AMATEUR RADIO

73

May 1963
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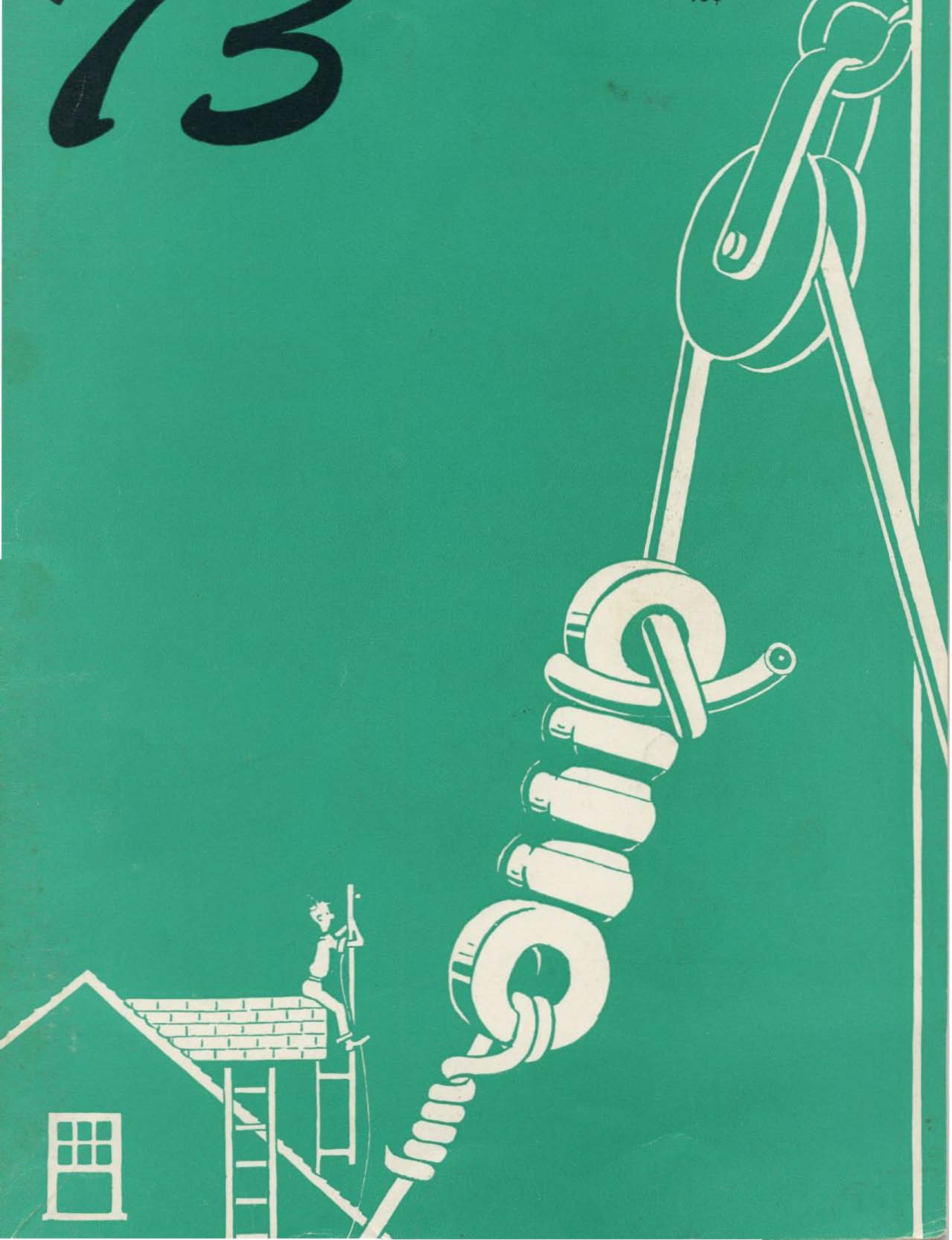

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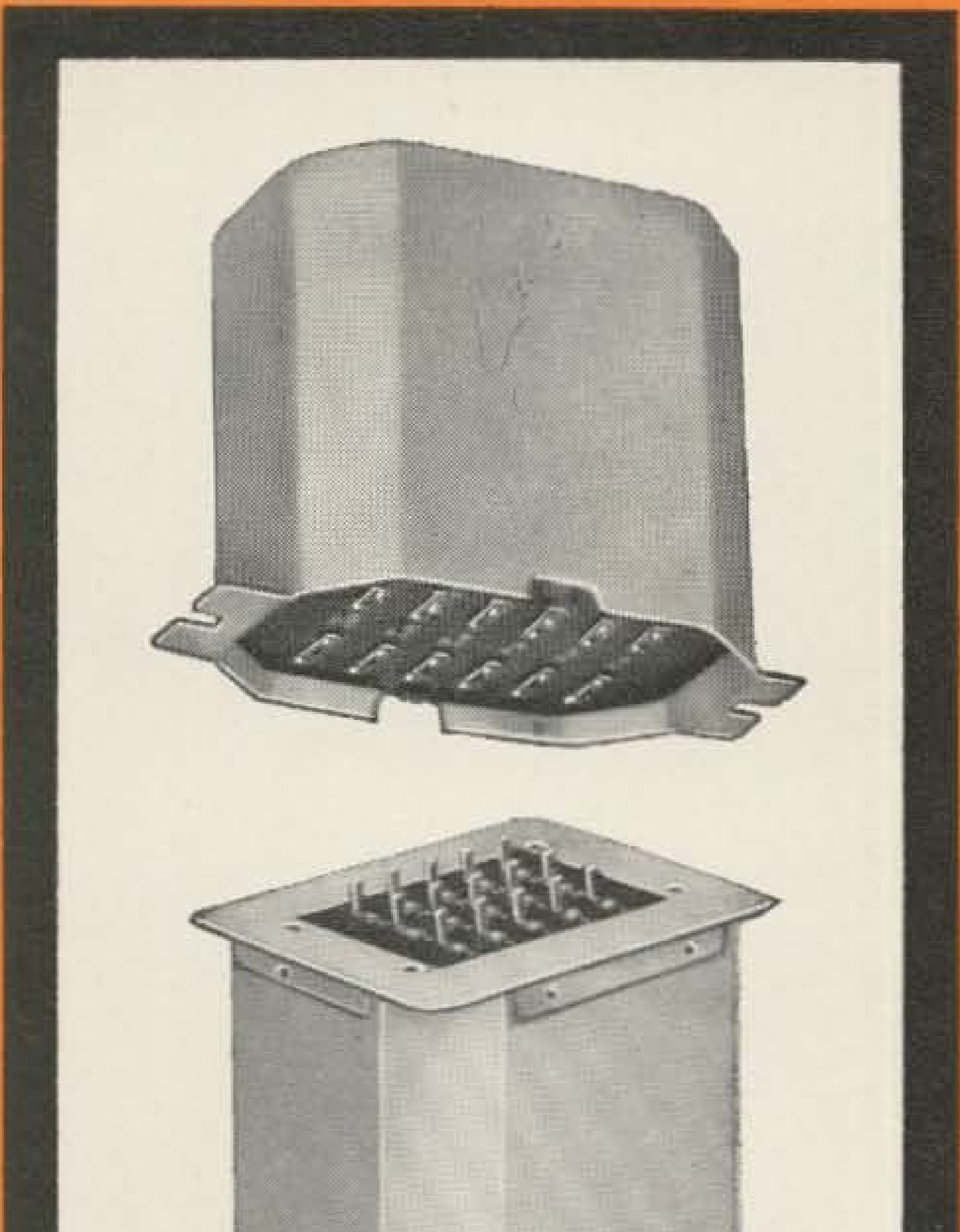

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73

Magazine

Wain Green, W2NSD/1

Editor, etcetera

May, 1963

Vol. XIV, No. 5

Cover:

Bob Kelly, K2VLO

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Postmaster: please send form 3579 to 73 Magazine, Peterborough, New Hampshire. Readers should stop reading the fine print and stick to the articles and editorial.

de W2NSD

Never say die

Notice to ARRL Members

It is now obvious that QST is going to keep beating the drums for their building fund until you all pay up. If you'd send in the money then QST could get back to their detailed operating news reports. After all, Egypt has its pyramids and China has its wall, so why shouldn't we have our ARRL Skyscraper? Get with it fellows; you joined the ARRL, now support it in its time of crisis. Of course this won't stop you from needling them a bit by marking your check out to the ARRL BUILDING FUND (73 WING). Send it to ARRL, West Hartford 7, Conn. Save just a little in case we get too jealous of the new building and have to have a shanty fund for 73 (we'd never be able to get enough for a building).

73 Parts Kits

My introduction of parts kits for our simpler construction projects back in March brought on mixed reactions. The readers wrote in complimenting us on the move. Some even went so far as to order kits, though not many. Remembering how long it took the Bookshop to build up steady orders I was encouraged that even twenty kits should be ordered the first month.

CQ, in an attempt to hurt us with the parts distributors, where my latest figures show we are outselling CQ by better than two to one, sent out a letter viewing the 73 kits with great alarm and worrying that we might shortly put parts distributors out of business. Though their intent was unfriendly, the result was very helpful for CQ's hysteria made many parts distributors aware of our kits and they were thus more disposed to go along with us on handling the parts kits through their companies.

It was obvious from the first we would not be able to finance more than a short test of the kit idea. You see, keeping our subscription rates and advertising rates very low keep us from making any money, so if something costs more than a few hundred dollars we have to forget it. The kit program won't make any money for anyone for a long time and I doubt if I could have convinced many parts distributors (or *any*) to participate without CQ's attack.

Now that we are getting better organized with the kits we will be looking into our back issues for good kit projects and will try to work up a good comprehensive kit list for you to select from.

April Cover

Old timers probably got a kick out of our April Fool cover last month. I am happy to report that the HQ gang seemed to enjoy it . . . see, they're not as stuffy as you thought. I did consider doing a parody of CQ, but couldn't think of anything funnier than they have now so turned my attention to QST.

Small Issue

We had planned upon running 128 pages again this month, but several factors interfered. For one thing the cost of running the 128 pages last month was considerably higher than had been estimated. Then I was laid low by a cold at advertiser harassment time and didn't get quite as many ads this month as I could have. And finally, Virginia, who does most of the work around here, had to take a couple of days off to have a baby. Next month we're going to have a really big issue, so wait it out. (It's a girl.)

(moron 4)

Europe!

The main topic of conversation around the 73 offices is the coming trip to Europe. Every time we hire a new employee we find them with their foot on the running board along about the second day on the job. Shirley, who is handling the subscriptions (and getting them straightened out pretty well, considering) is going to get her mother to substitute for her so she can go along. Pamela, our cute little bookkeeper, is already buying clothes for the trip.

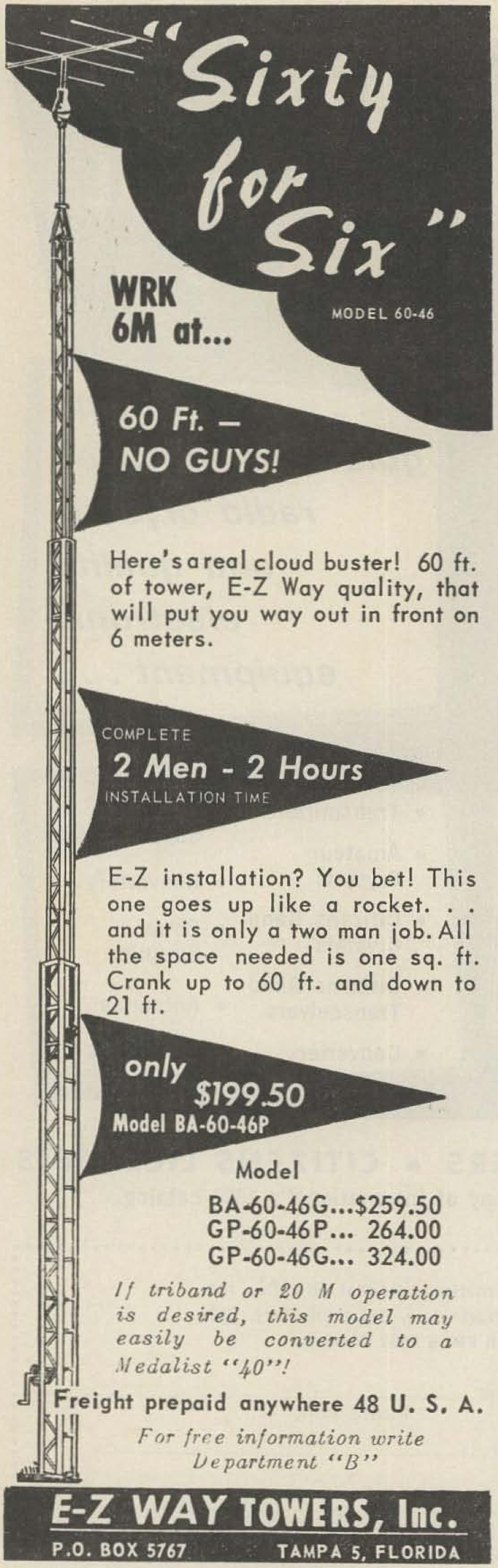
The most worn books around here now are our old copies of "$5 a Day in Europe" (the new edition is due any day now) . . .$1.95 from Bookshop. Lee Gunther W6THN/1 of the Ham Hop Club has been dropping letters to the tourist bureaus for the countries we are going to be visiting and as a result we have been inundated with interesting literature about these countries, maps, history, etc.

We'll be visiting London, Paris, Geneva, Rome and Berlin. If you have to make just a short trip to Europe, these are the five most important places to see. The trip starts October 6th from Idlewild via Sabena and lands in London the morning of the 7th, Monday. We'll spend four days in each city, returning the 27th from Berlin.

In my past trips to Europe I've had the most fun staying at the second class hotels. These are immaculate and are where the bulk of the Europeans stay when they travel. They are usually less formal and you have a better chance to get to meet Europeans instead of Americans. Also it keeps the cost of your trip down amazingly. This makes it so we can fly the entire trip and have our hotel bills and breakfasts paid for much less than the usual tourist plane fare. For example, on this trip the plane fare normally would run $630 round trip. Flying in a group and economizing on hotels we can make the entire trip, including all hotels and breakfasts, for $550. Further, since we'll all be hams we'll all have a common interest which will make the trip a lot more fun than if we were all strangers.

I'm doing all I can to set up get-togethers in all of the cities we'll be visiting . . . but you can help by making a date with any DX ham you contact who can meet you there. If you get an invite to dinner accept it by all means for you will have a wonderful chance to get to know the foreign hams this way . . . and the people of that country.

This is not going to be an escorted tour . . . there will be no schedule for you to follow when you arrive in a new city. We'll give you



(From four)

all the info we can on what is most interesting to see, and where the best reasonable restaurants can be found . . . plus anything else we can think of that will help make the visit more interesting.

One thing I guarantee: you'll have a wonderful time on this trip and never forget it as long as you live. Even if you have to borrow the money, splurge this once. One chap is selling his car so he and his wife can make the trip. We will have enough room for all comers until about mid May. After this time please call or write to make sure we have enough room.

Since we are obviously going to be well filled up on this trip and probably with a good waiting list for cancellations. Thus I can guarantee you that we will be able to refund your money should you be unable for some emergency reason not to make the trip. Send $250 per person with your reservation, made out to the Institute of Amateur Radio. The balance will be due sixty days before the trip. This money is necessary for reserving planes, hotel rooms, busses, etc. See the editorial in the March 73 for more details. Send your reservation to 73, Peterborough, New Hampshire.

Galaxy 300

In line with our policy of having a minimum of at least one major error per page of the magazine I would like to report that there were two beauts on the sideband transceiver chart last month. The World Radio Labs Galaxy 300 uses a crystal lattice system and not phasing as reported. Somehow we got the two lines scrambled on frequency range and the Davco was shortchanged the six meter band, which was donated to the Drake. Give six back to Davco.

Next Month

We've got another big issue coming up in June. This one will be aimed at the 83% of our readers who try their hand now and then at surplus conversions and buying. Some of the articles scheduled (we may not be able to cram them all in) are: BC-348, AN/DMQ-2, BC-230/BC-430, ART-26, RT-91/ARC-2, ARC-5, R-48/TRC-8, BC-453, BC-455, RT-45/ARQ-1, T67/ARC-3, R105A/ARR-15, R-508ARC, BC-442, PE-97A, PE-201A, etc. In addition to all these articles we expect up to 20 pages of special surplus ads which will make one of the finest surplus catalogs you've ever used. This issue will be quickly sold out, so don't miss out . . . subscribe.

(Skips to page 57)

BRAND NEW FROM CLEGG LABS . . . THE

POWER PACKED THOR 6

TRANSCEIVER FOR 6 METERS.

Come on up out of the noise . . . let 'em know you're around! For contests, marginal openings or just overriding the Qrm . . . your new sixty watt, VFO controlled, 100% high level modulated THOR 6 transceiver makes you the "Voice of authority" on six . . . and what's more you'll hear them too! The receiver section with its crystal lattice filter, is selective to the nth degree and so sensitive that even S1 signals are Q5. Sound good? Here's the rest of the story.

MOBILE OPERATION

Now you can run a mobile "power house" using the new Clegg Model 418 transistorized 12V DC power supply / modulator unit to power your THOR 6 transceiver.

TRANSMITTER FEATURES:

- **FULL 60 watts input on phone or CW to 6883 final.**
- **BUILT-IN VFO that automatically tracks the receiver or switches to crystal control for fixed frequency operation.**
- **ALL stages broadbanded for easy QSY.**
- **SPEECH-CLIPPING FOR MAXIMUM talk power.**
- **BUILT-IN PUSH-TO-TALK.**
- **BUILT-IN Keying relay for clean chirpless keying.**

RECEIVER FEATURES:

- **NUVISTORIZED front end for extreme sensitivity at lowest noise level.**
- **CRYSTAL lattice filter for maximum selectivity.**
- **BFO with variable carrier injection for SSB reception.**
- **ULTRA-STABLE tuneable local oscillator that also functions as VFO for transmitter.**
- **EXCELLENT audio characteristics. 2 watts into 3.2 ohm speaker.**
- **Sharp reduction in spurious responses and cross modulation.**
- **Effective noise limiter.**

The THOR 6 is of two unit construction with attractively styled receiver and transmitter rf section mounted in one cabinet for convenient desk top operation. The power supply/modulator section is mounted in a second cabinet for remote location. A ten foot interconnecting cable is provided.

Amateur net price for AC operation $349.95. 12V DC Mod./Pwr. Sup. $100.

COMING IN APRIL - SSB - THE VENUS 6

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Six Meter Ultra-Midget Transceiver

73 Parts Kit Available

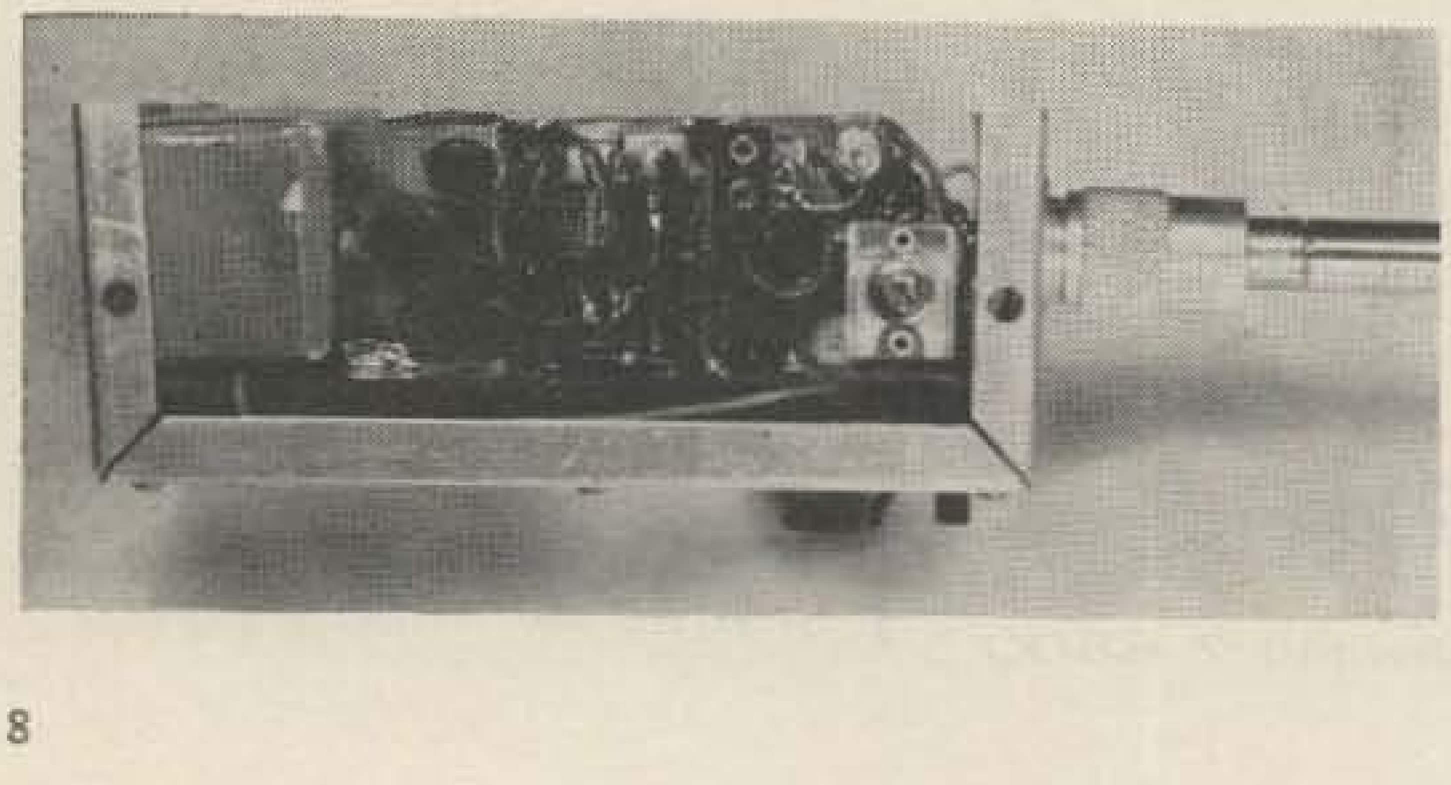
Robert Kopski K3NHI
Philco Corporation
Lansdale, Pennsylvania

The new Philco MADT transistors, though inexpensive, have brought about a minor revolution in VHF equipment and permit, for the first time, really miniature equipment to be constructed. Two of the transceivers shown here were made to illustrate this application. The unit uses five transistors in a superregenerative receiver and crystal controlled transmitter and modulator.

While not designed for the DX'ing crowd on six meters, this little gadget has received over an 80 mile path using an inside dipole. The more usual range is about a half mile between two identical units using built-in whips. Considering the simplicity of the rig it is difficult to imagine why any amateur who occasionally travels wouldn't pack one of these little gems in his suitcase so he could get in touch with local hamdom.

Circuit

Q1 is a single transistor superregenerative



receiver! Perhaps just a word should be put in here in support of this type of receiver. Heath uses this in their Sixers for the circuit is not only extremely simple, but very sensitive. It takes quite a superhet to do better on sensitivity. Selectivity suffers, and you can have some real problems if a very strong signal comes on near your frequency.

The detector is reflexed in that detected audio is fed back to the base of Q1 through C2 and is amplified. The operating point of Q1 is established by R1, R2, R3 and R4. R4 controls the regeneration. Tuning is achieved by varying C5. C7, C8 and R5 form a low pass filter to prevent the quench signal from overloading the audio section.

The transmitter uses two transistors, Q2 a fifth overtone oscillator and Q3 the final class C amplifier running a mighty 50 mw input. The output is on the order of 25 mw, down somewhere in the microbe-power division.

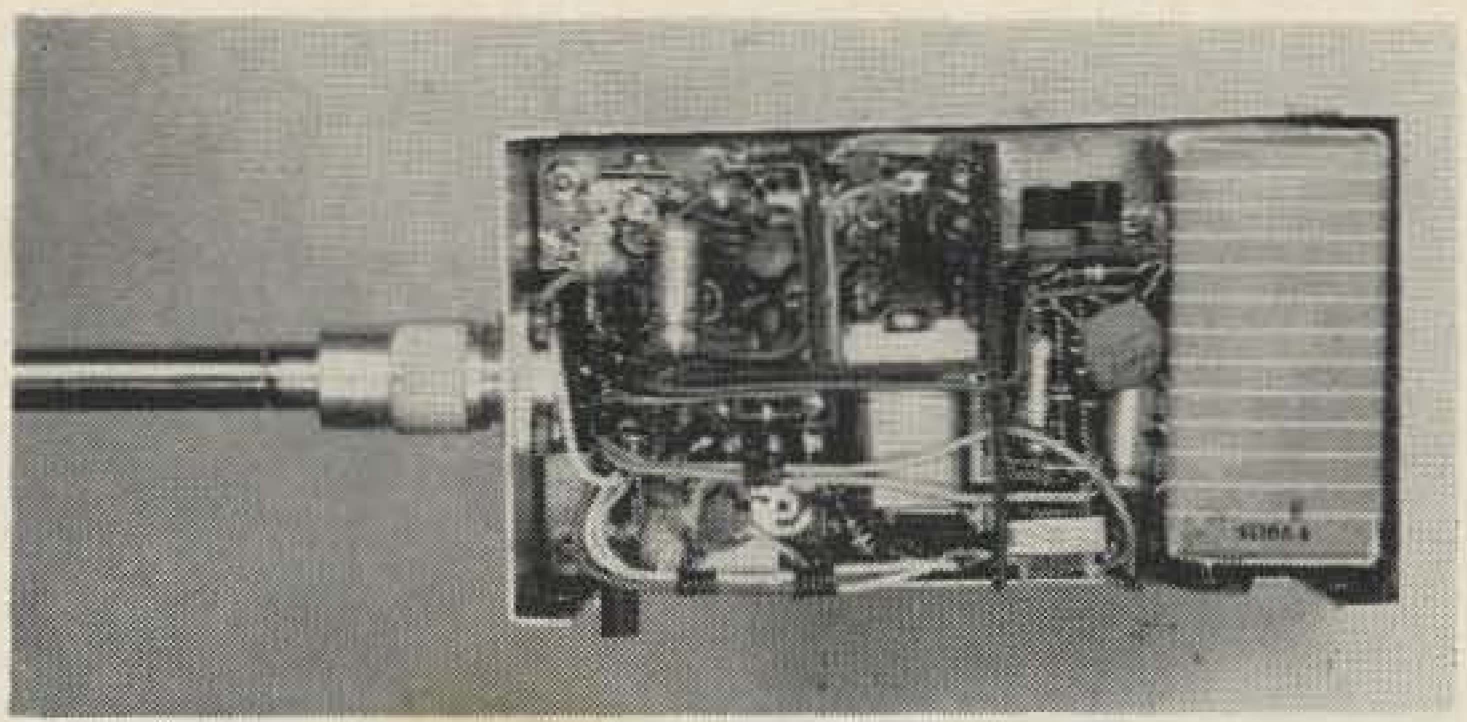
The audio/modulator uses two transistors, RC coupled, and a permanent magnet speaker which doubles as a dynamic mike. The receiver output transformer primary is used as a choke for Heising modulating the final on transmit, giving a healthy 90% modulation. Neutralization of the final might permit slightly higher modulation. The D1-C21 circuit prevents high voltages from the Heising choke from damaging Q5.

A four-pole-double-throw switch transfers all the circuits. Power is supplied by the usual 9 volt battery. In this unit a 5¼" x 3" x 2⅛" aluminum minibox was used and the circuit was mounted on a piece of double-sided copper-clad printed circuit board. The double-sided board acts as a fine shield between the audio and rf circuits. This board is excellent construction material for it is easily cut, drilled and soldered to. Shields can be soldered to it, making an extremely rigid assembly.

The whip antenna was mounted using a coax connector (photo) so that other antennas could easily be connected for better DX. The whip can easily be permanently mounted on a plexiglass or micarta mounting plate.

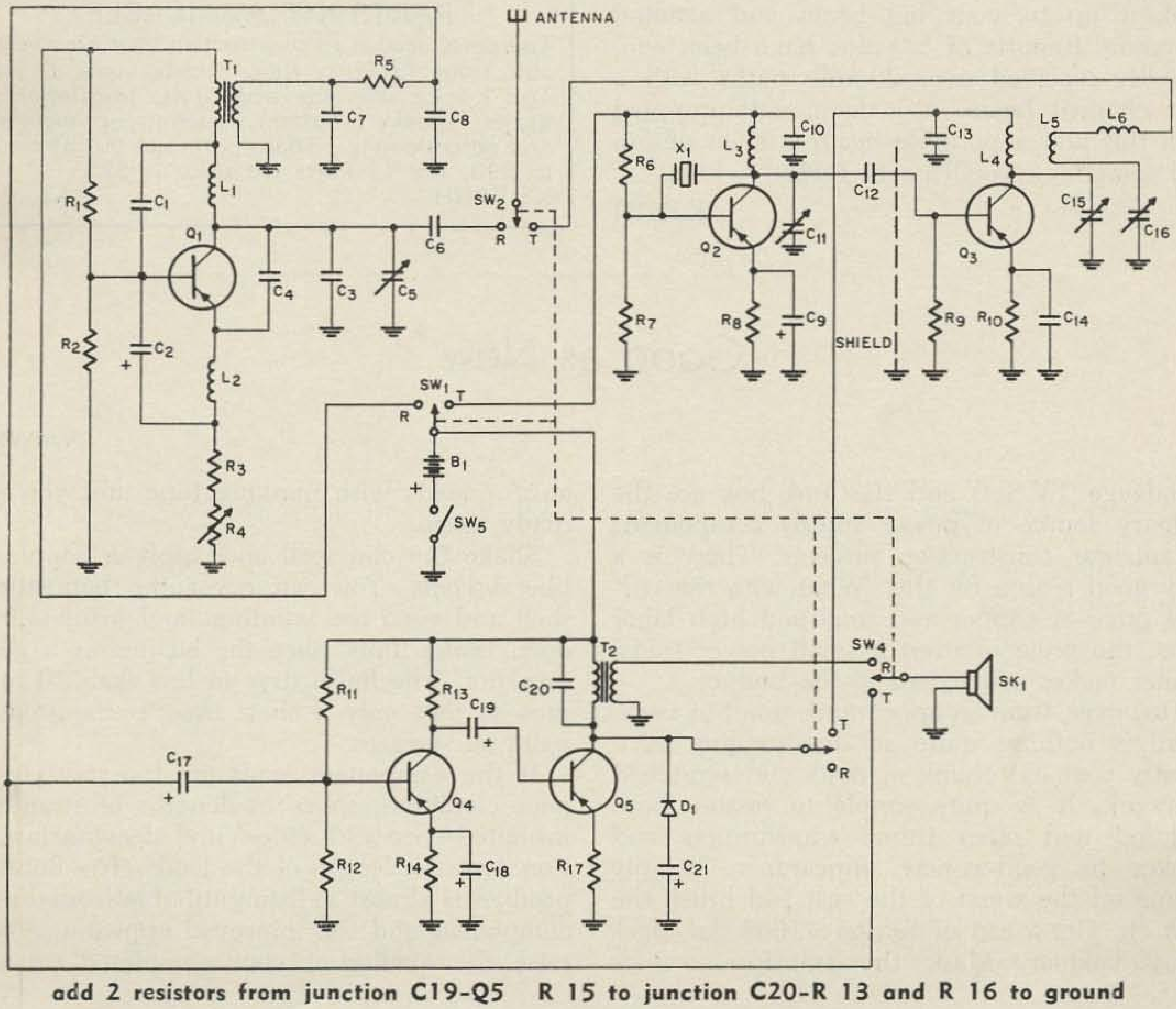
Tune-Up Procedure

The tune up procedure is straight forward. With S5 on, receiver regeneration control R_4 is adjusted for a strong rushing sound in the speaker. Final trimming of R_4 is best achieved while listening to an incoming signal. Capacitor C_3 may be adjusted slightly for bandsetting, and tuning capacitor C_5 should cover 2 megacycles of the six meter band. Quieting of the

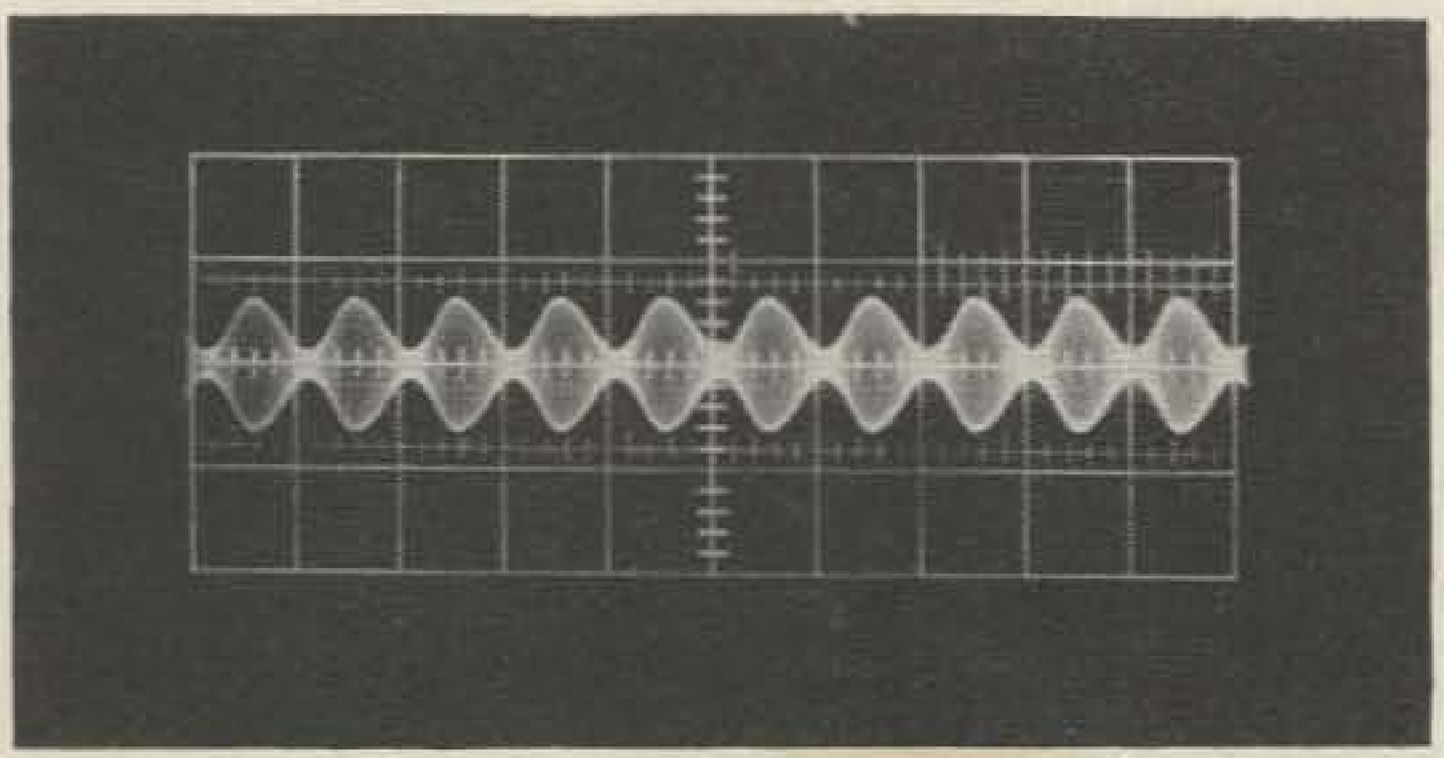


rushing sound should occur with an incoming carrier.

Transmitter tune up is also straight forward. The oscillator and final tank circuits can be initially set with a grid dipper. With S5 on, depressing the push to talk switch should cause immediate operation of the transmitter. Transmitter operation can be checked with a grid dipper, a field strength meter, or another receiver. If the oscillator fails to start when the push-to-talk switch is depressed, adjust C_{11} until it does so. Final transmitter adjustment is best achieved with the antenna fully extended and the case closed and held steady on a table with one hand. With a field strength meter nearby, adjust C_{11}, C_{15} and C_{16} for maximum output. Check to make sure the oscillator



add 2 resistors from junction C19-Q5 R 15 to junction C20-R 13 and R 16 to ground



Actual photo of the transmitter output modulated with a whistle and observed with a 100 mc scope. Note relatively clean envelope.

starts easily by depressing the push-to-talk switch several times. It should start each time. If it does not, back off on C_{11} slightly. Check for modulation by listening with another receiver. The signal should be crisp and clear. It is not necessary to hold the "mike" close or shout. Normal talking four to six inches from the "mike" should permit full modulation.

These little transceivers are a lot of fun, whether you pull them out at the local ham club meeting, talk all around conventions, meet hams in towns you are visiting, or even hook it up to your big beam and astound everyone. Reports of 5-9-plus have been consistently received over 20-mile paths with a four element beam. A little mountaintopping with this and a portable beam is a lot of fun and something you'll never forget.

. . . K3NHI

Table I

Receiver: dc input current	**15**	**ma**
Osc: dc input current	**4.5**	**ma**
dc input power	**40**	**mw**
Final: dc input current	**6**	**ma**
dc input power	**50**	**mw**

Parts List

(½ watt carbon)
R1—39,000
R2—12,000
R3—2200
R4—5000 pot
R5—3900
R6—10,000
R7—1000
R8—100
R9—1200
R10—22
R11—220,000
R12—10,000
R13—3900
R14—100
R15—47,000
R16—4700
R17—22
C1—100 mmfd
C2—2 mfd 10v elect.
C3—10 mmfd
C4—6.8 mmfd
C5—15 mmfd MAPC var. with 4 plates removed
C6—4.7 mmfd
C7—.01 mfd
C8—.05 mfd
C9—.002 mfd 50v
C10—.01 mfd 50v
C11—4-30 mmfd trimmer
C12—15 mmfd
C13—.01 mfd 50v
C14—.01 mfd 50v
C15—4-30 mmfd trimmer
C16—280 mmfd trimmer
C17—30 mfd 10v
C18—30 mfd 10v
C19—30 mfd 10v
C20—.01 mfd 50v
C21—30 mfd 25v
Q1, Q2—2N1499A
Q3—2N1749
Q4, Q5—2N2374
D1—1N34A or equiv.
SKI—2½" 3.2 ohm speaker
X1—6 meter 5th overtone HC6U type
ANT—52" telescopic antenna
L1—10 turns ⅜" i.d. #16 enam
L2—6.8 uh rfc
L3—8 turns ⅜" i.d. #16 enam
L4—8 turns ⅜" i.d. #16 enam
L5—2½ turns #20 hook up wire over L4
L6—9 turns #20 plastic hook up wire ¼" i.d.
T1—Calrad CR60 20K-1K or equiv.
T2—Calrad CR40 1.2K—3.2 ohms or equiv.
B1—9v Battery, Everready #246 or equiv.
SW—4PDT push-to-talk switch, Lafayette SW92

Good as New

W4WKM

Salvage TV sets and the junk box are the primary source of power supply components in amateur construction projects. There is a very good reason for this. What with the current price of copper and steel and high labor costs, the price of even a small power transformer makes a big dent in the budget.

However, from an appearance point of view, there is nothing quite so discouraging as a twenty year old chunk of rusty and scratched ironwork. It is quite simple to restore both inclosed and open frame transformers and chokes to good-as-new appearance. Simply scrape off the worst of the rust and brush the dust off. Get a can of Krylon #1602 flat black spray lacquer. Mask the transformer lugs and/or leads with masking tape and you are ready to go.

Shake the can well and apply a couple of liberal coats. You can cover the laminations shell and even the windings and insulation of open frame units since the lacquer is a good insulator. The finish drys in less than 10 minutes so that only a short time is required to paint all surfaces.

If the component leads are too short or in poor condition, splice on lengths of stranded, insulated wire and slide Vinyl sleeving insulation over the length of the leads. The finished product is almost indistinguishable from a new component and the improved appearance will raise the quality of your completed project.

A 6DJ8/ECC88 Converter for Six

Parts Kit Available, too!

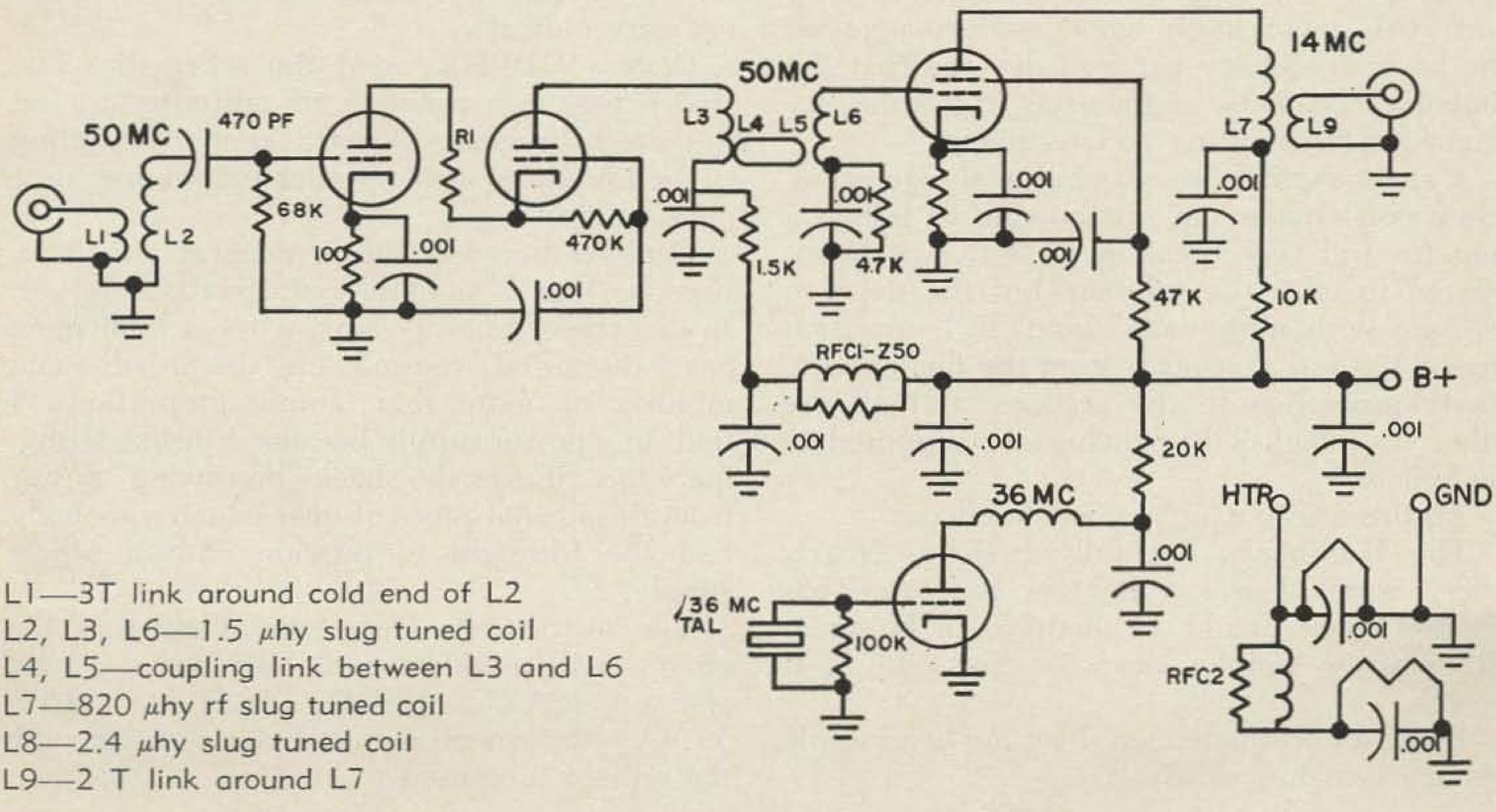
Bill Pasternak WA2HVK
1525 West 8 Street
Brooklyn 4, New York

In November of 1960, 73 published an article on improving the sensitivity and the signal to noise ratio of the Gonset Communicator III by replacing the 6BZ8 front end tube with a newly developed dual triode called the 6DJ8/ECC88. As a matter of fact virtual step by step instructions were given at that time to make this simple conversion. Anyone who did it realized an improvement in their equipment right away. Hence, you would think that this tube would be a natural for a converter article, but as fate would have it about this time RCA developed the Nuvistor, and a whole new trend in converters was started. Though many articles appeared using Nuvistors, the poor little 6DJ8 was all but forgotten. This held true until about a year ago when Clegg Labs brought out the now famous 99'er (see May 1962 73) and chose the 6DJ8 for the front end. After owning and operating one of these transceivers for about five months, I realized that they had made a good choice in the 6DJ8.

Since it had been about a year and a half since the last was heard of this tube it appeared that no one had taken the incentive to design a converter around this tube, so I did.

Construction

Basically this converter is quite similar to many others recently described. It is built on one half of a 2¼ x 2¼ x 5 Bud Minibox with the other half being used as the bottom cover. The 6DJ8 is used in a cascode circuit with neutralization being acomplished by R_1, a 12 to 25 ohm resistor and a shield plate that bisects the socket of V_1. The antenna is link coupled to the grid of the first section of the cascode amplifier as is the output of the amplifier to the mixer. This breaks a long standing trend toward capacitive coupling because of its ease of construction and lower cost. Although a little more difficult to construct, this system affords excellent image rejection and very good passband characteristics. In addition, because of the excellent isolation between the input



L1—3T link around cold end of L2
L2, L3, L6—1.5 µhy slug tuned coil
L4, L5—coupling link between L3 and L6
L7—820 µhy rf slug tuned coil
L8—2.4 µhy slug tuned coil
L9—2 T link around L7

and the output of the converter, it removes the need for trap circuits at the antenna usually found in most cascode converters. When laying out the chassis be sure that L_3 and L_6 are in the same plane about 1 inch apart. Then after ALL other wiring has been fully completed and checked for errors, install the link coil between L_3 and L_6.

The mixer stage is conventional and uses a 6CQ8 as a combined oscillator and mixer. A type 6U8A or 6EA8 can be substituted without any changes in circuitry. There is no difference in the sensitivity, however the 6CQ8 being a tetrode is less apt to overload due to a strong local signal. The output of the mixer is again link coupled to the output jack, J2. The *if* frequency chosen was 14 mc, and a 36 mc overtone rock was used in the conversion oscillator. The tubes own interelectrode capacity will afford plenty of oscillator injection as the tube was specifically designed for this use.

Alignment

Alignment is simple, all you need is a GDO. Pretune L_2, L_3 and L_6 to approximately 50 mc. L_7 should dip at 14 mc and L_8 at 36 mc. Now apply power to the converter and using the grid dipper as a wave meter adjust L_8 for slightly less than maximum output. Now tune in a weak station and tune everything else for maximum. You are now ready to go.

Results

While this is not the ultimate in converters, it does compare favorably with most of the Nuvistor jobs around today. According to the 6DJ8 specs the noise figure should be in the realm of 4 to 4.5 db. I can tell you that it has the ability to dig out the weak ones and make them Q5 copy, which is what counts.

. . . WA2HVK

George Thurston W4MLE

A Simple T-R Switch

Since I spend most of my operating hours as a CW traffic hound and gumbeater, and DX has been mainly an afterthought, I've used a separate antenna on the receiver for all of my 15 licensed years.

Recently with the DX contests coming up and with increasingly good performance on the lower frequency bands, I decided that the time had come to begin using the same antenna for transmitting and receiving.

A change-over relay was out of the question. They don't make 'em fast enough to follow a bug for full CW break-in. A T-R switch appeared to offer the solution—but the decision left me with misgivings about TVI, insertion losses, birdies, shot-noise from the final, inadequate protection to the receiver and all the other ills which T-R switches are supposed to be heir to.

All this aside, which circuit to choose?

The handbooks are full of them. Nearly every issue of every amateur magazine has another new (or old, or modified or better or different or simpler or more versatile) T-R switch.

Being an obstinate cuss, I set my head firmly against switches which:

(1) had to be bandswitched

(2) had to be tuned

(3) which cause insertion losses rather than gain.

The switch I wanted had to just hang in there and do its job with no more attention from the operator than the HV rectifier tubes.

I was commiserating with W4WHK on 80 M CW one evening about the Utopian nature of such aims and he offered the circuit he uses, developed by himself and W9PUH/K4PNS, but apparently not published and apparently not very radical.

Dave (W4WHK) sent the schematic. The switch took two evenings of puttering around the shack because the NCS kept interrupting in the middle of a solder joint to give me some more traffic.

Construction was the essence of simplicity because there's nothing critical about layout. In fact, there's hardly any layout. I built mine on a discarded, re-used and discarded again minibox of more than ample proportions. I built in a power supply because I dislike stringing wires all over the shack "borrowing" power from this or that piece of gear which somebody had the foresight to provide with a power supply.

The instructions Dave sent along said the circuit "will produce some gain in the overall system. 12AX7, 12BH7, 12AU7, 12AT7, 5814A, etc. can all be used. Gain varies with the type of tube used.

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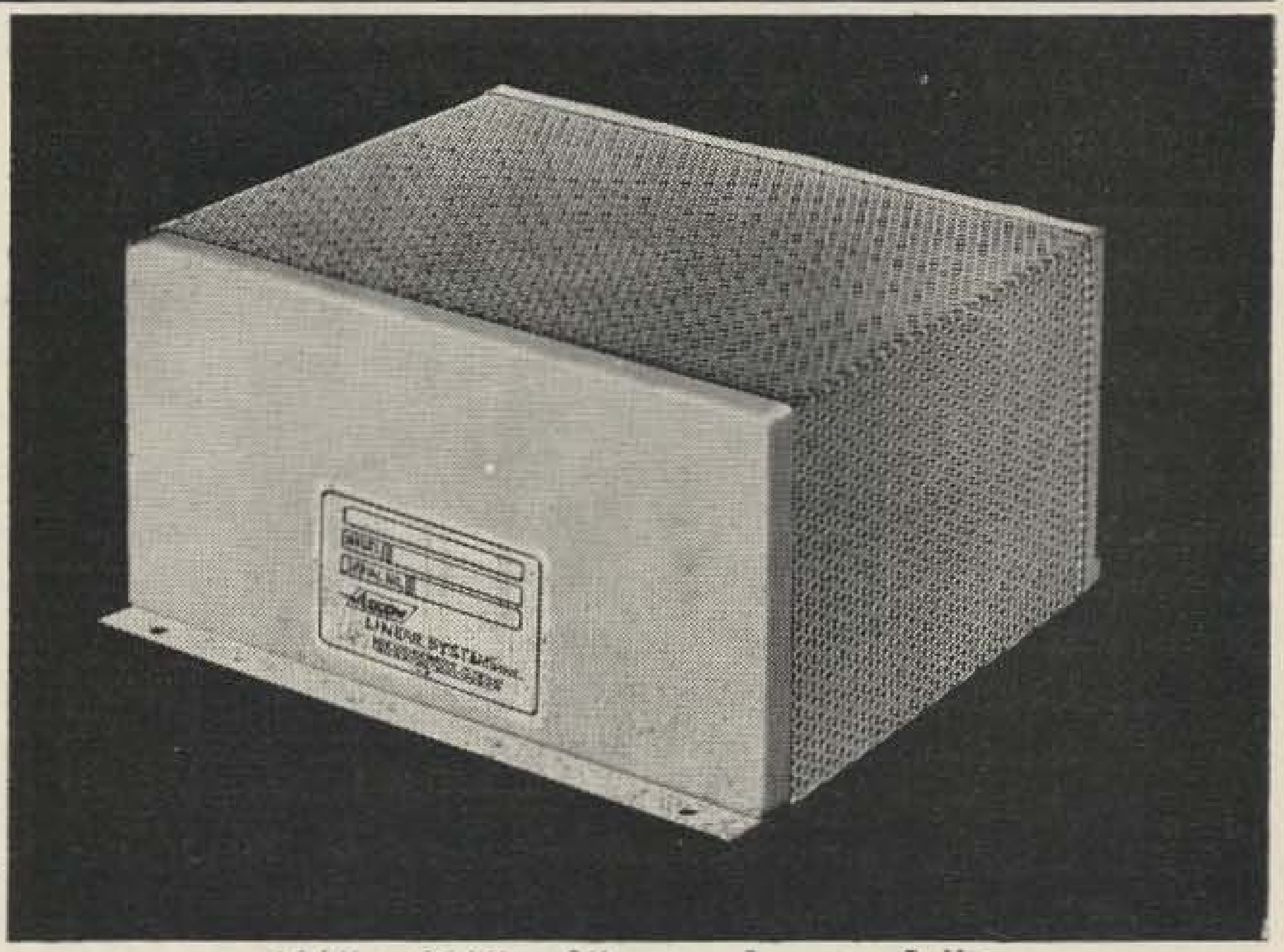
ADCOM 350-12

DC - DC TRANSISTORIZED CONVERTER

INCREASED POWER



4½" x 6½" x 8" . . . Approx. 8 lbs.
Encased in Gleaming Cabinets of Nickel-Plated Steel

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"Some lengths of coax (or combinations of lengths)," Dave continues, "tend to give some loss in the system and vary with the transmitter, receiver and antenna system. The right lengths have to be determined experimentally. Generally, the line length from the final to the T-R switch and from the switch output to the receiver tend to be the most critical."

So much for the theory.

Actually, I used the lengths of coax which were handy. They work. The switch produces a little gain. I left things alone. I haven't any idea whether other lengths of coax would work any differently. If you build the switch you can find out and let me know.

Since I run fairly high power (600 w to 1 kw on CW) I chose to put a third tube in parallel. I have no idea whether this is essential. W4WHK runs some 600 watts, uses two tubes in his switch and hasn't blown anything yet. I use 12AX7s because they were in the junk box. As an added precaution in the interest of receiver safety, I connected 1N34's back to back across the receiver antenna terminal connections. These diodes have *no* effect on the signal at the level used for receiving. However, when the forward voltage applied to them exceeds a few millivolts, the diodes conduct heavily, offering an effective short circuit to rf potentials of anything like damaging proportions.

So far the switch has met all my specifications.

Even with the minibox completely unbuttoned and no low pass filter in the line, there is no TVI.

I haven't experienced any birdies.

Although the 4-125As in the final draw 10 or 15 ma of idling plate current, I have experienced no difficulty with shot noise or similar effects.

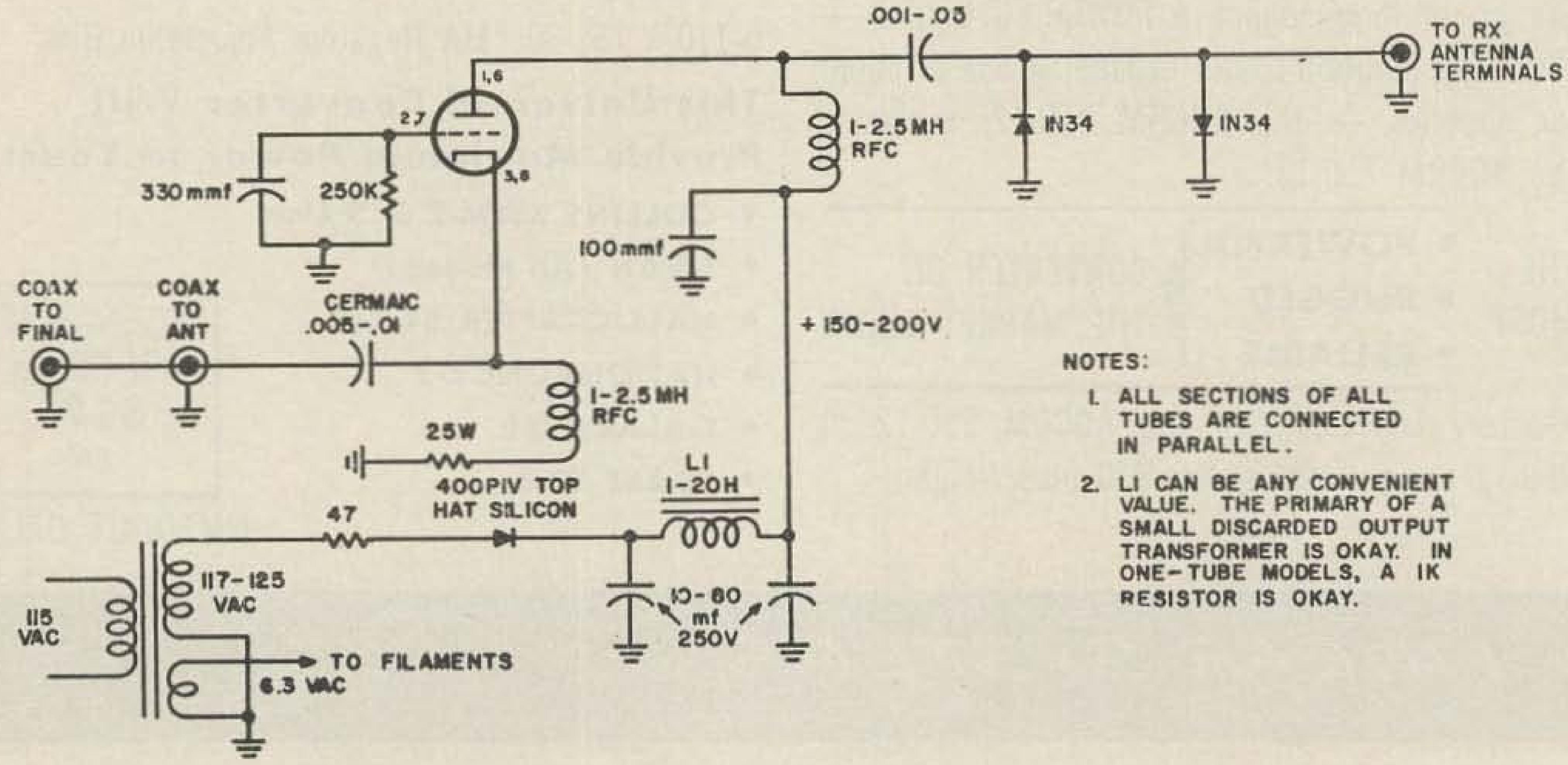
The switch works on 15, 20, 40 and 80 meters, without tuning, and provides gain on each band. Actually, tuning the transmitter final tunes the switch. There is a very perceptible increase in strength of received signals as the transmitter final tuning capacitor is rotated through resonance. In fact, I have used this for "rough tuning" the final before putting plate power on, with fairly close approximations of resonance.

