to monitor your own signal. To use the unit as a QSO COMPLETER it works in conjunction with Unit #1 as follows. The audio from the transistor amplifier plugs into the 2000 ohm jack on Unit #1. The tape recorder is fed from the 500 ohm jack, thus the receiver audio and my own audio are combined on the tape, making a complete recording of the QSO. The 1500 ohm jack is used to feed my headphones.

Just one note for the boys who go to bed with their grid dip meters. Don't measure the tuned circuit out of the metal box as it will measure LOW. When installed in a metal box the tuning should be from about 49 to 55 megacycles. Tuning of the tank circuit will have more effect on the meter than it will have on the audio output, so for all practical purposes the variable condenser can be set to the middle of the band and forgotten. Use the antenna



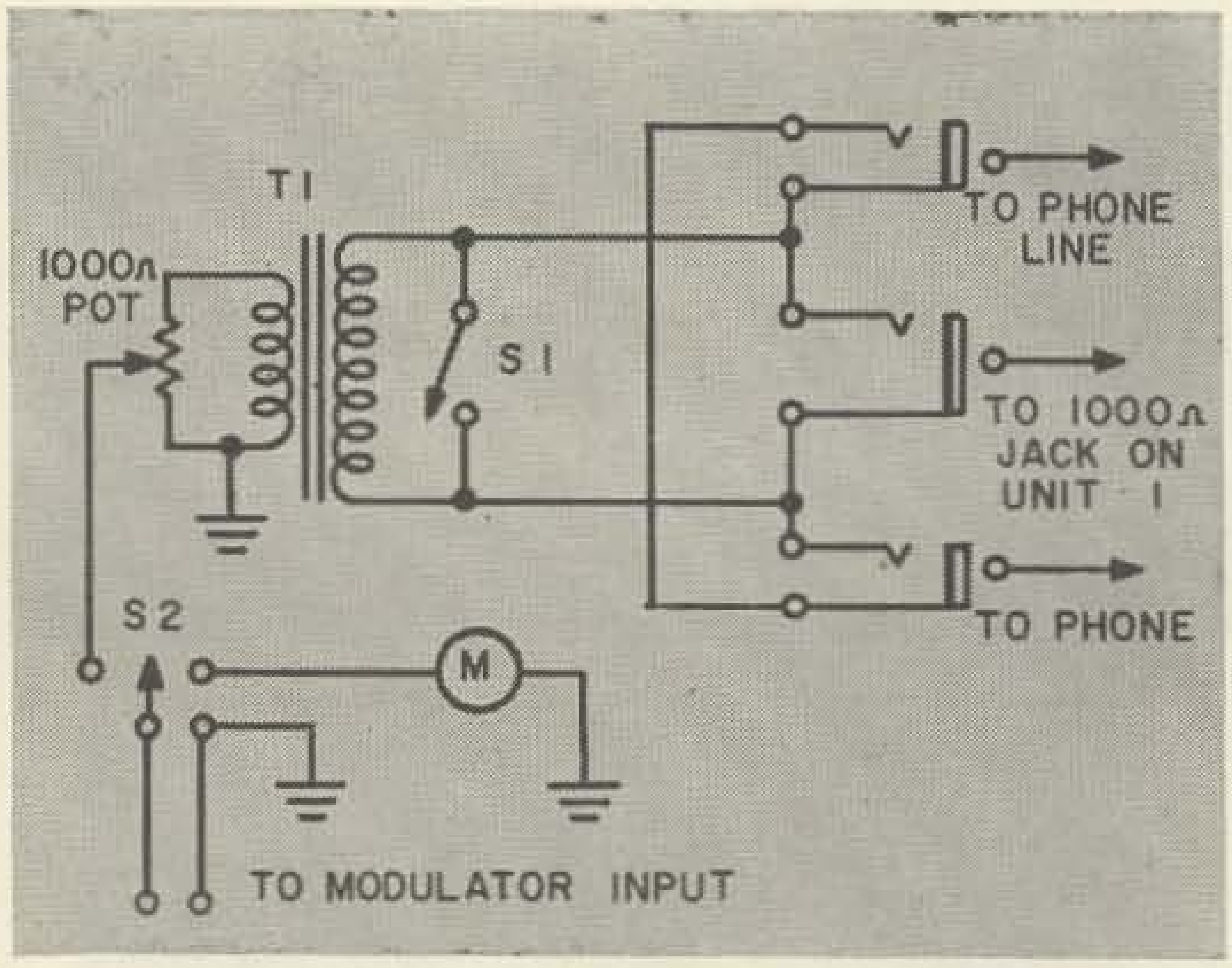
length to adjust for a convenient meter reading consistent with adequate audio output.

Having filled the void in my life I six metered it night and day, being fortunate in having an understanding wife . . . who is also weaker than I am. Then came cupid. A young gentleman in Pennsauken innocently asked me if I could phone patch him to his current lady love and thus provide him with entertainment while cutting the cost thereof of.

Being the possessor of a loving and gentle disposition I nevertheless had to deal cupid a dirty blow by answering negative. However, this did set me to thinking. I did have a phone. The phone bill was paid. I did have a means via Unit #1 of getting audio into the phone line. It was therefore up to the genie of the junk box to get audio out of the phone. Thus, because of purple passion, was born Unit #3.

Since we are going to attempt to deal with the telephone it is time for a few well chosen remarks. Somewhere inside your phone you will find three wires: Red, Green and Yellow. Red and Green are designated as L-1 and L-2. You have no need of the yellow wire as this is the ringing circuit which energizes the bell. One very important note: *do not place any grounds on any phone connections!* If you do, all kinds of loud and soft hums will ensue and the boys in the central office will be around to visit.

Now let's see how Unit #3 works. The row



of three jacks from top to bottom accept the incoming phone line—The audio from the 1000 ohm jack on Unit #1 and the phone instrument. The jacks are wired in *series* so that in effect the audio from Unit #1 is in series with one side of the phone line. With SW1 closed the phone works normally. With SW1 open two things occur. Audio from your receiver will go into the phone, and incoming talk from the remote phone may be switched into your transmitter via T-1.

T-1 is a single button carbon mike transformer wired with the high impedance side facing the phone equipment. The mike or low impedance side has a 1000 ohm pot across it to act as a patch level control for the incoming phone conversation to your rig.

SW-2 selects either the regular station mike or the phone audio to feed to your modulator. Naturally all leads at low level are run in shielded cable to avoid hum and rf feedback.

Now as to typical operation in normal use. SW-1 is left closed and SW-2 is set to the station mike position. You contact a ham who wishes you to phone patch. After dialing the number and reaching your party, you explain the principle of the phone patch. Friend ham is standing by so you contact him and say you are ready with the patch. At this juncture switch both SW-1 to its open position and SW-2 to the telephone position. This will put the telephone audio into your modulator. Let us assume that friend ham is to initiate the talk. You tell him to go ahead, kill your carrier and regulate his audio from your receiver so that the level in your phone receiver is comfortable to listen to. This generally works out to be good level to the remote phone without overloading the phone line and running the risk of cross-talk. Friend ham finishes his thought and says "Break." You switch your carrier on and the party at the remote phone speaks. You regulate the level to your modulator with the 1000 ohm pot as gain control.

While your carrier is on, you can interject your own comments by talking into your telephone, and both parties will hear you. In this regard you must watch out for overmodulation as you have the gain set for the remote phone which will be lower in level than your local phone.

