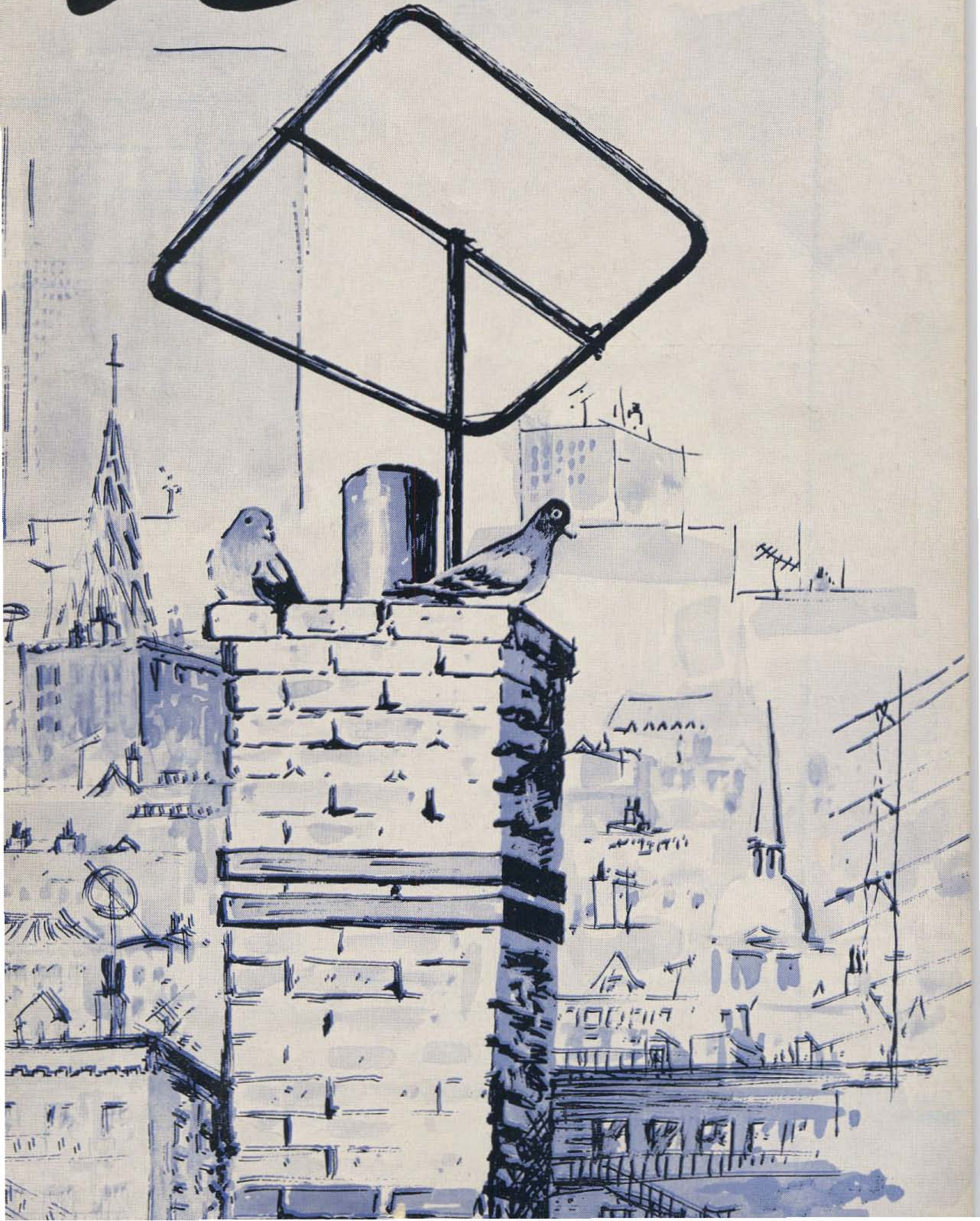
73 Amateur Radio

SEPTEMBER 1966
60¢? Certainly!



73 Magazine

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September 1966

Vol. XLII, No. 1

Our cover this month is by Sidney Willis of Bennington, N.H. Sid is a well-known artist who specializes in still lifes of objects associated with Old New England; he has won a number of gold medals at N.E. Art Shows.

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Coaxial Accessories Handbook WA6BSO 93
The third part of Jim's series on coaxial systems covers antenna tuners, baluns, switches, relays, dummy loads, SWR bridges and attenuators.

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de W2NSD/1

never say die

First WTW Winner

The first complete collection of QSL's for the Worked the World Certificate was received here in Peterborough July 8. Cdr. Gay Milius W4NJF of Norfolk, Virginia sent in 104 good cards to be the first winner. Gay is a Legal Officer at the U.S. Naval Station in Norfolk; he has an AB from Dartmouth and LLB from Fordham. Gay has written a number of articles for ham magazines, and, as the photo shows, is an avid DX'er.

Who's going to be next?

ET3AC system

One of the problems facing all DXpeditions, and for that matter, just about all rare DX stations, is how to go about working the maximum number of stations in a minimum amount of time. Those of you who chase DX know only too well how terrible some of the stations do at this art form.

Our more experienced DXpeditioners have got the business fairly streamlined. Don Miller cranks out one or two contacts a minute for hours on end. Gus does likewise. Don and Gus use split frequencies. They usually operate down around 14100 kHz on sideband and then listen from 14200 up for calls. This works pretty fast, but they do have to sit and wait for each caller they hear to stop sending before they can work him. Most savvy DXers make their calls short, but now and then you run across an idiot that spells out his call four times and you wonder if he is ever going to shut up.

Gay Milius W4NJF, winner of the first WTW award.

When you are transceiving on your own frequency the pileup problem can be devilish. Some DX stations find they have to wait several minutes before fellows stop calling them long enough to let anyone hear them come back. This only happens when the DX station lets the situation get out of control. I've had good success on my own frequency from rare spots by standing by for short calls from specific areas and using fast break-in. I can usually keep up with Don and Gus in contacts per hour using this system.

The other day I heard Blake, ET3AC, using a new idea while he was knocking them off from FL8AC. The idea seems like a good one to me and I'd like to pass it along because I think it has possibilities for working even more stations per given time than those we've been using. Blake would announce that he was going to tune a band of frequencies for given time and write down all the calls he heard. He would then look for the fellows on his own frequency with fast break-in. This spread out all of the calling stations over a ten or twenty kilocycle band so he could get their calls easily, and this is the hardest part of the contacts. He knocked off two to three a minute average this way.

Some rare DX operators complain that they get mobbed every time they come on the air by all the fellows who want a QSL card. Sure they do . . . because they haven't taken the few days it takes to work the several thousand DXers. If they would just devote a few days to working stations as fast as they can and get the services of a QSL manager they would be able to operate with little interference in the future.

It *is* possible to take the heat off by working all the DXers. We have several countries with just one or two stations, but which are not considered rare by any means. I've operated from 4U1ITU many times and it is so common even though it is the only station in the "country" that I frequently have to call CQ a couple of times to get a contact from there. To perk up interest in this station they had to run through some new prefixes (4U2ITU, etc.).

And let's just have a word on QSL's. They are a heck of a lot of trouble, as I know only

(Continued on page 80)

NEW from International

SINGLE SIDEBAND
9mc EXCITER-DRIVER
50-54mc MIXER-AMPLIFIER

The SBX-9 Exciter-Driver and the SBA-50 Mixer-Amplifier provide the perfect combination for 50-54mc SSB operation. Performance, versatility and reliability are incorporated into this new SSB pair. A tremendous value at a low price!

Model SBX-9

SPECIFICATIONS:
Exciter-Driver 9mc

Tubes:	6BH6 Oscillator 12AX7 Audio 7360 Bal Modulator 6BA6 RF Amplifier
Filter:	Four crystal half lattice Carrier Suppression 45db min. Unwanted SB Atten. 40db min.
Output:	Provides voltage drive for mixer such as SBA-50
Controls:	Carrier Balance Microphone Gain Test Switch USB-LSB Switch
Metering:	RF output for balance adjust. Two sensitivity ranges available with front panel switch.
Misc:	Relay included for push-to-talk operation. Crystals for upper and lower sideband included. Requires high impedance microphone. For operation on 117 vac 60 cycle power.

$125.00

Order direct from International Crystal Mfg. Co.

Model SBA-50

SPECIFICATIONS:
Mixer-Amplifier 50-54mc

Tubes:	6U8A Oscillator-Mixer 12BY7A Amplifier 6360 Linear power amplifier
Drive:	Requires 9mc sideband signal from SBX-9
Output:	SSB single tone 10 watts
Controls:	On-Off Power PA Grid Tune PA Plate Tune PA Load Tune Metering Switch
Metering:	Oscillator 9mc Drive Buffer Grid PA Grid RF Out
Crystals:	Three positions, uses 3rd overtone 41-45mc range. Crystal frequency = final frequency —9mc
Misc:	Accessory socket provided for connecting keying circuit to SBX-9. Comes with three crystals. Specify frequency when ordering. For operation on 117 vac 60 cycle power.

$145.00

INTERNATIONAL
CRYSTAL MFG. CO., INC.
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Editor's Ramblings

Paul Franson WA1CCH

Abbreviations for Basic Units

Name	Quantity	Abbreviation
ampere	current	A
bel	gain, loss	B
coulomb	charge	C
farad	capacitance	F
henry	inductance	H
hertz (old cps)	frequency	Hz
joule	work, energy	J
meter	length	m
ohm	resistance	Ω
second	time	s
siemens (old mho)	conductance	S
volt	voltage	V
watt	power	W
weber	magnetic flux	Wb

Note that abbreviations for units derived from proper names are capitalized. Other units such as hour and foot can also be used, of course. Liter and ampere-hour are units of capacity, but the farad is the unit of capacitance.

Abbreviations—again

I've been very surprised at the smallness of the uproar over our adopting the modern *hertz* for the older term, *cycles per second.* We've only received three letters so far, and two of them end with the clever pun, "... it hertz."

The tables on this page list the rest of the relevant abbreviations for units from the international system adopted by the NBS, the IEEE, and many U.S. magazines—including 73. Most of the changes are minor, and serve mostly to avoid the inconsistencies of the older system: *m* means *milli, micro* and *mega* in *mh, mf* and *mc* as used by older magazines. Nevertheless, some of them look a bit peculiar at first, though not as bad as *Hz.* In a few years, we'll be so used to the newer system that the old abbreviations will look as odd as the old schematics in *Radio* or pre-war QSTs. Here are some of the abbreviations we normally use:

capacitance: pF, μF
current: μA, mA, A
frequency: Hz, kHz, MHz
inductance: μH, mH, H
power: μW, mW, W, kW
power gain: dB
resistance or impedance: Ω, kΩ, MΩ
time: ms, s
voltage: μV, mV, V, kV

Some of the units are rarely used in electronics, of course. Many of the prefixes are also rare: *tera* is almost unknown; *giga* is used only in gigahertz; *hecto* and *deka* aren't used; *deci* is used only in *decibel* and *centi* in *centimeter; nanofarad* (.001 μF or 1000 pF) is used in continental Europe but not often in the U.S.; *femto* and *atto* aren't used in radio—at least by hams.

Many possible combinations of prefixes and units are not used or are rarely used. Here are some surprises:
MC: megacoulomb
μS: microsiemens (micromho)
mF: millifarad (1000 μF)
MF: megafarad (1,000,000,000 μF)
MA: megaampere (1,000,000 ampere)

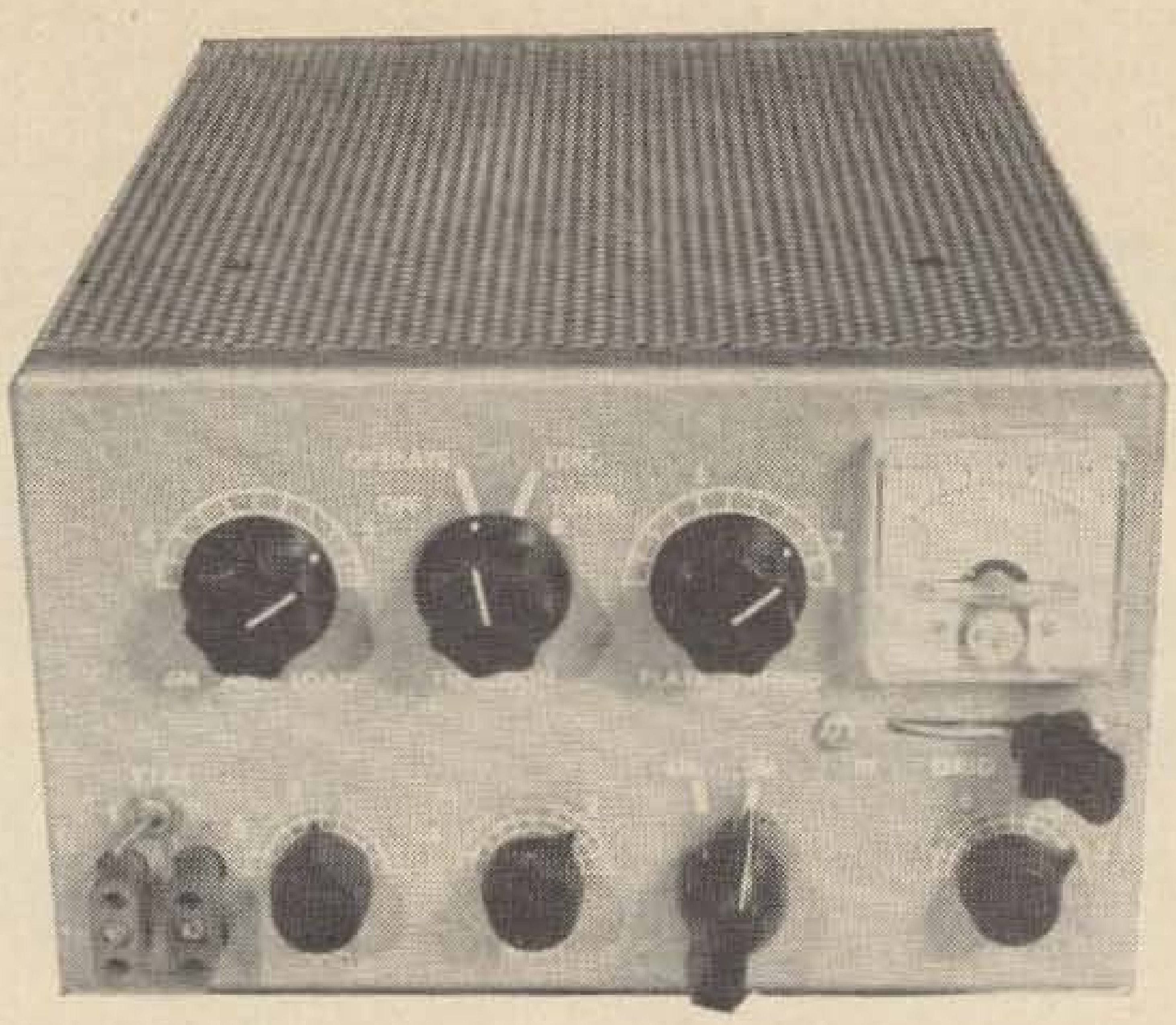
Confused? You needn't be. The whole system is straightforward and easy to understand after a few minutes' study.

... WA1CCH

Prefixes Used with Basic Units

Name	Abbreviation	Multiply by
tera	T	10^{12} or 1,000,000,000,000
giga	G	10^{9} or 1,000,000,000
mega	M	10^{6} or 1,000,000
kilo	k	10^{3} or 1,000
hecto	h	10^{2} or 100
deka	da	10
deci	d	10^{-1} or 1/10 or .1
centi	c	10^{-2} or 1/100 or .01
milli	m	10^{-3} or .001
micro	μ	10^{-6} or .000 001
nano	n	10^{-9} or .000 000 001
pico	p	10^{-12} or .000 000 000 001
femto	f	10^{-15} or .000 000 000 000 001
atto	a	10^{-18} or .000 000 000 000 000 001

Some prefixes are capitalized and some small. The distinction is important. Not all of the prefixes are used in electronics.



Del Crowell K6RIL
1674 Morgan Street
Mountain View, Cal.

A Compact Transmitter for Six and Two

Here's one of the cleverest, simplest and most effective two-band VHF transmitters we've seen. Wouldn't you like one?

Many VHF operators have, at one time or other, had the urge to have a signal with punch. After looking through many issues of magazines and handbooks, I noticed there is very little information published on band-switching VHF transmitters. This inspired me to design this compact transmitter, in which changing bands and retuning can be done in very few minutes. Using 600 volts on the final the power output is approximately 60 watts on 2 and 70 watts on 6.

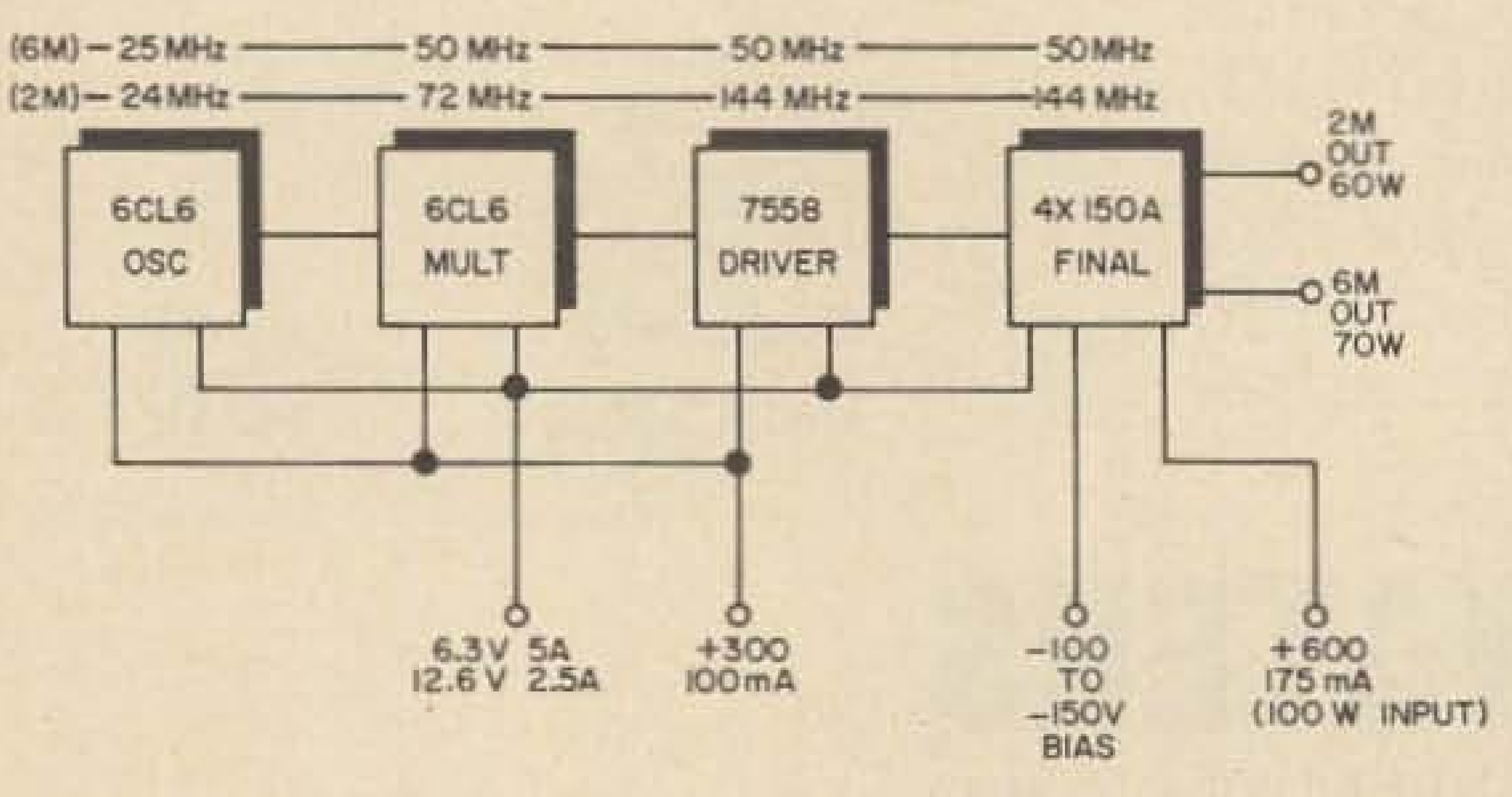


Fig. 1. Block diagram of the simple six and two meter band-switching transmitter with 60 watts output.

This article covers the rf section only. The power supply and modulation is left up to the builder.

Circuit description

The circuit is a simple but very effective design using the following tube lineup: A 6CL6 oscillator (VI) uses crystals in the 8-9 or 24-27 MHz range and the plate tunes from 23.5 to 27 MHz. Next a 6CL6 multiplier (V-2) either doubles to 50 MHz or triples to 72 MHz. The plate is tuned to 72 MHz on 2 meters and on 6 meters a shunt capacitor C9 is switched in to tune the 50 MHz range. The drive uses a 7558 as a straight thru amplifier on 6 meters, or as a doubler on 2 meters, because of loss of driving power on 2 meters the screen voltage on V2 and V3 is increased by shorting out a 27 k resistor R-11 with the bandswitch. This increases the driving power to obtain satisfactory final grid drive. The 7558 uses an unusual tank circuit which has two resonances. On 6 meters, one half of L3 and L4 is resonant at 50 MHz and on 2 meters L3 is resonant at 144 MHz, with L4 acting as an rf choke. C-15 is adjusted so that at 50 MHz the capacitance is near maximum and at 144

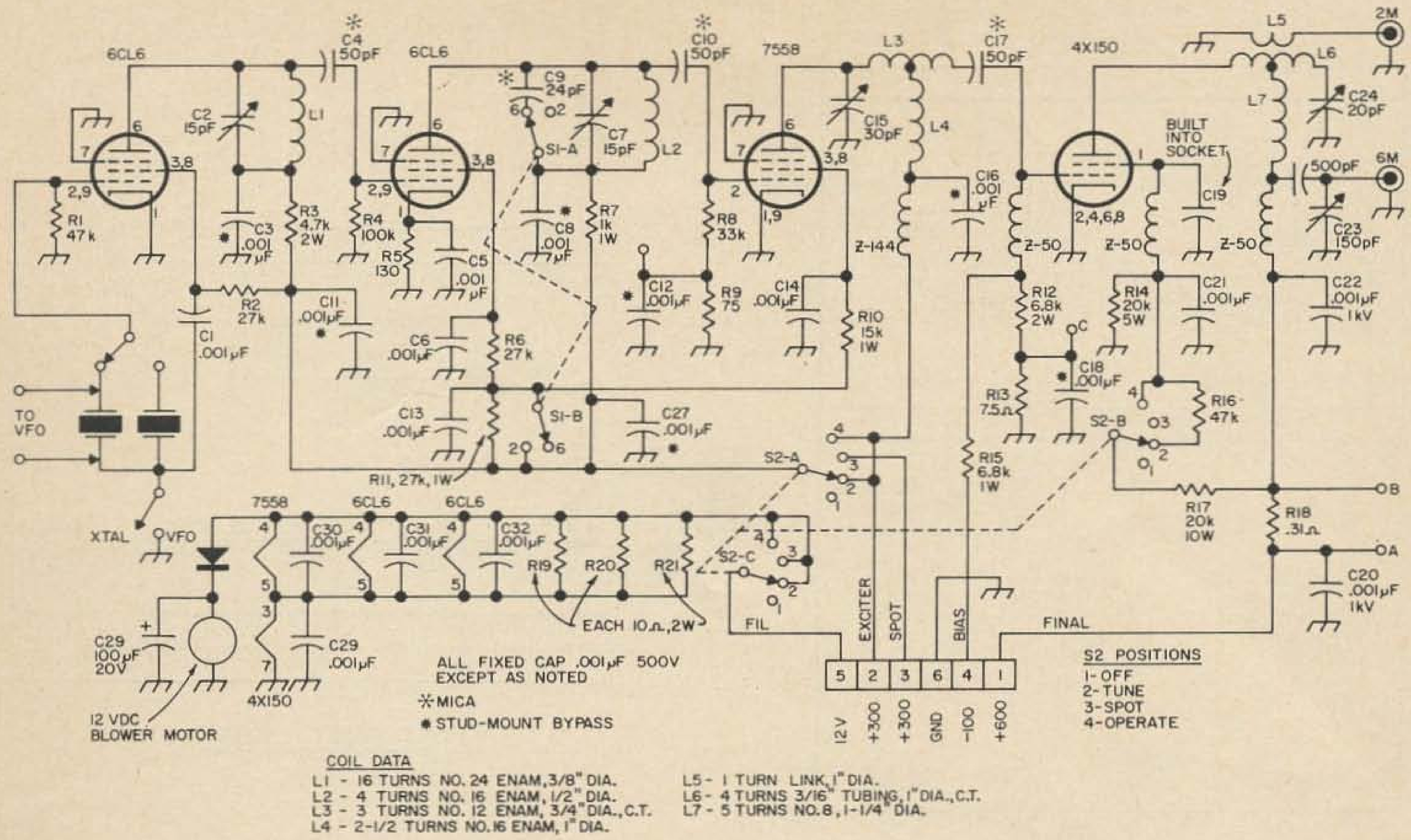
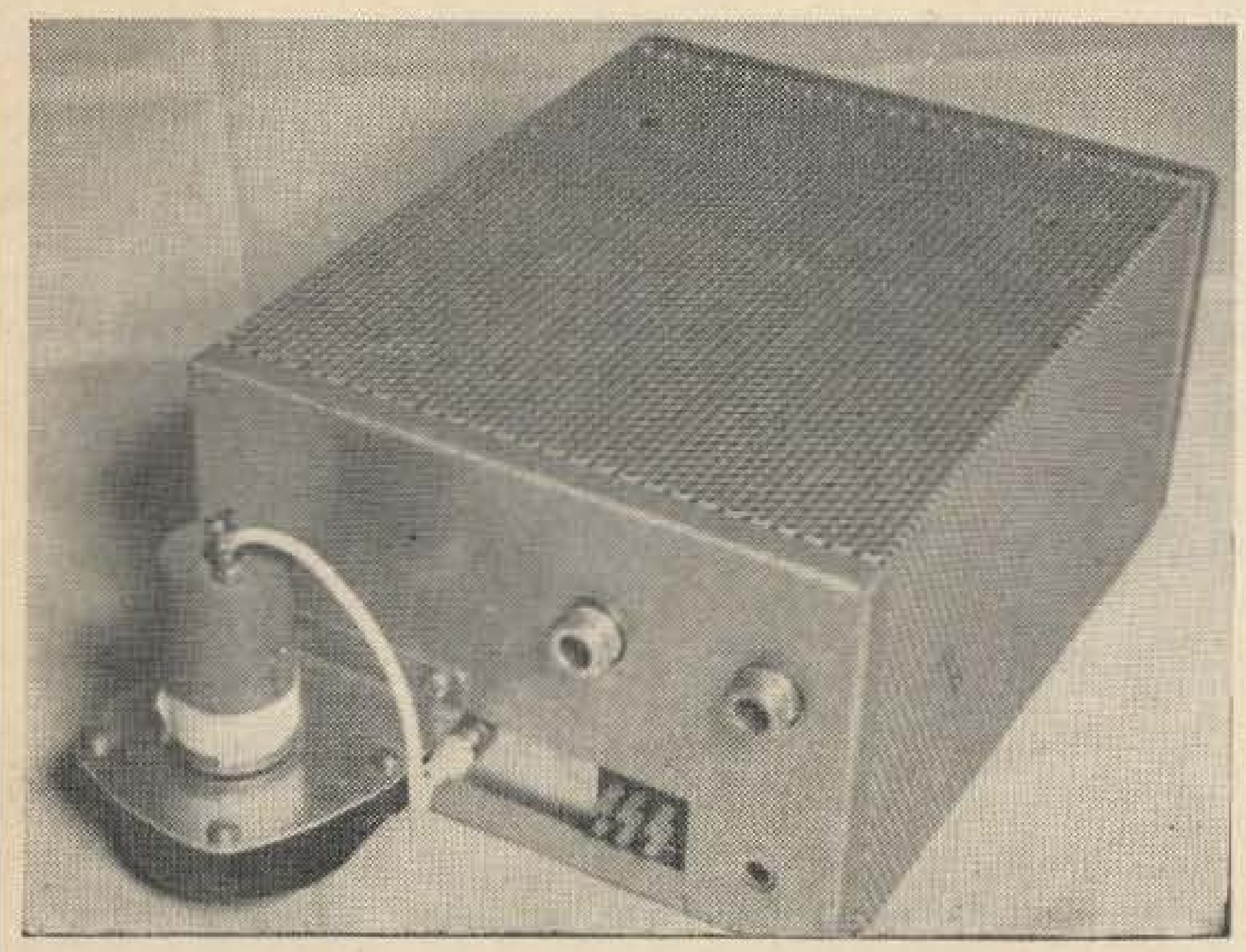


Fig. 2. Schematic of K6RIL's bandswitching six and two meter transmitter. Output from the 4X150A with about 100 watts input at 600 volts is about 60 watts. For metering, see Fig. 3.

MHz C-15 is near minimum. This prevents the resonances from becoming harmonically related, as example, while tuned to 50 MHz the 144 tank will tune near 130 MHz.

The 4X150A performs very nicely as the final amplifier. By using low plate voltage the tube requires a small amount of air flow to cool. Any small fan which will move air thru the socket and fins would do very well, (be sure to use the chimney). The final operates in class C service and requires at least 8 mA of grid current for plate modulation. The tank circuit L6 and L7 is similar to the one described for V3 (7558), operates as a link coupled output on 2 meters with L7 acting as the rf choke. On 6 meters the tank operates as a pi network output, providing separate outputs for 2 meters and 6 meters, again the tank should be adjusted with C-24 at minimum capacitance for 2 meters and maximum for 6 meters. C-23 adjusts the pi network loading for the 6 meter output. On 2 meters the link is inserted about half way for optimum coupling.

If plate modulation is used the screen must be modulated approximately 30% in phase with the plate. Screen voltage is obtained by a resistive divider from the plate supply. Adjusting the screen voltage to less than 200V will allow about 25% increase on modulation peaks. With



Back view of the transmitter showing the small blower, power receptacle, and the output jacks.

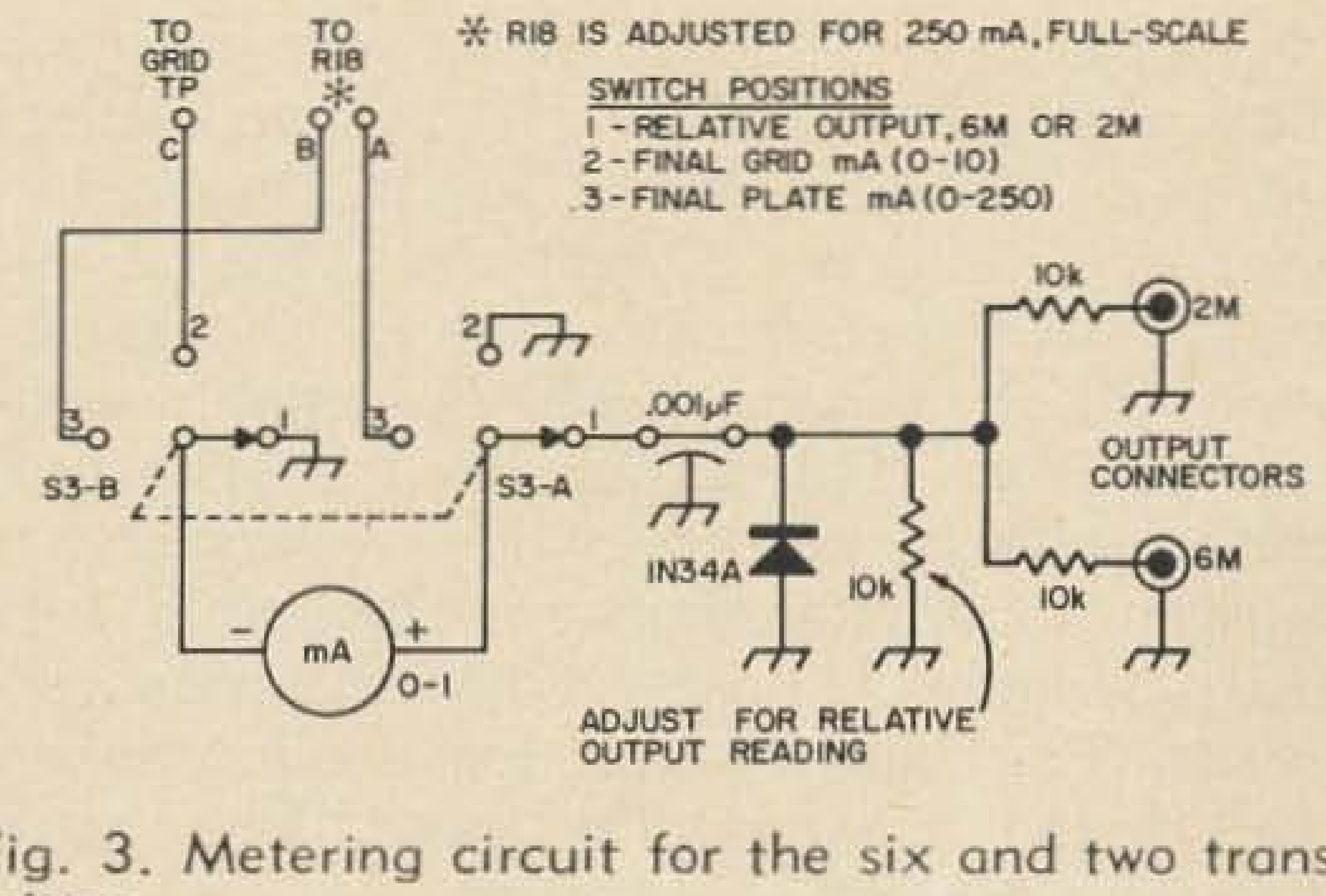


Fig. 3. Metering circuit for the six and two transmitter.

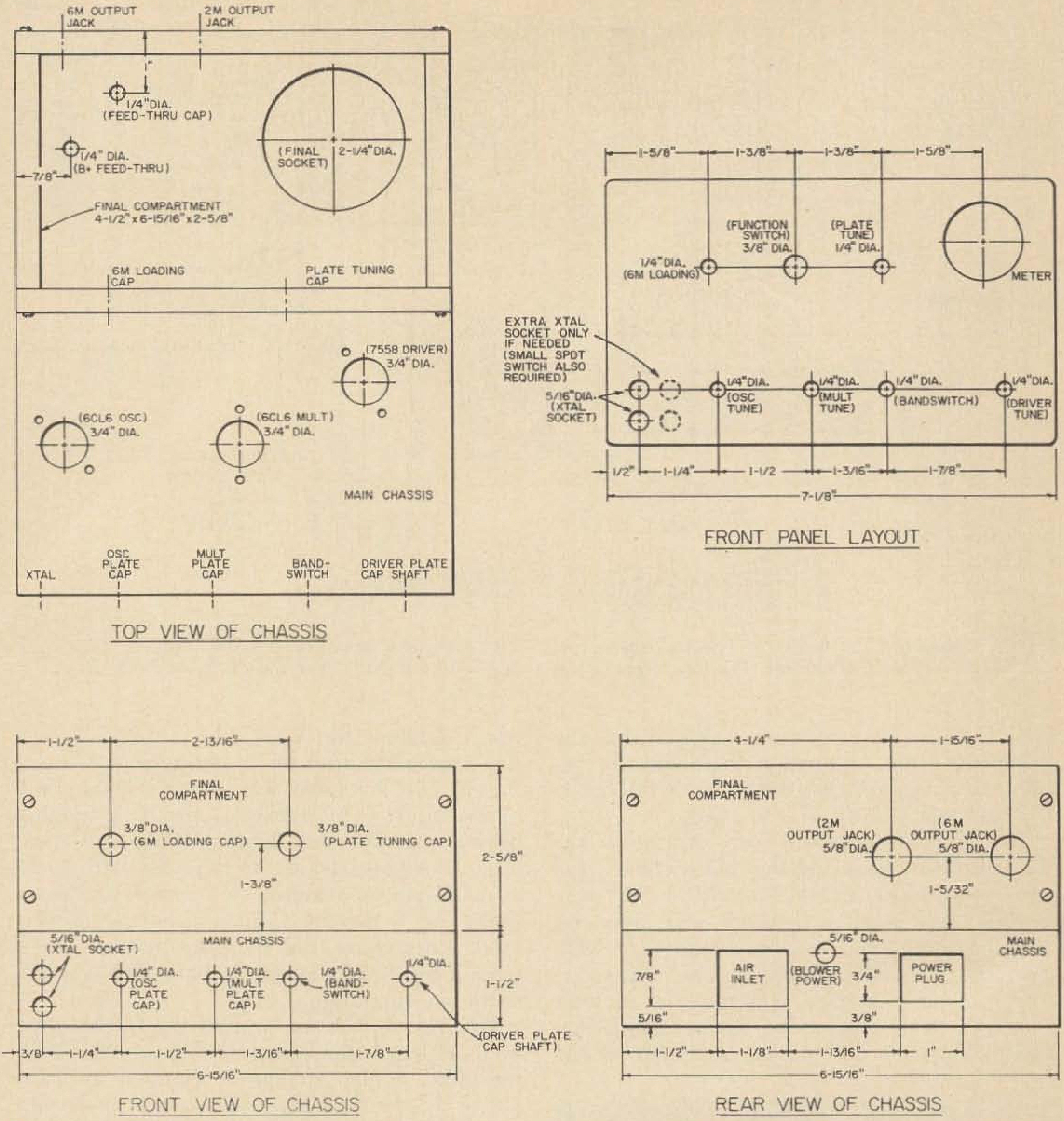


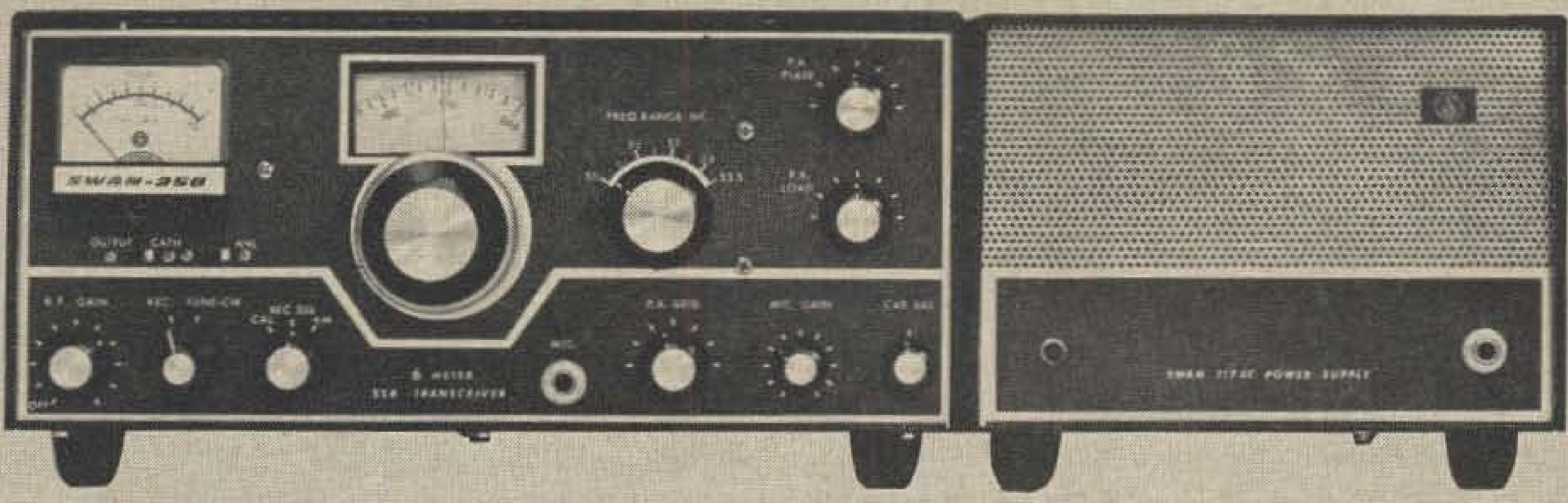
Fig. 4. Layout of the six and two transmitter. These drawings are one-third full size. Cabinet used is a California Chassis Company LTC-436. See comments at end of article for some modifications.

this method the 4X150A shows very good stability, using 600 V B at 170 mA and screen voltage of 200 V at 10 mA the transmitter delivers approximately 60 watts at 2 meters and 70 watts at 6 meters with close to 100% modulation, the modulator should be capable of 50 watts or more. This transmitter has been used mobile with a transistor power supply and transistor modulator similar to the one in 1962 ARRL Handbook (page 478) with very nice results. The blower used for cooling was a small dc motor and squirrel cage blower operating from the 12 volt battery.