Total cost of the project was nil. I had everything in the junk box except two coax connectors which I scrounged from a fellow-ham. Total cost if everything is bought new (how ridiculous!) would be somewhere between five and ten dollars—closer to ten if you include the power supply. Some saving in cost can be realized if phono-cable connectors are used to connect the switch to the receiver. The same type of connector can be used for low-power transmitters (probably anything from a pair of 6146's down) at another saving in cost. A coax "T" connector is *not* necessary. You can simply use another panel-type connector mounted in the T-R switch.

The unit could easily be built into a chassis along with an antenna tuner, SWR bridge, antenna switching circuit or similar device. It could even be incorporated into the chassis of a transmitter if space exists or a new one is under construction. There's a further saving in cost here, because it eliminates the need for a separate chassis and power supply.

Additional savings in cost can be achieved by using only one tube if the T-R switch is to be used strictly with transmitters in the 90-watt-and-under power category.

If I go any further, I'll be offering to pay you to build the thing, and I can't afford that, even with all the money I saved by building it myself. . . . W4MLE



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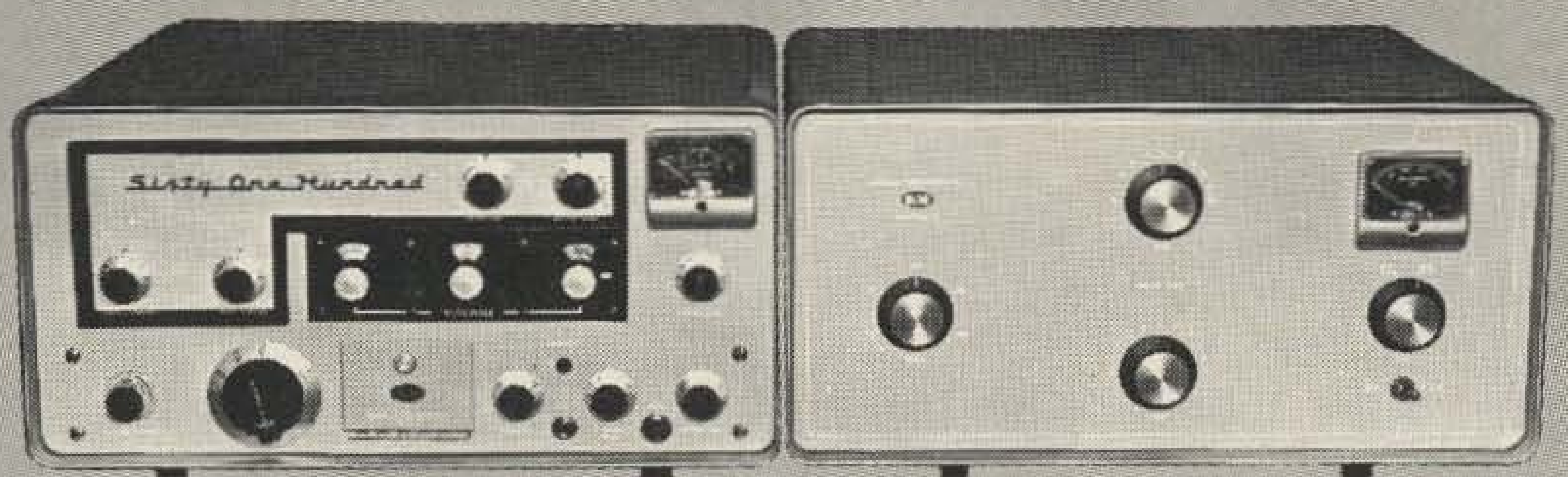

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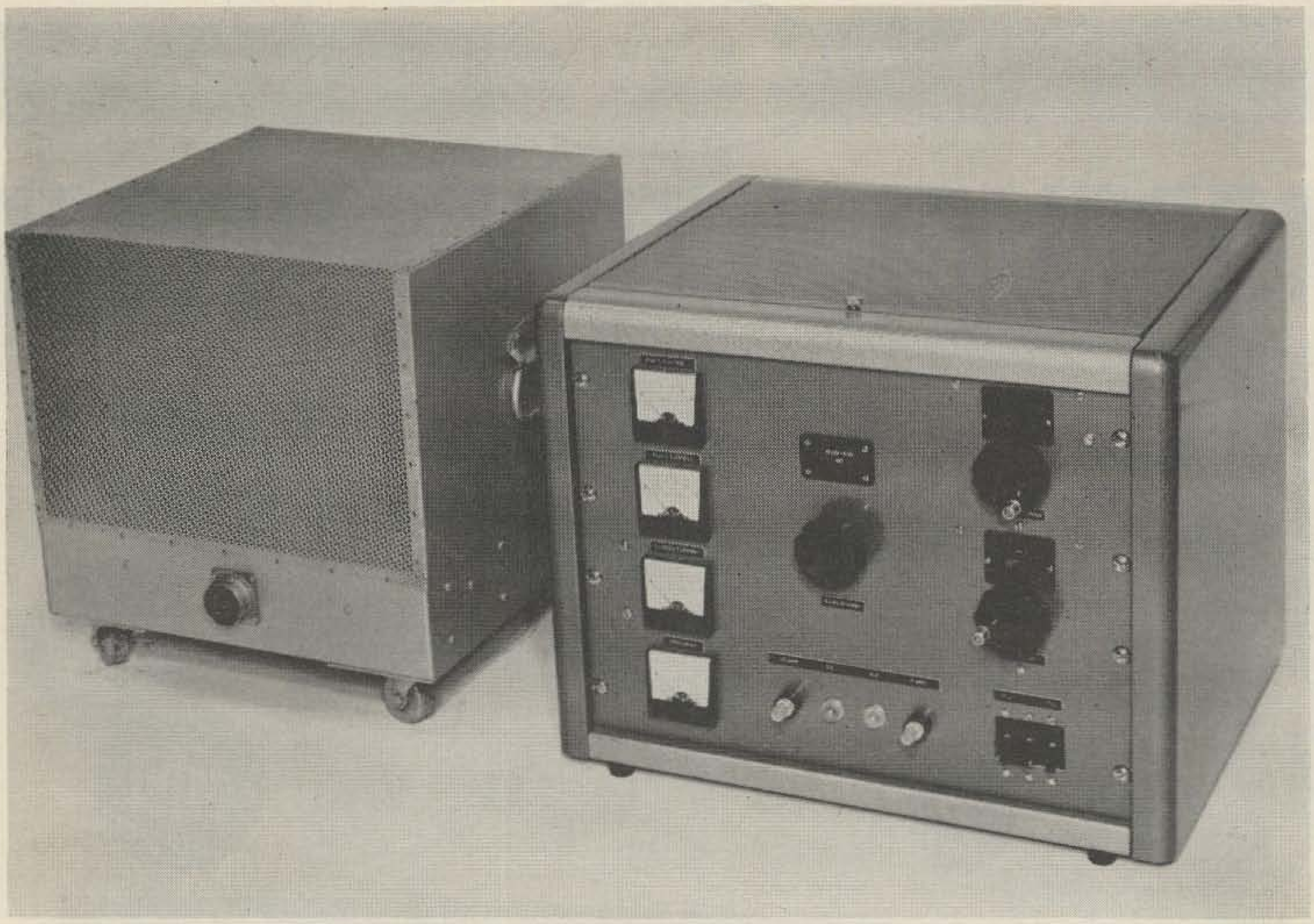


Low distortion

All Band Linear Kilowatt

Bert Green W2LPC
George Phillips WA2PDI
Amperex Electronic Corp.
230 Duffy Avenue
Hicksville, New York

When designing a kilowatt linear amplifier that will handle a full gallon input as a sideband, CW or AM linear, the selection of the tube depends on the following:

A. The linearity of the tube without feedback.

B. The overall physical size of the tube, socket, and blower.

C. The overall cost of the tube, socket and blower.

In category A, linearity, the Amperex 8179 was rated for lowest distortion with the 3rd order I.M. products being down better than 40db in a grounded grid circuit.

Category B, size, showed up as a close tie between three contenders. While the Amperex 8179 was physically larger than the other tubes it was able to utilize a much smaller blower for cooling. The 8179 only requires a small flow of air over the surface of the tube which means that any small centrifugal blower may be used. The external radiator type tubes required a larger type blower to deliver the required air flow against the radiator back pressure.

In category C, cost, the 8179 was the lowest priced tube by only a few dollars. However, the socket for the 8179 listed at 1/5 to 1/7 of the price of the sockets for the other two tubes. In addition the lower cost of the blower resulted in the 8179 tube, socket, blower price combination being much below the other choices.

Power Supply

The plate power supply is constructed on a 17 x 17 x 4 steel chassis enclosed in a perforated aluminium cover. The use of a choke input filter combined with silicon rectifiers and a husky transformer provide a power supply with extremely good regulation. Since the silicon rectifiers are used in series, each one is shunted with a one megohm resistor to equalize the inverse voltages across each diode. Being on the cautious side a few extra diodes were used to provide a safety factor.

A shielded cable, terminated in an Amphenol type 97-3106-28-410 connectors, carries primary power to, and high voltage from, the power supply.

Amplifier

The amplifier unit contains the rf amplifier itself, the bias supply, the screen supply, the filament supply, and the metering and control circuits.

The amplifier is a cathode driven, double grounded grid stage, with pi network input and output. A pi network was used for the input circuit for two reasons; first, it provides a proper impedance match between the 50 ohm input line and the 110 ohm input impedance of the 8179, thereby reducing drive power requirements.

The second reason for using a pi network input circuit is to reduce the harmonic input to the amplifier. In a grounded grid stage, the cathode impedance of the tube varies from a very high value to a low value at different points on the rf cycle. This causes a varying load to be presented to the driver and produces considerable second harmonic distortion. This second harmonic drive increases the plate input to the tube, but does not appear as usable output since the plate tank is an effective short at the harmonic frequency. This results in low tube efficiency and high plate dissipation. By driving the amplifier through a pi network input circuit, the amount of second harmonic appearing at the amplifier grid is reduced and the plate efficiency is increased, thereby producing more usable output for the same plate input.

The pi network used on the input of the 8179 amplifier is bandswitched to cover the 80, 40, 20, 15, and 10 meter bands and is designed to have a low Q in order to cover each band without the need for retuning. Trimmer capacitors on the input and output of the pi networks allows the SWR to be adjusted to close to 1:1 on each band.

The rf signal from the output of the pi is capacity coupled to the tube filament, while the 60 cycle ac power is fed to the filament by means of a B & W all-band bifilar filament choke.

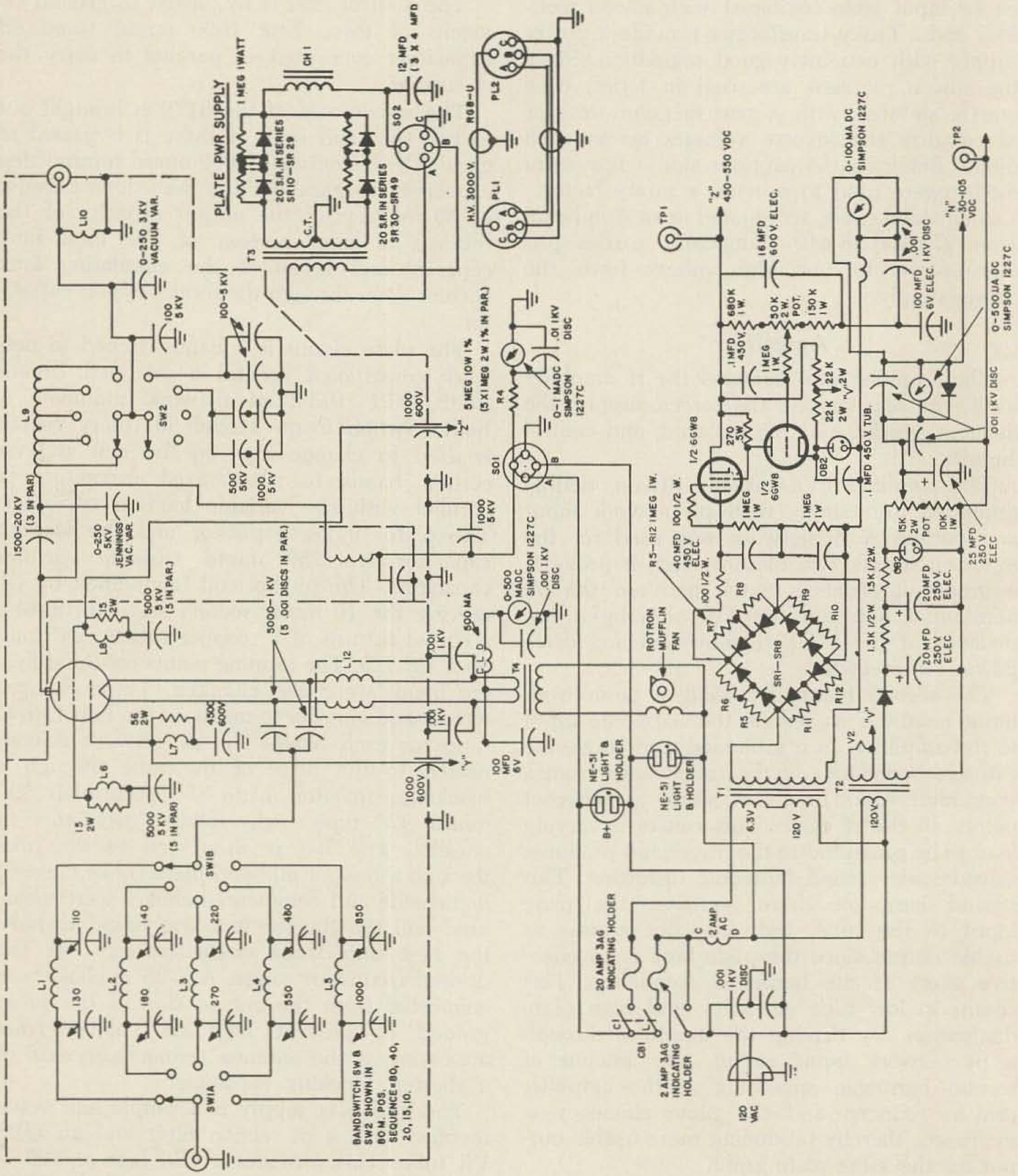
The control grid is by-passed to ground by means of three Erie 1500 mmfd stand off capacitors connected in parallel to carry the rf current.

The screen grid of the 8179 is brought out to two pins and each of these is bypassed to ground by 5 Centralab 1000 mmfd transmitting capacitors in parallel. This was done because at 30 megacycles the output capacity of the tube is a large portion of the total tank capacity and much of the circulating tank current flows through the screen bypass capacitor.

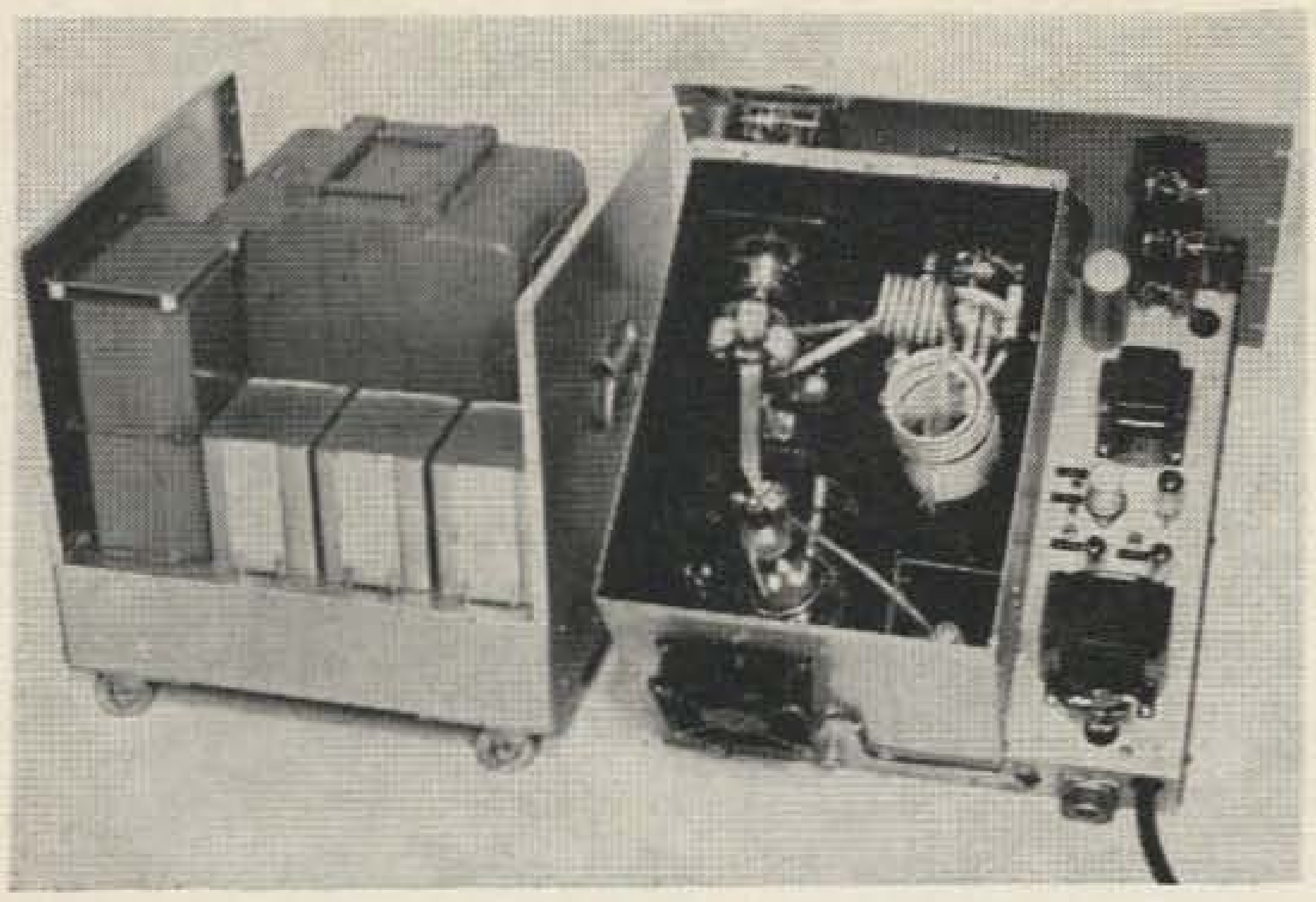
The plate circuit is a bandswitched pi network constructed around a modified Illumitronix #P1 195-2 pi network inductor. A Radio Switch Corp. Model 86 rotary switch is used to change taps on the coil and on certain bands to place fixed capacitors in parallel with the variable loading capacitor. The plate tuning capacitor and the loading capacitor are 250 mmfd variable vacuum capacitors. The pi dux coil is modified by removing the 10 meter section and substituting a coil of 6 turns of ¼" copper tubing, 2¼" long on a 1½" I.D. The tapping points for the different bands were also changed. These changes were made in order to maintain the best L to C ratio for each band. The pi network is connected to the plate of the tube through a blocking capacitor made of 3 centralab 500 mmfd TV type high voltage capacitors in parallel. The B+ is shunt fed to the tube through a Raypar all band plate choke. Several homemade and commercial chokes were measured and the Raypar unit was found to have the best impedance characteristics over the desired frequency range. A Z-28 rf choke was connected from the output side of the pi to ground to prevent high dc voltage from appearing at the antenna terminals in case of a shorted blocking capacitor.

The grid bias supply is a simple half wave rectifier with a pi section filter and an OB2 VR tube. This provides a grid bias of 105 V which is stable and has very low ripple. Since there is no grid current drawn from this supply, it was made variable merely by connecting a potentiometer across its output. A resistor is placed in series with the potentiometer to prevent the bias from accidentally being turned down to zero.

In a linear amplifier, in order to maintain low distortion, the screen grid power supply must be regulated. Ordinarily, this can be done with V.R. tubes. The 8179, however, draws more current than can be obtained from normal V.R. tubes, thereby, making necessary an electronically regulated screen supply. Electronic regulation generally requires considerable chassis space and can be quite expensive. For this transmittter, however, a regulator was designed which compares very favorably in cost and occupies less space than a



All values mmfd. unless otherwise specified



string of V.R. tubes would, even if they could handle the current. This regulator offers performance which is very much superior to the V.R. tubes plus the advantage that it is adjustable. The regulator consists of 2 tubes, 7 resistors, 2 tubular capacitors and a potentiometer. One of the tubes is an OB2 used as a voltage reference and the other is a 6GW8 triode-power pentode used as a series regulator and feedback amplifier. Power is supplied to the regulator by a Stancor PC8420 transformer and a bridge rectifier consisting of eight BY-100 silicon diodes and a single section capacitor filter.

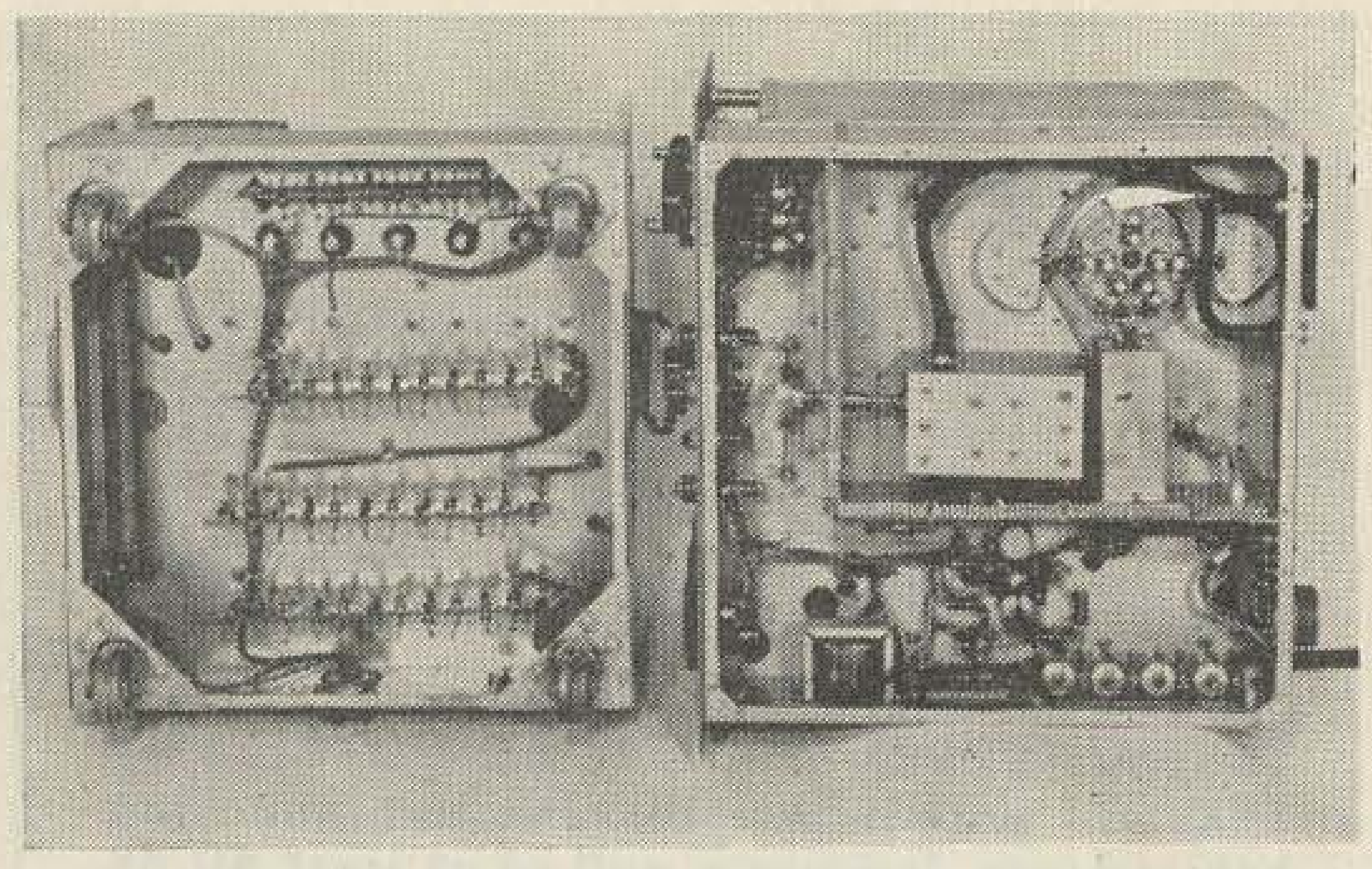
Four 2 inch meters allow for monitoring the operating conditions of the amplifier. Since the amplifier plate input is above 900 watts, both plate voltage and plate current meters are necessary to meet FCC regulations. The screen current meter in combination with the plate current meter allows the loading to be properly adjusted, and the grid current meter indicates if the amplifier is being driven beyond Class AB_1.

Full circuit protection is provided by fuses and a modified three pole Heinemann circuit breaker on the front panel. A Rotron muffin fan on the rear of the unit provides a small flow of air past the tube and tank coil. This is necessary since the amplifier is completely enclosed and would overheat unless forced ventilation was provided.

The amplifier is constructed on a 17″ x 17″ x 4″ aluminum chassis with a 19″ x 14″ aluminum front panel. The rf amplifier is at one end of the chassis and is completely enclosed in an aluminum compartment to minimize TVI.

In the photograph of the top of the chassis, the top cover is left off allowing the component layout inside the rf section to be shown. Also, in the top view, the filament transformer and the bias and screen supplies can be seen.

In the photograph of the under side of the chassis, the bottom cover of the rf section is



also left off to show the components. This cover is made of perforated aluminum to allow air to be drawn up through the bottom, through the tube socket, around the tube and out through the exhaust fan in the rear. A few holes were also drilled under the tank circuit to allow some air to flow past the coil.

In the bottom view, a small enclosed box can be seen with a coax cable coming from the side and a shaft coming from the front. This is the input pi network which is ganged to the output pi network bandswitch by means of a pair of pulleys and a bronze dial cord. (The pulley arrangement is shown in Fig. 1).

The ten adjusting screws seen on the pi net cover are the input and output trimmer capacitors for each of the five bands and are adjusted for minimum SWR at the center of each band.

Spring fingers along the partition which encloses the rf section assure good contact to the perforated metal cover. The use of extensive shielding and by-passing of all leads entering the rf section minimizes TVI and reduces stray feedback from the plate to the grid, thereby increasing the stability factor of the amplifier. It also prevents rf from getting into the power supplies which can cause loss of regulation, damage to rectifiers, etc.

Between the upper shield compartment and the front panel, are mounted the two Johnson turn counting dials for the vacuum capacitors used in the plate pi network. Also, in this space is a plastic disc which rotates behind a window in the front panel. On the disc are numbers which show through the window to indicate which band is in use. The shaft which turns this disc is an extension of the band change switch and extends through the front panel to the band change knob. On this same shaft is the pulley which drives the bandswitch on the cathode pi network circuit.

The rf amplifier section is housed in a brown hammer-tone desk top cabinet with perforated top and rear covers. A square cutout was made in the rear cover to allow the muffin fan to protrude out of the back of the cabinet. A series of 2" holes were cut in the floor of the cabinet to allow air to enter the bottom of the chassis. On the rear chassis deck are the rf input and output connectors, the plate power supply connector, and the line cord.

When first placed into operation, the amplifier was found to parasite at about 120 mc. This could have been cured by placing a

TABLE I 8179 AMPLIFIER SINGLE TONE TEST DATA

Freq. (Mc.)	PWR Out (Watts)	Drive (Watts)	Test Conditions	No Sig.	Max. Sig.
3.75	960	34	E_b	3275 V	3100 V
7.15	910	33	I_b	165 MA	470 MA
14.2	920	28	E_{c2}	500 V	500 V
21.25	920	30	I_{c2}	8 MA	93 MA
28.8	900	29	E_{c1}	−87 V	−87 V
			R_L	—	3400 Ω

TABLE II PLATE TANK CIRCUIT CONSTANTS (Approximate Values)

Freq. Mc	Plate Tuning CAP Dial Setting [1]	mmf [2]	Loading Cap. Dial [1]	mmf	+ Fixed	Tank Q
3.75	0712	157	0519	156	760	12.5
7.15	1160	66	0927	64	300	10
14.2	1300	38	0714	118	100	11.5
21.25	1587	27	0215	217	100	12.5
28.8	1362	31	0640	133	100	19

Note 1. Dial set to 000 at Max Capacity (Tune Max. = 272 mmfd, Load Max. = 257 mmfd). Dial Settings are approximate only and will vary somewhat with different capacitors.

Note 2. These values do not include tube output capacity.

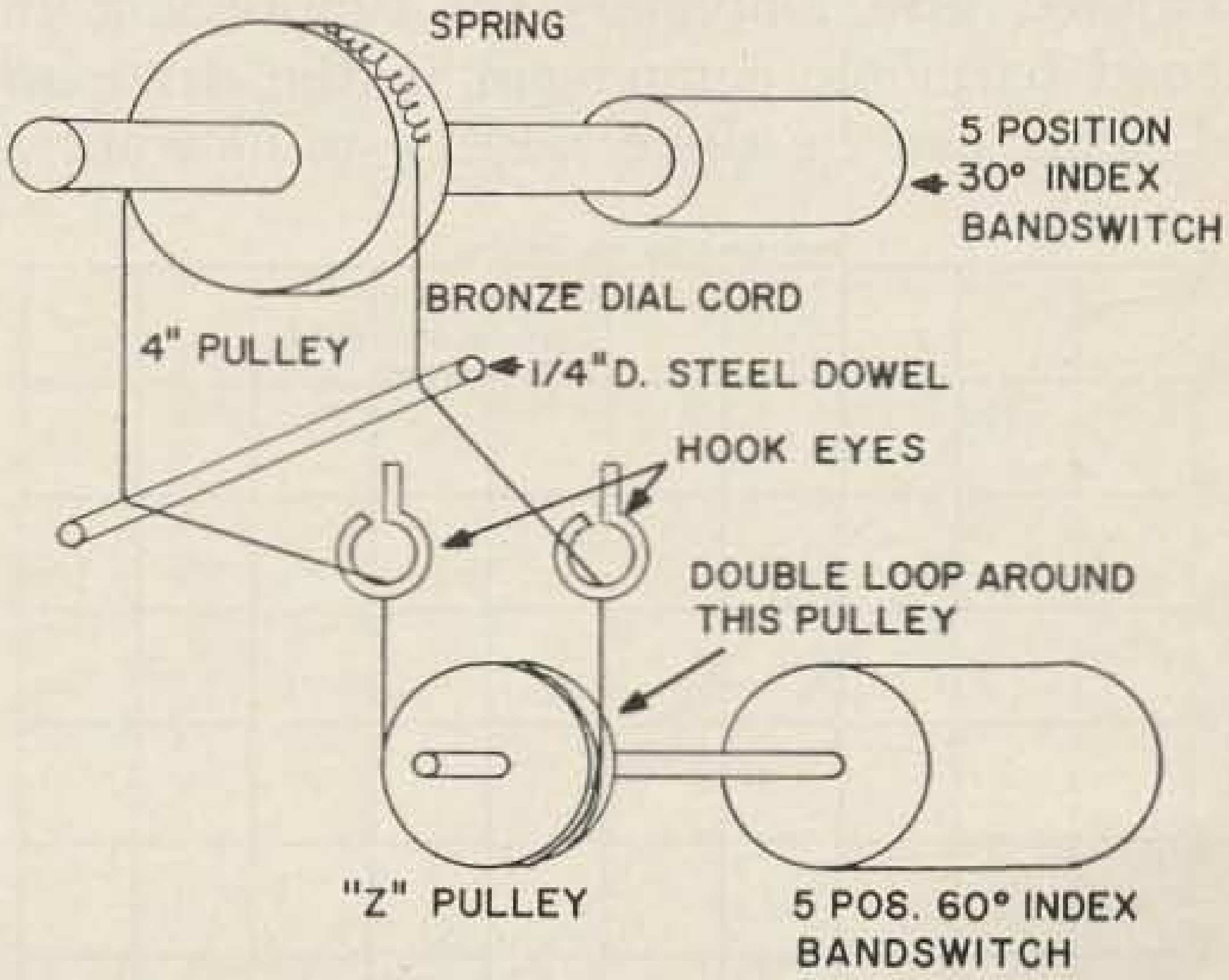
parasitic suppressor in the plate lead of the tube, but this would have inserted considerable resistance in series with this lead at 30 mc. Due to the high output capacitance of the tube, a good portion of the plate tank current flows through the tube and any resistance in the plate lead would cause high losses resulting in low tank circuit efficiency at 30 mc. For this reason, parasitic suppressors were placed in the control grid and screen grid leads instead of the plate. Since much of the plate tank current flows through the screen, the amount of resistance inserted in the screen lead was kept to a minimum, while the resistance inserted in the control grid was allowed to be as large as necessary to prevent the parasitic. This introduces some loss in the grid circuit, but in this manner high plate tank efficiency is maintained at the expense of a small increase in drive power.

The amplifier was tested into a 50 ohm dummy load on all bands for drive requirements and power output. The results of these tests are shown in Table I.

Table II shows the approximate capacitances, dial settings and Q used for the plate tank circuit at the center of each amateur band.

A test was also run on seven megacycles with a two tone signal to determine the amount of distortion present in the amplifier. The conditions were as in Table III.

When the amplifier was first constructed, the distortion was found to be quite bad (about −30DB). This was caused largely by the fact that the current meters and the circuit breaker coils in the negative leads of the power supplies were not bypassed for audio frequencies, causing an audio voltage to be superimposed on the power supply voltages. By bypassing the meters and circuit breaker coils with electrolytic



BANDSWITCH GANGING ARRANGEMENT

FIG. 1

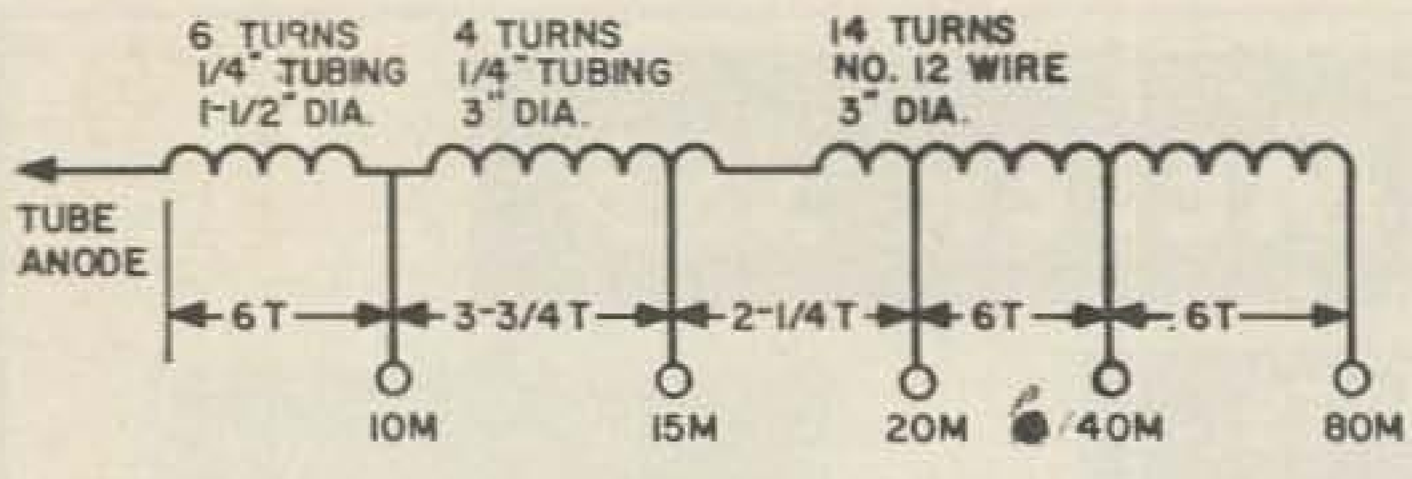


PLATE TANK COIL

L.T.

capacitors, the distortion was decreased considerably.

The distortion was decreased still further by leaving the unused turns on the plate tank coil unshorted when switching from band to band, instead of shorting them as was done when the amplifier was first constructed.

The 8179 data sheet states that the tube must be operated in a vertical position only. During testing, the amplifier was operated on its side and it was noted that the distortion figures became slightly degraded. This is normal and is probably caused by misalignment of the control and screen grids due to sagging of the elements when the tube is operated on its side.

General Linear Amplifier Design Considerations

In designing a low distortion linear amplifier for a tube such as the 8179, certain precautions must be taken to maintain low distortion and reasonably high efficiency. Some of these apply primarily to the 8179, while others are general in nature and apply to the design of any linear amplifier. Some of these precautions are listed below.

1. Any impedance in series with the power supplies must be bypassed for audio frequencies as well as rf. The power supplies themselves should have good audio regulation, i.e., a large filter capacitor across the output.

2. Some means should be provided in grounded grid amplifiers for suppressing the second harmonic component in the drive signal. This can be done with a pi-network or other tank circuit tuned to the fundamental, a low-pass filter with a cut-off just above the operating frequency, or a series tuned second harmonic trap to ground. The pi-network and tapped coil methods also have the advantage of matching the line impedance to the tube input impedance, thereby reducing drive requirements.

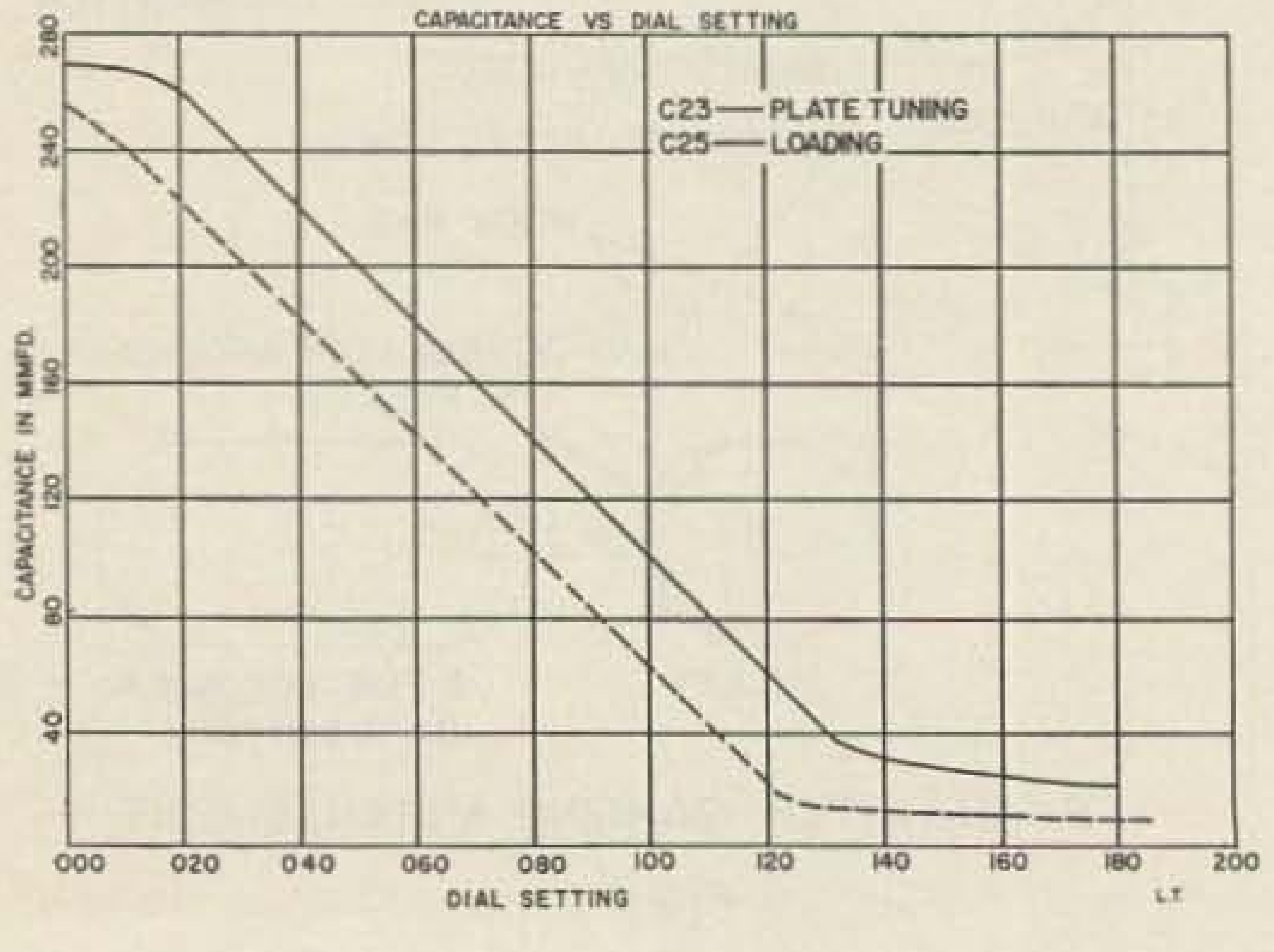


TABLE III 8179 AMPLIFIER 2 TONE TEST DATA

	ZERO SIGNAL	MAX. SIG. (2 Tone)
F	——	7 + 7.002 MC
E_b	3275 V	3150 V
I_b	165 MA	330 MA
E_{c2}	500	500 V
I_{c2}	8 MA	36 MA
E_{c1}	−87 V	−87 V
R_L	–	3400
PO (AVG.)	–	460 Watts
PO (Peak)	–	920 Watts
D3	–	−42 DB
D5	–	Better than −45 DB

3. The screen and control grid power supplies should be well regulated since a slight change in operating point produces a considerable increase in distortion. For instance, if the no signal plate current of the 8179 is changed 5 ma from the nominal 165 ma, the distortion increases 2-3 db.

4. The exciter distortion should be kept as low as possible. The exciter distortion should be at least 20 db better than the amplifier distortion in order not to increase the amplifier distortion by more than 1 db.

If extra drive power is available, the nonlinear loading of the driver by a grounded grid amplifier may be reduced by swamping the driver output with a resistive load.

5. The plate tank coil should be progressively opened instead of shorted when changing bands.

6. Parasitic suppressors should, if possible, be kept out of the plate tank circuit in order to keep the unloaded Q and, therefore, the plate tank efficiency as high as possible. At high frequencies, where the tube capacity becomes a good portion of the total tank capacity, this precludes the use of the normal parasitic suppressor in the plate lead. As much of the suppression should be done in the control grid circuit as possible with only as much suppression as is absolutely necessary in the plate and screen circuits. Suppressors should be made with the lowest values of resistance and inductance that will suppress the parasite to avoid excessive loss on the operating frequency.

Conclusion

The excellent performance of the 8179

linear amplifier shows what can be done in designing a low distortion, high efficiency amplifier by following the above recommendations and by using an extremely linear tube, designed specifically for single sideband use, such as the 8179. . . . W2LPC

L1—.38 μHY 8 Turns #406 Air Dux
L2—.49 μHY 9 Turns #408 Air Dux
L3—.75 μHY 11 Turns #410 Air Dux
L4—1.4 μHY 18 Turns #510 Air Dux
L5—2.8 μHY 12 Turns #616 Air Dux
L6, L7, L8—3 Turns #14 Wire Wound on R1, R2, R3
L9—Plate Tank Coil Illumitronic Pl Dux #P1 195-2 Modified as per Figure 11
L10—RF Choke OHMITE Z28
L11—Raypar All Band Plate Choke
L12—B & W All Band Filament Choke 25 Amp.
T1—Stancor PC-8420 Transformer
T2—Stancor PA-8421 Transformer
T3—U.T.C. Type CG307 Transformer
T4—Triad F-28-U Transformer
CH1—16 HY 300 MA Choke (2 x U.T.C. 5-33 in series)
SW-1—2 Pole 5 Pos 60° Index Rotary Switch, CENTRALAB #P-275 & (2) #Z-D
SW-2—2 Pole 5 Pos 3° Index Rotary Switch, Radio Switch Co. #86
CB-1—Circuit Breaker Heinemann Electric #XAM 666 Left Coil—500 MA DC Inst. Center Coil—75 MA DC Inst. Right Coil—2 Amps. AC Curve 3
Modified by removing companion trip connection between center and right poles.

Reducing Receiver Noise

George Gabus
14 Church Street
Deposit, New York

From time to time construction articles appear in the various publications dealing with the technical aspects of Amateur Radio. This suggests that amateurs are dissatisfied either with the price or with the performance of commercial receivers. Perhaps both.

A common frustration arises when we attempt to tune in that elusive DX station. As we raise the volume the noise level rises also. We reach a point of diminishing returns and give up. If we cannot read them we cannot work them.

Of course we have assumed that the noise originates somewhere "out yonder" and is all coming in via our antenna. That our receiver generates most of this noise has not occurred to many of us.

It is the purpose of this short paper to discuss this problem and offer suggestions whereby a receiver, either factory built or home-brew, may be greatly improved. The "practical" ham is invited to skip theory, if he must, and come back to learn the WHY after he has grasped the HOW of receiver noise reduction.

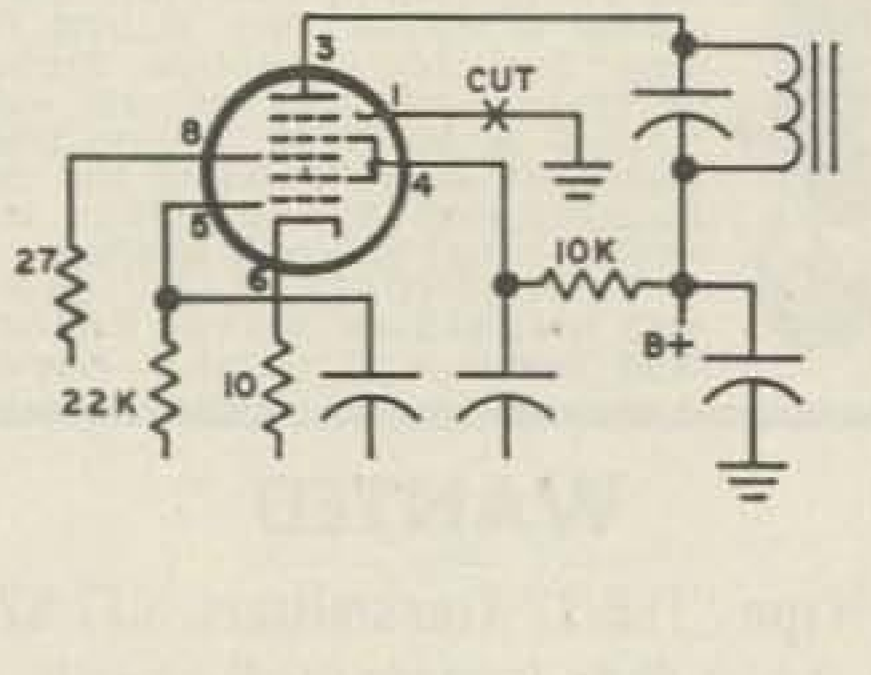


FIGURE I

Cut socket terminal 1 loose from terminal 2 and from ground and connect directly to socket terminal 6.

Consider the vacuum tube. Positively charged ions, either emitted by the cathode or produced by the collision of electrons with residual gas molecules, produce noise in this manner: since the ion is some 1800 times heavier than an electron it moves sluggishly and remains in the electron stream for a finite period of time before being neutralized by combination with an electron. These positive charges affect the electron stream in an erratic, or random, manner; both when appearing and also when disappearing.

Electronic devices, including tubes, transistors, rectifiers and the like, are essentially diodes through which current passes. Multigrid tubes which combine several "diodes" in one envelope are notoriously noisy. Every component carrying current is a potential noise generator.

Since ions are produced by collision of electrons with gas molecules, we should reduce all B plus voltages below the ionization potential of the gas left in the vacuum tube. To those accustomed to think of ionization voltages in terms of "runaway" tubes, neon lamps, and voltage regulator tubes, it may come as a surprise that B plus voltages must be reduced to a maximum of 18 volts, or less. Remember that in noise reduction, we are not concerned with "breakdown" or "avalanche" effects.

There is always a certain amount of leakage current, either from one electrode to another or to ground. This, together with that which we have called "diode" current, is reduced when we reduce the voltage applied to the tube.

In superheterodyne receivers a large part of the noise originates in the two oscillator circuits. This is mixed with the desired signal and passed along for further amplification. This suggests that noise be minimized in the two, or more, oscillator circuits.

Each stage not only contributes its own quota of noise but also amplifies any noise from previous stages. It follows that the front end is the most likely part of the receiver to begin attempts at noise reduction.

Think of the cathode of each tube as the ground return for all circuits associated with that particular tube. Contrary to accepted practice each cathode should have its own insulated ground wire connected to a single point on the chassis, either directly or through a suitable capacitor. For example, if more than one tube is grounded through one wire, current flowing through one tube will be directly coupled into the other tube's circuits through the common ground wire. What is not so obvious is the fact that the chassis may act in the same manner if used as a common ground connection for two, or more, circuits.

Each stage should be shielded from its neighbors by putting each component associated with a tube in its own metal box. All by-pass capacitors should be grounded directly to the cathode socket terminal using a minimum length of wire. Ceramic disc capacitors have long leads which should be shortened to ¼", wherever possible. Tube layout should be such as to keep control grid lead lengths to a minimum. If other, more important, considerations make this impractical, run the grid lead through shielded braid and connect the shield, not to the chassis but to the cathode socket terminal of the tube being driven.

While physicists and radio engineers have known all this (and more) for years, very little of this valuable information has been applied practically. Manufacturing costs must be kept to an absolute minimum. "Good enough is best" appears to be the motto of the industry. This means whatever minimum of performance the trade will accept. For the "do-it-yourself" builder no such motto need apply.

Recognition of the various sources of noise will suggest methods of dealing with them. For example, consider the noise produced by ions in the electron stream. Having previously reduced all B plus voltages, if the cathode temperature is slowly reduced a point will soon be reached where ions no longer will be emitted. Electron emission, though reduced, will continue. It has been found by experiment that the best signal-to-noise ratio occurs at about 75% of the manufacturer's rated heater voltage.

At this juncture we can imagine you, the reader, saying: "What good will this do me since I live in a noisy location?" We live in an apartment house, one door from State Highway 17. A power line runs along on our side of the highway. The roof of our building bristles with TV antennas, some connected to radiating TV receivers. We suspected that much of the hash was coming in over the power circuits. An effective line filter was constructed which reduced a part of the interference. After this it became possible to hear lesser sources of disturbance. We located two, a farmer's fence-charger, a couple of miles away, and an intermittent power leak where a wild grape vine had chosen to climb into a mess of wires on a utility pole. These were reported to their respective owners who were glad to co-operate promptly.

"Dirt" has been defined as "matter out of place." In like manner "noise" may be defined as "signals out of place." Our problem of "noise reduction" changes its appearance. It has become a matter with which we are more familiar; signal control.

There is a simple test anyone may make to check the noise produced by a receiver. With the antenna and ground leads disconnected, connect the receiver antenna and ground terminals together. A dime will do nicely. Now turn the rf and audio gain controls to maximum with avc control in the OFF position. Turn the AM-CW switch, if any, to the CW position. The noise, issuing from the speaker, did not come from outside. It was manufactured inside the receiver.

In case your receiver has been hissing at you it is easy to determine where most of the noise comes from. With gain controls full on try removing tube after tube, beginning with the rf amplifier, until the noise is sufficiently

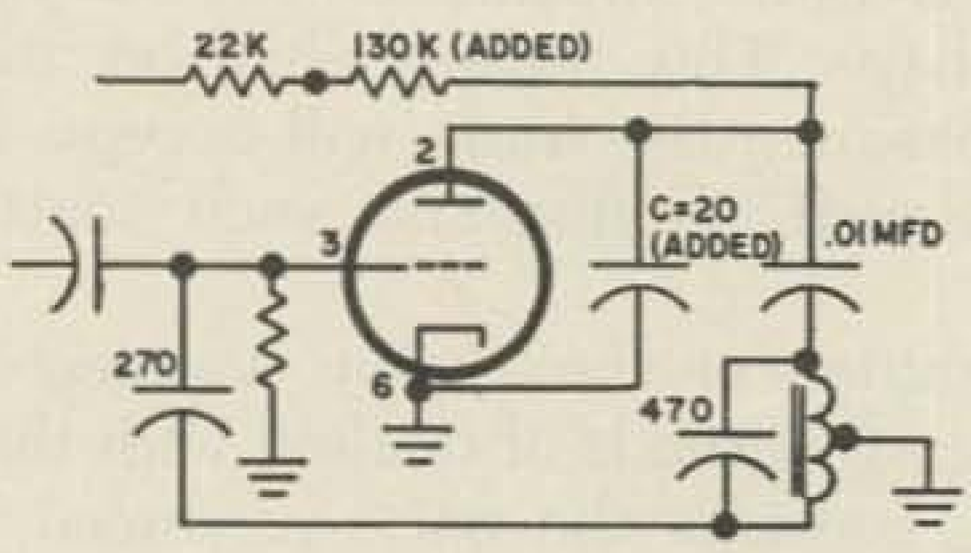


FIGURE 2

After adding resistor and condenser as shown retune pitch control to 455 KC by removing knob and turning shaft with pliers.

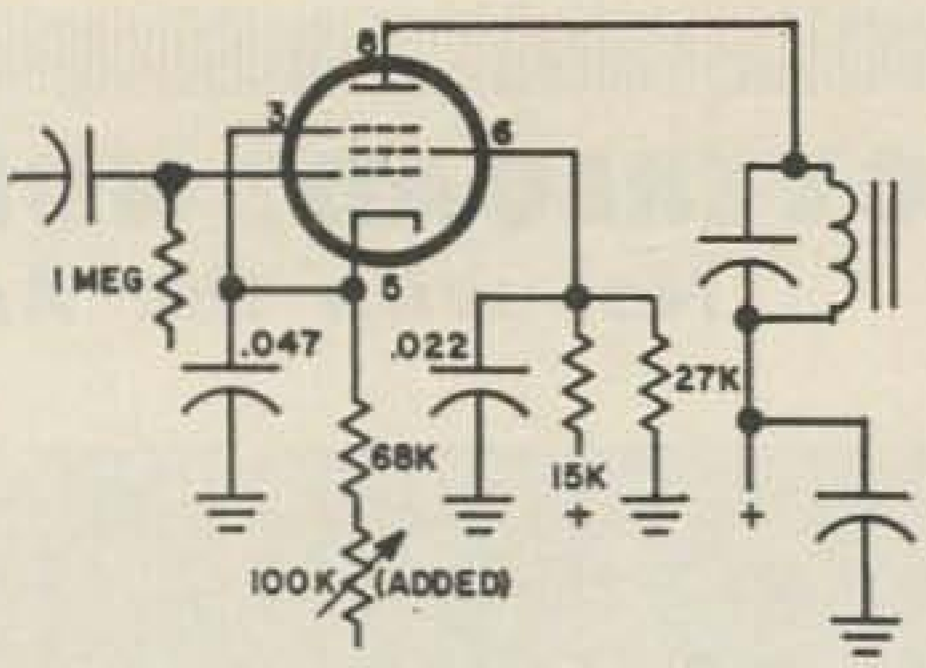


FIGURE 3

After determining proper maximum and minimum values with the 100 K ohm variable resistor it should be replaced with a fixed resistor of the minimum value and a variable resistor in series with the proper value to cover the entire range. One of the gain controls may then be replaced with a dual control to enable the operator to make front-of-panel adjustments possible.

reduced to be acceptable. The noise reduction which usually follows the removal of the converter tube has led to the erroneous belief that little, if any, noise reduction will follow the use of better tubes or circuits ahead of the converter, especially on frequencies below thirty megacycles. Let us repeat, this belief is erroneous.

The studious investigator no doubt has observed that much of the noise seems to come from the bfo and from the converter. We acquired a second-hand SX99 which had been modified by the previous owner. Having this to work with we decided to find out if theory would be verified by actual experiment. For it became evident that this receiver, like many others, had been producing plenty of noise without outside assistance.