If there should be any reason for cutting off the patch due to possible language which would violate FCC regulations merely throw SW-2 to the station mike position and explain your course of action to friend ham. You can ask him to stand by and talk to the party on the phone. If the patch is to be resumed with more cooperation and understanding, restore SW-2 to Patch and go ahead. If the phone call is at an end close SW-1 and hang up your phone. Finish your QSO and presto another patch is history.

Naturally, if you wish to, you can record the patch just as any other QSO as outlined earlier.

This patch is simple, effective, clean and foolproof. It has been duplicated by other hams with minor variations but always with success.

Just one final thought. A phone patch is an interesting aspect of amateur radio, just another way to serve the public and build good will for amateur radio. Don't abuse a good chance for public relations. . . . W3KBM

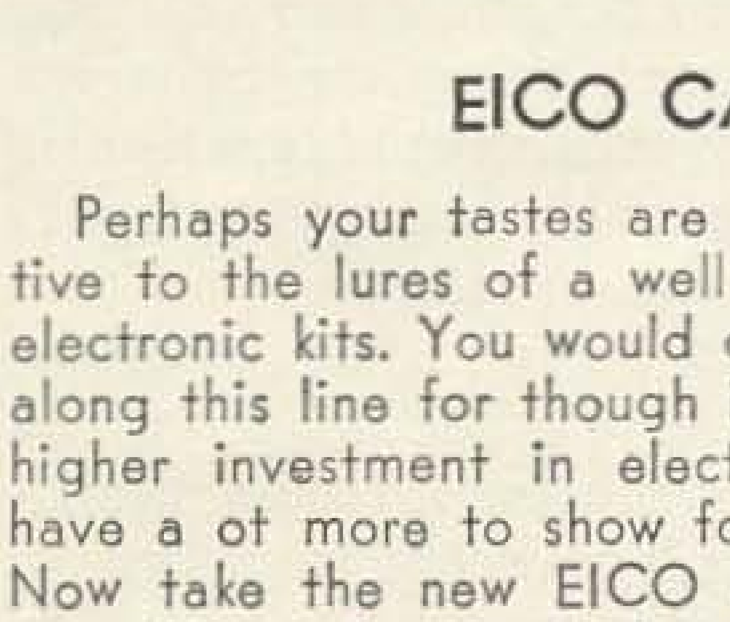
New Products

EICO CATALOG

Perhaps your tastes are jaded and you are insensitive to the lures of a well written catalog describing electronic kits. You would do well to develop yourself along this line for though it will inevitably result in a higher investment in electronic equipment, you will have a ot more to show for your years in the hobby. Now take the new EICO catalog (mention **73** when you do) and see if their seductive descriptions of ham, test and hi-fi gear don't get you busy at the workbench. EICO, 3300 Northern Blvd., L.I.C. 1, N.Y. or mark your name in the service card in this issue.

Miller Catalog

The builders amongst us will get a lot of pleasure out of the new J. W. Miller catalog. It's for free and runs for 48 pages describing their complete line of RF chokes and transformers. Drop a line to: 5917 South Main Street, Los Angeles 3, California and ask for catalog 62. If you have any extra space on the card mention **73.**



Coax Switch

Bay-Roy has a new miniature coax switch available. This one isgreat for transceivers and mobile installations where size is of importance. Operates from 28 vdc, will handle 150 watts. Models are available in all common types of connectors. Bay-Roy, Box 7503, Cleveland 30, Ohio.

Ted Adams KΦRRM
Box 26
Crescent, Iowa

Rewinding Relays and Transformers

THE first group we will discuss are the ac relays as most relays in use are ac 60 cycles.

Usually it will be found easier to supply the design voltage from a small transformer or directly from the line than to rewind the coil. Since this is not possible at all times it may be handy to note the following information. It is not practical to operate a dc type from ac directly. An ac relay is always constructed with a laminated pole piece and the armature is a solid strap or a laminated piece with a shading coil inserted. An ac relay will burn up if the armature is not in place, or if it fails to close when energized.

Coils are usually wound on a small paper or plastic spool which should be saved if at all possible. If not, a suitable one may be constructed of insulating paper and glued together. The most important consideration in winding is the number of turns of wire per volt of applied E.M.F. This varies considerably with the various types of relays, but usually is about 25-30 turns per volt for relays with a pole size of about ½ in. sq. The number of turns of wire on a relay may be easily determined by measuring the cross section area of the old coil and the size of the wire. The A.R.R.L. Handbook wire tables will give the number of turns. As can be seen from the above information a fellow would have a long white beard by the time he hand wound a 110 volt relay, but sometimes it is possible to mount the spool on a long bolt and chuck it up in a ¼ in. drill. The drill should be clamped in a vise and the wire supply mounted so the wire runs straight off the spool on to the coil. The wire may be guided lightly between the fingers and should be wound as evenly as possible. It is not usually necessary to layer wind relay coils, if good quality magnet wire is used. Formovar or enamel is usually best.

If the number of turns can be determined from the physical size of the original coil it is possible to find the number of turns for a different voltage quite easily by figuring the turns per volt. A coil designed for 110 vac is calculated to contain 2700 turns of #40 wire. This may be expressed as a fraction 2700 ÷ 110 and when reduced represents the number of turns per volt. Approximately 25 in this case. If the coil were to be rewound for 6 vac the number of turns would then be 150 and, as may be calculated from the wire table, #40 wire is rated to carry 14 ma, which would equal 38 ampere turns (product of ampere times turns). Thus it would be necessary to wind this coil with 150 turns of #28 wire to have the necessary operating energy required. This is found by dividing the number of ampere turns by the number of turns to be used in the new coil. In this case 38 ÷ 150 which gives 2 current of 250 ma. By referring to the wire table current carrying capacity list we find that #28 wire will handle 250 ma.

DC Relays

The dc relay is a much simpler and more dependable device than its ac counterpart. The dc relay may be made very sensitive and is easily adapted to any power source.

To rewind the coil of a dc relay the most important thing is the resistance of the coil. The coil must have enough resistance to limit the current to the current carrying capacity of the winding. The only other consideration is that the coil generate enough energy to overcome the armature tension spring.

The coil cross section area again may be used to approximate the number of turns in the original coil. The number of turns multiplied by the current will give the number of ampere turns necessary to operate the relay and the ampere turns may be converted to give the number of turns necessary for any given voltage.

The figuring of wire size and coil resistance could run into a complicated problem, so it was with a sigh of relief that I found that it is usually sufficient to compute the wire size and then wind the coil form full. The resistance of the coil may be checked and as long as it is high enough to limit current flow to the capacity of the wire, your coil will do the job ok. It is far better to have too much wire as it is easier to adjust the armature spring tension than to rewind the coil when it burns out. Of course if the coil resistance is so high that it is not possible to get dependable operation, a few turns may be stripped off quite easily.

Here is a very simple and useful way to compute the wire size to be used in rewinding a dc relay. Measure the resistance of the original coil with a good volt-ohm meter. This resistance divided into the operating voltage will give the current and this may be multiplied by the quotient of the original operating voltage divided by the voltage of the new coil.

This will give the current of the new coil and it is only necessary to refer to the current carrying capacity section of the wire table to find the nearest size and wind the spool full as was stated before.

There is a good supply of 24-28 volt relays on the market. These may easily be wound for 6 or 12 volt dc. Some of the plate types have two coils wound seperately and connected in series. These coils may be paralleled and the relay will then operate as a 12 volt relay for the mobile rig.

Transformers

The rewinding procedure on a transformer is much like a relay. The transformer is disassembled, (the laminated core is removed) and positions of the various windings are determined.

Usually the filament winding of a power transformer is found to be the top or outer winding with the H.V. windings next and the primary winding is found on the bottom, adjacent to the core.