Construction details

The chassis and cabinet shown in pictures is a ready made unit by California Chassis Co., Lynwood, Calif., model LTC436, measures 4⅝" H x 7¼" W x 9¼" D. Final tank compartment was fabricated from 1/16" aluminum and measures 4⅝" x 6 15/16" x 2⅝". A perforated cover allows air to escape but shields the rf. The bottom cover is made from 1/16" aluminum and seals the under side of the chassis to provide a pressurized compartment to cool the 4X150A. A homemade gasket seals between the blower and the chassis.

NEW FROM SWAN



SWAN 250

6 METER
SSB TRANSCEIVER

SPECIFICATIONS:

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- ★ Complete band coverage, 50-54 mc.
- ★ Velvet smooth vernier tuning covers 500 kc, calibrated in 5 kc increments.
- ★ Transmits and receives on Upper Sideband.
- ★ 2.8 kc bandwidth with crystal filter at 10.7 mc.
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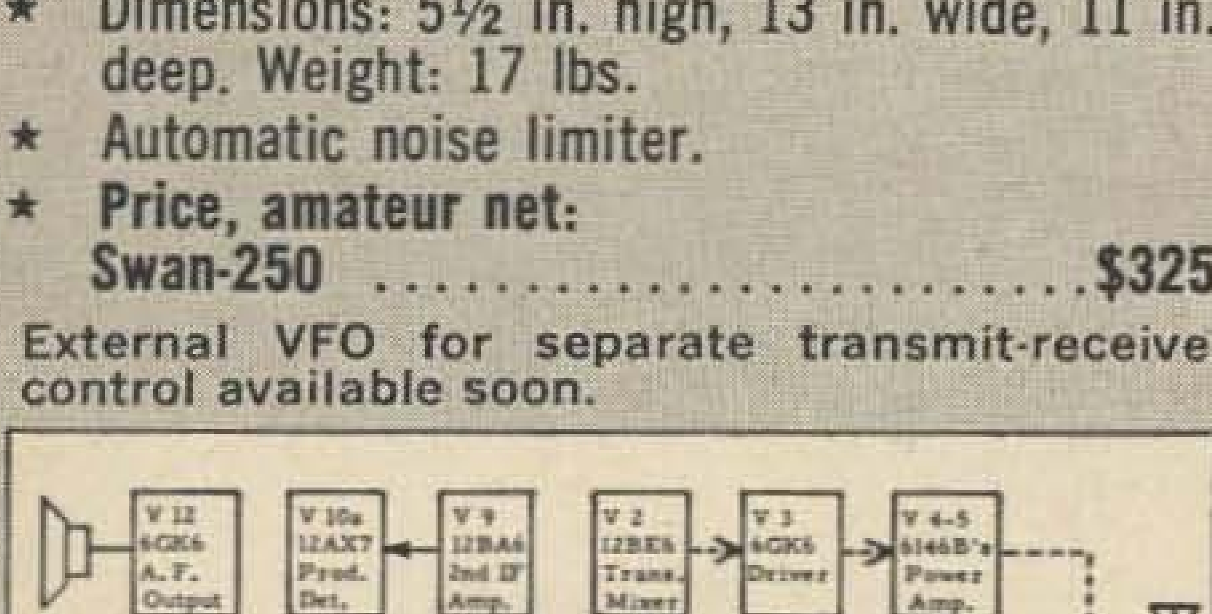
- ★ 40 db unwanted-sideband suppression, 50 db carrier suppression.
- ★ Receiver noise figure better than 3 db. 6HA5 triode R.F. amp., 6HA5 triode mixer. Includes
- ★ **Separate AM detector.**
- ★ **Automatic noise limiter.**
- ★ Audio response essentially flat from 300 to 3100 cycles.
- ★ Pi output coupling for matching wide range of load impedances.
- ★ Meter indicates either cathode current or relative output for optimum tuning and loading.
- ★ Provisions for adding 500 kc calibrator, or plug-in Vox unit.
- ★ Dimensions: 5½ in. high, 13 in. wide, 11 in. deep. Weight: 17 lbs.
- ★ Automatic noise limiter.
- ★ **Price, amateur net:**
  Swan-250 .... $325

External VFO for separate transmit-receive control available soon.



SWAN MODEL 250, BLOCK DIAGRAM

6 Meter Band Openings Increase!

With sun spot activity now on the increase, 6 meters is rapidly becoming one of the most interesting bands to operate, and the next few years will undoubtedly see tremendous activity on this band. Sporadic E openings are occurring several times each week over all parts of the country, making excellent contacts possible from Coast to Coast and over intermediate paths. With long F2 skip and trans-equatorial propagation to look forward to, plus the consistent ground wave and tropospheric scatter contacts made possible with the power of the Swan 250, there is practically no limit to the operating pleasure you can find in the VHF world above 50 mc.

The Swan 250 is at its best in the SSB mode. for which it was primarily designed. With 240 watts PEP input and an average beam antenna, its talk power does an outstanding job. To work your AM friends you simply insert carrier to 75 watts input, and they will read you loud and clear. AM reception is provided for by the receiver function switch. Also, a noise limiting circuit is effective on both AM and SSB.

The Swan 250 is engineered to provide the same excellent voice quality which has become the trademark of all Swan transceivers. And, naturally, the same customer service policy, second to none, applies to our VHF models.

If you are seriously interested in working 6 meters, see the new Swan 250 at your dealer. We are delivering now, but the back order list is getting longer, and we suggest you place your order soon.

73 Herb Johnson
W6QKI

SWAN
ELECTRONICS CORP.
OCEANSIDE, CALIFORNIA

6 and 2 Meter Transmitter Operating Voltages

	Osc		Mult		Driver		Final	
	6CL6-V1		6CL6-V2		7558-V3		4X150A-V4	
	2M	6M	2M	6M	2M	6M	2M	6M
Plate mA	15	15					170	175
Screen V	160	170	170	150	210	195	210	215
Screen mA	1.2	1.2	3.0	4.5	4.0	3.5	9.2	9.0
Grid V	−37	−37	−50	−70	−40	−42	−90	−95
Grid mA	.7	.7	.5	.7	1.25	1.35	13	14
Supply V	280	280	280	280	280	280	600	600
Plate V	190	200	240	260	270	250	600	600
Power output							60W	70W

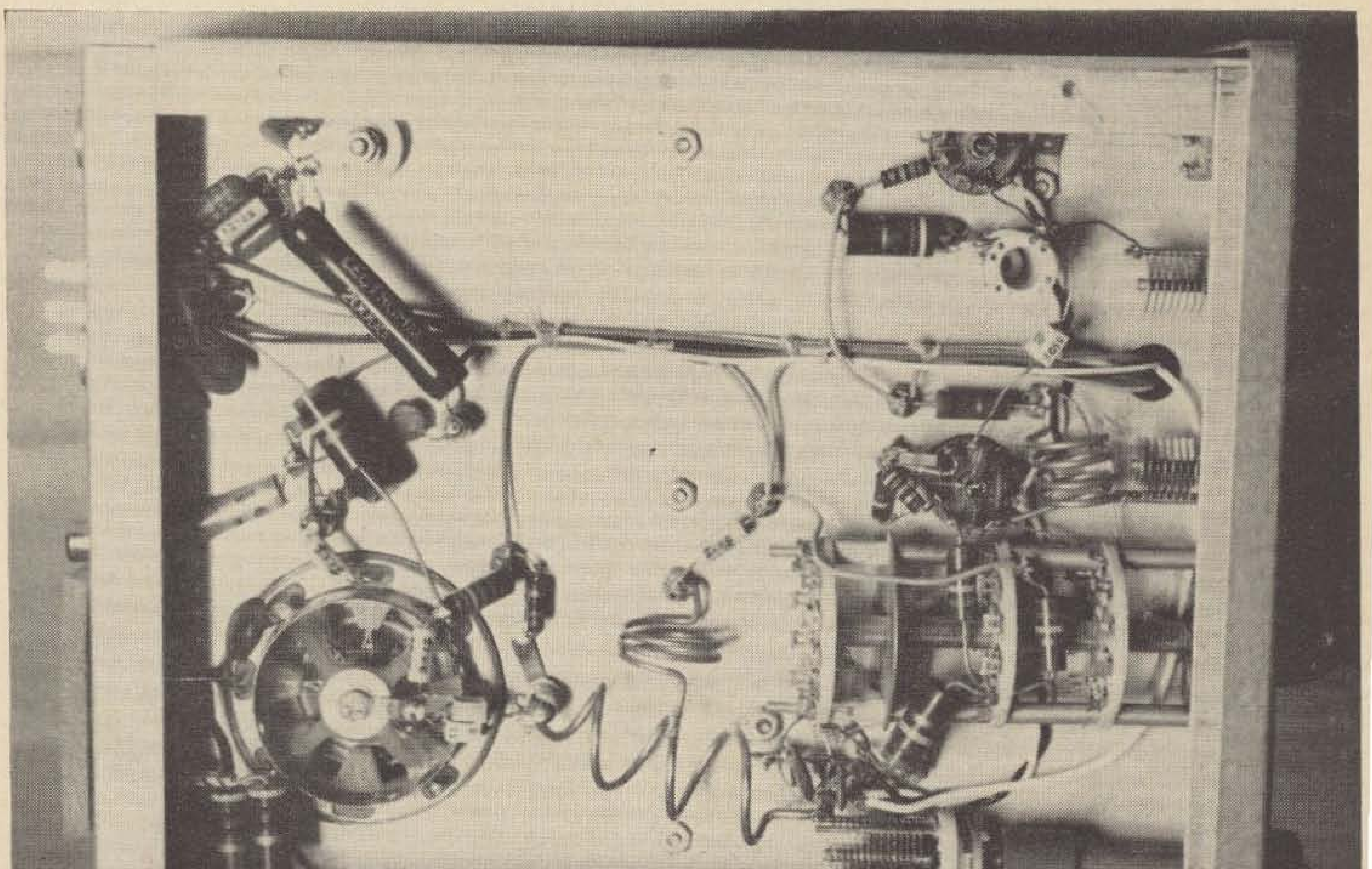
Although the circuit shows the heaters wired for 12 V operation the builder may do as he chooses.

Voltages required are as follows 6 V at 5 Amps or 12 V at 2.5 amps and + 300 V at 100 mA for exciter section and + 500 to + 800 volts at 200 mA and − 130 V bias for final. Originally the final was wired for self bias but for mobile operation proved to be troublesome and fixed bias for protection was added later.

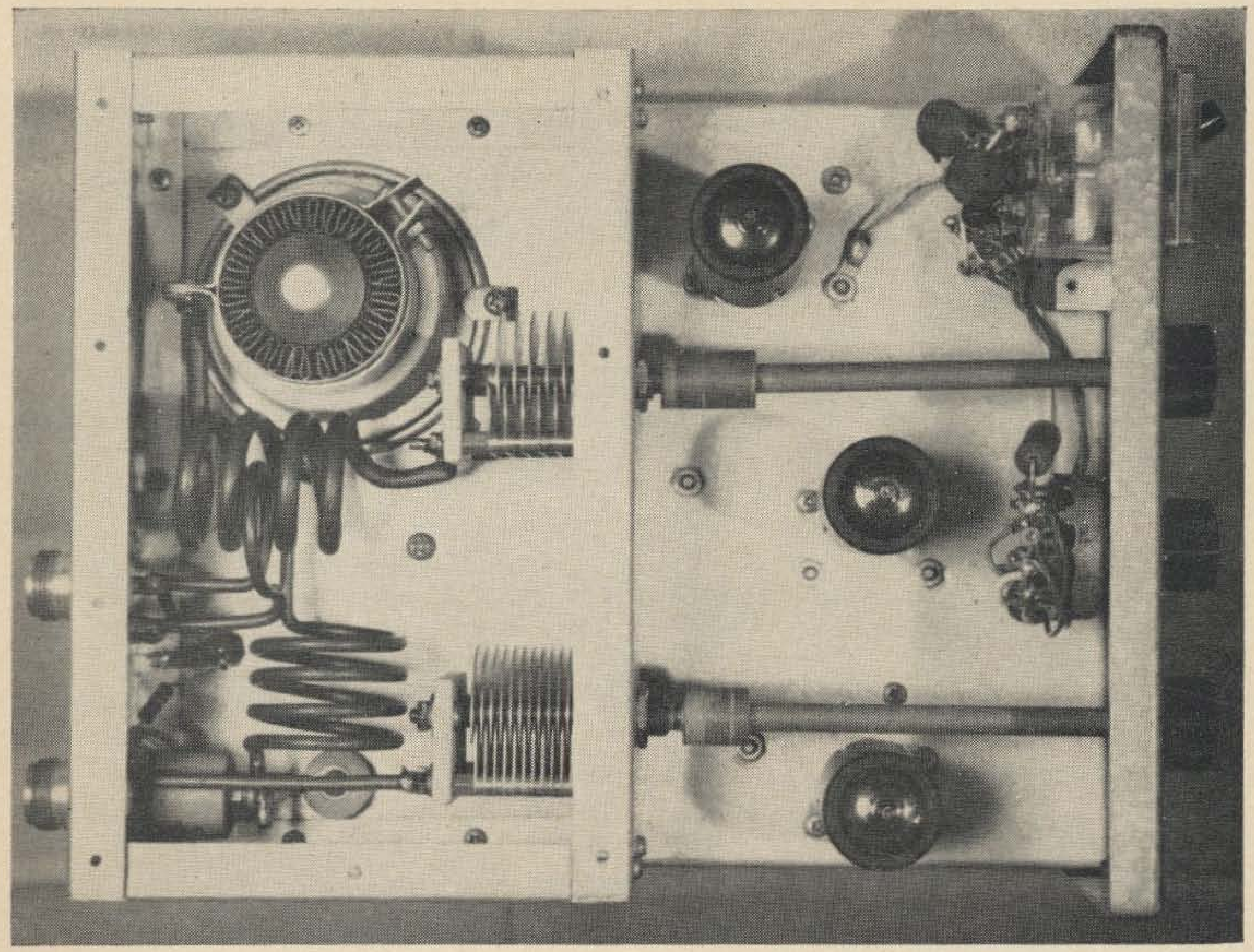
As shown in pictures the controls are marked with the proper positions for both bands as this simplifies changing bands. The panel meter monitors final grid current, plate current and relative rf output. The chart shows the approximate readings for all tubes while tuned and operating on each band.

Power supply and modulator used can be any one of the units constructed from the many handbooks available on the subject. This is left up to the builder depending on the type of operation he desires.

This transmitter has proved to be very enjoyable for over two years of mobile operation. Crystal control was originally used and for the last 1½ years a transistor VFO to be described in 73 has given very good results. The transmitter has also been used in a fixed station with equal results. It won second place



Bottom view of the transmitter showing the two-band grid circuit of the 4X150A. It is very similar to the final plate tank. Note how simple and clean the circuit is, especially when you realize that only two poles of that bandswitch are used. Note that the chassis must be sealed for cooling.



Top of K6RIL's transmitter. The right side contains the three exciter stages and the left the 4X150A final. The final tank is a clever two band circuit. On two, the coil next to the tube acts as a "series" tuned coil resonant at about 146 MHz and the coil below it acts as an rf choke. The six meter loading capacitor has very little affect on two. The two meter output is from a link in the coil. On six, the two meter coil acts as a connection to the pi network tank used for tuning.

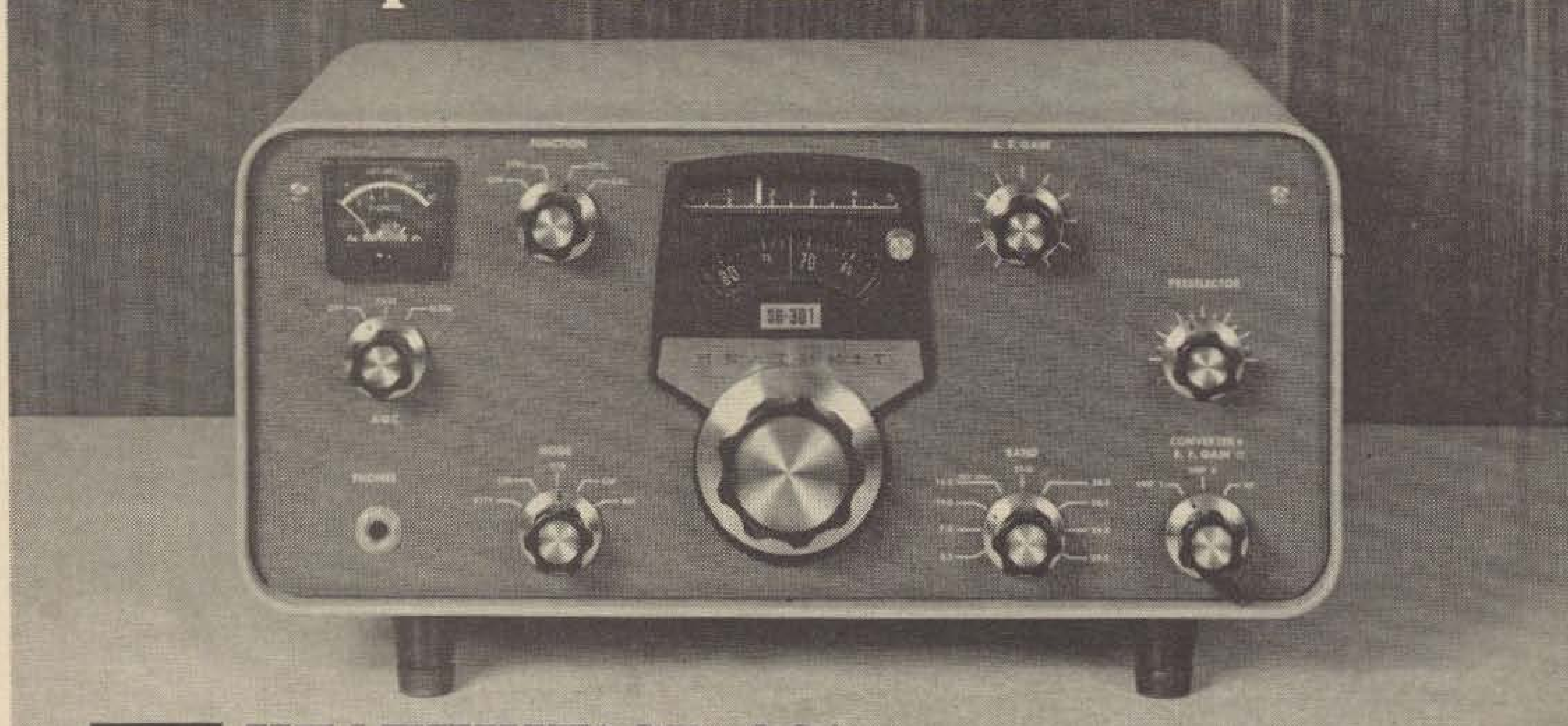
in the homebrew contest at ARRL Convention July 1965 at San Jose, Calif.

Using this transmitter has brought great pleasure and many compliments from other stations.

. . . K6RIL

Editor's note: I couldn't resist the simplicity of this transmitter, so built myself one. Of course, I made some changes. John Boyd WAØAYP bent me a nice case and chassis the same size as the one K6RIL used. I made the bottom row of controls on the panel symmetrical by using a smaller band switch and a five-position switch for crystal-VFO switching instead of the panel sockets. A 5763 worked as a driver, but I imagine the 7558 would be better. I found that the 4X150A grid circuit tuned to both 72 and 144 MHz at once, so I added a 72 MHz series tuned trap there to prevent radiating some strong competition for channels 4 and 5. You could probably avoid this by fiddling with the tank instead of the trap. Instead of the socket recommended, I used a surplus one without a bypass, and the homemade bypass I used wasn't quite good enough, so I'd suggest that you use a good Johnson socket. . . WA1CCH.

Now A Flip-Of-A-Switch Selects Transceive Or



New HEATHKIT® SB-301 amateur band receiver

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THE NEW SB-301 SETS "THE STATE OF THE ART" FOR AMATEUR BAND RECEIVERS. The new 15 to 15.5 MHz tuning range enables the most accurate attainable frequency check with the built-in 100 kHz crystal calibrator and WWV ... and as you read the specifications, notice the Heath pre-built LMO surpasses the tuning characteristics of every other receiver on the market. What's more, if your QTH is a high noise location, you'll appreciate the new ANL, providing excellent impulse noise rejection.

NEW "SUB-PACK" PACKAGING & ASSEMBLY SPEEDS CONSTRUCTION TIME. Components are packaged separately for each phase of construction ... saves you time in selecting components ... lets you see your progress more clearly as each phase is completed. Order the new SB-301 for unmatched value in a deluxe AM, CW, SSB, and now RTTY amateur band communications receiver.

Kit **SB-301**, Amateur Band Receiver, less speaker, 23 lbs. **$260.00**

SBA-301-1, Optional AM crystal filter (3.75 kHz), 1 lb. .. **$20.95**

SBA-301-2, Optional CW crystal filter (400 Hz), 1 lb. **$20.95**

Kit **SBA-300-3**, 6-Meter Plug-in Converter, 2 lbs. **$19.95**

Kit **SBA-300-4**, 2-Meter Plug-in Converter, 2 lbs. **$19.95**

Kit **SB-600**, Communications Speaker, 5 lbs. **$17.95**

SB-301 SPECIFICATIONS — Frequency range (megahertz): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 15.0 to 15.5, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megahertz. **Frequency stability:** Less than 100 Hz per hour after 20 min. warmup under normal ambient conditions. Less than 100 Hz for ±10% line voltage variation. **Visual dial accuracy:** Within 200 Hz on all bands. **Electric dial accuracy:** Within 400 Hz on all bands after calibration at nearest 100 kHz point. **Backlash:** No more than 50 Hz. **Sensitivity:** Less than 0.3 microvolt for 10 db signal-plus-noise to noise ratio for SSB operation. **Modes of operation:** Switch selected; LSB, USB, CW, AM, RTTY. **Selectivity:** RTTY; 2.1 kHz at 6 db down, 5.0 kHz at 60 db down (crystal filter supplied). SSB; 2.1 kHz at 6 db down, 5.0 kHz at 60 db down (crystal filter supplied). AM; 3.75 kHz at 6 db down, 10 kHz at 60 db down (crystal filter available as accessory). CW; 400 Hz at 6 db down, 2.0 kHz at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Audio response:** SSB; 350 to 2450 Hz nominal at 6 db. AM; 200 to 3500 Hz nominal at 6 db. CW; 800 to 1200 Hz nominal at 6 db. **Audio output impedance:** Unbalanced nominal 8 ohm speaker and high impedance headphone. **Audio output power:** 1 watt with less than 8% distortion. **Antenna input impedance:** 50 ohms nominal. **Muting:** Open external ground at Mute socket. **Crystal calibrator:** 100 kHz crystal. **Front panel controls:** Main tuning dial; function switch; mode switch; AGC switch; band switch; AF gain control; RF gain control; preselector; connector & ANL switch; phone jack. **Rear apron connections:** Accessory power plug; HF antenna; VHF #1 antenna; VHF #2 antenna; mute; spare; anti-trip; 500 ohm; 8 ohm speaker; line cord socket; heterodyne oscillator output; LMO output; BFO output; VHF converter switch. **Tube complement:** (1) 6BZ6 RF amplifier; (1) 6AU6 Heterodyne mixer; (1) 6AB4 Heterodyne oscillator; (1) 6AU6 LMO osc.; (1) 6AU6 LMO mixer; (2) 6BA6 IF amplifier; (1) 6AU6 Crystal calibrator; (1) 6HF8 1st audio, audio output; (1) 6AS11 Product Detector, BFO, BFO Amplifier. **Power supply:** Transformer operated with silicon diode rectifiers. **Power requirements:** 120 volts AC, 50/60 Hz, 50 watts. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D. **Net weight:** 17 lbs.

James Dillman K4USK
P.O. Box 4159
St. Petersburg, Fla.

Poorboy Mark II Quad

Here's an easy-to-handle three band quad made from inexpensive aluminum tubing.

As a result of the article in January, 1964 QST indicating that the cubical quad is the top choice among DX'ers, a renewed interest in this proven performer has been generated on the ham bands.

Many of you yearn to try the quad and have searched hopefully for a design worth investigation.

About the second paragraph of the usual quad article, the words "Take it to your friendly neighborhood welder . . ." leap up from the page to strike you where it hurts. Your neighborhood welder isn't so friendly--he charges, and how!! Besides, did you ever try to explain a "gizmo" that you understood perfectly to someone who didn't? So you get discouraged but still you read on . . .

A couple of paragraphs further down appears the word "bamboo," followed by more words telling you to take tape and wrap every cotton-picking inch of all that bamboo so the weather can't get at it quite so quickly. Let's see: 100′ of bamboo. That means X hundred feet of tape, times Y number of hours wrapping time. Then after that comes . . . ah, heck!

Or, possibly the author urges: "Use wood dowel to join two pieces of EMT to form the crossarms." Dowel is cheap. So is EMT. But, wait! Wood isn't very strong, is it? And, didn't someone tell you that EMT was the stuff that skilled metallurgists developed especially so that it could be easily bent? Remember the time you tried to "unbend" a piece of tubing?

Shucks, you say, it just isn't worth it. Besides, this guy says that the element lengths and the length of the boom are entirely different from the last article you read.

Take heart, OM, and read on about the Poorboy MK II, a quad that will solve all your problems—a tri-band quad made of aluminum tubing, light enough to be handled by a TV rotor, of simplest construction, weatherproof and at a cost of about two-thirds that of a commercial quad made of conventional bamboo.

With this quad, there is no "machine-shop" type work to be done, no welding, no special tools and, except for the tubing, no parts that cannot be obtained at your nearest TV wholesaler, or your neighborhood hardware dealer, etc.

The unique construction design of this quad eliminates the usual bugaboos normally found in the building and raising of the conventional quad. Its two-piece boom eliminates the necessity of having to turn it over on the ground. It can be hoisted into final operating position, one section at a time, by one man.

The Poorboy MK II has been in use at this QTH for five years, using an inexpensive TV rotor on a 30′ slip-up mast and has survived the 90 mph winds of Hurricane Donna and, on two occasions, winds in excess of 70 mph. In addition, it has withstood winds in the 40-50 mph range which are fairly common locally. It is still in perfect alignment and recent examination disclosed that revarnishing of the wood parts was the only item needing attention.

Investigation of Bill Orr's handbook, *Quad Antennas* shows that the gain of a quad is almost constant with spacings from .1 to .2 wavelength between the driven element and the reflector. Further invetsigation shows that the impedance values in this range of spacings

Jim is a printer for the Tampa Tribune-Times.

vary from 60 to 110 ohms at an antenna height of ½ wavelength. Arithmetic shows that .1 at 14 MHz is .15 at 21 MHz and .2 at 28 MHz.

The .1 and .15 spacings give impedances of about 60 and 75 ohms which are right smack in the middle of the ball park. But the .2 spacing gives an impedance of about 110 which is somewhat out in left field. The 28 MHz antenna could be fed with 93 or 125 ohm coax. However, in order to use the more readily available 72 ohm coax, an impedance value of about 90 ohms is obtained by the use of 7½" TV stand-off insulators on both the driven element and the reflector which reduces the element spacing at 28 MHz.

Further arithmetic at these spacings gives a boom length of 7'1" but the boom is cut to 7'9" to allow for mounting of the crossarms and a slight bowing effect.

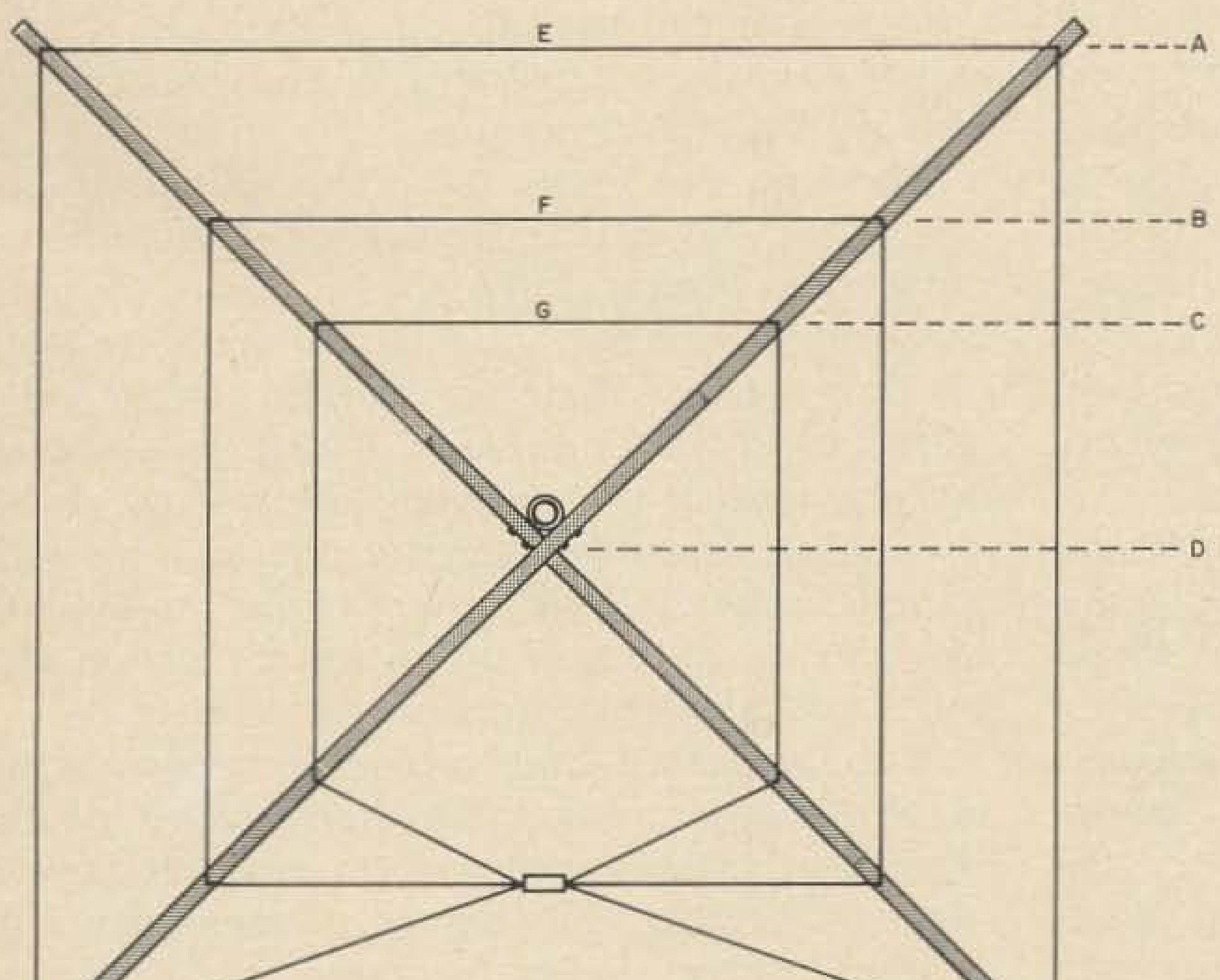
The heart of the Poorboy MK II is the boom which is made from two 5-foot sections of standard 1¼" galvanized TV mast (flared for stacking) joined into a single 10-foot length. Cut the boom 7'9" long, locating the center of the joint 1' from the center of the boom. This is to facilitate mounting to the boom clamp. Locate the large part of the joint on the short side of the boom. The driven elements are built on this short section so that any desired changes may be made by lowering only the driven elements. Minor changes to the reflectors can be made by repositioning the tuning stubs.

Drill a small hole through the joint and insert a steel bolt to insure exact realignment of the boom during assembly. The hole should be barely large enough to accommodate the bolt as insurance against the two sections slipping out of alignment at any time.

The boom clamp is simplicity itself and quite possibly you can scrounge up the materials at no cost to the XYL. Cut a piece of plywood at least ⅝" thick into an 8" square. Fasten an 8" square of galvanized sheet metal (about 18 gauge) on one side of the plywood with several small wood screws.

Use two U-bolt type TV mast clamps with serrated yokes to mount the boom diagonally across the wood side of the boom clamp with the TV clamps as near the corners as possible. Mount the metal side of the boom clamp to the mast with another identical pair of TV mast clamps. Use metal straps similar to those furnished with ordinary U-bolts to lock down on the wood side. Run the mast through the two remaining corners of the boom clamp with one TV clamp at the bottom corner and the second just far enough above the boom to insure clearance. Cut off the tip of the boom clamp above the top mast clamp.

Tubing designated 6061-T6 is generally considered to be an excellent choice for purposes as described here. This is based on economy, strength, corrosion resistance and general availability. Tubing generally comes in 12' lengths but try to get the ¾" in an 18' length which is sometimes available. Use .049 wall



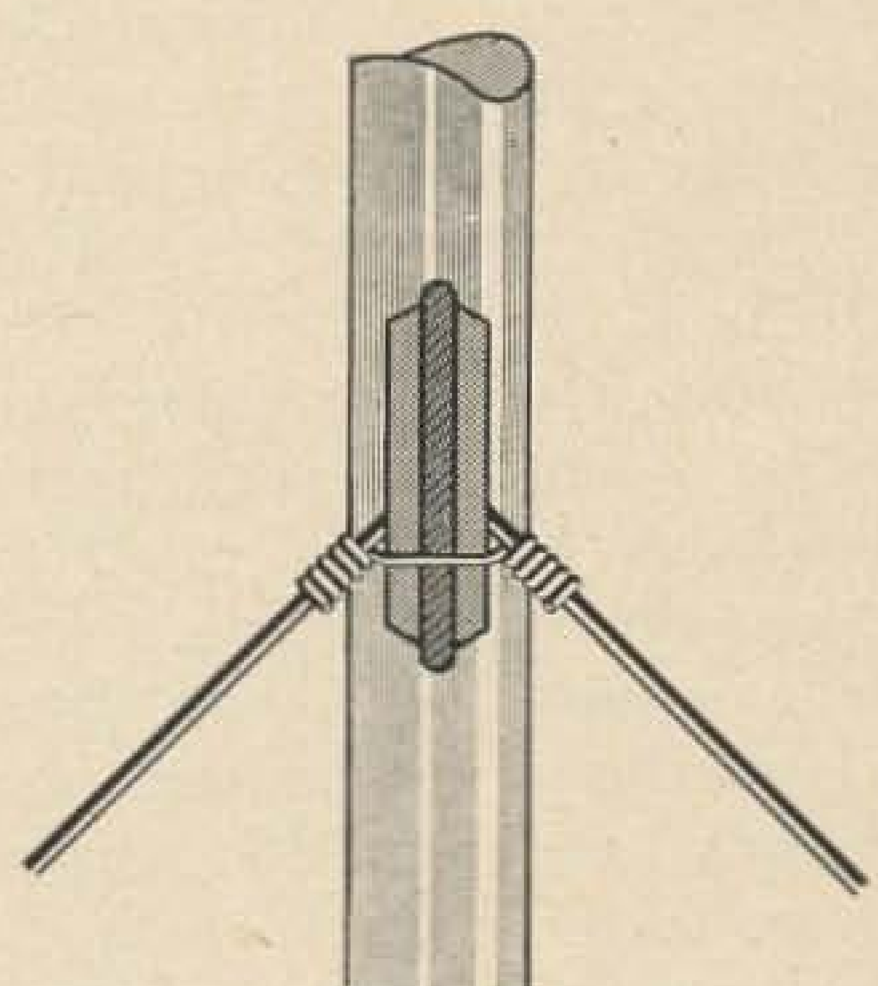


Fig. 1. Left: Arrangement of driven elements when using single feedline. Note boom above point where arms cross. Dimensions are: AD 12'6", BD 8'4", CD 6'2", E 17'8", F 11'9", G 8'7". Right: Exploded view of TV mast clamps used to secure center section of boom and stand-off insulator to tubing.

if possible. It may be difficult to obtain ⅝" and ½" in anything heavier than .035 which can be used as tip sections with no problems. If it must be used as inner sections, it will be necessary to shim up the inside tube. This is not recommended. Going to larger diameter tubing would be preferable.