Let us re-examine the circuit of the BFO. We found it was feeding much too much power into the *if* strip. Enough, in fact, to block the receiver completely when the avc was turned ON. The "gimmick" capacitor was reduced to a minimum by cutting the lead from the bfo back to the shield braid and by placing a wire as a shield between this lead and the *if* transformer. Bfo output was reduced further by feeding voltage to it through 150K ohms instead of 22K ohms. Finally a 20 mmfd capacitor was connected between plate and cathode at the socket and the circuit then retuned to 455 kc. While this greatly reduced strong signals and also strong noise it had very little effect upon weak signals. Most evident of all, it reduced the hiss appreciably.

Since a large part of the noise appears to come from the bfo and the converter let us re-examine their circuits. Turning to the converter circuit it was noted that the suppressor grid, instead of connecting directly to the cathode (as it should), was connected to the chassis. Since this violated two basic theoretical considerations it was cut loose from the chassis and conected directly to the cathode socket terminal.

Returning to a physical examination of the converter circuit, as modified by the previous owner, an OB2 had been installed to stabilize the voltage to plate and screen circuits and thus reduce drift. A 0.0047 mfd ceramic disc capacitor, which we connected directly across the OB2, resulted in still further quieting. However, this had the adverse effect of preventing the converter from functioning on the *low* frequency end of band four. It was found necessary to introduce a 1000 ohm isolation resistor between the OB2 and the converter circuits to restore it to normal.

We would like it known that noise reduction followed each change. This was evident to the ear as well as by the built-in S meter. Between changes a foot long antenna was connected in place of the short from antenna terminal to ground terminal. This was done to make sure that received signals were not being reduced along with the noise. Finally the receiver was connected to an outside vertical antenna, 22 feet high, for further tests under normal working conditions. Truly, we were amazed!

It was decided to carry decoupling of stages a bit farther than had been done at the factory. The rf amplifier stage was decoupled by adding a 0.5 megohm resistor in series with the 1.0 megohm connected to the control grid of the first tube. Then the junction of these two resistors was connected, through a 0.0047 mfd disc capacitor, to the tube cathode at the socket. Although this resulted in some further improvement, in some positions of the rf gain control the receiver would motorboat accompanied by flickering in the OB2. In spite of this (or perhaps because of this) we decided to similarly de-couple the first *if* tube.

Then the unforeseen occurred! We installed the second decoupler, using a 2.2 megohm resistor. When we tested the receiver, regardless of any adjustment we might make, silence reigned and the S meter indicated zero current. We were about to disconnect the receiver and open it up when a weak signal came from the loud speaker, but with absolutely no noise! Although we had anticipated a little noise reduction, we were unprepared for total elimination of noise as it seemed we had achieved. Upon turning both rf and audio gain controls wide open, however, many other stations leaped out at us, accompanied by very little noise. We had stumbled onto a circuit that was bringing in signals from all over, with a minimum of noise.

Although we were using a loud speaker the volume left much to be desired. It would have been ample for headphone reception but we wanted to use a speaker and avoid being tied to the set.

We thought that the 2.2 megohm resistor was too large and that volume would be increased if a resistor of lower value were substituted. In order to learn its exact value a 100K variable was connected across the 2.2 megohm resistor. We were surprised to learn that the signal-to-noise ratio could be varied over a considerable range merely by turning the 100K rheostat very slowly in one direction through its range while rocking the rf gain control. Those of you who have had experience with old time two or three dial tuners will understand what we did.

We were delighted with the way the reciever now operated. But we became less and less happy because we did not understand the reason for its greatly improved performance. After much thought on the subject it was finally assumed that in some, as yet, unknown manner, we had goofed while making the next to last change. Once this unflattering, ego-deflating idea was accepted it was easy to surmise what the goof might have been. Examination of the base diagram of the tube, a 6SG7, showed that we must have connected our second de-coupler circuit, not into the grid return circuit but into the cathode return circuit of the tube. By making this goof we had unwittingly verified the theory by greatly reducing all B plus voltages, as measured from the cathode.

Close examination of the socket terminals showed us just how the goof had occurred. The manufacturer had joined terminals one and two together and connected both to the chassis as a unit. We had counted the two as one! What we had counted as pin terminal number four was actually number five!

The most outstanding improvement which came about as the end result of these various modifications, however, is this. Using a separate, small size receiving antenna, it is now possible to work break-in without other equipment of any kind. Another convenience is that we may now raise the gain to the limit without being assailed with a hiss like a steam locomotive letting off steam. Limiting the power of the bfo tends to limit strong signals to a point where they no longer prevent one from hearing DX stations. These latter come through much better, not having to compete with an overpowering beat frequency oscillator.

In conclusion we offer a word of advice to those who wish to profit by our experience. Should you decide to make any of these modifications to your present receiver, MAKE BUT ONE CHANGE AT ONE TIME. Then give your receiver a thorough test. This is because it is much easier to locate, and clear, one "goof" at a time than to find, and fix, many. Being human, we all make mistakes. The trick is to be able to profit by our mistakes.

Do not imagine that we have achieved the ultimate in noise reduction. This is only a small beginning. A whole unexplored field lies ahead for the researcher to delve into. We will continue experimenting and should further discoveries warrant publication, we will rush to the typewriter. . . . Gabus

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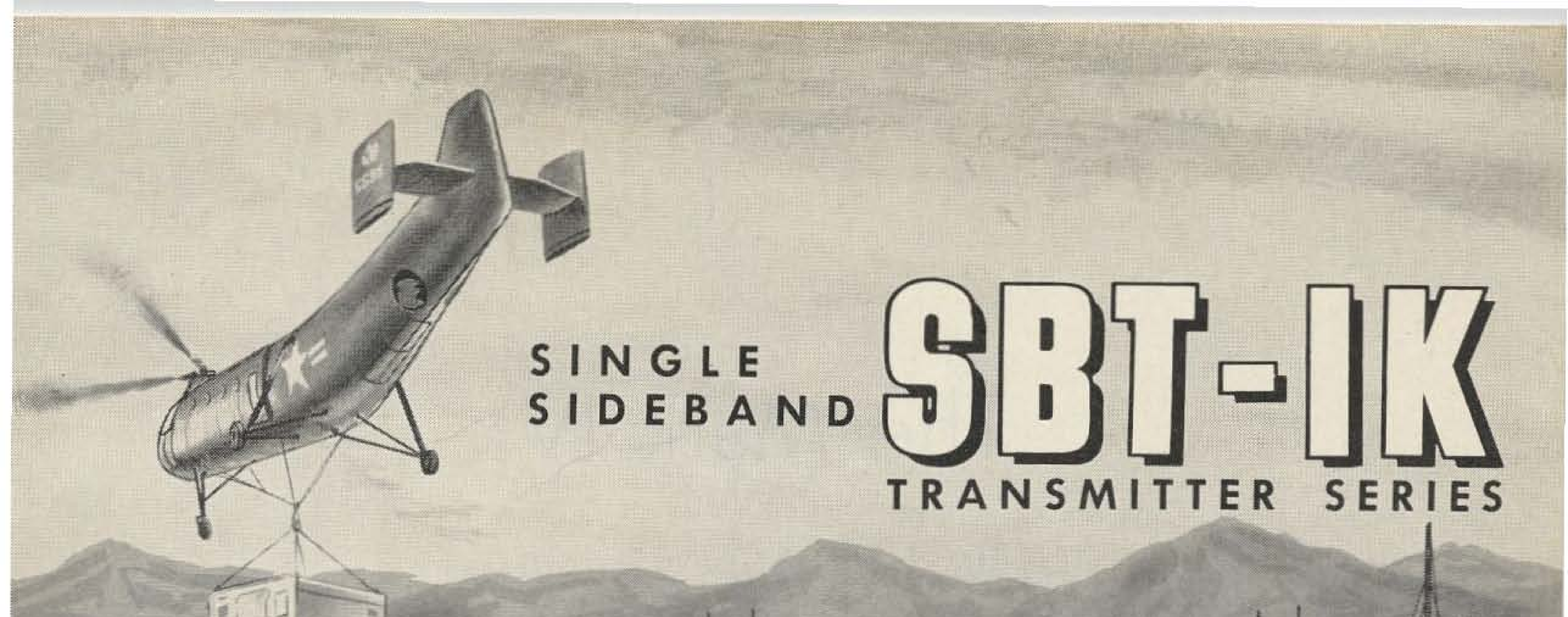
The Improved Challenger

Some time ago a Viking Challenger was purchased by WA6BXZ. After a considerable period of time it was evident that the 6DQ6A's used in the final and driver were subject to instability and overheating. In fact, one plate cap of a 6DQ6A driver melted off! It was decided to replace the 6DQ6A's with 6146's.

The conversion is quite simple, and involves only shifting the base connections from the 6DQ6A's to those of 6146's. New plate caps had to be purchased, however, since the heat-dissipating caps for 6DQ6A's do not fit 6146's. The original parasitic suppressors were removed, since the heavy wire used could not be soldered to the new plate-caps, and new suppressors were wound, consisting of five turns of number 18 wire on 100 ohm two watt resistors.

Care should be taken to re-neutralize the driver and final stages after the conversion. If this is done properly the rig is a real improvement over the "stock" Challenger. There is plenty of grid drive on all bands, and the signal must be heard to be believed. The rig will load up to ratings and possibly higher.

. . . K6TBW



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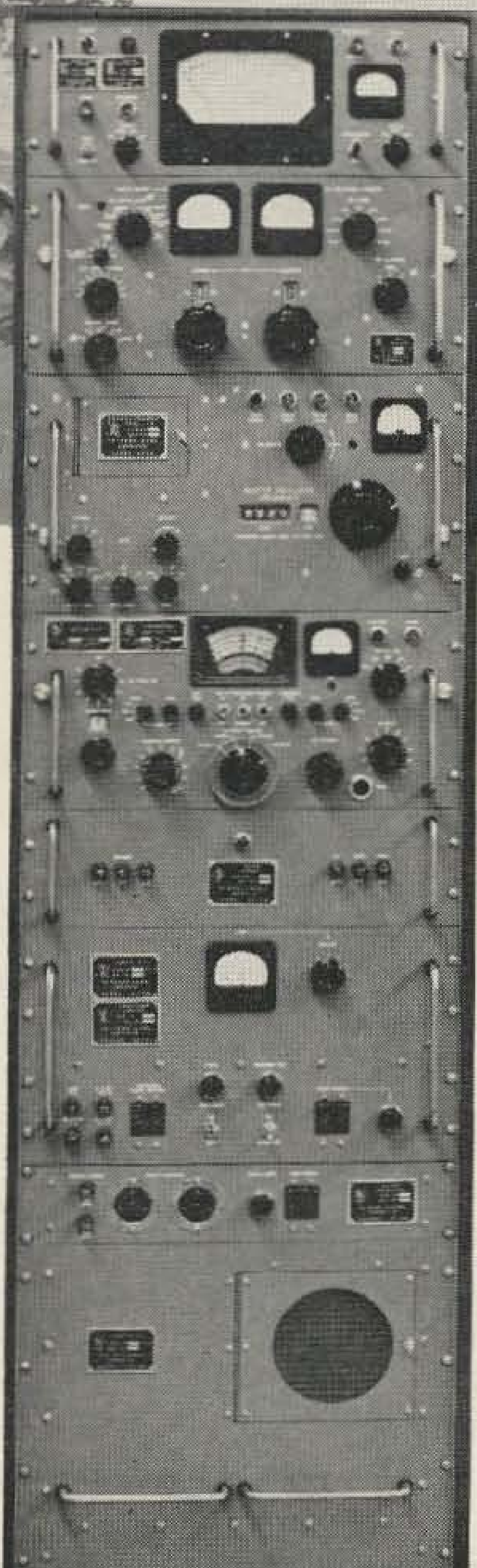

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The Mark IV

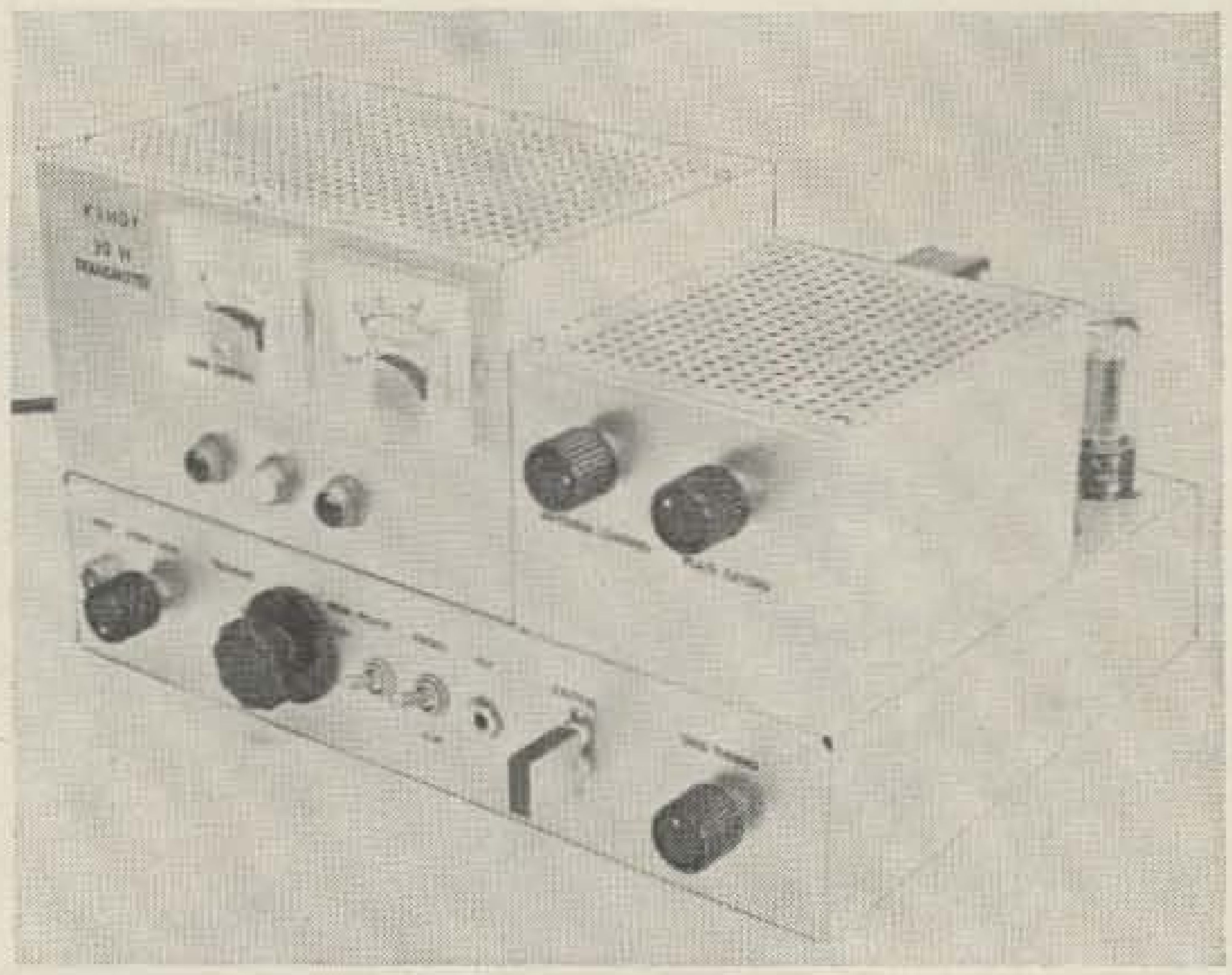
60 Watt Six Meter Transmitter

The transmitter shown in this article is the end result of some five years of on-again off-again spare time work. Using the same chassis, the author has rebuilt, added on and modified the rig so often that about all that is left of the original rig (2E26-10w) is the front panel controls. This final edition, the Mark IV, runs 60 watts input on 6 meters, fully plate modulated.

Circuit

The rf section of the rig consists of a 12BH7 harmonic oscillator-doubler feeding a 6146 run with about 500v on the plate. Eight megacycle crystals are used in the third overtone oscillator, the plate of which is tuned to 24mc by L1. The output of the oscillator then feeds a standard doubler stage tuned by C1 and L2. Under loaded conditions a good 4.5ma of drive is available for the 6146. Detuning C1 slightly will bring this down to the required 3.5 ma. The plate of the final is tuned by double spaced capacitor C2 and L4 and rf is coupled into the load by means of fixed link L5 and C3, a 100mmfd variable. The 10 ohm cathode resistor provides a small amount of self bias for the 6146. Both grid and plate meters are provided for the final. The two coils, L2 and L3, act as an rf transformer so that the doubler plate tank will "appear" to be in the grid circuit of the final, a condition necessary for neutralization. Were an rf choke substituted for L3 as is seen in some circuits, neutralization could not be achieved. Cn does the neutralizing.

The modulator design is straight forward and a close copy of one that appeared in the ARRL Mobile Manual.[1] That circuit would not supply sufficient power to fully modulate the 6146 at 60w input so I substituted a pair of 6L6-GC's for the 6L6's and upped the plate supply voltage to 450v. Lest some of you be aghast at applying such a high voltage to a pair of 6L6's

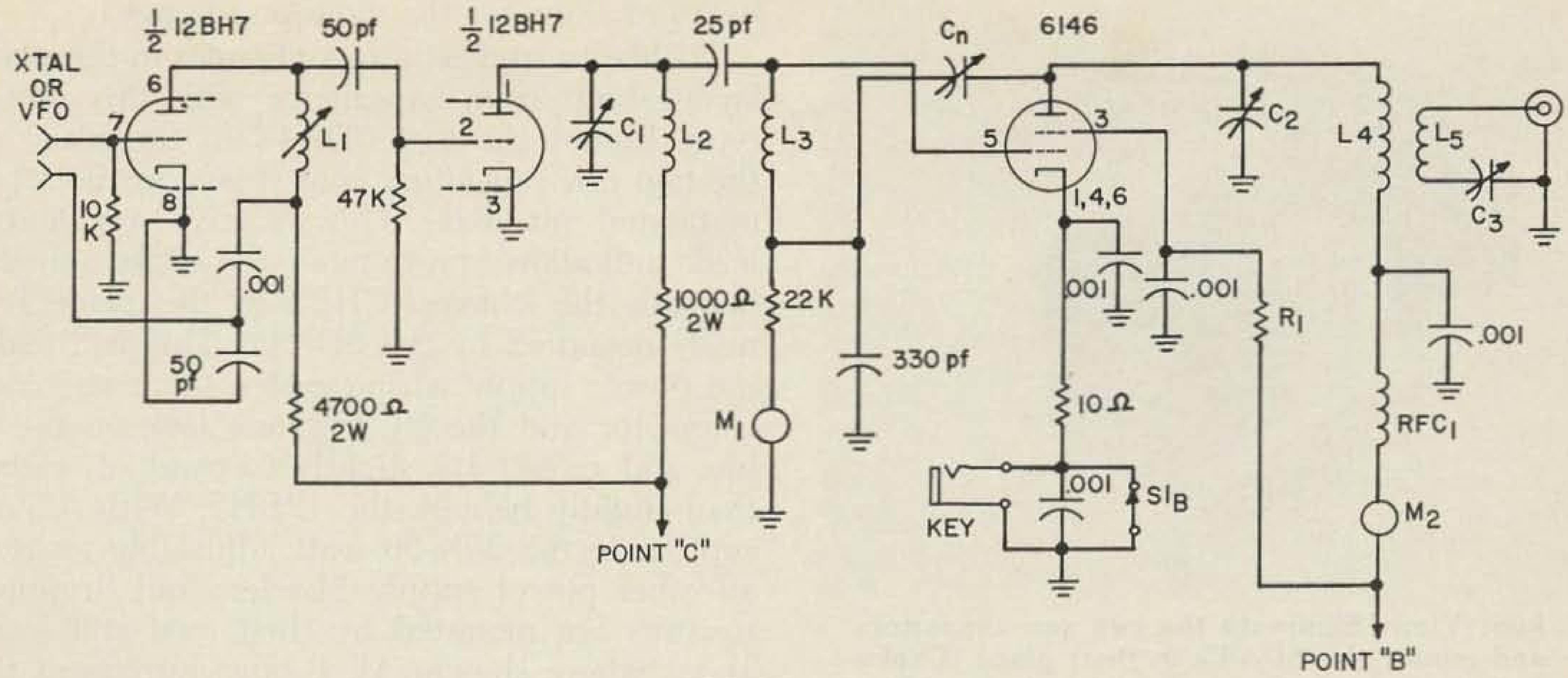


Front View: It should say 60 W on the panel, of course. The aduio section is to the left (in the box with the meters and pilot lights on it) and the rf section in the smaller box on the right. Covers for the two boxes are cut from a sheet of Reynolds Do It Yourself Aluminum. The control labeling should be self explanatory. The right hand meter reads plate current.

let me hasten to explain. These 6L6-GC's have a new form of plate construction which allows them to have better heat conduction and radiation than the old style plates, hence the higher allowable plate voltages. In fact, GE claims that a pair of 6L6-GC's, operated with 450v on the plates and 400v on the screens will give 70 watts output in AB1.[2] A 125 watt transmitter could easily be modulated by a pair of these tubes driven by a single 12AX7. In this rig, the pair easily overmodulates the final and care must be taken to prevent this. Some form of negative peak limiter would be nice but the author has not had a chance to try anything like this.

Power is obtained from a self contained

1 ARRL Mobile Manual, First Edition.
2 GE Ham News; Jan.-Feb., 1960.



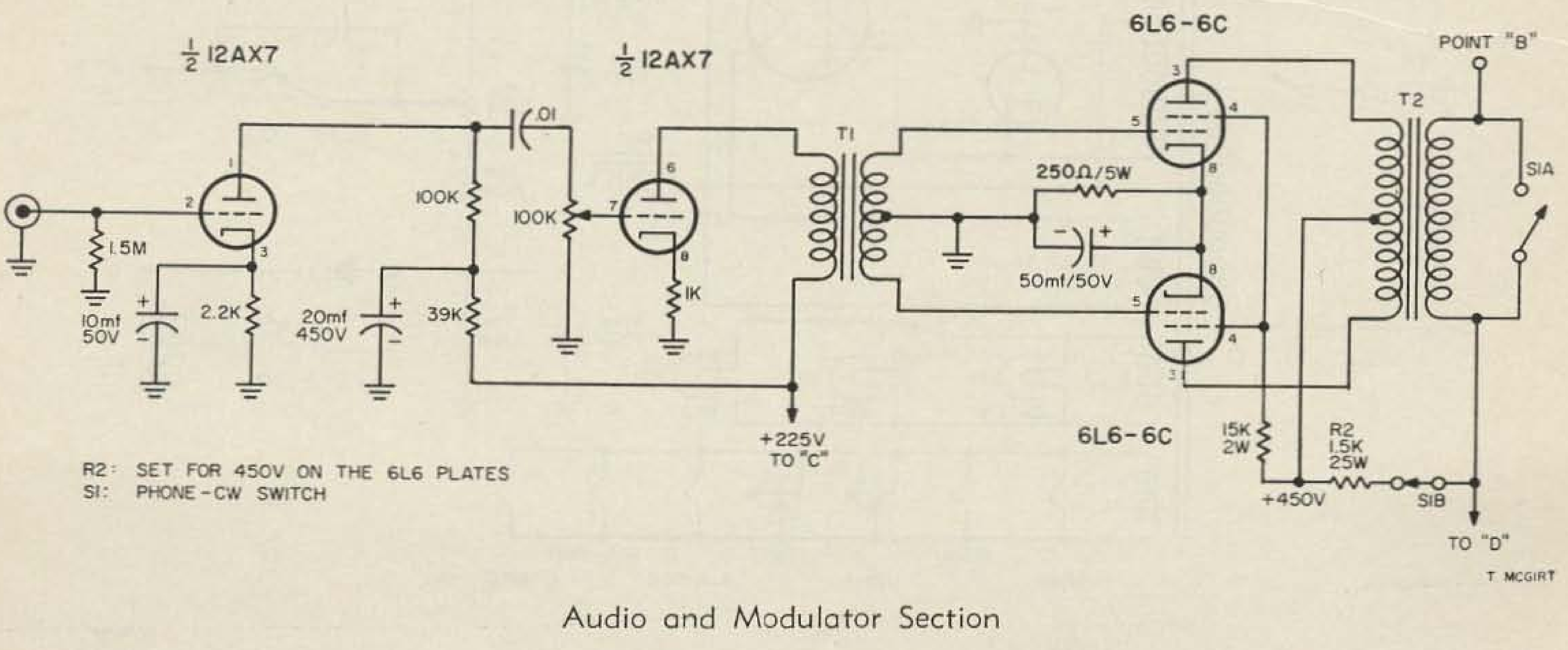
RF Section

"economy" type power supply using a 5U4-GB and a pair of 6DA4's in a bridge circuit. The power transformer (T3) was lifted from an old 16" television set as was CH2. Under load some 500v is obtained from the high voltage output and about 250 volts from the low voltage output. This low voltage output is used to feed the 12AX7 stages and operate the plate supply relay. Make sure that the transformer that you use is at least 375-0-375v on the high voltage winding. If it came from a large screen TV set the current ratings on the windings will be OK for this use.

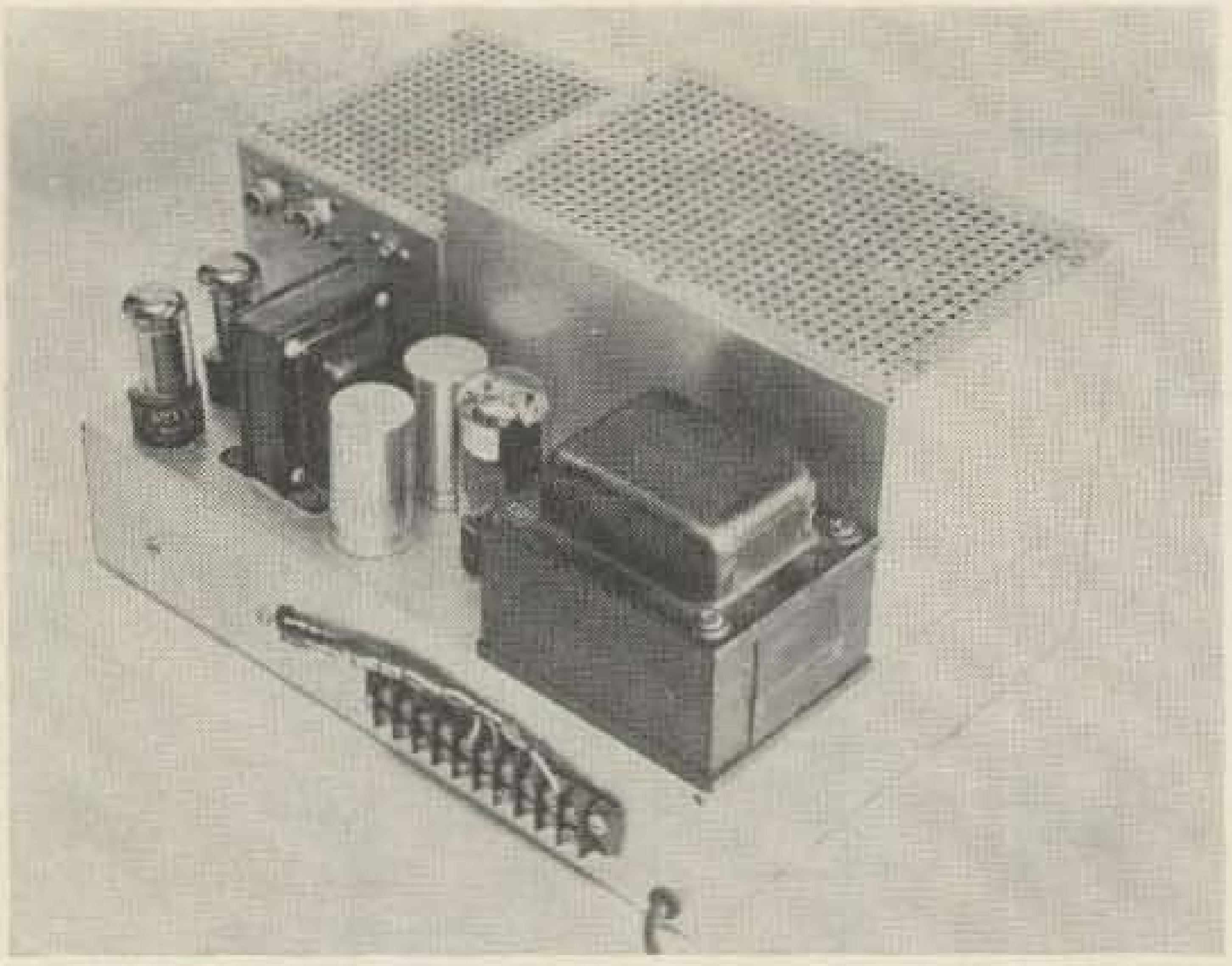
You could easily omit the plate supply relay mentioned above, but I feel that it provides more positive control over switching than the rotary switch originally used which arced over badly a number of times. The relay contacts K1a and K1b have .01mfd capacitors across them for spark suppression. As the control circuit is set up now, the rotary switch (S2) controls the pilot lights, activates the control relay and provides three spare sets of contacts (SPDT) which are brought out to a Jones terminal strip on the rear of the chassis. These extra contacts may be used to control an antenna relay, disable receiver B-plus, etc. The relay is mounted on a small "L" bracket near the 6DA4 sockets. You are not limited to this control circuit, of course. If you wish you may buy one relay with say a 6.3v ac coil, which will handle all the functions mentioned above and have push to talk. I like my method for fixed station use.

Construction

The entire transmitter fits nicely on to a 10"x14"x3" aluminum chassis with the audio and rf sections enclosed in small aluminum boxes for shielding purposes. A bottom plate is attached to the chassis for the same reason. The 5"x6"x9" box holds the audio section and mounts the meters and the 6"x5"x4" box houses the rf section. Shielding is complete in this



Audio and Modulator Section



Rear View: Eliminate the two can capacitors and mount the 6DA4's in their place. Choke CH2 can then be mounted in place of the 6DA4's. The leads to the barrier terminal strip are all "dead" and run to the TR switch for external control purposes.

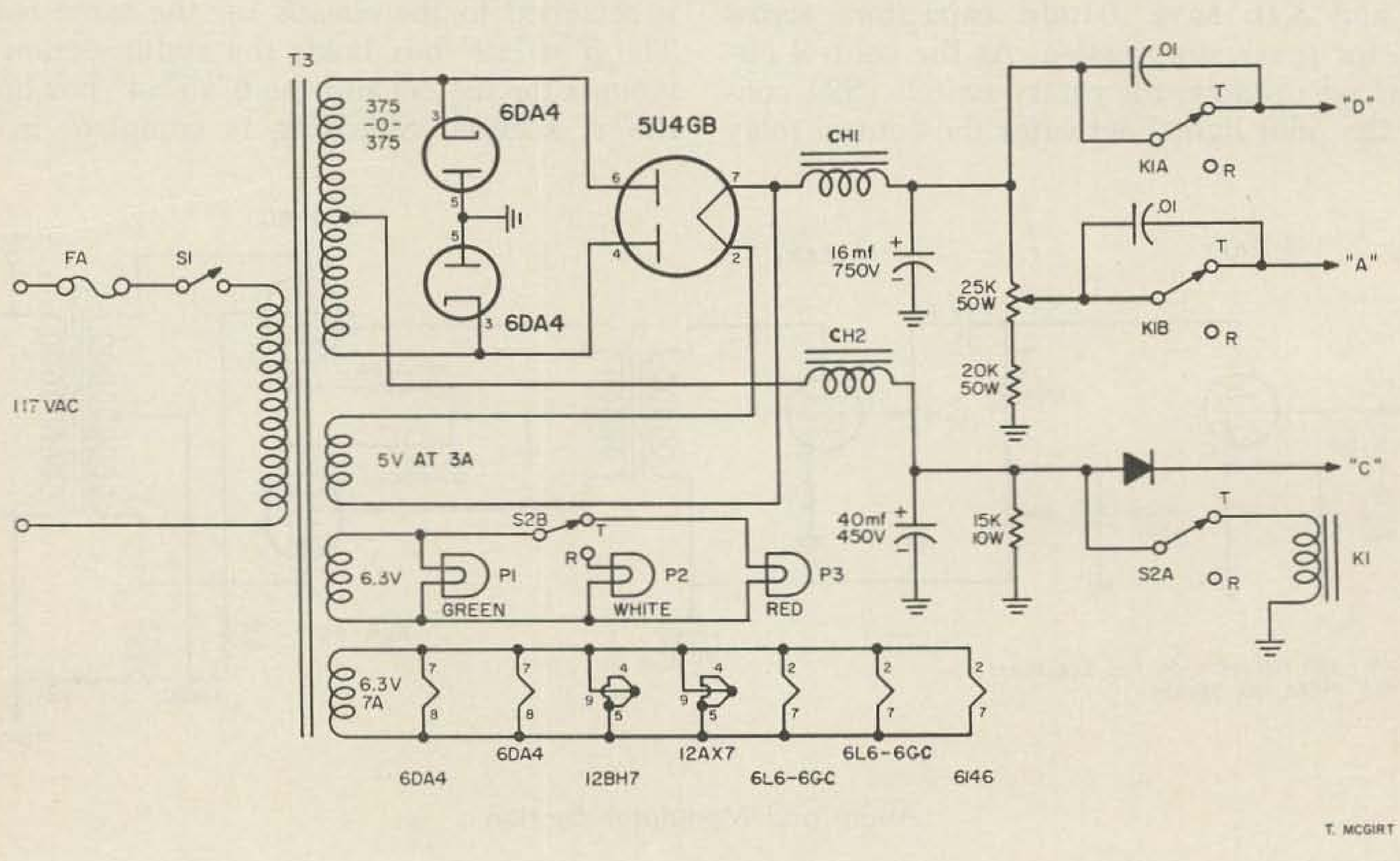
way and very little TVI has been experienced. Pieces cut from perforated aluminum sheeting are used as covers for the boxes to allow for good ventilation.

As you will notice from the photos, the chassis has a number of unused holes. This comes from all the rebuilding mentioned before. When you build the rig try to omit some of the more glaring things like that absurd hole the modulation transformer mounts in. I assure you, the rig will work just as well with a nice rectangular hole. Mount all of your large parts on the chassis after scribing lines on it to indicate the boundaries of the boxes (Don't forget to do this on the inside as well as the outside of the boxes to allow for the mounting flange).

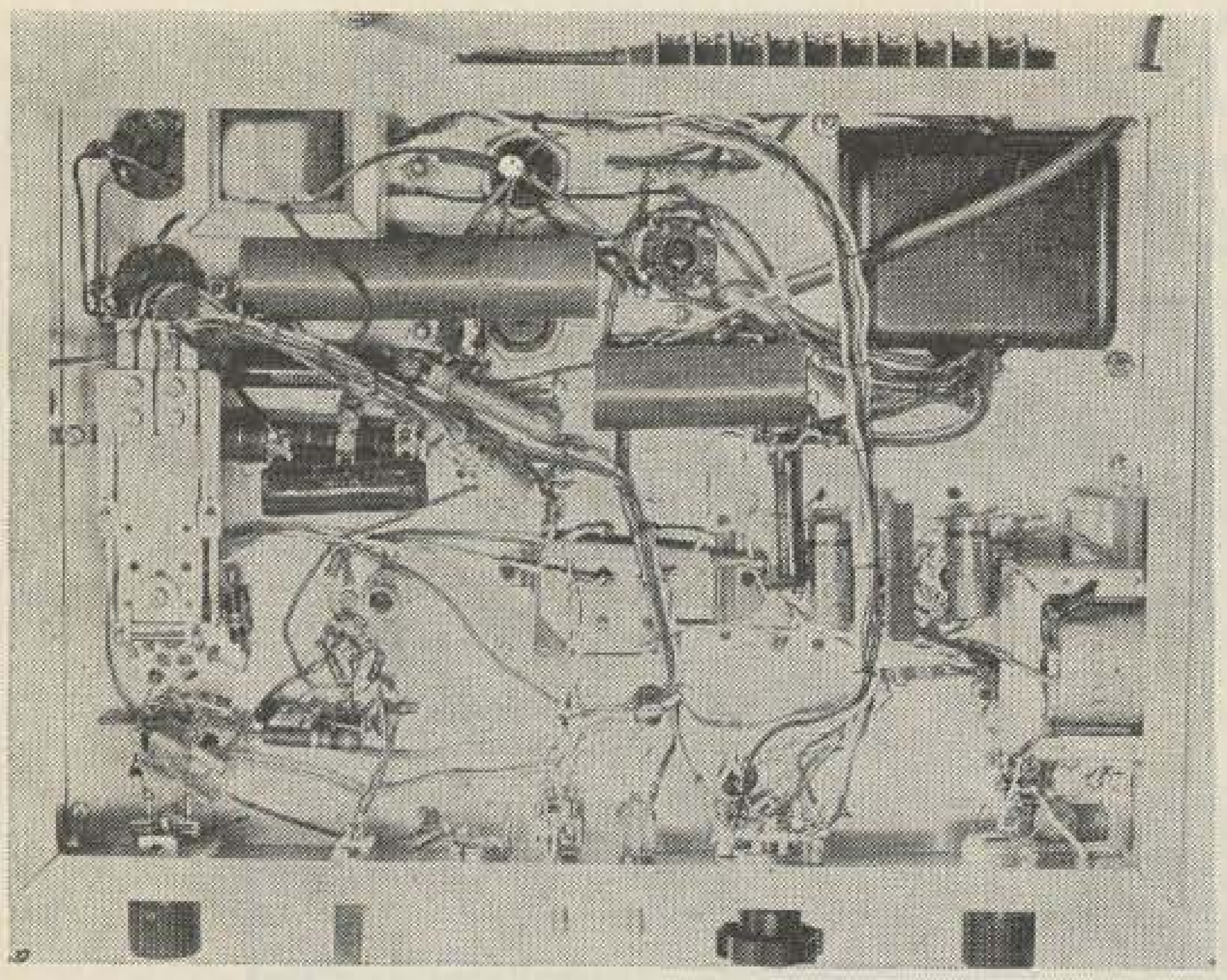
I'd like to suggest a few changes in the parts layout born from experience with this prototype. Mount the two 6DA4's in the place of the two can capacitors (not shown in the schematic and not used). This will give you shorter leads and allow you to move the choke (shown beneath the chassis—CH2) to the place formally occupied by the 6DA4's. This will make the power supply wiring easier. Omit one coax connector and the RCA phono jack on the rf box and mount L1 slightly forward of, rather than slightly behind, the 12BH7. With the exception of the 25K-50 watt adjustable resistor, all other power supply bleeders and dropping resistors are mounted by their own stiff leads about where shown. All B-plus outputs of the supply are brought to a terminal strip near the center of the chassis.

Wire up the rig, section by section, beginning with the power supply. Some 800v should be obtained under no-load conditions. Do the rf section next. As each section is completed it can be checked out separately—using a grid dipper and a 50 mc receiver. when the oscillator is running and stable, putting a finger on the crystal or near the plate tank should cause only a slight shift in frequency. Listen on a receiver at 50 or 24 mc with the bfo on. If the oscillator proves to be unstable, decrease the feedback by increasing the 50mmfd capacitor slightly. This should not be necessary since the circuit appears to be quite stable with respect to tube changes, etc. Keep your leads as short as possible and keep the rf leads away from the

POWER SUPPLY AND CONTROL CIRCUITS



chassis. Filament and metering lines in the section are all run in small diameter shielded mike wire. The output link is constructed by slipping a 4" piece of non-plastic spaghetti over a piece of hookup wire and winding two full turns over the cold (B-plus) end of L4. Make sure the spaghetti you use will not melt. It gets warm in there. Twist the two leads to hold the link in place. You should be able to slide this coil up and down L4 about ¼" to adjust coupling. Resistor R1 is made up of two 100k, 2 watt and two 470k, 2 watt resistors all connected in parallel. When testing this section from the internal supply, series resistors will be needed in the B-plus leads to keep the voltages down. The 6146 should receive from 500 to 550 volts and the osc-doubler stage about 300v. Coils L2 and L3 must be spaced very closely because the drive is highly dependent upon the coupling between them. I got over 5 ma with the circuits peaked. Anything over 4 ma is sufficient. Neutralization is accomplished in the usual manner by removing B-plus from the final and adjusting Cn until the grid current shows no flicker as the plate tank is tuned through resonance. Under normal conditions, with 500v on the plate and 3.5 ma of drive, plate current will be 110 to 120 ma for 60



Bottom View: The audio driver transformer is mounted in the upper left hand corner just below the 12AX7 driver stage. Choke CH2 (lower right of the chassis) should be moved to the top of the chassis and L1 moved slightly forward to shorten its leads as suggested in the text. The neutralizing capacitor now resides on the terminal strip just below the grid tuning capacitor. The screen resistor of the 6146 (near the upper left hand corner of the relay) is now two 470K-1w and two 100K-2w resistors in parallel. The filter capacitors are mounted by their own leads as shown and the decoupling capacitor for the audio stages is placed below the audio driver transformer.

watts input. Without drive the current rises to well over 150 ma. The audio section is wired next and no special precautions are necessary. It would be a good idea to wire the 12AX7 socket before the driver transformer is mounted though. The phone-CW switch is also wired in now and the entire unit tested. With 450v on the plates of the 6L6-GC's screen voltage is 400v and cathode voltage is 33v. 100% modulation occurs with the gain control half open when close talking the mike in a normal tone. Before putting the rig on the air you should put the output on a 'scope so that you will know at exactly what point overmodulation occurs with your mike and voice.

As you can see from the photos, I have made liberal use of surplus parts and components. Scavenge an old TV set for the power supply parts and go through whatever surplus houses you have available for the audio transformers and such. At the time of writing, the modulation transformer (I used a Collins 7R3, nominally 20 watt job) was available for two bucks, the driver for 97 cents and 6146's were going for about $1.80 in the New York Cortlandt Street area. These items represent the major cost of any transmitter and buying them surplus (and using TV set parts) will keep the cost of this rig way down. Inexpensive meters help too. You'll probably have to buy the 6L6-GC's new.

That just about covers it. I have had good success and pleasing reports using this rig on 6. Even into an indoor dipole it was rare not to have a comeback when I went on. It appears that even in this day and age 50 watts is quite a bit of power on this band. TVI has been practically nil on a color set whose antenna is only 15′ from the transmitting dipole. Give the rig a try, I think you'll like it. Oh yes, if you want to use a VFO with the rig, feed the 8 mc signal into the crystal oscillator between the grid and ground, not between the crystal socket pins.

. . . K2HQY

PARTS LIST

In addition to the small parts shown on the three schematics the following items are required. Coil data is included

L1—16 turns #30 enam. on National XR-91 Coil Form (⅜" dia.-slug tuned)
L2—5¼ turns 16 TPI ⅝" dia. B&W #3007
L3—7 turns 16 TPI ⅝" dia. B&W #3007
L4—4½ turns 8 TPI ¾" dia. B&W #3010
L5—2 turns hookup wire tight wound on cold end of L4
C1—15 mmfd. miniature variable Hammerlund HF-15
C2—15 mmfd. miniature variable Double spaced HF-15X
C3—100 mmfd. miniature variable HF-100
Cn—Use standard 8 mmfd. variable with airgap sufficient to handle 1200 to 15,000 sudras E. F. Johnson 160-104 1.8 ⟶ 8.7 mmfd.
M1—0-5 ma. Shurite MT-317
M2—0-150 ma. Shurite MT-323
T1—Interstage Transformer Chicago Standard IN-16 or Equiv. Ratio pri; entire sec., 1:3
T2—#30 watt modulation transformer 1 :1 ratio. Surplus or use UTC S-19
S1—DPDT toggle switch
S2—6 pole, 2 position ceramic rotary switch. Centralab 2019
T3—TV Power transformer. Salvage from old TV set or use Stancor P-6315
CH2—Exact value unknown (removed from TV set). Can use hy at 75 ma
CH1—5 hy. 200 ma choke
K1—Hi-voltage Relay Coil resistance (dc) 10K. Requires 3 make contacts. 6.3v ac relay off filament line would work as well

Misc: Three ilot lamps, #47 bulbs, knobs, hardware, mike connector, tube sockets, plate cap for 6146, Jones barrier strip, terminal strips, Key jacks, 10x14x3 inch aluminum chassis, 5x6x9 aluminum cabinet, 4x5x6 inch aluminum cabinet XR-91 coil form

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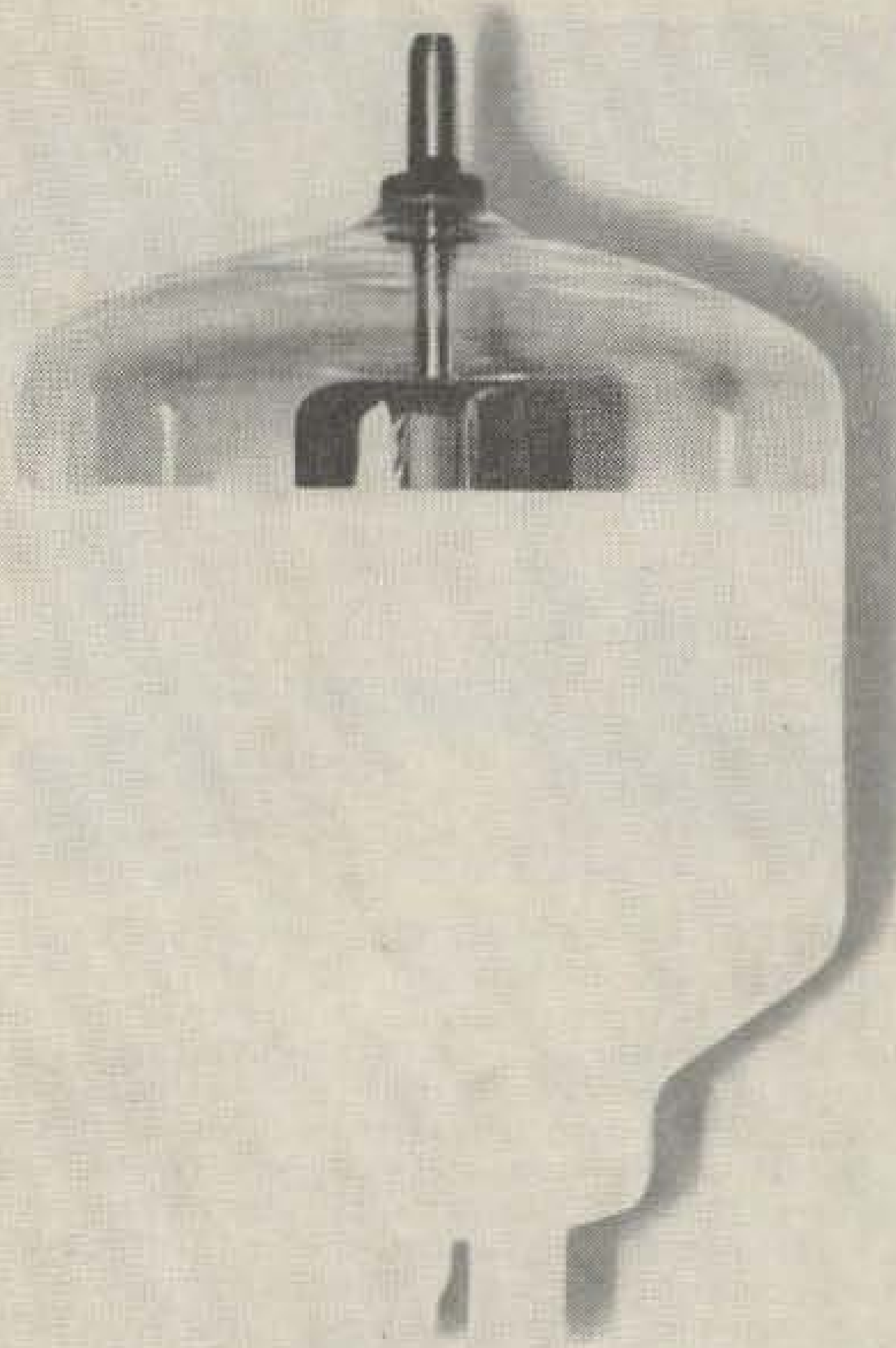

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Max. Signal DC Grid No. 2 Current	115 Ma
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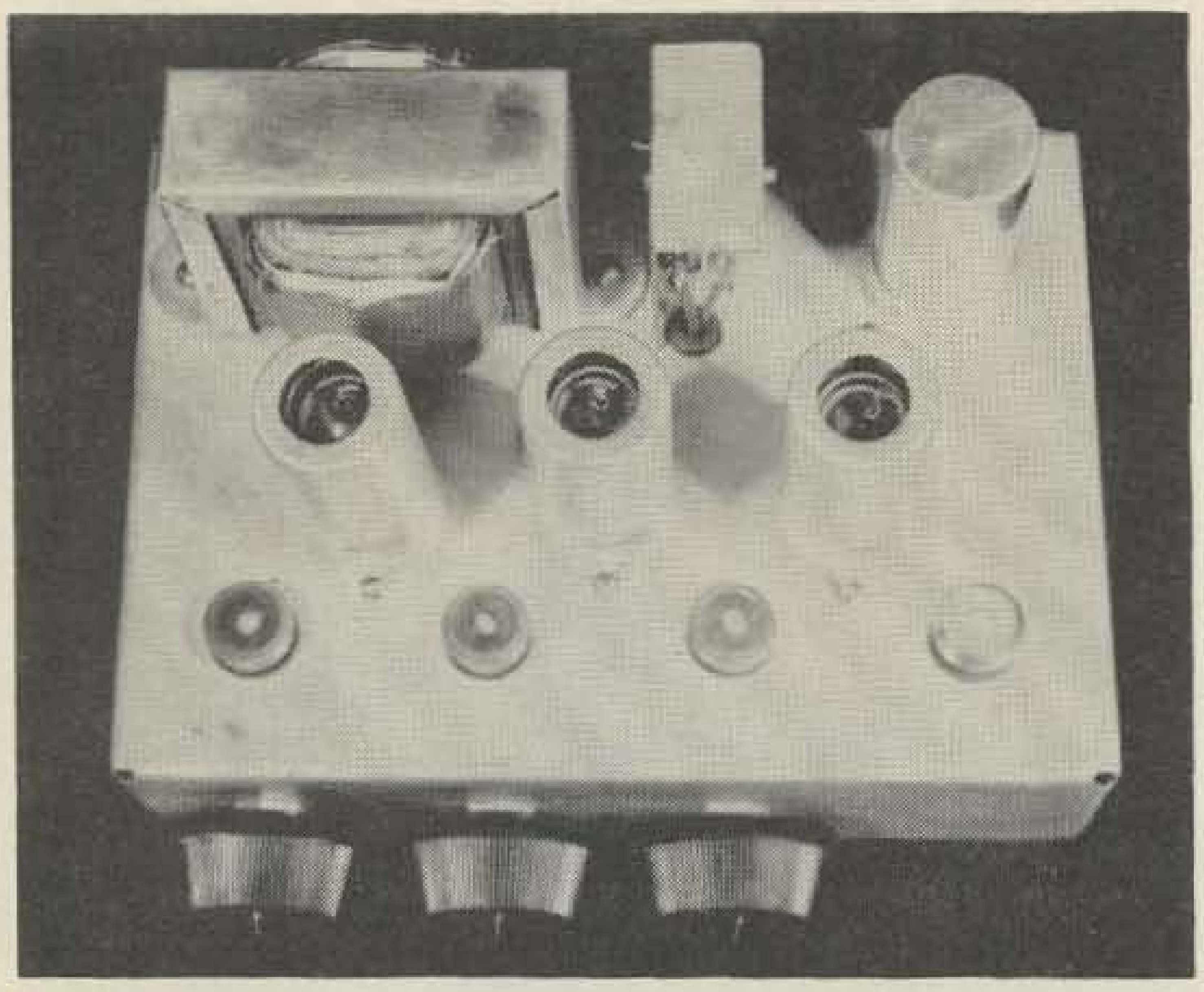

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807 Lincolnway
Valparaiso, Indiana

The pre-amp described here evolved as a result of having several transmitters on different frequencies, each with its own microphone or needing the microphone already tied to another transmitter. It was reasoned that with one pre-amp stage feeding several cathode-follower stages one microphone could be used on the operating table with each cathode-follower connected to a different transmitter. The low impedance of the cathode-follower would match the input of the two meter FM transmitter, this being one of the obsolete commercial two-way units, made obsolete by the FCC's so-called "split channel regulations." Most manufacturers of mobile two-way radios designed around the carbon

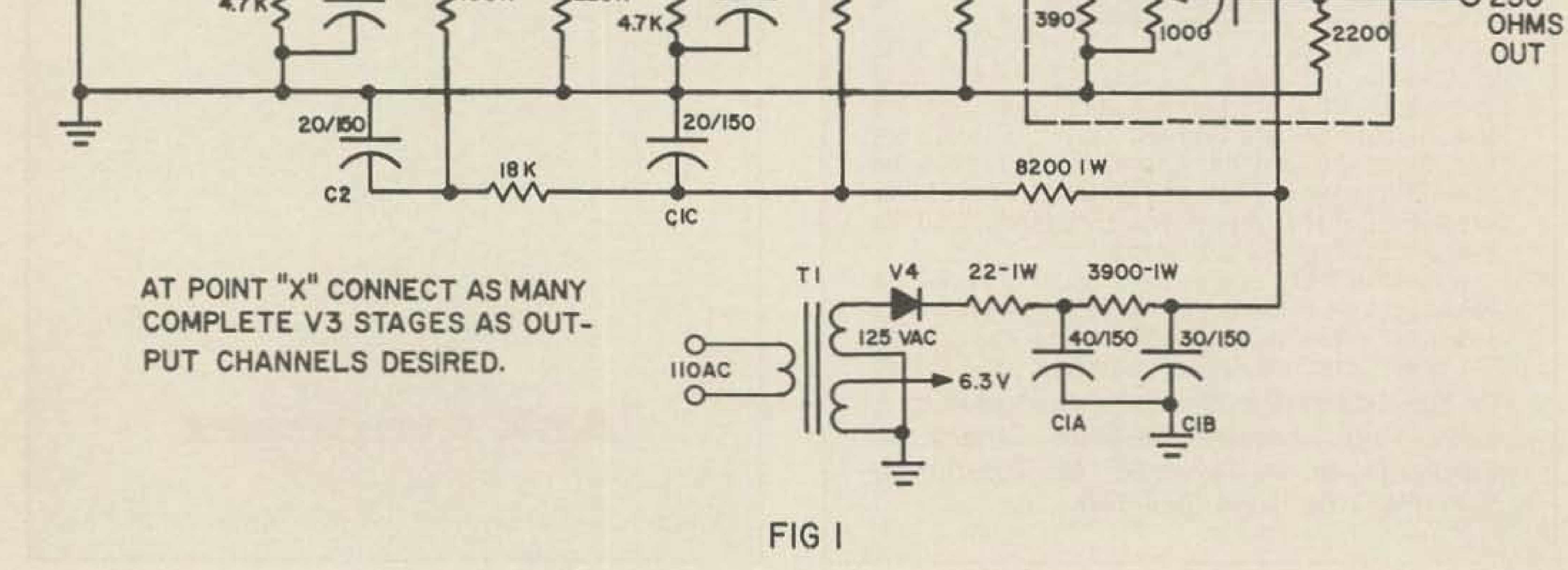
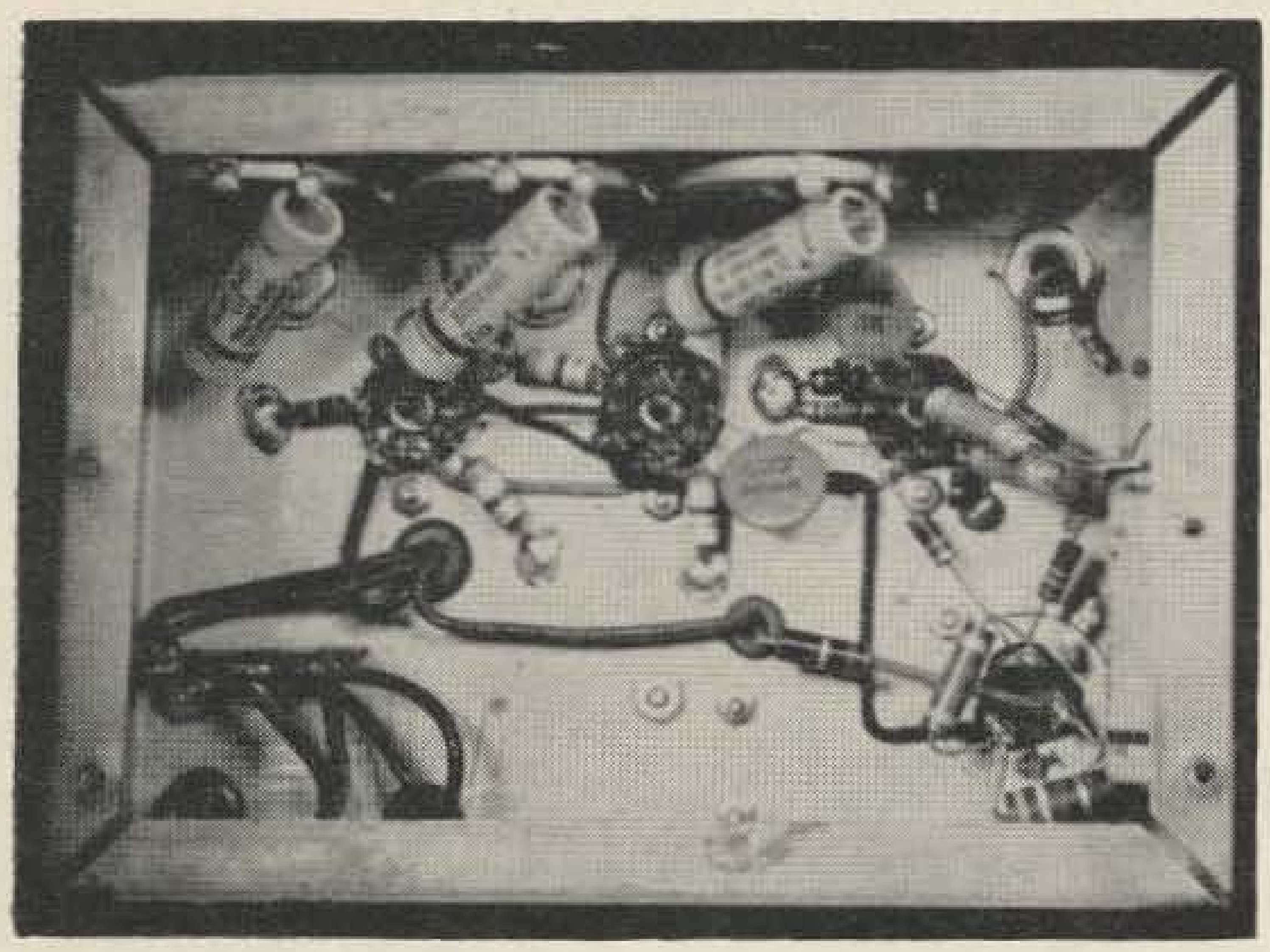


FIG I

microphone in the days prior to the transistorized dynamics now available. Also, the low impedance can be connected directly to the high impedance microphone inputs of most ham transmitters with a minimum of hum pickup problems. A word to the wise here. Use conventional shielded cables and wiring techniques when tying into any transmitter. Why ask for trouble?