To rewind a transformer the turns per volt is again the most important factor to be considered. The small transformers used in radio gear and designed to operate on 120 volt 60 cycles will be found to have a ratio of from 6-10 turns per volt. If there is a filament winding to be removed from the transformer you are rewinding, simply count the turns as you remove them and divide the number of turns by the voltage. A 6.3 volt winding was found to have 44 turns of wire; the turns ratio would be 44 ÷ 6.3, or 7 turns per volt. If the transformer is to be rewound for 24 volts the number of turns would be 24 x 7 or 168 turns. It is possible to count the turns of the H. V. windings in the same manner, but the large number of turns takes more time than it is likely to be worth.

Entire transformers may be rewound using any good magnet wire, but enamel or formovar will usually be best.

As in all uses the wire must be of sufficient size to carry the necessary current. The necessary information may be found in the A.R.R.L. handbook tables. Care must also be used in order not to exceed the wattage rating of the transformer. If the rating is not to be found on the nameplate the load may be computed by totaling the individual winding rating—i.e. A transformer was to be wound for 12 volts, the original winding was found to be 6 volts at 10 amps and the original primary was to be retained. The wattage rating would be 6 x 10 or 60 watts, thus the current of the new secondary would be 60 ÷ 12 or 5 amps.

A final word deals with insulation. The enamel of Formovar on the wire is sufficient for turn to turn insulation, but layer to layer voltage will be too high for this insulation. The best insulation is regular transformer paper, but if the transformer is to be varnished or wax dipped, regular note or kraft paper may be used. . . . KØRRM

The Fine Art of Surplus Utilization

Roy E. Pafenberg W4WKM
316 Stratford Avenue
Fairfax, Virginia

SINCE World War II, probably more words on the general subject of surplus have appeared in the amateur periodicals than on any other single subject. This is an opinion area and strong feelings, pro and con, are the rule. Individuals who have been severely burned are vehemently opposed to amateur use of surplus and those who have made fortunate acquisitions and used them intelligently are firmly entrenched on the other side of the fence.

The day is long past when surplus for the sake of surplus alone has any attraction for the average amateur. Aside from the questionable value of the nostalgic memories it evokes in the mind of the ex-GI, many items of surplus have no practical value and are probably best forgotten.

Military electronic surplus, of value to the amateur, falls in the following categories:

1. Equipment which may be put to immediate amateur use, requiring little or no modification, roughly equivalent to commercial equipment and available at substantially less cost than on the new equipment market.
2. Equipment which requires extensive modification or "conversion" to make it suitable for amateur use. A reasonable prospect should exist that the finished product will, at far less cost and labor, equal in performance and appearance a similar unit constructed from new commercial components.
3. Equipment of little or no value to the amateur as an end item but which contains one or more expensive or hard to get items for which an immediate requirement exists. To fall in the "good buy" class, the equipment should cost considerably less than the new cost of the required components.
4. Equipment of no value as an end item but so priced and containing such a quantity of modern components and hardware that it is worthwhile to strip for the salvage value of the parts. Be very cautious in dealing with this category of surplus. The cost should not exceed 10 to 20% of the new price for the expected yield of usable components.

Of course, as is true of all generalities, specific cases seldom fall precisely in a single category outlined above. In any surplus conversion, parts and hardware will be accrued and components expended. The main point is that a clear cut plan should exist for any item of surplus equipment purchased. All too much surplus equipment, representing funds that could have been better used in the purchase of commercial components or equipment, lies gathering dust for the lack of such a plan.

Before we enter into the actual mechanics of dealing with surplus, another aspect of the subject should be discussed. One fringe benefit derived from working with surplus military electronic equipment may not be apparent on first consideration. The technically inclined amateur usually attempts to pattern his construction projects to the highest standards with which he is familiar. This is where detailed knowledge of truly good equipment pays off.

If a construction project is based on standards derived from familiarity with $9.95 broadcast band "bloopers" and bargain basement "short wave" receivers, the results will probably leave much to be desired. If, on the other hand, construction standards are derived from a detailed knowledge of the design and construction techniques used in the best equipment, the project is off to an auspicious start.

This is not to imply that the design and construction details of all military surplus equipment are worthy of immediate amateur adoption. The reverse is often the case. Anyone who has worried through a number of surplus conversions knows that the biggest part of the job often lies in finding the best method of circumventing the intent of the equipment designer.

This, however, is not a matter of design but of application. The final electrical design and mechanical packaging of any item of military electronic equipment is based on the intended use and probable environment. Assume two items of military radio equipment, electrically similar and functionally identical, one designed for use in fixed radio stations and the other for use in open combat vehicles. The first would probably be ideal for amateur use, while the second may be doomed to open storage in a surplus yard.

"Where should I buy surplus equipment?" is a question that is often asked. Despite the attractiveness of mail order surplus prices, purchase from a local dealer has many advantages. Local merchandise is available for inspection and condition is easy to determine. Also, a good price, swap or other deal is easier to arrange when you are bargaining in person. Further, if you only need certain components of an equipment, a favorable "strip on the spot" purchase is often possible.

Another argument for patronizing the local dealer is that all surplus houses sometimes have very desirable items in quantities too small to advertise. The best buys are often contained in these small lots.

Not to be ignored are transportation costs. Military electronic equipment is heavy, particularly when boxed for overseas shipment. It is not at all unusual for transportation costs to exceed the purchase price of the equipment. For example, to ship a 70 pound item of equipment 1500 miles, the charges would be about

Surplus from page 73)

$10.91 by Parcel Post, $11.19 by Railway Express and $7.40 by Motor Freight.

Once the purchase is made, you are truly committed. If the acquisition falls in the first category of commercial type equipment, your troubles are minor. No great difficulties should be encountered since the application will be much the same as the original intended use. If the instruction manual is not available, write a letter to the manufacturer. If this does not produce the required publication, contact the surplus dealers who specialize in such literature. Government sources of publications are more productive than is generally realized and details on this subject will be covered in a future article.

Surplus military equipment requiring "conversion" to meet amateur needs includes the bulk of available items. This equipment, falling in the second category, may or may not be applied as originally intended. Much equipment, for example the famous Q-Fiver application of the low frequency Command Set receiver, has its greatest value when used to satisfy a totally different need. Successful use of surplus equipment for conversion purposes requires that the following conditions be met:

1. A positive, individual requirement must exist for the equipment after the proposed conversion is accomplished.
2. There should be a reasonable prospect that the converted equipment will fully meet the minimum requirements.
3. There should be evidence that the proposed conversion is, in fact, the most economical approach to the problem. It goes without saying that the determination should be reached prior to the purchase of the surplus equipment.

There are, of course, other considerations than that of immediate practical application. If, as the writer, you get a great deal of pleasure and satisfaction in exploring the intricacies of strange equipment and can afford it, as he can't, then more power to you. The sky is the limit and any practical return is pure gravy.

If you are following a published conversion plan or working from an already converted model that meets your requirements, then go ahead. If, on the other hand, you are treading new ground, a few general pointers are in order. Follow the philosophy of making the minimum required changes. Try, if at all possible, to keep the conversion completely self contained and within the confines of the original enclosure. Try to keep your workmanship to the same standards as those displayed in the construction of the equipment. There is rarely any real justification for haywire. Make an effort to bring all controls out to the front panel and strive for a convenient, symmetrical arrangement.

Perhaps the majority of available surplus equipment is designed for aircraft use. This equipment is usually housed in the black crackle finished, standard aircraft electronic equipment cases and is normally powered by the 28 volt dc and/or the 115 volt ac, 400 cycle aircraft power system.