Each crossarm is constructed from five sections:

A. One center section of ¾" .049 wall tubing, 4½' long.

B. Two inner sections of ⅝" .049 wall tubing, 6' long.

C. Two tip sections of ½" .049 or .035 wall tubing, 6' long.

The inner and tip sections are telescoped about 1' to provide a total length of 24½'. A 1' length of ⅜" wood dowel is inserted 6" into each tip section. These serve as insulators for the 20M elements.

Cut a slot 8" long into both ends of the ¾" tubing and one end of the inner sections. Cut a slot 4" long in one end of each tip section. Remove all burrs inside and out with a file. Sand 6" of the dowel until it slides easily into the tip sections. Drill a hole in the dowel 3" from the metal, just large enough to accept the wire easily. Drill two or three small holes in the tip sections as near as possible to the inner end of the dowel to prevent moisture buildup inside the arms.

Drilling the holes to accommodate the TV mast clamps which hold the center sections of the arms to the boom is the only part of construction requiring special care. It would be prudent to practice on pieces of scrap to drill holes straight through the tubing. A drill press is best, but with care it can be done with a hand drill. Be sure holes are perpendicular to the tubing. The diameter of the holes should only be large enough to insure 90 degree alignment of the arms to the boom. Locate the holes in the middle of the center sections.

Join the two sections of boom and secure with bolt.

Clamp a center section loosely to each end of the boom. To align these sections, place four small blocks of wood of identical thickness under the ends on a flat surface. With a large square borrowed from your friendly neighborhood carpenter, make sure center sections are exactly perpendicular to the boom. Carefully secure the clamps but avoid crushing the boom or tubing. Use clamps with contoured bar under the nuts. These bars can be made from scraps of tubing if they do not come with the clamps.

Once these two sections are aligned, place the ends on something high enough so that the remaining center sections will clear the flat surface an inch or so when in the vertical position. Here is where the XYL can help. Borrow her kitchen chairs. Use blocks of wood and, if necessary, QSL cards to make sure the previously aligned sections and the boom are exactly horizontal by means of a spirit level. The longer the better.

Place the inner center sections about ¼" inside the outer sections. Adjust the inner sections exactly vertical in all planes with the level. Cross check by placing the inner sections on the chairs and use the level to see if the outer sections are vertical.

Clamps for the slotted ends of the tubing are of the garden hose variety. Note: The sizes marked on the clamps are for the INSIDE diameter of the hose. Use two clamps at each joint except the tips where only one is necessary to secure the dowel.

Insulators for the 10 M and 15 M elements are the common 7½" and 3½" stand-off strap variety used for holding a single TV lead clear of the mast. Get those with the V-ends made of solid, flat metal.

With a light hammer, carefully tap both sides of the V narrow enough to rest on the tubing. Place the V on the tubing and run the strap through the slots. Tighten the shaft enough to get a light fit on the tubing. Release the shaft and run the strap around the tubing a second time and repeat the process. You should have a snug, but not tight fit.

With regard to the lengths of the elements, there are almost as many figures available as there are articles written about it. In addition, the usual modifying factors of location, height, construction, etc., enter into the overall picture as with any antenna.

Through the years since the advent of the first quad, the unrealistic claims and confusing dimension figures have jelled down to more conservative claims and a fairly accurate table of dimensions. Bear in mind, always, that stated element dimensions of any antenna are merely typical or average. However, unless something drastic enters the picture, the completed antenna will usually be sufficiently close to its optimum operating condition that tuning adjustments are a simple matter.

It is suggested that you make generous use of a grid-dip meter. The construction of this quad lends itself very well to easy changes of element lengths. The driven elements must be resonant at the design frequency before proper tuning adjustments can be made. Unless this condition is met, no setting of the tuning stubs will produce maximum gain, F/B or minimum SWR. The reflector elements are duplicates of the driven elements with tuning stubs added.

The performance curves of a two-element

DRAKE **2-C** RCVR & **2-NT** CW XMTR

Basic pair for all Hams... Novice or General

Receiver Model 2-C $229.00

Excellent performance at low cost

• **Triple Conversion** • **Crystal-controlled First Converter** • **500 kc ranges** for 80, 40, 20, 15 and 10 Meters • **Also any 500 kc range** between 3.0 mc and 30 mc by inserting an accessory Crystal • **Temperature-compensated VFO Tuning** • **Selectable Sidebands** without retuning • **Three Bandwidths**—.4, 2.4, 4.8 kc at 6 db • **Solid-state** Audio, Product and AM Detectors, AVC Amp and Xtal Osc • **AVC Switch** (Fast, Slow and Off) • **SSB, AM and CW** with AVC and S-meter • **Works Break-in CW** with 2-NT Xmtr • **19 Tubes and Semi-Conductors** • **Dimensions:** $11\frac{5}{16}$"W x $6\frac{9}{32}$"H x $9\frac{3}{32}$"D. **Wt.:** $13\frac{1}{2}$ lbs.

Accessories available: 100 kc Calibrator, Q Multiplier, Matching Speaker, Noise Blanker, Crystals for other ranges.

CW Transmitter Model 2-NT $129.00

Built-in essentials and accessories

• **100 Watts Input** (can be reduced to 75 watts for novice) • **Operates Break-in CW, Semi Break-in CW or Manual CW** with Drake 2-C or other receivers • **Automatic Transmit Switching** • **Side Tone Oscillator** built in • **Antenna Change-over Relay** built in • **Pi-Network output** with fixed loading • **Lo Pass Filter** against TVI built in • **Drop-out delay** of change-over relay adjustable • **CW Coverage** on 80, 40, 20, 15, 10 Meters • **Simplified Tuning** • **Frequency Spotting** without xmtr output • **Grid Block Keying** • **Code Practice** in stand-by position • 13 Tubes and Semi-Conductors • **Dimensions:** $9\frac{7}{8}$"W x $6\frac{9}{32}$"H x $9\frac{3}{32}$"D. **Wt.:** $12\frac{1}{2}$ lbs.

Accessories available: Antenna Matching Network, VFO, and Crystals.

All prices are Amateur Net. See your distributor or write for free brochure.

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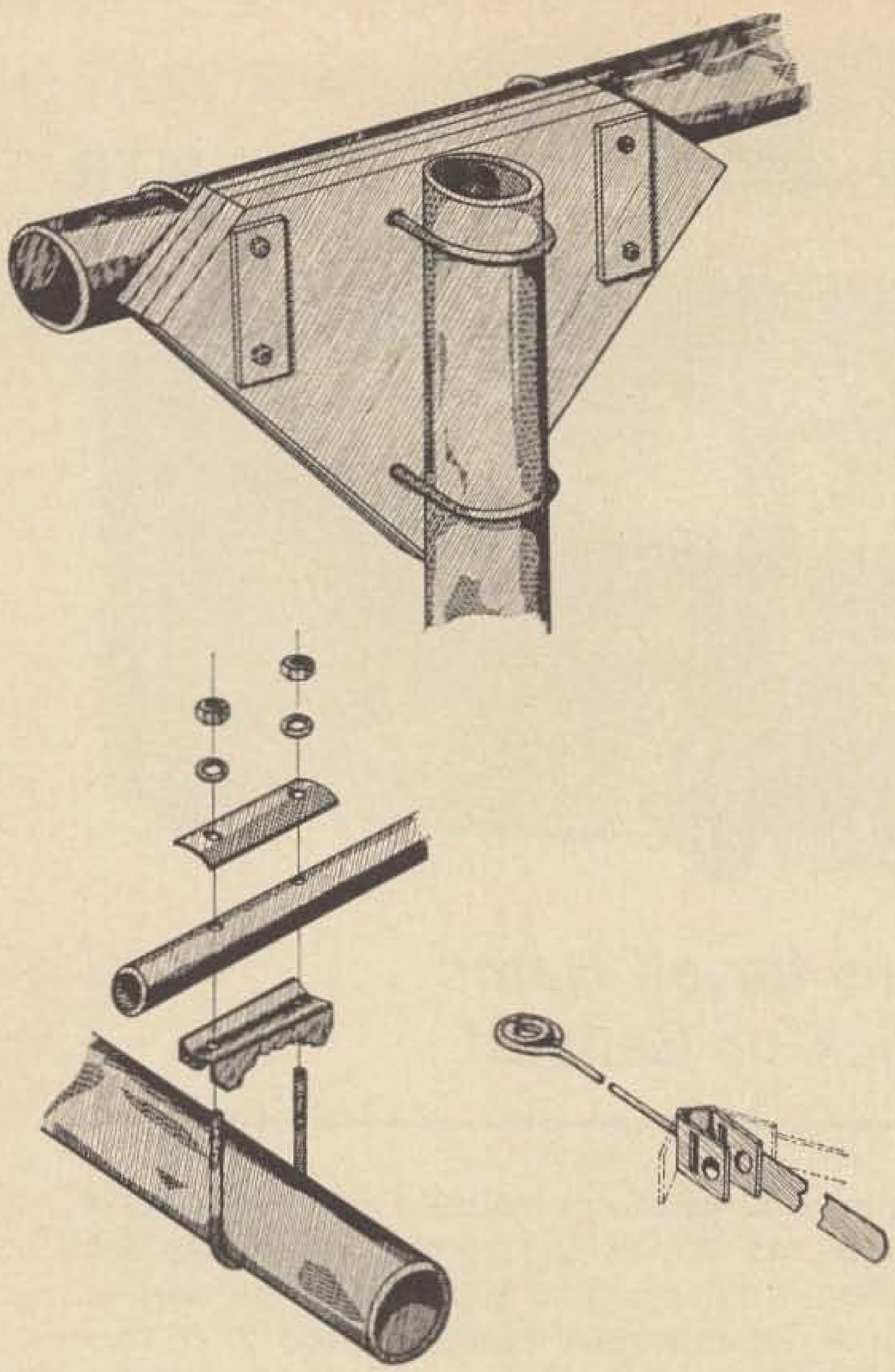


Fig. 2. Top: Boom clamp. Not shown are serrated yokes used with TV mast clamps to attach boom clamp to mast. Bottom: End view of stand-off insulator showing insulated wire twisted around element wire on one side of insulator, passed around outside of loop and twisted on opposite side to secure element wire to stand-off insulator.

beam show that the greatest usable portions fall above the design frequency in the case of the reflector-type beam. On the high side, the curves drop off slowly, while on the low side, they drop off rapidly as they near the self-resonant frequency of the reflector. For this reason, a design frequency in the low end of each band was chosen. The performance curves for the quad indicate that it will perform with near-maximum effectiveness across the entire 20 M and 15 M bands and across the greater portion of the 10 M band.

The design frequencies for the Poorboy MK II are 14.1, 21.2 and 28.8. The side dimensions as determined by the formula 250÷f (MHz) are 17′8″, 11′9″, and 8′7″.

Use #14 stranded wire as it is inexpensive, easy to handle and lightweight. Place a small dot of the XYL's brightest nail polish about 6″ from one end. Measure half the distance of one side and mark it with polish. Measure three full sides and mark each with polish. Last is another half side. Cut the wire about 6″ beyond the last mark.

Complete the 10 M and 15 M elements by fastening the ends of the wires to 3″ center insulators at the dots and solder. The 20 M elements must be left unfastened on one end until later.

Tuning stubs provide the mechanical means for varying the length of the reflector elements to tune the antenna to its maximum effectiveness. The reflector is approximately 5% longer than the driven element. The stubs consist of suitable lengths of #12 bare solid wire spaced 3″ apart and soldered across the center insulators of the reflectors. Sliding shorting bars used for tuning are made from small bits of solid wire with clips attached to each end to facilitate moving them easily.

Tuning stubs are 38″ long for 20 M, 22″ long for 15 M and 18″ long for 10 M. These are maximum lengths and after the proper positions for the shorting bars are found, cut off the excess stubs and solder permanent shorting bars at these points.

Select the long section of the frame. This will be the reflector. Lay it with the boom upward on the most level area of the lawn. Slide two hose clamps on each end of the center sections and insert inner sections. Slide a 7½″ SO insulator followed by two more clamps on each inner section. Next, insert tip sections with dowel locked in place and with a 3½″ SO insulator attached.

Note that the length of the arms is to be measured from the point where the arms cross. Measure from cross to ends of inner sections and equalize with about 1′ insertion. Set tip sections so that holes in dowel are 12′6″ from cross and in line with wire direction. Place SO insulators exactly vertical at 8′4″ and 6′2″. These settings are approximately correct as a starting point.

Tighten all clamps and insulators enough that they will not slip but do not lock.

Raise assembled section in the air by the boom enough to clear the ground. Gently lower straight down to allow arms to fall naturally into position. Measure to be sure tips are equidistant from each other. Drive small pegs in the ground in pairs at several points along the arms to insure their staying in place.

Slide 20 M element into place with its center insulator on the cross side of the boom. Place dots at holes in dowel. Use small scraps of wire to tie elements to dowel to prevent slipping. Attach the other two elements in a similar manner and adjust by manipulating the SO insulators. Use INSULATED wire to tie these elements to insulators.

Do not attempt to pull element wires tight as this will cause a severe bowing effect. Allow all wires to hang loosely. Attach tuning stubs.

Securely fasten boom clamp to mast and loosen clamps used to hold boom. Raise reflector section, slide through clamps and lightly lock into place to await completion of the other section.

Assembly of the second section is identical to the first. 72 ohm coax is connected directly across the insulators. Upon completion, hoist it up and mate it to the first section, and lock in place with the aligning bolt.

Although a lower boom is not an absolute necessity, it serves several purposes. It will eliminate much of the quad's tendency to whip in severe winds. It supports the weight of the feedlines and tuning stubs and reduces the bowing of the arms from the weight of the elements, etc.

A light, well-varnished piece of wood of sufficient length will serve well. Mount it to the mast by a TV clamp or U-bolt at the height of the 15 M insulators. Tie the 15 M elements to the lower boom. Run feedlines out one end of the boom and tie tuning stubs to the other end and this completes construction.

With proper care and consideration in construction, the Poorboy MK II should last for years. Treat all wood with several coats of good, high grade, spar varnish before assembly. Hang the dowel with a thumbtack driven in one end from a clothesline and this job is no problem. Remember to cover the ends of the dowel and the insides of the holes. After assembly, give it another couple of coats to protest against unseen nicks and scratches. Give all metal, except the tubing, generous coats of aluminum paint both before and after assembly.

Tuning is accomplished by pointing the back of the quad at a nearby cooperative ham buddy who provides a steady, horizontally polarized carrier at the design frequency which is tuned for the lowest reading on the station S-meter by sliding the shorting bar along the stub. After each band is tuned, check the other bands for deterioration of F/B. Readjust as necessary. The point of highest F/B lies in a narrow range. Remember that the F/B obtained during tuning will not be the same for all received signals due to different angles of received signals. It would be wise to test F/B with as many local hams as possible and choose a best average setting.

Tests were run using separate feedlines and using a single feedline for the three bands. Interaction during tuning was more noticeable in the case of the single feedline but tuning was no more difficult. In actual operation, there is little to indicate that one system is superior to the other. However, as with all multi-band antennas fed with a single feedline, the chance of harmonic radiation is great enough to give the nod to the separate feedline system.

To connect the three driven elements to a common insulator for a single feedline, adjust the two lower corners of the 20 M element in toward the boom enough to allow the wire to reach the 15 M insulator. Adjust the lower SO insulators of the 10 M element toward the boom and run the wire to the now-common insulator centered in the 15 M element.

The frame of the Poorboy MK II can be used for a mono-band 20 M quad, a 20/15 M and 20/10 M dual-bander. In the event a 15/10 M dual-bander is desired, the metal part of the arms can be reduced to a length of 12′ with suitable 3′ lengths of wood dowel inserted 6″ into the tip sections to bring the total length to 17′. Both the 15 M and 10 M elements can be threaded through the dowel, eliminating the SO insulators. The boom can be simplified by using a single section of TV mast cut to 5½′. In case you've been wondering, this version was the MK I which was cannibalized in the development of the MK II.

Antenna purists frown on the use of coax to feed a balanced antenna such as the quad with no matching device. However, it is a common practice and the performance of such an arrangement seems to suggest that it works better than a casual reading of the textbooks indicates.

The use of metal arms for the quad seems to be a neglected subject. The greatest danger is resonance at an operating frequency. In this case, the arms are close to resonance at 21 MHz. Avoid an arm length of less than 24′.

During the experiments with multi-band quads, the author received the distinct impression that the use of 20 M and 10 M quads on the same frame left a lot to be desired. Interaction between these two was definitely more noticeable than other combinations on the same frame. The answer is probably due to the harmonic relationship. For this reason, a design frequency of 28.8 MHz was chosen on 10 M. Also, this combination never seemed to produce as sharp a pattern as other combinations. Lacking the wherewithal to continue it further, the matter was never fully pursued.

The author realizes that the Poorboy MK II is not the ultimate in quad design but offers it as a good compromise for the average ham with limited resources. . . . K4USK

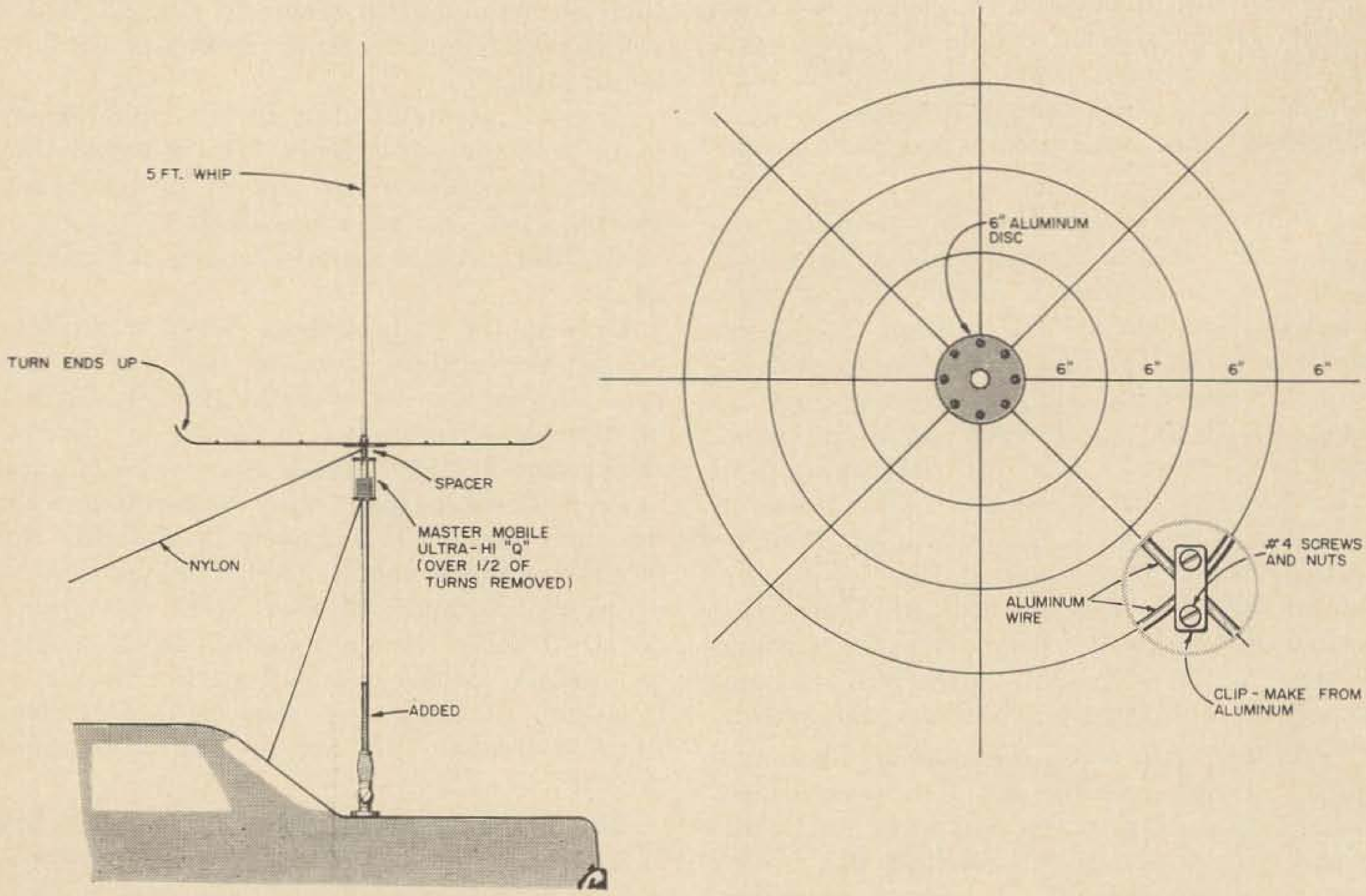
Len Yerger W3BTQ/5
908 So. Alamo St.
Rockwell, Texas

Want 5dB Gain on 75 Meter Mobile?

This article will tell you how to substantially increase your 75 meter mobile signal. The solution is not for the timid or the finicky. It's for the ham who is master of his own car, and really wants a big signal.

In case you haven't given it a try, 75 meters is a very good mobile band. It doesn't close down at night like 20 meters, or become infested with commercials like 40 meters. Also, the home stations don't have big beams on 75 meters, so you can give them a tussle.

Most commercial mobile antennas have calculated overall efficiencies of between 2% and 4%. There may be some arguments at this point, but check with the mobile antenna books and Terman's, and figure it out for yourself. The radiation resistance is very low for short antennas, and the loading coil resistance, and car body and ground resistances are very high. With 75 meter mobile antennas nearly everything goes up in heat. Let's see how we can radiate more and heat less.



The Big Signal 75 meter capacitance loaded mobile antenna.

First, make the antenna as high as the law and your normal travel route permit. Also, mount it up on the back deck of the car where it is out in the clear. You can probably add two feet or so to the regular base section and still not exceed the height limit.

Up goes the radiation resistance and up goes the efficiency. Now perhaps the efficiency becomes 3% to 5%. The center loading coil has moved up, but that hasn't done any harm—perhaps helped a little.

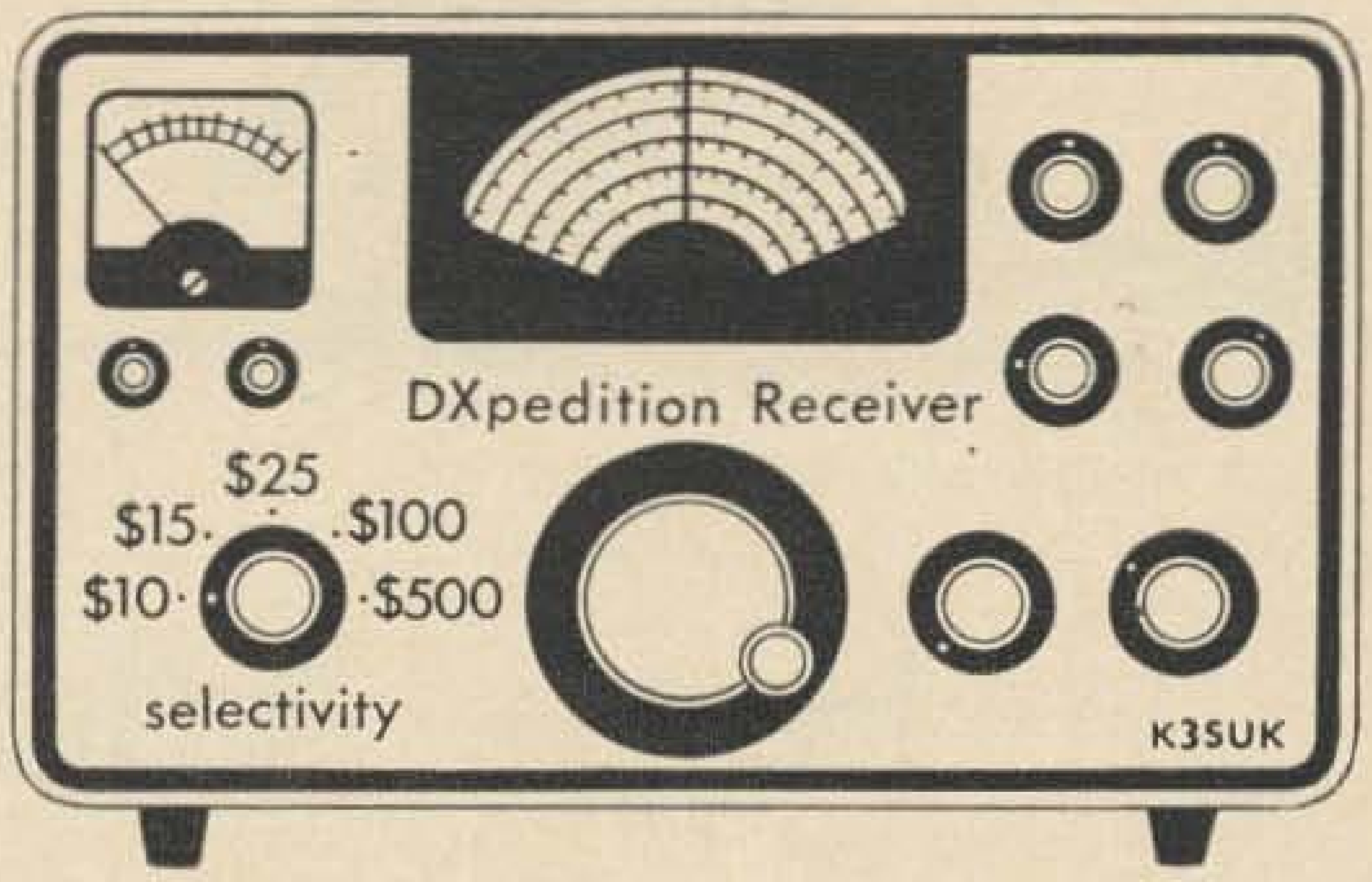
To match the antenna to your 52 ohm feed line, shunt about 1500 picofarads from the base of the antenna directly to the car body. Don't use a coil at the base. It is more trouble to install, and has more loss. The capacitor will do the trick. You may have to adjust the value somewhat. Use your VSWR meter.

What next? We can't go higher. Let's look at the loading coil. Larger wire has less loss, but as the wire becomes larger the coil begins to grow in size and weight to hold the same inductance. A good high Q coil is fine, such as the Master Ultra Hi Q. Trying to improve over this coil is a rough game to play. Silver plate the wire? The improvement is hardly worth the trouble. The way to lower the coil resistance is to cut down on the number of turns. The way to cut this down is to increase the antenna capacitance above it.

One way to increase the capacitance would be to use a large diameter pipe above the coil, but this is not practical. Think of the trees, and the five foot flexible whip remains. What can be done with a capacity hat? The answer is—plenty!

If you want to develop your own top loading arrangement, start by obtaining a coil of aluminum clothes line wire. It appears to be a little larger than #8. Cut an 18 inch piece, and install it on about a 3 inch spacing rod above the coil. Head the wire aft. You will be able to take a few turns off the coil and still be resonant on the same frequency. Fine, how about four of these lengths, arranged like a two meter ground plane. Off come more turns. You can do the trimming with nothing but your rig and a VSWR meter if you go slowly. Keep the power way down. Don't add too much capacitance at once or you may find resonance outside the band, and you will need more than the rig and a VSWR meter to straighten things out.

The aluminum wire is surprisingly strong, and is self supporting at lengths up to more than two feet at fast car speeds. With the four radials and the increased height, the antenna efficiency has now become somewhere near 8%. File sharp edges to prevent corona and receiver noise.



If you still have courage, lengthen the radials a little, double the number, and strengthen them with three concentric circles of the same material. You now have a big capacitance hat of good strength. A 6 inch aluminum disc in the center can serve as a good building platform. The aluminum wire can be joined by small clips and screws, or binding with wire and covering with aluminum solder, or better yet by means of Heli-arc.

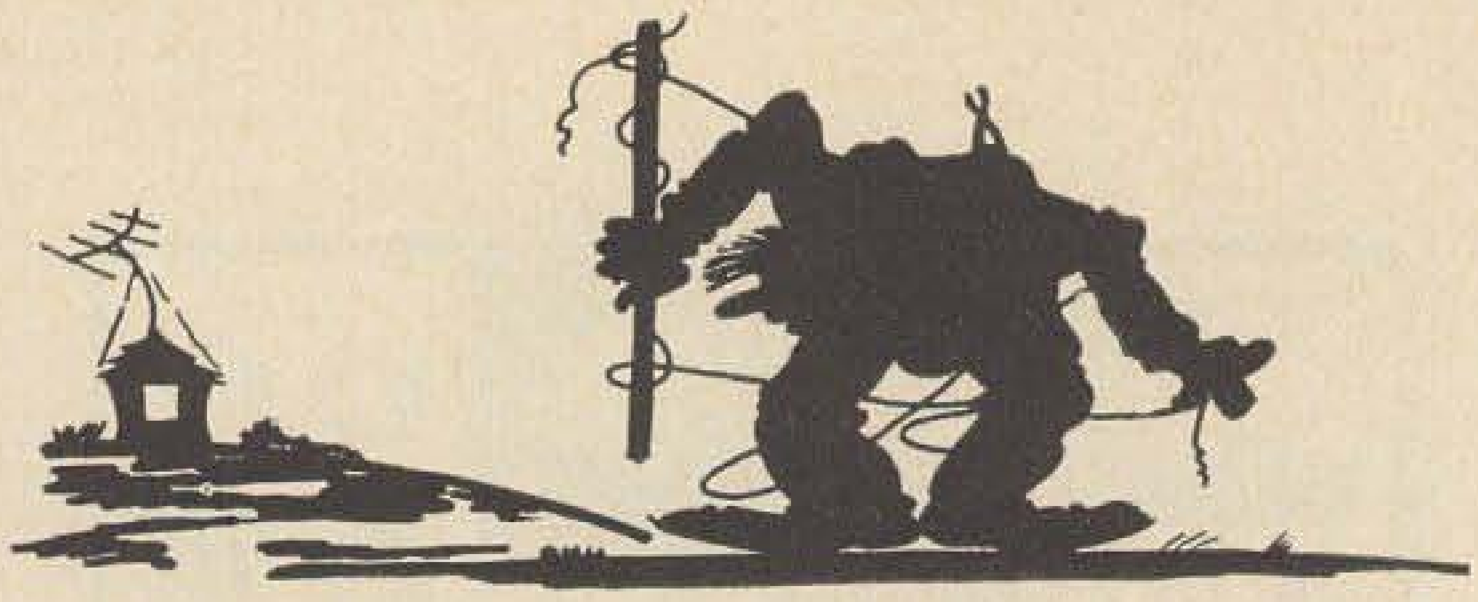
A capacitance hat of this type will allow you to cut your coil down to less than half of its original size. Efficiency will now calculate to be 10% or higher. Your actual output should have increased by at least 5dB. The 200 watt PEP rig has now become the equivalent of about 700 watts. You don't need a linear, and all of the problems of supplying power. Now, at 10% efficiency, you have a good vertically polarized signal. The efficiency has started to approach the efficiency of some home station ground plane antennas.

It is recommended that a light nylon cord be run from just above the antenna coil to the forward rain gutter, and another to the deck opposite the antenna base. These guys will stabilize the antenna at high speeds, and prevent it from swinging over the highway in a cross wind.

A second coil, which will resonate without the capacitance hat, is recommended for use when the hat or guy lines are not desired.

The writer has used an antenna of this type for over a year. Results have been very gratifying. The mobile signal is consistently stronger than other mobile signals of equal power using conventional antennas.

. . . W3BTQ/5



. . . a couple of wires, a long ruler, and a short conscience.

Howard F. Burgess W5WGF
1801 Dorothy Street N.E.
Albuquerque, New Mexico

High Accuracy VHF Frequency Measurements

Measure your VHF frequency to better than .00015%.

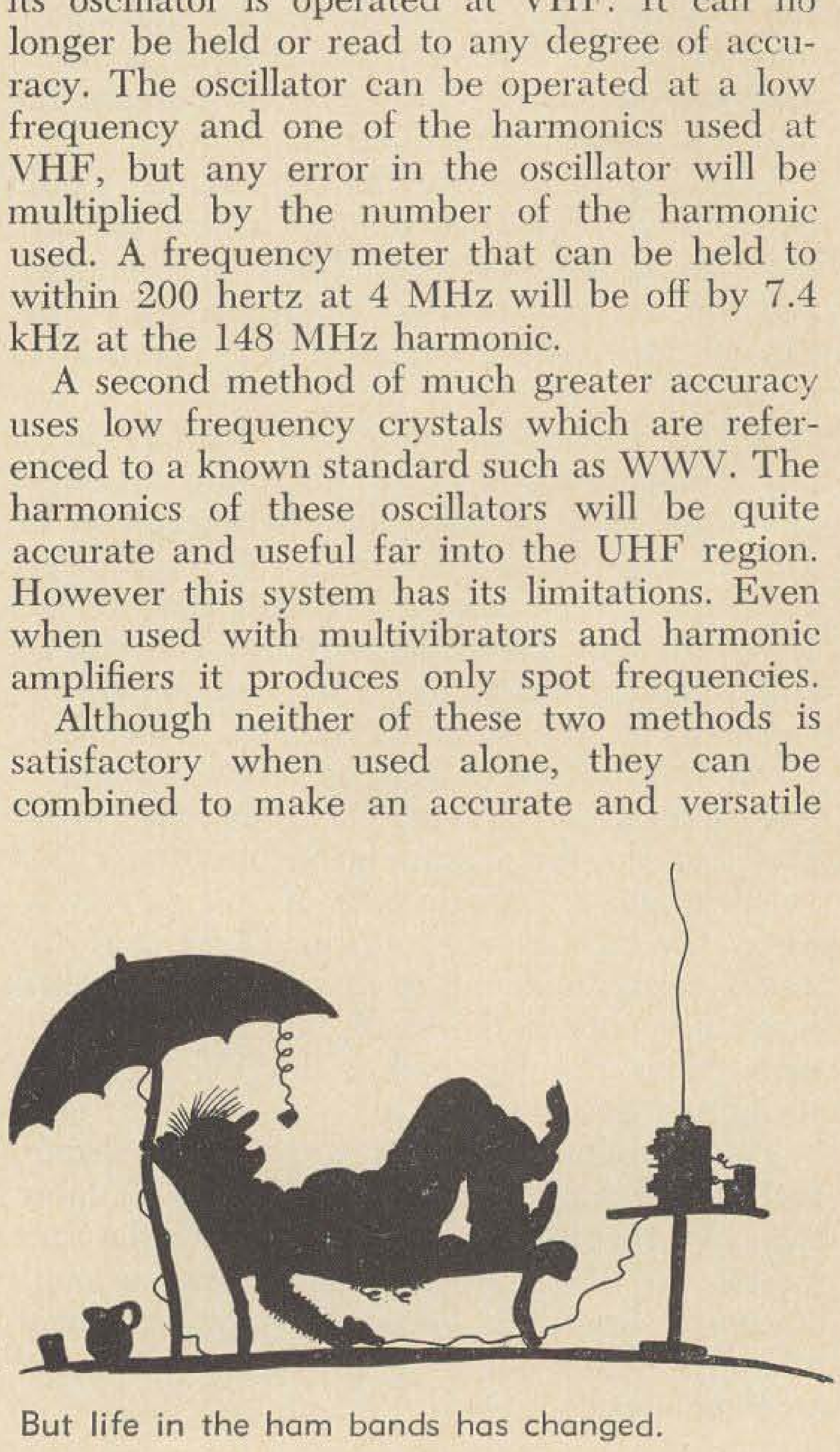
In years past the only need for a VHF frequency measurement was to make sure that the transmitter was in the right band. This could usually be taken care of with a couple of wires, a long ruler, and a short conscience. But life in the ham bands has changed. New narrow-band techniques and equipment make it necessary to know much more about frequency than just how to find the band. This is especially true in certain types of DX work. Frequency measurement capability also has its fringe benefits if you happen to belong to the "net set." You can alienate your friends, lose your peace of mind, and do wonders for the net by just reminding everyone at frequent intervals that he is off frequency, or drifting too badly to be measured.