The circuit and wiring of the unit is straightforward in all respects, as evidenced by the schematic and photos. The 12AX7 stages are used in conjunction with as many V3 stages as your particular application requires. The gain control in each V3 stage cathode permits adjusting the individual channel gains as required. Here, 1k pots were available so they were used in parallel with a 390 ohm to give the proper value of bias resistance. 250 ohm pots could be used if they must be purchased.



Interstage coupling was chosen to cause considerable low frequency rolloff. As shown in Fig. 2 the response is down approximately 18 dbm below the mid-frequency range. The mid-frequency output level is -8.5 dbm or approximately 0.3 volts. This level is more than adequate for transmitters previously using carbon microphones. Coupling capacitors could be changed from those shown if a different frequency response is desired. In my particular case, other operators objected to the excessive bass response in the original model. A standard input level of -50 dbm was used. Hum and noise measured 52 dbm below max output level. The transmitter audio characteristics are relied upon to give the necessary high frequency roll-off.

As noted in the schematic, no off-on switch was used. This unit is mounted under the operating table since after it is initially adjusted no further access to it is needed. It runs all the time that power is turned on to the operating table. Its very small power con-

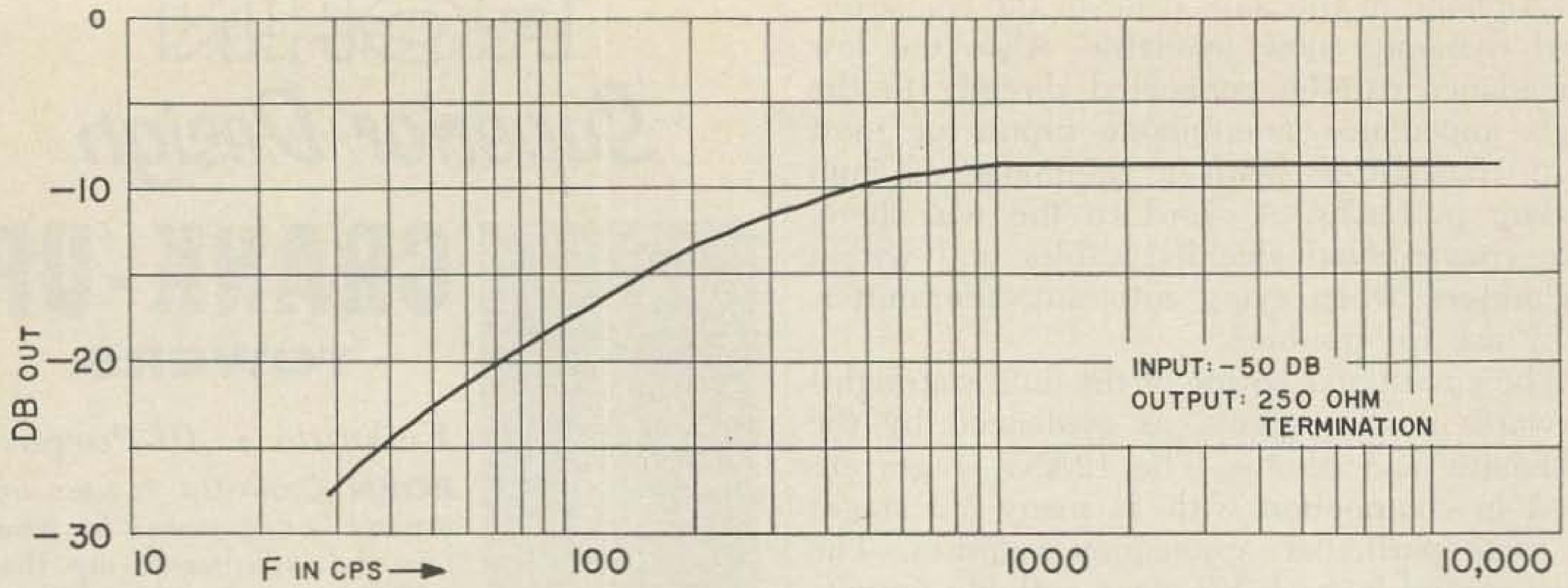


FIG. 2

sumption is negligible even if you happen to be operating CW.

The choice of power transformer, T1, will depend on how many output channels are required. Base this choice on the basis of 0.3 amps of filament for each 12AT7 or 0.15 amps of filament for each 6AB4. The 12AX7 also requires 0.3 amps. Select the transformer having adequate filament current rating.

. . . W9CWG

Parts List

All resistors are half-watt unless otherwise stated.
T1—Stancor PS-8415 or PA-8421. See text for selecting proper transformer.
V4—50 ma selenium or silicon diode
C1—40-30-20 ufd, 150 volt electrolytic
All other parts should be self explanatory.

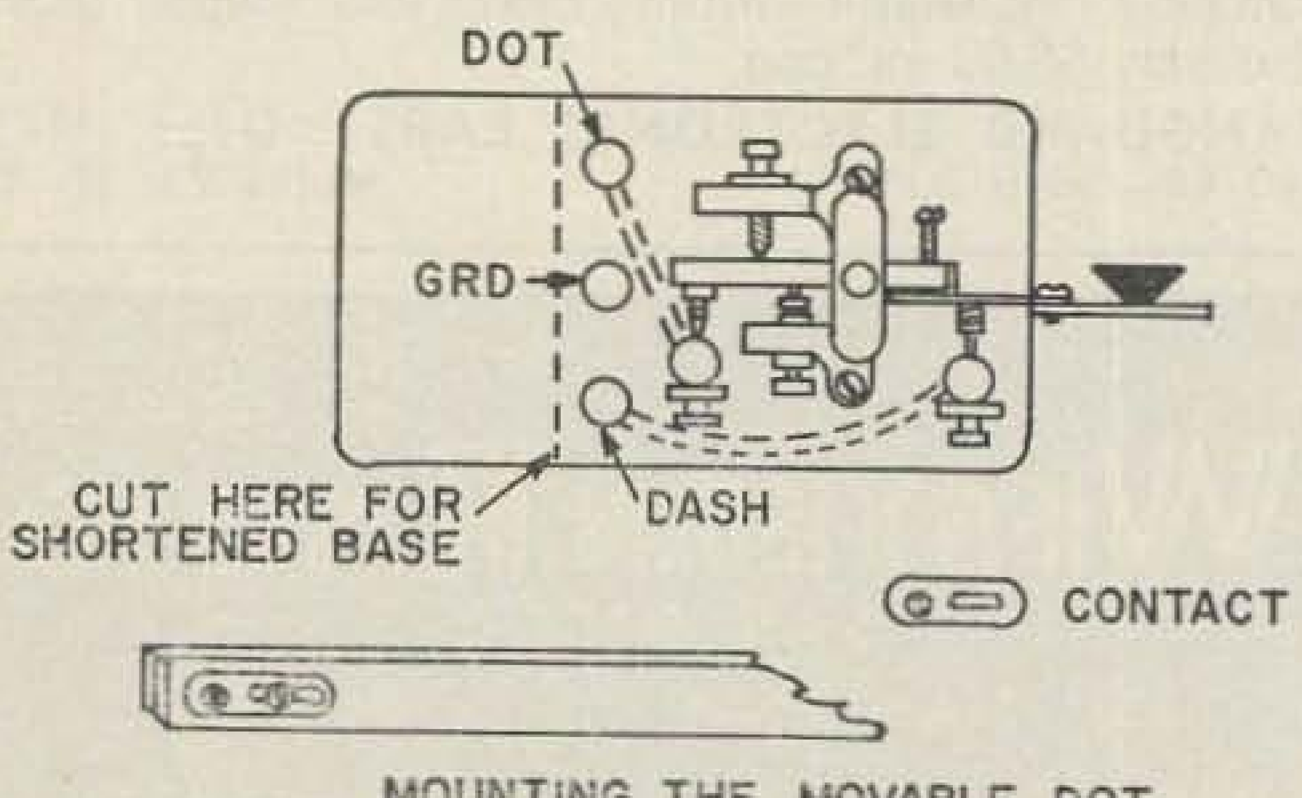
Modifications of Vibroplex Bugs

The easiest to modify for the "Do It Yourselfer" is the type of "Bug" using the solid-cast pivot housing.

The following ten step by step method is easy to accomplish with simple tools:

(1) Remove spring and vibrating arm from armature by filing the heads off of the two rivets and forcing out with a punch.

(2) Buy or fabricate a contact similar to the one used for the moveable dash contact (an old antenna relay contact is fine).



MOUNTING THE MOVABLE DOT CONTACT ON ARMATURE.

(3) Drill and tap the armature for 6-32 screw so that the contact will be as close as possible to the end of the armature on the left rear side.

(4) Cut the left hand arm of the pivot housing frame between the dot stop and the tension spring. This makes clearance for the repositioning of the stationary dot contact.

(5) Drill holes for the new stationary dot contact and for the grounded (base) binding post. (See diagram).

(6) Cut stationary dot contact support post to match the height of the dot contact on armature, mount in position with insulated sleeve and washers. Connect to insulated binding post on right side of base with short brass connecting strip under base.

(7) Mount insulated binding post in previ-

ous stationary dot contact hole. Use long connecting strip from dash contact after shaping it to clear new dot contact mounting screw.

(8) Mount uninsulated binding post between insulated dot and dash bp. Clean top and bottom of base down to bare metal and use star lockwasher for good electrical contact.

(9) If desired cut base behind binding posts and re-mount rear rubber foot.

(10) Total cost: 1 contact $.25, one binding post $.25.

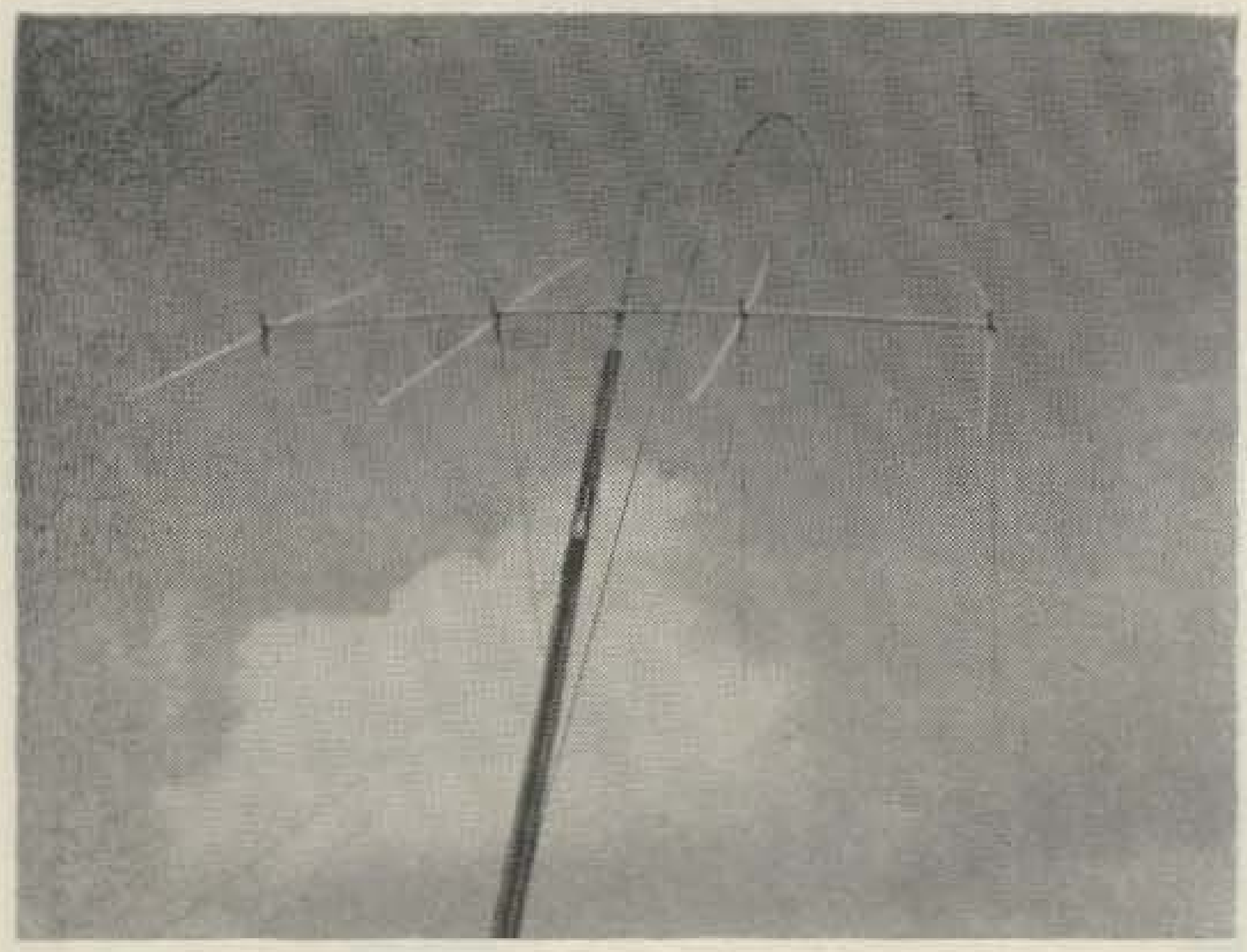
. . . W2CDJ

more use for the Knockout Punch

Many users of screw actuated, knockout punches may not be aware of their utility in cutting plastic and fiber material. Such punches are widely used for metal chassis work but their use often stops there.

Some insulation material, such as laminated Bakelite, is especially processed for superior punching characteristics. Printed circuit stock is a good example of this. Try a sample hole in a piece of scrap first. Some plastics, such as Lucite, will not punch without cracking while others will cut cleanly. Masonite hardboard, in both the ⅛" and ¼" thicknesses, cuts nicely.

Give it a try. The punches work well with most materials. One word of warning: Be careful with small pieces of thin work. If there is insufficient material around the hole, the beveled cutting edge of the punch may bend and crack the more brittle plastics. . . . W4WKM



David Traer W4AZK
P.O. Box 215
Naples, Florida

A Challenge to the Antenna Experimenter

This very controversial subject will be dealt with here, not so much from the technical angle but on practical operating results produced, the methods of achievement, mechanical structures and other odd bits of observations that may well be utilized by the quad experimenter.

Many years back questions arose as to "What is a quad?" "How does it operate?" Not having an antenna testing range nor other such technical equipment, I set out to learn as much as possible about quad operation under practical operating conditions. Results had to be obtained with equipment that could be found around most any ham shack and with the meager information found in other writings.

A small quad was built in the vicinity of 90 mc. This set up was about eight feet off ground and some surprising results were obtained. Two similar closed square loop elements were made, using .25 wave lengths per side, and spaced .2 wave lengths apart. A grid dip oscillator was coupled at the center of the bottom horizontal section. An FM tuner was set up several wave lengths away tuned to the resonant frequency of this driven element. The general method of tuning the reflector with a small stub was used by turning the reflector toward the FM receiving antenna and tuning for minimum signal. The usual results were obtained with a minimum backlobe and very sharp deep side nulls.

Then, laying out the current distribution around the quad on paper, lead to the theory that two two-element yagis stacked one-quarter wave lengths apart and fed in phase should produce the same results. These two stacked yagis were found already available in the quad itself except the one-eighth wave length on each end of the top sections were bent down to meet the one-eighth wave ends of the bottom sections bent up, thereby voltage feeding the upper section in phase.

Insulators were then put in the center of each side of the quad on both reflector and driven element. (Fig. 1) Also, an insulator was placed in the center of the upper section. A transposed quarter wave open line was run from the feed point to the center of the upper section where the insulator had just been placed. This configuration gave the approximate results of the quad configuration but required more material and left no easy method of tuning the reflector or driven element. Sufficient power was supplied to the feed

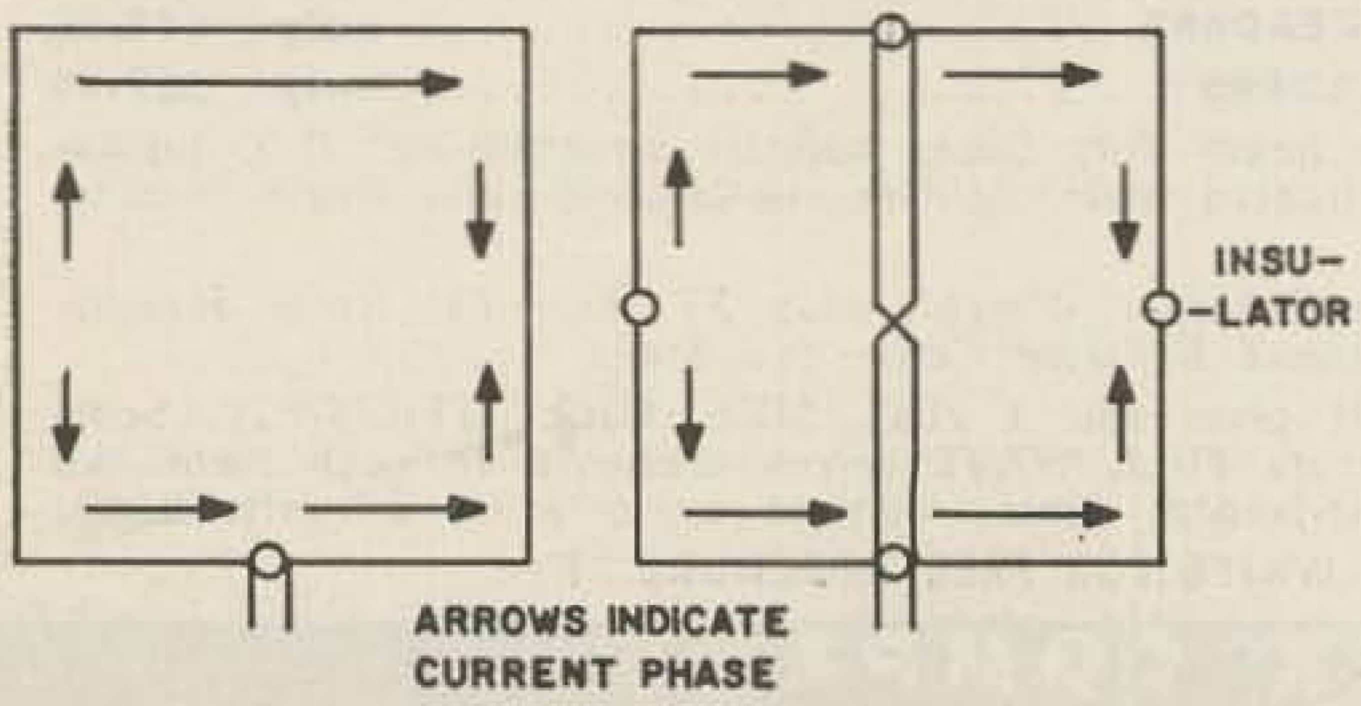


FIG I

point so that a neon bulb would light at the side ends of the driven element. As the bulb was moved up or down toward the center of the upper or lower section of the driven element, it would extinguish itself. An rf galvanometer confirmed the neon light conditions.

Because of the difficulty of tuning the director and reflector using this configuration, tests were made on the simple closed loop of the quad configuration with the same results thus showing that the high voltage points were on each side of the quad and the high current points at the center of the upper and lower elements. This experiment was to satisfy myself of a theory that had already been proven in previous antenna articles, and the satisfaction of knowing that the quad could be treated as a stacked yagi array.

Primitive methods? Yes, but still a beginning of practical application. Basically the quad is horizontally polarized unless fed at one side. The diamond configuration was not tried because it appeared from the current distribution that the side null would not be as complete. However, experiments by others have confirmed there is no difference in operation of the diamond configuration.

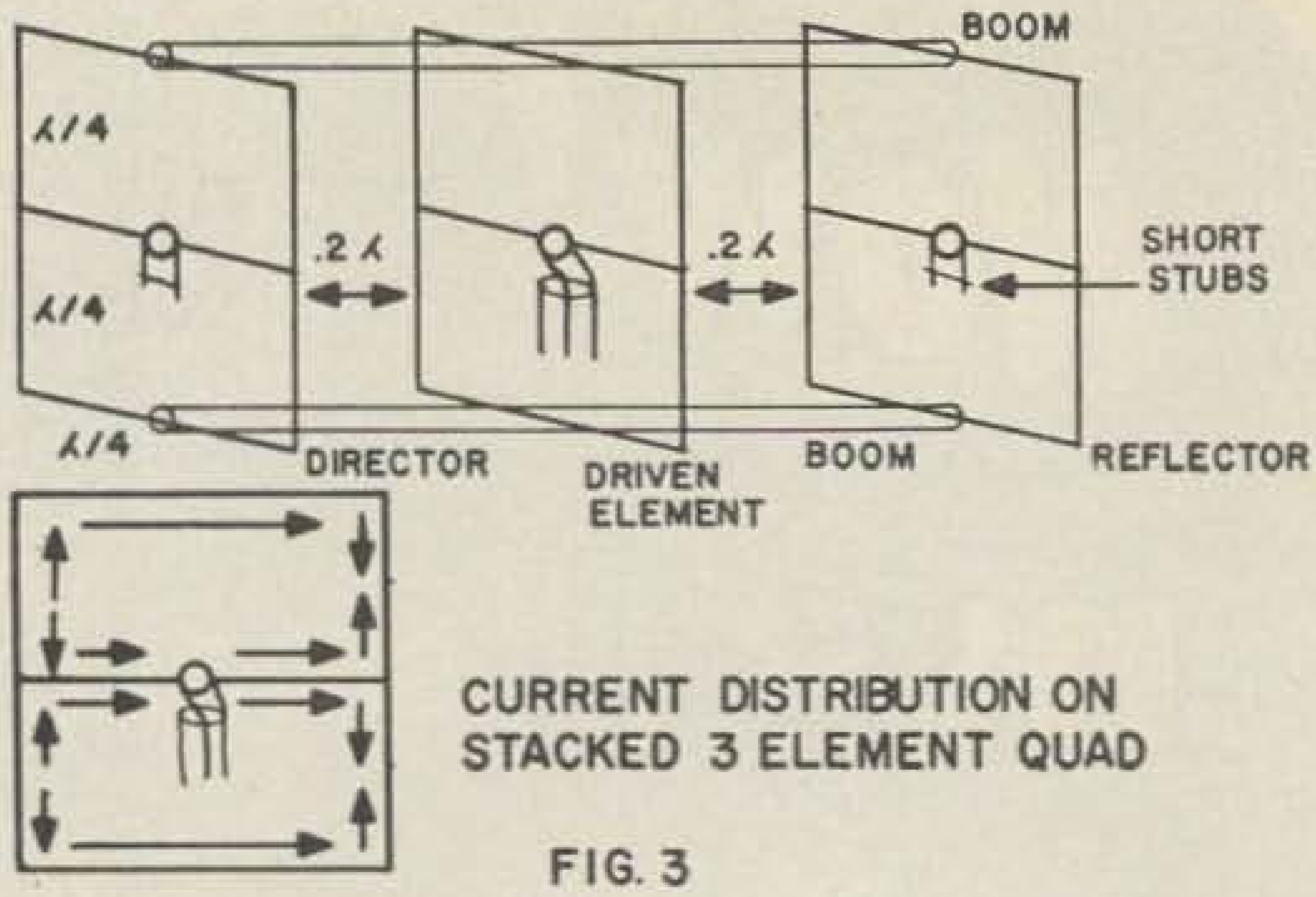


FIG. 3

Now came the time to try the full sized ham band models. The tri-band quad being in vogue with separate transmission lines used for the three different impedances for the three different bands didn't look good from this point of view. After several trys a simple spider and tri-band quad was designed (Fig. 2) so that all three bands would have the same percentage spacing. That is, .15 wave length on each band. This spider type of con-

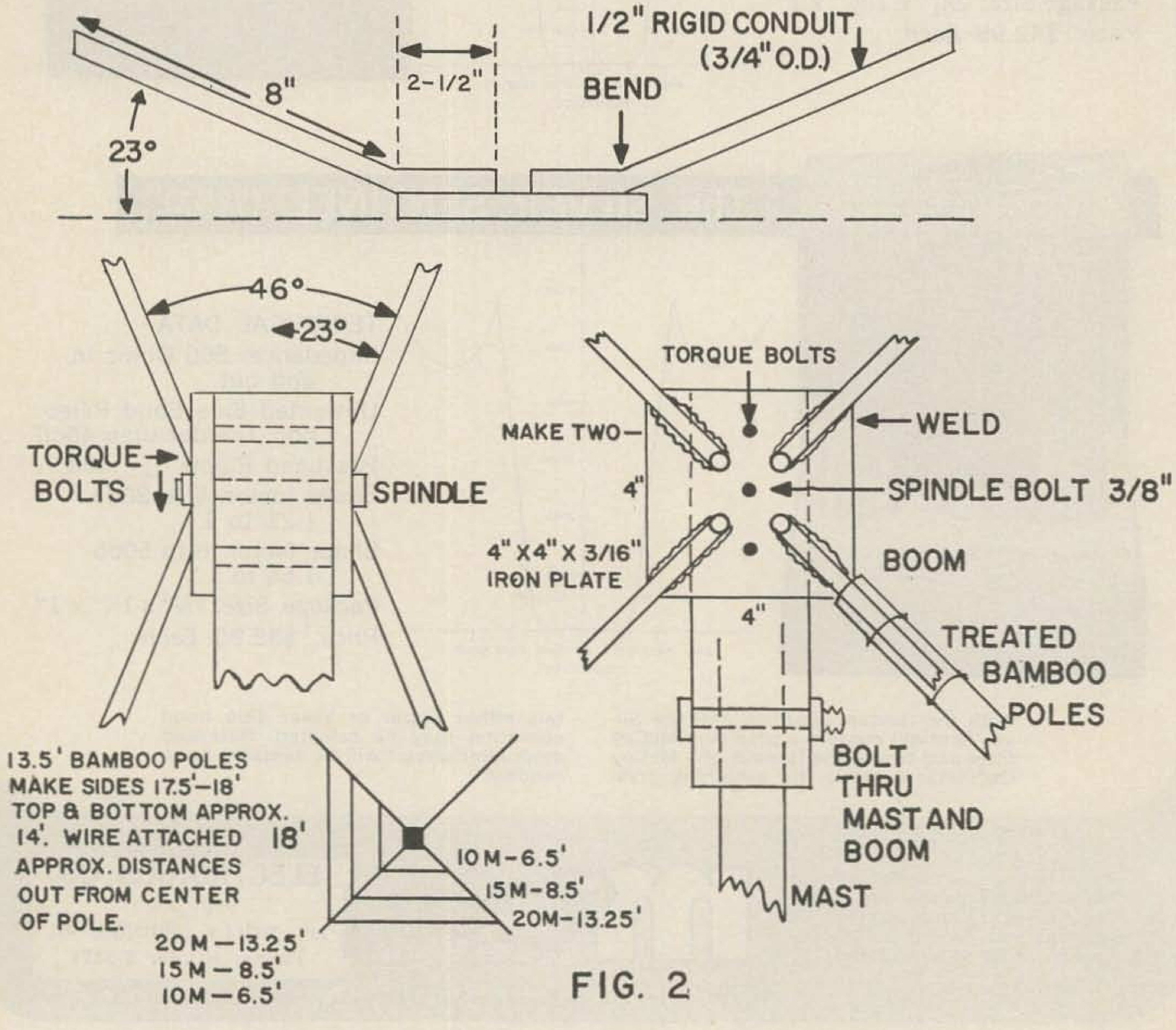


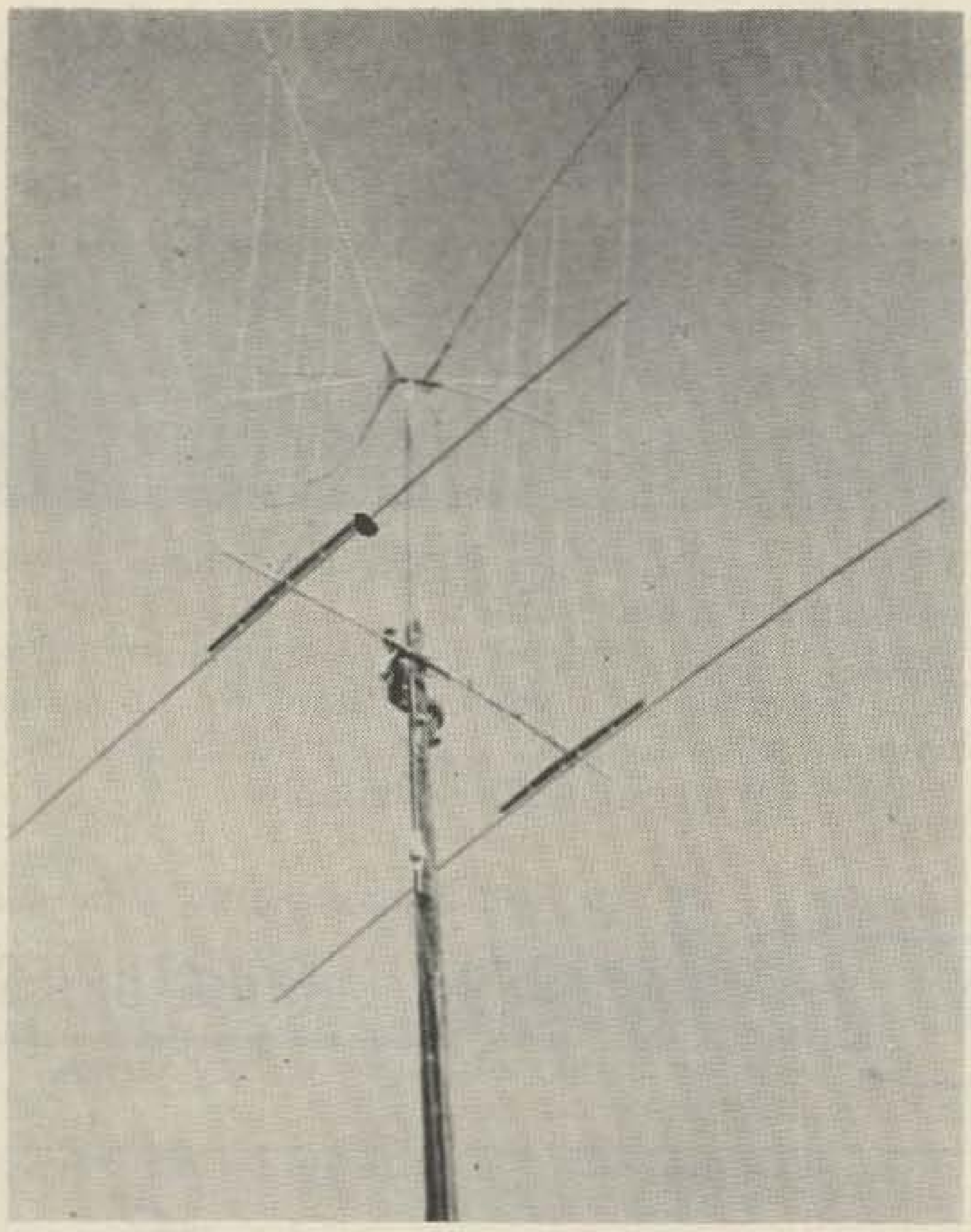
FIG. 2

struction at a heighth of twenty feet withstood 170 miles per hour winds during Hurricane Donna. Impedance measurements showed all three bands to be within a few ohms of 60, also that the spider angle design would allow additional quad elements up to 144 mc on the same spider.

The driven elements of the 10-15 and 20 meter bands were all paralleled at the feed point with no change of impedance because of the parallel arrangement. Measuring the driven elements, either singly or in parallel, the three bands showed very close to the same impedance.

A 52 ohm coax feed line was used and SWR measurements showed extremely broad banding on all three bands, ten meters going the highest of 1 to 3.7 at 30 mc at a design frequency of 28.7 mc.

Hours were spent with a fellow ham about four miles away to properly tune the reflector stubs on all bands. This, however, was not to be as critical an adjustment as at first thought. Of course, for maximum gain at a single frequency this adjustment would be critical. Depending upon the portion of the band for single frequency use, this could tune the reflector within the band thereby causing the driven and reflector elements to become both resonant at some other frequency making the beam become bi-directional. The method of tuning, explained later, eliminates this possibility with negligible loss in gain. This triband quad (actually five bands as six and two meter elements were added to the 10-15 and 20 with a single additional transmission line)



The "Box Kite." This took 175 mph winds down at 20 ft.

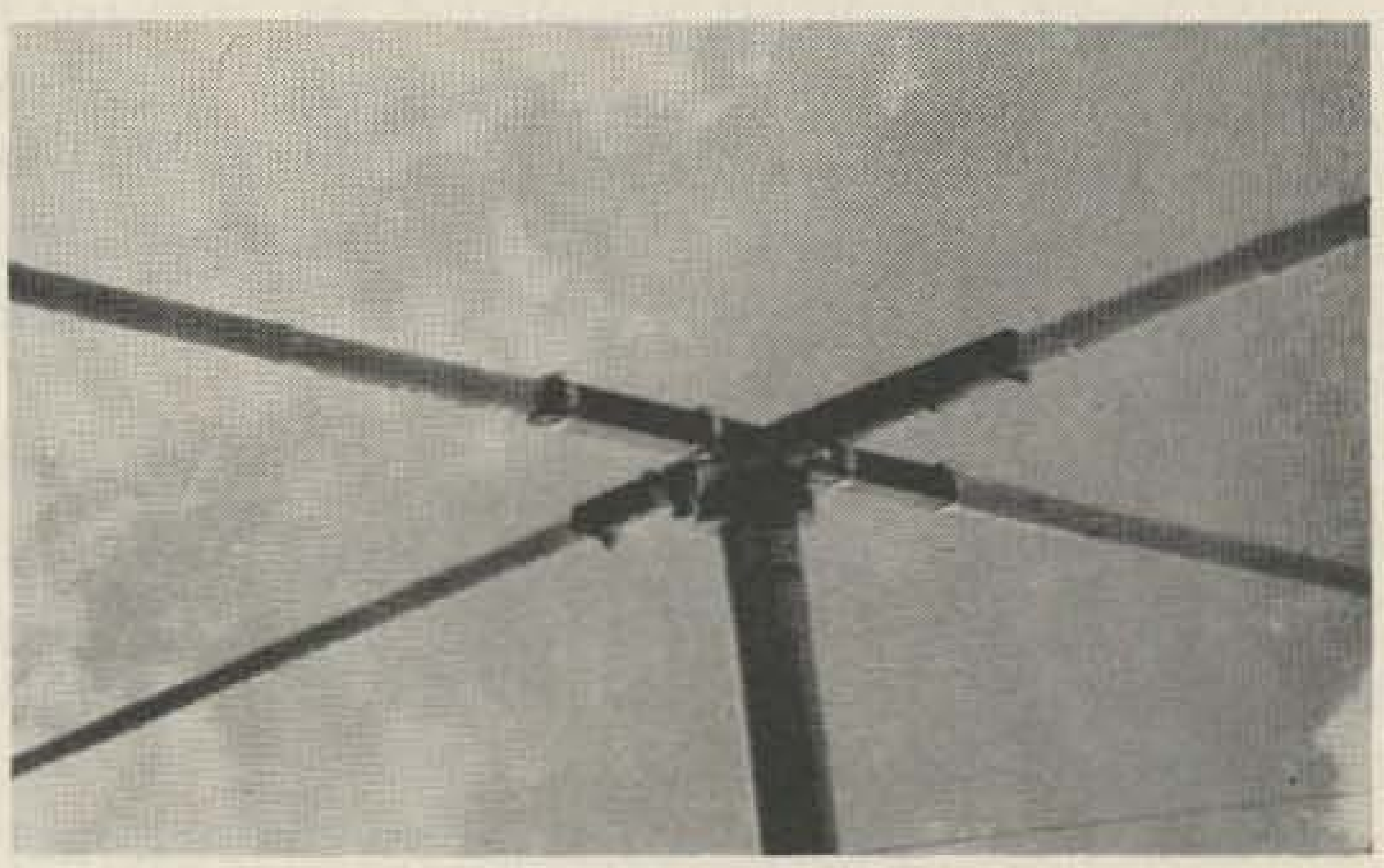
was operated for two years and compared against a manufactured medium spaced trap tribander with far better average DX reports from the quad.

On local station's signals little difference of strength was noticed. The quad would receive DX signals earlier and stay in longer than the comparison antenna. This observation may be due to the quad's automatic heighth adjustment of up to one-quarter wave between the lower and upper horizontal quad elements which possibly could be accomplished if it were possible to instantly lower or raise a yagi the same amount during skip changes.

Next, a three element quad was constructed on a twenty foot boom but was quickly discarded, only because a proper allowance could not be made for the driven element to swing around the 55 foot pole that was used for a tower. Initial tests, however, did prove promising, as this was used for a few months with a decided improvement in general overall signal strength over the long path.

Further development on the quad was temporarily interrupted for experiments with a stacked three element quad for FM reception. Our local broadcast station had been using an eight wave length per leg terminated rhombic antenna pointed to Miami for FM rebroadcast as part of the Florida hurricane network. It became necessary to pick up FM stations in more than the one direction. Fig. 3 shows a stacked three element quad which gave an excellent account of itself, not so much in gain over the rhombic, but in less fading, which is so prevalent on FM signals in this location. These FM quad results confirmed our faith in the theory and gain of a multi element quad.

Next, the commercially built tri-band three element yagi was raised again for further comparative tests. This time with its sixteen foot boom extended to twenty-six feet and two full size fourth elements added for fifteen and twenty meters. This was the first yagi beam used here that gave any indication of equalling or out performing the two element quad tribander and seemed as though it might be the ultimate for this location as a heighth of 55 feet is the maximum that can be used here. Wonderful results were obtained during the ARRL DX contest. However, with the "Long Johns" starting to increase in number around the States on towers with heights up to 140 feet, it became necessary to start something new. A five element yagi or a four element quad? The quad was chosen for further tests to maintain a "big signal." The four elements of the quad would mount properly, perfectly and very simply on a thirty foot boom and no difficulty would be encountered in turning the elements around the pole. The ten foot spacing between



Construction of spiders, four element quad.

elements gave plenty of clearance.

Fig. 4 shows the simple mechanical construction. The problem: How do you go about tuning the four element quad? Previous experience had proven one point; the closed quad loop as director or reflector was not as critical in tuning as was first supposed. Over a period of time a formula has been derived for element lengths that had met with all other previous requirements. These are somewhat longer than other published lengths to allow plenty to *cut off* rather than to *add on*. Stub lengths are never left more than approximately eight inches long. After initial resonating, should a longer stub be left, take out this portion of the stub by adding the excess stub wire to the perimeter of the square.

The driven element is equal to 996/FMC. Reflector is equal to 1,044/FMC. Director was equal to 946/FMC.

Electricians' "bugs" are used to hold the stub connectors and any other connections, then sprayed with Krylon to prevent corrosion. With no transmission line connected, but with the loop closed, the driven element is grid dipped to about 50 kc lower in frequency than the desired design frequency. The reflector is grid dipped to outside the low end of 20 meters to approximately 13.5 to 13.8 mc. The first director was grid dipped to outside the high end of 20 meters to approximately 14.4 mc and the second director resonated to approximately 14.4 to 14.45 mc. Resonating the parasitic elements outside the band prevents any possibility of the beam becoming bidirectional with little loss of forward gain and F/B ratio.

These adjustments were made with the boom about 20 feet off the ground. The lower sections were easily reached on a step ladder. Making adjustments at this low height requires resonating the elements approximately 50 kc lower than the design frequency as when raised to operating heighth (40-60 feet), the resonant frequency is raised about 50 kc or more.

The impedance measured about 38 ohms, a little low for 52 ohms,—but read on—when raised to 55 feet the SWR was almost flat from 14.0 to 14.350 mc!

This broad banding effect on the SWR was obtained with a beam impedance some 25% or more lower than the feed line impedance. Note that the SWR does not fall to unity at any given frequency, but that there is a general overall broad banding which proves much better than the unity at center of band and 4 or 5 to 1 SWR at either end of the band. (See G4ZU article CQ November 1959 page 67.)

Tests on front to back ratio naturally would

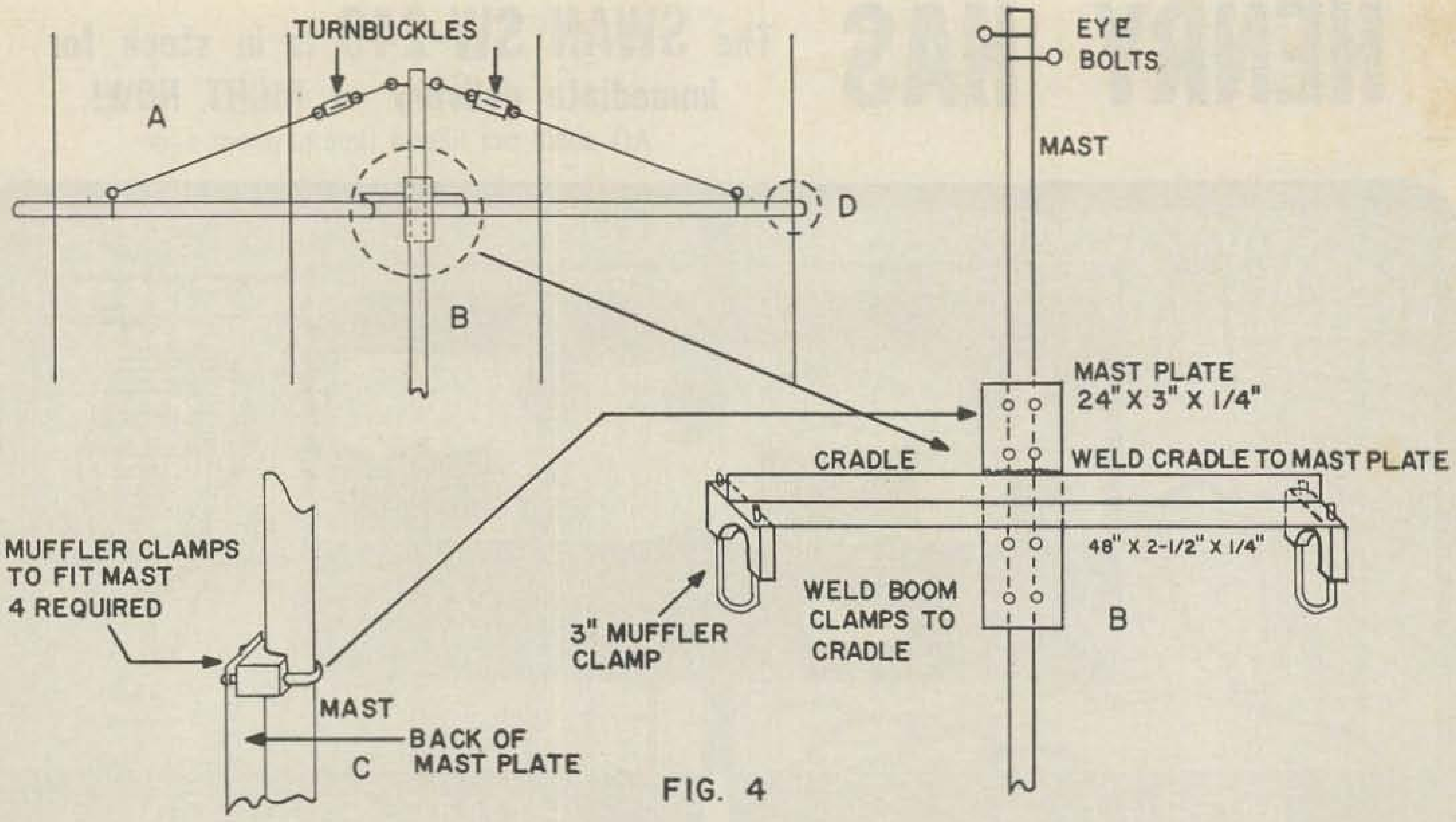


FIG. 4

be variable as with any beam antenna, depending upon the conditions at that time. Safely, the four element quad has 23 to 35 db front to back ratio. The forward gain showed 12 to 14 db over a dipole erected at the same height for test purposes. Of course, under some conditions of back scatter these figures are somewhat lower. The greatest gain is apparently on some lower vertical angle. Our tests methods did not include vertical angle measurements. However, a 2 S unit gain over a dipole is not to be sneezed at.

It is true that many yagi type beams show 10 db or more gain, but when it comes to getting a db or more, the average ham disregards this. "Well, it won't show up on the S meter." True, but has it ever been noticed that the "big signals" get to the Dx'er (who may not even have an S meter other than his own two ears) by a margin of only one-half of an S unit or less over the gang in a pile up? (3 db gain is enough for a noticeable change to the ear). How this apparent additional gain is achieved is not fully understood.

A further experiment with the four element quad was to operate two of the elements on 40 meters. The method used was stub switching.

The characteristics exhibited by transmission line segments as can be obtained from most any handbook, show that a half wave section of transmission line at a given frequency shorted at one end will exhibit the same impedance at the opposite end. That is zero or shorted regardless of the characteristic impedance of the transmission line. This property, coupled with the fact that a similar line one quarter wave length at a given frequency shorted at one end offers an infinite impedance at the opposite or shorted end. Thus, the same stub at 14,200 kc will offer a short opposite the shorted end, but at 7,100 kc will exhibit an infinite impedance or insulator opposite the shorted end. When this principle applied to

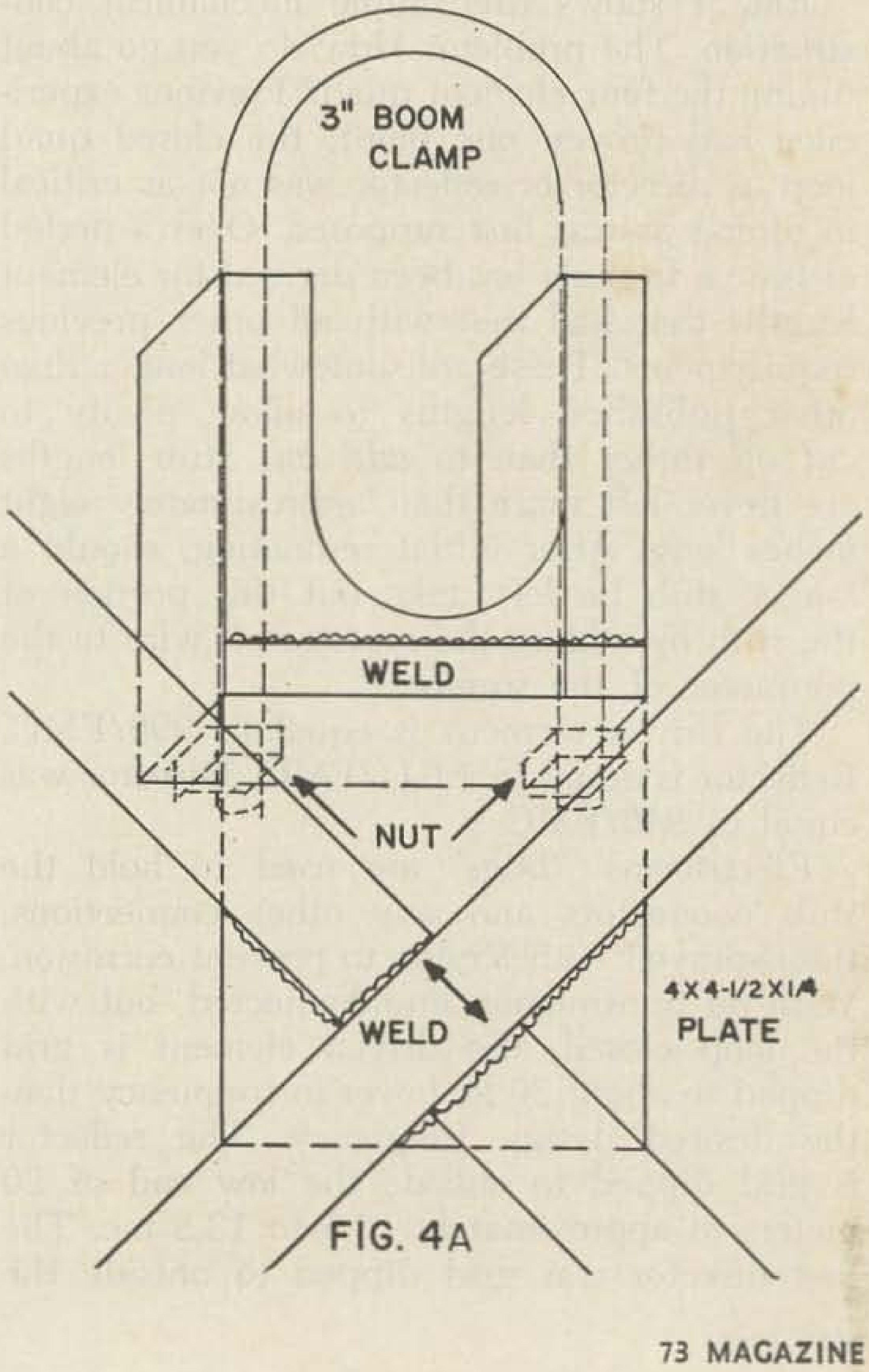


FIG. 4A

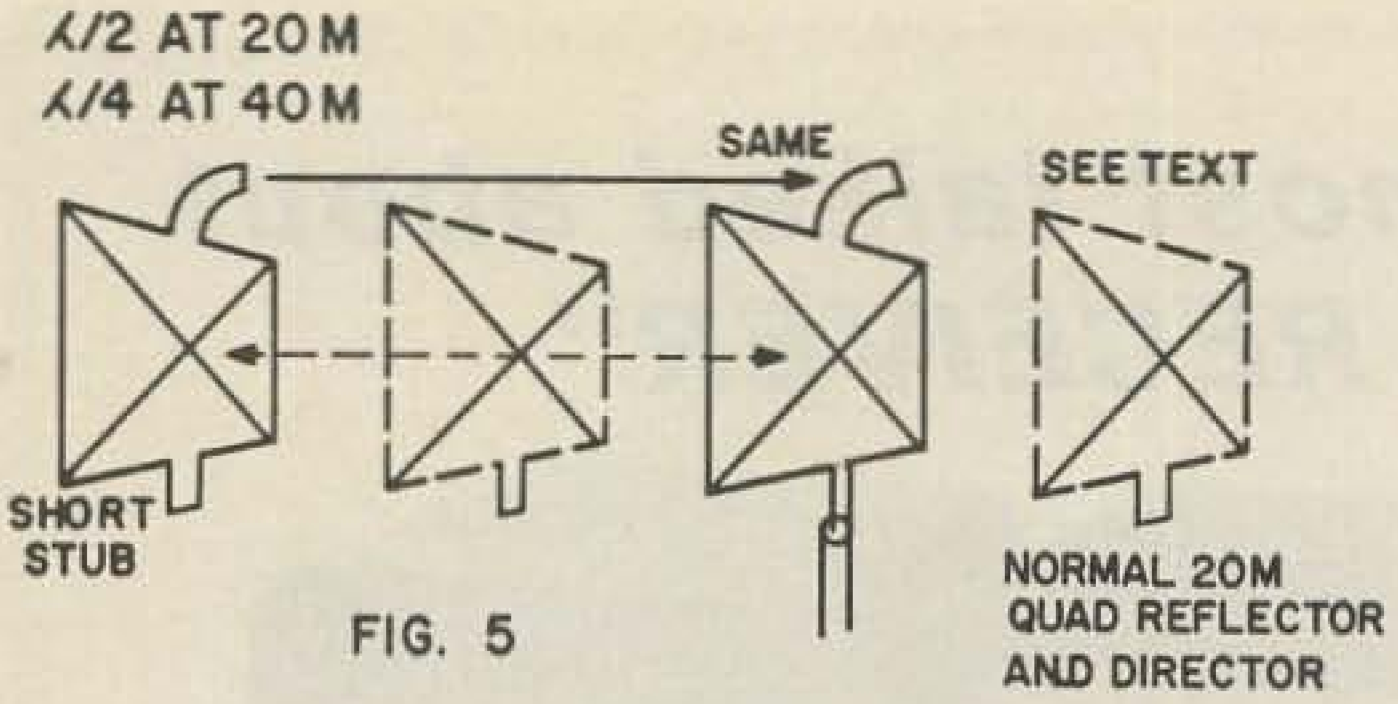


FIG. 5

two of the elements of the four element quad as shown in Fig. 5, it becomes possible to have a two element 40 meter parasitic beam with one-half wave elements folded in the shape of a square. These stubs had absolutely no affect on the 20 meter quad operation.

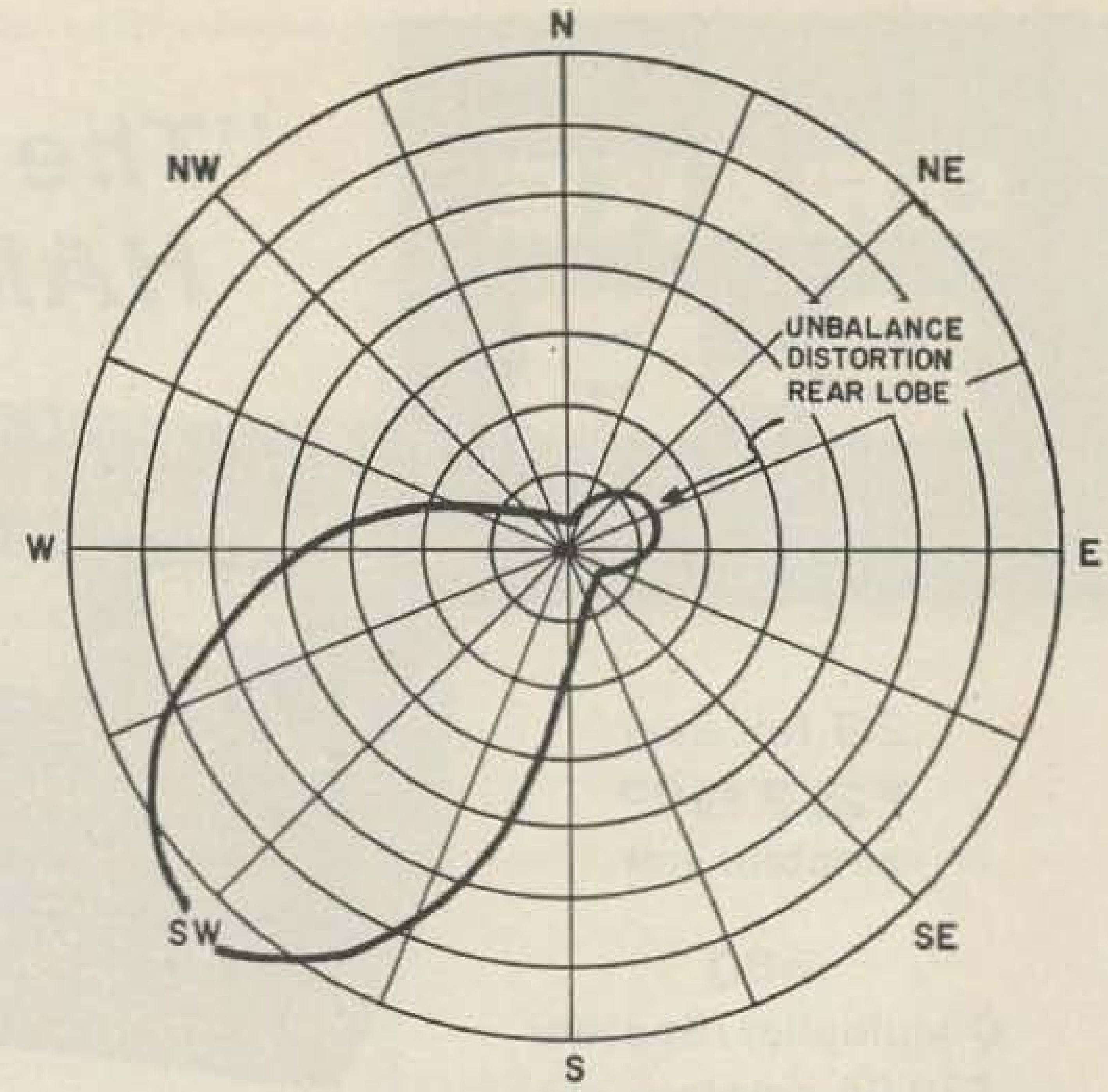
At this writing no further adjustments have yet been made to improve the operation of the 40 meter elements which do exhibit some directivity but with little front to back ratio.