Conversion of this type equipment to 115 volt, 60 cycle operation has been greatly simplified by the introduction of economical silicon rectifiers and the development of reliable, economical, high value electrolytic capacitors. Design and construction of these compact semiconductor power supplies for this application is a subject in itself which will be covered in a future article.

The aircraft equipment enclosures are fairly easy to deal with in these conversions. The ATR cases are usually finished in black crackle and this, despite the popularity of the thousand shades of gray, fits nicely in most decorative schemes. After all, we are dealing in communications equipment and as long as it presents a neat, functional appearance, this should be sufficient. If the finish is scuffed or abraded, a coat of gloss black, spray lacquer will restore the finish to its original condition. These pressure cans, spray lacquers, of which the Krylon line is representative, make equipment finishing easy.

The front panel of most aircraft radio equipment is formed to fit over the front edges of the case. Since it is highly improbable that the generous assortment of original connector holes would be used, it is best to provide a face panel to fit over the original. This finish panel may be a rectangular piece of 16 or thinner gauge aluminum cut to a slightly smaller size than the original panel. This panel may be finished in a matching or contrasting color and commercial decals applied for the professional touch. The control bushings and mounting hardware will usually be sufficient to hold the new panel in place.

(Turn to page 76)

(Surplus from page 75)

Once a surplus item of equipment is acquired, categories 3 and 4 become the same. The objective is to, by discriminating buying and careful salvage, accumulate a comprehensive stock of hardware and components. For the technically inclined amateur who does considerable experimenting and construction, this is indeed a lucrative area. Projects always start with an inventory of the junk box and the more complete the stock, the less the cost will be.

If you intend to obtain the maximum value from your salvage components, you had best abandon the junk box concept. Adequate, segregated storage facilities are essential if your parts accumulation is at all extensive. Small parts storage bin units such as the parts jobbers use are ideal for the purpose although expensive. The compartmented drawers will protect the parts from damage and enable you to find parts as you need them. The same considerations apply to hardware storage.

If funds are a problem, you might consider fabrication of your own storage facilities. Glass baby food bottles are easy to secure and will hold a fair amount of hardware and small parts. If your shop is located in the basement or an unfinished room, shelving may be made for them from 1" x 4" pine and installed between the wall studs. Shelves should be spaced slightly farther apart than the height of the bottles and the units fitted with Masonite or plywood backs. Molding applied over the studs and the edges of the shelving makes a professional job of your storage wall. A wall space, 4' x 6', will store over 600 bottles.

The actual stripping operation should be orderly and logical, using the scalpel rather than the sledge-hammer technique. Open up the cable lacing and clip the wiring leads a few inches back from the component terminals. This will give you a handle to work with in the clean up operation. Lead mounted components should be carefully unsoldered and the leads uncrimped with long nose pliers or one of the available unsoldering tools. As the components are freed of the wiring, dismount and lay them aside. When the job is completed, survey the chassis, enclosure and the less likely of the components. There will be some items that could be of no future value. Ruthlessly dispose of these immediately.

During the stripping operation, be on the watch for subassemblies that are of possible "as is" use. Dismount these and leave them intact. Store them separately along with any special mounting hardware.

All components should be cleaned up before storing them. An electric solder pot is ideal for this purpose. The terminals of the parts may be immersed in the molten solder and the leads worked loose. Discard the wiring and when it is all removed, straighten the terminals and the leads of lead mounted components. As a final step, dip the leads or terminals in non-corrosive soldering flux and immerse in the molten solder. Flick the parts or drop them on the bench to remove the excess solder. If the solder pot is not available, place a regular soldering iron in a stand or clamp it so that the tip is accessible and both hands are free. It will take a bit longer but the results will be the same. The appearance of the parts may still leave something to be desired. If so, a thorough washing in alcohol will remove accumulated dirt and resin.

Inspect the parts and give them an ohmmeter check, discarding those that did not survive the ordeal. Segregate and stock as you would new parts. While there is work involved, and lots of it, very substantial savings can be made in the salvage of surplus electronic equipment.

The availability of military surplus electronic equipment is a definite asset to the amateur fraternity. Judiciously purchased and intelligently applied, it can save the technically inclined amateur much money, broaden his experience and increase his technical competence.

. . . W4WKM

(W2NSD from page 4)

attend the dinner and be charged $19 more. "Sorry, we don't have a seat for you up front here, these are all reserved. See if you can find one in the back somewhere." As you can guess, his name was not brought up when congratulations were being modestly exchanged on the podium for the success of the convention. Ass, what therapy an editorial page is for a grumbling editor.

It is nice as part of the exhibit area, to have a few booths allocated to the special interest in our hobby. For instance you might have a VHF booth, with a place for the fellows to post their QSLs and confab. You might also have a DX booth, and a sideband booth. If you can arrange special badges or buttons for these chaps they will wear them prominently. Most areas have a group of RTTY'ers that

(Turn to page 78)

(W2NSD from page 77)

will turn out in force if recognized.

Conventions can be a lot of fun if properly planned. I've been to many that I'll not forget, some with pleasure.

No Postcard

A call from our postoffice in Norwalk requested that we omit the postcard from this issue pending an investigation brought on by "some publisher" in New York City who had questioned whether it was strictly according to postal regulations or not. They couldn't enlighten me as to what the problem might be, so we're all in the dark until further word comes from Washington. A great many magazines now use inquiry cards these days so this might have rather widespread repercussions. Until we hear further we'll have to leave out the card . . . sob!

Last Will

A small ad in the *New York Times* auction section was the first word that I had of the demise of John Williams W2BFD. There was a small note saying that there was to be an auction of his equipment a few days hence.

All you fellows who have been hearing so much about ham Teletype should know that John had a large hand in its popularity. He started working with it right after the war and fanned interest in a handful of locals. From there it spread to several thousand who are busy with it today. I first heard the strange signals on the high end of two meters back in 1948 when I was Chief Cameraman for WPIX (TV) and had my two meter station installed on the top of the News Building on 42nd Street in Manhattan. I worked out magnificently from there with my 16 element and five element beams. There is nothing like a tall building to give one's signal stature.

So there were those tweedle-tweedle noises. I asked around about it until I ran into Bill Knott W2QGH, who explained all. I contacted John and soon was frequenting his small radio service store in Queens. After a while I had converted an armload of cash into an old Model 12 printer and a duplicate of the W2BFD RTTY converter, complete with auto-start, etc. I went on to full tape gear, the works. And I had a ball. We were restricted to two meters at that time, plus eleven. On the other ham bands we had to use make-break keying, which was not very efficient. The best I did was get an envelope of "copy" from Bob Weitbrecht W6NRM, another important pioneer TT man. I ran tests on 80M make-break too, but never worked very far due to the poor performance of make-break reception of RTTY through interference.

John spent most of his time in the back of his radio store playing with electronic gadgets. He built the most amazing things. He insulated himself from the world with an automatic telephone answering system, and few people have managed to get past this for the last few years. He continued to round up Teletype equipment whenever he could and passed it along to the boys. When he died he had a tremendous collection of stuff. In addition to his regular store he also had at least three other stores full of RTTY and other gear, piled to the rafters. In one store I saw 1,500 Teletype keyboards.

When John died he left no hint to his surviving daughter as to how to get rid of this hoard. She didn't know which way to turn. She finally called in an auctioneer from Canal Street in New York. I drove over through the hurricane to see the auction and was amazed to find only a handful of people there, mostly keeping out of the rain, while this auctioneer quickly rattled off one lot after another to a junk dealer (electronic junk) who I understand is in the same building as the auctioneer. It took a while before I managed to get in some bids for at every opportunity the auctioneer would award a lot to his friend. I was appaled to watch hundreds of dollars worth of equipment being sold for $3 and $5. I started bidding in earnest. They still got a lot of bids past me by fast maneuvering, but I ended up with a few pieces that I was glad to have saved.