Accurate frequency measurements can be a problem for the amateur with a limited budget. However with some home construction and careful operation the average ham can make VHF frequency measurements to an accuracy better than .00015% at two meters. This is the equivalent of measuring the distance from New York to Los Angeles with an error of only 25 feet. Many commercial units cannot equal this figure. The same method can also be used for HF and UHF measurements.

There are many ways to measure frequency but few of them are satisfactory for use at the very high frequencies. The well known hetrodyne frequency meter becomes unstable when its oscillator is operated at VHF. It can no longer be held or read to any degree of accuracy. The oscillator can be operated at a low frequency and one of the harmonics used at VHF, but any error in the oscillator will be multiplied by the number of the harmonic used. A frequency meter that can be held to within 200 hertz at 4 MHz will be off by 7.4 kHz at the 148 MHz harmonic.

A second method of much greater accuracy uses low frequency crystals which are referenced to a known standard such as WWV. The harmonics of these oscillators will be quite accurate and useful far into the UHF region. However this system has its limitations. Even when used with multivibrators and harmonic amplifiers it produces only spot frequencies.

Although neither of these two methods is satisfactory when used alone, they can be combined to make an accurate and versatile



But life in the ham bands has changed.

Howard, former W9TGU, W7KGD and WØBDH, has written many articles in his 32 years of licensed hamming. He now works for Sandia in AEC primary standards.

. . . from New York to Los Angeles with an error of only 25 feet.

system. If you haven't guessed it by now, the system works like this. A crystal oscillator operates on 5 MHz. This oscillator can be kept to zero beat with WWV with very little effort. With a simple harmonic amplifier following it, strong markers are available every 5 MHz far into the UHF region. To fill in between the 5 MHz points, and get full tuneable coverage, all that is required is to add the output of a stable low frequency VFO to the proper marker. Example: To measure 146.25 MHz just add 1.25 MHz from a calibrated tuneable oscillator to the 145 MHz harmonic of the crystal. The same results can be had by using the 150 MHz marker and substracting 3.75 MHz.

The tuneable low frequency oscillator of this hetrodyne system can be any stable, calibrated, oscillator that will give the desired frequencies. A good signal generator can be used but better yet is the old faithful BC-221 frequency meter. The crystal oscillator that supplies the 5 MHz markers should be designed for high stability. However, even simple crystal-controlled units can be kept zero beat with WWV for periods long enough to make most measurements.

Earlier we quoted a figure of .00015% or better for the accuracy of this system. Perhaps we should show how this is possible. The crystal oscillator can be held to near zero beat with WWV but due to propagation errors in the signal of WWV, we can never be sure that our crystal is closer than 2 parts in 10 million. This would be 2 hertz of error at 10 MHz or an uncertainty of 29 Hz in the 145 MHz marker. The BC-221 is normally considered to be a .05% instrument. This would be an error of about 1.75 kHz at 3.5 MHz. However with care in calibration, and reading it is not difficult to reduce this value to 200 hertz or less. In a hetrodyne system the error of the VFO is not multiplied at VHF but is just added to the error of the crystal marker used.

The total error at 2 meters is 29 Hz contributed by the crystal and 200 Hz by the VFO for a total of 229 Hz. This is a little more than 1.5 hertz per million hertz for a tuneable system. Of course these values are approximate and with careful operation they can be reduced by 50% or more.

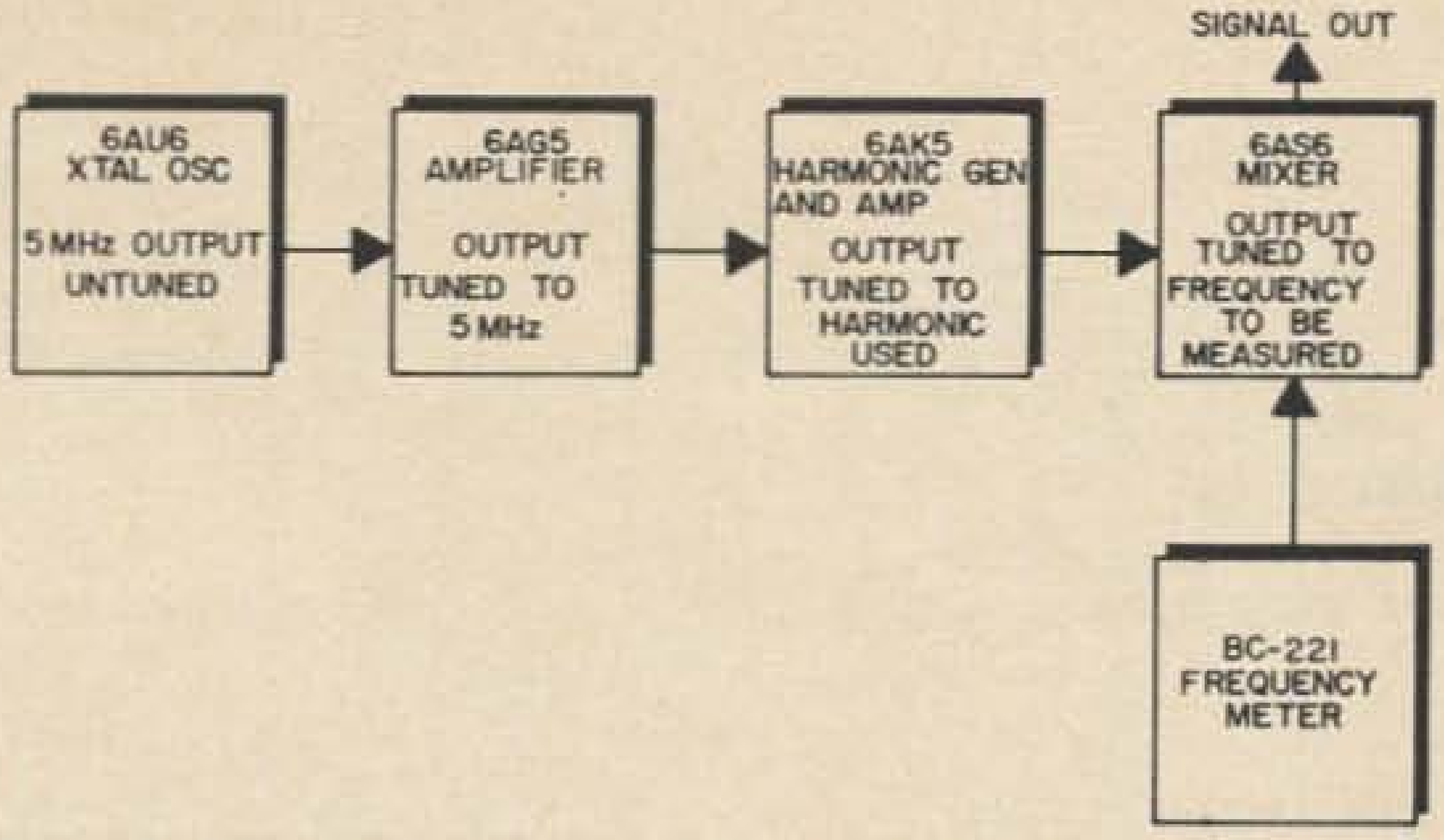


Fig. 1. Block diagram of the VHF frequency meter.

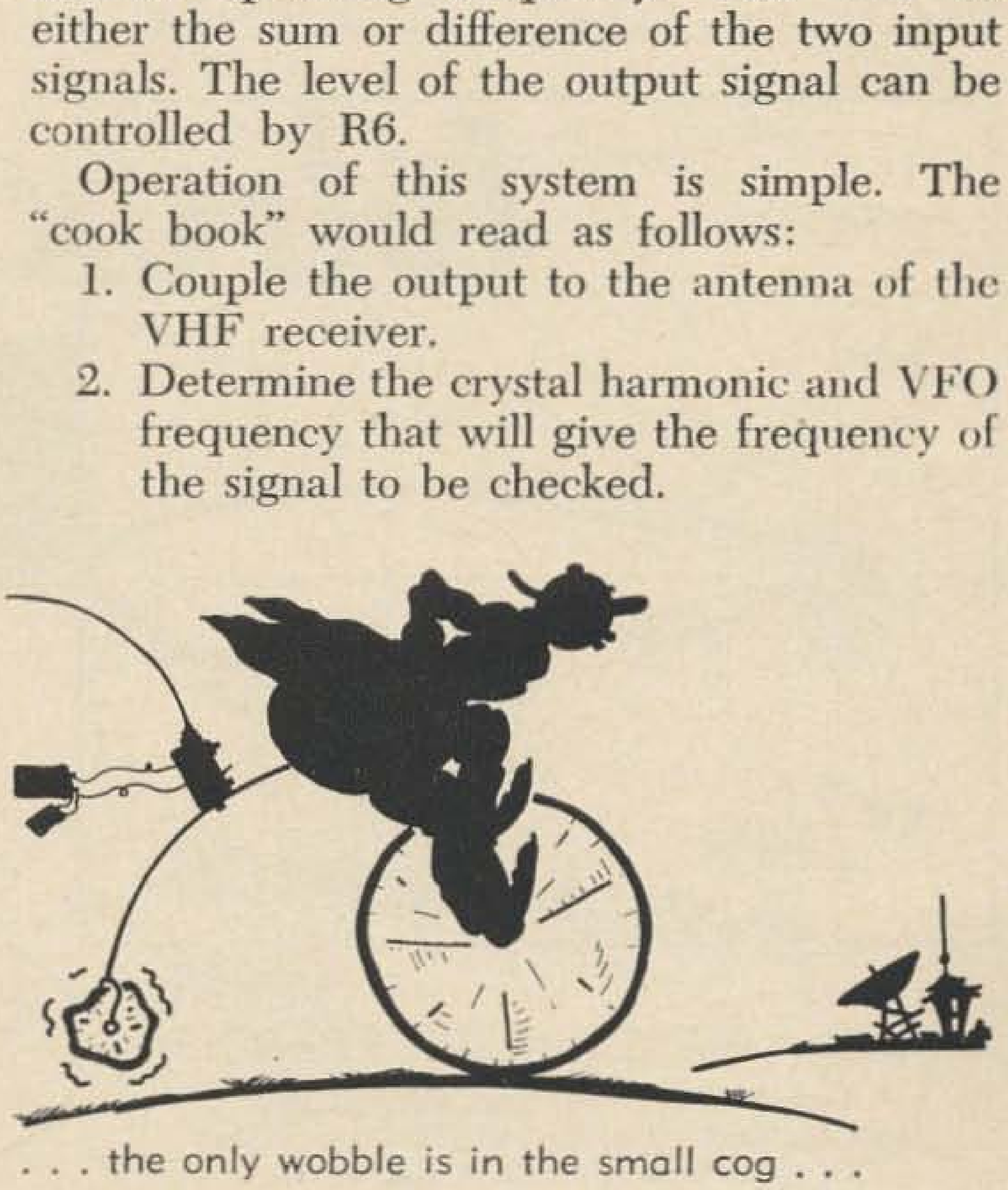
In the 146.25 MHz example used earlier, the VFO was required to furnish less than 1% of the total output. To put it another way, the only wobble is in the smallest cog and its contribution is so small it can't shake up the machinery too much.

The circuit shown in **Figs. 1 and 2** has been used for monitoring MARS, CAP, and several other services. The crystal oscillator is quite stable but can be tuned enough to zero with WWV. Tuning is done with C1. One stage of harmonic amplification is sufficient to give strong signals well above 150 MHz. The plate circuit of this amplifier stage is tuned to the harmonic to be used. This feeds one input grid of the mixer. The other grid of the mixer is driven by the output of the BC-221 frequency meter. The tuned circuit shown in this grid resonates broadly in the 2-4 MHz range of the BC-221. This helps to keep the higher harmonics of the BC-221 out of the mixer.

The output of the mixer is resonated to the desired operating frequency. This will be either the sum or difference of the two input signals. The level of the output signal can be controlled by R6.

Operation of this system is simple. The "cook book" would read as follows:

1. Couple the output to the antenna of the VHF receiver.
2. Determine the crystal harmonic and VFO frequency that will give the frequency of the signal to be checked.



. . . the only wobble is in the small cog . . .

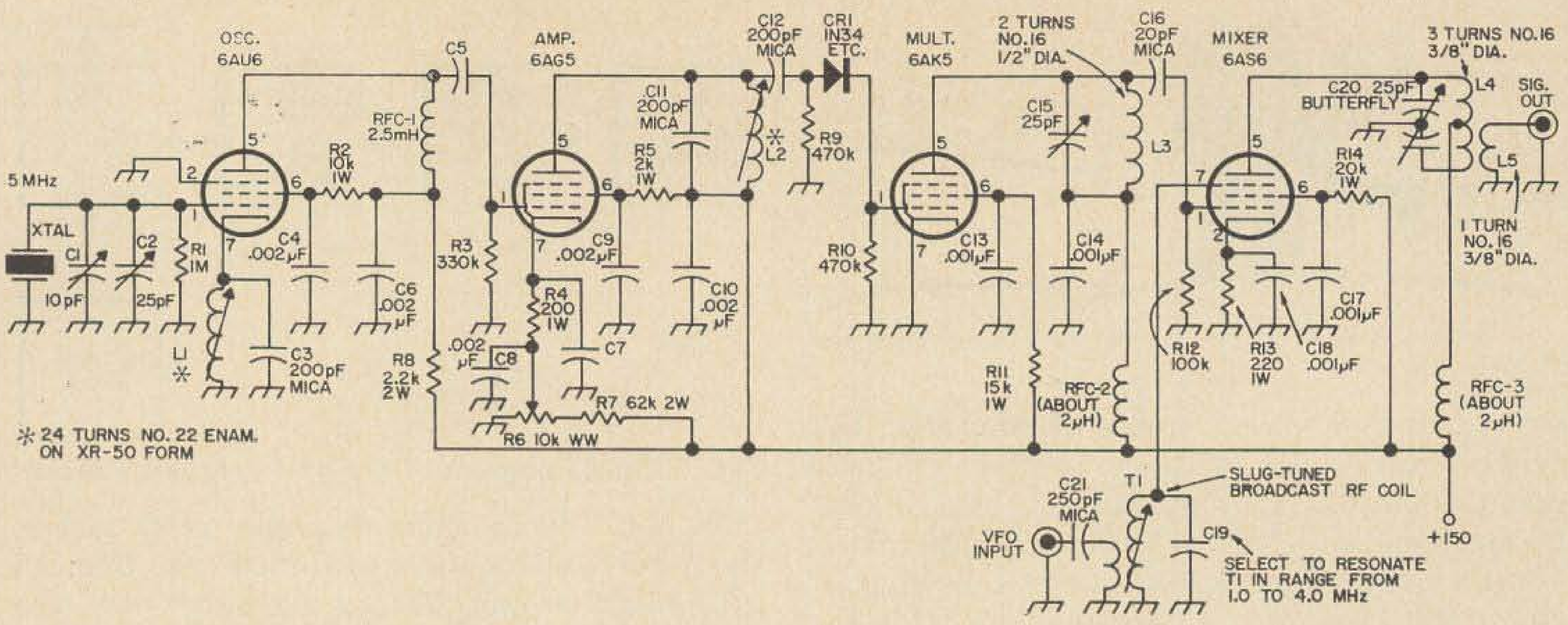


Fig. 2. Schematic of the oscillator, multipliers and mixer for using a BC-221 on the VHF ham bands.

3. Tune the VHF receiver to the signal to be checked.
4. Tune the BC-221 until the output of the frequency monitor zero beats the received signal.
5. If required, peak the tuned circuits in the monitor for maximum output and adjust R6 as needed.
6. The frequency of the received signal will be the crystal harmonic plus (or minus) the reading of the BC-221.

Many details cannot be covered in one story due to lack of space. The operator will have to determine the most effeceive method of coupling to this particular receiver. He will also have to explore the many combinations of frequencies which can be used. These and many other questions cannot be included at this time. However those who require such a system as this will probably be capable of filling these details.

One word of caution is in order. With two oscillators that are rich in harmonics, there can be many unwanted "birdies." These present no problem after the operator has gained experience but the new user should be very cautious. Many times an unwanted beat can be eliminated at a critical spot by changing the two frequencies that are being mixed (shift from sum to difference).

Perhaps we should emphasize that this system is a "trade off" where the amateur can trade his skill and patience for highly accurate measurements with simple equipment.

. . . W5WGF

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Adding Sideband AGC to Your Old Receiver

There are several ways of adapting an older receiver for SSB reception.[1] "Product detectors" are often mentioned, and the words look very nice in the promotional literature. As any student of instruction books can tell you, there are many ways to get good sideband demodulation, and only a few of them are protected by valid patents . . . not that that matters to the home constructor. Any diode detector is a product detector provided that the BFO voltage applied is as strong as the peak of the strongest signal, and also provided that that strongest signal is somehow kept *within* those bounds, preferably by some sort of fast-attack, slow-release AGC.

1. For instance, the NC-300 is not very good on sideband as it stands, but the NC-303, changed only a bit, has reasonable action. I intend fixing up a friend's NC-300 for better sideband AGC in the near future; it appears from the circuit diagram that a 2 μF capacitor is all that needs to be added (Drop me an SASE and I'll let you know what we finally did). I have also made some modifications to the SP-200 and —400 series Super Pros which seemed to help.

The conversion described in this article enabled me to add sideband reception *with* AGC to three receivers with a minimum of butchery and without adding too much to their internal crowding. In one of them the BFO tube was also used to run the S-meter on phone; by adding a couple of transistors (*seventy-cent* transistors, my favorite brand) I got a separate S-meter amp with no new socket holes and no extra power drain. I'm happy I did it, in all three cases.

The circuit diagram (**Fig. 1**) shows the AGC, MGC, audio and S-meter circuits of the receiver that had the most done to it. If the whole thing overwhelms you, the obvious course is not to start any modifications. As a matter of fact, the drawing is simplified: where it shows a three-pole two-position switch, I used a four-pole five-position type. It now appears that I wish I had used a six-pole five-position, shorting, and if having a switch labeled PHONE-USB-LSB-CWU-

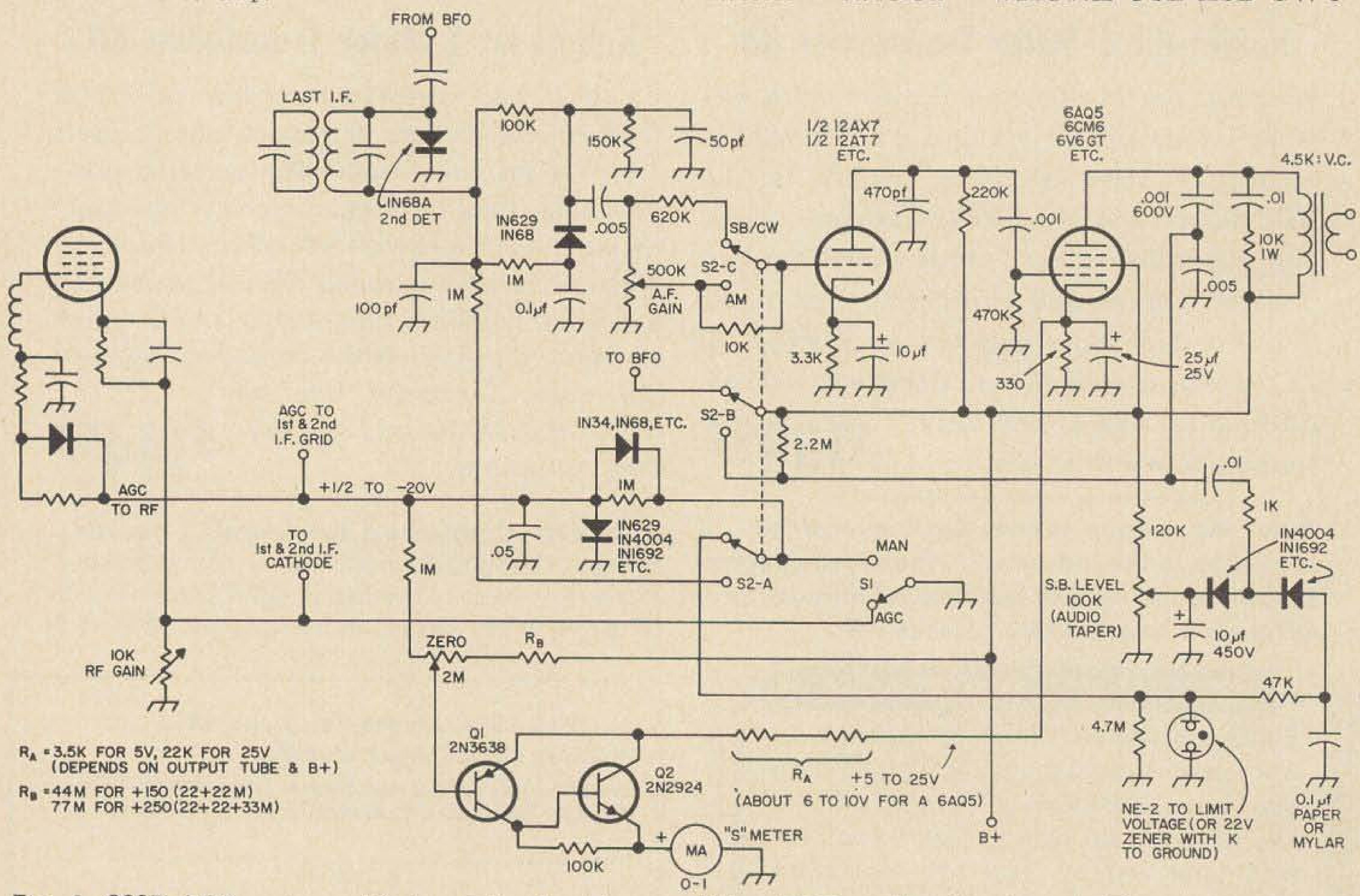

Fig. 1. SSSB AGC system with transistor S-meter amplifier, MGC and audio circuits. This is an excellent adapter for many old communications receivers. SSB level and AF gain should be ganged for best results Adding the RF gain to the same shaft is also nice since it makes room for the SSB-AM switch. The .1µF capacitor in the lower right should be 1µF.

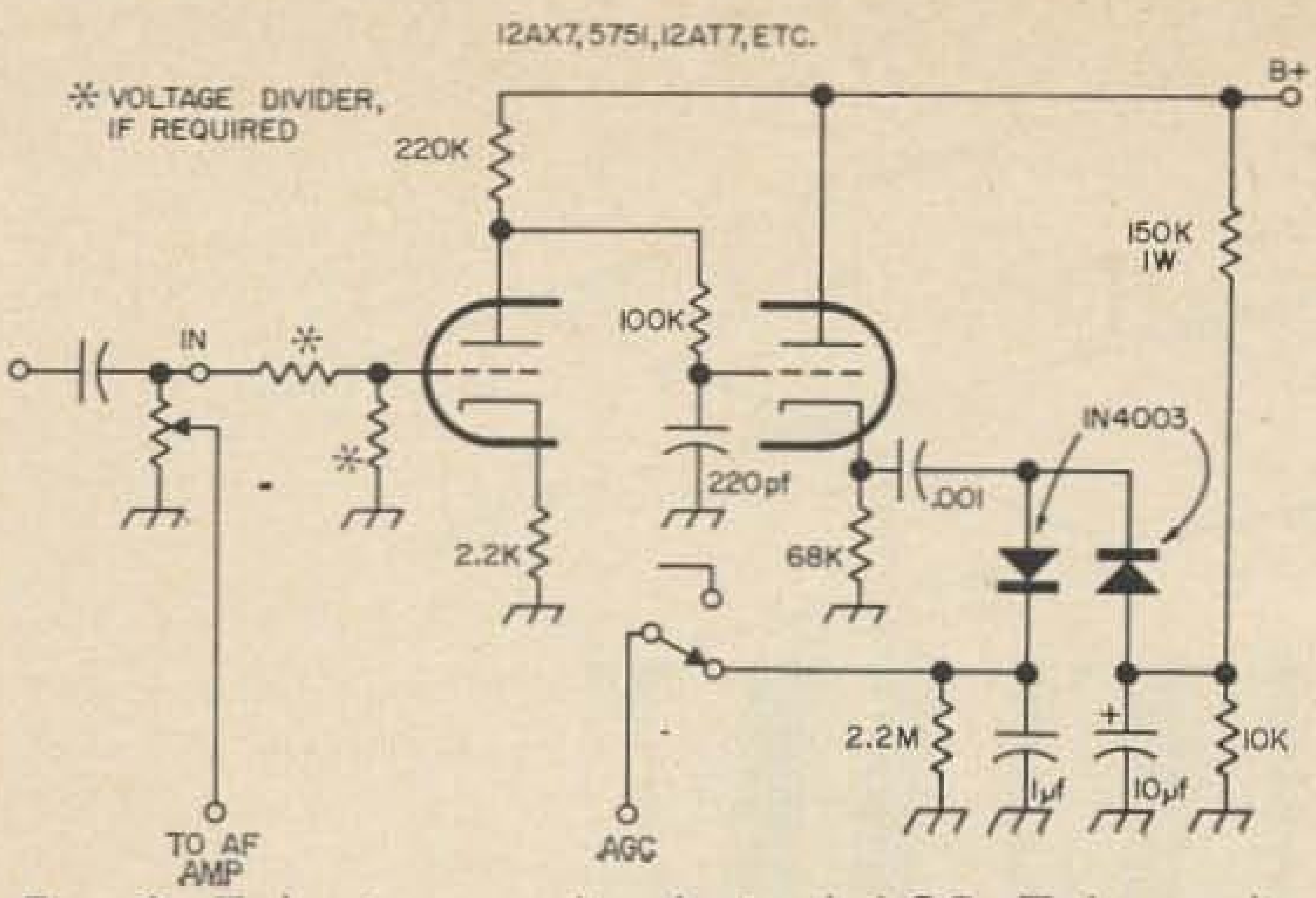

Fig. 2. Tube type audio derived AGC. Take audio from after noise limiter and before audio gain control.

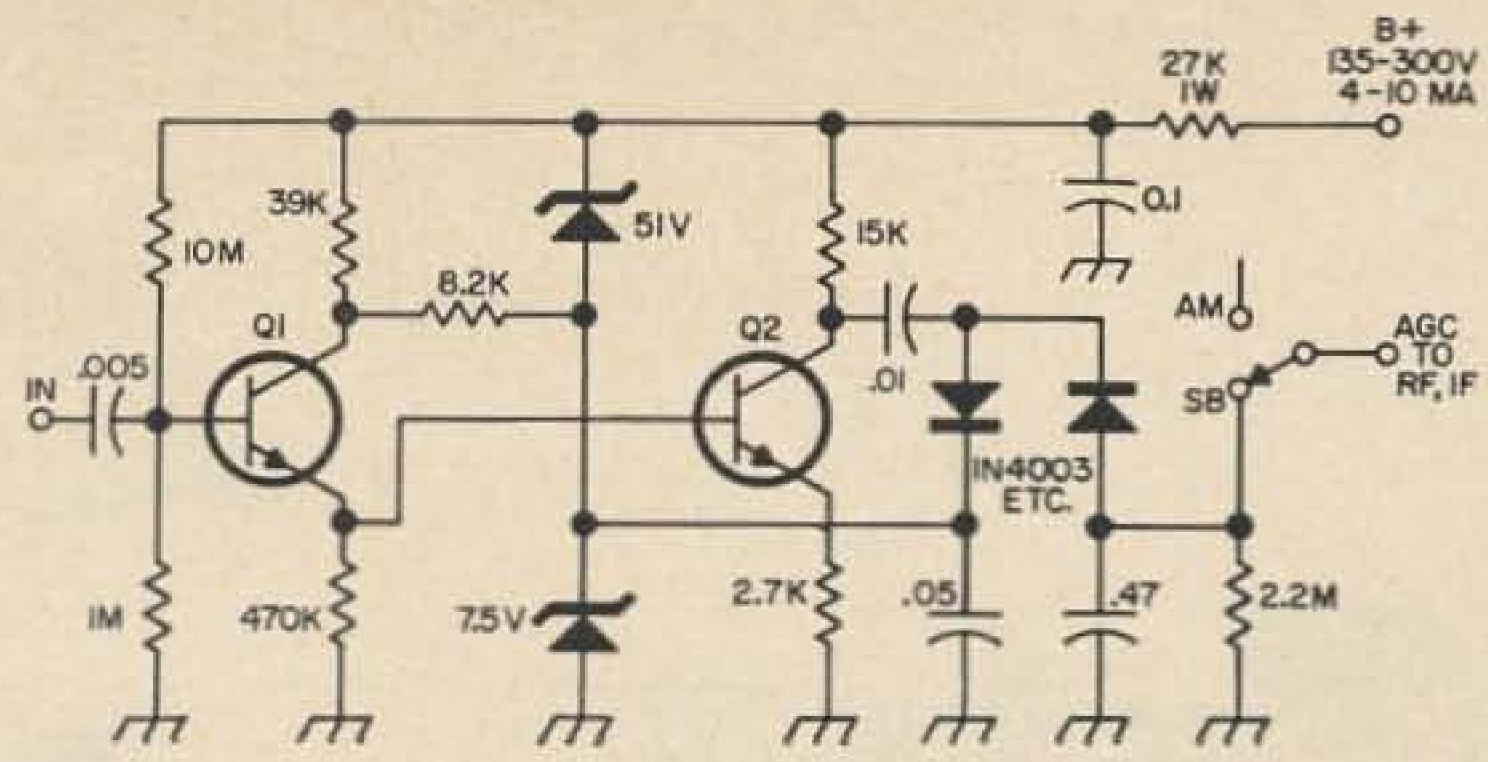

Fig. 3. Transistor audio derived AGC. Q1 is a 2N2925 (25¢), Q2 a 2N3404 (85¢). The 7.5 volt zener is ¼ or ½ watt, such as the 1N958 or 1N755. The 51 volt zener is a ½ or 1 watt one, such as the 1N3036. Pick up the signal as in Fig. 2.

CWV sends *you*, *I* could send a *circuit* (*in* a SASE).

The audio-derived AGC was originally suggested by a note in a *Swan* manual. Incidentally, doing it their way worked in one receiver but in another the silicon power diodes used to rectify the audio voltage produced harmonics which got into the *if* and fed back. The resistor (1000 ohms in the diagram; the value is not critical at all) ruins this "varactor action" without any other ill effects. The charge time constant, in practice, is a few milliseconds; if it's made too short, the receiver quits whenever a Ford drives by. The AGC "delay" bias (the value of peak voltage below which no AGC voltage is developed) is adjusted by the potentiometer labeled SB LEVEL. I found that this worked best if it was ganged to the volume control, so that the volume adjusted by the same knob in either mode. If this is done, the volume control circuit must be doctored up so that the gain of the audio section is never reduced all the way, (although *some* variation in the audio gain did turn out to be desirable) and the net result is the circuit shown.

Whether you like the manual gain control ganged with the audio gain (BC-348 style) is a matter of taste; it only operates in the MGC mode, which is when the audio pot doesn't in those receivers. Ganging THAT with the other two is a possible way of freeing a panel hole for use as a switch for AM-SSB. The only way I know to buy a three-gang pot is to make it up from IRC parts.[2]

Some of the switching is to make sure that the 1 µF capacitor cannot start out with a charge when you switch to SSB. For some other ideas, see a previous article[3] on the same sort of thing.

The S-meter circuit requires a silicon PNP and an NPN transistor. These both are now fairly cheap and common. The AGC delay on AM is about three volts, caused by the bleed current through the 44 megs or so in the divider which is part of the S-meter circuit, the 1 meg AGC filter resistor, and the 1N629 diode clamping the AGC bus. The bleed current also affects the release time of the AGC in the sideband mode. The 2 M pot is to set the S-meter to zero for no signal, and the "CAL" pot is to set the *maximum* meter reading. With the values given, the motion was reasonable over the range of AGC volts from 0 to minus 10. Q1 and Q2 should have reasonably high gain at low currents and BV_{ceo} at least as high as the rated cathode bias of the output tube. I put both transistors on a card screwed to the back of the S-meter by its terminal posts. The holes for the pots were already in the chassis from the previous S-meter circuit.

If you'd like a little simpler modification, almost any receiver (without restriction, if it uses tubes) can have audio-derived AGC added by attaching one of the amplifier-rectifier units shown in **Figs. 2 and 3.** The input impedance is high, and the extra power needed is small; the gain is adequate and, in fact, may be excessive. If it is too high, the receiver will be short of audio output on sideband. A suitable cure is to put a one megohm potentiometer at the input and adjust so that the sideband audio matches the AM audio. The cost for all parts for the transistor model is just under $15, and the silicon transistors permit it to be put in a fairly hot spot inside the receiver without loss of performance. I built it up on a piece of perforated circuit board and taped it to an *if* can to try it out. Eventually it's going in another receiver, which will have transistor audio and audio-AGC sections but tubes for the RF and *if*.

. . . W1OOP

2. 73 Magazine, Feb. 1964. "Unusual Receiver Circuits."
3. For two-gang, 500k audio is Mallory FA55A, 100k is 15A (second section). There is also a shaft required, you pick it. For two gang, IRC Q- or PQ-13-133 plus M13-128. The RF section can be piggybacked on later, buy IRC M17-116, making three.

The Classic Feed System

By W. E. "BARNEY" ST. VRAIN, WØPXE

DESIGNING ENGINEER - CLASSIC 33 PROJECT

MOSLEY ELECTRONICS, INCORPORATED

4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

Code 107.

SINCE the introduction of multi-frequency beams several years ago, the method of feeding such antennas has been a subject of much disagreement. When these antennas were introduced a few years ago, Mosley Electronics ran a series of advertisements in the technical magazines explaining the method used on our Trap-Master and Power-Master series. Since that time we have tried a wide variety of feed systems endeavoring to improve on the original system.

Testing Other Feed Systems

In testing, we found a three band gamma system ineffective without isolation networks which resulted in the feed system costing about equal to the antenna cost; with a system using hairpins, the cost proved low but did not provide a better match than the original Mosley matching system. It became quite clear to us, the Mosley system was hard to beat, for we had found only one slight disadvantage, the elements needed to be stagger tuned to raise the feed point resistance from about 30 to 50 ohms. This slight detuning, which proved advantageous in increasing the bandwidth, brought about, in turn, a slight gain loss of about 0.5 to 1.0 db. at resonance.

The Classic-33 System

In order to give hams a new choice in beam matching systems and an antenna featuring maximum gain with increased bandwidth, we devised the matching method used on our New Classic 33 antenna, a method which takes advantage of the principle that antenna resistance at the center driving point increases as the antenna length increases. Figure No. 1 shows the radiator element of a three element beam at resonance having an impedance at the driving point (Z_A) of about 30 + J0 ohms. If the element is made longer, Z_A can be raised to about 50 + J50 ohms. (Figure No. 2) Since the reactance is inductive, it can be canceled with a series capacitor of 50 ohms reactance, leaving 50 ohms feed point resistance. (Figure No. 3) Series capacitors used on the Classic 33 are made by inserting a suitable length of heavily insulated wire into each half of the element tube at the center. The wires are terminated in a plastic tube enclosure with a type "N" connector for connection of the coaxial cable. To isolate the outer coax conductor from ground, the coax line is coiled for a few turns near the antenna end. This is designed to prevent the very unlikely affect of "Feed Line Radiation".

Fig. 1.

$L = \frac{\lambda}{2}$ $Z_A = 30 + j0$

Fig. 2.

$L = \frac{\lambda}{2} +$ $Z_A = 50 + j50$

Fig. 3.

$Z_A = 50 + j0$

Converting Other Beams

This feed system could feasibly be used on our other Trap-Master beams, but little would be gained and the antenna would need to be completely rebuilt. The big difference between the new Trap-Master beam and the TA-33 is that the latter has conversion features, while the Classic 33 does not. The engineers at Mosley designed the Classic 33 to give the ham a little extra gain on all bands. It is our conviction that discriminating DX'ers will find this new tri bander specifically suited to their needs, but hams buying the well-known TA-33 will still enjoy a superior quality DX antenna with a gain very close to that of the Classic 33.

Dennis Bryan W2AJW
4 Crescent Drive
Apalachin, New York

The Ultimate Station Control

Arrange your station for perfect break-in and complete control of antennas, power and changes of equipment.

How many times have you visited a fellow ham's shack and left wishing that you had a set-up like his—a set-up that was a pure pleasure to operate? How many times have you tuned the low ends of 80 and 40 and listened to the brass pounders operate full CW break in and felt like joining the fun? You knew you couldn't join in because of the manual receive-transmit switching you have and so you dejectedly tune off frequency looking for a "you send awhile—then I send awhile" QSO. How many times have you rejected the idea of building or buying a TR switch because they "suck-out" signals in the transmitter tank circuits in receive mode?

Well friend, read on and find out how you can organize your equipment into a sweet running system that'll make you beam with pride. But—WARNING!—you may have to buy your XYL a fur coat to compensate for all the operating time you'll be putting in with your rig once you get it working in this type of system.

Although few hams will have the exact equipment configuration as this system the features of this control unit can be applied to almost anything you may have.

The highlights of this system are:

1. Full break in by using a TR switch with no signal "suck-out" at all after being in receive mode for a couple of seconds.
2. Automatically switches to transmit mode when the key contacts close or the VOX relay is activated.
3. Allows rapid change (flip of a switch) between exciter only or amplifier operation.
4. Controls DC input to final amplifier.
5. Gives rapid selection of antennas.
6. Automatically mutes receiver when the key is closed.
7. Provides CW side tone. Can be used as a code practice oscillator.
8. Allows rapid changes in equipment configurations.
9. Puts only 17 volts, low current, across key contacts—eliminates exposed shock hazard and arcing.

At the end of this article is a list of component functions that will assist your "treck" thru the diagrams without wasting time. A more thorough explanation of the more involved functions is in the text between here and there.