Time has not permitted further experiments along this line but one wishing to have a four element 20 meter quad and a 40 meter beam antenna with the same transmission line and no relays or switches, this may be worth further investigation. Fig. 5 shows how the stubs are attached. It must be noted, however, that the word "beam" was used as it has been "sweatfully" learned that a so-called shortened quad with loading coils or stubs will take a load and show some directional properties, but with anything less than one quarter wave spacing between upper and lower and/or side to side wires the arrangement looses the quad characteristics.

Some readers may have noticed the unbalanced method of feeding the quad directly with the coaxial cable. Various horizontal pattern measurements have been made and in each, only the small rear lobe is partially distorted with no effect on the forward lobe. This was a very minor consequence from this point of view. Of course, a balun or gamma match could be used to rectify this situation and again one may refer to most any handbook.

Reversing the coax leads will, of course, reverse the slight distortion of the pattern on the rear lobe.

The final outcome of these quad experiments has been very gratifying. The signal from here has been greatly improved from

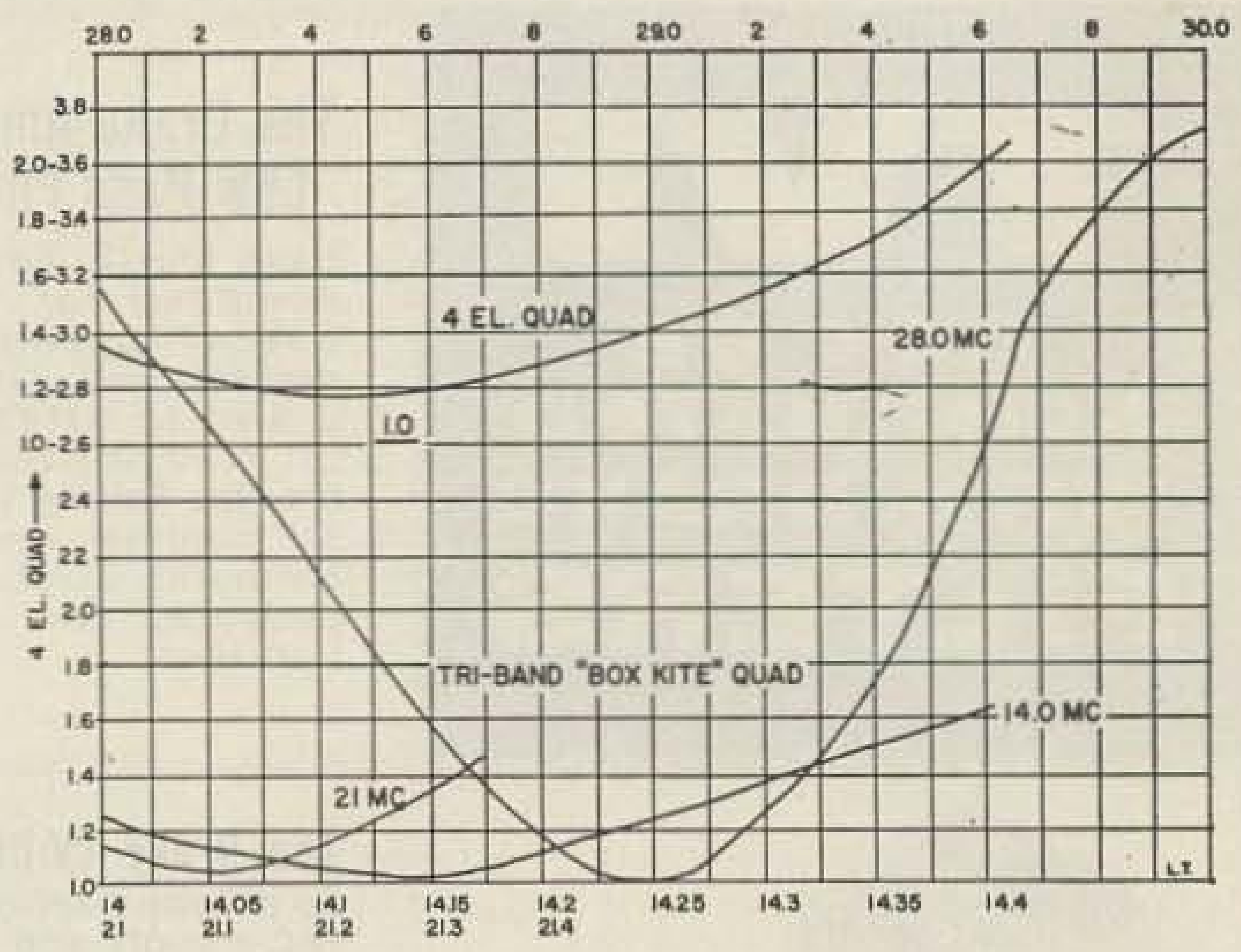


2 EL. QUAD TRI-BAND 14.1 MC 40 FT.

over the past few years and those with an experimental nature will find numerous new features in the antenna field within which to explore.

Experiments are now under way on a full sized dual band four element quad for 40; 20 and 15 meters. Gain figure for 15 meters should exceed 15 db and 8 db on 40 meters.

For invaluable help on tests over long and



short paths it is gratefully acknowledged of Reeve K4AW, Walt the late K5JLO in New Orleans, Jim VK6SA and Lambert ZS6IF. Locally to Armon K4FOM, Frank K4YPA, John K4UGE and others who graciously gave of time and energy. . . . W4AZK

LETTERS

Dear Wayne:

I would like to point out an error in the schematic of my article, "Building a 6 & 2 meter portable." (March, Page 33) The Ant. connector, switch S1-A, relay K1-A and K1-B, all are connected with coax, and the shield is grounded, not the center conductor as shown.

Also it should be noted that coil L1 is tapped 1/3 the way up from ground for the Ant. connection.

A very limited supply of the mmfd 27 mmfd variable, can be obtained by sending $1.59 to "Red" Johnson Electronics, 3311 Park Blvd., Palo Alto, Calif.

. . . Richard Juengel K8KDX16

PHL Revisited

Gentlemen:

I would like to comment on Fred Doughty's article "Double Sideband" in the Feb. '63 issue. I have long been a supporter and booster of DSB and concur with Fred's excellent comparison of modulation systems. However, to be fair about things, I think it should be pointed out that these comparisons are only valid when the final stage is coupled directly to the antenna. When, as is customary, the signal generated is amplified by a linear amplifier many of the advantages described are lost. This is particularly true of power in for power out comparisons. It is significant that even with the "linear equalizer" in the system we still have two sidebands for the receiver to select with DSB. Further, one point that seems to have been overlooked is the ease of bandswitching with DSB as compared to SSB. How about some expert coming up with plans for a good high power DSB transmitter with modulation applied at the final stage so that the "lazy linear" can be discarded?

W. E. English KØDLF/I1DFB

Dear Wayne,

In your capacity as editor of 73 how did the article by W3PHL in Feb. '63 on DSB ever get by your editing and appear in the Mag. It is the biggest bunch of garbage I have ever heard. It is untrue, contradictory all the way through and nothing but a bunch of doubletalk. Its proper place should have been for an April fool joke.

John Badali WA2VME

Att. Wayne Green Editor??

I have been a ham for 36 years and I have never seen any article published as stupid as the one you published by W3PHL. I will not spend any more money for your magazine.

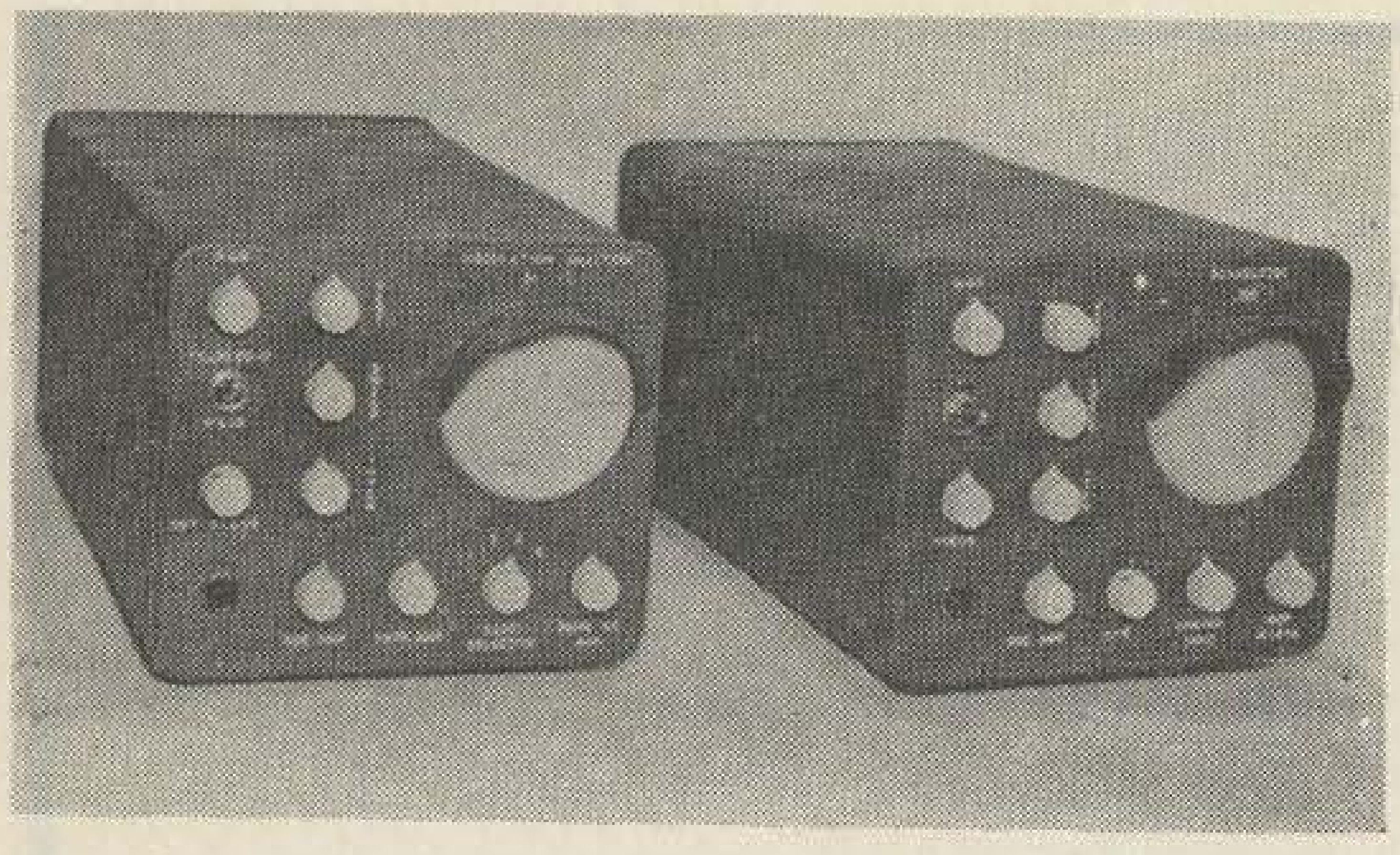
G. V. Lichtenfels W3AQT

Dear Wayne,

I enjoyed the thoroughly informative article by Fred Doughty W3PHL on the subject of double sideband.

Dick Genaille K4ZGM

F M
FREQUENCIES
52.525 mc
146.94 mc



Denys Fredrickson WφBMW
3923 East Funston
Wichita 18, Kansas

Panoramic Spectrum Analyzer

HAVE YOU EVER wondered how congested the band was on either side of the frequency to which you were listening? Is there a hole in the QRM for one to which to QSY? Should one QSY up or down? How far should one QSY? When he did QSY, where did he go? How close am I to the edge of the band? How can one zero beat or check for splatter without changing the receiver dial? Does the received signal have carrier shift? These are but a few of the questions that can be answered by building this unique and easy to operate panadaptor. It is also a tremendous aid in chasing DX and for net operation.

The Panadaptor was designed and built as a twin to the Modulation Analyzer[1]. The same size chassis and case were used. The *if* and sweep circuits are similar to those in the "Snooper' built by W7HEA[2]. The components are all available commercially which eliminates reworking surplus gear which many times is difficult to obtain.

The signal input to the panadaptor is obtained from the first or second conversion stage in the receiver. Although connecting to the first stage will allow a greater bandwidth to be observed, the writer used the second stage because of convenience. A satisfactory bandwidth of 70 kc was obtained.

Circuit

The first consideration should be the signal from the receiver because the input of the panadaptor will have to match the frequency obtained from the receiver. The Panadaptor rf input transformers were stagger tuned to obtain the best linearity and bandwidth as possible.

The mixer-oscillator was tuned to a frequency of 630 kc so when mixed with the 455 kc signal from the receiver, the mixer-oscillator output frequency will be the panadapter *if* frequency of 175 kc. A different rf input and/or panadaptor *if* frequency may be used if desired by changing the transformers and/or retuning the mixer-oscillator to produce the desired *if* frequency.

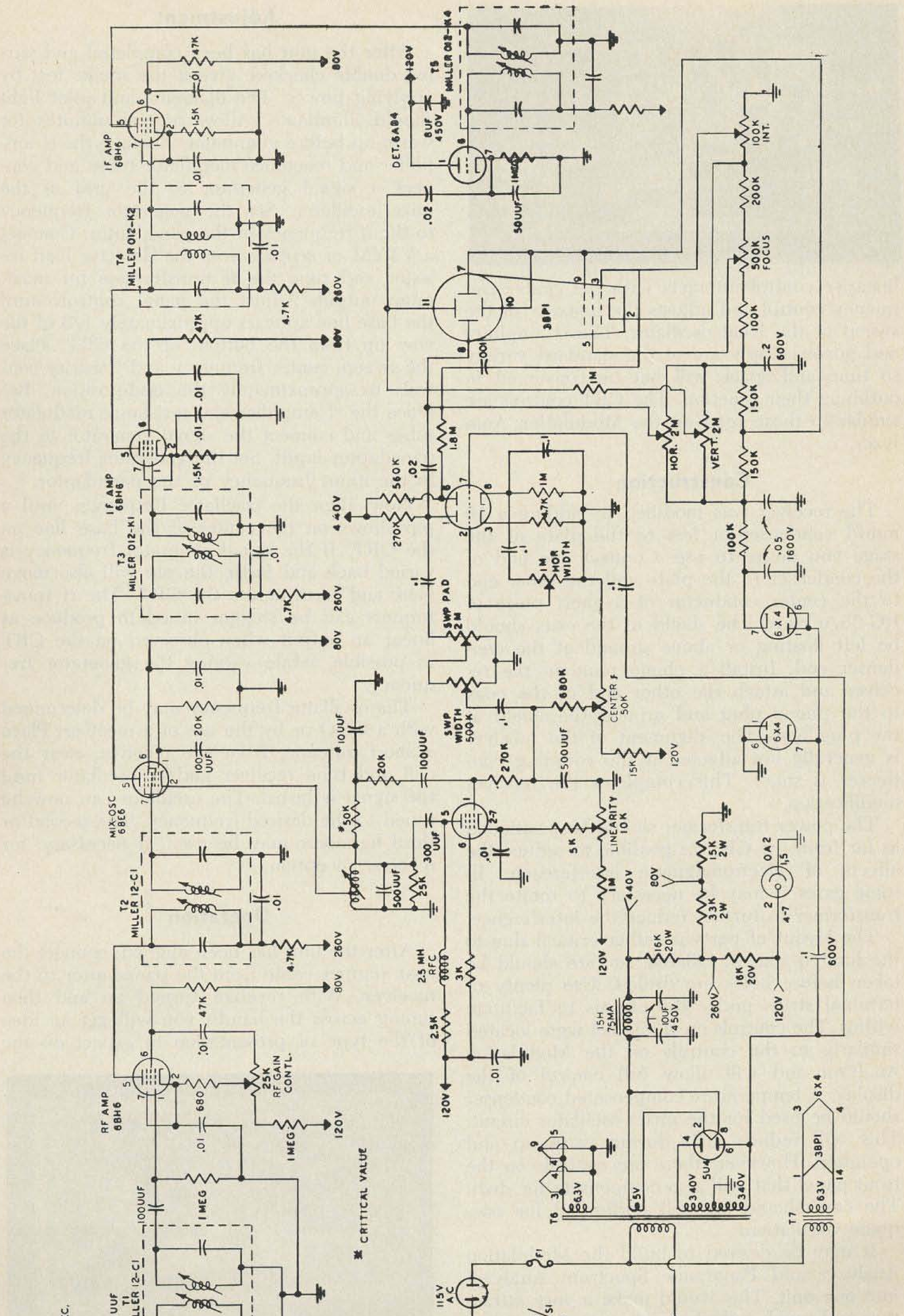
A 6AK5 reactance modulator is used to sweep the spectrum on each side of the center frequency by varying the reactance of the oscillator circuit which causes the oscillator frequency to change. The 50K resistor and 10 mmfd capacitor in the reactance modulator and oscillator circuit are somewhat critical for proper reactance tube and oscillator operation.

A question may arise concerning the 1 meg resistor which is connected between the rf gain control and B plus. This little device will allow a smoother and broader control of the gain rather than have it all bunched up on one end of the control.

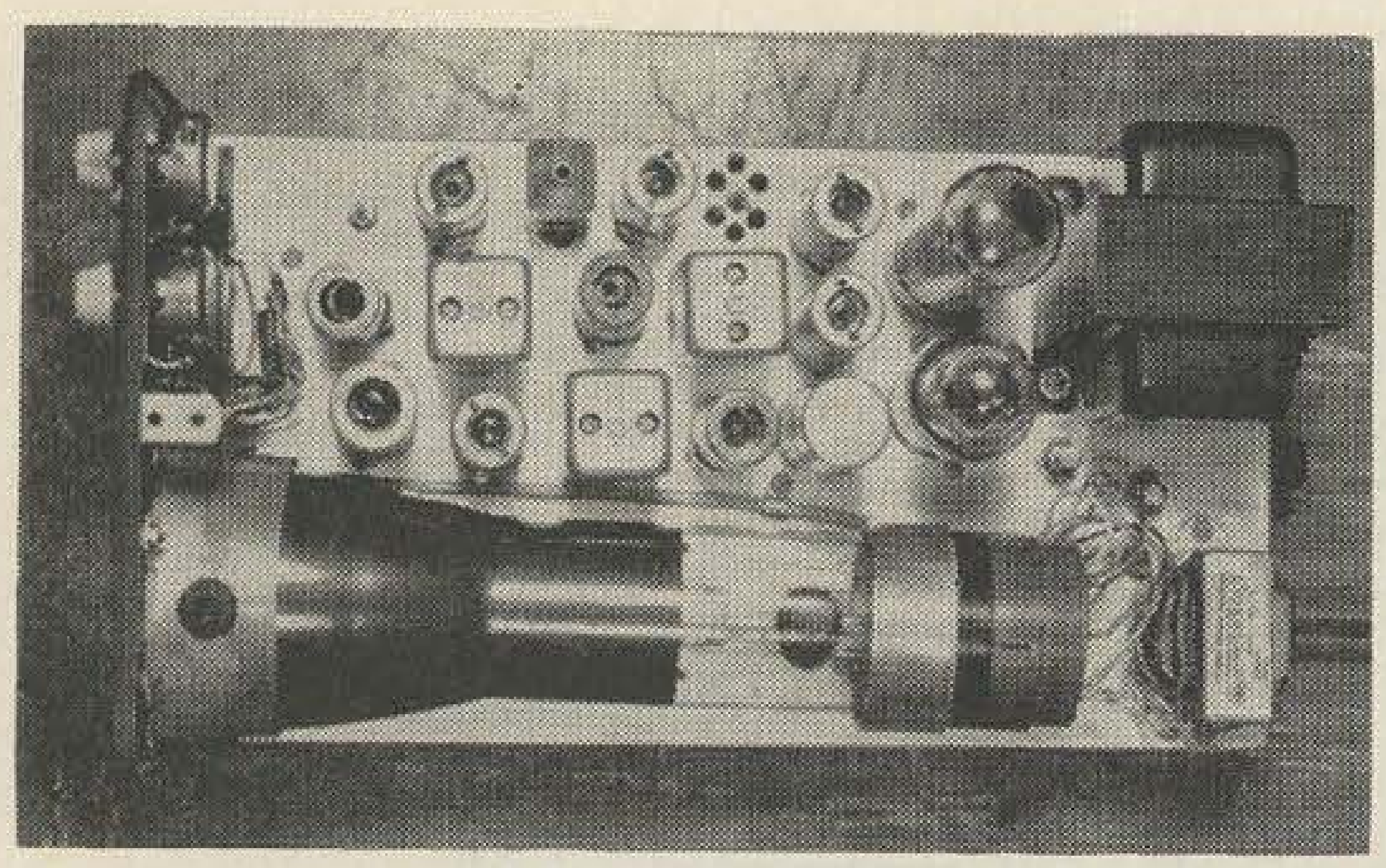
The 12AX7 operates as a sawtooth generator and amplifier to drive the reactance modulator and horizontal sweep of the CRT.

The length of the base line can be adjusted with the horizontal width control. The sweep pad control (broad adjustment) and the sweep width control (fine adjustment) will control the amount of radio frequency spectrum that is to be viewed. By adjusting the sweep, the display can be varied until only one signal appears on the CRT. Centering the received signal on the base line is accomplished by the center frequency control. The

[1]Modulation Analyzer, CQ, January, 1961
[2]The Snooper, CQ, August, 1952



TO REC.
10UUF
T1
MILLER 12-C1
100UUF
1 MEG
RF AMP
6BH6
680
.01
47K
RF GAIN
CONTL.
25K
1 MEG
120V
80V
T2
MILLER 12-C1
4.7K
260V
MIX-OSC
6BE6
100
UUF
20K
T3
MILLER 012-K1
IF AMP
6BH6
1.5K
T4
MILLER 012-K2
4.7K
IF AMP
6BH6
DET. 6AB4
T5
MILLER 012-K4
8UF
450V
50UUF
1MEG
.02
3BP1
.001
1.8M
560K
270K
440V
SWP PAD
2M
SWP
WIDTH
500K
10UUF
50K
300
UUF
500UUF
25K
2.5 MH
RFC
3K
2.5K
270K
500UUF
680K
CENTER F
50K
15K
HOR
WIDTH
1M
4.7K
LINEARITY
10K
5K
1M
HOR. 2M
VERT. 2M
100K
INT.
200K
500K
FOCUS
150K
.2
600V
.05
1600V
6X4
0A2
15K
2W
33K
2W
16K
20W
16K
20V
15H
75MA
10UF
450V
5U4
340V
6.3V
5V
T6
T7
6.3V
3BP1
6X4
115V
AC
S1
F1
✱ CRITICAL VALUE



linearity control interacts with the center frequency control and adjusts the linearity of the sweep of the local oscillator. The *if* amplifier and power supply are of the standard variety so time and space will not be consumed in outlining their function. The CRT controls are similar to those used on the Modulation Analyzer.

Construction

The receiver was modified by adding a 10 mmfd condenser or less to the plate of the stage you desire to use. Connect one end of the condenser to the plate and the other end to the center conductor of a short piece of RG-58/u coax. The shield of the coax should be left floating or above ground at the condenser end. Install a phono plug on the receiver and attach the other end of the coax to the phono plug and ground the shield at the plug end. The alignment of the receiver is generally not affected if the coupling condenser is small. This completes the receiver modification.

The power transformer should be positioned as far from the CRT as possible to reduce the affects of electromagnetic interference. In some cases it may be necessary to rotate the transformer to further reduce the interference.

The layout of parts is rather critical due to the limited space available, so care should be taken before holes are drilled. Use plenty of terminal strips under the chassis to facilitate wiring. The controls on the panel were located similarly to the controls on the Modulation Analyzer and will allow full control of the display. A temperature compensated condenser should be used for the mixer-oscillator circuit. This will reduce drift during warm-up and operation. However, there are controls on the front panel that will also compensate for drift. The case should be well perforated for adequate ventilation.

It may be desired to build the Modulation Analyzer and Panoramic Spectrum Analyzer into one unit. This would make a very attractive and much talked about accessory.

Adjustment

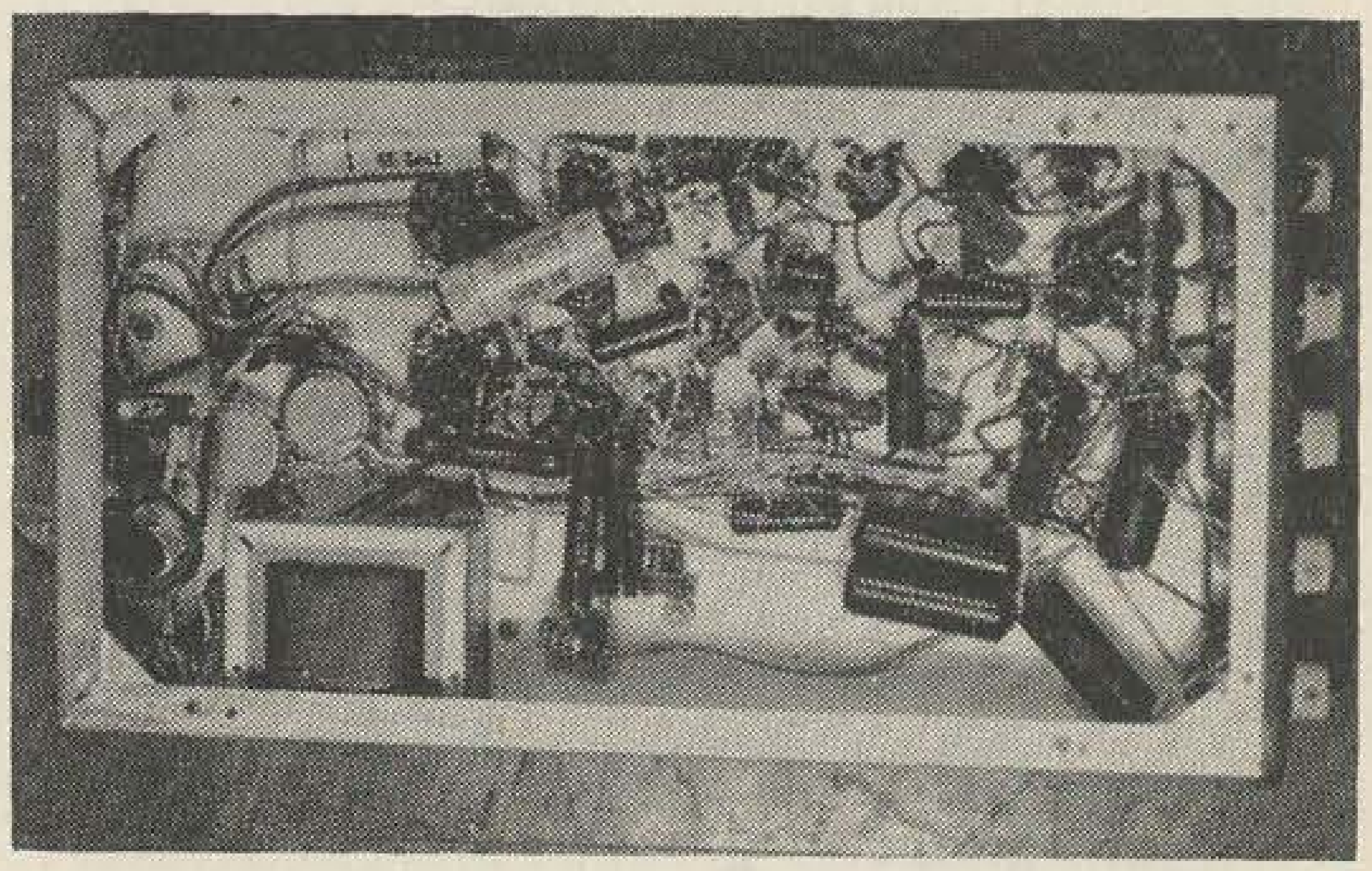
After the unit has been completed and wiring double checked, give it the smoke test by applying power. The filaments and pilot light should illuminate. Allow several minutes for warm-up before alignment. Remove the rf amplifier and reactance modulator tubes and connect a signal generator to the grid of the mixer-oscillator. Set the generator frequency to the *if* frequency of the panadaptor. Connect a VTVM or scope across the detector load resistor and tune the *if* transformers for maximum output. Adjust the panel controls until the base line appears approximately 1/3 of the way up from the bottom of the CRT. Place the sweep, center frequency and linearity controls to approximately the mid-position. Replace the rf amplifier and resistance modulator tubes and connect the signal generator to the panadaptor input. Set the generator frequency to the input frequency of the panadaptor.

Now align the oscillator frequency until a pip shows on the center of the base line on the CRT. If the signal generator frequency is varied back and forth, the pip will also move back and forth across the CRT. The rf transformers can be stagger tuned to produce as linear an output when observed on the CRT as possible, while varying the generator frequency.

The oscillator frequency may be determined with a GDO or by the use of a receiver. Place a short antenna, from the receiver, near the coil and tune receiver and/or oscillator until the signal is heard. The oscillator can now be tuned to the desired frequency. The second or third harmonic may be used, if necessary, for receiver reception.

Operation

After the unit has been aligned, connect the coax jumper cable from the panadaptor to the receiver. With receiver turned on and then tuning across the bands, you will get an idea of the type of presentation to expect on the



CRT. You may desire to touch up the alignment as a final adjustment.

The height of the pip will double when the modulation is 100%. Carrier shift is indicated by a sidewise movement of the pip under modulation. Splatter is evident when smaller pips appear and disappear on either side of the received signal when modulated. Zero beating is simply accomplished by moving the pip from your VFO to coincide with the received signal. Out-of-band operation can be eliminated when using a crystal calibrator and the panadaptor. You can immediately see if your signal is "In or "Out" of the band by its position with respect to the crystal calibrator signal. After calling CQ you can see the signals replying (within limits) without touching your receiver. The face of the CRT can be calibrated by using an overlay or thin strips of tape as markers.

The signal may be monitored by using a pair of headphones and by adjusting the center frequency or receiver the desired signal can be heard.

It is also a considerable aid for SSB and CW operation. It is the writer's opinion that it could be used in copying code visually for those that are deaf.

When chasing DX, the signals are sometimes quite weak. As you are tuning across the band you will see the signal before you hear it, thereby tuning more carefully when you approach his frequency. If the DX signal should take a dip at the time you tuned to his frequency, chances are you would have missed a rare one without the panadaptor.

The writer has worked 125 countries on phone in approximately two years and quite a few of these are attributed to the use of the panadaptor. It is a very versatile piece of equipment and will also enhance the beauty of the shack.

The writer wishes to thank Mr. Dick Azim, KφJEJ, for the fine job of photographing the equipment. . . . WφBMW

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I'd like to see . . .

. . . coaxial cable made lower loss by silver plating the surface of the inner conductor since most of the skin effect loss is on this surface. Tinning increases skin effect losses, silver reduces it. . . . W2WLR

(W2NSD/1 from page 6)

S-920

The portents are good for the reciprocal licensing bill this time. Senator Goldwater fought it through all of the various agencies involved last year and was able to reword the bill so that all of the objections raised were taken care of. No great problems are envisioned in getting it through this year. The following are the reasons why I believe it important for us to give this bill all the backing we can. You may keep in mind that I am a well known worry-wart, though I alibi this deficiency in my makeup by pointing out that I haven't been wrong yet.

Passage of the bill will, I believe:

1) Permit us to operate from a great many countries of the world while traveling. This would allow us to do a lot more DXpeditioning and would also make it possible for us to meet the local amateurs through on-the-air contacts and achieve better people-to-people relations.

2) Foreign amateurs visiting the U. S. would be able to meet the lower powered U.S. amateurs and get to know them better.

3) The expense of visiting the U. S. is high and unfortunately it is the important and influential foreign amateurs who suffer from not being able to operate while in our country. We will have quite an advantage if we make this demonstration of international good will toward foreign amateurs. This will come home to roost at the next Geneva Conference when reallocations of the short waves will be the major matter of moment.

In this day and age of inexpensive tours and miniature transceivers we can benefit much from the passage of this bill.

Continental QSL Club Kaput

It seemed to me that the chain-letter economics of the Continental QSL Club would eventually be their downfall . . . well I was wrong. Section 25 of the Postal Regulations did it instead. You see, the Post Office has been set up as a monopoly by law so that there cannot possibly be any competition to their service. This possibly has a lot to do with the shape the P.O. is in now. The part that

(more trivia on page 85)

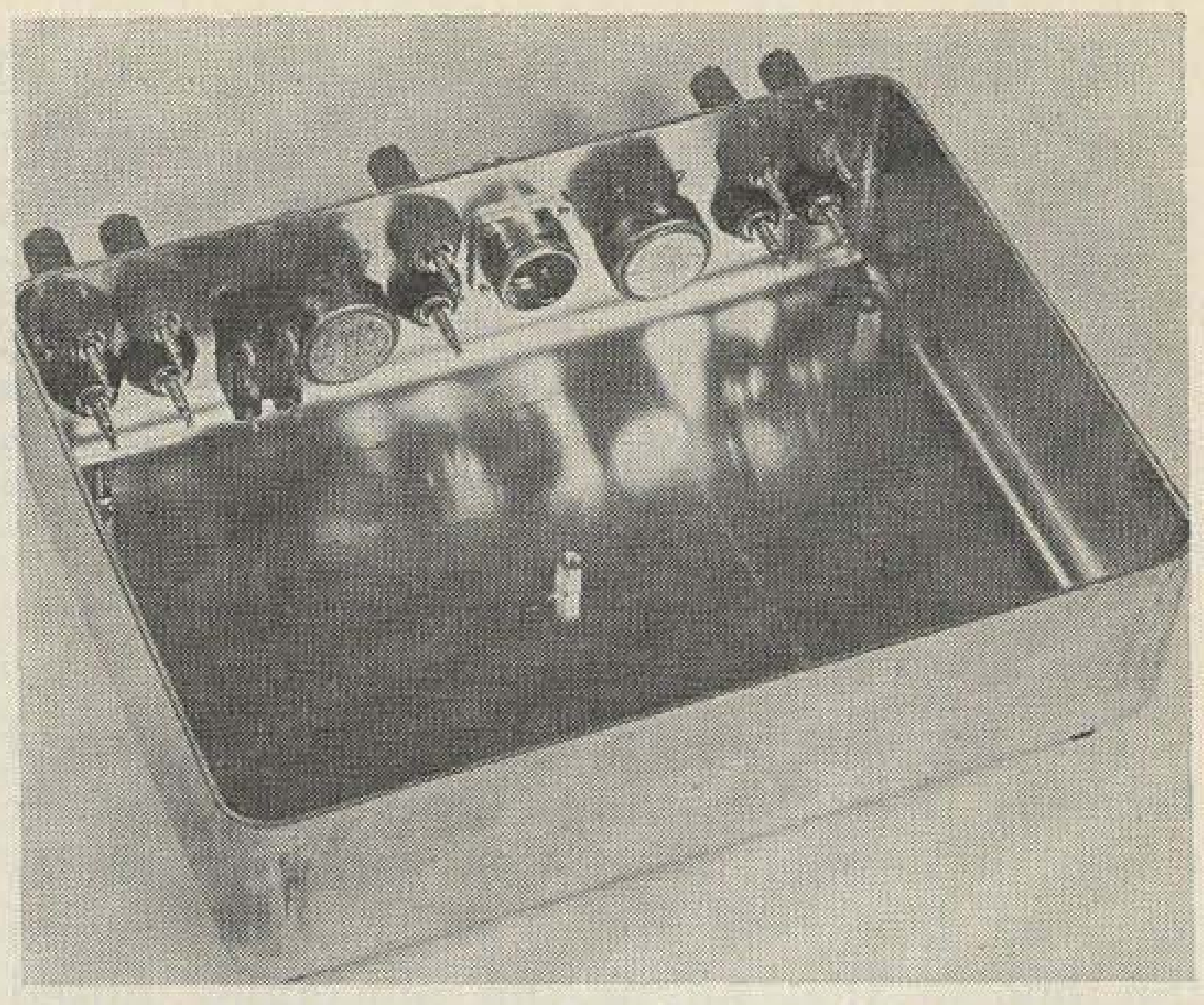
Shielding the Breadboard

Charles Miller W1ISI
General Radio Company
West Concord, Mass.

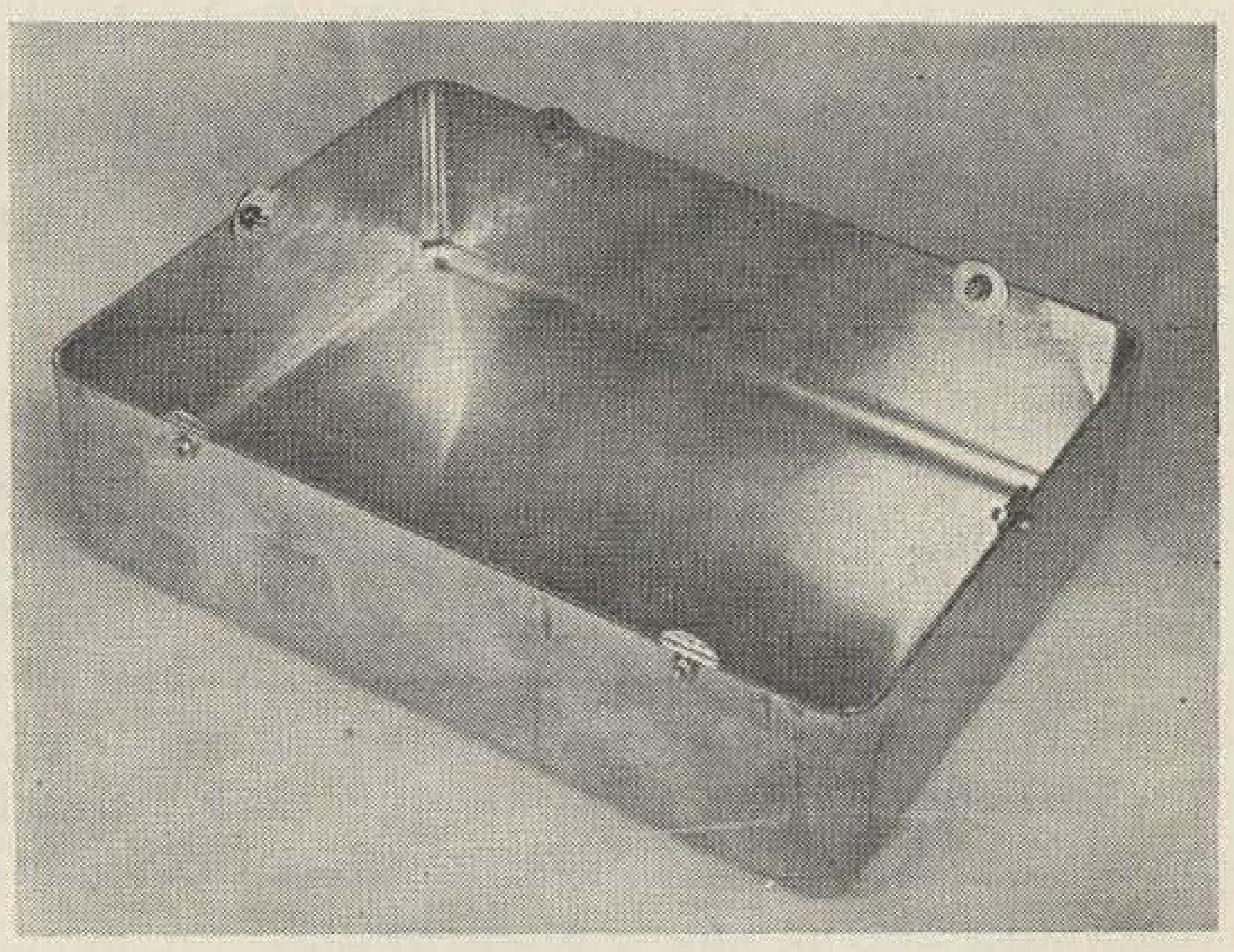
It appears that few circuits ever become successful without passing through what is known as the breadboard stage. The importance of this stage of development is not to be minimized, and some knowing individuals have even formulated laws for the construction of breadboards.[1] A number of materials have become available in recent years which are designed expressly for use in breadboard construction. One of the most useful of these has been perforated, insulated board. Most manufacturers supplying this material also supply complementary components specifically designed for breadboard work. Unfortunately, the need often arises to shield circuits from stray fields present either in the work area or between various parts of the circuit. The photographs illustrate my solution to this problem.

Basically, the breadboard should be a time saver. That is, it should allow the desired circuit to be constructed with the least possible attention to mechanical details. To avoid making odd packages for each new breadboard, the author built several standard packages. Each package has a variety of connectors and miscellaneous holes in at least one side. A section of standard perforated board may then be mounted on spacers permanently attached to the bottom. Breadboard construction then proceeds normally. A lid is provided for shielding purposes. When shielding is required between several circuits, they are simply mounted in separate enclosures and connected by means of shielded cables. Although the author's primary use is with transistor circuits, the total height is sufficient for vacuum-tube work, though ventilation should be provided.

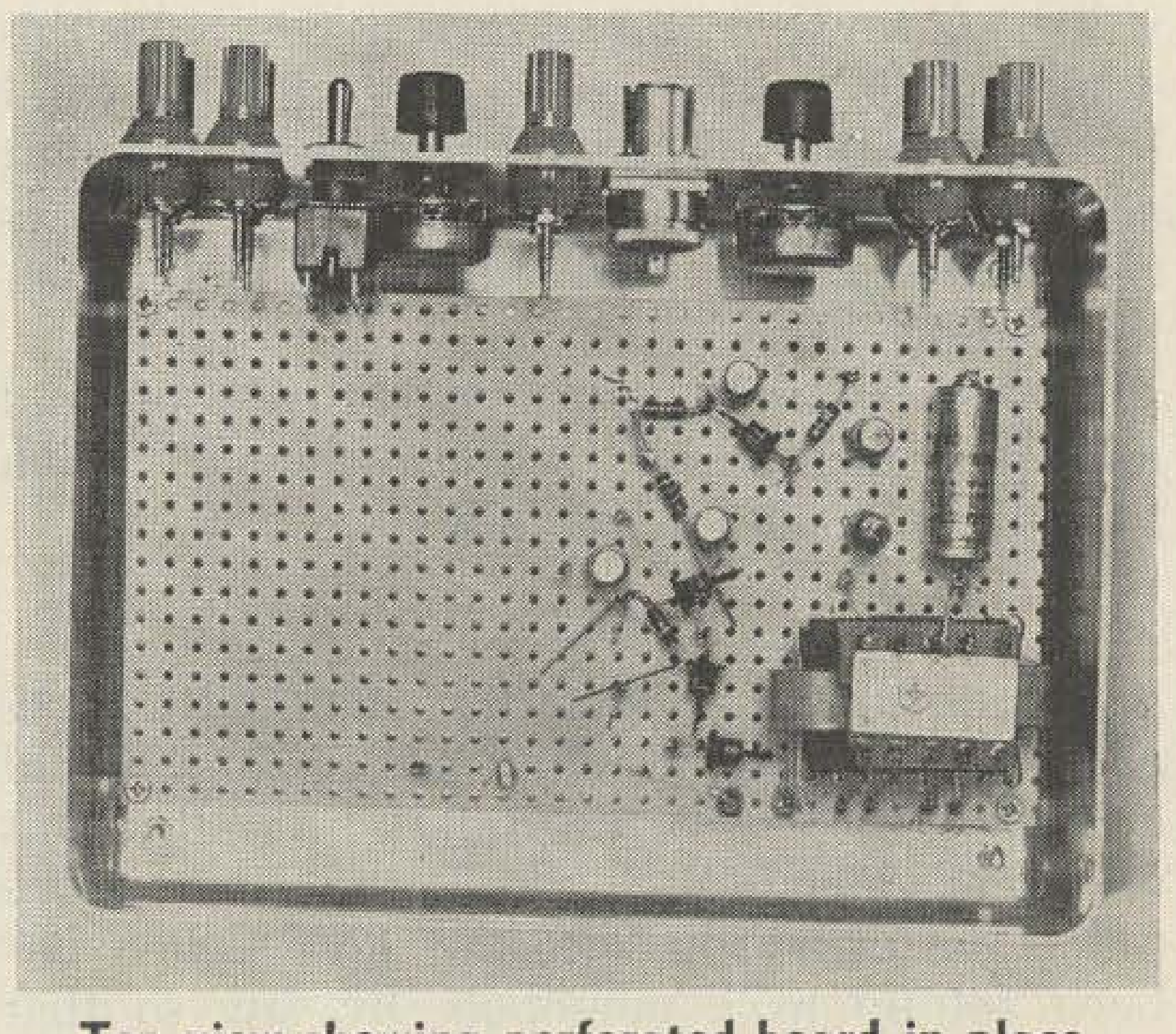
The enclosures shown are deep-drawn aluminum boxes manufactured by the Zero Manufacturing Company.[2] Although standard, less expensive electronic chassis or boxes could have been used, the absence of the lip is highly desirable. The enclosure and its lid are identical, measuring 6⅝ by 9⅛ inches, 2½ inches deep. This leaves sufficient clearance behind permanently mounted components such as connectors and switches, so that a section of Vector-board® may be readily inserted or removed. The choice of connectors, of course, is up to the individual, but it is recommended



Shielded breadboard cabinet illustrating a variety of components and connectors mounted on one face.

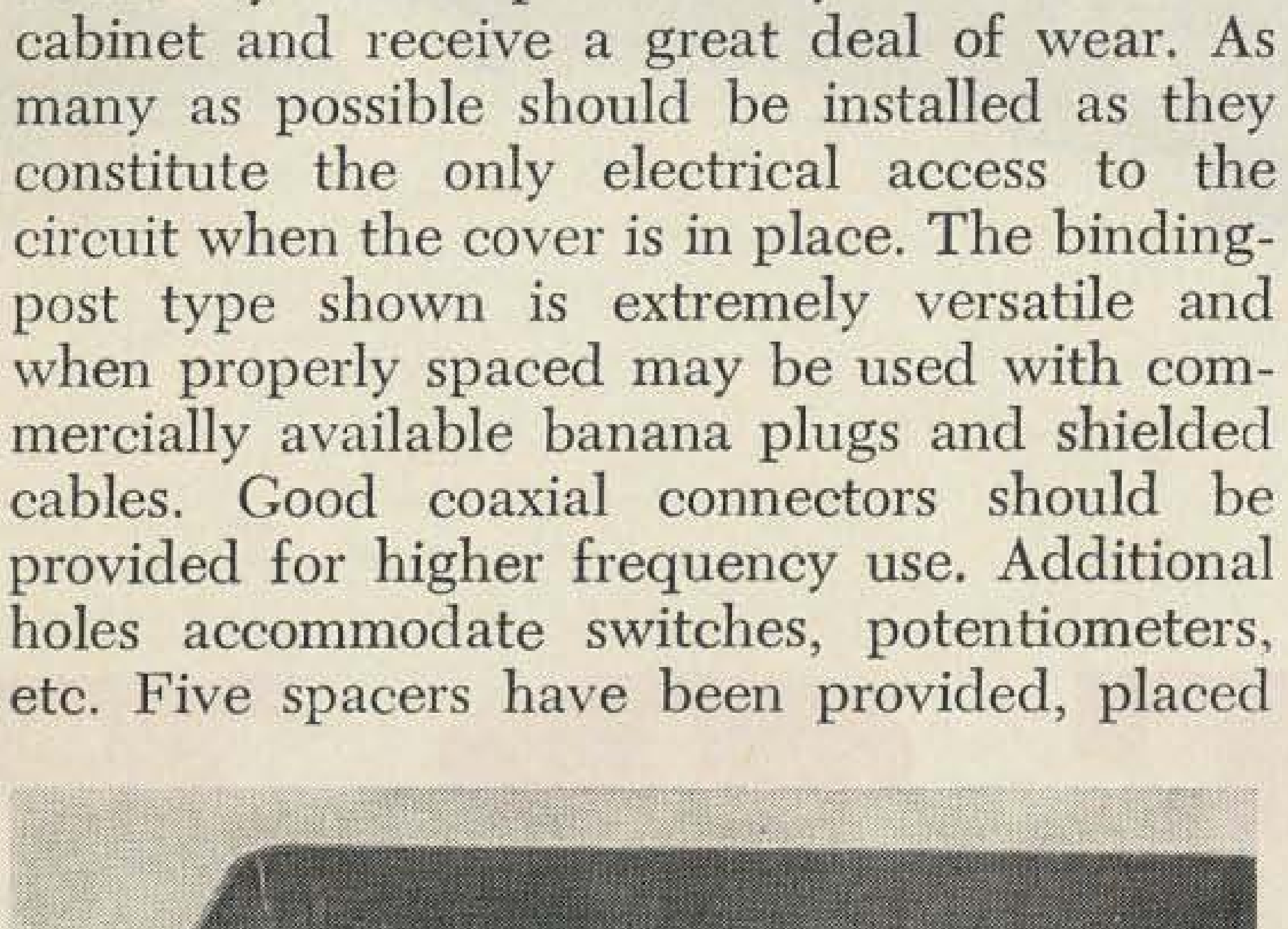


Cover is made by bolting washers to inside of box of same dimensions. Total height is adequate for vacuum-tube circuits (see text).



Top view showing perforated board in place. Note accessibility of terminals on panel-mounted components through the use of a deep-drawn box. Additional components may be mounted on rear face, if required.

that they be of high quality as they will undoubtedly remain permanently attached to the cabinet and receive a great deal of wear. As many as possible should be installed as they constitute the only electrical access to the circuit when the cover is in place. The binding-post type shown is extremely versatile and when properly spaced may be used with commercially available banana plugs and shielded cables. Good coaxial connectors should be provided for higher frequency use. Additional holes accommodate switches, potentiometers, etc. Five spacers have been provided, placed so that they line up with hole centers in the Vector-board. The fifth spacer (center) will be found necessary if it is intended to use the standard Vector push-in terminals. The added support eliminates the possibility of breaking the board or causing a short when inserting terminals. Rubber feet are provided to prevent marring bench tops by the heads of the screws holding the spacers down. Photos 2 and 3 illustrate some breadboard work in progress. The enclosure as shown was adequate for this particular circuit. Had this not been the case, additional components and/or connectors could have been mounted along the rear face of the enclosure without hampering the removal of the entire board.



Front view of cabinet with perforated board in place.

The integrity of the shielding will be maintained if snap buttons are employed whenever the components are permanently removed. Covers are made by simply bolting washers around the inside edge of identical cans as shown in Photo 4. If vacuum-tube work is anticipated, adequate ventilation must be provided. Screen-type snap buttons may be used on the sides of the main cabinet and the top of the cover. . . . W1ISI

[1] Johnson, R. W., The Art of Tacking, Electronic Design, July 19, 1961, p. 176.
[2] Zero Manufacturing Company, 1121-23 Chestnut Street, Burbank, California.

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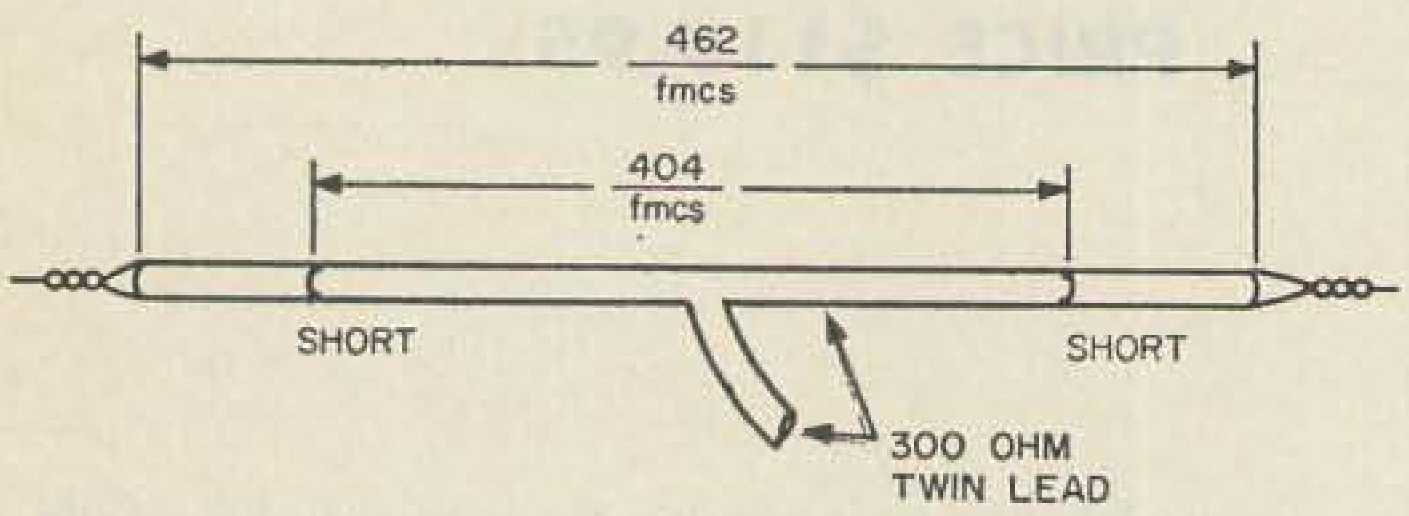
A Broad Band, Coax, Folded Dipole

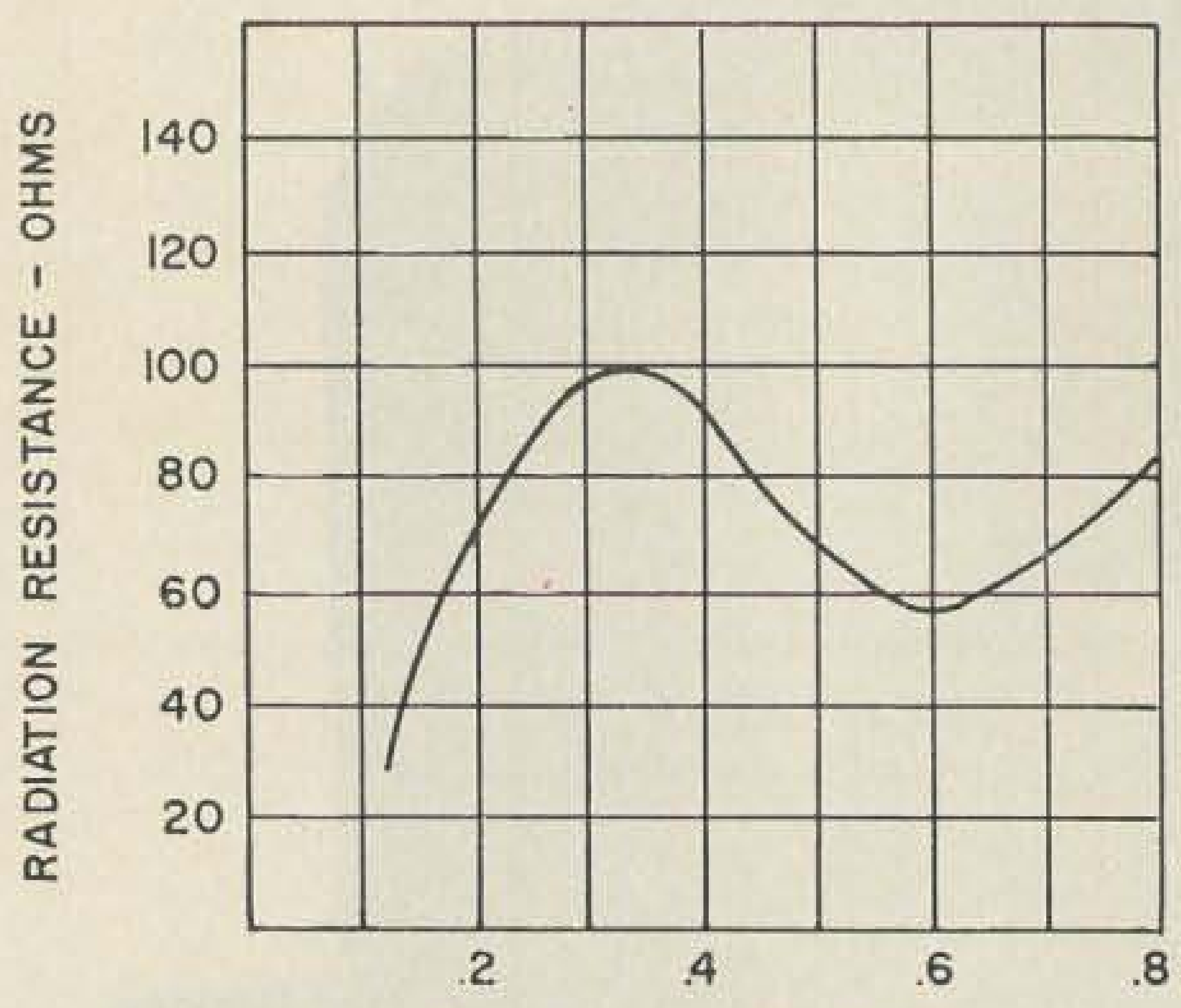
Ray Abraczinskas W3HJR/ϕ
412 Elm Grove Lane, Apt. 7
Hazelwood, Missouri

I have heard numerous comments on the bands lately such as, "Don't work any CW here on 80 meters because my antenna is tuned for the phone band and won't load up down there." "I can't talk to him because he works on 3810 and my antenna is cut for 3950." "I'm using an inverted V antenna and the apex angle is sharp causing the bandwidth to be narrow." "I want an antenna that will perform well with a low SWR across the whole 20 meter band." "I can't put up a low frequency dipole because I haven't got the room." This article is presented for these persons' benefit.