All in all I think I watched about $100,000 worth of electronic gear get sold for about $1,500. Those keyboards went for $75 total! I gritted my teeth because I don't have any place to put 1,500 keyboards.

The moral? Sit down fellows and make up a list of what you have, about what it is worth and put down some suggestions for your heirs to use when they are faced with liquidating your empire.

U.S.S.R.

One of our readers, Lee Gunther W6THN/1, who is also publisher of the International Ham Hop Newsletter, paid for a subscription to 73 for UB5UG. A recent letter from Yuri thanked him very much for the gift and explained that the magazine is thoroughly read and enjoyed by just about every ham in Kiev, with photocopies being sent to other cities. Unfortunately they are unable to subscribe since they cannot send out money, IRC coupons, or even postage stamps.

Perhaps you know some hams in Russia that would like to get 73. It costs us a little over two dollars per year in postage to send copies out of the States. As a gesture toward international friendship we'll send two subscriptions to Russian hams for you for the price of one. You send $4.00 and the name, call and QTH for two Russian hams. This is a temporary offer and will be voided if you start russia'ing us toward bankruptcy or if I get a sudden flash of business accumen.

Charles E. Spitz W4API
Associate Editor

73 Tests

The Gonset Communicator IV

IN THESE parts the Gonset Communicator is known as a "Gooney Box." This is said as affectionately as the famous "Gooney Bird" C-47 of World War II fame. Reliable and trustworthy, regardless of the operator.

In fact operating ease is one of the oustanding characteristics of the Communicator IV, yet with a technical perfection usually ascribed to fine custom made VHF equipment. Amateur radio, whatever the mode of transmission, passed through the stages of breadboard construction, six foot racks with glowing "jugs," the table top set of matched cabinets, and now is concentrating upon portable integrated equipment which can match the performance known previously only to fixed station operation.

Portable equipment has been with us longer than most people appreciate. The writer had the dubious pleasure of field operating the heavy wood cased single VT-1 tube, battery powered, portable at Ft. Monmouth when it was a military operational radio. For a long time we have come to accept many limitations in portable gear, attributing peak performance to the weight and bulk of fixed station equipment. I am happy to report that the Communicator IV packs in its 21.8 lbs all of the refinements of fixed station performance on 2 meters, and is a proponent of the modern trend where you can use it at home or take it with you.

Although the Communicator IV functions as a transceiver in convenience and operating ease, it is essentially a separate transmitter and receiver in the small cabinet. The only part common to transmit and receive is the audio system. Although it is a 20 watt transmitter, it seems to have more "punch," which can be attributed to the fact that there is 10 watts of audio modulation provided, with high level speech clipping instead of the commonly used screen modulation system. This means a peak power of 80 watts rather than a possible 20 using the rf system limits. The receiver sensitivity of better than one microvolt and a triple conversion super heterodyne winds up with very credible performance indeed, better than many fixed stations can boast. When you add to these characteristics an *ac and dc mobile power supply as an integral part* within the cabinet dimensions of 5" high, 12½" wide and 11" deep, you begin to appreciate the compactness of the system.

No external gadgets, plugs, relays, meters, inter-connecting cables, etc., are necessary for functional operation. You merely plug in the appropriate power cord for 110 v. ac, or 12 v. dc, the antenna, then load and talk. The slide rule dial is illuminated, and is driven by a dual ratio planteary drive knob. The illuminated self contained meter reads either rf output, facilitating antenna loading, or in "S" units for relative receive strength readings. There are no transmitter intermediate stage tuning controls, and the six crystal sockets in the rear provide ample frequency selection for average operation. Incidentally, the spotting switch which shows your transmit frequency on the receiver dial and "S" meter, serves as a good indication of crystal activity in case you are in doubt as to the merit of your surplus crystals.

Although there is no means of receiving sideband or cw, it is said a bfo conversion kit may be offered as an optional accessory later. However, the writer was able to obtain a beat by turning on the spotting switch using appropriate crystals to receive both ssb and cw. This is a crude method, of course, and a matter of accident so far as available frequencies are concerned, but perhaps the new Model 3357 matching VFO may be used for this purpose in the interim, pending the bfo conversion, for those who desire it.

Transmitter RF Section

The rf stages use three 12BY7's, one of which normally functions as a crystal oscillator-tripler, where 8 mc crystals or a VFO of that frequency is connected to one of the crystal sockets. However, 6 mc crystals or VFO with a 6 mc output, or a VFO with a 24 mc output may also be used. The output of this stage is at 24 mc. This is tripled to 72 mc in the following stage, then doubled in the third to 144 mc, permitting the 6360 dual triode to operate "straight through" as a final amplifier with its 20 watts input for high efficiency operation. All of the coils are peaked at a point within the band where the output of each stage is equal at each band edge. In this manner, there is sufficient drive for the final amplifier over the entire band without the necessity for panel tuning or trimming, with the exception of the final. Conventional final plate condenser tuning is used in conjunction with a link-series condenser combination which results in less interaction between the two controls than a pi network. This method permits a more rapid frequency change yet maintaining some loading while tuning. Only the final tuning and loading control, in conjunction with the rf output meter, is used when changing frequency once another crystal or VFO setting is made. For most frequency changes, this is a minor trimming.

An rf wattmeter in series with the antenna indicates the Communicator meter as being sufficiently accurate and responsive in order to obtain maximum output. Although the output is 50 to 75 ohms impedance, it was possible to load an unmatched antenna. However, it is recommended that the antenna impedance be determined since the meter understandably responds only to rf voltage. A mismatch of higher rf voltage could be misleading if it were to be construed to indicate a greater output.

Audio Section

On one transmission I rambled through a long dissertation, only to have one of the fellows who watched me on a 'scope tell me to turn up the gain, since I appeared to be undermodulated. This caused a search for a gain control, since none appears on the front panel. The old Communicators had one in the rear. After a fruitless search, the schematic diagram was spread out.

The boys were really impressed, as was I, to find none in the circuit. In my customary SSB operation, wandering from the mike merely means a not very noticeable lesser output. Here I had failed to take into account a basic design feature. The gain level and Astatic 331-18 ceramic microphone design has been set for mobile and field use where close talking is essential to the reduction of background noise. Close talking brought the modulation level back to 100%.