Fig. 1 is a diagram of the RF and antenna selection circuits of the system. By bringing all low level RF circuits up to a patch board on the side of the station control units it is possible to change the system configuration without getting out of your chair. Sure beats crawling behind the desk or table to change connections.

Note that when RL2 is down (de-energized) RF is fed straight thru the amplifier to the antenna circuit. When RL2 is up (energized) the exciter is coupled to the amplifier input and the amplifier output is connected to the antenna circuit.

RL5 is the little gem that prevents receiver signal "suck-out" after the system is in receive mode for a couple of seconds. RL5 is normally down, isolating the antenna circuit from the amplifier or exciter tank circuit, and comes up when the key contacts close or the VOX relay is activated. The use of RL5 along with a TR switch allows you to operate full break in and still be able to hear the real weak DX stations when you are in receive mode.

When S5 is in the 160 meter position RL6 will be picked up. RL9 will stay down because current will not flow thru D9. When S5 is in the 80 meter position RL9 will be picked up and at the same time current will flow thru D9 picking RL6. Although RL6 thru RL9 have 12 volt coils 17 volts is applied because of the long line run to the relays and resulting voltage drop.

The Marconi antenna in this system is ⅜ wavelength long on 160 meters and has a feed point impedance of 120 ohms. Even though this requires a reverse-pi matching network the higher impedance reduces ground losses commonly associated with Marconi antennas. With the low power restrictions on 160 meters you cannot afford unnecessary losses.

Fig. 1 also shows the RF patch board and jumper diagrams for: 160 meter CW/AM, 80-20 meter CW/AM, and 80 meter SSB. Any of these configurations can be patched in less than a minute. The patch board is made up of phono type sockets mounted on an aluminum bracket. Coax cables going to the various units are soldered to the jacks and have plugs to match the units on the other ends. When you get that new piece of equipment all you have to do is unplug the old unit and plug the new unit in. All the RF circuits of the new unit will be available at the patch board ready to go.

Fig. 2 shows the 110 VAC primary circuits of the control unit. The operation of the primary circuits is quite straightforward. It is important that S1 and S2 have the indicated current rating. RL2, RL4, and RL5 are Guardian Series 200 DPST relays with like contacts wired in parallel to increase their current carrying capacities. Here also, flexibility was the prime goal. Jacks J7 thru J11 will provide controlled primary power for any piece of equipment you have—unless you're bootlegging with a 10 kW job.

Fig. 4 is a graphic representation of what actually happens inside the control unit when the key contacts close or the VOX relay is activated. The lines shown in **Figs. 4A, C,** and **D** and referenced to **4B** which represents in this case the letter "L" being sent with the key. The up levels show the key contacts closed and the down levels show the key contacts open. By working your way from left to right on line **4B** and taking a reading on lines **4A, C,** and **D** each time the level of line **4B** changes you can see exactly how the break in function of the control unit works.

At first glance the transistor circuits shown in **Fig. 3** looks a bit complicated to digest. Actually, all the transistors except Q8 and Q9 are used as switches. They are either in a state of conduction or completely cut-off. This makes the selection of transistors to use quite simple. About anything you have in your junk box will work. The ones used here, other than Q8 and Q9, were obtained from Radio Shack and didn't have any commercial type indicated on them. They were removed from scrapped computer circuit boards that Radio Shack has for sale. Q8 is a 2N718 and Q9 is a 2N269 as recommended by Robert D. Corbett in his July 1965 73 Magazine article "CPO-CWM" that described the CW sidetone oscillator used in this control unit.

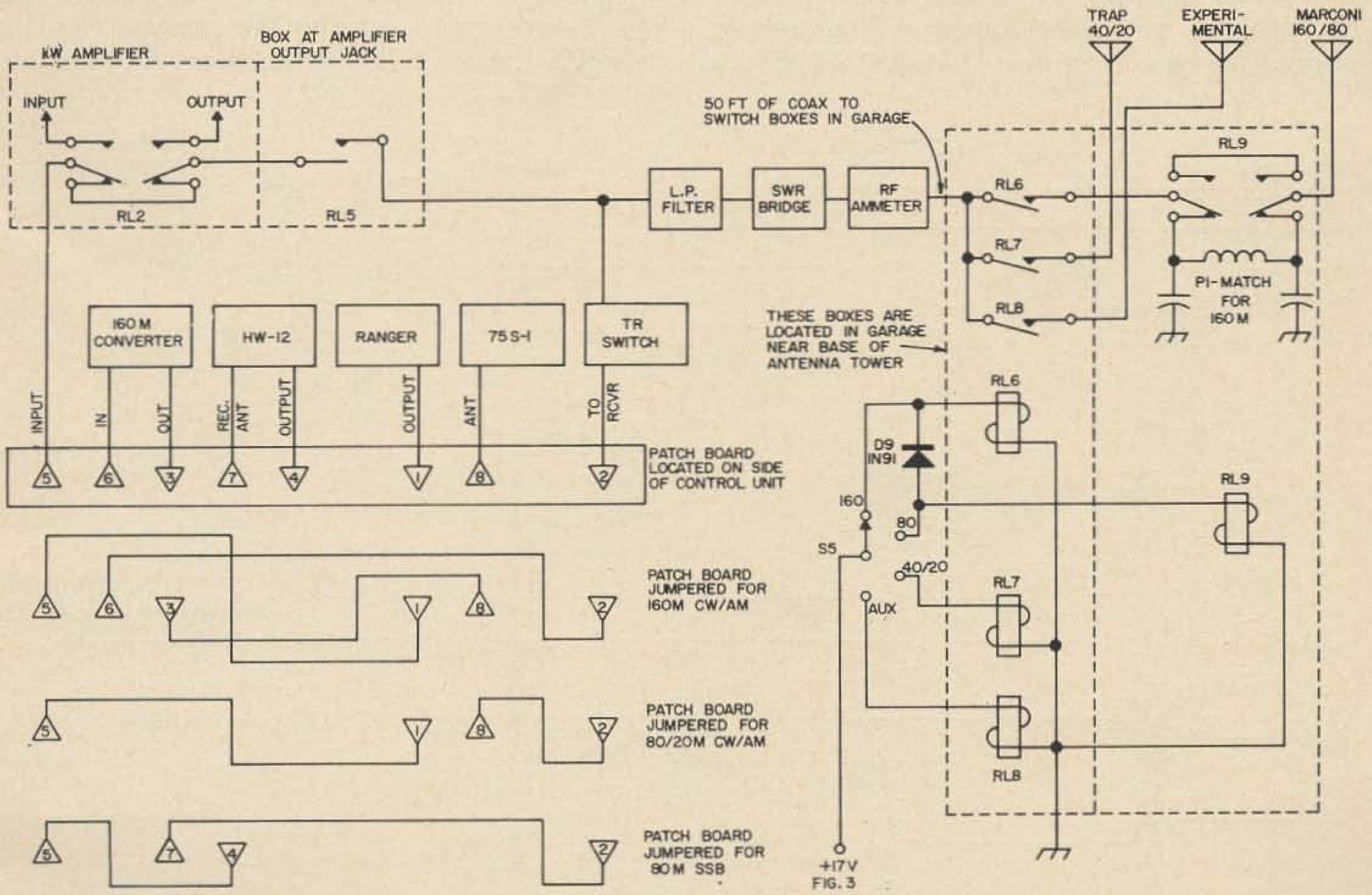

Fig. 1. RF routing and station configuration of W2AJW's station control system. The function of each major part is explained at the end of the article.

To determine if a transistor is conducting note the relationship of base voltage to emitter voltage. If the transistor is an NPN type like Q1 and the base is more positive than the emitter it will be conducting. If, in the case of Q1, the base is negative in respect to the emitter the transistor will be cut-off and no current will be flowing thru it. Just the opposite is true of PNP transistors, like Q4. When the base of Q4 is positive in respect to its emitter it will be cut-off.

Let's take a look at Q1, Q2 and RL3A and RL3B. In receive mode with the key contacts open the bases of Q1 and Q2 are at minus 17 volts. Because the emitters of Q1 and Q2 a biased to a minus six volts they will be cut-off and RL3 will be down. When the key contacts are closed, as in the first dit of the character "L" shown in **Fig. 4**, the bases of Q1 and Q2 will be shorted to ground thru the 330 ohm resistor. Now that the bases are more positive than the emitters Q1 and Q2 will go into heavy conduction with current flowing thru RL3A and RL3B picking up RL3.

Simple huh?

By keying the bases of Q1 and Q2 rather than keying the relay directly you have removed that source of high current from the key contacts and eliminated that source of arcing and key-clicks.

RL3 has two coils mounted side by side. The coils are each 5000 ohms and are wired in series by the manufacturer. This application requires that the connecting wires be removed so that the coils can be wired as shown. You must experimentally determine how to wire the coils so that when both coils are wired in this circuit the fields do not oppose each other. If they do oppose each other the relay will not pick up. Why do we split the coils of RL3 into two coils, RL3A and RL3B? This is done to satisfy two conditions. First-to allow RL3 to pick up and close its contacts as quickly as possible to reduce the amount of the first dit or dah that is missed while the station is going into transmit mode. Second-to provide a hold-up circuit for RL3 and therefore stay in transmit mode between characters and words Q1 and RL3A take care of the first condition and Q2 and RL3B and C1 the second.

Diode D5 isolates Q2, RL3B, and C1 from Q1 and RL3A at the instant the key is closed and Q1 and Q2 conduct. Because at this instant C1 is discharged it will act as a dead short across RL3B. If RL3B was the only coil on RL3, RL3 would not pick up until C1 had charged up to the point that enough current started to re-route thru RL3B to attract the relay armature. This would cause a considerable portion of the first dit or dah, in fact quite a bit of the first character, to be lost. Coil RL3A, because it is not shunted by a capacitor and is isolated from C1 by D5 at key closure time, provides the necessary quick pick up time of RL3. When the key contacts

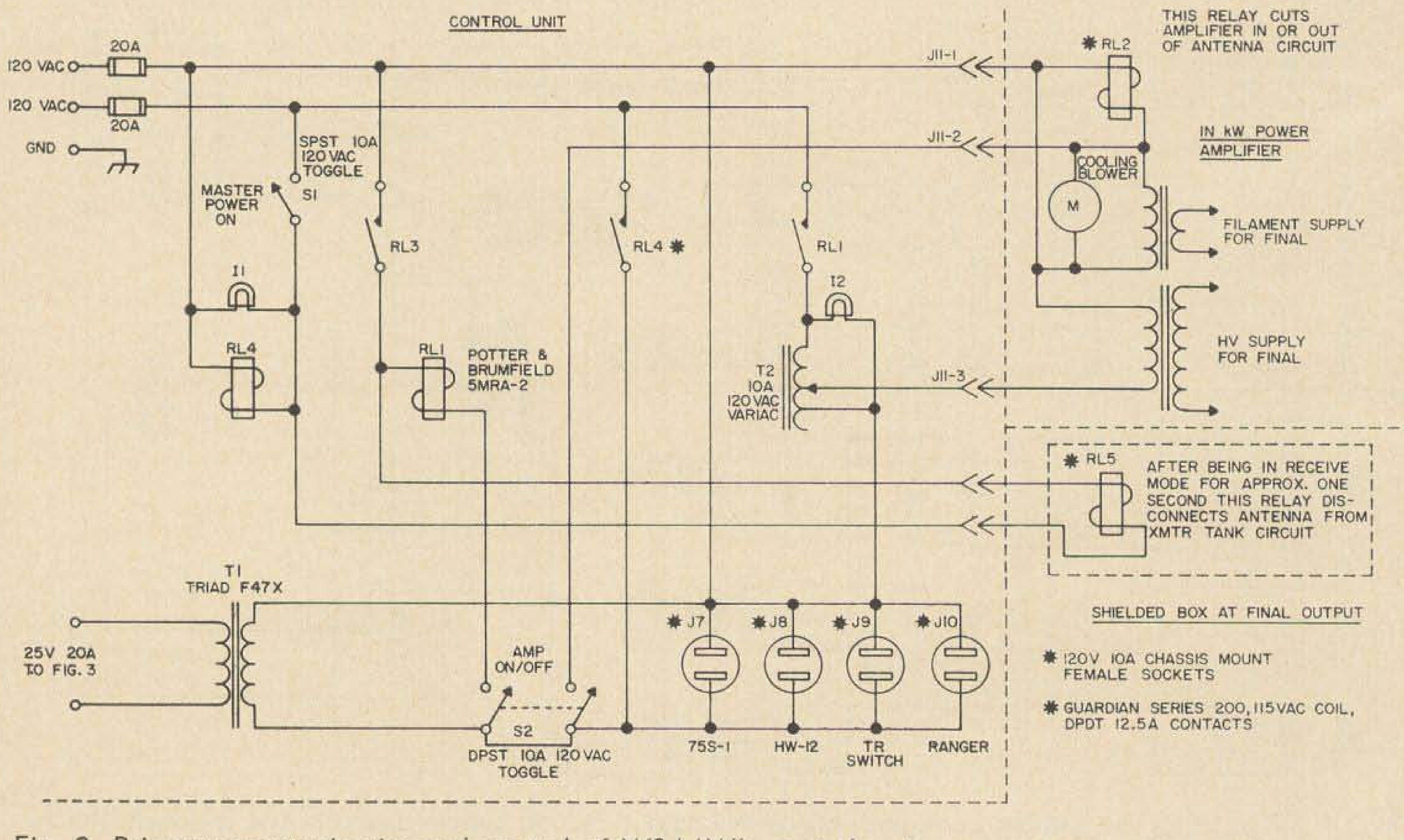

Fig. 2. Primary power circuits and control of W2AJW's control system.

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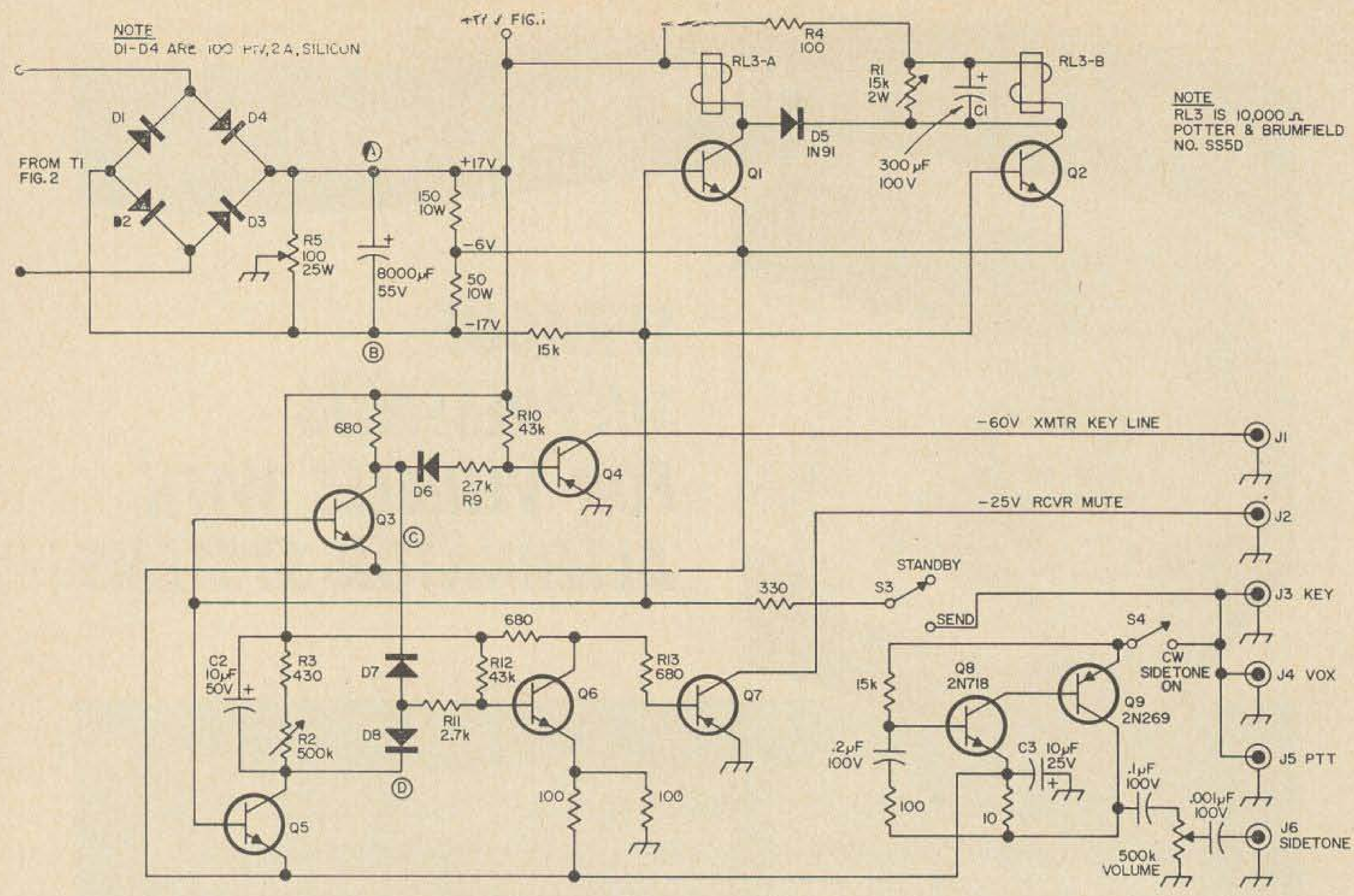

Fig. 3. Transistor switching circuits and code moni tor.

open Q1 and Q2 will be cut-off and C1 will have three discharge paths: 1-thru RL3B, 2-thru R1, 3-thru R4, RL3A, and D5. The discharge path thru RL3A as well as RL3B gives a more uniform pull on RL3 armature and better control on its drop out time. Note that the discharge path thru R1 is variable. Decreasing the resistance of R1 will make C1 discharge more rapidly and cause RL3 to drop out quicker.

Q3 and Q5, along with Q1 and Q2, are controlled directly by the key contacts or VOX relay. Like Q1 and Q2, Q3 and Q4 are normally cut-off and conduct when the key contacts close. Q3 controls Q4 and Q6. Q5 controls only Q6. When Q3 conducts its collector goes to a minus 6 volts, current will flow thru D6, R9, and R10. It can be seen from the values of R9 and R10 that the base of Q4 will go to about a minus 4 volts (from plus 17) and Q4 will conduct keying the transmitter.

Now we run into a circuit known as a "minus or". This is made up of diodes D7, D8; resistors R11, R12; and transistor Q6. When the key contacts are open Q3 and Q5 are cut-off and points C and D of diodes D7 and D8 are at a plus 17 volts. Since R12 ties back to plus 17 volts the base of Q6 will be biased so that it will be conducting. With Q6 conducting its collector will be at a minus two volts. This same voltage is applied to the base of Q7 making it conduct putting the receiver in receive mode. (Like many receivers this one is in receive mode when the "receiver mute" line is grounded.)

In order to satisfy a "minus or" all you have to do is "make" one leg of the switch. For instance, if point C was minus and point D was plus, current would flow thru D7, R11, and R12 to plus 17 volts. Since R11 has a much smaller resistance than R12 most of the voltage drop would be across R12. The voltage at the junction of R11 and R12, point E, would be negative. Conversely, if point D was minus and point C was plus current would flow thru D8, R11, and R12 to plus 17 volts. In either case the base of Q6 would be baised to cut-off and the collector would go to plus 17 volts and in turn cut-off Q7 muting the receiver. At the same time we could call this a plus "and" circuit. That is, if both points C and D are plus Q6 will conduct.

When the key contacts close Q3 and Q5 will conduct and points C and D will go to a minus six volts and the receiver will be muted. Capacitor C2 will charge thru the path; minus six volts, Q5, C2, to plus 17 volts. At the instant the key contacts open the transmitter oscillator STARTS to turn off. The turn off time of the transmitter oscillator takes but a fraction of a second but if your receiver has a rapid recovery time, as in my case, you will hear a "thump" in the speaker. Q5, C2, and

D8 eliminate this "thump". Remember it was said that C2 charges when the key contacts close? Well, when the key contacts open C2 has two discharge paths: 1- thru R3 and R2; 2- thru D8, R11, and R12. The first path is variable and is used to control the length of time the receiver will be muted between dits and dahs or characters. The second path is the one that actually holds the receiver muted after the key contacts open. The smaller the resistance of R2 the quicker the receiver will recover. It is possible to set R2 so that all transmitter sound is removed but still be able to hear a break in signal between bits of a character when sending at 20 wpm.

Fig. 5 shows an alternate method of keying a transmitter or muting a receiver. This method would have to be used if your transmitter has cathode keying or if your receiver has a positive mute line. Of course a combination of **Fig. 5** for the transmitter and **Fig. 3** for the receiver could be used, or vice versa.

The relays shown in **Fig. 5** are ultra sensitive radio control units that pull in with only 1.4 mA coil current. If a less sensitive relay is used it will be necessary to increase the voltage fed to the relay. Diodes D10 and D11 prevent ringing in the circuits when Q4 and Q7 are cut-off. At the instant the circuit thru the relay coils is cut-off the voltage in the coils will spike to a very high value and possibly ruin Q4 or Q7. In any case this spike will generate electrical noise.

So there you are. If you want the ultimate in station control then drag out the tools and get busy. The effort will be well worth it and besides—here's that "built it yourself" project you've been waiting for. A project that will not only give you that sense of accomplishment in building something yourself but will also add immeasurably to your operating pleasure.

Here is the list of component functions that I promised you earlier.

C1— Provides a hold for RL3. When Q2 conducts C1 will build up a charge. When Q2 is cut-off C1 will discharge thru R1 and RL3 and keep RL3 picked up. The length of time that RL3 will stay up depends on the setting of R1. The smaller the resistance of R1 the quicker RL3 will drop out.

C2— Keeps the receiver muted for a short period after the key contacts break. This prevents break clicks or thumps. The discharge rate of C2 and consequent mute time is controlled by the setting of R2.

C3— Bypasses CW side tone on minus six line to ground.

D5— Isolates RL3A from RL3B at the instant Q1 and Q2 are put into conduction. Provides a C1 discharge path thru RL3A as well as RL3B after Q1 and Q2 are cut-off.

D6— Allows a rapid cut-off time of Q4 when the key contacts open.

D7-D8— Make up a two legged "minus or" switch. A minus shift into either D7 or D8 will cut-off Q6.

D9— Allows the pick up of RL6 when S5 is in the 80 meter position as well when S5 is in the 160 meter position.

D10-D11—Prevent ringing in relay coils at the instant Q4 or Q7 in **Fig. 5** are cut-off.

I1— Lights when primary power is on.

I2— Lights when high voltage is on in amplifier.

J3-J5— Any device that switches to ground can be connected here. When one of these jacks is shorted to ground, with S3 in the send position, the control unit is put in the transmit mode.

J6— Provides CW side tone if S4 is on and one of jacks J3 thru J5 is shorted to ground.

J7-J10— Provide 110 VAC to station units (receiver, TR switch, etc.).

Q1— Allows a rapid pick of RL3. Normally cut-off.

Q2— Charges C1 to provide a hold up voltage to RL3 after Q1 and Q2 are cut-off when the key contacts open or VOX relay drops out.

Q3— Provides a minus switch voltage to Q4 and Q6. Q3 is normally cut-off and conducts when the key contacts close.

Q4— Keys the transmitter. Q4 is normally cut-off. Q4 conducts when a

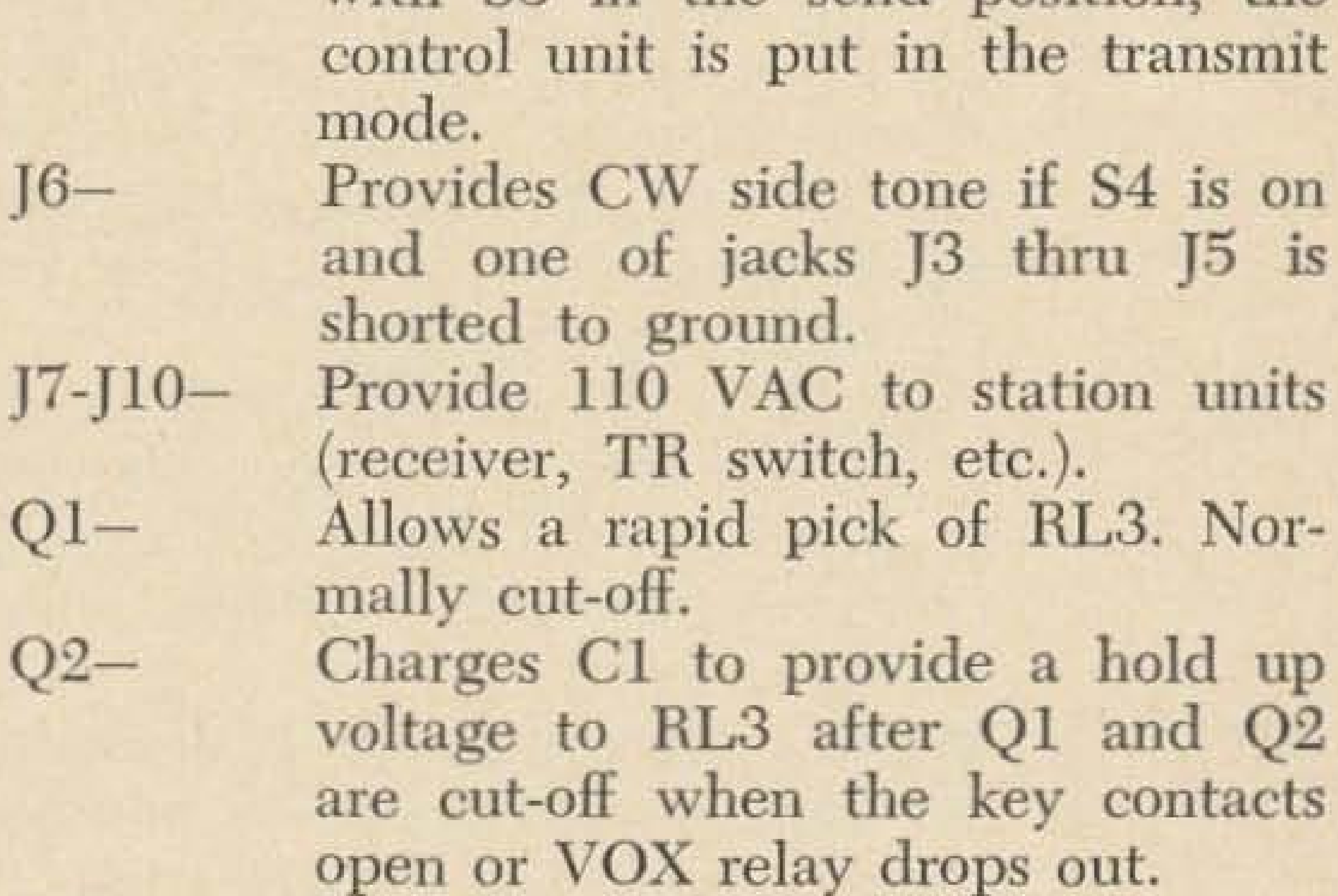

Fig. 4. Control unit timing.

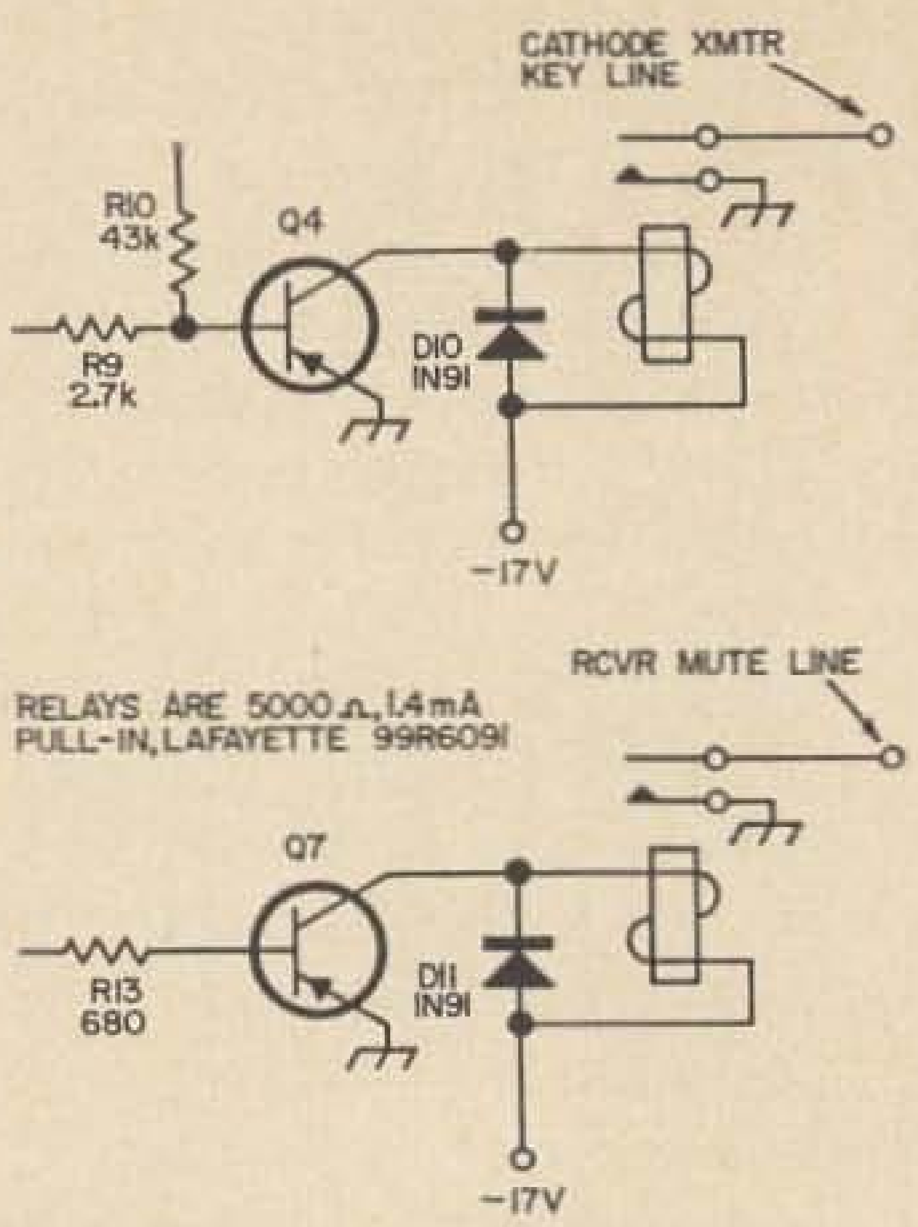

Fig. 5. Alternate key and mute circuits.

minus voltage is applied to its base thru D6.

Q5— Provides a minus hold voltage to Q6. Q5 is normally cut-off and conducts when the key contacts close. When Q5 conducts C2 developes a charge. When Q5 is cut-off when the key contacts open C2 will discharge thru R2 and R3. The time that C2 takes to discharge depends on the setting of R2. The charge on C2 will keep Q6 cut-off.

Q6— Provides a minus switch voltage to Q7. Q6 is normally conducting. Q6 is cut-off when either Q3 or Q5 conducts providing a minus input to D7 or D8.

Q7— Mutes the receiver. Q7 is normally conducting and is cut-off, muting the receiver, when the key contacts close.

Q8-Q9— CW side tone oscillator. July 1965 73 Magazine.

R1— Controls the length of time that RL3 stays up and therefore, how long the control unit will stay in transmitt mode after the last CW character has been sent or the VOX relay has dropped out.

R2— Controls the length of time that; the receiver will stay muted after the key contacts open.

R3— Prevents ruining of Q5 in the event R1 is turned to zero resistance.

R4— Prevents ruining of Q2 in the event R1 is turned to zero resistance.

R5— Sets power supply ground point. Should be set so that points A and B are of equal potential but opposite polarity.

RL1— Completes the circuit to the Variac, T2, which in turn applies primary power to the amplifier high voltage power transformer. RL1 picks up if S2 is on and RL3 picks up.

RL2— Connects the amplifier between the exciter and the antenna. RL2 picks up when S2 is on and RL4 picks up.

RL3— RL3 contacts pick up RL1 (if S2 is on) to turn on the amplifier high voltage supply and to pick up RL5 to connect the antenna circuit to the exciter or amplifier output circuits. RL3 picks up when Q1 and Q2 conduct.

RL4— RL4 contacts provide primary power to T1 and units connected to sockets J7 thru J10. RL4 picks up when S1 is turned on.

RL5— RL5 contacts connect the antenna circuit to the exciter or amplifier output circuits. RL5 prevents transmitter tank circuit signal "suck out" when in receive mode. RL5 picks up when RL3 contacts close.

RL6— Routes RF voltage to RL9. RL6 picks up when S5 is in either the 160 or 80 meter positions.

RL7— Selects the 40-20 meter trap inverted vee antenna. RL7 picks up when S5 is in the 40-20 meter position.

RL8— Selects the experimental antenna. RL8 picks up when S5 is in the AUX position.

RL9— Picks up when S5 is in the 80 meter position. When RL9 is down the pi network is connected between the 52 ohm line and 120 ohm Marconi antenna. When RL9 is up RF is fed streight thru to the Marconi antenna. (This Marconi matches 52 ohms on 80 meters).

S1— Turns on the control unit and supplies 110 VAC to the receiver, exciter, TR switch, etc.

S2— Turns on RF amplifier. S2 also switches the amplifier into the antenna circuit.

S3— In the "SEND" position allows the station to be put in transmit mode when the key is closed or VOX is operated. In the "STBY" position allows the CW side tone oscillator to be used as a code practice oscillator.

S4— In the "CW SIDE TONE" position gives side tone when the key is depressed.

S5— Selects the antenna to be used.

. . . W2AJW

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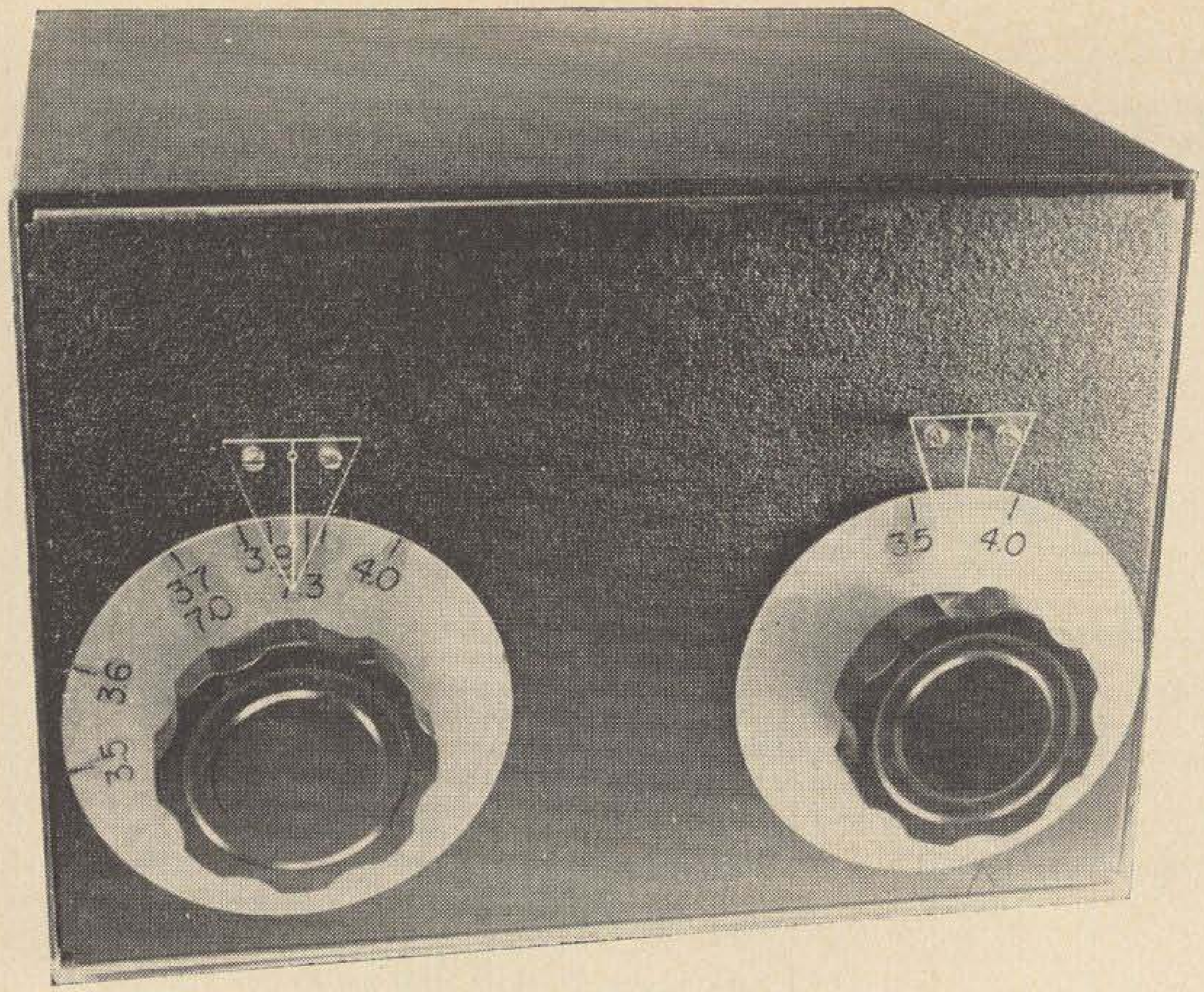


Ed Marriner W6BLZ
528 Colima Street
La Jolla, California

Match Box Tuner

That Old Tuned Line

When I was young and in my prime
I used antenna tuners all the time,
But now that I am old and grey
I use coax the modern way.
I think I've strayed and find it's time,
I went back to that old tuned line
I went back to that old tuned line.