Many oldtimers who have used the folded dipole antenna will recall that shorting the two wires of the ribbon a distance out from the center equal to the velocity factor of the ribbon times a free space quarter wavelength, see Fig. 1, will cause the antenna to have a more constant impedance match over a wider range of frequencies thereby giving better bandwidth characteristics. This is the theory on which the material presented here is based with minor variations to suit one's need and fancy.

Since most new commercial transmitters have a relatively small variation in output impedance, 52 ohm coax is a natural choice for a transmission line. When connected to an ordinary wire dipole antenna, coax will match adequately over a relatively narrow range of frequencies provided the dipole is at the proper height





HEIGHT IN WAVELENGTHS
ABOVE PERFECT GROUND

above good conducting ground, see Fig. 2, and effects from surrounding objects is held to a minimum (get it out of those trees and above the house roof). The antenna described here will perform over a comparatively wider range of frequencies than the conventional dipole.

Basically the antenna is a folded dipole made from coax cable. The flat top portion of the antenna is constructed of coax cable (of the same impedance as the feedline) with the end extensions made either of coax, copper wire or twinlead. The end extensions can be fanned or dropped, see Fig. 3, depending on how large your lot is. Fanning the ends (either horizontal or vertical) is desirable in that the Q of the antenna is lowered more by further decreasing the effective length to diameter ratio, hence the antenna bandwidth is increased. This type of construction is very effective on 80 meters especially if the fanned wires are coax cable. It must be kept in mind that fanning the ends of a dipole will shorten its resonant length. The factor depending upon the degree of fanning.

The total length of the shorted center portion which should be made with RG-8U coax (RG58 will work OK with decreased results) is;

$$L_T = \frac{492 \times .66}{f_{mcs}}$$

L_T = Length in feet of center part
f_{mcs} = Mean frequency of operation (megs.)
The length of the end extensions would then be;

$$L_E = \frac{231 - L_T}{2 \times f_{mcs}}$$

L_E = Length in feet of one end extension
f_{mcs} = Mean frequency of operation (megs.)

Hence the total length of "shorted" coax in the flat top portion for 80 meters would be 86.6 ft. and the length of each end extension would be 19.2 ft. making the overall length of the antenna 125 ft. At each end of the coax in the center of the flat top portion the braid is shorted to the center conductor by stripping the insulation, pushing the braid back, stripping the polyethylene and twisting the two conductors together. At this point the end extension wires can be twisted together with the "short" and the connection soldered. Make sure this connection is substantial both electrically and mechanically because these connections support the weight of the antenna. The feedline is fastened at the center by cutting the braid exactly at the center of the flat top portion without disturbing the center conductor and its insulation. The braid is then separated not more than 1½" and pigtailed so the feedline can be soldered to it, see Fig. 4. When soldering the feedline to the parted braid use long nose pliers to conduct heat away from the polyethylene to prevent excessive heat damage. The completed connection is then taped sufficiently to prevent

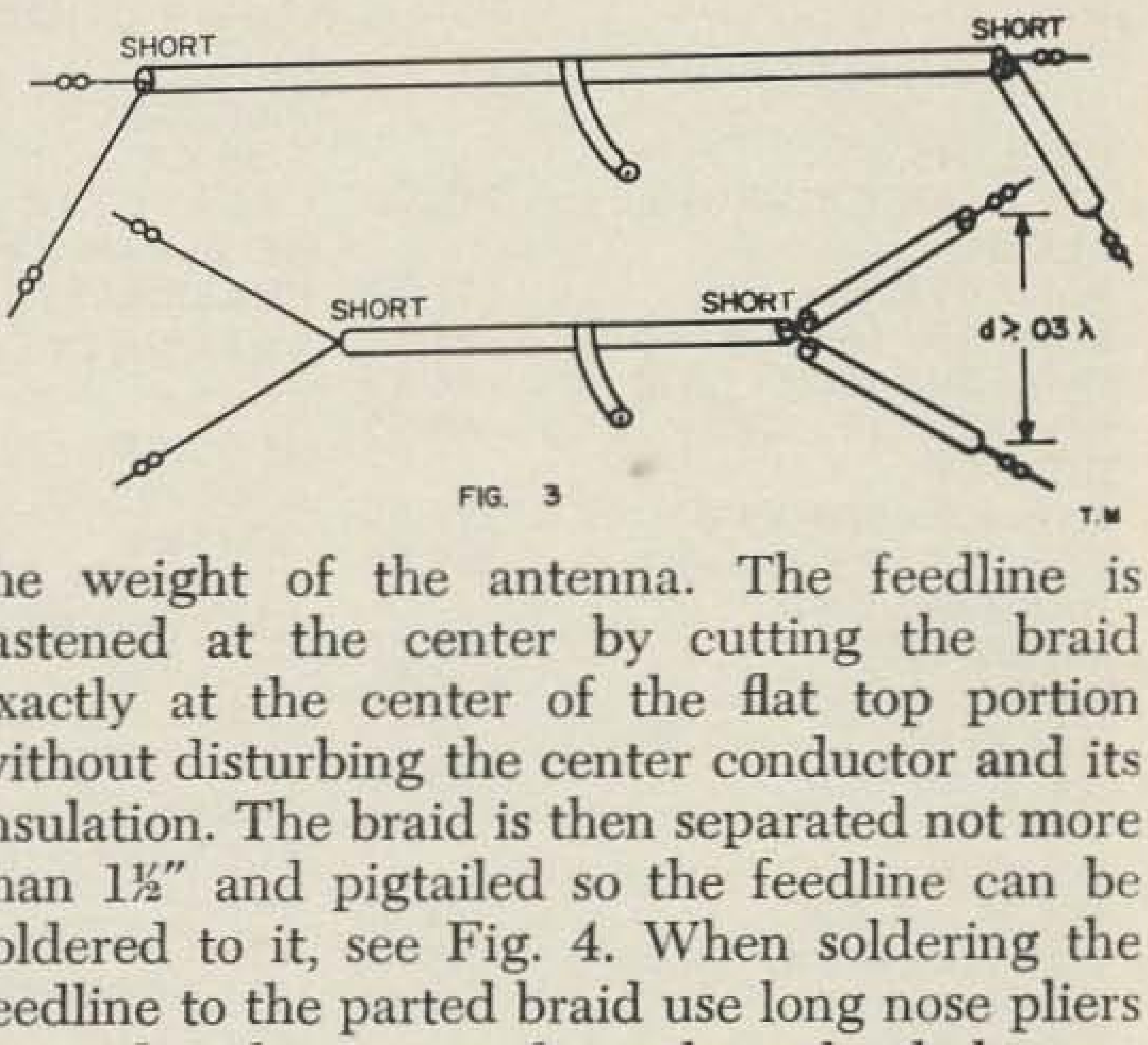


FIG. 3

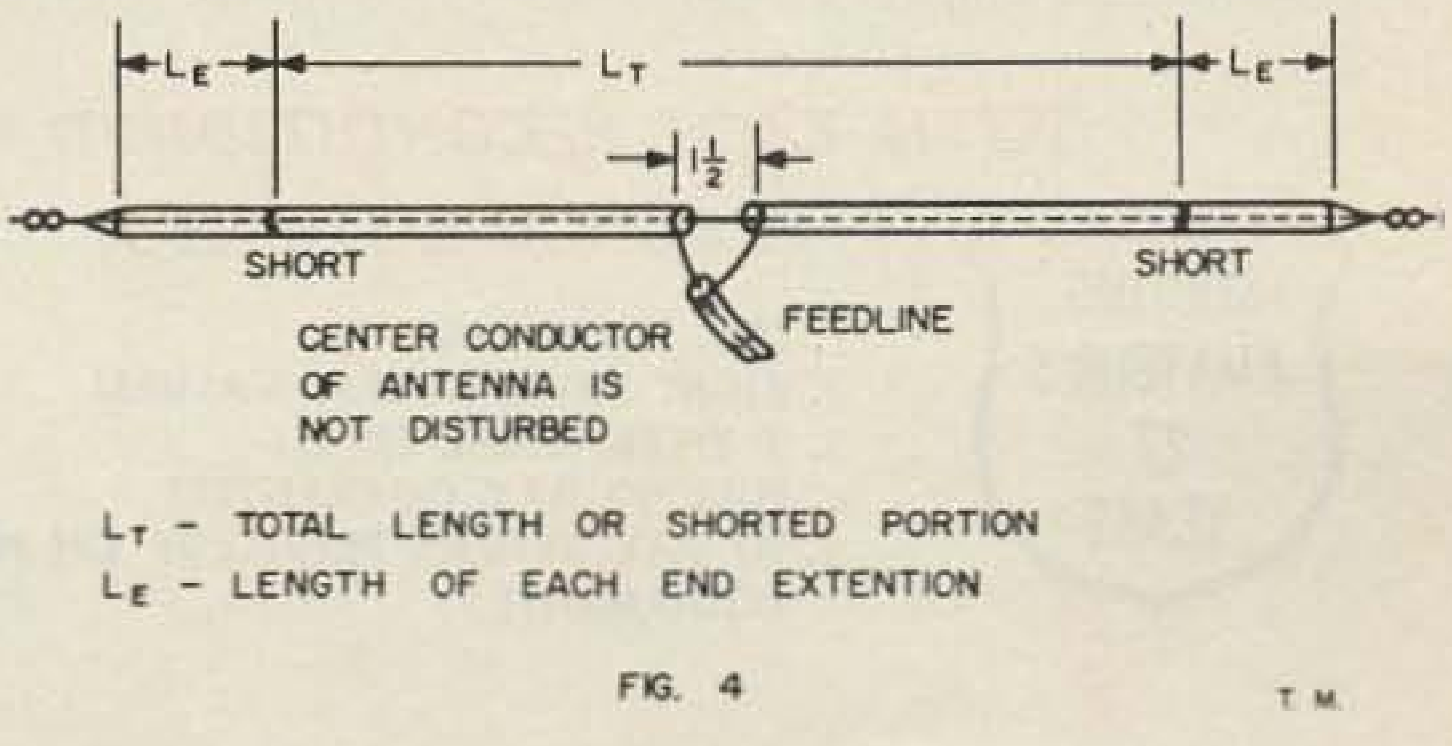
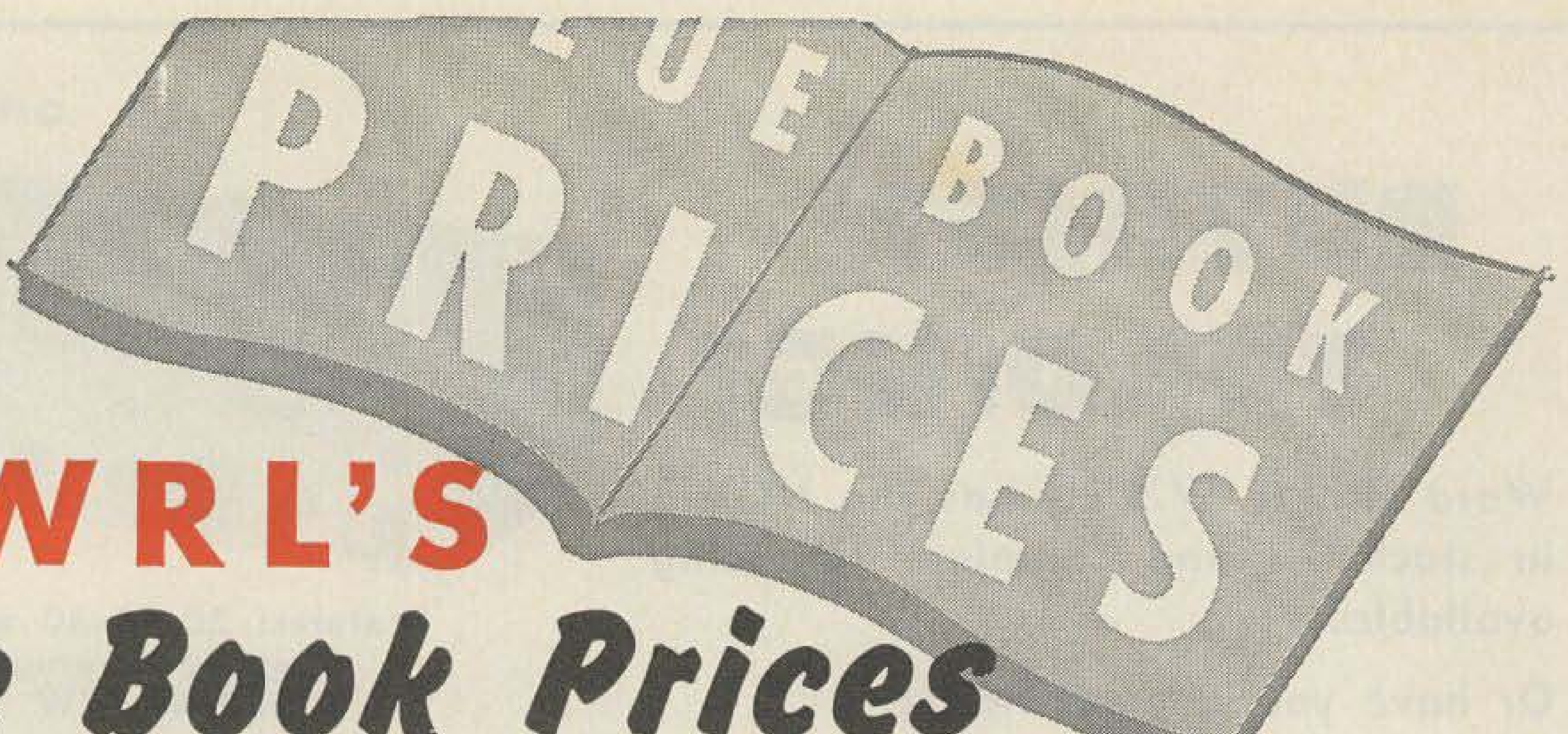


FIG. 4



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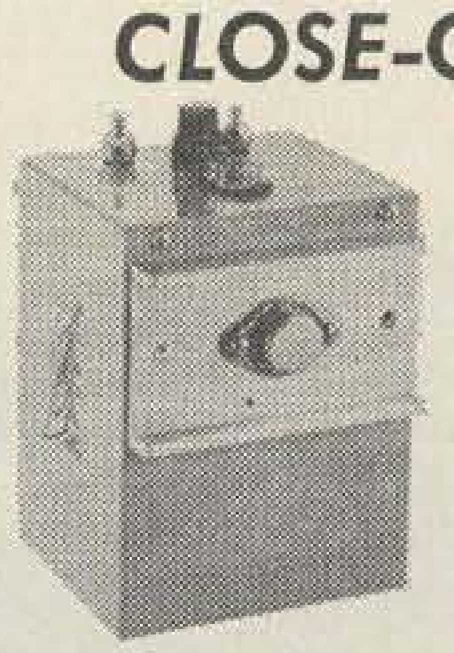

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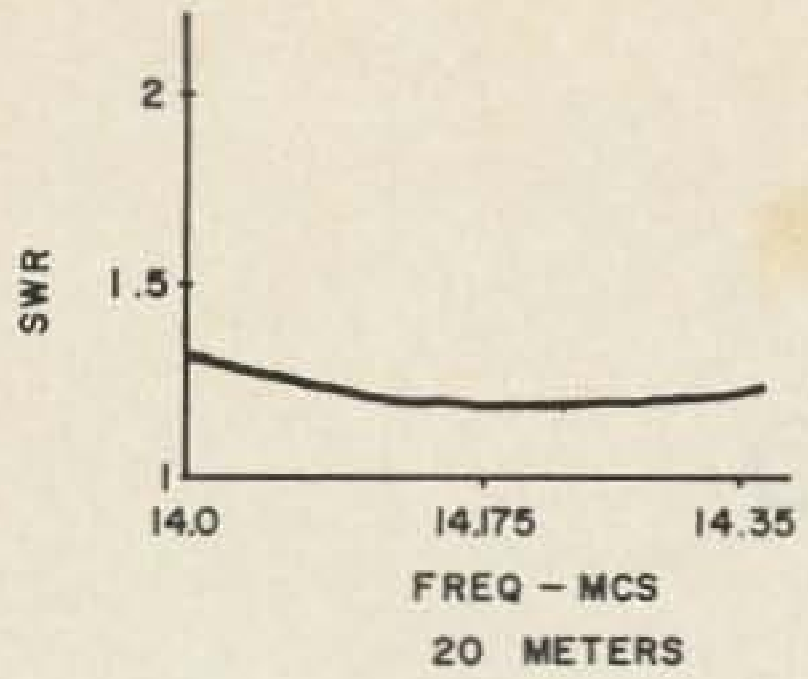


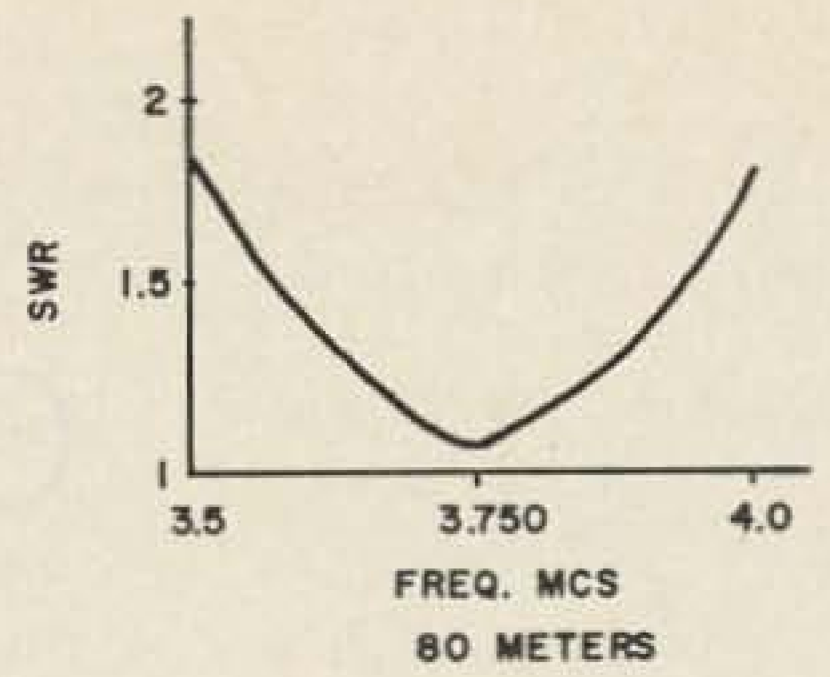


FIG. 5

water from entering the coax. (Note: this connection when made properly is sufficient to support the heavy coax feedline.)

Halyards can be fastened at the feedpoint and ends to raise the dipole and provide a means of adjustment of feedpoint impedance by adjusting the height of the antenna while observing the SWR at the design frequency. Since coax is heavy, end insulators with sufficient strength should be used to support the antenna. It is desirable to support the center of the antenna as high as possible and adjust the ends for lowest SWR at the design frequency. The reason for this is because most of the radiation takes place from the center part of the antenna. The antenna lends itself to be used as an inverted "V" very nicely with an increase in bandwidth over the usual wire inverted "V" which generally has a narrow bandwidth due to a sharp apex angle.

Two of the described antennas have been constructed at this QTH with results as presented, see Fig. 5. No gain or fantastic increase in signal strength is claimed with this antenna as it is still only a dipole but the improvement in operation at frequencies far from design resonance is advantageous and noticeable. This improvement could be considered as a gain. Many hams throughout Michigan, Indiana and Ohio are using this antenna on 75 meters with variations in construction as shown with similar results as presented.

Homebrew Exposed

W5HJV

We never cease to be amazed at the homebrew construction articles in the ham radio magazines. You know, the ones where the chassis doesn't have a single extra hole, and is all decked out with store boughten parts.

Down about the third paragraph, the author casually mentions that part number F-1 (Multi-Frammis Snickafoo Filter) can be special ordered from Shifting Sands Electronics Corporation for only $75. And of course old Charlie down at the machine shop was happy to make the gears for the dial drive for $25.

Needless to say, this is enough to make the average amateur return to stamp collecting. One must inevitably conclude that the amateur builder must be either a fabulously wealthy eccentric, or a bright young engineer with sticky fingers.

Fortunately, fellow amateurs, such is not the case . . . and in support of this statement the following parts list, complete with translation, is respectfully submitted.

Parts List	Translation
19" x 12" Chassis	Any size available. Check kitchen for suitable cake pans, etc.
350 mmfd variable (Raunchy Radio Co. Part. #QQ-4X4)	Tuning condenser removed from XYL's clock radio.
1 mfd 400V tubulan	This is for the key-click filter, stupid . . . leave it out.
16 mfd 700V electrolytic	Any electrolytic in the junk box which will handle the voltage. Check possibility of using assorted sizes in series.
Inductor, 9½T. #20, 1" O.D., 4 T.P.I.	Any size wire wound around varnished toilet paper tube. Cut and try for resonance.
750 uh RFC) 2.5 mh RFC)	Two rf chokes from junk box . . . inductance unknown.
26,000 Ohm, 2W resistor	Any combination of junk box resistors which hits within 5000 Ohms.
50,000 Ohm, 4W potentiometer	Grid drive control removed from front panel of brother-in-law's rig.
Fused Line Plug	No fuse necessary. Use cord and plug from XYL's hair dryer.
900VCT 200 ma power xfmr	Cannibalized from stand by rig if within 300V either way.
8 Henry 300 ma filter choke	Secure from K5BNK's garage. Flashlight and sneakers are strongly recommended for this operation.

Getting into Electronics

Paul Barton W6JAT
Jennings Radio
San Jose 8, California

The ads for courses in electronics read so rosy, it is misleading. The electronics course is an excellent thing to have, but is only the barest beginning towards a career in electronics. These courses only put you in a position to *begin* to learn how to actually *do* things. To get paid, you must be able to DO things. Experience as a ham is one of the best qualifications for an electronics technician career. The engineers are supposed to furnish most of the theory and the technicians are the practical workers that put the theory into practice. Many an enginner's lamp would be very dim without the backup of some sharp technicians.

Let's take a look in the Jennings Radio's Radio Frequency testing laboratory to see what technicians might be doing on a typical day.

"Tut" Tuttle, senior electronic technician in Jennings Radio's Radio Frequency laboratory arrived as usual at about seven thirty A.M. As foreman, he is not "on the clock." He is privileged to keep his own time. So, he arrives

Leonard Espinosa operating Jennings Rig No. 3, a 20 KW linear amplifier with a 4 W 20,000 in the final.

about thirty minutes early every day—no overtime either—and usually is fifteen minutes or more late getting away at the day's end. But there are few things that would worry him less than a few extra minutes of his time on the job.

In the past half century or so, he has made a long string of tracks that has given him the wide experience that is so valuable on his present job. He has been on his present job for over 6 years. His previous job was as electrical maintenance foreman for Westinghouse during World War II. Before that was power house operator, and various other comparable jobs.

Most of his family are grown up now. Two have gone to college. He is active in community work.

Only in recent years has Tut gotten a ham ticket, though he has had the ham instincts all his life. Now he is as ardent a ham as any high school boy.

The brief few minutes before the gang arrive is about the only time till quitting time Tut will get to sit at his desk. He turns over a fresh page on the desk calendar and initials the work cards of his crew from the day before. He knows from experience that this must be done before eight or they will likely not be done by the time the girl from accounting comes for them.

As the rest of the crew arrives, Tut exchanges pleasantries with them, while considering the jobs to be worked on that day. The rest of the crew consists of technicians of various skills and levels of experience.

There is the usual load of rf testing to be done, plus some special tests. Tut discusses this with Bob Goddard, leadman.

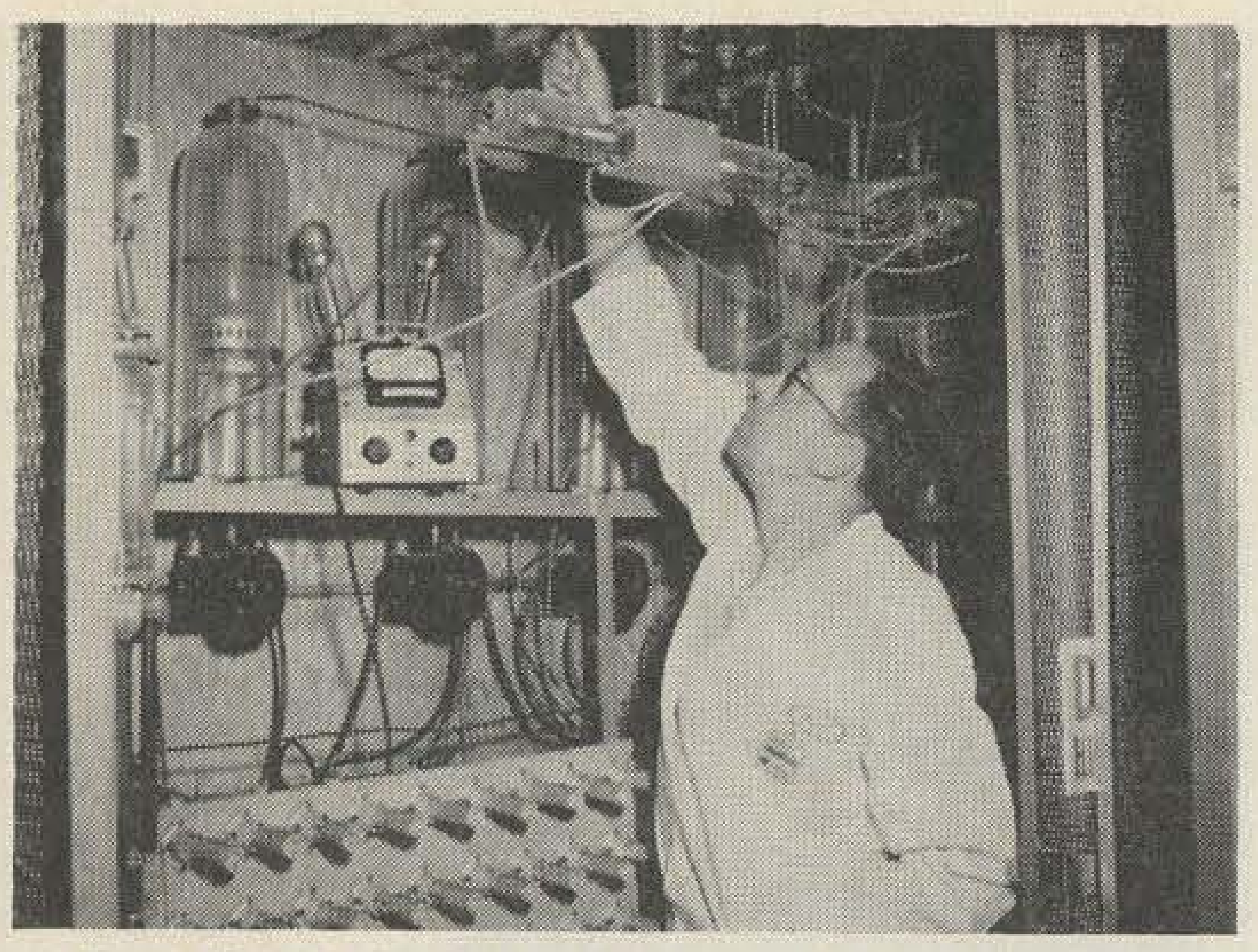
Bob arrived with a ham ticket and a high school diploma some eight years earlier. Starting as a junior electronic technician, he worked up to leadman due to an excellent personality and a natural aptitude for getting things done. He was willing and able to accept responsibility and figured that if he worried about the work, the pay would take care of itself.

Like most of the technicians, Bob has set up an excellent ham station at his home, including SSB & Teletype. His other activities include bowling in the two-hundreds, and flying a Cessna 150.

Bob prepares for the day's testing by examining the test reports left on his desk by the night crew. He puts these in the basket to be filed later by the secretary. Now he checks that his various operators are assigned and have work before them. By the time he has made a couple of telephone calls regarding units to be tested, made out a consolidated report for the supervisor's attention, and helped re-tune one of the transmitters that was a little balky, the noon whistle is stopping all official activity. Actually, tho, the difference is small. Many of the tests are on a basis of time, and the operators are reluctant to interrupt them, so they pull out their "sacks" and eat while watching the test.

Bob has four test operators helping him with his regular testing, plus four more on special tests. His equipment includes a 50 by 150 foot building full of rigs from a few kilowatts to a hundred KW. There are rf generators to test switches, capacitors, insulators, etc. Most of the rigs are linear amplifiers for ease of controlling the output and low harmonics. The operators have all been trained on the job, usually arriving with a ham ticket as their main credential. Besides operating, they often maintain the equipment when needed.

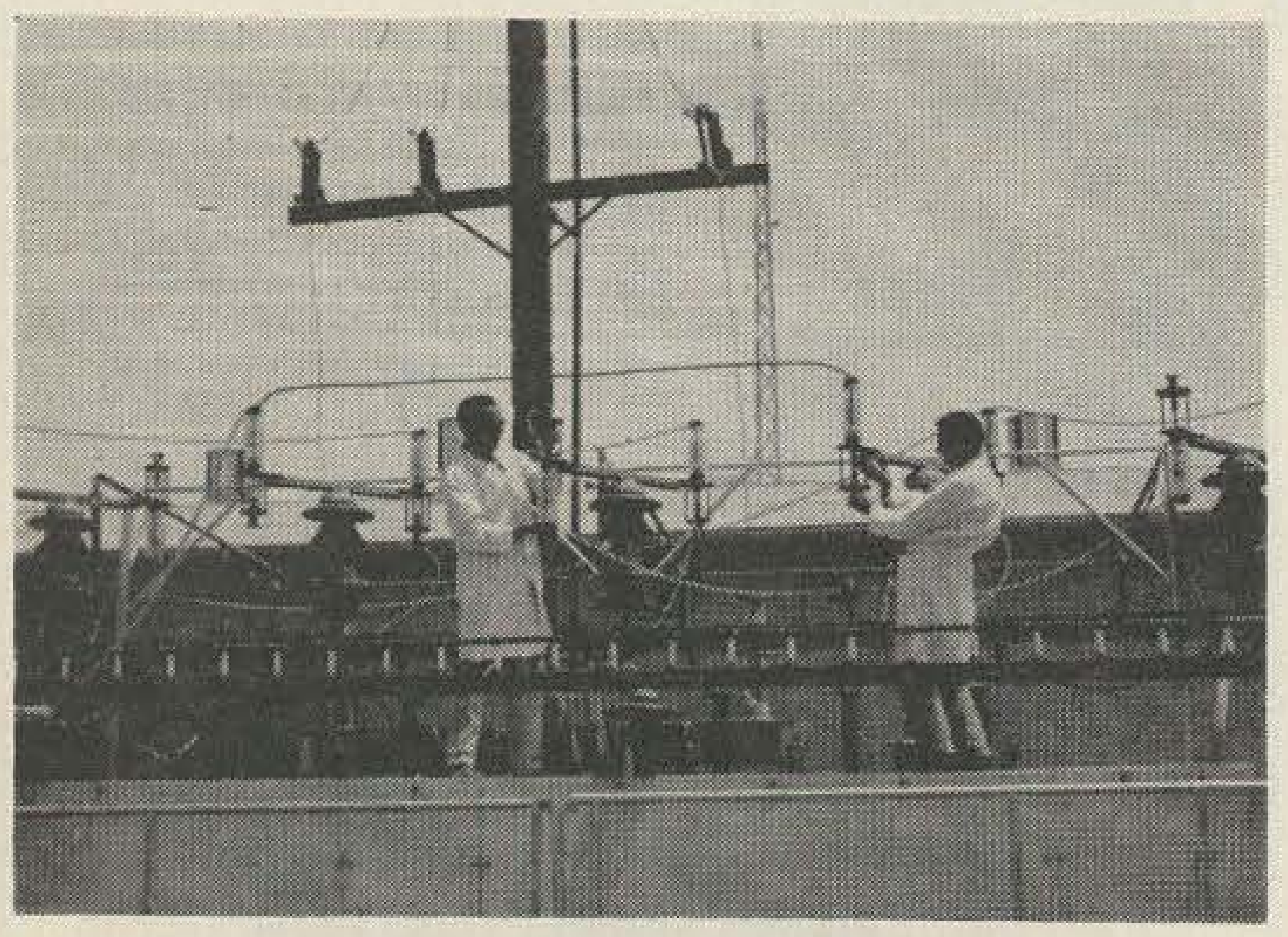
Lloyd, the senior operator of the test crew, has had a ham ticket for 34 years. He proudly boasts 11 grandchildren. Very soon he will be great grandpa. Now he takes his test request sheet from Bob, along with a capacitor to be rated and returns to his 100 KW SSB rig, which has been warming up for 30 minutes. It takes only a few minutes to jig up for the test, then excitation is applied to the proper output level. Now he settles back for the long, dull, but very exacting job of determining just how much current and voltage this capacitor can be expected to handle. A man of less experience could have trouble with this job. It is very easy to get wrong results that look correct. A crystal ball and a witchcraft license are probably part of Lloyd's regular equipment.



Bert Newkirk WA6 SIX inside power supply enclosure of 25 KW output 600 Mc Klystron transmitter.

Leonard is one of the younger operators. He took two years of college, but family responsibilities dictated that he go to work and take his college on a part time basis. He will likely get his BA or EE some day, but in the meantime he is a test operator in the RF testing Lab. He is an excellent testing operator, but his academic ability is constantly being used to real advantage in compiling and analyzing test results for condensed reports. This is a rare ability seldom found in non-college graduates.

Among the younger operators, but a veteran of several years testing, is Roy. Of course he is an avid ham. He was net control of one of the MARS nets for over a year. Today, he will spend several hours running a 600 mc, 25 KW output klystron to test some switches that are destined for high powered radar use. Later in the day, he will likely run some rf voltage tests on some capacitors, a part of getting them ready to ship to customers. Of course, at any time, some special "hot" job may come through and Bob may very well put Roy on it.



Bert Newkirk WA6 Six and Tut Tuttle WA6 LUM adjusting switches on a 500,000 watt power supply.

The youngest member of the family is Dick. (Naturally, he's a ham—in fact that was his only qualification when he arrived a couple of years ago.) Now he is literally growing up in the job. He operates any of the dozen or so rigs including the 100 KW rig. But lately, he has tended to specialize in high voltage dc testing. He takes a tray of capacitors and applies 50 to 100 KV dc to them to determine their ability to withstand dc.

Howard is one of Bob's most valuable test operators. He retired from the Quartermaster Corps as a major several years ago and decided to start over in a new line so he went to work as a jr. electronic technician. Practically his only qualification was his desire. He has made out very well. Most of his training was on the job, but he took some night school courses and studied at home on his own. His maturity is to his advantage. Hasty judgment in the testing field can be very expensive. Now, Howard specializes in high power dc switch testing. His two main pieces of equipment are a 13,000 volt dc at 50 amps power supply, which can be overloaded to 200 amps on short duty cycles, and a 75 to 100 KV dc supply rated at 7 amps continuous, but often operated at 20 amps for a quarter of a second or so. The 100 KV supply uses a 50 horsepower fan to cool the load resistors.

For better utilization of the equipment, two men (and sometimes more) work a night shift. Bill and Henry work as a team on the night shift, running whatever equipment is necessary for the test at hand. Bob tries to keep Bill and Henry on catalogue rating work, but often he has to use them for other "hot" tests. Both Bill and Henry learned most of their technical know how on the job.

With testing for the day under way under Bob's eagle eye, Tut turns his attention to some of the technical problems before him.

There are some special set ups to be done on the 300 kc rig. A cranky time delay relay on rig #3 is clamoring for attention. A 5 KW exciter being built for some special tests needs "eyeballing" before it goes much farther. There is some clean up work to do in the transformer's yard, etc. There is no end of jobs that he would like to get done. By carefully hopping from job to job, Tut keeps the hottest jobs going and even gets some of them finished now and then. He knows he can never get it all done, but as long as he doesn't fall too far behind, he feels he is doing OK.

There are three college part time workers. They will likely be engineers some day, but now they are getting experience and going to college. One of these men, Bob, of course a ham, Tut puts on the special 300 kc set-ups. Bob will likely stay on this special low frequency testing all summer, operating the 5 KW rig, changing set ups, repairing the rig, making reports, etc.

Another college man, Rudy, has been assigned recently to some special low power dc testing, of a type that a sharp ham/college man would be good at. Rudy has shown a particular aptitude with transistors, so he has been called on to design and construct transistor gear for the lab several times. It was desired to hear what was going on in one of the test cabinets that had to be kept closed during testing for safety reasons. So, Rudy made a little audio amplifier with microphone and speaker, using transistors, to monitor the testing sounds in the enclosure.

Dave, another college man, has worked part time the longest. He is letting his college work "age" a bit. In fact, he may never finish, and the world will have lost a fine engineer to the technician ranks. Dave has helped build most of the equipment in the lab in the past 3 years. Today, Tut puts him to checking out a truckload of large transformers just received to be used in various large power supplies. Some time during the summer, Dave will be a high-climber and paint the 100 foot steel antenna tower that the lab's 20 meter beam is topping off.

Tut has two journeyman technicians that can build or repair anything that comes along. Both migrated to the west about 2 years ago with considerable electronic experience behind them. They broke in very quickly and were earning their pay in a few weeks.

One of them, Bert, a ham of many years standing, goes on with his present assignment of building a 25 KW autotune amplifier to be shown at the fall Electronics show. The other one, Ernie, a ham, of course, has just completed a 5 KW rig so he and a junior technician are working on installing a 20 KW bandswitching rig.

The junior technician, Ron, started a few months before with his only qualification being a willingness to learn. He is picking up shop practices and construction know how under Tut and the other more experienced "experts." He will be an expert himself in a couple of years.

In this lab, a strong effort is made to determine the strengths of each worker, and then play to those strengths. There is such a variety of jobs to do that there is usually enough of the right kind of work for each kind of worker with some left over.

The main requirement is that a worker be eager and willing. If he is eager and willing, he can learn. Actually the work in each lab tends to be so special that a new worker has to be broken in almost from scratch even tho he has some experience. However, the man with experience will break in much quicker.

It costs a company a great deal to train a technician. Therefore, a company will try to select a prospective trainee very carefully before investing in his training. Any evidence of instability such as previous job hopping will count against him. Usually there is a probationary period for new employees. During this time, the company can size him up, and if they don't like what they see, they can let him go with little or no explanation. Once accepted as a regular full time employee, it is not as easy (from a supervisor's standpoint) to let an employee go. Seldom is an employee clearly and definitely "no good." This kind of worker would have been weeded out in the first few days of his probationary period. It is more common to find a man to be not as good as you had at first hoped he would be. But it may be difficult to find sufficient reason to satisfy the personnel office that the man should be let go. Therefore, a supervisor really takes a look during that probationary period of a new man. Once accepted, if a worker becomes a small problem in one position, it is best to protect the company's training investment by trying the worker at a different position. This often works out very well to the company's and to the worker's best interest.

The first step is usually the hardest—getting your foot in the door. For a new, inexperienced worker, it is best to "take what you can get," even perhaps not directly an electronic job, to get into a desirable company. Then, after you have shown your willingness to work, you will likely be able to transfer into electronics when there is an opening. This opening problem is often a major obstacle. Everyone wants to get into the act, so there are not always openings.

Many good technicians, working for a good company, have found that if they have genuine interest in their work, show willingness to work and learn, and when the time is right, a willingness to accept responsibility, the pay and promotions are taken care of without worry on their part. The worker who will work harder *after* he gets more pay is not likely to to get the promotion. The worker that makes himself valuable to the company is the one who gets the promotions. . . . W6JAT

Selected Circuits

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The ALTEC 460A Transistor Compressor Amplifier is typical of the transistorized, modular audio assemblies. All are housed in identical, plug-in cases.

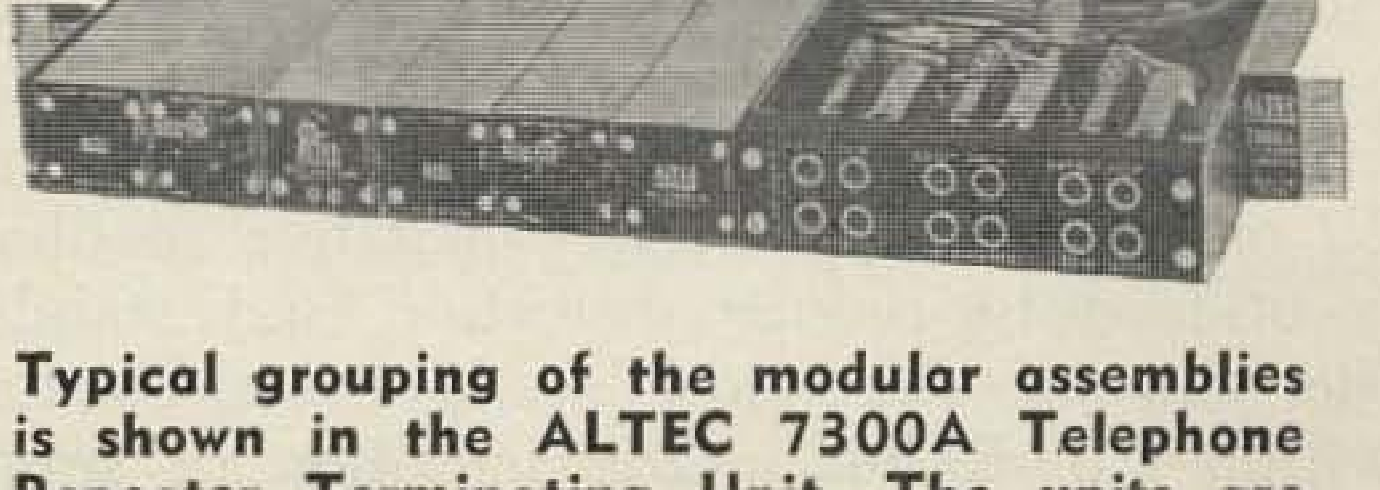
The communications industry has long recognized the practical utility and flexibility of modular or "building block" construction. Even the most complex multi-channel carrier systems consist of large numbers of relatively few types of circuits inter-connected to meet specific system requirements. Where minor differences occur, such as oscillator and filter frequencies, these elements are often made plug-in to permit fullest flexibility in manufacturing, installation and maintenance.

The ALTEC Lansing Corporation of Anaheim, California, manufacturers and markets a line of compart, modular plug-in units to meet the requirements of the telephone industry. This line includes transistorized line, compression and power audio amplifiers. The circuitry of these audio components is of particular interest to amateurs who may desire to pattern their construction projects along these lines. The ALTEC line is rounded out by a series of attenuators, equalizers, line transformers, hybrids and networks of similar construction.

These individual system elements are housed in compact, plug-in cases. The basic package is similar to the Western Electric V-3 vacuum tube line amplifier. This unit is used in great quantities by the telephone companies as repeater amplifiers. The compact construction of these units is shown in the photograph of the ALTEC 460A Transistor Compressor Amplifier which measures 1¾" x 1¾" x 6".

The various units may be mounted and interconnected to meet specific system requirements. An example of this is shown in the photograph of the ALTEC 7300A Telephone Repeater Terminating Unit. While other assembled packages are available, probably the greatest use of the line amplifiers is to replace existing vacuum tube amplifiers or to expand existing installations. Several models of the basic transistor line amplifiers are available for operation from various supply voltages. Other variations include dual input and output impedances with optional simplex taps on the transformers and monitor output options.

The ALTEC 457B Transistor Amplifier is typical and the schematic is shown in Fig. 1. This unit provides 37 db gain from and into 600 ohm loads and delivers a maximum output power of +18 dbm. Distortion is low and output is flat within 1 db between 200 and 3,000 cps.



Typical grouping of the modular assemblies is shown in the ALTEC 7300A Telephone Repeater Terminating Unit. The units are easily removed for service.

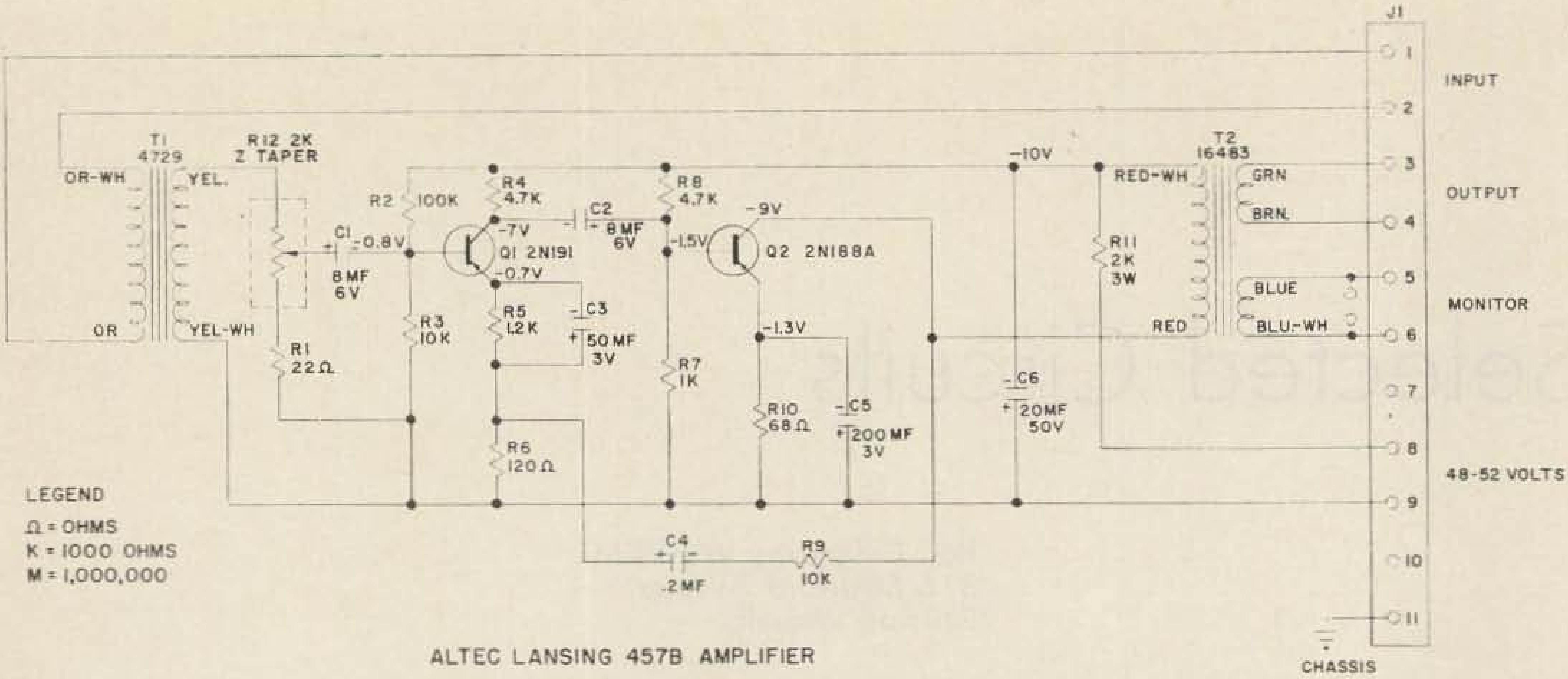


Fig. 1 Schematic diagram of the ALTEC 457B Transistor Amplifier. This little unit provides 37 db gain and has a maximum output of +18db. Gain may be increased to over 50 db by opening the C4-R9 feedback loop.

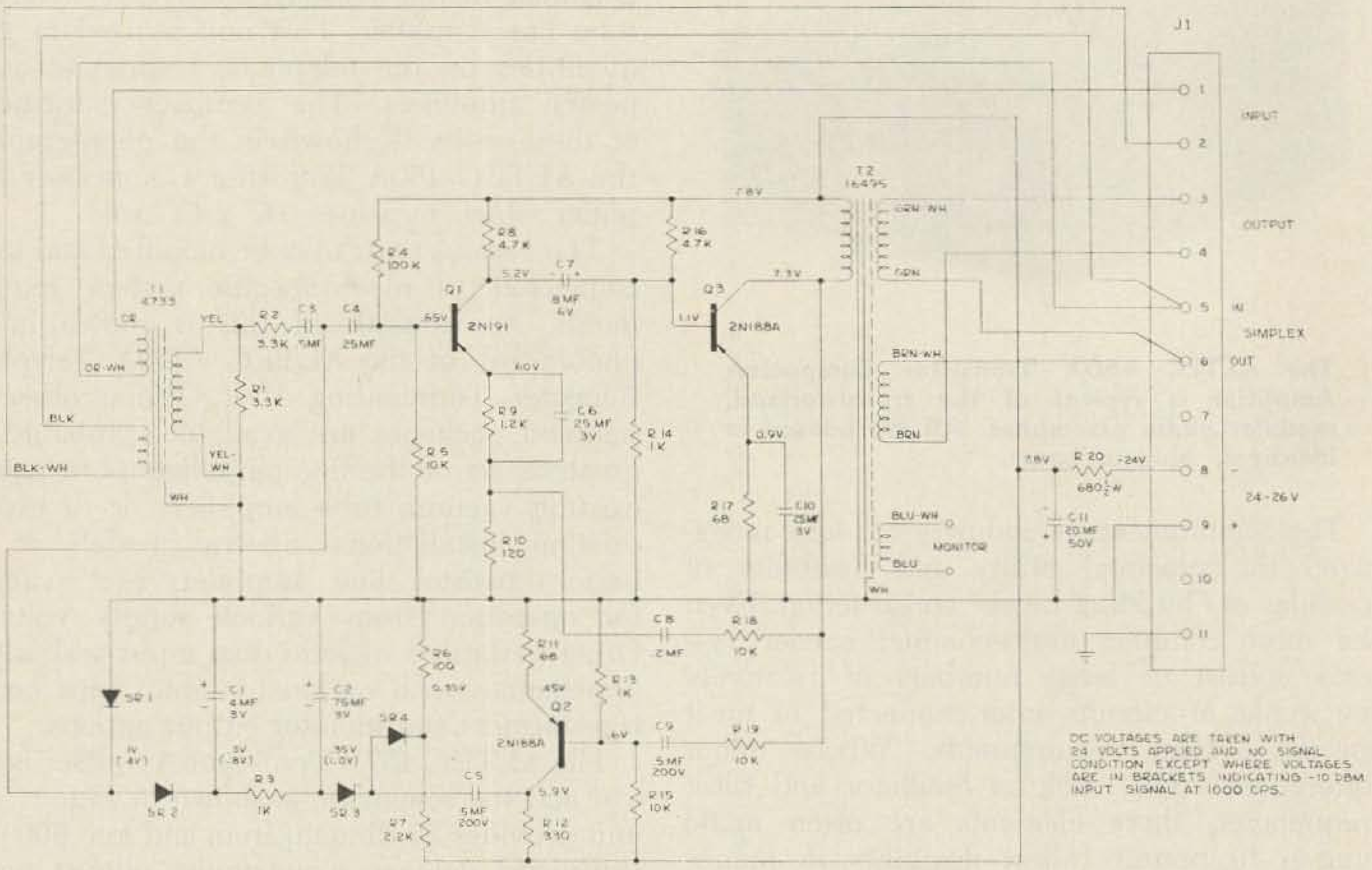


Fig. 2 Schematic of the ALTEC 460A Transistor Compressor Amplifier. While designed for telephone repeater service, the circuit is ideally suited for amateur transmitter applications. Output level varies less than 20 db for an input range in excess of 50 db.

Output noise level is −70 dbm. As designed, the unit draws 25 ma from a 52 volt source. However, the majority of this power is dissipated in the R11 dropping resistor. The actual power requirement is approximately 25 ma at 10 volts. Heavy negative feedback is utilized to reduce distortion and stabilize the gain of the amplifier. Gain is constant within 0.3 db for a 25% variation of supply voltage and within 0.2 db for an ambient temperature increase from 75° F. to 110° F. While the circuit is usable, as is, for many amateur applications, more gain may be required for others. For these applications, gain may be increased to more than 50 db by opening the C4-R9 feedback loop. While this will make the gain of the amplifier more susceptible to temperature and supply voltage variations, no great difficulty should be encountered in fixed installations.

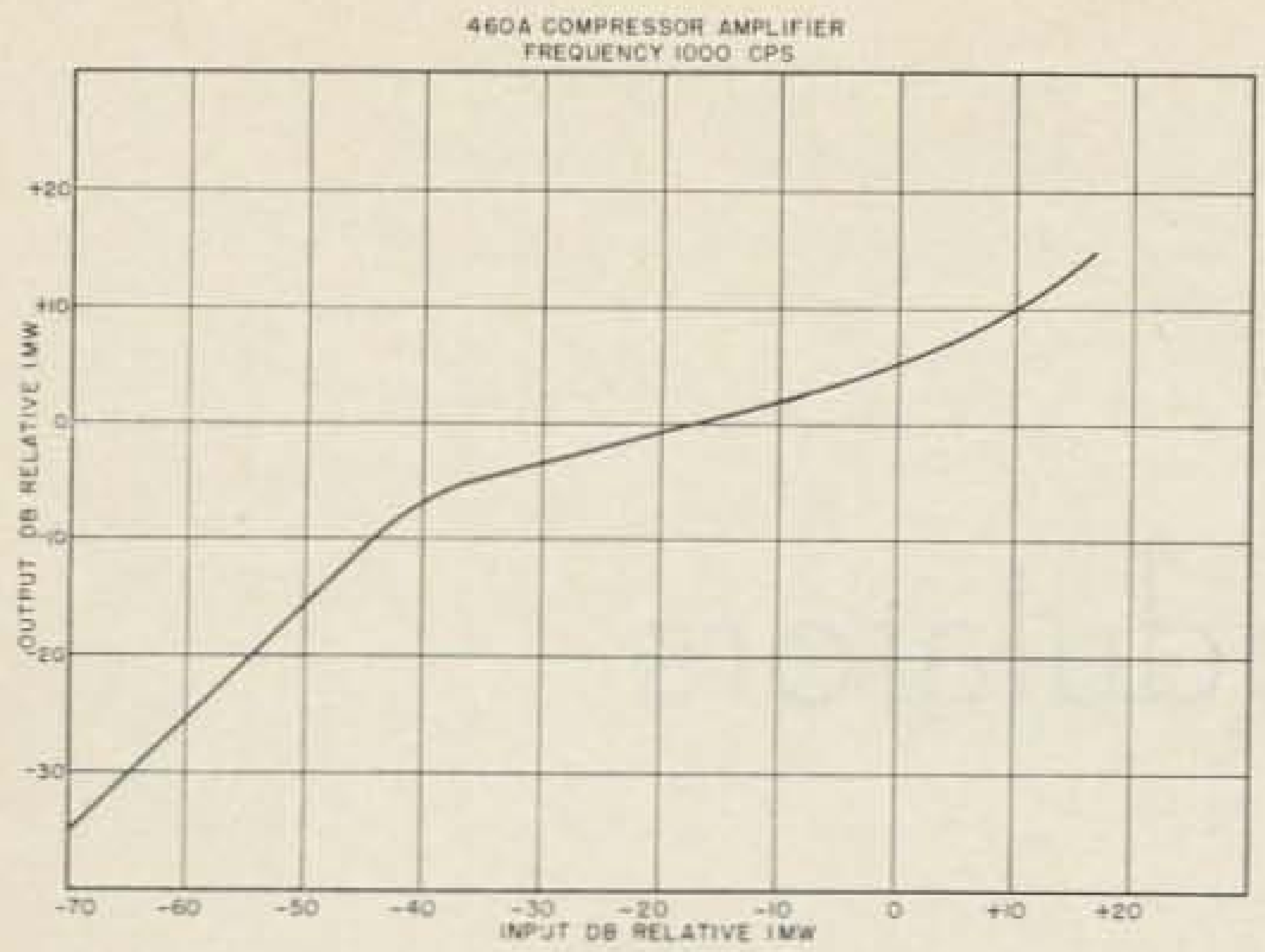


Fig. 3 Performance curve of the ALTEC 460A Compressor Amplifier. While designed for automatic equalization of telephone circuit levels, it is ideal for amateur speech applications.