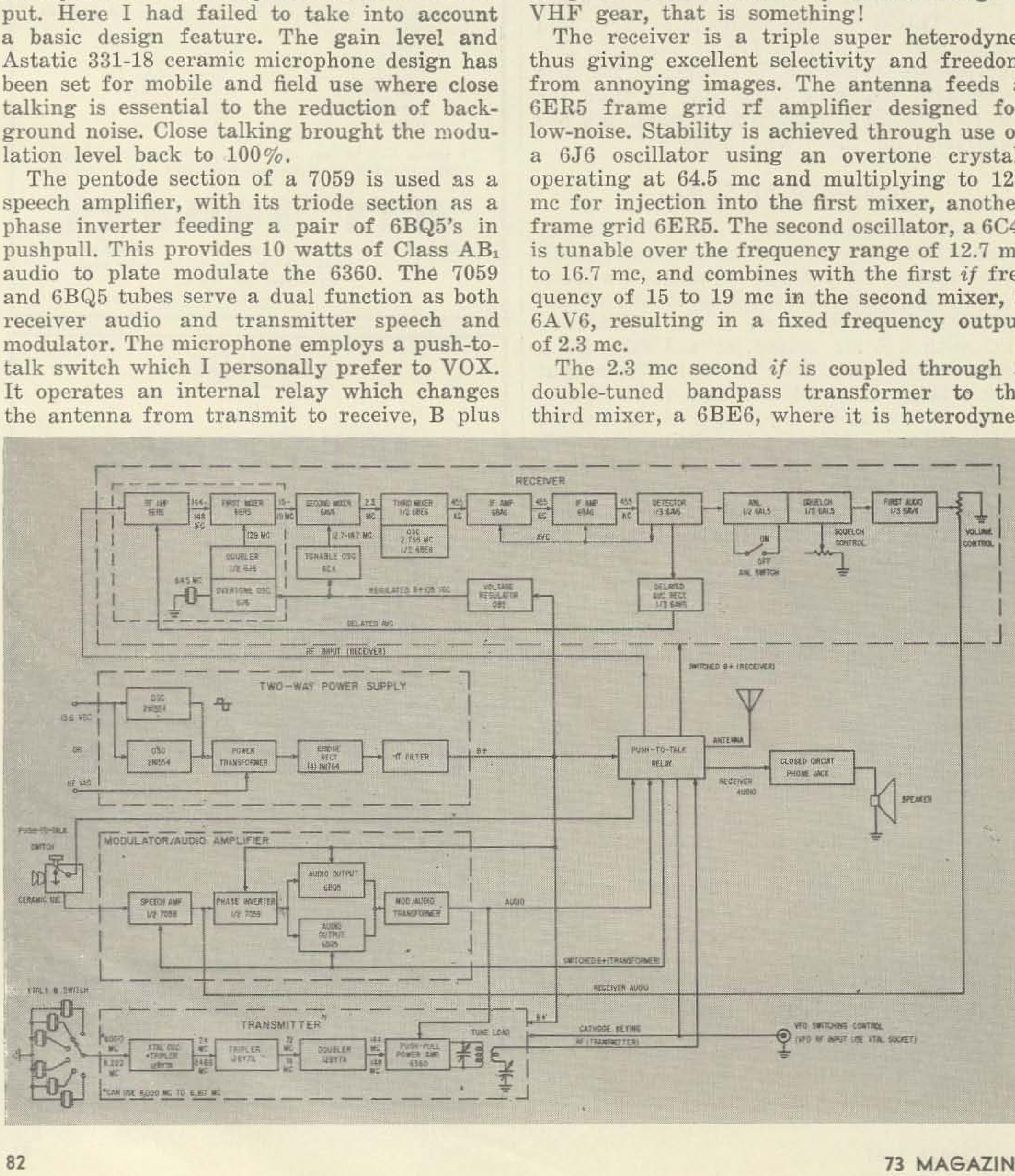
The pentode section of a 7059 is used as a speech amplifier, with its triode section as a phase inverter feeding a pair of 6BQ5's in pushpull. This provides 10 watts of Class AB_1 audio to plate modulate the 6360. The 7059 and 6BQ5 tubes serve a dual function as both receiver audio and transmitter speech and modulator. The microphone employs a push-to-talk switch which I personally prefer to VOX. It operates an internal relay which changes the antenna from transmit to receive, B plus from receiver to modulator, disconnects the speaker and keys the transmitter.

Receiver Section

There are a number of outstanding features in this receiver, to the degree that it is difficult to pinpoint that which is the most outstanding feature. Certainly the fact that the receiver handles like a first class communications set does on the lower frequencies, yet operates within the 2 meter band with such performance, does indicate something out of the ordinary. When this is coupled with a simplified control system, as it has to be for the non-technical users of Civil Defense and the Civil Air Patrol, yet retains the features desired by critical amateur radio users and is compared with meticulously custom designed VHF gear, that is something!

The receiver is a triple super heterodyne, thus giving excellent selectivity and freedom from annoying images. The antenna feeds a 6ER5 frame grid rf amplifier designed for low-noise. Stability is achieved through use of a 6J6 oscillator using an overtone crystal, operating at 64.5 mc and multiplying to 129 mc for injection into the first mixer, another frame grid 6ER5. The second oscillator, a 6C4, is tunable over the frequency range of 12.7 mc to 16.7 mc, and combines with the first *if* frequency of 15 to 19 mc in the second mixer, a 6AV6, resulting in a fixed frequency output of 2.3 mc.

The 2.3 mc second *if* is coupled through a double-tuned bandpass transformer to the third mixer, a 6BE6, where it is heterodyned



Specifications

Size: 5" x 12½" x 11" deep

Weight: 21.8 lbs.

Power: At 117 v. AC
Receive 87.5 watts
Transmit 110 watts
At 12.6 v. DC
Receive 7.2 amps
Transmit 10.3 amps

Tubes: 18 plus 2 power transistors and 5 silicon diodes, including dual and triple purpose tubes.

Transmitter: 6 or 8 mc xtals; 6, 8, or 24 mc VFO
20 watts input, high level modulation RF Output Meter

Receiver: Triple conversion super-heterodyne
Squelch; noise limiter "S" meter
Sensitivity, 1.0 uv for 10 db S + N/N ratio
Noise figure, 3 to 5 db
Selectivity, from BW 6 db at 8.5 kc to 60 db at 47 kc
Tunes 143.7 mc to 148.3 mc (CAP & MARS)

Price: Model 3341 Transmitter-Receiver $369.50
Universal Mounting Kit Model 3365 .... $ 3.95
Telescoping Antenna Model 3152 .... $ 3.95
Carrying Bag (Blue).......... $ 12.00

against a 2755 kc oscillator to produce the 455 kc third *if* signal. Two stages of *if* amplification, using 6BA6's, are employed at 455 kc. Six tuned circuits produce the desired selectivity.

A vacuum diode (⅓ of the 6AV6), is used as the detector. This same tube is used as a delayed AVC rectifier, furnishing delayed AVC to the rf amplifier. One-half of a 6AL5 is used as a highly effective automatic noise limiter, switched in or out by a front panel control. The other half of the 6AL5 is used for squelch operation to permit muting of the background noise in the absence of a signal. The first audio amplifier is the triode section of the 6AV6. This audio is then fed into the 7059 which is employed as a speech amplifier when transmitting, thence to the 6BQ5's. An audio jack is provided on the rear apron for an external speaker or headphones.

The squelch range of 0.1 uv to 50 uv introduced the writer to an innovation for tuning in local stations. There is a fair amount of background noise at the site at which the equipment was put through its paces. A relief from noise in the hours of listening throughout the band was provided by setting the squelch to just override the fairly uniform background noise, then the fast tuning knob of the receiver could be rapidly rotated for band scanning with stations "popping in" out of the silence as they were tuned in.

One of my first QSO's was with two stations who were complaining about QRM. This was news to me, because I could not hear any QRM on the frequency due to the receiver selectivity. As received from the factory, the receiver bandpass is broader than the maximum selectivity than can be achieved. This is because of OCDM requirements, when used for Civil Defense. It is 6 db at 10.3 kc, 20 db at 15.5 kc, and 60 db at 47 kc. For most amateur areas, this is plenty good and facilitates easy tuning. If you are faced with a QRM situation, three 2 mmfd QC type coupling capacitors on the 455 kc *if* transformers can be removed with a pair of diagonal cutters. No readjustment of the *if* transformers is necessary, and the selectivity curve will start at 8.5 kc instead of 10.3 kc.