About thirty years ago most radio amateurs used tuned feeder lines in conjunction with an antenna tuner. Today just about all amateur stations use coax fed antennas, but some station operators are going back to the old method. Why? Until recently transmitters and SSB transceivers used large plate dissipation tubes in the output stage. If these tubes are overloaded they might get a little cherry red, but it did not seem to hurt them. Every one was happy, no problems, even if the rig was operated far from the resonant frequency of the antenna.

Today every radio gadget is smaller, and so are the tubes. Many manufacturers are using small TV sweep tubes in transceivers to keep the size compact. They hope the amateur operators using them have a flat antenna feeder line with no SWR (standing waves), and they also hope that he stays on SSB and does not hold the key down too long when tuning. The use of small tubes is based on the SSB operation with its low duty cycle, and that type of operation is not hard on the output tubes.

Just how many amateurs are using beams or dipole type antennas fed with coax today? Just about all of them, and how many of these have tuned the transmitter off from the resonant frequency of the antenna and taken a good hard look at the SWR and the color of the output tubes? The SWR does not have to go up in value very much before the rf begins to stay in the rig and be dissipated in the plates of the output tube rather than in the antenna.

Well, just what can be done about all of this faulty operation? Really there isn't a thing the coax fed operators can do about SWR except keep the rig looking into 50 ohms by a matching network, or change to an antenna that can be resonated to the operating frequency. The only reasonable way to use a resonant antenna is to go back to the antenna tuner and some type of antenna that can be tuned. Those operators who have fussed with antenna tuners in the old days will back away from the idea and shudder because it brings back memories of trying to locate the feeders on the proper matching point on the tuner coil. This can be an exasperating job. However, the old timers can relax. The Johnson Company makes a gadget to replace tapping the coil. It is called a duo-differential capacitor. This capacitor when put across the coil acts as a capacitance tap, and in conjunction with the tuning capacitor keeps the coil in resonance. The old pain is gone. It's now easy to tune up the tuner.

The duo-differential capacitor is only made by the E. F. Johnson Co., and is generally not found in the catalogs or radio stores. It has to be ordered directly from the factory under the part number 169-25. When constructed the antenna tuner will handle 300 watts of CW or SSB on all bands, and maybe more depending on the insulation. Actually this match box is the same as the regular standard Johnson Matchbox but with modifications. The coil has been adapted to the Air-Dux coil in place of the specially wound Johnson coil which has a variable pitch in the center for the high frequency bands. The insulated switch shaft used by the manufacturer was also impossible to duplicate, and other arrangements were used to change bands. A battery clip fastened to flexible leads was used in place of a switch and worked very satisfactorily.

In this constructed tuner two separate coils were used. One coil tunes the 80-40-20 meter ham bands, another the 10-15 meter bands. Two separate inputs are used, as the link for the big coil is matched better with three turns, and the small coil with two.

To change bands the lid is lifted on the tuner box, the fahnstock battery clips are quickly pressed with the finger and moved to the taps desired for the proper band. The dial is moved to pre-marked settings for the various bands and slightly adjusted for minimum SWR.

As it turns out the maximum received signal on a receiver is just about the proper adjustment for the minimum SWR point when the transmitter is used.

For an all band antenna it is recommended that a 136 foot center fed zepp antenna be used if possible, with 600 ohm feeders about 45 feet long. Another suggestion would be to use 450 ohm manufactured feeders made from number 12 wire. Another suggestion is to use screw-in type electrical insulators for long runs of wire under the eaves of the house and pulling #12 wire through them and soldering tight. This method cuts down on the use of spacers except for the part actually going up to the antenna.

Construction

There is no special way to build the tuner. It is nice if it can be put in a box, but construction on just a chassis will be fine. The split-stator capacitor is mounted on metal studs to the chassis and the duo-differential capacitor is mounted on stand-off insulators. Two, 4½ inch lucite insulators are mounted at each end of the duo-differential capacitor to hold a ¼ inch thick by one inch wide lucite bar. Some long 4-40 machine screws with lugs were put in the strip to slip the band switching clip lead over when changing bands. The coil could have been shorted out when changing bands if separate coils had not been used, but in this construction the surplus turns are left floating rather than shorting them out.

Tuning

The transceiver output probably should be first tuned using a 50 ohm dummy load resistor to get the pi-network setting correct for 50 ohm output. The rig can then be connected to the tuner input. The tuner condensers can be varied for maximum signal strength, and then tuned for the low SWR indication which is between the tuner box and the transmitter in the coax link. When correctly tuned it should read very close to zero! Now you can increase the output power and are on the air. If a center fed zepp 136 feet long is used, operators will be surprised how much better signal reports will be over the old antenna especially when it is used on the higher frequency bands where the lobes begin to reach out. The main comparison from the long wire against the beam is that more noise is apparent on the zepp because it is not very directional. It is fun to switch from the zepp to the beam, there is not as much difference as one might suspect. It is also easier to use the center fed zepp for round table QSO's. I predict

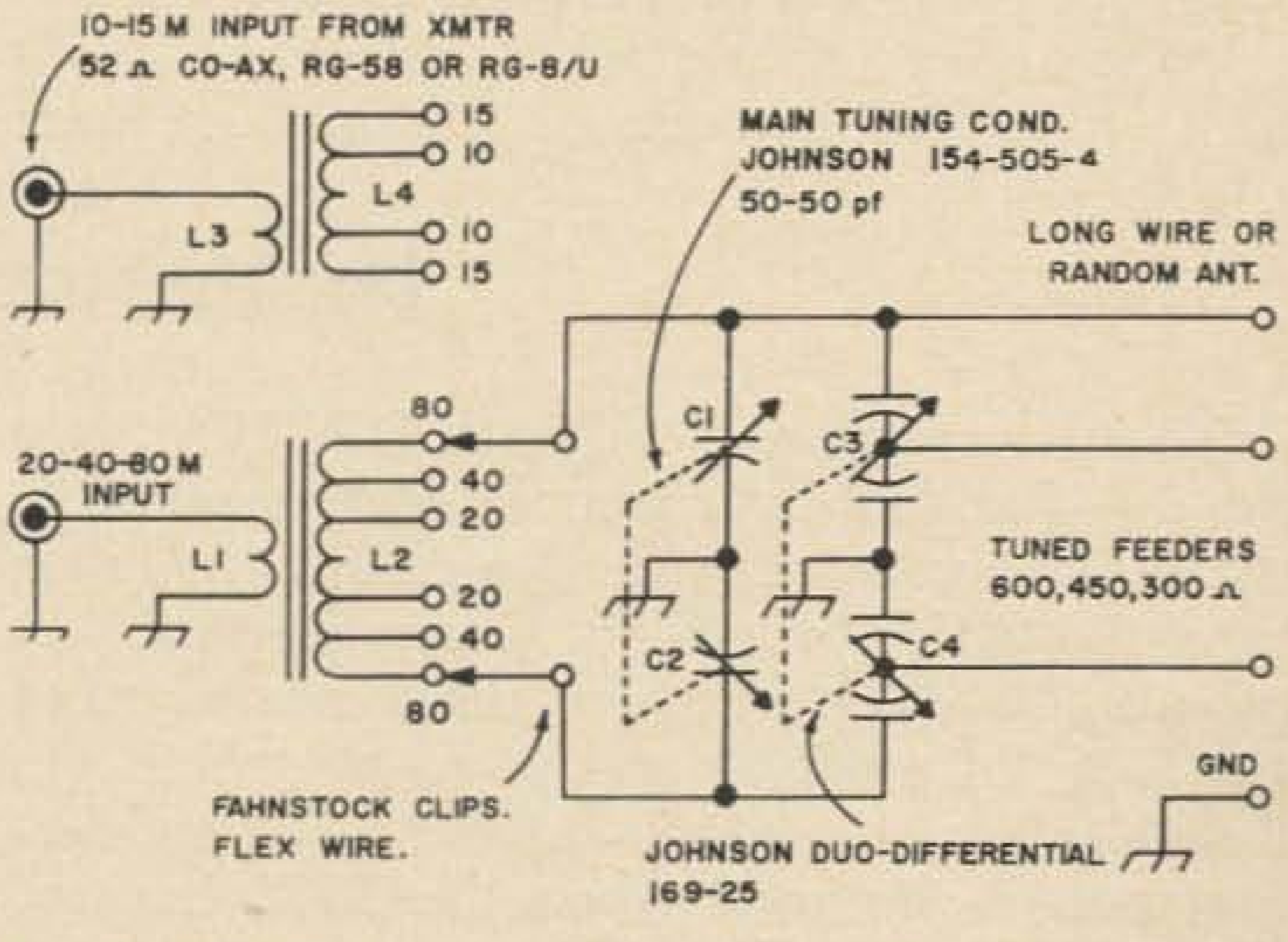
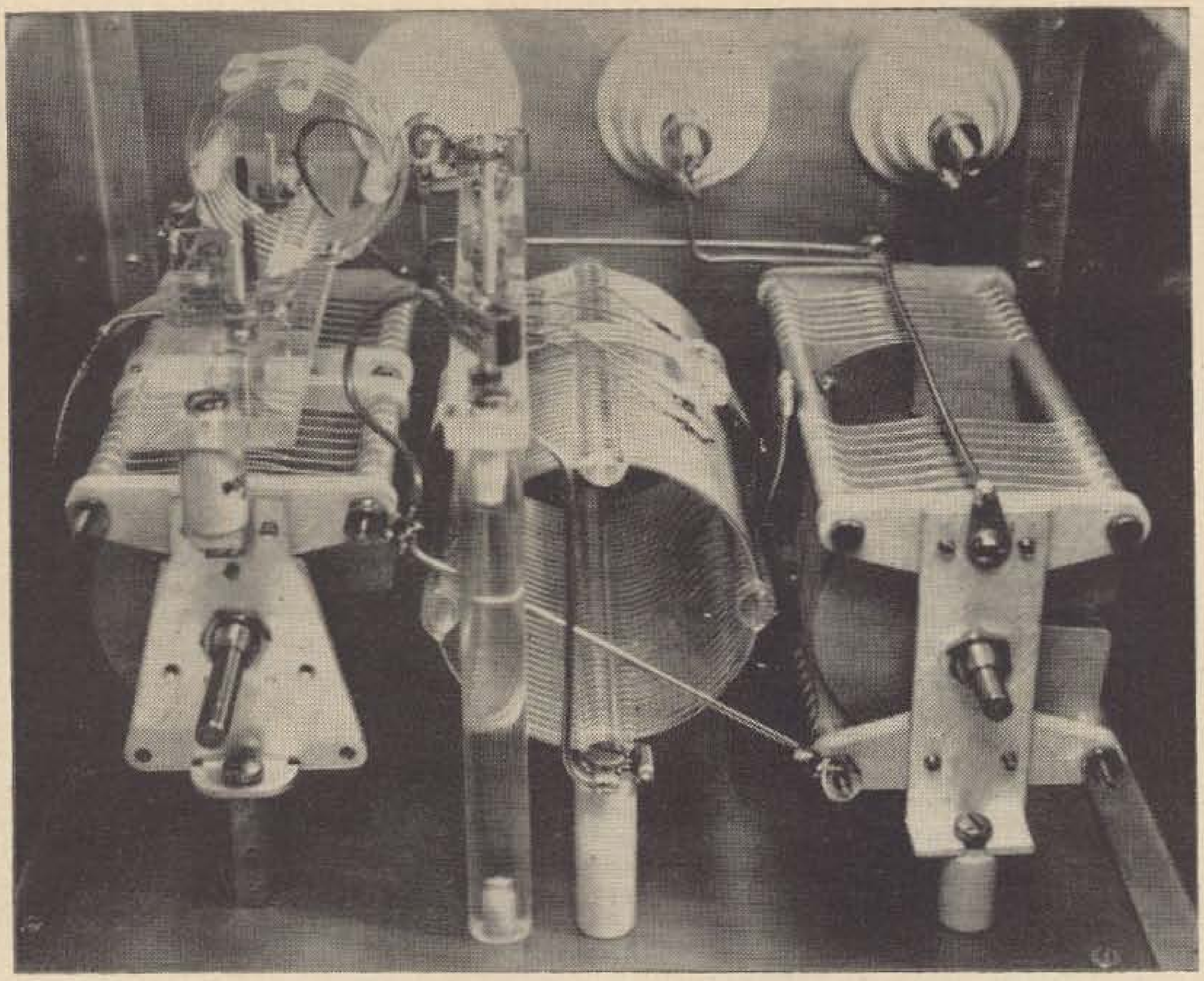


Fig. 1. W6BLZ's match box tuner. The coils should be shown as air wound.



Rear of the match box tuner.

in the future more amateurs will return to this ancient type antenna with the old tuned line.

General information

This tuner will match a 52 ohm coaxial line from the transmitter output into any line from 25 to 1200 ohms. For unbalanced lines it will match up to 3000 ohms making it suitable for using a long wire, or random wire antenna. The coupler is designed for antenna and transmission line matching and switching within the amateur bands from 3.5 to 30 MHz. A SWR indicator should be used between the coupler and the transmitter, inserted in the 52 ohm transmission line. The coupler cannot be expected to correct standing waves on the transmission line, which is a matter of match between the antenna and the line. The coupler will, however, properly terminate the coaxial line from the transmitter and match it to the transmission line terminal impedance. The link itself will have no standing waves on it. By doing this there will be a maximum transfer of energy from the transmitter to the antenna system and the tubes in the final will keep cool.

When the coupler is used with broad band antennas the tuning will cover the whole band with one setting. The system will become more frequently critical as the SWR on the transmission line is increased. If the resistance at the coupler terminals is too high for the range of the coupler, the line should be either lengthened or shortened until the capacitors inserted into the line correct for it. This might occur when a random piece of wire is used for an antenna.

. . . W6BLZ

Double Your Sixer Power

The power input of a Heath HW-29A Sixer can be doubled by a simple reconnection to the 6CL6 output tube and a change in tubes from the 6CL6 to a 7558. Components C8-10 pF and R4-47 k must be disconnected from pin 9 of V4 (6CL6) and re-connected to pin 2 of V4. The oscillator, doubler, and final tuning must be retuned when the 7558 is used. The cathode current should run about 60 mA compared to 30 mA for the 6CL6. The 12 V power cable filament jumper must also have the 150 Ω resistor replaced with a 50 Ω —1 watt resistor for mobile operation to correct for the higher filament current of the 7558. Improved audio can also be obtained by changing R-14 10 megohms to a 500 kΩ resistor located between pins 2 and 4 on V-B (12AX7). The pin changes to V4 permit the use of either the 6CL6 or 7558 interchangeably when used on 110 VAC. . . . K3QAY

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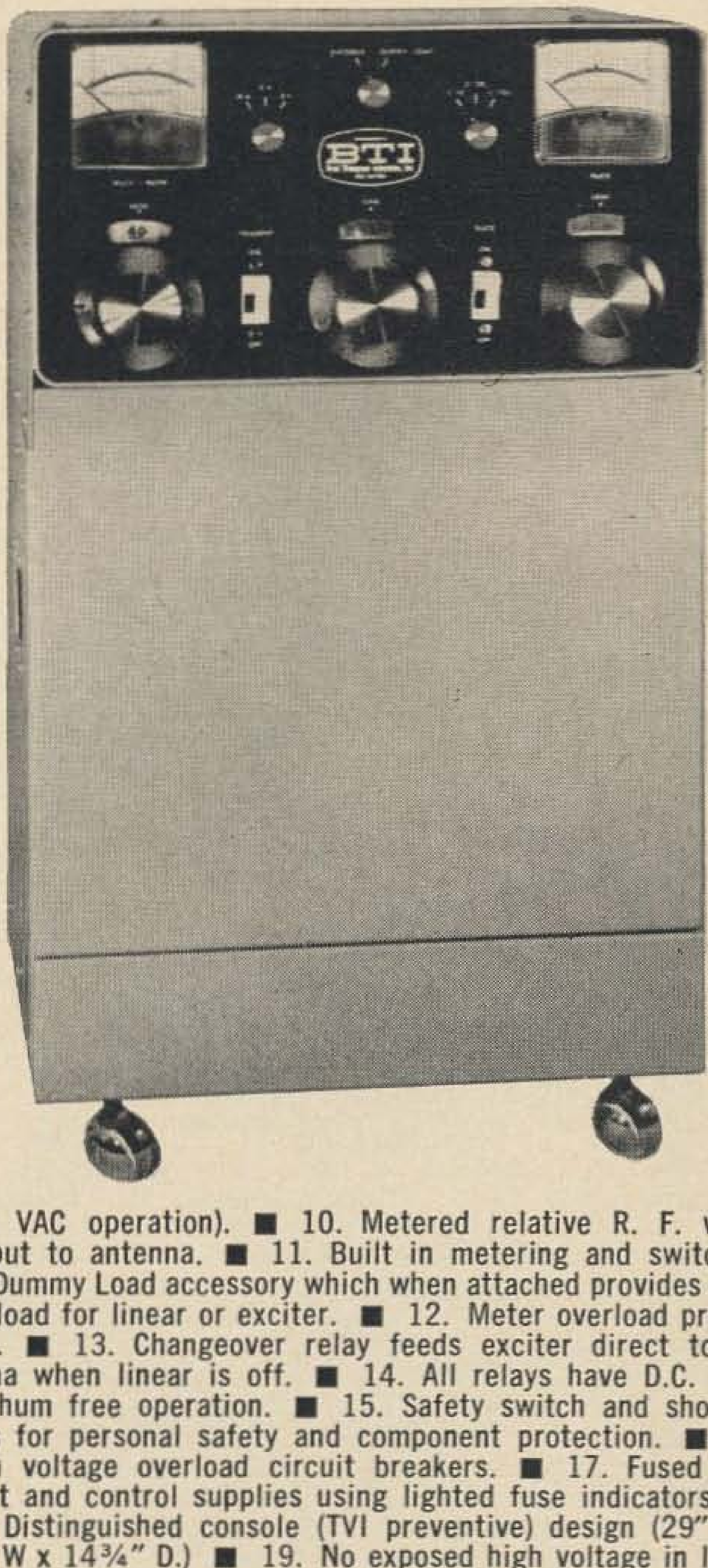

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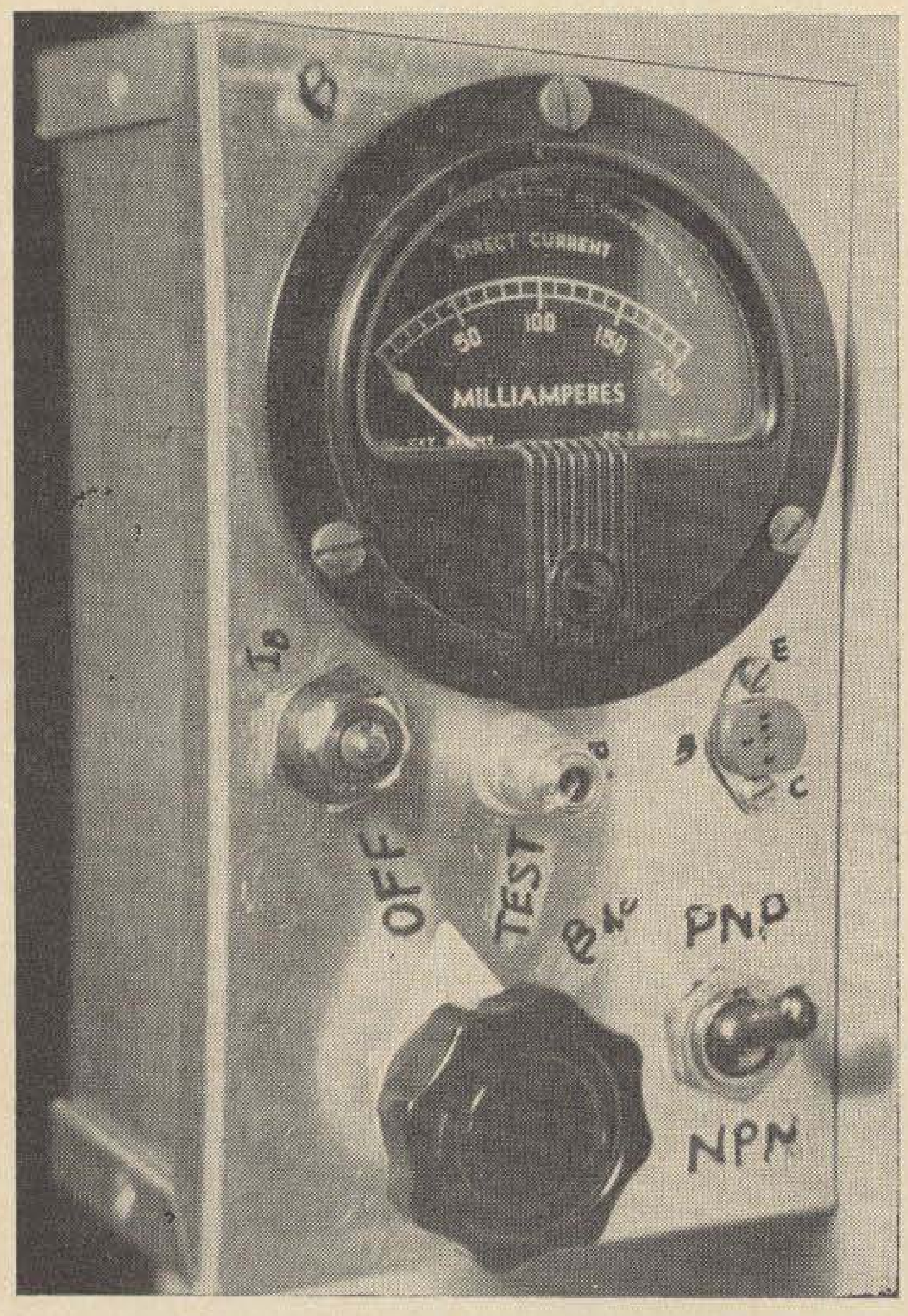
Two Transistor Testers

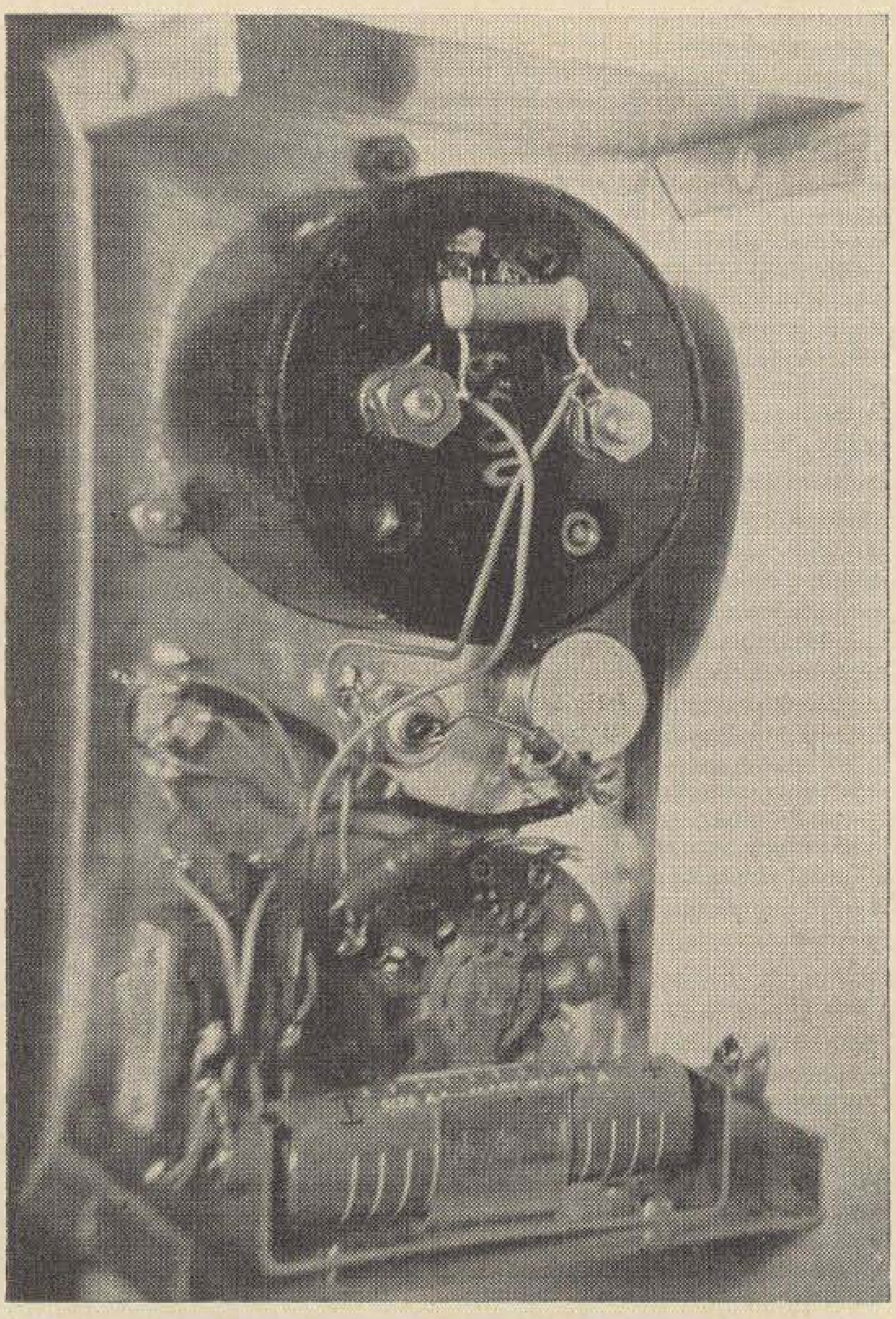
One of these two very simple transistor testers belongs in the shack of every up-to-date ham.

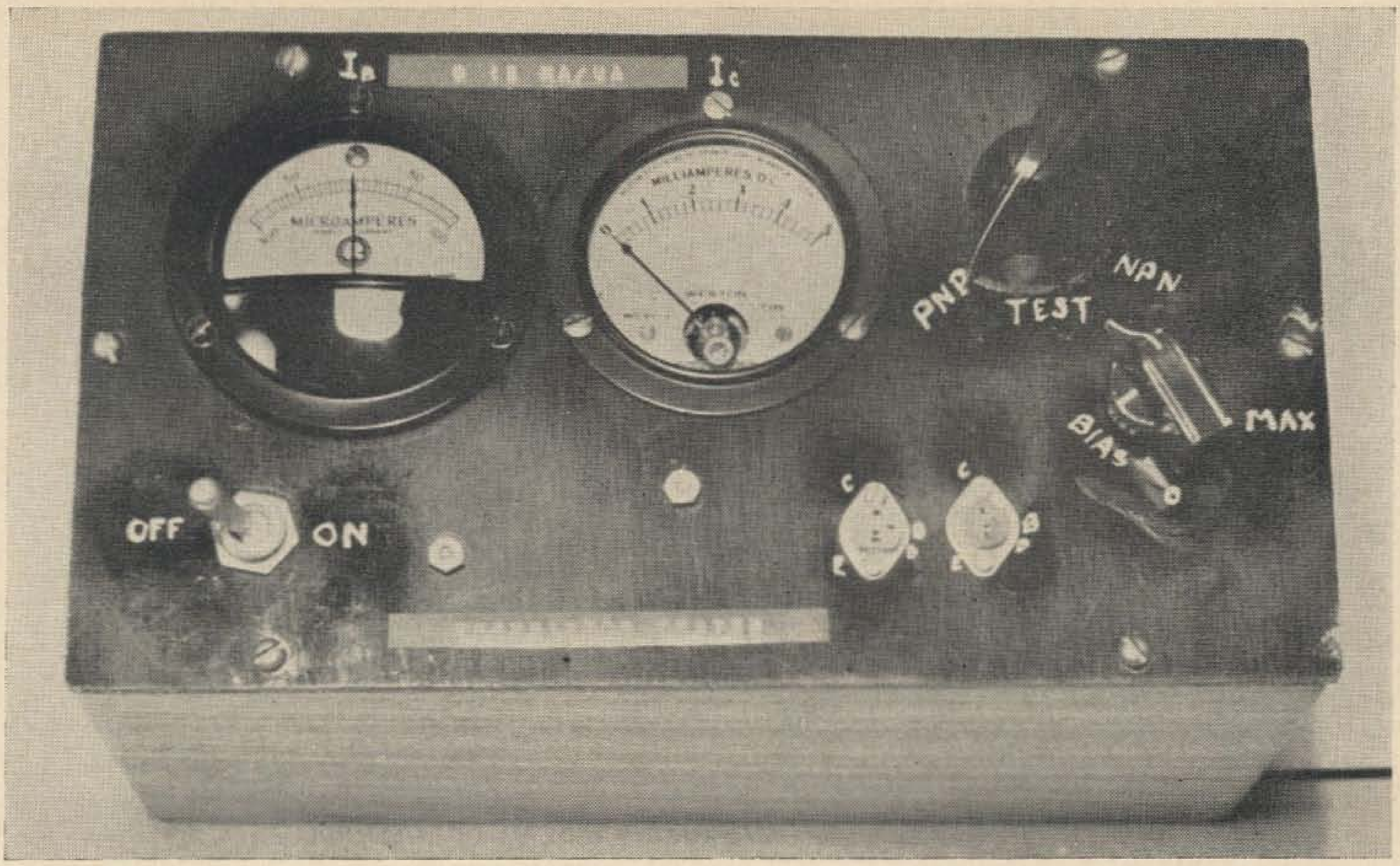
Two simple transistor testers are shown here both having the same basic circuit. The one shown in **Fig. 1** is about as simple as can be made for measuring the relative dc beta of either an NPN or PNP transistor. It was built into an aluminum box 3 x 5 x 2 inches with an old 0-200 Am meter. The latter had the internal shunt removed, giving a 0-2 Am meter with a 0 to 200 scale reading. A small half ohm resistor was shunted across it to make it read somewhere between 5 and 10 milliamperes full scale since most small transistors operate within this value of collector current. The exact reading is not important since the beta reading can be set to use the 0-200 division scale on the meter by adjusting the potentiometer in the bias circuit.

A battery and meter polarity reversing switch in **Fig. 1** is a DPDT toggle switch labeled NPN and PNP. By having a "test" position on the other switch, an unknown type of transistor can be plugged in for test without damaging it or the meter. The protective resistor should be 150 ohms for a 0 to 10 Am meter, or 300 ohms for a 0 to 5 Am meter in order to keep the meter reading to within



Front of the simple transistor tester in Fig. 1.


Inside of the transistor tester shown in Fig. 1.



Here's the front panel of the transistor tester shown in Fig. 2. Note the use of a zero-center meter for measuring base current. This avoids the necessity of using a meter-reversing switch there.

range even with a short-circuited transistor. If no reading is obtained with the NPN-PNP switch in either position, it indicates a very weak transistor or one with an open lead. Once these tests have been made, the dc beta can be read on the meter in the third position of the "test" and "off" switch.

The calibrating potentiometer can be set to read correct beta for a known type of transistor which has been measured on a more accurate transistor tester. The battery voltage affects the beta reading which means it should be checked occasionally to be sure it is near the 1.5 or 1.4 volt reading. The ordinary penlite sized cell should measure 1.5 volts and a single mercury battery cell should read 1.4 volts. Either type is suitable in this tester.

A more accurate type of dc beta tester is shown in **Fig. 2.** This tester was built into a larger box with two meters, one a zero center microammeter for reading the transistor base current for either NPN or PNP transistors without need of a reversing switch. The other meter, a 0 to 5 Am unit, reads the collector current for any particular value of base bias voltage and current. The milliampere reading can be set to any desired value such as 2 Am by means of the bias potentiometer knob. The reading multiplied by 1000 gives the collector current in microamperes. This value is then divided by the base current reading to give the dc beta of the transistor being tested. If the latter reading was 20 microamperes then

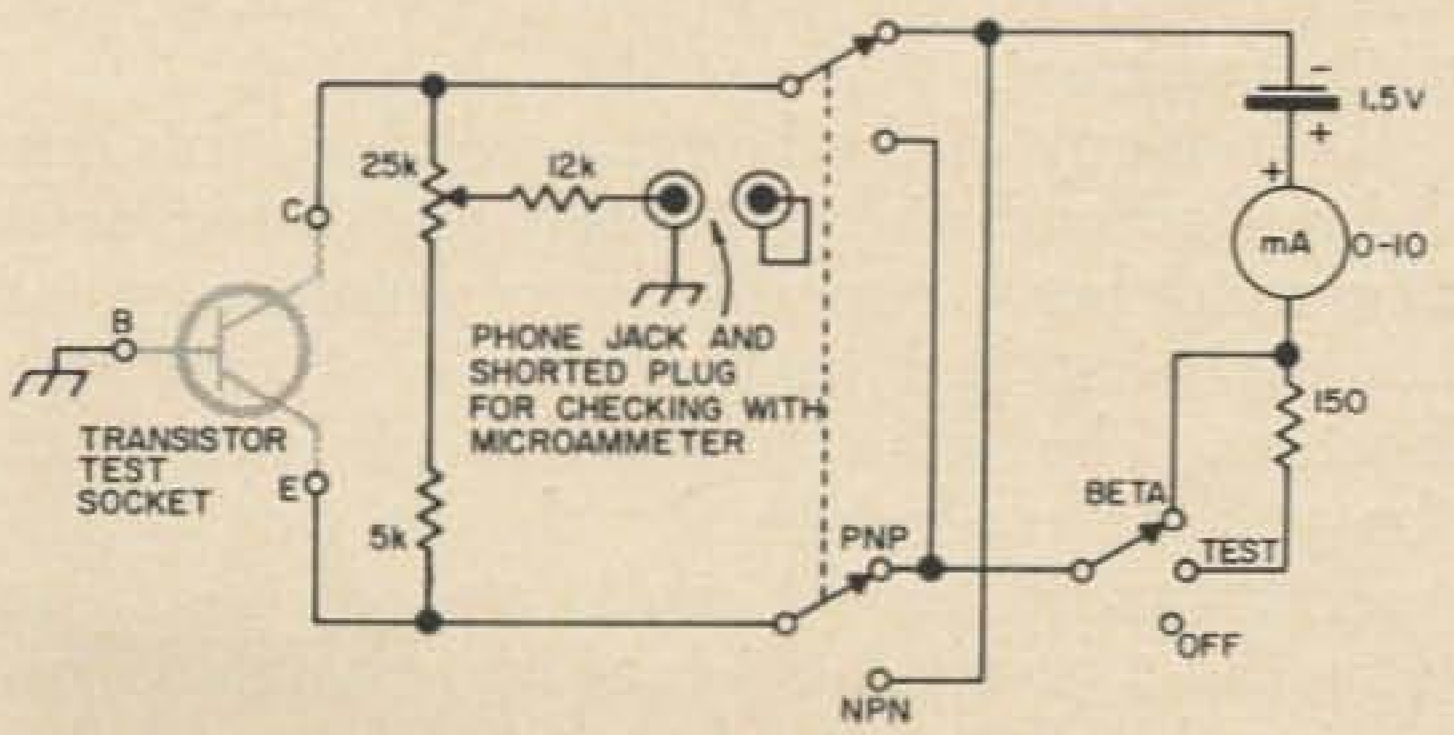


Fig. 1. The simpler of the two transistor checkers described by W6AJF in this article. The proper scale can be set by adjusting the potentiometer.