The ALTEC 460A Transistor Compressor Amplifier is designed for use in communications systems, where it is desirable to maintain a relatively constant output level for a wide range of input levels. Since the problem is similar to that encountered in amateur transmitter speech systems, the circuitry of this unit, shown in Fig. 2, should be of amateur interest. As in the line amplifiers, input and output impedances are 600 ohms. Below compression, the gain of the amplifier is approximately 35 db. Compression characteristics of this amplifier are shown in Fig. 3.

The last of the ALTEC units to be described is the type 461A Transistor Power Amplifier. This compact little unit is housed in the same style package as the other units and will deliver 2 watts output into an 8 ohm speaker. The amplifier is designed for use in a speaker type, telephone terminating set but the circuit should be valuable in amateur audio work. Fig. 4 gives the schematic diagram of this little amplifier. Input impedance is the standard 600 ohms which makes it compatible with the other units described.

While the writer is certainly not recommend-

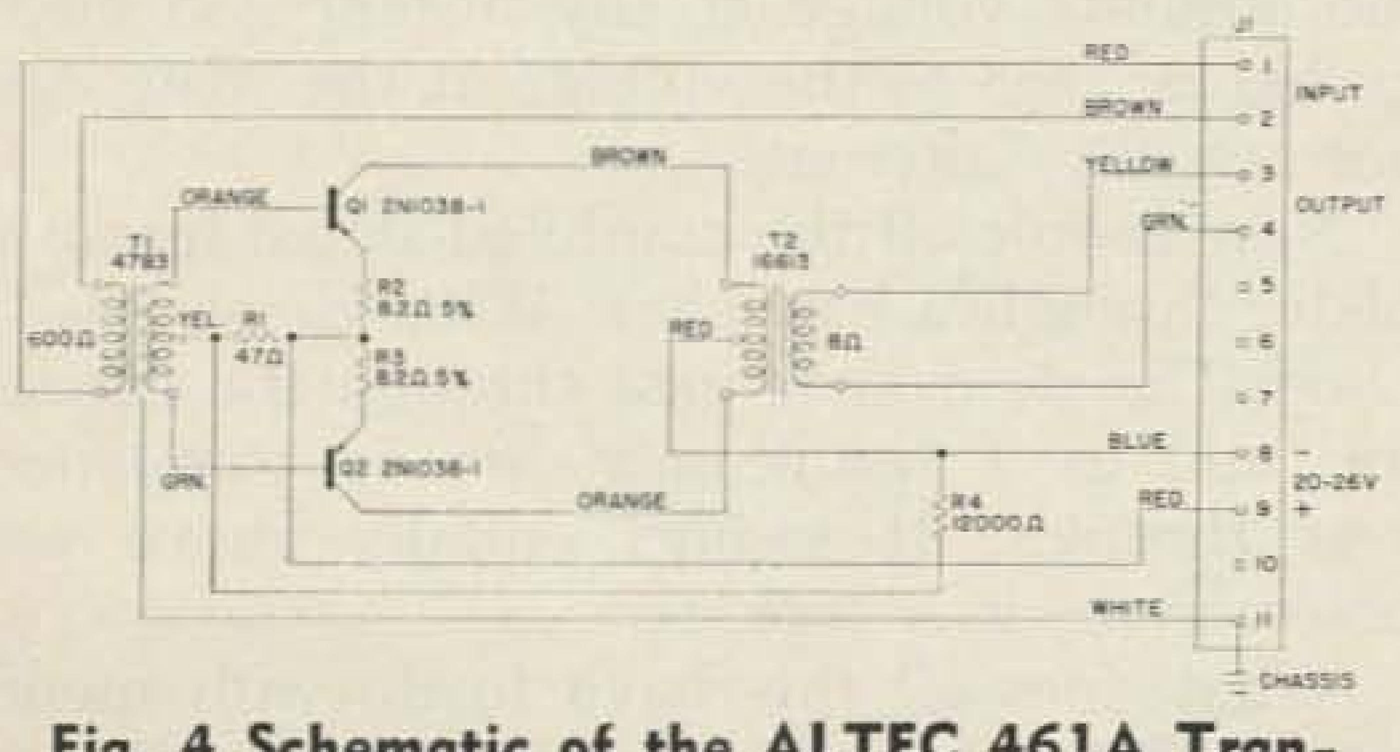


Fig. 4 Schematic of the ALTEC 461A Transistor Power Amplifier. This modular building block provides 2 watts of audio to an 8 ohm speaker.

ing that every amateur go out and buy a truck load of these ALTEC audio components, there is much to be said for the modular concept employed in their design. Think it over carefully. You may want to use modular packaging in your next construction project.

. . . W4WKM

Diode Modulators

Staff

One of the first points at which SSB construction details vary drastically from the older AM techniques is in the wide use of diode modulators with SSB.

This sometimes causes much head-scratching and consternation among sideband neophytes. Who ever heard of a diode being able to modulate a signal?

However, as many, many on-the-air signals will testify, it works. And it works quite well, if a few simple precautions are followed.

Before we dive into the depths of the several diode-modulator circuits available for our use, let's settle this question of how a diode can act as a modulator:

To do this, we'll have to back up and examine first the differences between ac and dc. For our purposes, the essential difference is that ac voltages go *equal* distances either side of zero on adjacent half-cycles. If you have an ac voltage which goes farther positive than negative, it's not true ac—rather, it's ac superimposed on a dc component.

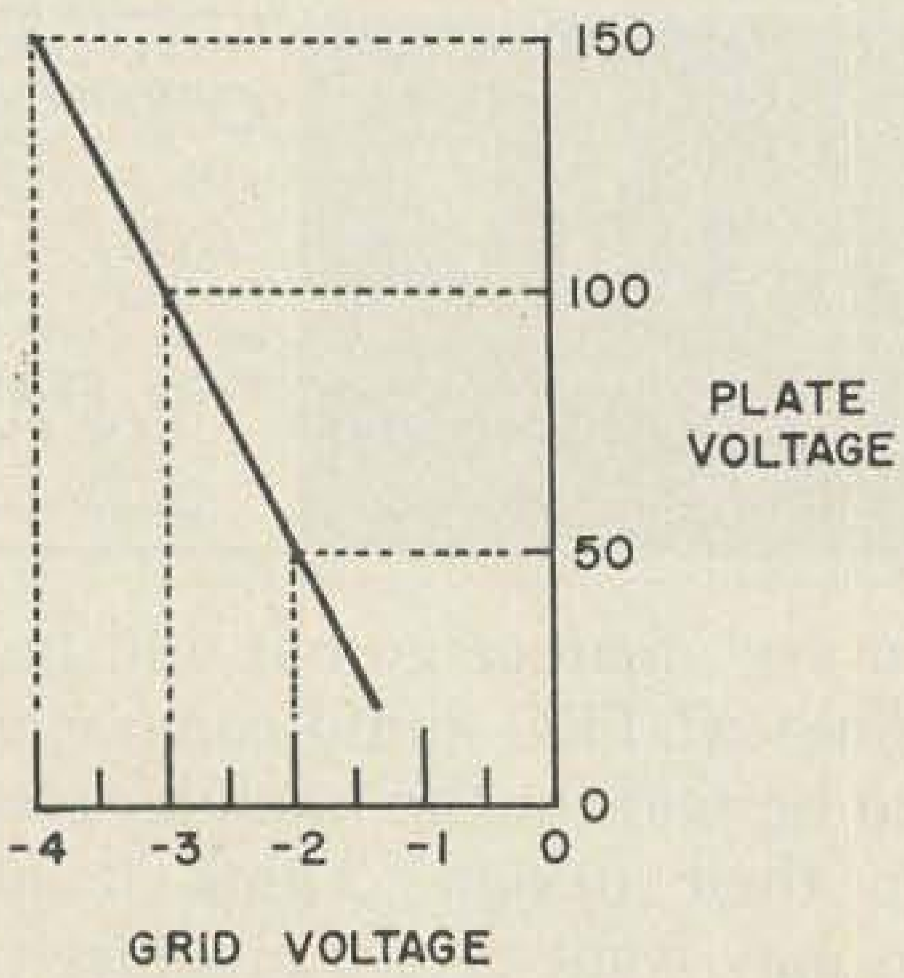


FIG. 1

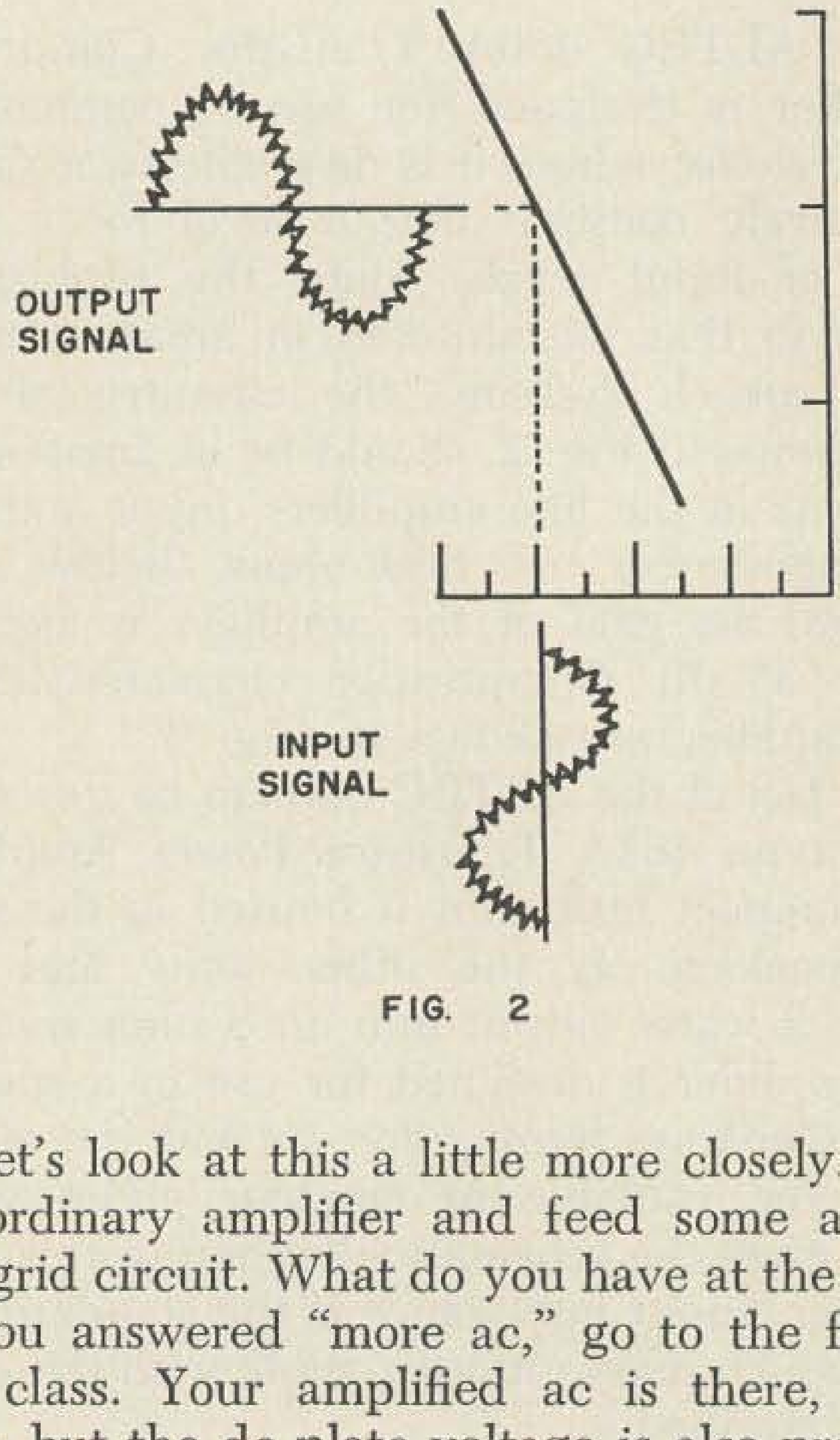


FIG. 2

Let's look at this a little more closely. Take an ordinary amplifier and feed some ac into the grid circuit. What do you have at the plate? If you answered "more ac," go to the foot of the class. Your amplified ac is there, to be sure, but the dc plate voltage is also present—and if the amplifier is working within its limits, the absolute voltage at any instant will never go below zero so the voltage at the plate cannot actually "alternate."

Now couple off the amplified signal from the plate, through a capacitor. What do you have now? The dc cannot pass through the capacitor, and as a result only the ac component gets through. It swings equally above and below zero; it is *true* ac.

What does all this have to do with modulators? To answer this, we have to draw a couple of pictures of "transfer characteristics."

The "transfer characteristic," for those unfamiliar with the term, is simply a graph which shows output voltage of a circuit in relation to input voltage. For a triode amplifier, it would read instantaneous plate voltage on the vertical scale in relation to instantaneous grid voltage on the horizontal scale (Fig. 1).

Taking that amplifier in Fig. 1, let's examine it. The graph says that when the grid voltage is minus 3, plate voltage is 100. When grid voltage is minus 2, plate voltage drops to 50. When grid voltage is minus 4, plate voltage rises to 150.

Such an amplifier is linear, in that the output voltage changes the same amount for equal changes of input voltage. What goes into a linear amplifier comes out unchanged.

Now, let's put two ac tones into the input of this amplifier (Fig. 2). The two tones are completely separate, and as a result neither of them is true ac; the higher-frequency tone "rides" the lower-frequency one. So far as the higher tone is concerned, the lower tone is its zero-voltage reference. But since the amplifier is linear, the tones come out unchanged.

At this point, let's take a look at the transfer characteristic of a perfect diode. It's shown in Fig. 3. Note that, unlike our amplifier, this characteristic is *not* a straight line. It has a sharp break in it; the sharper the break, the better the diode.

Now, in Fig. 4, let's apply those same two ac tones to the diode. When the input signal swings positive, the diode conducts and an output signal appears. When it swings negative, nothing happens. Thus, the output signal is *not* a replica of the input. The diode is said to be "non-linear."

Note that in all four illustrations, the output signal is *not* true ac. All have some dc components present. However, passing them through a capacitor will remove the dc and the output will then be true ac.

The output of the diode, when treated in this manner, becomes completely true ac; it's

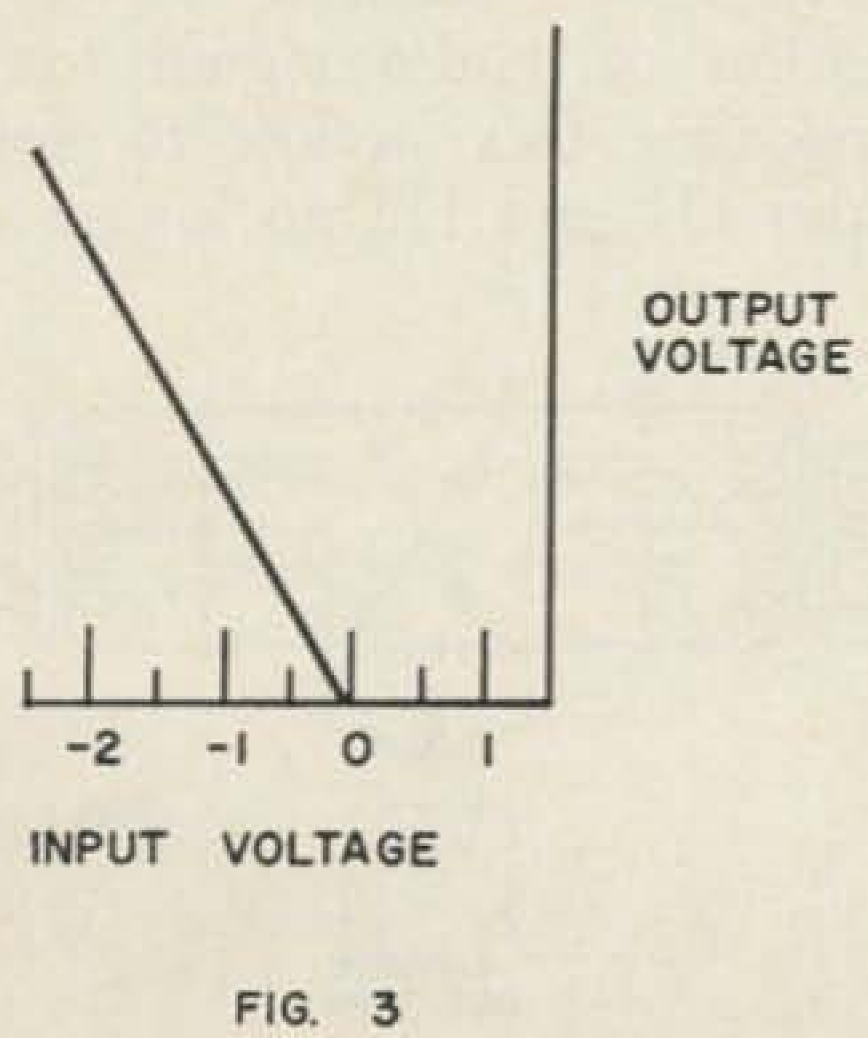


FIG. 3

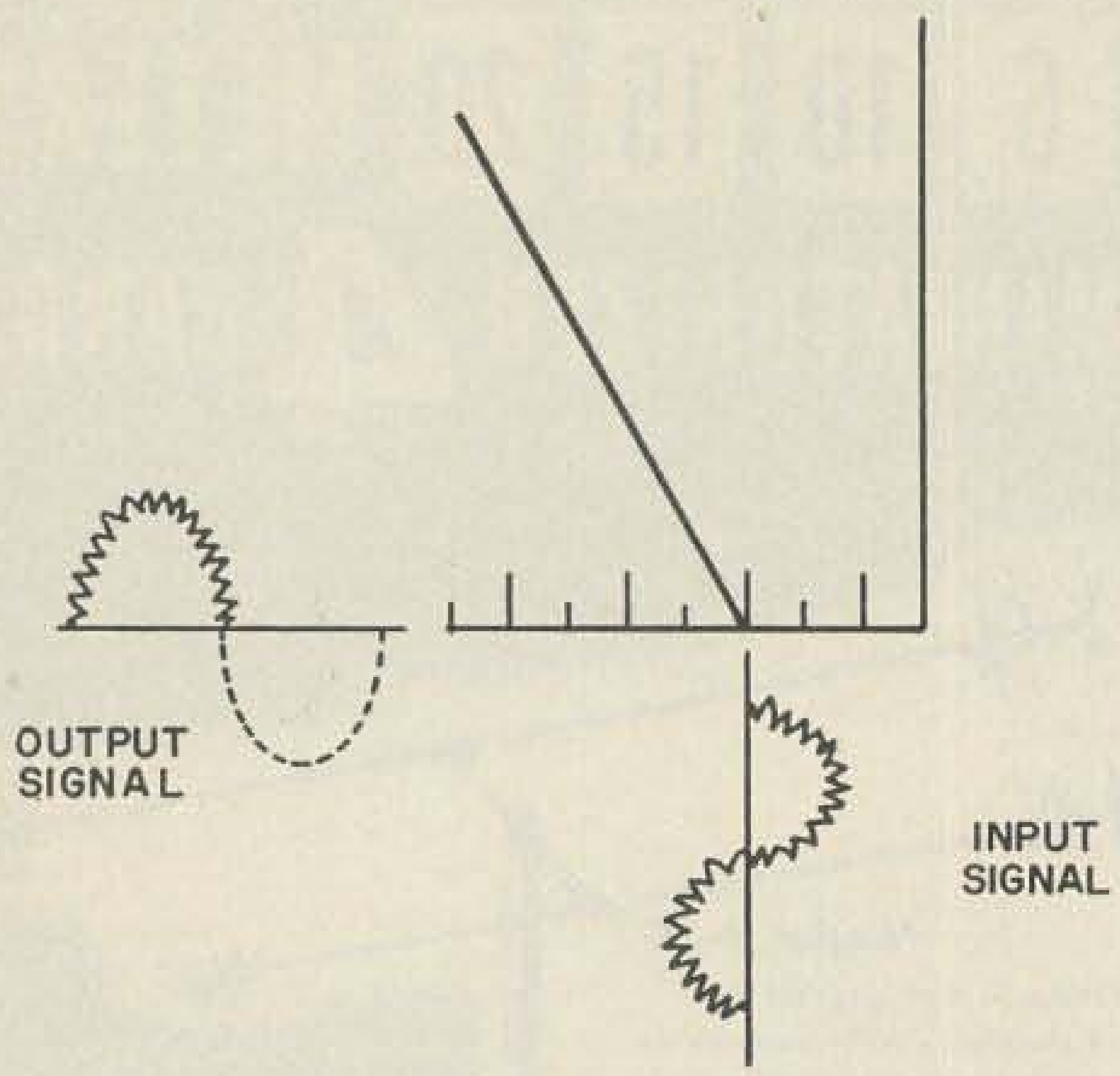


FIG. 4

no longer a pair of separate tones. The lower-frequency tone has *modulated* the higher one. And that's how a diode can modulate.

One point deserves careful attention. For our diode to act as described, the levels of all the signals must be very carefully controlled and bias level on the diode is also critical. This is never a difficult thing to do, but since it is so vital to proper circuit operation deserves this special mention.

The simple single-diode modulator we just discussed is a basic diode modulator. It could be used for amplitude modulation of a low-level signal, or for a mixer in a receiver, but it is not especially useful in sideband. In a sideband modulator, we want to get rid of the carrier at the same time.

A number of circuits which will do this have appeared in the literature, under the common family name of "balanced diode modulators." They may be divided for study into several categories, but unfortunately authorities differ on these categories.

Collins Radio Company, in their excellent manual "Fundamentals of Single Side Band," declare that only three types of diode modulators exist: ring, shunt, and series.

Going on to the ARRL publication, "Single Sideband for the Radio Amateur," we run into a fourth type—the bridge modulator. Except that this bridge modulator is identical to the one Collins calls a series circuit, and the circuit known as the series circuit in most references is not included in the Collins manual! Confusion is still rampant in the field, apparently.

So we won't try to classify the types here. We'll simply go through the published references, describe the workings of each, and list some advantages and disadvantages as reported in the original scattered descriptions:

The Ring Modulator. This modulator is usually referred to as the "classic ring" circuit, since it was developed by telephone engineers in the very early days of commercial sideband and is possibly the oldest balanced-modulator circuit. A typical ring-modulator circuit is shown in Fig. 5, and one suitable for ham use in the 455 Kc region appears in Fig. 6 with parts values.

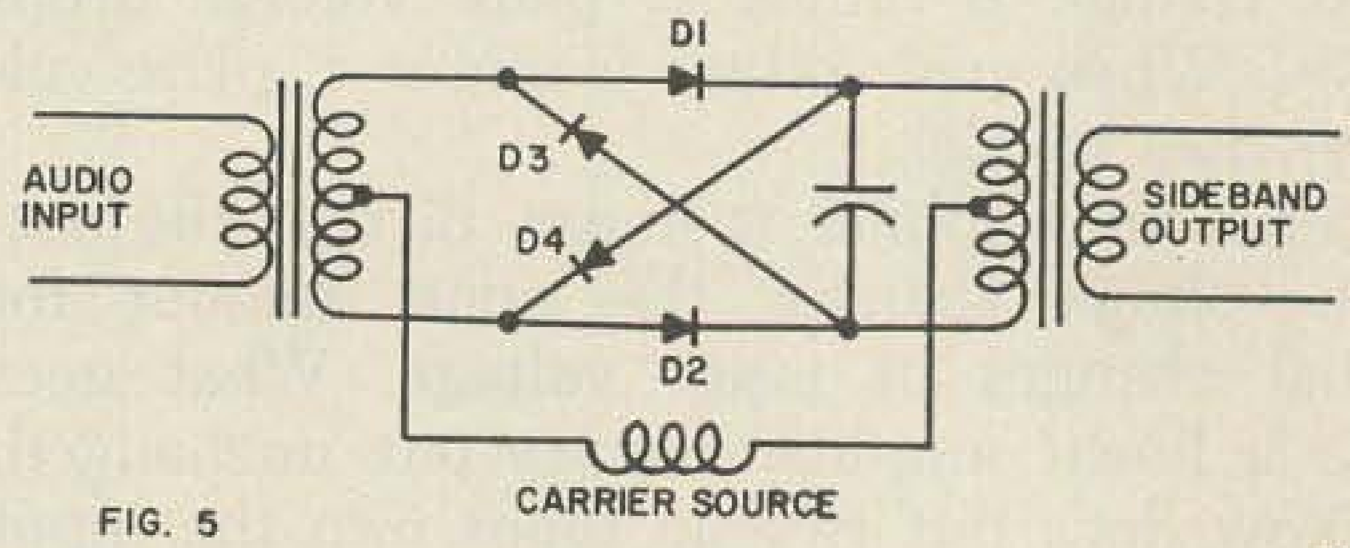


FIG. 5

According to the Collins reference, the ring modulator has the highest efficiency of all diode balanced modulators, being able to provide twice as great an output voltage for the same inputs as the other types of modulators. However, as Hooton points out, the diodes must be more closely matched in this circuit to obtain satisfactory carrier suppression than is necessary with other circuits which contain balance adjustments.

Here's how the ring modulator works: both the audio input and the sideband output are push-pull circuits, while the carrier input is single-ended. In the absence of any audio signal, the carrier is balanced out in the output tank. When carrier voltage at the audio-input center-tap is positive, rf current will flow through the output tank (from center-tap to both ends), D1 and D2, the audio transformer, and back to the carrier generator. When carrier voltage at the same point is negative, current flow reverses—but in either case, the current flow through the output tank is from center-tap to both ends at the same time. This means the potential at each end is the same, and with no voltage drop across the entire coil no output current flows.

Application of audio signal to the transformer modifies this action to some extent. Now diodes D1 and D2 no longer conduct at

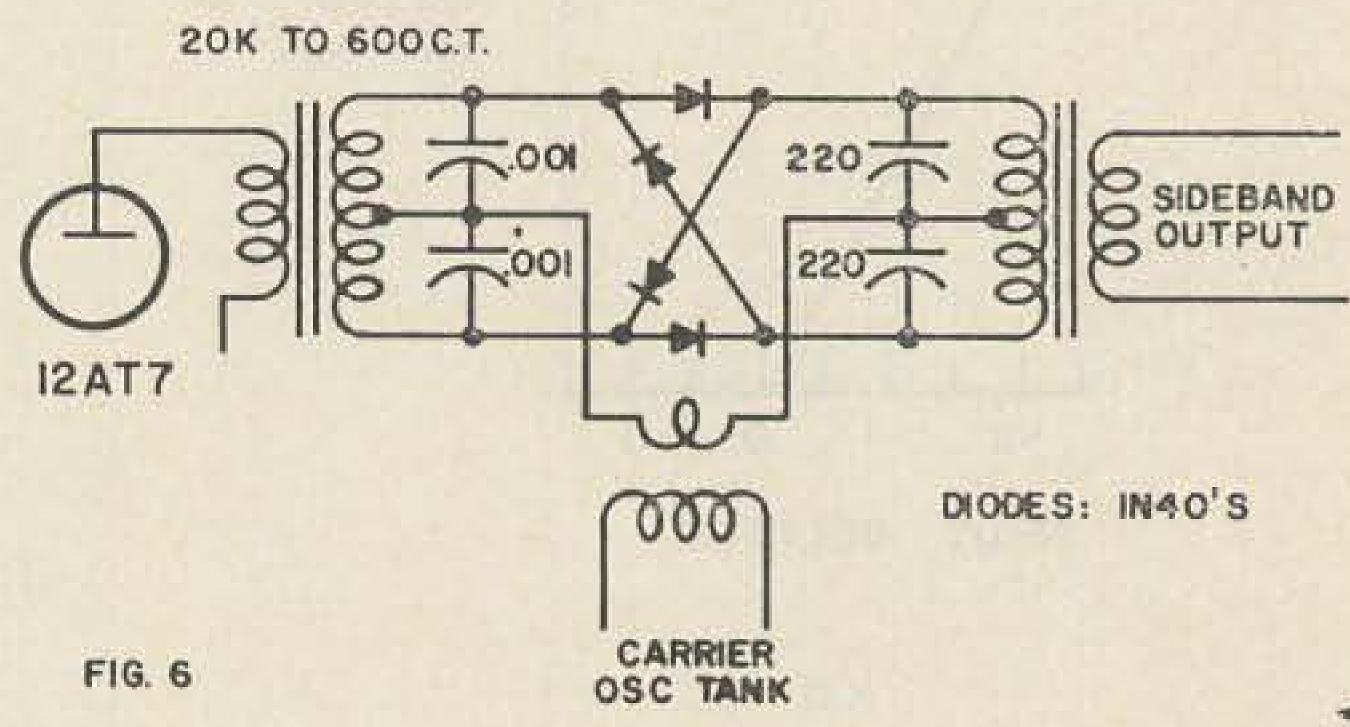


FIG. 6

exactly the same times; the one which tends to be turned "on" by the audio signal conducts for a longer time than does the one which tends to be turned "off." The same is true for D3 and D4. Now, current from the carrier generator flows for a longer period through one half of the output tank primary than through the other. The result is a series of pulses in the output circuit, whose polarity and frequency are determined by the carrier, and whose height is determined by the audio. After passing through the tank circuit, these pulses are not distinguishable from the sideband components of an AM signal.

Input and output impedances of the ring modulator are low, according to Stoner. Figures in the neighborhood of 600 ohms are usually quoted. For the audio input, a plate-to-600-ohm transformer is satisfactory; for the sideband output, much more capacitance than usually used would be indicated.

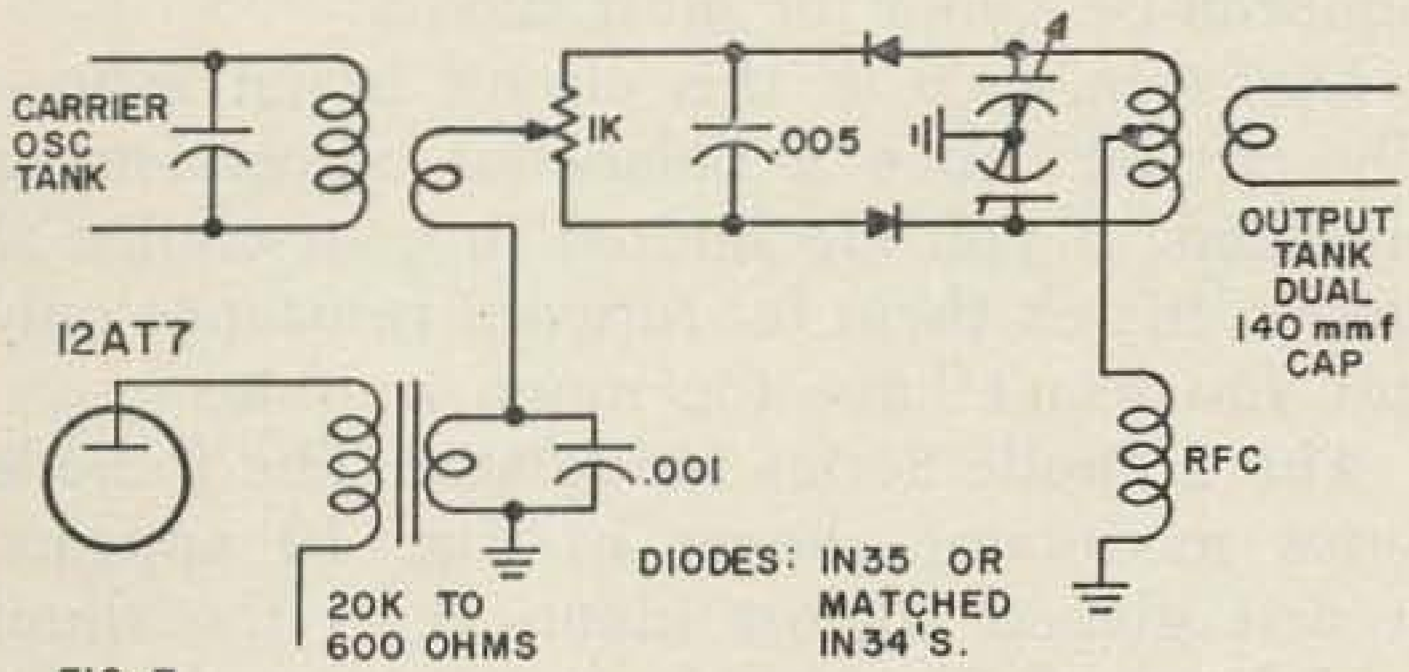


FIG. 7

Stoner describes also a "modified ring modulator" which was used in W2KUJ's "SSB-Jr." exciter described in a 1950 issue of GE *Ham News*, and later in the Central Electronics line. The circuit for this modulator is shown in Fig. 7.

In this circuit, carrier and audio frequencies are applied, in series, to the arm of balance pot R1. The voltages appear at each end of this pot, in ratio determined by the setting of the potentiometer, and pass through diodes D1 and D2.

In the absence of audio signal, the carrier passes through the bypass capacitor; this places the rf voltage across the diodes at the same level on each side, and as a result no rf current flows.

With audio applied, the diodes are unbalanced in the same manner described for the classic ring, and sideband-signal current flows through the output tank.

The rf choke from output-tank center-tap to ground is essential; without it, no carrier balance is possible. In addition, the audio transformer should be by-passed for the carrier frequency. The carrier-injection link usually has no effect on the audio.

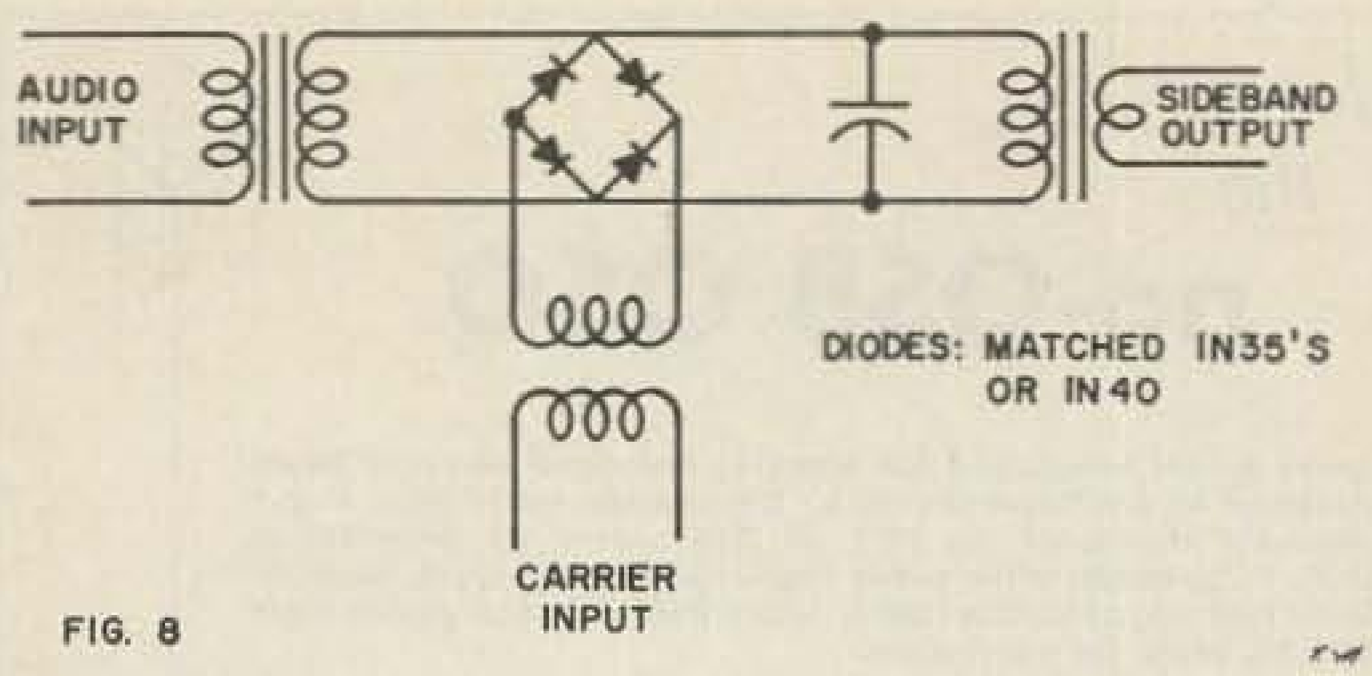


FIG. 8

The Bridge Modulator. For understanding more clearly how it's possible to balance the carrier out, there's nothing like a study of the bridge balanced modulator.

As the name implies, this modulator (Fig. 8) is based on the Wheatstone bridge, with diodes replacing the usual resistance arms.

Audio input and the sideband output are taken from the same set of terminals, while the carrier input is applied to the remaining terminal set. If all diodes have identical characteristics, the bridge will be in balance at all times (if no audio is applied) and the carrier will find no path to the output.

However, application of audio will affect the diodes in the upper half of the bridge differently than those in the lower half, because of diode polarities—and the bridge is no longer balanced. The signal finds its way from carrier input to sideband output.

To understand how this is sideband signal, rather than pure carrier, you have to go back to the basic diode modulator and note that all signals reaching the output consist of *both* audio and carrier, and all have passed through at least one diode before reaching the output.

The bridge is seldom used in practice any more, since it (like the classic ring) requires four diodes and equally satisfactory results may be had from either the modified ring, the 2 diode shunt, or the 2 diode series modulators. For this reason, no "practical circuit" with parts values is included.

The 2 Diode Shunt Modulator. The 2 diode shunt modulator is similar to the bridge type except that the two lower diodes are replaced by a push-pull carrier input. A typical circuit is shown in Fig. 9.

The key feature of this modulator is that the carrier signal causes the diodes to short out the audio signal. Depending on carrier-half-cycle polarity, the pulse in the output tank will be either positive or negative going. For the shunt modulator to operate properly, great care must be taken with circuit impedances.

For instance, all diodes (in practice) have some forward resistance. Their back resistance, also, while high is not infinite. Thus, if the audio signal source impendance is too low the diode will not "short it out," while if audio impedance is too high the inactive diode will still tend to short out the signal.

This is the reason for the 1,000 ohm resistor shown in Fig. 9. It establishes 1,000 ohms as the circuit source impedance. This is a good compromise value for most diodes.

Diode balance in this circuit is not especially critical, since a balancing adjustment is provided. If you are limited in your choice of diodes, match them for *forward* resistance only and you won't have too much trouble.

The 2 Diode Series Modulator. The 2 diode series modulator shown in Fig. 10 appears, at first glance, almost identical to the shunt modulator of Fig. 9. However, it works in a radically different manner.

Where the shunt modulator uses the carrier to short out the audio, the series modulator uses the carrier to establish a signal path through which the audio can travel.

So far as we have been able to determine, this circuit was first described by Fred Berry WØMNN in the September 1952 issue of QST. It has since been republished in almost all sideband manuals.

Like the shunt modulator, this circuit requires fairly well matched diodes so far as the forward-resistance characteristic is concerned. However, this resistance need not be excep-

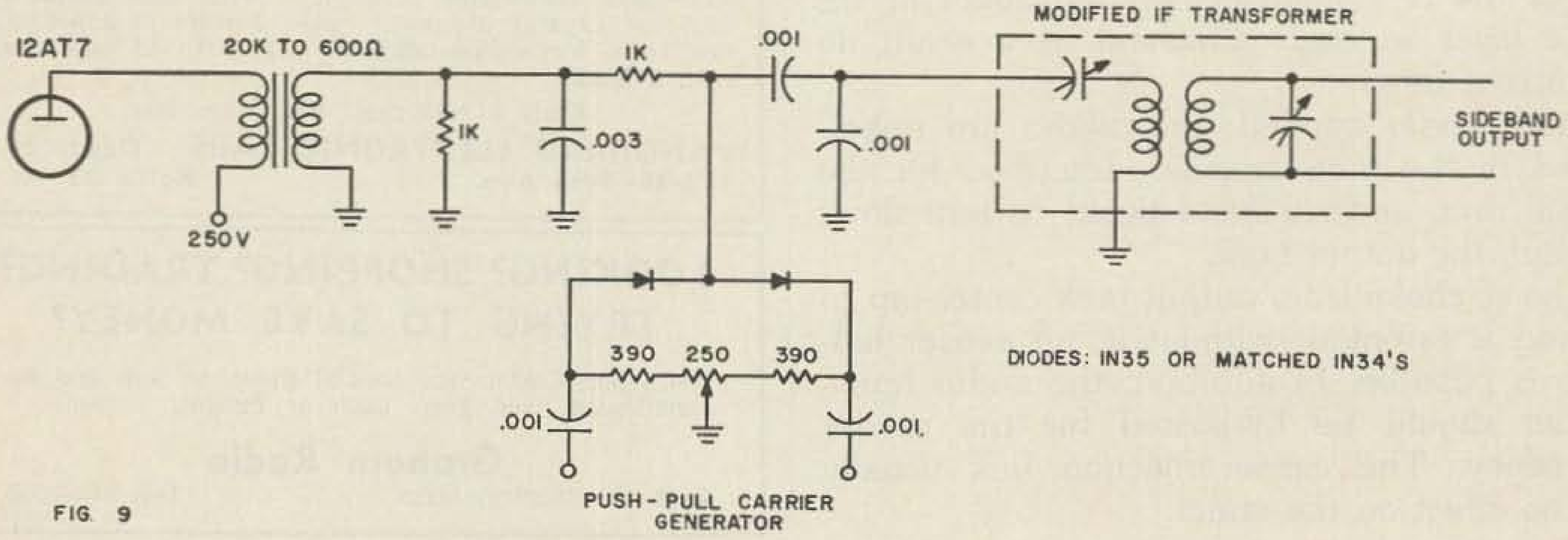


FIG. 9

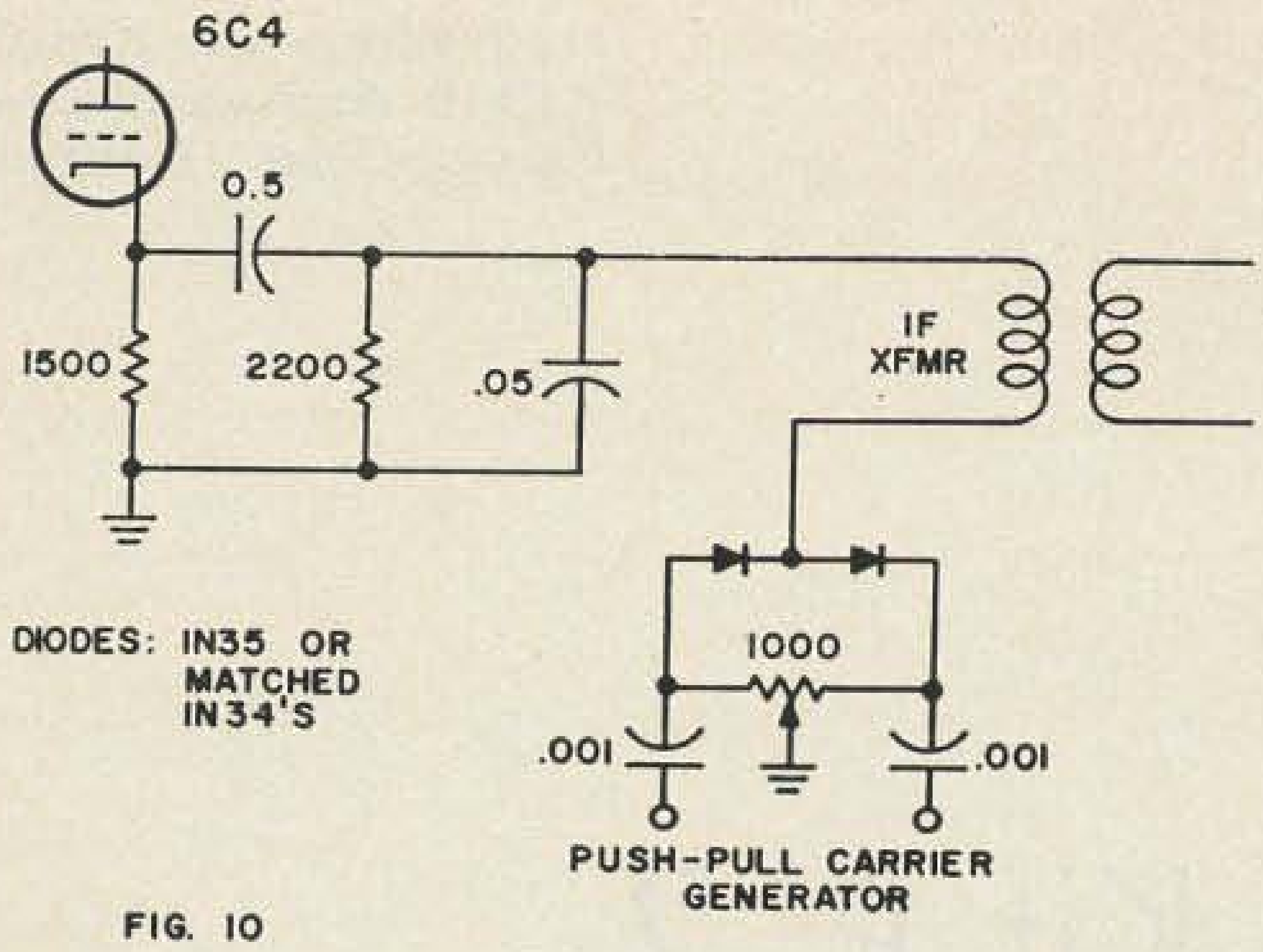


FIG. 10

tionally low; the original circuit used vacuum-tube diodes instead of semiconductors!

The major disadvantage of the series or shunt modulators is the requirement for push-pull carrier injection. In a filter-type exciter, this is no particular problem, and as a result these modulators are widely used in filter rigs. However, phasing becomes slightly more difficult with these circuits—so most phasing rigs end up using the modified ring circuit which allows single-ended carrier injection.

Up to now, we have simply discussed the circuits without much mention of their place in the overall scheme of sideband. Naturally, the major use of diode modulators is in generating the original set of sideband signals from audio and a carrier—and in all our descriptions we have taken this for granted.

But the balanced modulator has many other uses; it can be used anywhere you would use a mixer (mixing and modulation are two names for the same process) and frequently such use makes circuit design much simpler.

In a receiver, using a balanced modulator means you have one signal (the local oscillator) you don't have to worry about getting through the *if*. As a product detector, a balanced modulator eliminates any worries about overloading the audio section with the BFO injection.

However, diode balanced modulators are only half the story. Balanced modulators can be—and are—built with active devices such as tubes and transistors, also. Such active modulators offer a wider variety of subjects—and that's the subject of the next instalment.

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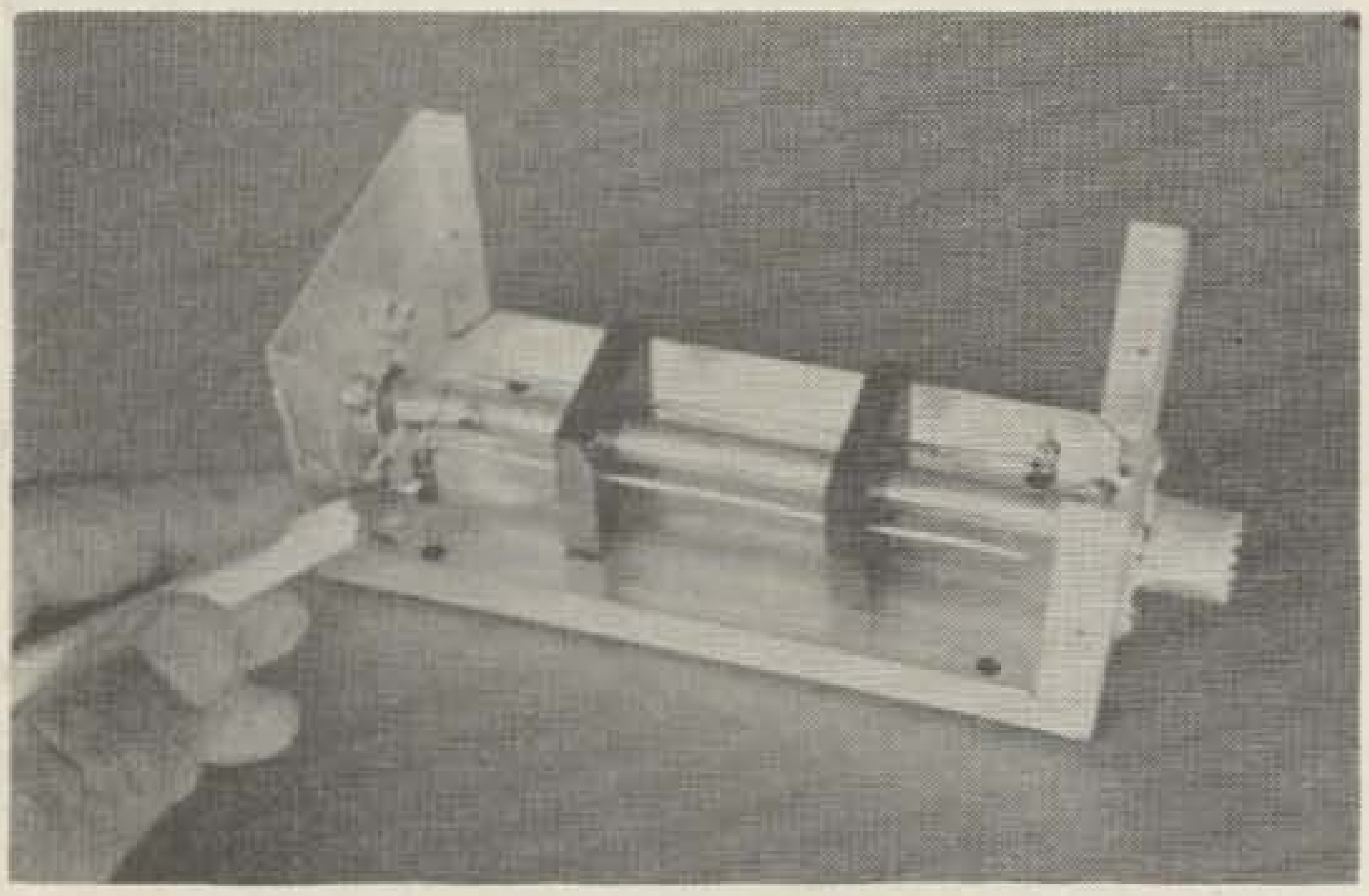
Fred Blechman K6UGT
23958 Archwood Street
Canoga Park, California

73 Tests

the Knight-Kit P-2 SWR/Power Meter

Standing wave ratio is a subject of discussion and controversy on the amateur airwaves, and is of special concern to those limited in transmitter power. Like the weather, everyone talks about swr, but no one seems to know much about it! However, Allied Radio (100 N. Western Ave., Chicago 80, Illinois) has just made a new Knight-Kit available which is bound to stir up the curiosity of newcomers and old-timers alike regarding swr.

The P-2 SWR/Power Meter Kit (Catalog # 83 YX 627R) sells for $14.95, and consists of two units, a 2 x 5 x 2½ inch coupler and a 2⅞ x 6¼ x 3 inch indicator, connected by a 4-foot shielded cable. Standard SO-239 rf coaxial receptacles are part of the coupler unit, which may be left in the transmission line permanently with negligible power loss.



The "coupler" is built in a separate enclosure, with standard coaxial connectors to allow convenient attachment to the transmission line.

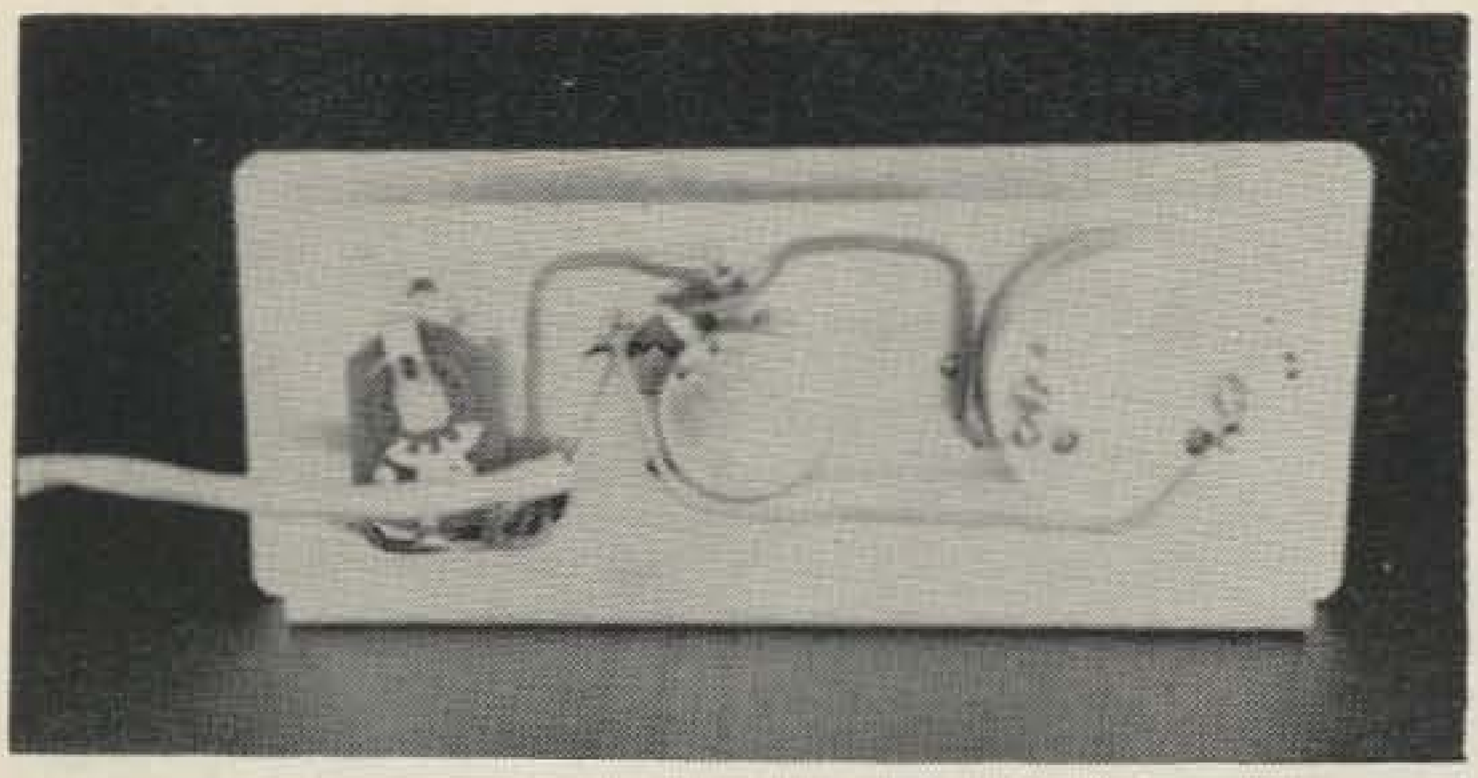
The resistor value used depends on the impedance value of the transmission line with which the coupler is to be used.

The coupler may be assembled for use with either 52 or 72 ohm coaxial transmission line, and may be used from 3.5 to 432 megacycles. No external ac power or batteries are required for its operation. It will handle a kilowatt of rf power, yet requires less than a watt at 432 mc for a full scale reading of the 100 microamp meter in the indicator unit. Unfortunately, the red and black meter scales are on a gray background (to match the unit two-tone gray color scheme); a white meter background would enhance visibility in subdued lighting, since the meter is not illuminated.

Assembly of the units is very clearly shown in the detailed assembly manual and the photos accompanying this article. No real problems were encountered in the construction, which takes about 1½ hours if done carefully, as it should be. The author's unit worked perfectly when completed, and no adjustments were required.

During construction of the indicator unit, it would be wise to mount the knobs on the power switch and sensitivity potentiometer shafts right after placing the meter dress panel on the meter sub-panel. This makes it much easier to handle the panel as it is being installed in its case. The black sheet metal screws used to hold the rubber mounting feet are rather brittle, and should be installed without too much "brute force" to avoid breaking the tips of the screws. Also, avoid over-tightening these screws, or they will go *through* the rubber feet; just tighten until the feet are snug, or use a flat washer under the head of each screw.

When assembling the coupler, the place-



The complete wiring of the indicator subpanel involves only a few wires, and a 2-conductor shielded cable which goes to the coupler unit.

ment of several of the parts is critical, and the instructions should be followed closely. Two sets of resistors are supplied with the unit. If you intend to use the coupler with 52 ohm transmission line use the 160 ohm resistors; for 72 ohm line, use the 100 ohm resistors. If the parts tend to shift during handling, use pencil marks on the copper rod and chassis to allow you to return the parts to the proper location when ready to solder. The coupler has no markings on it, and it would be wise to mark J1 XMTR on the end with the connecting cable, and J2 ANT on the other end.