Power Supply

I wish all the rest of my gear in the hamshack had supplies like it. It is a universal supply, using a single power transformer for 110 v. ac, or 12 v. dc. The changeover is made by plugging in the appropriate power cord so that switching is automatically done. The filter and four silicon diodes, 1N1763 types, are arranged in a bridge for both modes of operation. One transformer winding is for 110 v. ac. The primary and feedback windings utilized by the 12 v. dc source employ two 2N1554 transistors.

Accessories

This is usually an important part of the game when it concerns any major piece of equipment. The Communicator IV is remarkably free from the need for accessories for any normal operation. You can operate it on a desert island if you have 110 volts of ac, or 12 volts of dc, a crystal, and a 19 inch piece of wire to insert in the rf plug in the rear. You could do better with a good antenna, of course. In fact there is no limit as to how good the antenna could be. A minimum starting point should be at least a 5 element Yagi. Do the best you can, and it will do justice to the equipment.

The shape of the cabinet lends itself to convenient mobile operation. The Mounting Kit Model 3365 is inexpensive and is designed for the job. There are times when a telescoping set mounted antenna for portable use would be invaluable. The Model 3152 Telescoping Antenna is used for both the 2 meter Communicator IV and the Communicator IV-220, the latter being a 220 mc job.

The carrying bag, Model 3363, was designed primarily for Civil Air Patrol or Civil Defense use. It is a darn good item for amateur portable use also, and much more reasonable in price than a fitted case. The Communicator IV tested has a permanently fastened microphone, and these are available at distributors. There has been a demand for a detachable microphone and jack, rather than the permanently fastened system, which is to be produced. For these sets, the Turner Model 350 microphone, Gonset part number 113-021 has been recommended, although your old favorite may do the trick for you.

The equipment has been put through all its paces with many hours of continuous operation. This report has been as objective as possible with an attempt to reduce to the minimum the reviewer's own personal preferences. It is hoped the manufacturer will smooth out the irregular rim on the rear dust cover. This resulted in a slight wrist cut when unpacking and could conceivably happen again in handling. A BFO for CW and SSB reception would bring forth many voters. So would CW keying. These things are relatively minor, and can be set up by the user as well as the manufacturer.

The specifications are pretty severe for gear of this type, frequency and price range. The quality control, sometimes a greater factor than design engineering in the end, appeared to be very good as is the design. It is difficult to produce production equipment for the higher frequencies where there are so many advanced amateur specialists and yet meet their approval. However, few will quarrel with these specifications, purpose and overall quality of the equipment.

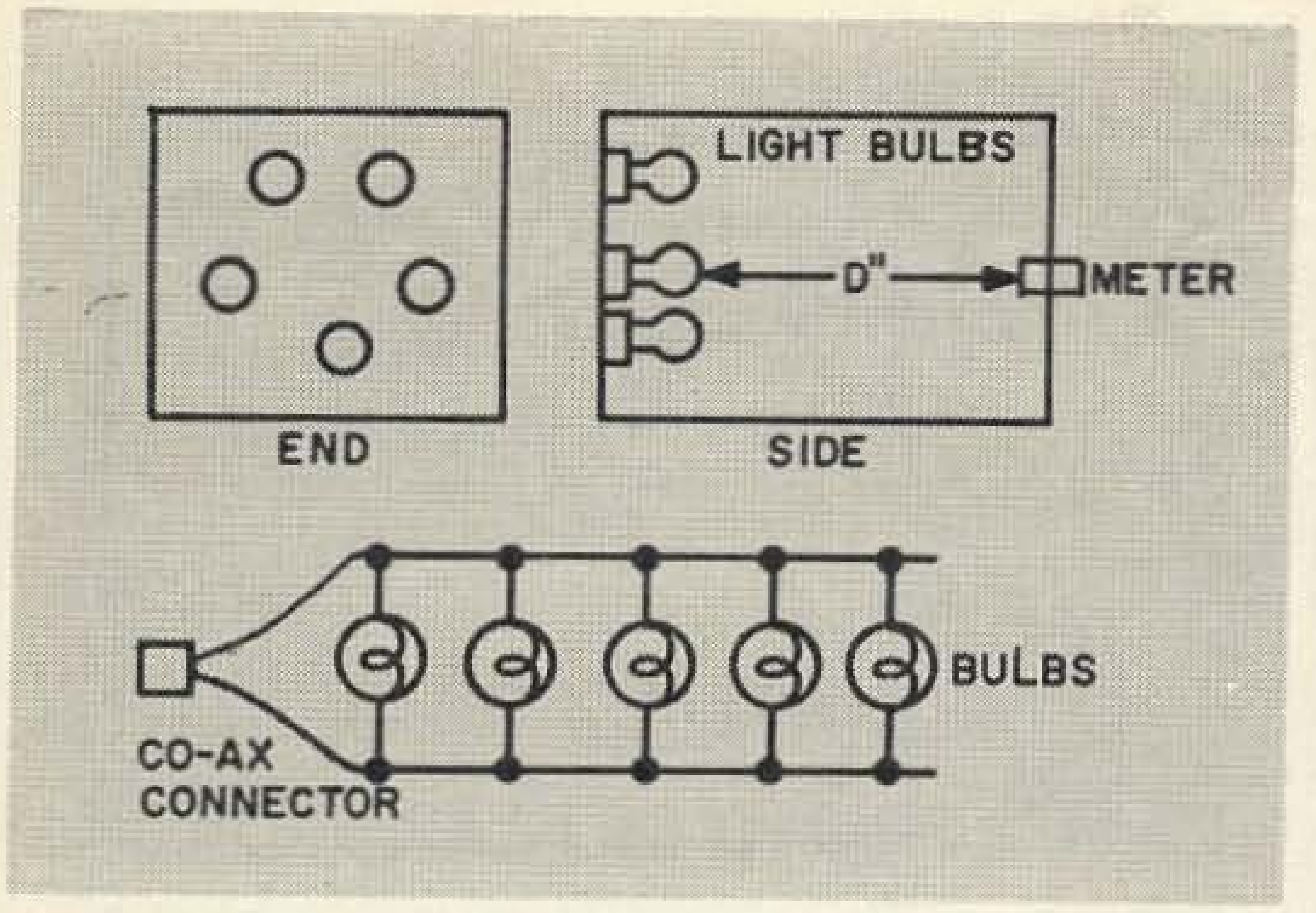
For the non specialist, and one who has had most of his operating experience on the lower frequencies, he will be agreeably surprised with the dependable and familiar communications receiver type of operation, as here is no haywire. There is a freedom from the headache producing QRM of the lower frequencies and an opportunity to meet people who are closer to you. Many on VHF also operate on the lower frequency bands and have common interests. VHF is still on the fringe of amateur frontiers, and the Communicator IV is a better tool.

RF Output Indicator

John Wilson

THE question of how much power a transmitter is putting out is one that often arises. There are a number of devices on the market which measure rf output, but most of them are pretty expensive. The device explained in this article will measure rf output in watts and should cost less than 10 dollars to construct . . . or almost nothing if you have a light meter.