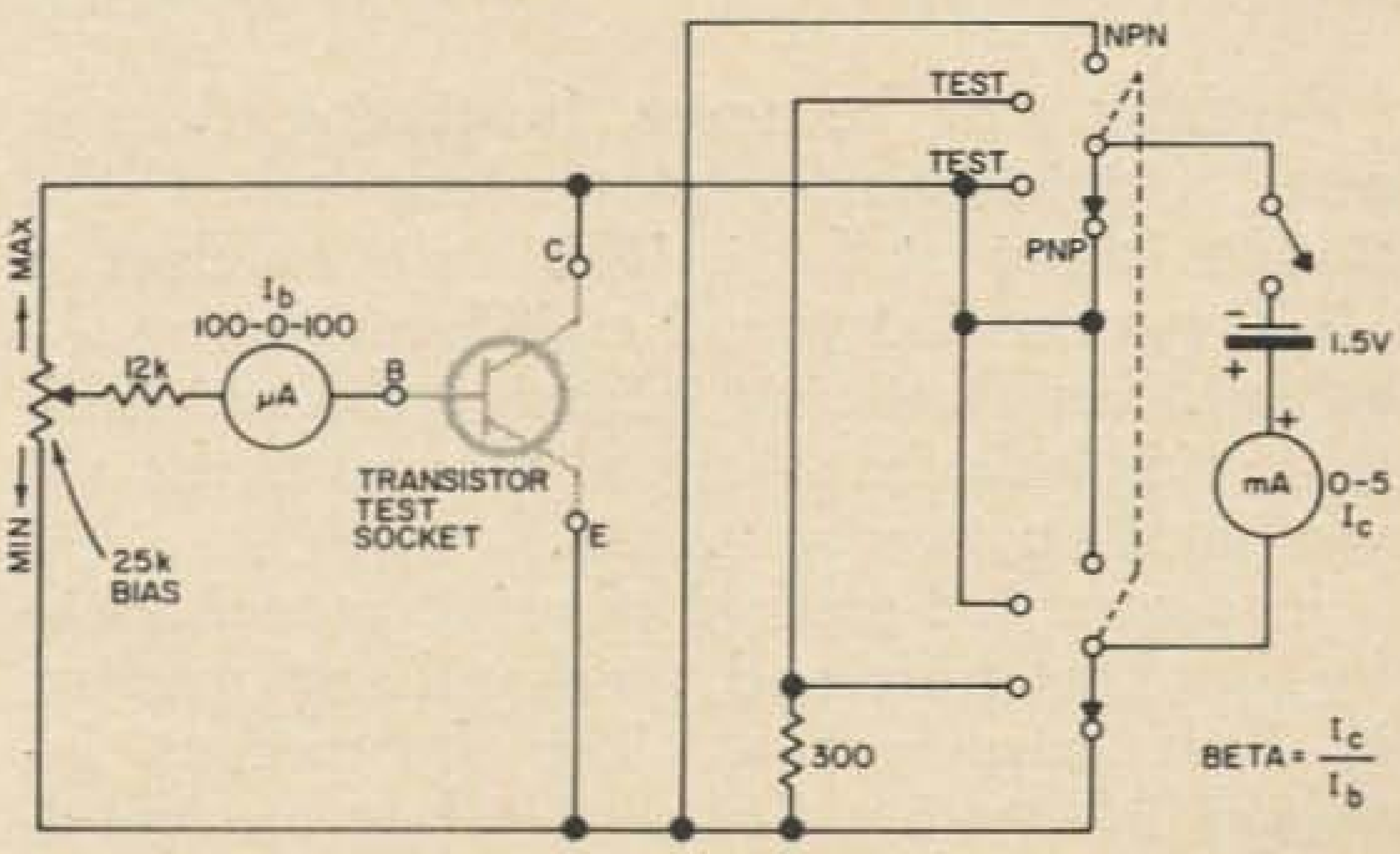
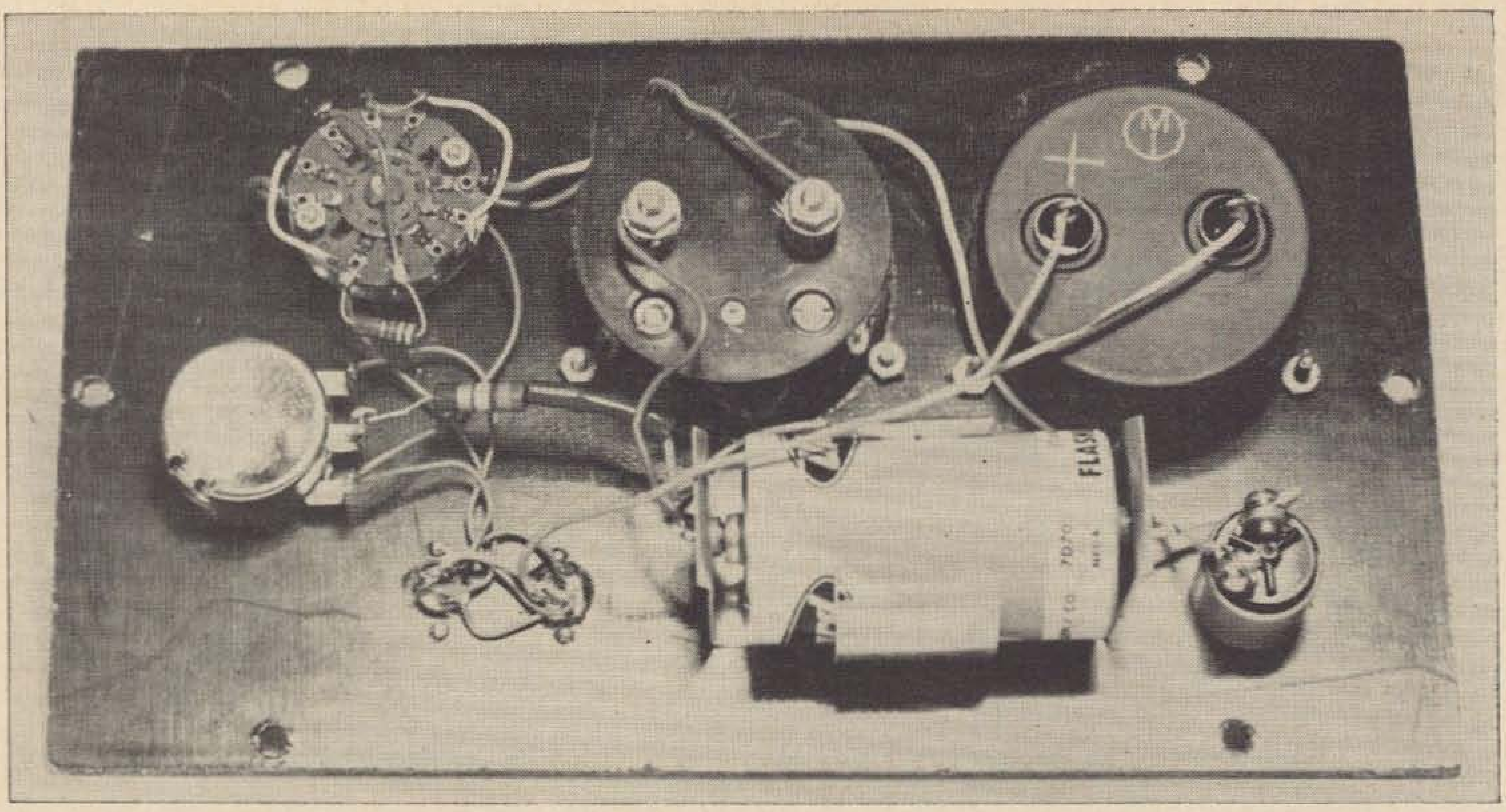


Fig. 2. The more complex of the two simple testers. You can figure the beta of the transistor under test more accurately with this tester than the one in Fig. 2 since you get a specific collector current for each value of base current you use.



Back view of W6AJF's transistor tester as shown in Fig. 2. The circuit is very simple and construction is completely non-critical. Either a mercury cell or a regular flashlight battery (shown) can be used.

for our example the beta is $2000/20 = 100$.

The PNP-test-test-NPN switch is a DP4T wafer switch. Two test positions were used with the 300 ohm protective resistor inserted series with the meter to prevent burnout for the case of a short-circuited transistor. Another protective resistor of 12,000 ohms was connected in series with the base circuit microammeter in case of a faulty transistor. A single flashlight battery was used to power the tester.

In testing either NPN or PNP transistors the current of both meters should increase simultaneously as the bias is increased from 0 towards maximum. If such is not the case, try the other switch position PNP instead of NPN or vice versa. If the beta reading is too much lower than transistor handbook values listed for "hfe" for a given type of transistor, it should be discarded. Higher valeus generally mean that you are in luck, as the transistor has a higher dc beta and hfe than the average units.

These testers do not measure anything except the relative efficiency as a dc device. It does not show up noisy transistors or give any indication of the operating frequency range. However, if it tests good on dc values, the transistor will probably work well in the frequency ranges listed in transistor handbooks.

. . . W6AJF

De-Bugging the Hi-Fi

Nothing can be more frustrating than a case of interference, particularly when the station is not at fault. This case involves a Hi-Fi system that would emit from the speaker, with ear-shattering intensity, the unintelligible single-sideband signal whenever the rig was used on twenty meters.

The accepted method of using capacitors to by-pass the grids and speaker leads resulted in little improvement. The frustrations involved in locating the elusive bug are unimportant but the specific cause is worth mentioning. After all, it could happen to you.

The final cure was the use of a capacitor from one side of the volume control to the chassis. According to the schematic this point was already grounded. After another careful examination of the amplifier, the cause was quite apparent.

As in many of the better amplifiers, this one did not ground directly to the chassis but used a ground buss, running from point to point before being tied to the chassis at only one location. The extra foot or so of wire from the volume control to the chassis was an excellent ground for the audio and, at the same time, did a pretty fair job as an antenna. Eliminating the rf at the volume control cured this particular source of interference.

. . . Ronald Farren WAØBGQ

Gary Jordan WB6MOC
Member, Technical Staff
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The Transistor for Voltage Regulation

Here's a voltage regulator that puts out 9 to 28 volts at up to 10 amperes with excellent regulation.

In many instances the amateur is interested in using or adapting a circuit using transistors, only to find that he has no means for supplying properly regulated and filtered power. Unlike the vacuum tube, which is relatively insensitive to minor voltage excursions and ripple in dc, the semiconductor demands a stable supply source and negligible ac in the dc to give optimum performance.

A change in bias voltage of 1 volt on a vacuum tube usually has very little effect upon the tubes operation. A one volt bias change on a transistor however is usually disastrous. One volt can mean the difference between class A and class C operation, or possibly no operation at all.

Gary has been W3AEX, W8LWL, WAØEFT and K1FPM. He's an electronics research engineer with a BSEE from Ohio and an AMIEE pending.

Circuit theory

The circuit of **Fig. 1**, is a rather standard series voltage regulator in the commercial field but needs a bit of explaining here because it is rather rare in amateur usage.

The easiest way to understand how the circuit works is to imagine the series transistor Q_1

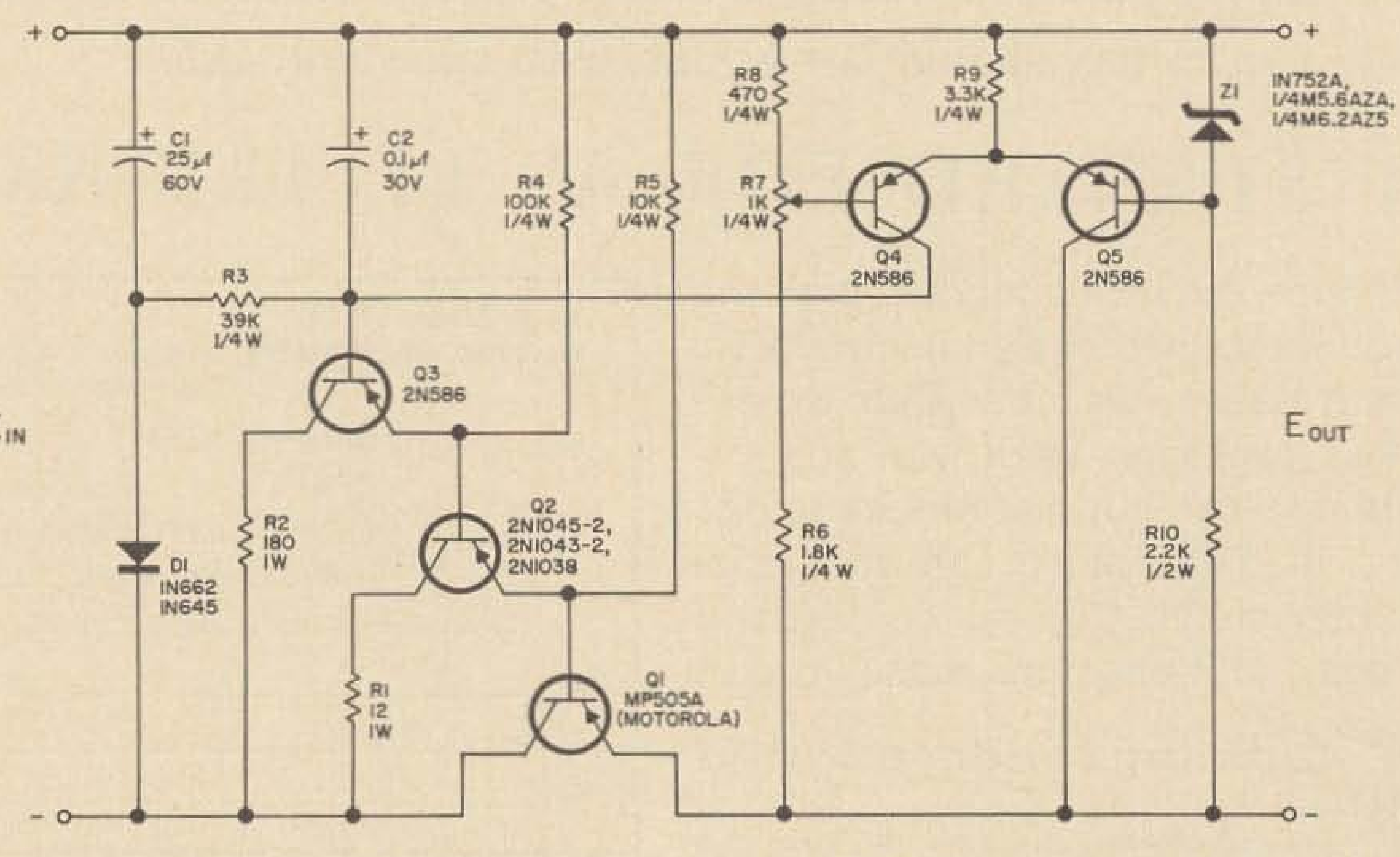
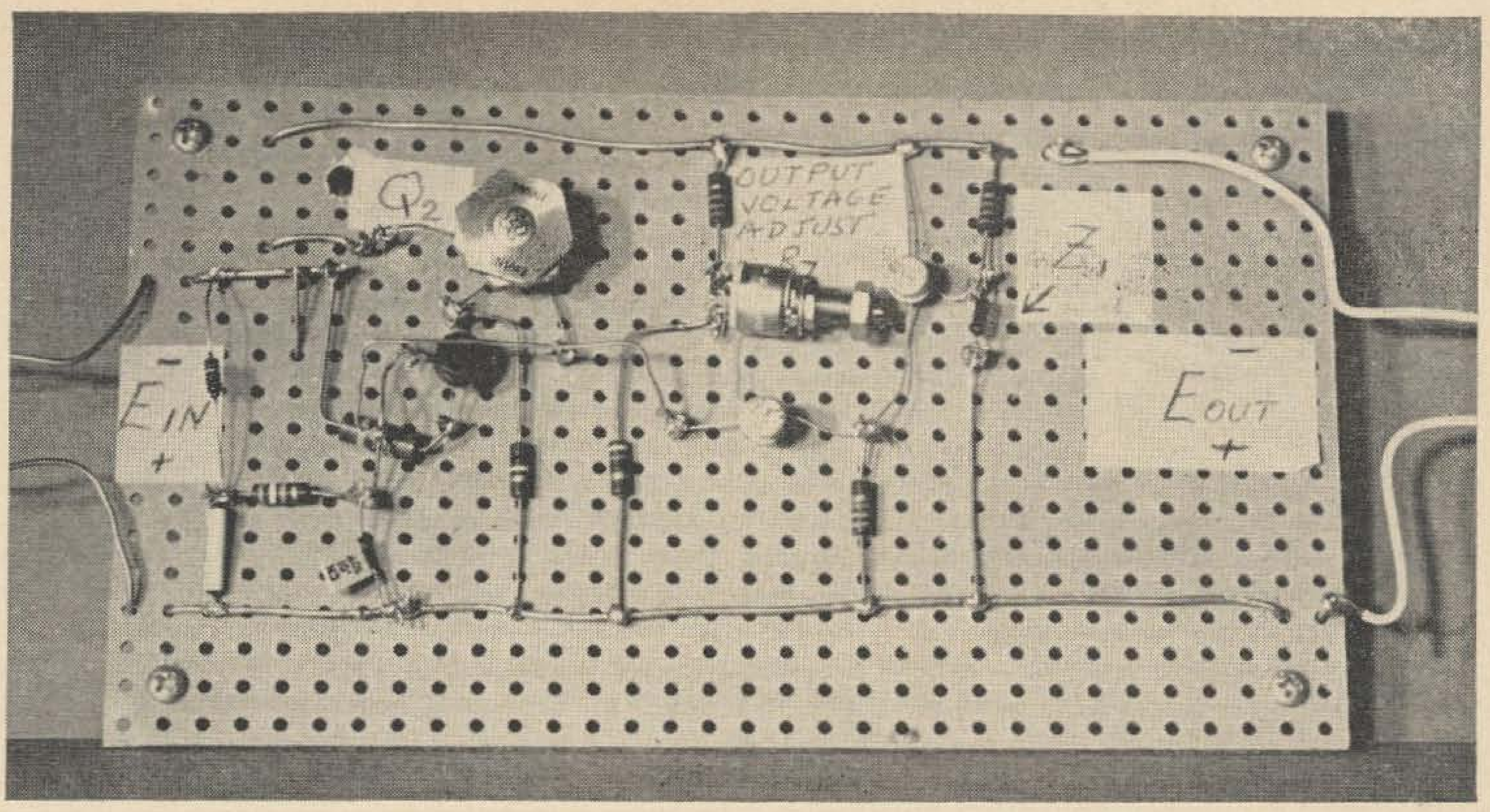


Fig. 1. Transistor regulator for 9 to 28 V output at up to 10 A. You can omit Q1 for a maximum current of 3 A.



Breadboard of the regulator shown in Fig. 1.

as a variable resistor that is automatically controlled. If the input voltage E_{in} were to increase, or the current being drawn by a load at E_{out} to decrease, the resistance across Q_1 must increase to keep the voltage at the E_{out} terminals constant. Similarly, if the load current goes up then the resistance of Q_1 should decrease to keep E_{out} fixed.

Now we might want to draw quite a bit of current through Q_1, maybe as much as 10 A. Since the current required by the base of Q_1 is approximately the current through the transistor divided by its amplification factor B (which may be any where from a value of 10 to about 30) a bit of dc amplification is in order. Q_2 and Q_3 provide this implification in a so-called Darlington configuration. Darlington circuits are simply those that hook the base of one transistor directly to the emitter of another, providing a very simple means of increasing gain. In effect, the gain, or B, of Q_3 is multiplied by the gain of Q_2 which is multiplied again by the gain of Q_1. Thus a very small current at the input of Q_3 can control very large currents through the series transistor.

Now all that remains is to provide some sort of feedback network which will sense the output voltage and control the series transistor. The sensing of the output voltage is done with a simple resistor string across the output, in this case the $R_{6\text{-}7\text{-}8}$ string. Also, we need a stable voltage source as a reference, and you will note a simple zener diode does the whole trick admirably here.

With the zener providing a good stable reference we can now compare the output voltage to the reference and make the series regulating transistor "take up the slack." This is accomplished by a simple differential amplifier, of which the operating theory is adequately covered in most transistor manuals.

If you've made it this far you should have a fair idea of how the gadget works, so now to the easy part, the "makings."

Construction and operation

The circuit shown can provide any regulated output voltage from 9 through 28 volts. The value of E_{in} is best selected as 25 to 50% greater than the desired output voltage, E_{out}. The input voltage can be easily obtained by a simple bridge rectifier and single capacitive filter, as shown in **Fig. 2**. With Q_1 in the circuit, a 10-A load current may be drawn continuously. Omitting Q_1 and connecting Q_2 in its place allows 3 A maximum.

Both Q_1 and Q_2 should be mounted on a suitable heat sink, such as a chassis, with an area of 20 square inches or more. Use the insulating material supplied with the transistors to keep the cases electrically isolated from the chassis, as the collectors are connected internally to the case.

Use the value of capacitors specified; they provide proper time constants for regulation and for damping feedback oscillations that can occur.

The output of the regulator should not be

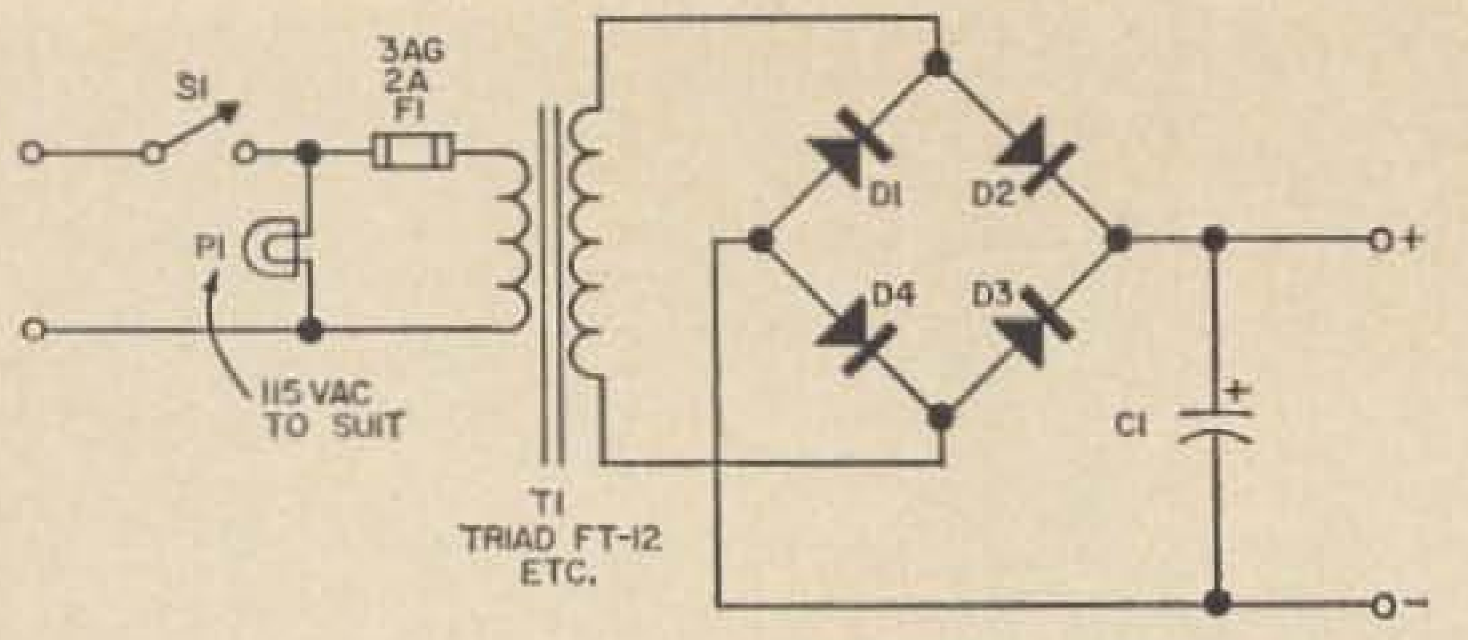


Fig. 2. Power supply for the regulator in Fig. 1. D1 through D4 can be 1N538 for values of C1 below 2000 μF or 1N2610 for larger C1. C1 should be as large as possible and rated at 60 to 75 V.

short circuited even if a fuze is used in the transformer primary supply, because either Q_1 or Q_2 may exceed current ratings and fail before the fuze opens. A more advanced version of this circuit would include some provision for current limiting. Other than these restrictions, the circuit can be built in any reasonable configuration and will work quite well. Output voltage can be easily set and adjusted by adjusting R_7; once set, it may be forgotten or varied at will.

Use of the circuit

Similar regulators have been built and used with excellent results. Specifications and requirements for professional uses far exceed those needed by amateurs, yet the cost of this circuit is now reduced to its most economical form without sacrifice of good characteristics.

Amateurs should find this circuit quite useful, because either side of the output may be grounded, and regulation and ripple reduction are such that a home laboratory or equipment supply is as feasible as the more common vacuum tube B+ supply. . . . WB6MOC

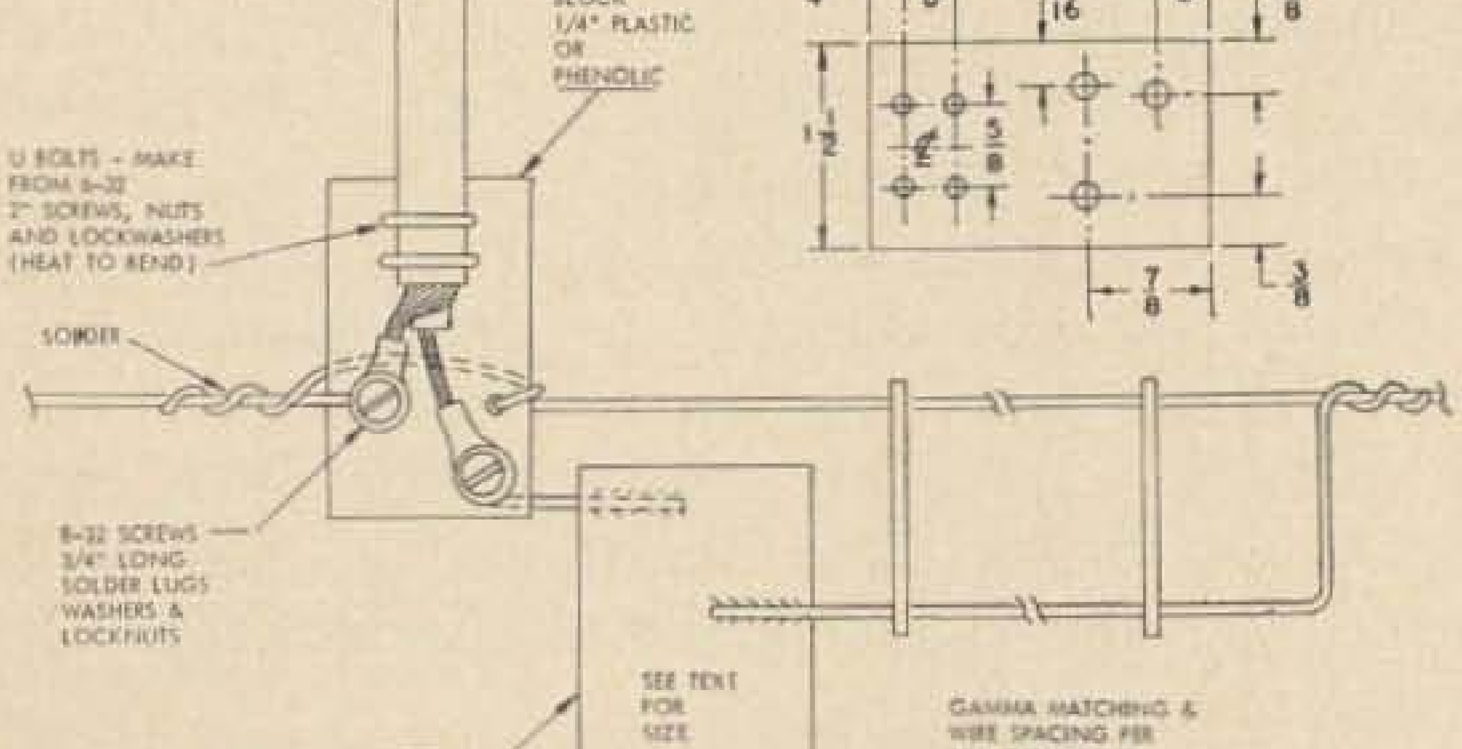
Improved Gamma Match

Prior to constructing my homebrew tri-band quad I had concluded from on-the-air discussions that a gamma match was a mighty good investment but was somewhat complicated due to problems in waterproofing the large air-gap gamma capacitors.

After giving the matter considerable thought, the following relatively simple approach was developed and has been used very successfully at this QTH.

Bill Orr's Quad Handbook gives dimensions for gamma rod spacing and length; however, in lieu of air-gap variable gamma capacitors simple fixed capacitors were constructed from 1/16" thick double surfaced copper printed circuit board material.

First, a separate gamma match assembly was constructed for each band per Bill Orr's dimensions as shown in **Fig. 1** except that a small variable capacitor was temporarily substituted for the printed circuit boards and the support block was added. Capacitors can be 150, 100, and 75 pF for 20, 15, and ten meters.



The transmitter (use low power 200 watt type) was then tuned for 14,300, 21,300 and 28,600 kHz and each capacitor was adjusted for minimum SWR.

The capacitors were then carefully removed without changing their settings and the capacitance of each was measured. Printed circuit board material was then cut with a hacksaw to slightly larger values (+5 pF) and edges bevelled as shown using a small wood rasp. These were then soldered into place and the SWR was again checked on each band. The boards had to be cut down slightly using a pair of dikes or tin snips to achieve minimum SWR. Plastic tape was wrapped around each board and VOILA!—we had a light weight weather-proof gamma match.

If you want to gamble and avoid the variable capacitor substitution method the following sizes will be more than enough and can be easily trimmed on the spot to give minimum SWR.

Band	PC Board Gamma Capacitor		
20 Meters	1½ x 3"	Approx.	size
15 Meters	1½" x 2"	"	"
10 Meters	1" x 1½"	"	"

Two separate feedlines should be used, one for 10 meters and a common 15-20 meter line or three separate lines may be used.

. . . W. H. Paxton K6ZHO

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St. Joseph, Mo. 64507

I recently found myself in Miamisburg, Ohio, home of all that good Drake gear, so thought I'd drop in for a visit. I found their building, was warmly received and shown around by Peter Drake.

A Visit to the R. L. Drake Company

Here is part of the Drake production line. Drake only makes ham gear and TVI filters.

Here's more of the production line. The engineering department and metal work are in another building.

Here are some of the new products shown at the Dayton Hamfest: The 2-NT CW transmitter and the 2-C Ham band receiver. Another product they make is the SW-4 short wave broadcast receiver. Watch for details in 73.

The new Drake L-4 linear offers 2000 watts PEP—1000 watts DC. Tubes are two Amperex 8163's. Price with separate power supply and tubes is under $700.

Here next to the Drake factory is the new addition they've been working on. Business is good. Also notice Bob Drake's Triumph. I enjoyed my visit with Drake. I'm sure you would, too.

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Try Homebrewing Now

When I sit around a swimming pool, I'll notice three groups of people: there is one group that stays around the pool, soaking up sun but never getting their feet wet; another group that dives in, discovers that the water is cold and runs out again; and a final group that edges into the water slowly. These people usually have the most fun and stay in the longest time.

Ham radio homebrewing has the same groups. Some never bother to homebrew; they sit home, their pudgy fingers glued to a knob, praying that a tube doesn't go. On the other hand, some guys buy up their local electronics store and try to build an imitation NCX-5 before they have learned how to solder. Finally there is a group that thinks about building, works on it carefully, stays in the longest and has the most fun. This is the group to join.

How, you say. How can I "edge in" to homebrew? Tools cost, and besides the thing will probably do nothing more than exude black noxious fumes when I plug it in. But this doesn't have to be so. It is easy to get started in homebrew without money, parts, or even tools.

No tools? Most—if not all—towns have a ham with a set of chassis punches and drills. Being a homebrew fan, he'll be glad to help out and get another convert. Seek this man out and swipe a weekend of his time. Hams are notorious for their brotherhood; use it.

No parts? Old TV's, radios, tuners, anything electronic will furnish parts. The best thing to salvage is a good power supply. Again, most hams in any reasonable sized town have an overstuffed junk box. Grub a few parts from them and you won't have to spend more than five dollars a project. If you load yourself with catalogs and flyers (Say you saw it in 73) you'll be able to save money to the point where you'll feel sorry for the manufacturer. Parts? No problem.

No money? A five dollar bill will take care of preselectors, Q-multipliers, a VOX, full CW break-in, a code monitor or two, a noise limiter, a product detector, a crystal BFO . . .

I could go on forever. And how do I know? Either I or a friend has built one of the above items for a five dollar bill. Don't say it can't be done.

By now, hopefully, you see that all the myths about the great expense, great labor, high rate of failure, etc., are a lot of pap. Armed with this knowledge, you desperately go searching through your old back issues of 73 in order to find that six-meter converter you never had guts enough to build. But let us suppose that you are a hard-core cynic who still believes that homebrewing is for the birds. Here are a few reasons why homebrew pays.

First of all, satisfaction. Big deal, you say. Well, if you don't care about the personal satisfaction involved, read on. But it means a lot to a lot of guys.

Second of all, you can own equipment that no manufacturer could supply. Who is going to produce a product detector that you can put in your old decrepit receiver? That, believe me, is a limited market. Where are you going to get hundreds of accessories? The only way you can get them is by homebrew. That, I think, is one of the best reasons.

You learn a lot. Big deal again, you say. You say you don't need to learn; you simply push a button and you're on the air. Yeah? What happens when your receiver kicks out? Try sending your 105 lb transceiver back for servicing. And have fun packing it.

You save money. How much money? To get off ham matters, I know a guitar-playing friend who paid forty dollars for a fuzz-tone. A ham friend copied the schematic and built one for ten dollars. In most cases of homebrew there's nothing to compare it to since there are no equivalent units available. But look up the price of a VOX and see how much it would take you to build it, using the techniques of sophisticated grubbing mentioned before.

If you haven't tried homebrew, start edging into the swim of things. In a while, it'll get mighty hot for the boys sitting around the pool doing nothing. Get a head start on them.

. . . WB2JQC

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R.D. 1
Freeville, N.Y.

Diodes for Oldtimers and Beginners

A few simple games help explain electron current in a vacuum, wire or semiconductor.

One evening a venerable oldtimer presented me with a problem. He said, "If a diode conducts with the anode end plus, why does the cathode end carry the plus sign?" I said, "That's the end that goes plus." He replied, "It has to be minus." Round and round we went, and it turned out to be quite a problem. I finally had to write this article to clear it up!

What's confusing about such a thing? From a practical viewpoint, diodes are too simple to raise serious questions. But the problem is not diodes, it is words. We say a current flows this way, or that. But which way does it *really* flow?

About 1747 Ben Franklin believed electricity flowed from plus to minus. It was the best opinion available in his day. In 1891 the researchers just starting atomic physics had found some puzzling things, for which the Irish physicist Johnstone Stoney (three cheers, etc!) suggested the term 'electrons'. Finally, in 1895, J. J. Thompson showed that electrons really exist. This should have settled the matter permanently.

But the plus-to-minus convention is still with us. And in some semiconductors it is correct! We call it hole current. I'll tell you something if it won't see print: I'm still confused sometimes.

The best way to avoid this confusion is to get past the terms, right down to a clear picture of what actually happens inside conductors and diodes. Three games, described later, will help to make this picture clearer. You'll get the most from them if you read from the bibliography about some of the things I left out to make the games simple.

Diode current

What the old-timers called just plain current, back around World War II and earlier, I'll call electron current. This absolutely eliminates the question of which way it goes, because we can tell any time by thinking about vacuum tubes. But how many electrons are actually moving when an electron current is flowing? If you use an ammeter, the magic number is 6.3 billion billion electrons per second per ampere!

The vacuum tube not only tells us which way electron current flows, it supplies the simplest picture. The cathode serves as a source of electrons. The anode takes them out of the picture again and not very much happens in between. This is the first illustrative game, the Diode Game.

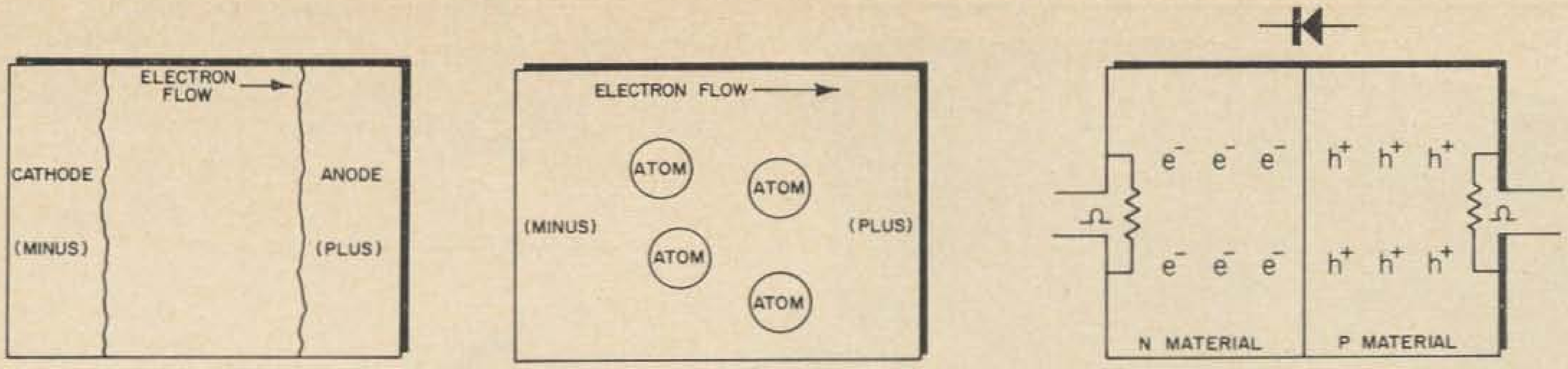
Fig. 1 shows what labels are required. This is marked out on a piece of paper which is then attached to a board or book and tilted as indicated. Marbles or pennies will do for electrons. Drop them at the cathode end and watch them exit at the anode end. You may feel stupid, but do it anyway. The important thing is to get into your bones the idea that something like this *really happens* when a current is flowing in a vacuum diode.

Wire current

All electron currents flow in a vacuum! From the electron's viewpoint, the interior of a wire is mostly open space. The atoms are well separated, and serve partly as a source of electrons for conduction. Is that a little hard to believe? It took thousands of years to discover this fact, and even now practically nobody appreciates its truth or value.

Because the wire's interior isn't quite all open space, wire conduction differs from vacuum conduction in two ways. In the first place, the electrons travel within the wire in relatively straight lines. Sooner or later each will collide with an atom. That's the end of its trip, which is taken up by another electron. And each time an electron comes to a sudden stop, the atom is slightly warmed.

That's why wires get hot if they carry enough current. This knocking about, recurring billions upon billions of times per second, heats the wire. The result is very useful in vacuum tubes, not so desirable in transistors.



DIODE GAME WIRE GAME PN GAME

Fig. 1. W2DXH's three games illustrates what really happens in vacuum tubes, wires and PN junctions as electrons flow from one end to another. The games are explained a bit more fully in the text.

There may be some question of how many electrons belong in the piece of wire. Of the various answers, the simplest is: as many must leave as enter. This preserves the electrical balance of the wire, which in a more elaborate explanation is not necessary. Leave this problem 'til later!

You might try working out a game to illustrate wire current. But if you want to copy mine, refer to the Wire Game chart in **Fig. 1.** It resembles the Diode Game chart, but cathode and anode are omitted and some atoms have been added.

The atoms are physical obstacles pasted to the paper. Bottle caps will do admirably. One end is labeled minus, the other plus, the sheet it tilted with the plus end down, and you can start sliding electrons down between the atoms.