The schematic diagram of the P-2 SWR Meter is shown in Fig. 1. The design of the instrument follows that of the time-proven and justly popular Monimatch of QST and ARRL Handbook fame. This instrument, sometimes known as a reflectometer, consists of a short section of coaxial transmission line with two pickup loops which are connected to rf voltmeter circuits. One of these circuits is so positioned with respect to the center conductor of the transmission line section as to read the incident or forward power component of voltage in the line while the other reads the reflected component. In the P-2 instrument, the circuit associated with diode CR-1 is the forward power voltmeter and the circuit associated with CR-2 is the reflected power voltmeter. Resistors R-1 and R-2 must be adjusted to match the characteristic impedance of the line being measured to balance out the undesired voltage component. In use, the instrument is switched

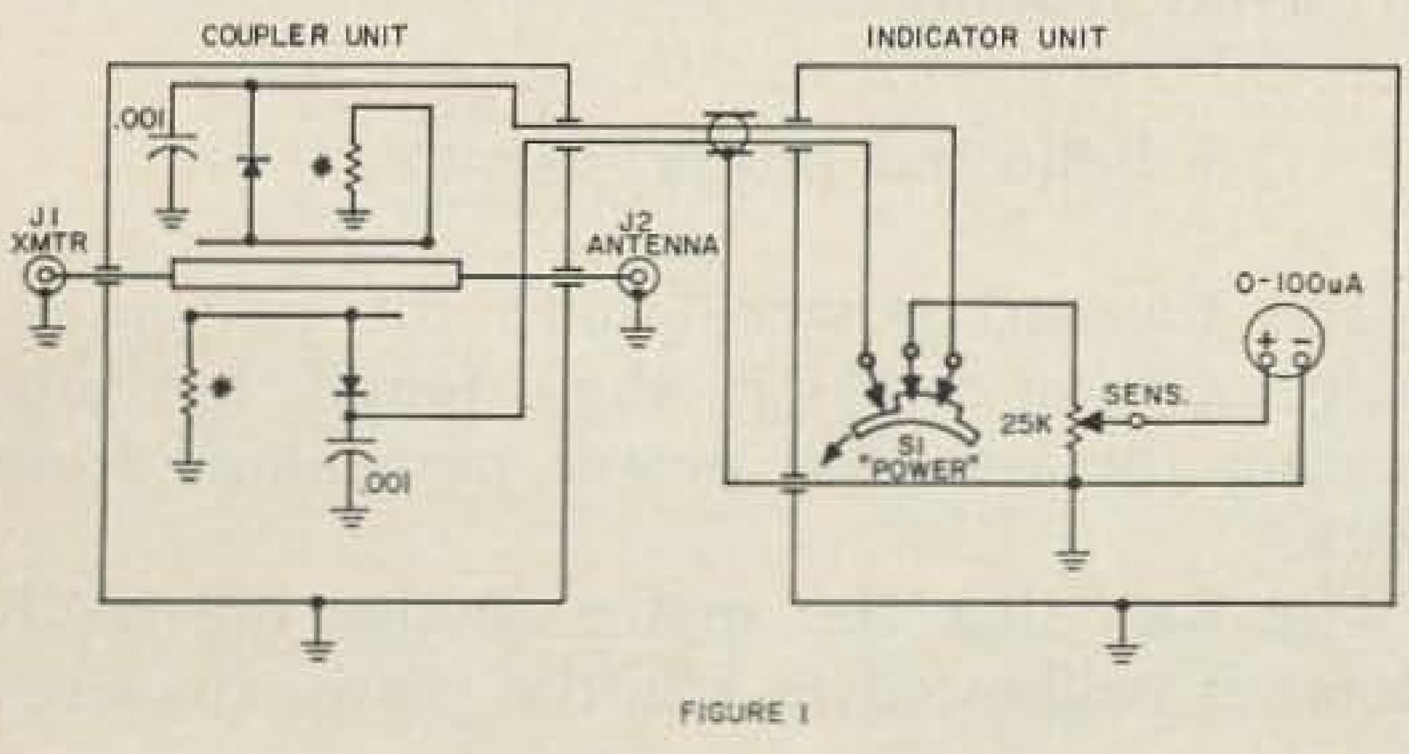
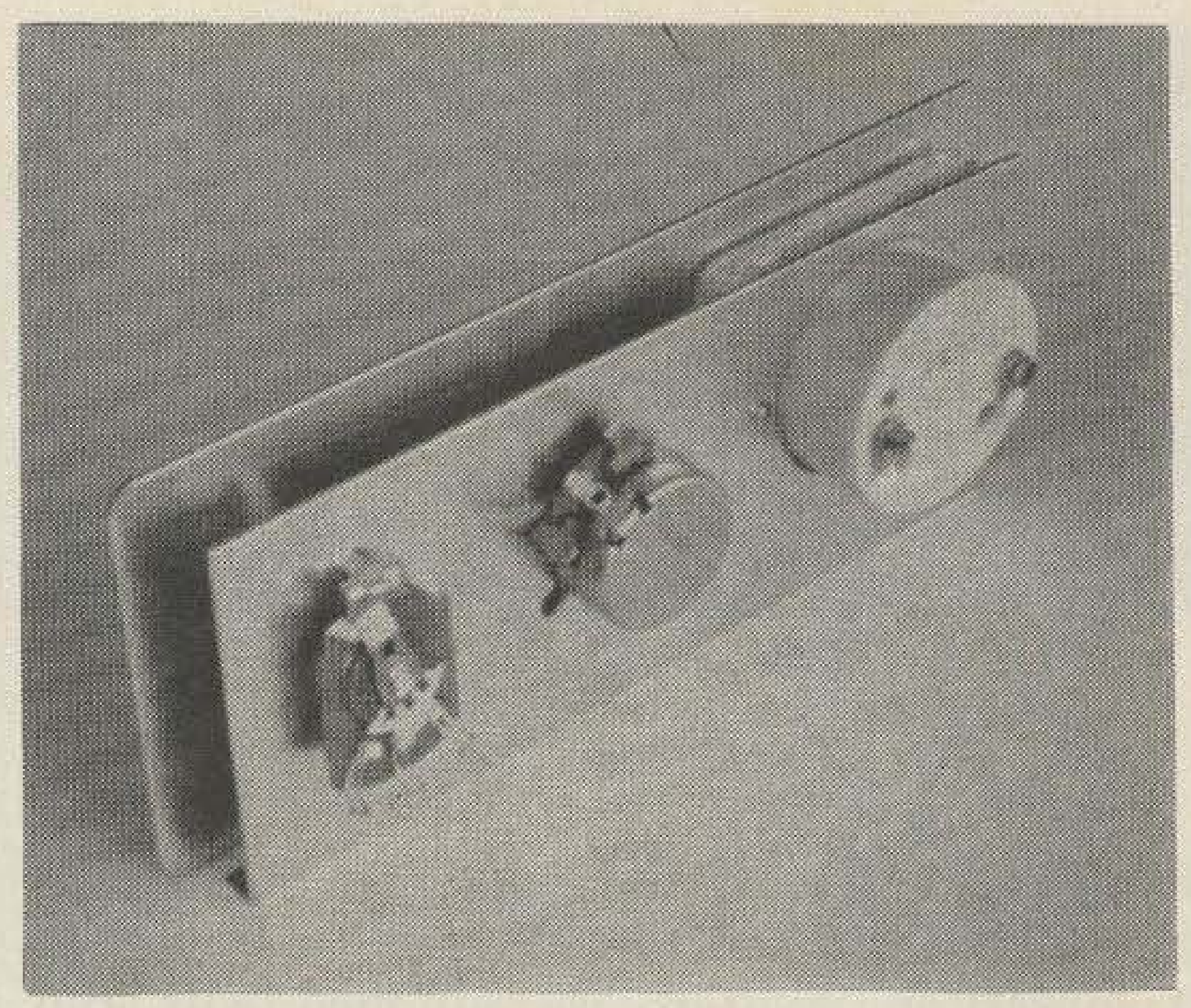


FIGURE 1



The indicator unit contains a sub-panel to hold the meter, switch and pot, with a "dress" panel for the nomenclature.

to the forward power position and the sensitivity control adjusted for full scale meter deflection. The instrument is then switched to the reflected power position and the existing standing wave ratio read directly from the meter scale.

In use, the J1 receptacle of the coupler is connected to the transmitter output connector (using a jumper cable or a double-male connector) and J2 goes to the transmission line feeding the antenna. The transmitter is turned on and tuned in the normal manner, with the sensitivity control on the indicator unit positioned to keep the meter on scale. (The swr meter Power switch must be in the Forward position. You can peak your transmitter output very conveniently by tuning for maximum deflection of the swr meter). Adjust the sensitivity control, once you are tuned up, so the meter reads CAL. (full scale). Now switch the Power switch to Reflected, and read the swr directly on the meter top scale. Although the operating instructions fail to mention it, the REL. POWER scale of the meter, if multiplied by 10, reads the percentage of reflected power! Notice that only 11% power is reflected at an SWR of 2.0, and 25% is reflected at SWR of 3.0. You may calculate the reflected power percentage quite simply from the SWR reading:

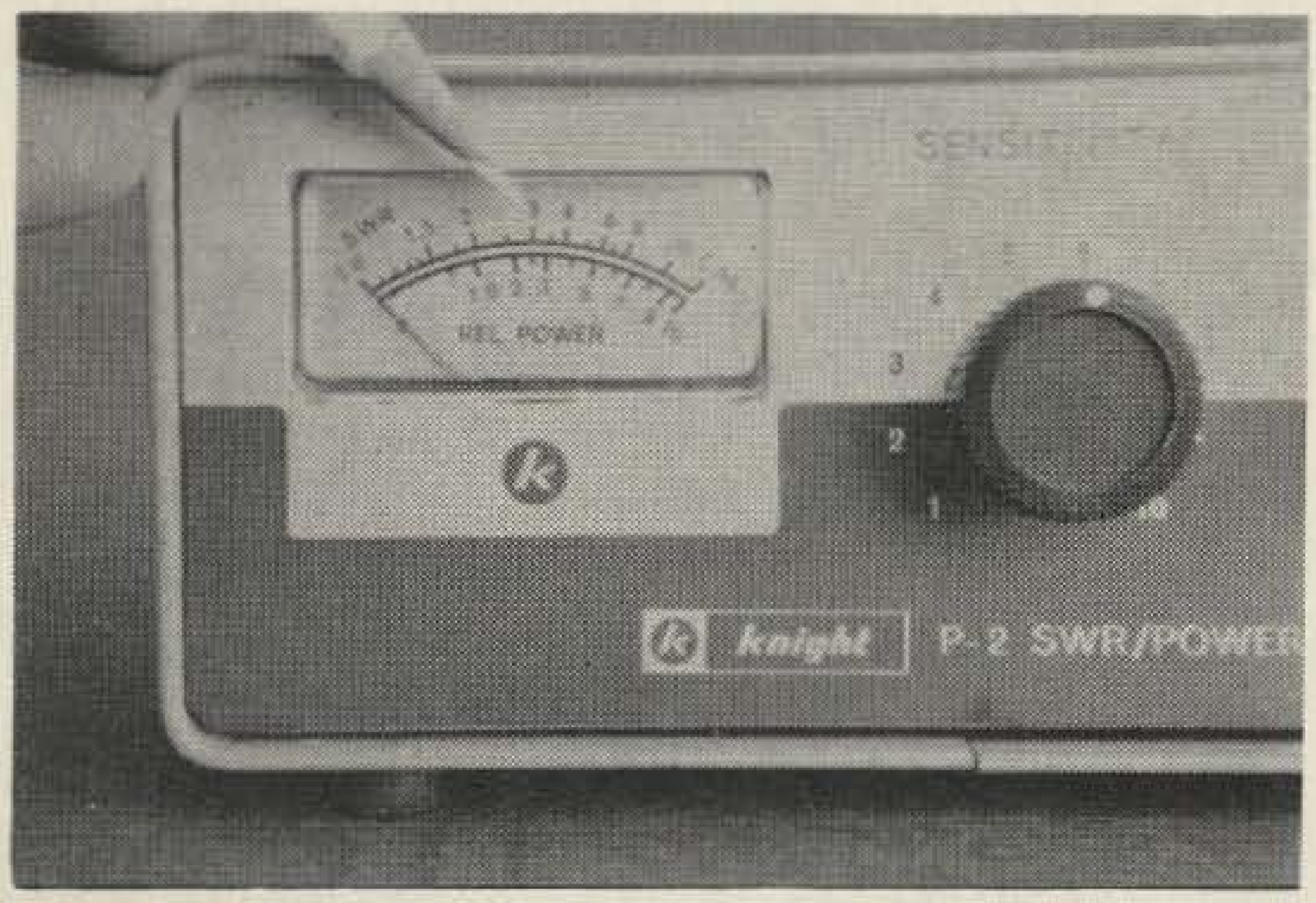
$$\% \text{ Reflected power} = \left(\frac{\text{swr}-1}{\text{swr}+1}\right)^2$$

The forward power (that's the power actually getting out) is then found by subtracting the reflected power percentage from 100%.

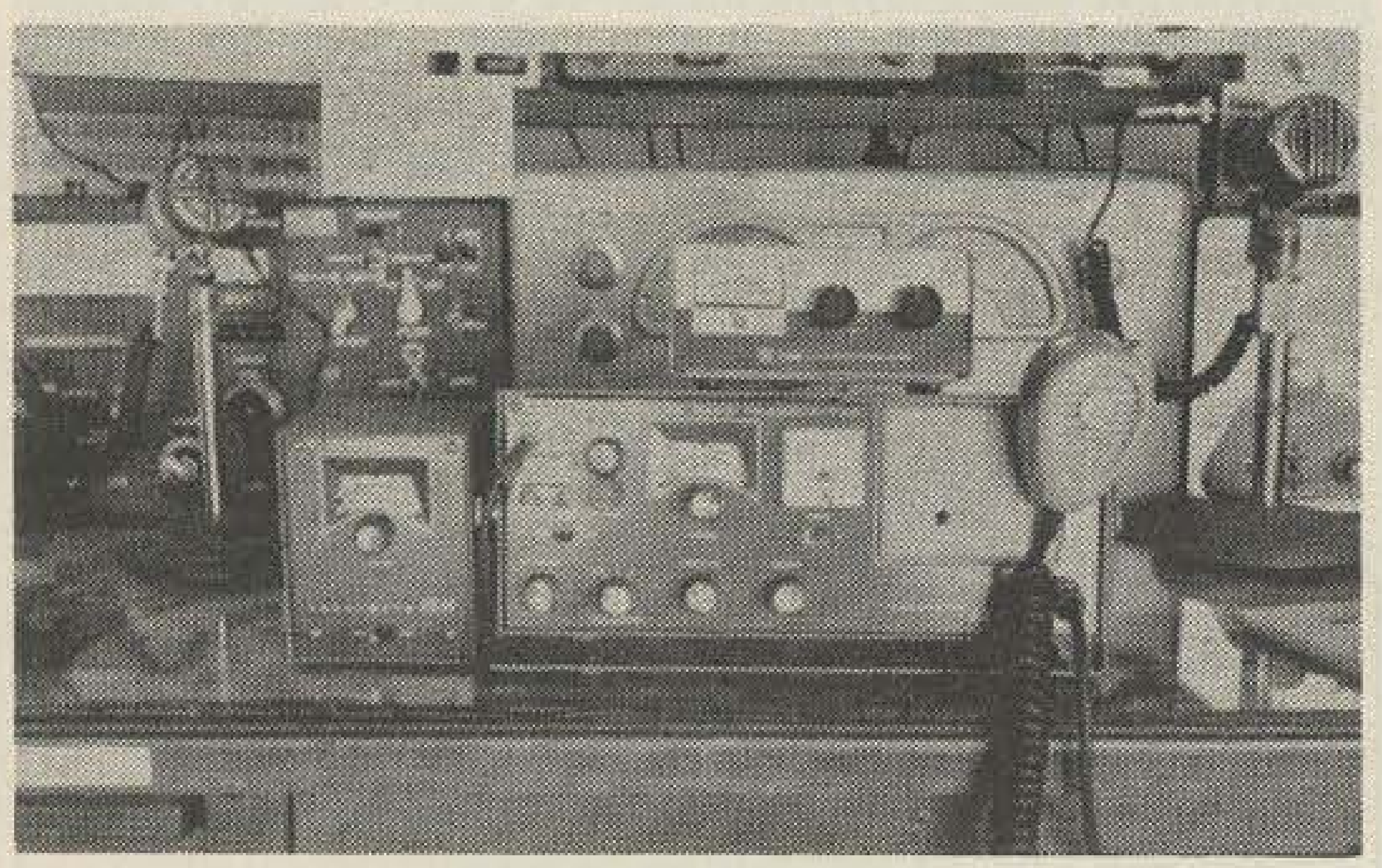
The fact that the meter of the P-2 SWR Meter is calibrated in relative power deserves some explanation. The reflectometer type of SWR meter is quite dependent on frequency for any given output indication. Note that 45 watts is required for full scale deflection at 1.8 mc while only ½ watt is required for full scale deflection at 432 mc. This ratio is perfectly normal for this type of meter. However, it prevents the inclusion of absolute power scales in an all band instrument. Despite this, the relative power scale is quite convenient for transmitter tuning, etc.

The calibration of the completed unit may be checked several ways. The instructions go through an alignment procedure which requires a non-reactive dummy load. At the higher frequencies and for high power this might pose a problem. A simple way to make a quick check is to *reverse* the coupler in the transmission line, connecting J2 to the transmitter output, and J1 to the transmission line. Now set CAL on the meter with the Power switch in the Reflected position, and read swr in the Forward position. If the same swr is obtained as using the coupler the correct way, the unit is well balanced. If not, the position of the diode connections to the pick-up wires in the coupler must be adjusted slightly, as described in the manual. The author's unit required no adjustments.

Be careful about quoting your swr readings with too much certainty. You see, it just so happens that the swr read at the transmitter is *always lower* than the actual swr at the transmitter. The reason is simple: the forward power is attenuated on its way to the antenna by line loss, and the power reflected at the antenna is also attenuated by the transmission line on its way back to the transmitter. Therefore, the percentage of reflected power reaching the swr meter is less than it should be, compared to the outgoing forward power.



The meter is calibrated to SWR of 20. The lower scale, multiplied by 10, reads percent reflected power. For example, at SWR of 3, 25% power is reflected from the load.



A typical "neat" station!

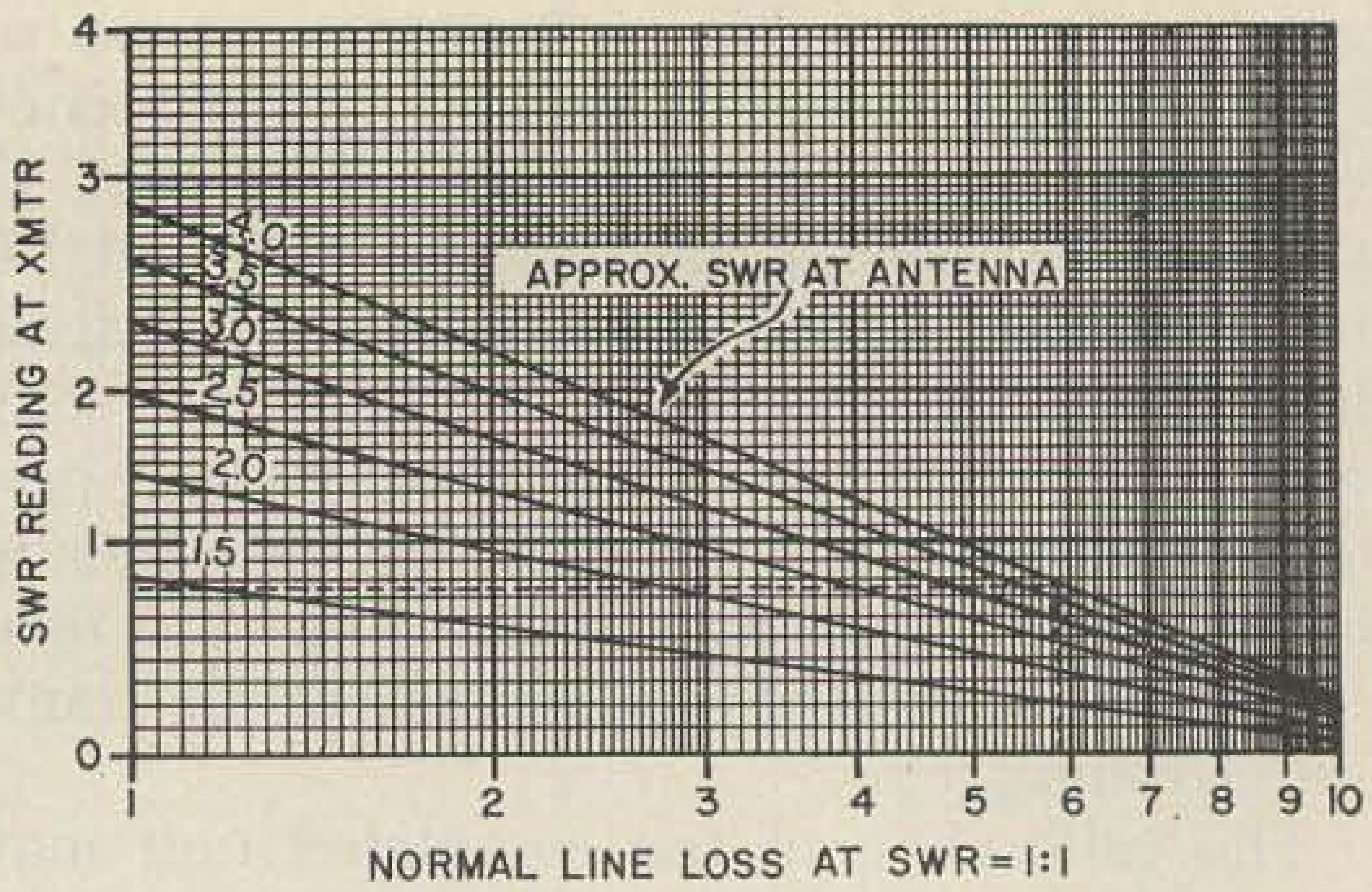
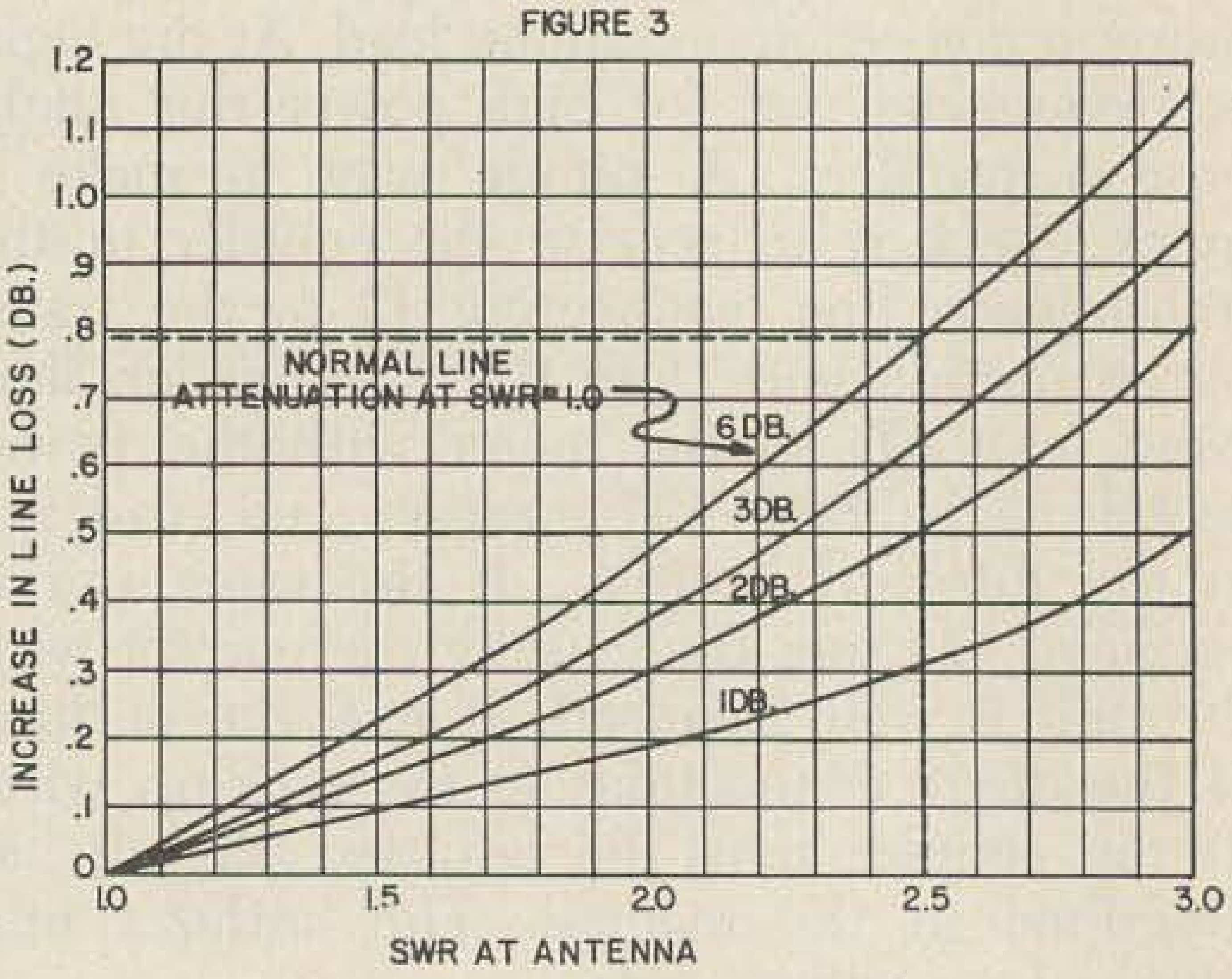


FIGURE 2

FIGURE 3



Since the swr meter is usually located at the transmitter, this variation can be considerable. Look at Fig. 2 for a shock. If the basic transmission line loss (at swr of 1.0) is 6 db, and the swr at the antenna is 4.0, the swr meter will only read 1.37. You can estimate your basic line loss from tables that list the loss per 100 feet for different types of transmission line at various frequencies; the *Radio Amateur's Handbook* has this information in a graph in the transmission line section.

Swr has a couple of other villainous features: it increases your transmission line loss, and lowers the power limitation of the transmission line. Fig. 3 shows the added loss to a transmission line due to swr. For example, if the line loss at swr of 1.0 is 6 db, but the actual swr at the antenna is 2.5, the line loss will be increased by another .79 db. At higher swr this effect can be a lot worse; at swr of 10, with a basic line loss of 6 db, the increase in loss will be 4.5 db. As for the power limitation, caused by the increased peak voltages of the standing waves, the allowable power is equal to the rated power (at swr of 1.0) divided by the swr:

$$\text{Allowable power} = \left(\frac{\text{Rated power}}{\text{swr}}\right)$$

Generally speaking, unless you have high transmission line losses to begin with, an swr of 3.0 or less will make very little difference at the receiving end. Remember, one S unit is 6 db. at the receiver. But it all makes for good conversation on the air.

Specifications of the Knight-Kit P-2 SWR/Power Meter

Minimum rf power for full scale deflection	**45 watts at 1.8 mc** **½ watt at 432 mc**
Maximum rf power	**1 kilowatt**
Input and output impedance	**52 or 72 ohms**
Power requirements	**none**
Frequency coverage	**1.8 to 432 mc**
Meter sensitivity	**100 microamperes full scale**
Meter scales, standing wave ratio	**1:1 to 20:1**
Relative power	**0 to 10**
Kit assembly time	**1 to 2 hours**
Cost	**$14.95 in kit form**

(NSD/1 from page 57)

got the QSL Club was this: "It is not permissible for two or more persons . . . to establish a system . . . to reduce the amount of postage they pay, by assorting, grouping and mailing in one envelope their . . . letters to be forwarded to one customer . . ." This means that it is illegal for a person or group to receive bulk mailed QSL's, sort them out and remail them in groups to the addressees. This is terrible.

How come our government is blasting away at monopolies wherever possible in business and yet chooses not to practice what it preaches. It seems to me that some competition could do the P.O. a lot of good. If they had to automate to keep business going they would soon be able to give us service on the order of that which you get in Europe . . . and they make our service look sick.

Boy Out Back

Last month, in a burst of enthusiasm, CQ's publisher opined that they actually have more active hams reading CQ than QST. Since we only have their hilarious "sworn statement" to go by . . . their true print run and circulation are closely guarded secrets . . . we have to figure out what is going on by other indications.

For instance I judge by little things such as the dropping number of ads, the tremendous falling off of mail-order advertising which is a sure indication of the effectiveness of a magazine, the inability to continue providing the half-cent wrapper for subscriber copies, the cutting down for the first time in years from 128 pages to 112 pages, the use of the cheapest paper I've seen yet in a ham magazine, the loneliness at CQ booths at conventions, and leaks from members of the CQ staff.

Putting all this together with candid comments by advertisers who have compared results recently between the two magazines I come to the conclusion that QST must have about 2.3 times the circulation of CQ.

K2CM Absolved

Tom McCann K2CM thought I went a little too far in rewriting his review of the Waters Coaxial Switches in the April issue and wants everyone to know that this piece, which he calls "the most inept piece of writing which throughout that I have ever read on a printed page" was written by me and not him.

. . . W2NSD/1

73 Tests The

Wayne Green W2NSD/1

Listening in on our bands, one might be inclined to suspect that amateurs are incapable of agreeing on anything. There is one area of rather complete agreement however: our bands are miserably crowded.

There are many approaches to meeting the challenge of trying to get through the QRM curtain. Some chaps string up one antenna after another, others build up rather impressive final amplifiers, some just build bigger modulators, some wait until the wee hours of the morning, etc. But, even after you've moved to that salt marsh on top of the mountain, put up the hundred foot tower with the twelve element beam, and done everything else known to man to put out a signal, there is still an area for improving the punch your signal puts into that DX receiver.

Naturally you can get the same improvement in punch with any rig. The idea is to increase the percentage of modulation or (in the case of SSB) the average power output without creating the splatter that accompanies your turning up the gain control. When you try to get through a little better by increasing your mike gain you flattop on the positive peaks and clip on the negative peaks. The result is a bandful of furious hams and not much improvement in your ability to get out.

There is, of course, nothing really new about using clippers or compressors to increase the modulation percentage of transmitters and many designs of both have been around for a long time. The Metrodynamics Compreamp is a much more modern application with a two transistor logrithmic compressor, matched silicon diodes in the clipper and a cleverly designed RC filter to eliminate the harsh resultant frequencies usually associated with clippers. The result is a smoothly working compressor which connects between your mike and your mike jack.

It is obvious that the Compreamp will change the sound of your voice a bit as more compression is used. Thus you would normally run it with the control in the off position and would increase the compression when fading or QRM become apparent. It sometimes seems almost magical how your voice can get through a seeming solid wall of QRM even though you may be running lower power than a lot of the big boys on the channel . . . unless, of course, one of the big boys has a compressor too.

The Compreamp is small, being transistorized, and costs only $13.95 complete with built in battery. Write Metrodynamics Corp., 8 Westover Avenue, Caldwell, New Jersey for info.

. . . W2NSD/1

LETTERS

Dear Wayne:

Just a couple of thoughts in connection with your proposed junket to Europe this fall. First, I think it is a wonderful idea and all those able to go along should have a wonderful time.

The only fly in the ointment appears to be your choice of a foreign carrier.

What is the matter with a good old US carrier? You know the airlines of this country are having a hard time filling their seats and feeding all the people necessary to operate an air carrier. Just think of the money spent by these airline people for everything from ham gear to groceries.

Another factor is the balance of payments. Our gold is melting away at an alarming rate and it is just such deals as you are cooking up that helps us get further in the hole in this area.

A very large percentage of the fare money will do no one any good in this country, it will go over seas along with the other millions we spend or give to them.

So, while you are pacing up and down your office just think about this a little and I think you will agree that I have a point some where in here.

Only wish I could go with you . . .

. . . R. C. Multon WB6BFR

Yep, it sure is too bad you can't go . . . and maybe find out a little bit of what the world is about. Our gold is melting away because we have inflation here and the U. S. dollar is weakening. I have watched the dollar shrink to a 25c piece in my short lifetime. I work a lot harder for the few dollars I have than most people even imagine and it infuriates me to have Uncle Sugar give them away, but every infuriates me to have Uncle Sam give them away, but every time I spend a dollar in Europe that is a dollar that doesn't have to be sent over as a gift . . . I like it a lot better that way. Now, regarding the use of Sabena Belgian Airlines for our trip . . . let me tell you about that. After letters and phone calls to all U. S. trans-atlantic airlines I found that only Pan Am could handle the cities that we are going to visit. After many phone calls, letters and a personal visit to the New York HQ of Pan Am to see one of the top men in traffic there, I found that Pan Am was "completely sold out" on all charter flights for this year. The only other way they could handle us would cost everyone an extra $75 for the flight and about $100 extra for hotels. So much for all those empty seats. Now, while I was busy trying to force Pan Am to carry us, several other airlines were calling me and trying to sell me on using them. Sabena went so far as to send two men up to our New Hampshire HQ and explain all the things they could do for us. Having travelled both Pan Am and Lufthansa to Europe in the past I had been impressed by the service and hospitality of the European airlines compared to the U. S. lines. There is a tremendous difference in attitude. We are going Sabena and I guarantee that everyone will have a flight whose pleasures they will never forget.

Dear OM:

Please put a notice in 73 requesting those Kiiwanians who are hams to send a QSL to me. We hope to establish a Kiiwanis net.

Bob Fleming KGLS
1007 W. Summit
Fergus Falls, Minn.

OK.

DISCOVERY!

The postage bill on last month's 128 page issue was enough to curl your eye-teeth. We've been holding the sub rates at $3.50 for a long time now, but we just can't do it and keep making the magazine larger. The next issue looks like another big one . . . a special Surplus Issue, so we'll just have to jog up the subscription rates to $4.00 soon. Vote here for a smaller 73 . . . send your $3.50 subscription now while we are vacillating.

Name .... Call ....

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☐ $3.50 One Year ☐ $6.50 Two Years ☐ $9.00 Three Years

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73 Products

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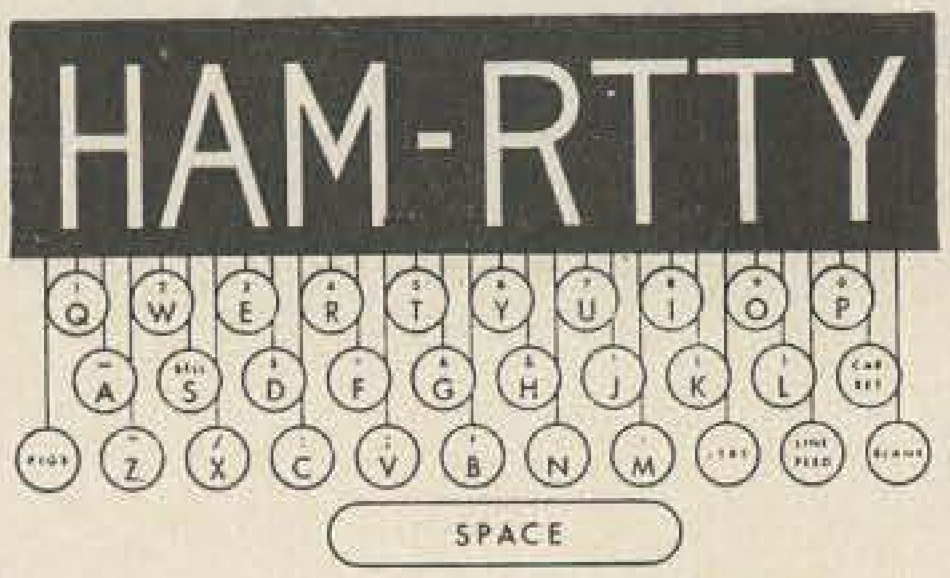
MICKEY MIKER 50c

Complete and exhaustive construction project for building a precision capacity tester. Very thorough.

IMPEDANCE BRIDGE PRINTS $1.00

A complete set of full scale prints (15) of all parts of the precision impedance bridge which originally appeared in the August 1961 issue of 73. Comes complete with a reprint of the original article.

NEW RTTY BOOK $2.00



This handbook is written for the beginning RTTY op, but due to the profusion of info, pictures, circuits, etc., it will be valuable to all RTTY'ers and those who may RTTY themselves. If you don't know what RTTY means don't buy it. For $2 what can you lose? It's worth almost that much in paper.

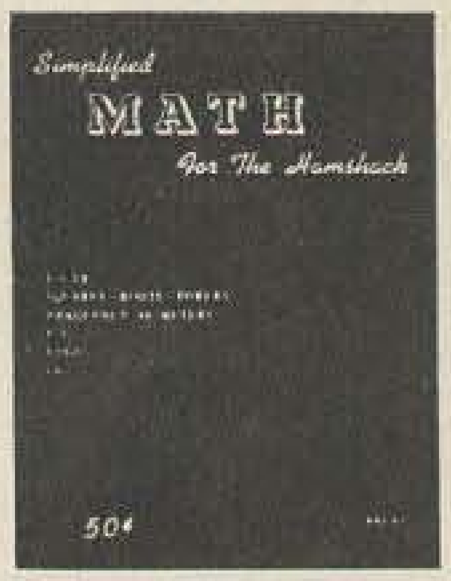
BINDERS FOR 73 $3.00

Keep your issues of 73 all in good shape and keep them from straying. Specify year: '60-61, '62, '63. Red Leather binder with gold stamped "73" and year. Darbs.

BACK ISSUES 50c

You can enjoy back issues of 73 just as much as current. Send for one each month to pad out those dreary days. All back issues now available except January 1961. Early issues going to $1 soon. Supply very limited.

SIMPLIFIED MATH 50c



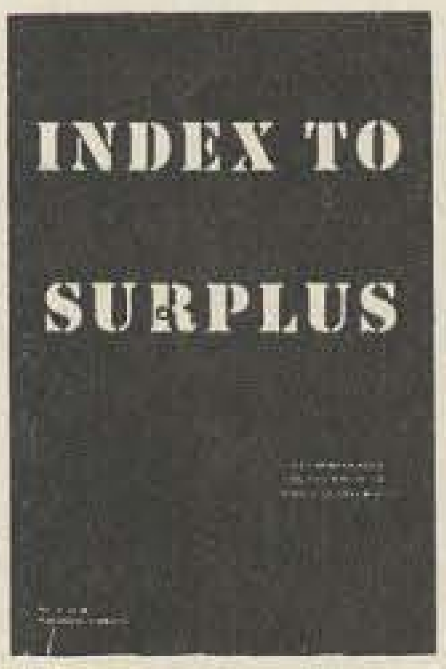
This booklet takes you gently by the hand and leads you through the mysteries of Ohm's Law, squares, roots, powers, frequency/meters, logs, slide rules, etc., and does it by an amazingly new method.

SURPLUS TV SCHEMATICS $1.00

TV'ers who are interested in saving a lot of construction time and still want to have elaborate TV gear will do well to watch those surplus ads and invest in this booklet, the only source of the diagrams you'll be needing.

CW $1.00

Written by an expert. One of the best methods for learning the code yet devised. Lays in a good foundation for later high speed CW ability. CW can be a lot of fun if you go about learning it the right way. This book will be invaluable to the beginner and the ham who wants to really increase his code speed.



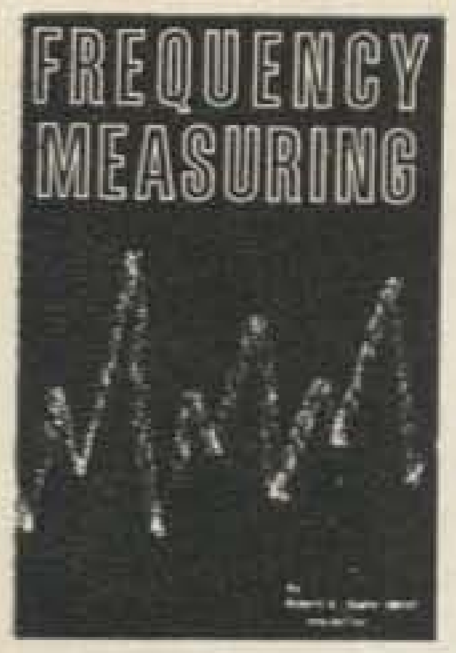
INDEX TO SURPLUS $1.50

This is a complete list of every surplus conversion article that has ever been published, with a brief description of the conversion. Invaluable bibliography.

HAM-TV $3.00

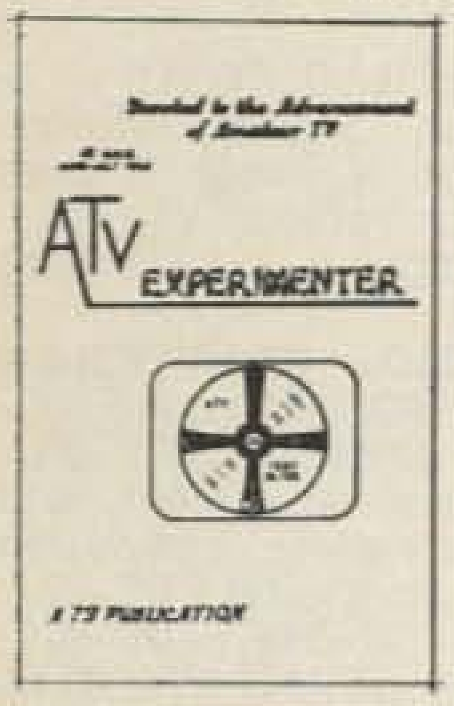
This book gives you a blow by blow description of how to get on the air on TV for under $50. This book is the reason that hundreds of hams are now going on TV. This is not the usual theory book, just a how-to-do-it manual.

FREQUENCY MEASURING HANDBOOK $1.00



Rather thorough exploration of the subject, complete with an exhaustive bibliography. By WφHKF

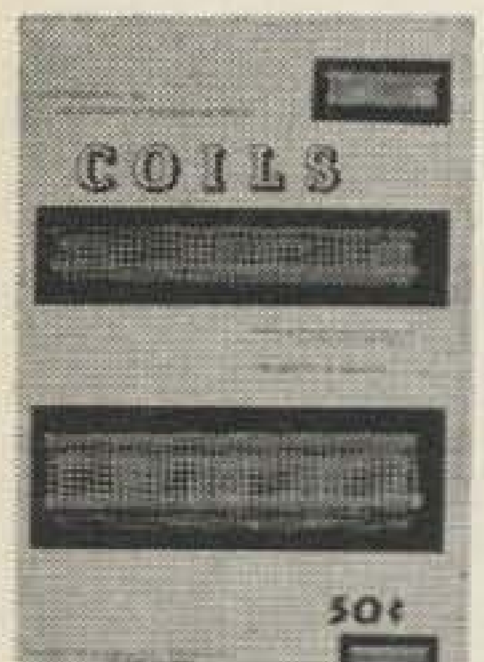
AMATEUR TELEVISION EXPERIMENTER $1.00 per year



The first five issues of this invaluable bulletin are now in print. Each one is worth more than the year's subscription. Send $2 for complete set from #1 up through #12. Quantity limited so don't wait.

CARE AND FEEDING OF HAM CLUBS $1.00

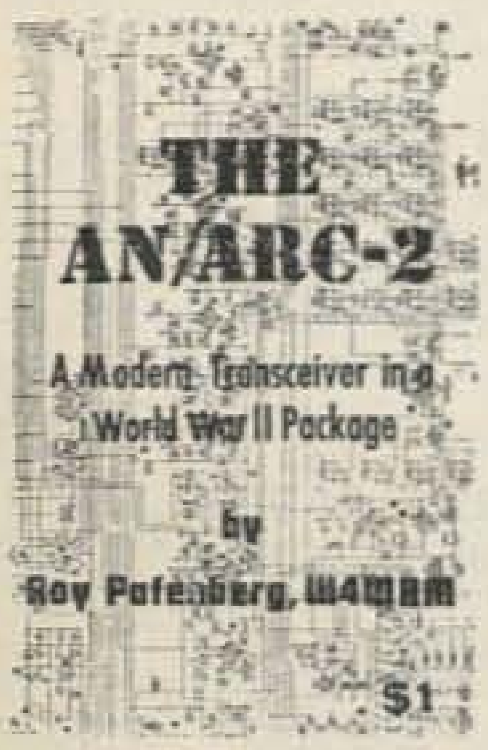
K9AMD's interesting book on all aspects of forming and holding together a ham club. This is the result of exhaustive interviews with many club officers and will be invaluable to every club going.



COILS 50c

Well illustrated basic book which describes all of the different types of coils to be found in radio work. Covers theory and practical aspects.

AN/ARC-2 CONVERSION $1.00



Complete schematics and thorough conversion details on this modern transceiver which covers 2-9 mc (80-40 meters . . . and 160). This unit now sells for $40 to $50 surplus and is easily converted into a terrific little transceiver.

WORLD GLOBE (plus subscription for one year) $16.95

Every visitor to the 73 HQ shack is taken aback by the beautiful world globe next to the operating position. We find this invaluable for figuring out beam angles and planning world tours. It is 18" in diameter, normally sells for $19.95 (via CQ), is nearly five feet around the equator. Canadians please allow a little extra for Diefendollar exchange.

In the interests of making home construction simpler for those readers with anemic junk boxes 73 has gathered together the parts required for building our less complicated projects. These kits are as complete as we can make them, containing good quality parts. Except where the chassis or case is integral to a unit we do not supply it. We will mention when we do supply a case or chassis. We do supply tubes, sockets, condensers, resistors, transformers, connectors, etc. The kits are kept in stock to the best of our ability, though sometimes the distributors who supply us delay us a bit.

TWO METER THREE NUVISTOR PREAMPLIFIER for perfectionists, complete with self-contained power supply. Kit contains nuvistors, sockets, all condensers, resistors, potentiometers, power transformer, rectifier, switch, antenna coax connector, etc. See article in March 73 page 8. Everything you need, complete with full scale drilling template.
Kit W9DUT-1 . . . . $18.50

QRP TRANSMITTER. One tube (1S4) ½ watt 40M rig. Fun to build and really works. See article in March 73 page 22. We've built a lot of 'em here.
Kit W1MEL-1 . . . . $6.00
W6SFM-1 . . . . $4.00
Nuvistor preamp for 15 & 20 meters. March 73.

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DIODE NOISE GENERATOR P. 15, April 73.
THOMAS-1 . . . . $9.00

VECTOR VFO (p. 24 April 73)
Complete VFO kit. W7IDF-1 . . . . $6.50

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Form your own Book Club! Order one book each month from this list. Just think, in one hundred years you will have a teriffic radio library with 1200 volumes. Order the book anyway.

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11—16TH EDITION RADIO HANDBOOK—by Bill Orr W6SAI. This fantastic book is loaded with the most understandable theory course now available in our hobby plus dozens of great construction projects. This is the best ham handbook in print by a wide margin. Easily worth twice the price. $9.50

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INDEX TO ADVERTISERS

To aid you in finding ads which are not running in this issue we have listed the last ad run by each company in 73.

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Factory Tested Gtd.!

NEWEST TYPE! LOW LEAKAGE

D.C. or Batty. Derate 20%

rms/piv 35/50	rms/piv 70/100	rms/piv 140/200	rms/piv 210/300
.07	.14	.19	.29
rms/piv 280/400	rms/piv 350/500	rms/piv 420/600	rms/piv 490/700
.34	.44	.53	.69
rms/piv 560/800	rms/piv 630/900	rms/piv 700/1000	rms/piv 770/1100
.85	.98	1.08	1.50

Low Priced T300 Silicon Diodes Rated 400 pvi/280rms @300Ma @100°C , .25 each; 30 for $7; 100 for $20;

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SILICON POWER DIODE STUDS*

Operation Up to 125°C Case Temp.

D.C. Amps	50Piv 35Rms	100Piv 70Rms	150Piv 105Rms
2	.23	.34	.42
3	.60	.85	1.10
6	.70	.95	1.15
12	.85	1.15	1.35
35	1.80	2.20	2.95
70	3.75	4.50	5.00
240	4.50	5.40	7.70

D.C Amps	200Piv 140Rms	300Piv 210Rms	100Piv 0Rms
2	.49	.60	.84
3	1.25	1.50	1.80
6	1.40	1.65	1.95
12	1.60	1.85	2.07
35	3.25	4.90	6.10
70	5.60	8.80	Query
240	9.00	Query	Query

**Derate 20% for Battery or Capacitive Load or D.C. Blocking!*
**Stud mounted on Heat-sink*

LO PRICED SILICON TUBE REPLACEMENTS WITH BUILT IN SURGE AND SERIES BALANCING PROTECTION

TYPE	VRMS/PIV	AMPS	PRICE
T866	5000/10400	0.3	$16
T5R4	1900/2800	0.5	$7

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Full Length Leads Factory Tested & Guaranteed! U.S.A. Mfg.

PNP Hi Power 15 Amp. TO3 & TO36 Round Pckg. 2N441, 2N277 $1.25, 4 for $4; 2N442, 2N278 $3@, 2 for $5; 2N443, 2N174 $4@, 2 for $7; 2N677 $1@, 12 for $10; 2N677A $2@, 6 for $10; 2N677B $3@, 4 for $10; 2N677C $5@; PNP 2N123, 2N107, CK722 4 for $1, 25 for $5; NPN 2N292, 2N293, PNP 2N223 ¢30@, 15 for $4, 100 for $22; PNP 2N670/300MW ¢40@, 20 for $7; PNP 2N671/1W ¢60@, 10 for $5; 2N597, 2N598, 2N599 PNP $1.50@, 4 for $5.
$10 or more this item POSTPAID U.S.A.

RND(TO36), or Diamond (TO3) mica kit 30¢ ea. Power Heat Sink Finned (80" sq.) $1.25, 5 for $5.

GTD! Power-Diamond-Transistors

Factory Tested
***MFGRD in U.S.A.
Univ. Replcmnt
2N155, 2N156,*2N234, 2N256, 2N307, 2N554
SPECIAL TO3GP ....55¢, 10 for $5
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$10 or more this item we pay P.P./U.S.A.

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WE BUY! SWAP & SELL TRANSISTORS, DIODES, ZENERS

"TAB" THAT'S A BUY

"TAB" Tubes Factory Tested, Inspctd, Six Months Guaranteed! No Rejects! Boxed!

GOVT & MFGRS Surplus! New & Used

OA2	1.00	6J7	.99	5651	1.20
OA3	.95	6K7	.79	5656	3.00
OB2	.65	6L6	.99	5670	.89
OC3	.65	6SN7	.72	5687	.90
OD3	2/$1	6T8	.98	5725	.75
OZ4	.79	6V6GT	.70	5732	.65
1B3	.99	6X5	.49	5751	1.00
1L4	2/$1	12AT6	.59	5814	.60
1R4	5/$1	12AT7	.85	5879	2/$1
1S4	.60	12AU6	.63	5894	13.50

We Swap Tubes! What Do/U Have?

1T4	.60	12AU7	.69	2AP5	3.00
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1U4	5/$1	12AY7	.89	3KP1	6.00
1U5	.65	12BA7	.90	3SP1	3.00
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2C40	5.00	12J5	.69	5MP1	6.00
2C43	5.50	12J7	.69	5MP4	6.00
2C51	1.25	12K8	.70	5NP1	6.00
2D21	2/$1	12SC7	3/$1	5ABP1	20.00

Send 25¢ for Catalog!

2E22	1.75	12SG7	.60	5AQP1	20.00
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2E25	2.50	12SJ7	.60	5AP1	5.00
2E26	1.80	12SK7	.75	5ADP1	35.00
2K25	6.50	12SL7	.59	5ADP7	25.00
2V3G	2/$1	12SN7	.69	5BP1	6.00
2X2	2/$1	12SR7	.59	5BP2	6.00
3C24	3.00	24G	3.00	5BCP7	25.00
3D23	2.40	25A6	1.25	5BGP2	35.00
3E29	5.90	25L6	2/$1	5BHP2	25.00

Wanted 304TL Tubes

3Q5	.85	25T	5.00	5CP1A	7.00
4-65A	9.50	25Z5	.72	5CP5	4.00
4-125A	21.00	25Z6	.75	5CP7A	4.00
4-250A	33.00	35Z5	.85	5CP11A	5.00
4X150A	14.00	RK39	2.50	5FP1A	18.00
4X250	34.00	50L6	2/$1	5FP4A	18.00
4X500	37.00	75	.81	5FP5	3.00
5R4	1.00	83V	2/$1	5FP7A	3.00
5T4	2/$1	2000T	150.00	5FP14	3.00
5U4	.75	4X150G	12.00	5FP14A	6.00

125°C SILICON PNP TRANSISTORS 250 to 400 MW

FULL LENGTH LEADS Factory Tested & GTD!

$5 to $11 — SMALL — TO5 & TO18 Pckg. Replaces 2N327A; 332, 3, 4, 5, 6, 7, 8; 474, 5, 6, 7, 8, 9; 2N480, 541, 2, 3; 2N935, 36, 37; 2N1034; 2N1131, 2; 1276, 7, 8, 9. "TAB" SPECIAL ¢69@, 7 for $4, 20 for $10.

$10 or more this item, we pay P.P./U.S.A.

5V4	.89	4X250B	30.00	5HP4	10.00
5Y3	.59	4-400A	33.00	5JP1	2.00
5Z3	.89	250TL	18.00	5JP2	1.00
6A7	.99	307A	3/$1	5JP14	25.00
6A8	.99	VR92	5/$1	5LP1	18.00
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6AC7	.69	350A	1.00	5LP4	6.00
6AG5	.59	350B	1.00	5LP7A	6.00
6AG7	2/$1	6146	2.45	5RP1	25.00
6AK5	.69	450TH	25.00	5SP7	15.00

Wanted Test Sets and Equipment

6AL5	.59	450TL	24.00	5SP7A	21.00
6AQ5	.65	460	11.50	5QP4	8.00
6AR6	.75	707B	1.25	5UP1	6.00
6AS7	2.85	715C	10.00	5XP21	36.00
6AT6	.65	723AB	2.50	5YP1	25.00
6AU6	.70	725A	3.50	7BP1	5.00
6B8	.80	805	3.35	7BP4	5.00
6BE6	.59	807	1.10	7BP4A	5.00
6BG6	1.49	811	3.90	7BP7	2.00
6BH6	.79	811A	4.75	7BP7A	5.00

Top $$$ Paid for 304TL, 813, 811A, 812A Tubes

6BK7	.99	812	3.95	7EP4	5.00
6BL7	1.30	813	12.00	7GP4	7.00
6BX7	1.11	815	1.75	9AUP7	5.00
6BY5	1.19	829B	7.50	9JP1	5.00
6BZ6	.73	832A	5.00	9LP7	1.00
6C4	.45	833A	36.00	10BP4	6.00
6C5	2/$1	837	1.50	10KP7	11.00
6C8	2/$1	866A	1.50	12GP7	7.00
6CB6	.70	954	10/$1	12QP4	9.00
6CD6	1.49	957	10/$1	12KP4A	9.00

Top $$$ Paid for 304TL Tubes!

6E5	.79	991	5/$1	12SP7	11.00
6F4	1.85	1619	5/$1	14EP4	10.00
6F5	2/$1	1620	1.00	16GP4	12.00
6F6	2/$1	1625	3/$1	16DP4A	12.00
6F8	.74	1626	12/$1	17AVP4	14.00
6H6	4/$1	1629	4/$1	17AP4	14.00
6J4	1.72	2050	1.20	17CP4	14.00
6J5	2/$1	5517	2/$1	17KP4	14.00
6J6	2/$1	5608	3.95	19DP4	16.00

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Kit 5 lbs. Surprise Package
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Kit 6 Insltd Tuning Tools
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Kit 5 Sub-Min Tubes
Kit 75 Mica Condensers
Kit 8 Crystal Diodes
Kit 200ft Hook Up Wire
4 Rolls, 50ft/ea. Asstd. Color
Kit 100 Ceramic Condensers
Kit 5 FT243 Xtal Holders
Kit 4 Microswitches
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Kit Adj Wire Striper & Cut
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Kit 6 ea Phonoplugs & Jacks
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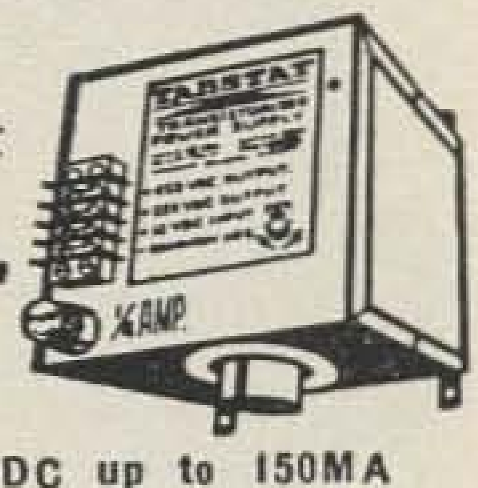

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100 Watts; Tap 250VDC
DB500 $33
12VDC to 250VDC up to 150MA Type C1225E $30

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DC-METER One Ma/4" Rd...$5@. 2/$8
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4x150 Ceramic/LOKTAL ....2 for $1.00
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Tube Clamps Birtcher..........5 for $1.00
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Line Filter 50Amp/250VAC...$10@.
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Bruning Parallel 6" Rule....69¢@.
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2	2.15	3.00	6.25	11.10
3	2.90	4.00	8.60	13.45
6	4.15	8.00	18.75	31.90
10	6.10	12.15	26.30	41.60
12	7.75	14.90	30.95	43.45
20	12.85	24.60		
24	15.00	29.45		

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