This unit operates by measuring the amount of light given off by a dummy load consisting of five 20 watt light bulbs. The unit is designed



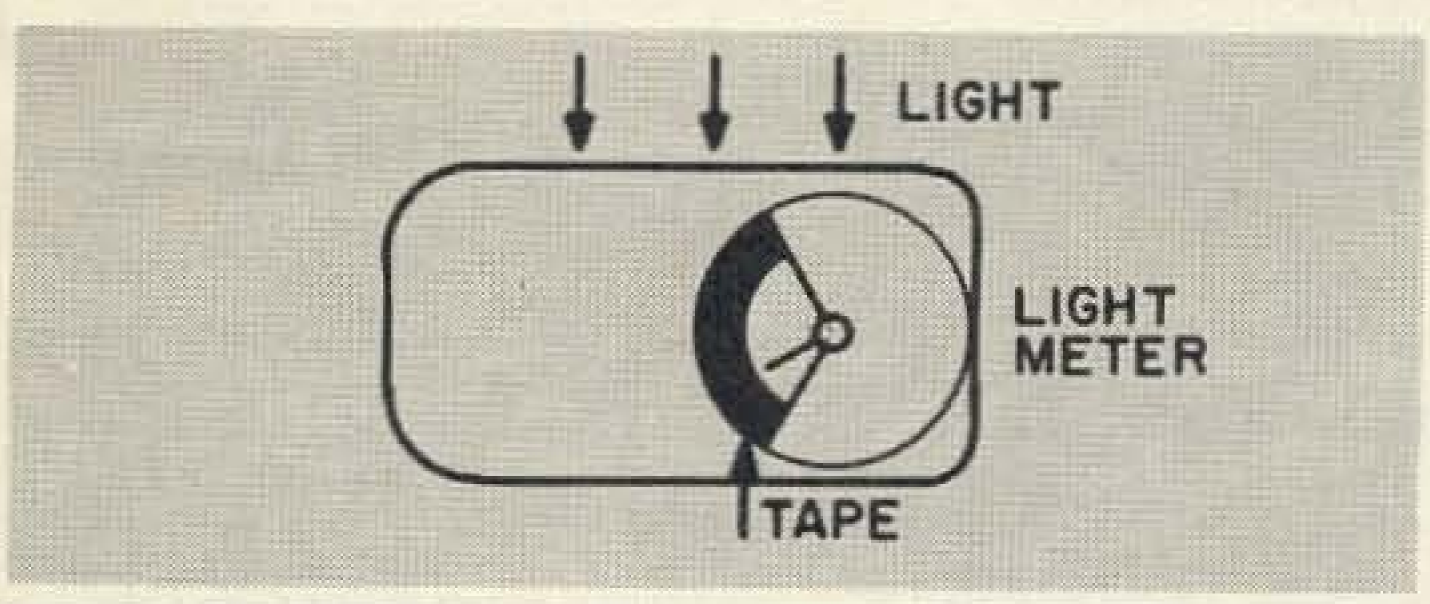
to measure rf output in the 0-1000 watt range.

This unit can be housed in any wooden or steel box of suitable dimensions. The original unit was housed in an 8″ x 10″ x 6″ wooden box. The inside of the box should be painted black to cut down reflection.

The bulbs are placed in a pentagon configuration so that each bulb will concentrate the same amount of light on the meter.

Once the bulbs have been mounted, the calibration of the unit is simple. Temporarily connect the bulbs to a 115 volt source. Mount the lightmeter at a distance from the bulbs that gives full scale deflection. Place masking tape on the light meter scale and mark the position of the deflected needle 100 watts. Remove one 20 watt bulb and mark the new meter position 80 watts. Remove another 20 watt bulb and label the new needle position 60 watts. Continue calibrations to the last light bulb.

Now connect the light bulbs to a connetcor suitable for the transmitter in question. With the transmitter tuned, the light meter should read the approximate power output in watts.



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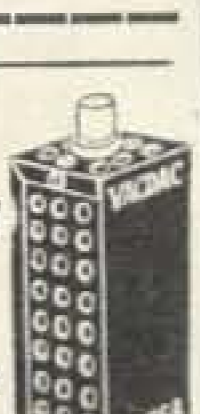

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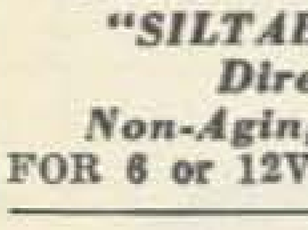

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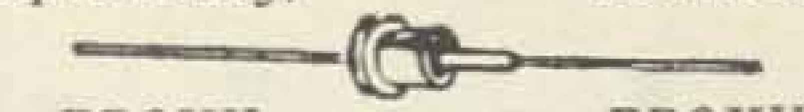

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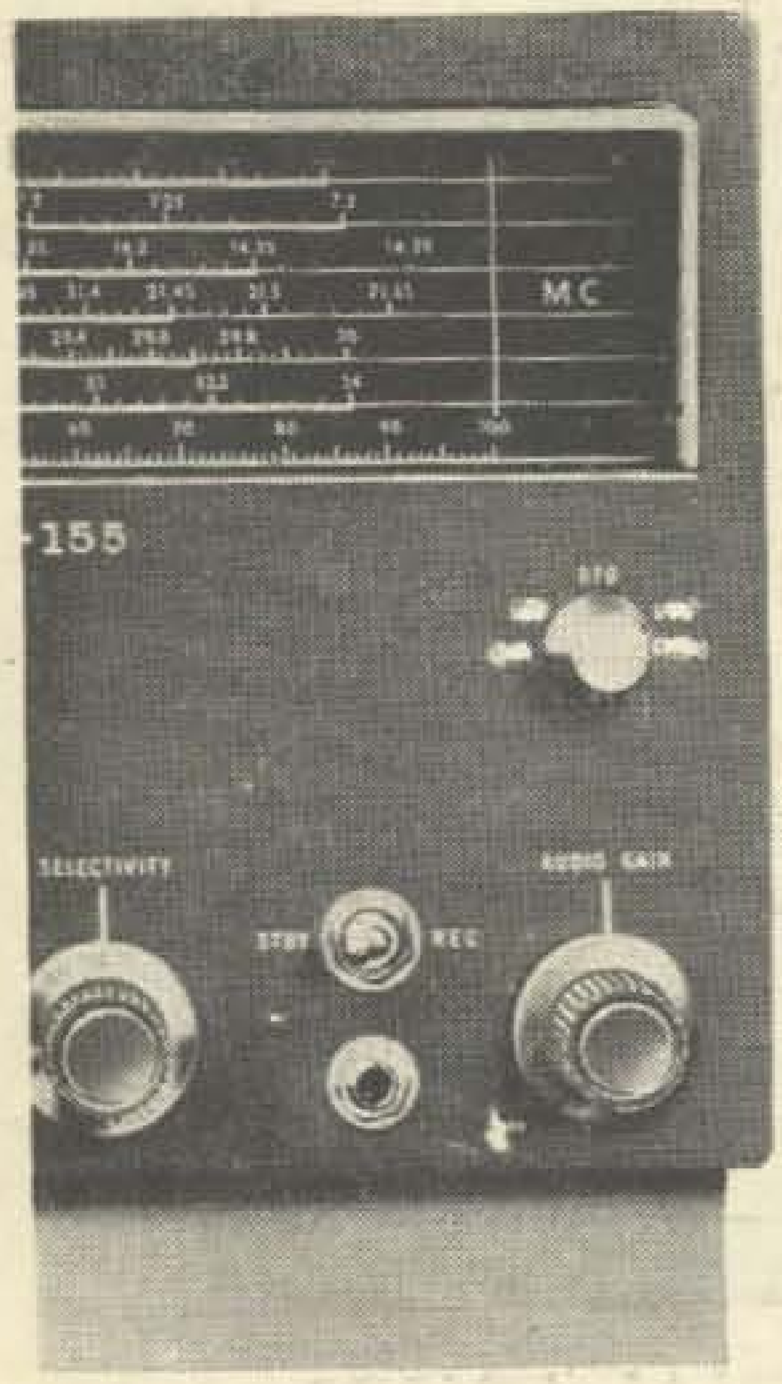

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