Remind yourself that if an electron strikes an atom, it sticks and another continues the journey. The atom gets warmer. And as you watch things go, think about those big numbers, amounting to millions of millions of electrons moving for each microamp of current!

PN junction current

Solid state conduction resembles wire conduction. But there are two kinds of solid state conduction. Both require that the material be crystalline, and that it be doped with carefully regulated amounts of impurities. The type of conduction depends on the impurities chosen.

The first type of solid state conductor, N type material, depends on the presence of impurities with extra electrons. If there is no such impurity, the electrons in the crystal will be all tied up holding it together, none available to move as a current. Conduction in N type material closely resembles wire conduction.

P type material is doped with an impurity having too few electrons. As a result, many sites within the crystal should, but do not, contain electrons. But they can get electrons from other regions in the crystal. If a hole captures an electron, the hole and electron seem to trade places.

The sequence of events is best explained by going on to the PN game in **Fig. 1.** From left to right across the drawing, we have a piece of wire entering the diode, an ohmic, or bidirectional contact between the wire and N material, a PN junction between the two types of semiconductor, another ohmic contact between P material and wire, and finally a wire leaving the idode.

If we push an electron into the LH wire, electrons will be displaced along the wire and shortly one will cross the ohmic junction into the N type material. But since the N conductor is already balanced, another electron is pushed over the PN junction into the P type material, where it promptly falls into a hole. The P material, unbalanced, kicks an electron across the ohmic junction into the RH piece of wire. And our electron, many times removed, continues its journey. This is a forward conduction process.

Suppose, now, that we push the electron into the RH wire. With a little urging (reverse bias) it crosses the ohmic junction and falls into a hole, leaving the entire region charged slightly negative. No electrons from the N region are interested in stepping into this; in fact they will retreat a little way from the PN junction. A similar event occurs if an electron is removed from the N region. This is the fundamental process of reverse biasing.

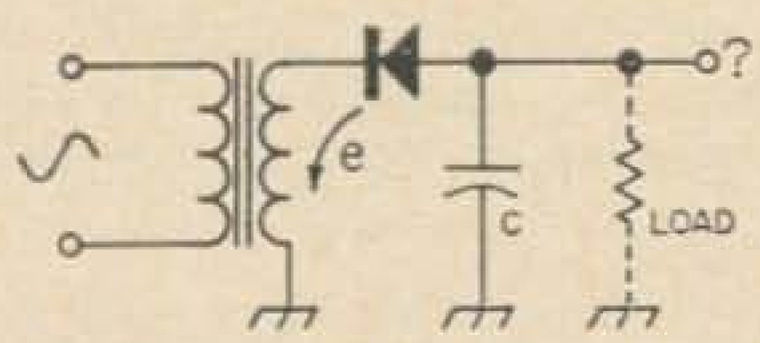


Fig. 2. W2DXH's transformer and diode problem.

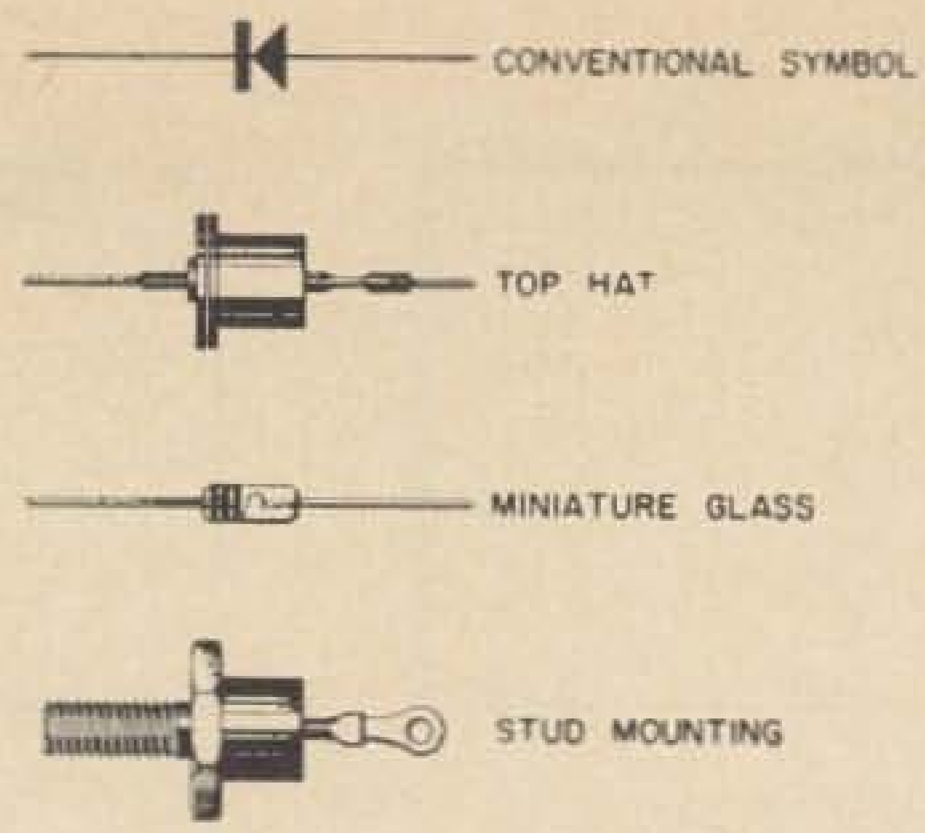


Fig. 3. Some kinds of diodes that we often use.

Diode circuits

When these games have been played out, the diode problem should be clearing up. Just to make sure let's look at a simple diode and transformer circuit (**Fig. 2**) and watch its operation through a single cycle.

The diode is drawn in the same orientation as shown in the PN game diagram. We immediately know that electrons will flow from left to right but not from right to left. If we look at the transformer as a device which tries to sweep electrons through its secondary first one way and then the other, everything works out promptly. The slightly curved arrow indicates which way the transformer tries to sweep electrons in the first half-cycle, and a letter "e" is placed by it as a reminder. We see right away that no electrons flow during the first half-cycle. They flow against the arrow of the diode, so during the second half-cycle, electrons swept the other way pass through the PN junction and collect in the capacitor. After one or a few half-cycles of conduction the capacitor has developed enough charge so that no further current flows, except that through the optional load resistor. Try to work this out for yourself.

We get exactly the same final result if the current is assumed to flow from plus to minus. But then the diode seems to conduct in the direction its arrow points, and it appears that positive charges have been removed from the capacitor, rather than negative charges collected there. Have you ever read Orwell's "1984"? Well, here's a good example of something like this "double-think." When you've caught the trick, try it out on the best man you know. You just might surprise him!

. . . W2DXH

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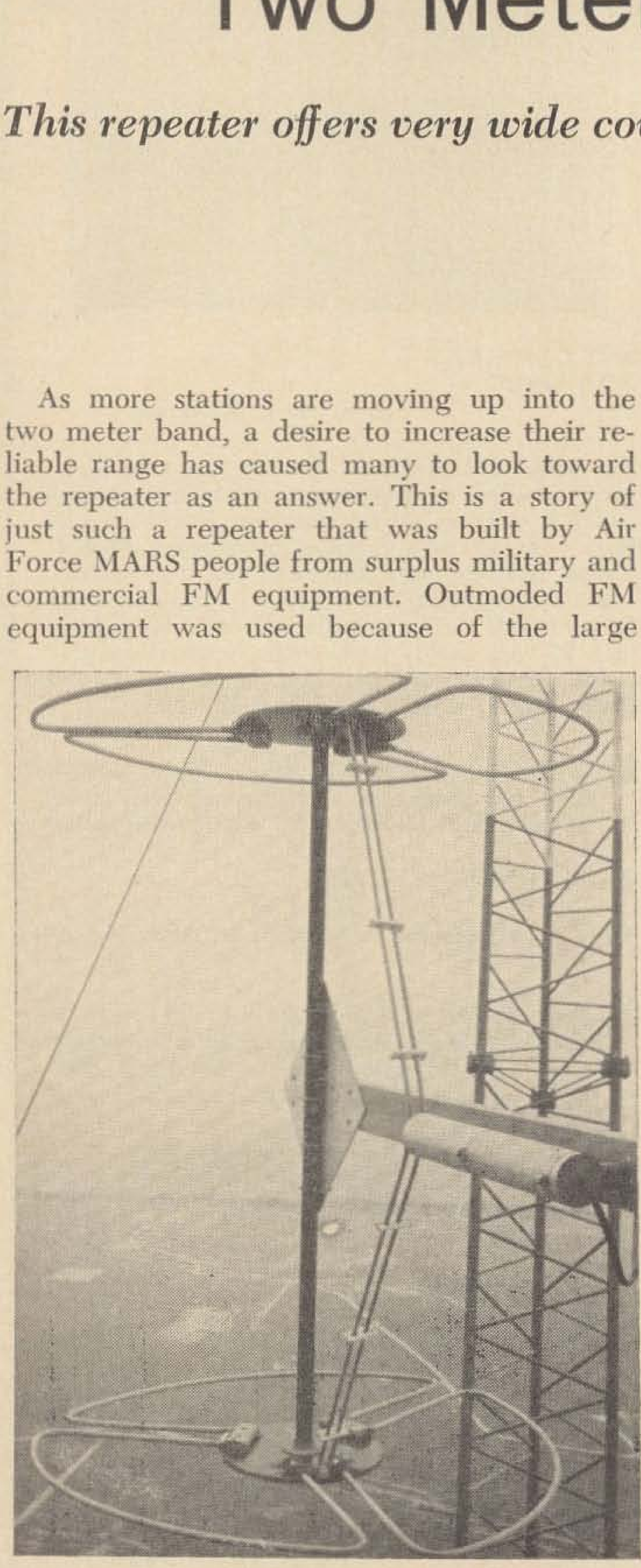
Two Meter Repeater

This repeater offers very wide coverage for fixed or mobile.

As more stations are moving up into the two meter band, a desire to increase their reliable range has caused many to look toward the repeater as an answer. This is a story of just such a repeater that was built by Air Force MARS people from surplus military and commercial FM equipment. Outmoded FM equipment was used because of the large amount available from commercial users. No effort will be made to endorse any piece of equipment as this is what we used and other gear could probably be used just as well.



The transmitting antenna with coax balun as it looks on the 1400 ft. tower also used for KPRC-TV.

As can be seen in the block diagram, **Fig. 1**, the receive and transmit frequencies are separated by only 490 kHz. The methods used to prevent the receiver from being desensitized by the transmitter are little known to hams and should prove interesting to other amateurs who are plagued by strong carriers near their operating frequency. A cavity transistor preamp has been added to the receiver and can be placed on the tower to make up for the loss in a long transmission line.

This repeater was developed to receive on 143.46 MHz and transmit on 143.95 MHz, Air Force MARS frequencies just below the two meter band. Although these are not amateur frequencies the information supplied here has been used by amateurs using repeaters on 146.94 MHz. Different crystal frequencies are the only changes necessary to operate in the two meter band.

We used a surplus FRC-27; however, the TRC-34 and VRC-19 are very similar. The FRC-27 and TRC-34 are ac powered units and are almost identical. The VRC-19 is a mobile unit designed for a 28 V electrical system so would need an ac supply.

The block diagram (**Fig. 1**) shows the complete repeater. It will be noted that the companion receiver R-394-U is not used. It was very unreliable. A GE Progress line 4ER25D was modified and substituted to give very reliable performance. This wide band receiver is expensive to narrow band so is available at very low cost.

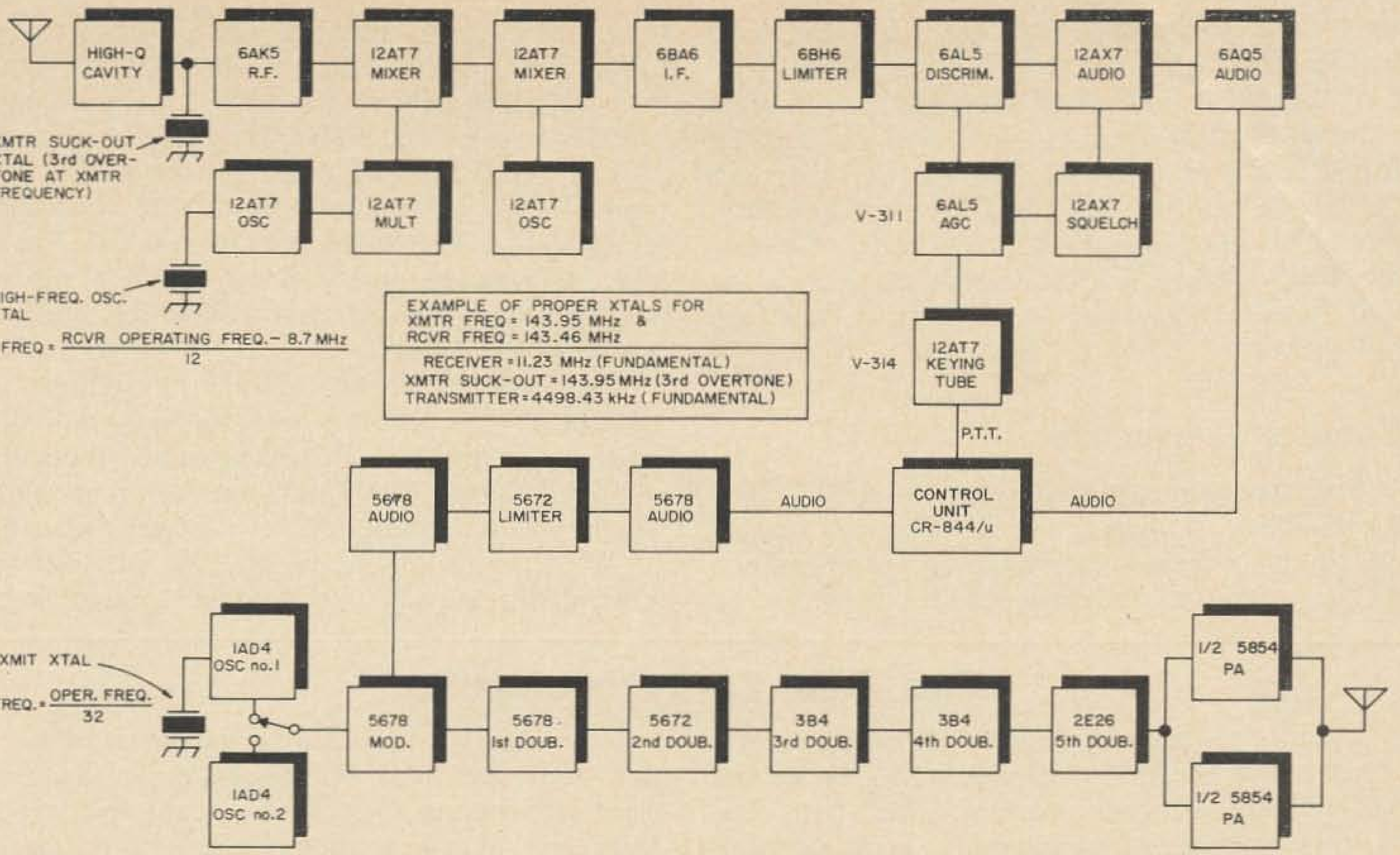


Fig. 1. Block diagram of the 2 meter FM repeater described in this article. The transmitter is a surplus unit from the FRC-27 and the receiver is an out-dated GE wideband commercial receiver.

Transmitter Adjustment

The transmitter is coded T-416-GR and is installed in the lower right compartment. This unit uses instant heating tubes up to the driver, so only two tubes draw filament power during stand-by. The 5894 final operates in a very efficient push pull circuit and is capable of about 70 watts output. This unit uses a crystal multiplication of 32 times. The crystals shown are for either the 146.94 MHz or 143.95 MHz frequencies. These crystals should be in the HC-6U holder to take advantage of the ovens in the units; however, a FT-243 may be used if the oven is not desired.

A test card CX-2371U to allow removing the transmitter from the cabinet was found with some units; however, several have been made by using surplus connectors. A VTVM is used for the tune-up. Insert a crystal into the socket and switch transmitter to tune. Do not operate the transmitter for longer han 10 seconds until the final has been tuned. Remove both side covers and note the test point marked J401, etc.

Turn on the unit and allow time for the final and driver to heat. Switch the frequency select switch to the socket which has the crystal in it as this is a two frequency unit. The transmitter is keyed by turning the test switch to on. The switch should be returned to the off position as stages are tuned and the meter is advanced to each test point. Place a 50 ohm dummy load on output jack P1902.

Tune up as follows:

VTVM connected to	Adjust	Indication	Reading
J-401	Z-401	Max	−5 V
J-402	Z-402	Max	−23 V
J-403	Z-403	Max	−30 V
J-404	Z-404	Max	−70 V
J-501	Z-405 C-502	Max	−40 V
J-502	C-507 C-508 C-509	Max	−45 V

Insert the VTVM in J-505-506 PLT CWR JKS. (Caution: HV to ground is present on these lugs). Adjust C-514 PA tune condenser for a dip on VTVM. Now load the PA to

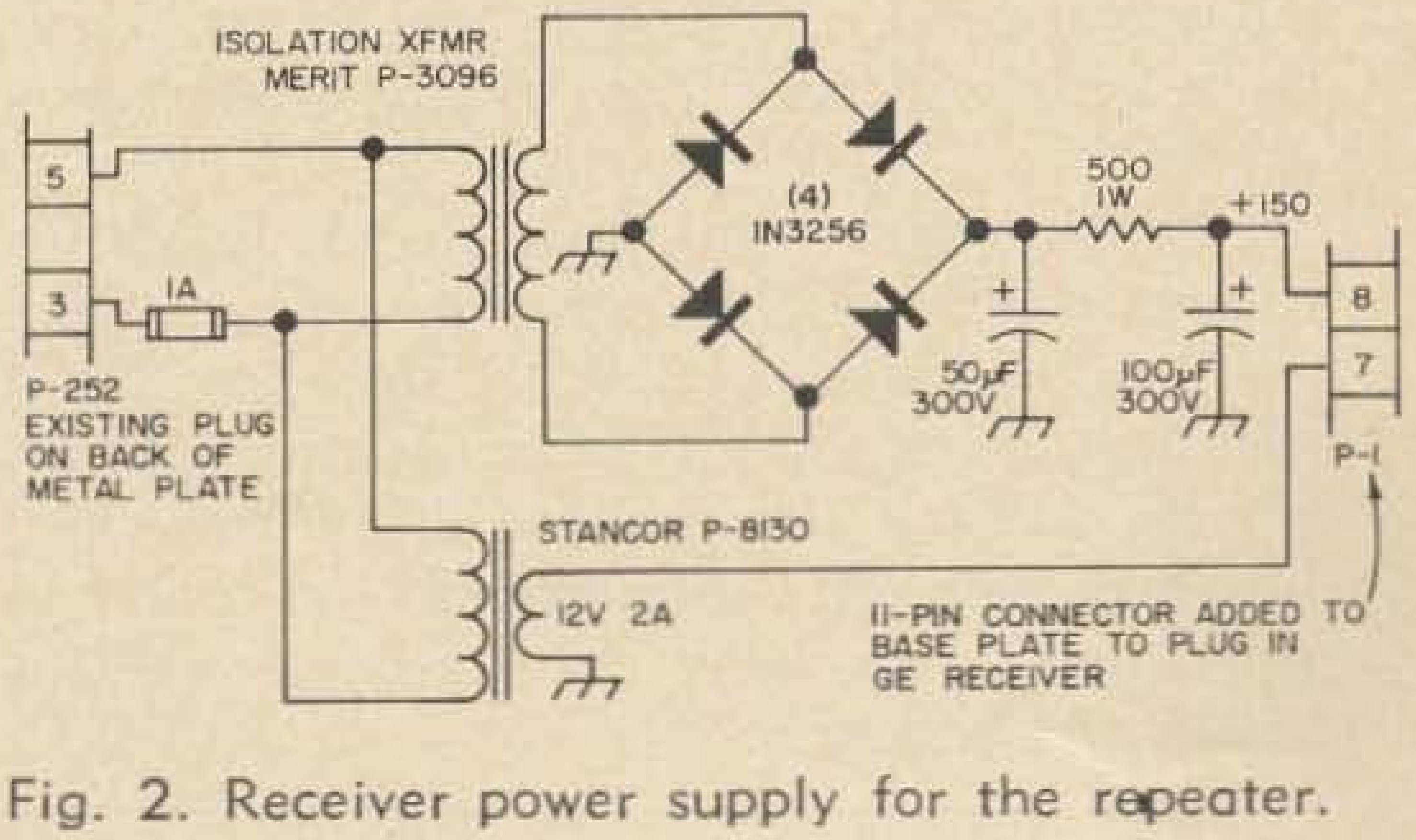


Fig. 2. Receiver power supply for the repeater.

about 200 mA as indicated by a 2 V reading on the VTVM. After each loading adjustment is made adjust final plate tune for minimum.

Insert VTVM in BAL JKS and alternately adjust PA grid tune for balance as indicated by zero reading VTVM. The transmitter should be putting out about 30 watts. Placing the tune-operate switch in the operate position should allow the transmitter to put out full power.

Receiver Conversion

The receiver supplied with the FRC-27 is the R-394-U. This receiver has been the greatest single cause of unsatisfactory performance in the repeater, and was finally discarded in favor of a more reliable unit. The receiver found more adaptable was the G E progress line 4ER25D. This is a double conversion unit built in two models. The 4ER25D1 will cover 144 to 152 MHz and will operate in the two meter band with no modification to the tuned circuits. The 4ER25D2 operates in the 152 to 174 MHz range and will require a 5 pF capacitor connected across the first RF and antennas coils.

The B-394-U chassis should be stripped of all metal work leaving only the base and upright back plate. All wiring and plugs are removed except for P-252 on the rear plate. The receiver is mounted on its side supported by 2" spacers as shown in the photograph. The power supply and filament transformers

Two Meter Cavity Preamplifier

Here's a high-Q cavity and transistor preamplifier to add selectivity and gain to the front end of your receiver. The cavity has about 20 dB of gain and is very useful if the repeater is located very far from the antennas. It can be seen that the junction of the transistor will look like a very low resistance to any power coming down the receiving antenna, and were it not for the cavity filter the transistor would be destroyed by the rf from the transmitter. It is for this reason that the cavity must be built with the highest possible Q.

The cavity is somewhat shorter than optimum, but it is very effective in providing the desired selectivity. It is made from a 7" section of 4" brass pipe. The center conductor is a 6½" length of 1¼" copper pipe. The best source of supply for this stock is a local plumbing contractor. These lengths are too short for his needs and he will probably sell them to you as scrap.

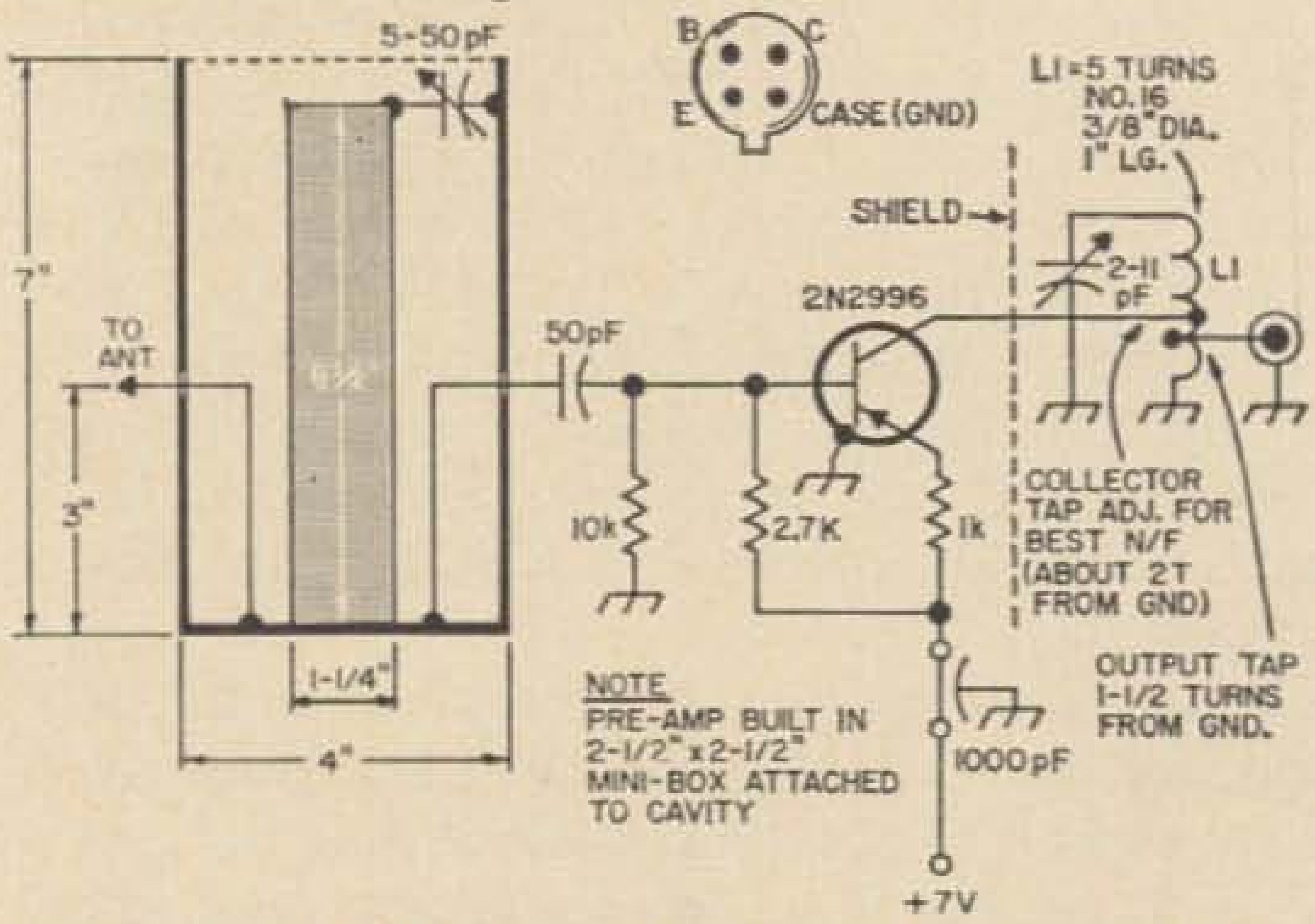
First make the end plates from sheet copper and cut a 1½" hole in the center of one to accept the center conductor. Solder this all around the pipe as this is a high current spot and must have very low resistance. Next bend two pieces of #12 bare copper wire for the pick up loops. Drill holes on each side ½" from the center conductor.

At this point you must decide whether to use the transistor pre-amp or not. The receiver will detect a .5 μV signal with 20 dB of quieting, and it will provide excellent results without the pre-amp. The pre-amp, however, should be used if you plan to use a very long coax line between the antenna and receiver.

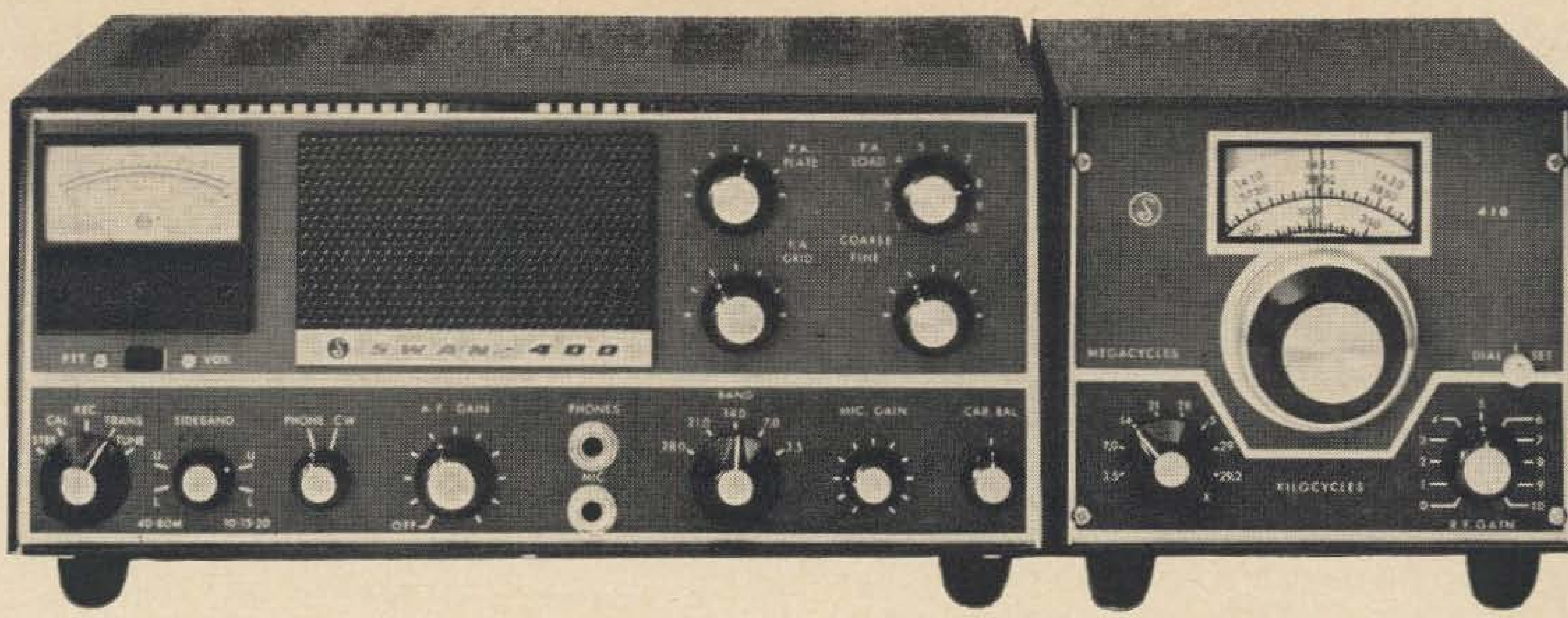
Now punch two holes in the brass cylinder to accept two female type N chassis type coax connectors. If you want the pre-amp, one of the connectors can be a feed through insulator to feed the base of the transistor. Solder the wire loops to the coax connectors, and attach them to the cylinder. The wires will stick out the bottom.

Now slide the base plate over the pick up loops and solder the plate to the cylinder. Solder the loops to the bottom of the base plate. Install the tuning capacitor at the top and you're ready to go. After the cavity is tuned, you can solder the top plate to the cylinder.

The pre-amp showed the best NF with about 6 to 7 Vdc. To tune up the cavity and pre-amp, connect to your receiver and tune the cavity and pre-amp for maximum output with a weak signal. A noise generator will allow the optimum adjustment of the collector tap, but this is about two turns from the ground end.



Simple coaxial cavity and transistor preamplifier. The emitter should be bypassed to ground with a 1000 pF capacitor.



SWAN 400 SSB TRANSCEIVER

FIVE BANDS-400 WATTS

So often when thinking of investing in a mobile rig, the thought occurs that it will have to be a cheap outfit, without many of the excellent features of the home station. Can't afford two rigs like the home station, you say? This may be true, but when you have the combination that is designed for the job, the home station can be the mobile station, too, and the changeover simply a matter of moving the transceiver and VFO from the house to the car.

The SWAN 400 and its components fit together conveniently for this type of service. With the basic 400 you can operate as a fixed station using Model 410 VFO (for ham bands) and/or Model 405 MARS Frequency Oscillator (5 pre-set and locked channels on any 5 frequencies in the MARS allocations), both attached to the 400 at the same time through an adaptor on the back of the 400 that has a switch for changing from one VFO to the other, and both VFOs are kept warm so long as the 400 is "on". If you have the means of supplying the home station from a DC source such as batteries, gas generator or AC inverter (and a DC source for the home station is a mighty useful item in an emergency), you would need only a DC power supply for the SWAN 400, and could put both the Swan and the power supply in the trunk of the car, connect them with the cables from the VFOs under the dashboard, Model 406B Mobile VFO and/or Model 405 MARS, using the RC-2 remote control assembly, and be ready for business as completely as if you were in the house, taking very little space in the front seat area of the car.

How, you ask can I latch on these gems? Nothing could be easier: Pick up the phone and call us and let's talk it over . . . or drop us a line and tell us what kind of a proposition you have in mind.

Swan 400	**$420.00**
117-XB AC Power Supply	**75.00**
14-117 500 Watt Mobile Power Supply	**130.00**
Model 410 VFO	**95.00**
Model 406B Mobile VFO	**75.00**
MARS Oscillator Model 405	**45.00**
Dual VFO Adapter Model 22	**25.00**

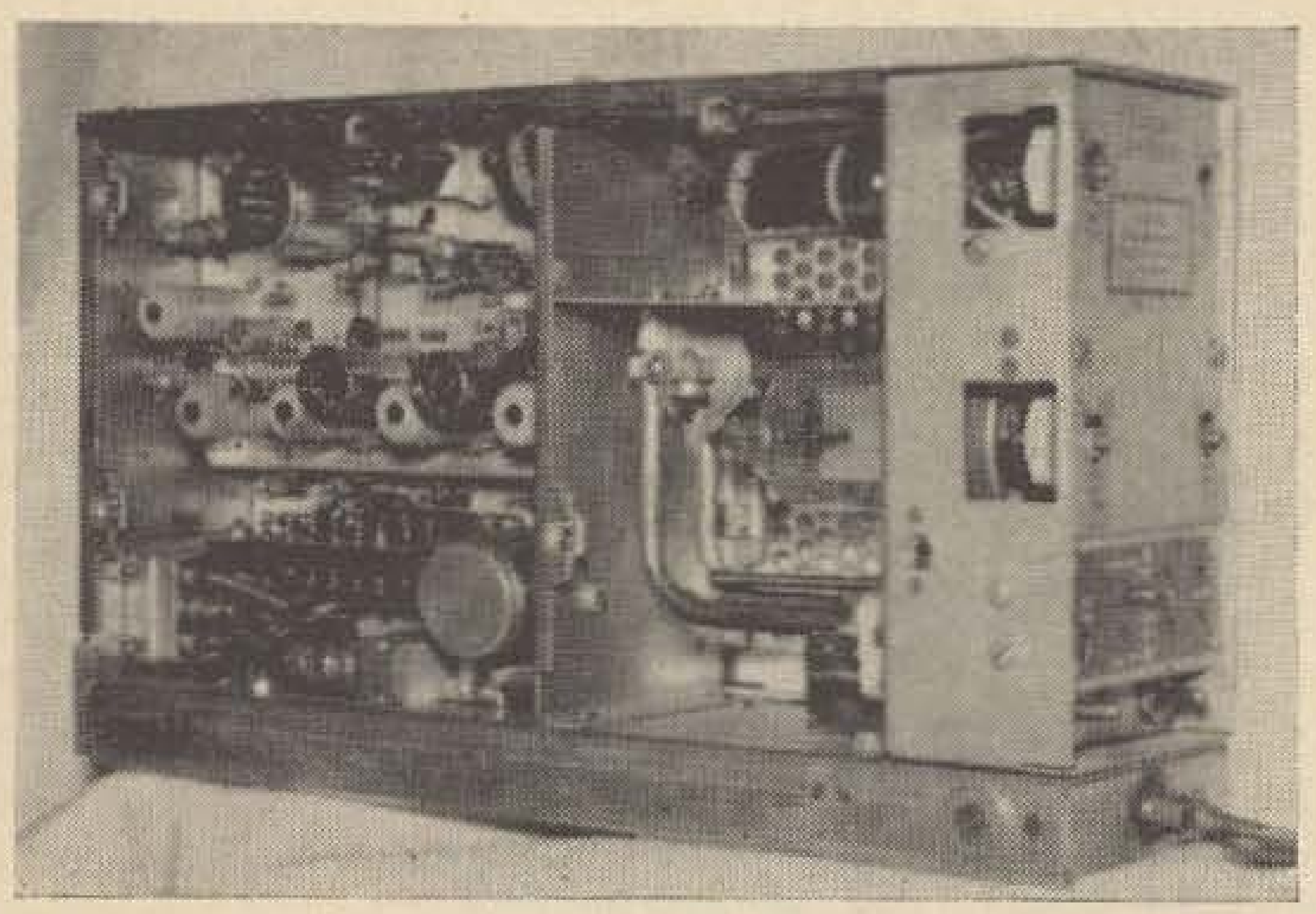
Adirondack Radio Supply

Ward J. Hinkle, W2FEU, Owner

185-191 W. Main St., Amsterdam, N.Y. 12011, 518-842-8350

are visible mounted on the base plate. Punch a hole in the base chassis and mount a 11 pin socket (P1) so that the receiver power plug can be connected. A small power supply, delivering 12.6 V ac and 150 V dc can be constructed to furnish power to the receiver as shown in **Fig. 2.** It is suggested that this be constructed on the receiver chassis base plate. By carefully orienting the transformers, the parts can be fitted. The voltages are now fed to P1 on the base. There are many variations of transformers but they must be small. Most any 110 V 40 watt isolation transformer will work. On the front of the base assembly between the four small holes that were used as the old receiver test points, mount two miniature pots, 10 kΩ for the squelch and 100 kΩ for the volume. Connect these to P1 as shown (**Fig. 3**). The receiver has a provision for a second crystal using one half of the 12AT7 as oscillator. This half of the tube is not needed, and for repeater service is wired to key the PTT line in the transmitter. Build the circuit as shown in **Fig. 3** using the unused half of the 12AT7. The frequency 2 lead to the power plug can now be used to connect the PTT line to the transmitter as shown. The frequency 2 lead is the middle lug on the three lug terminal strip next to the oscillator tube (lug 2 of TB 15). It can be seen that a small positive voltage on pin 5 of V-311 will cause tube V-314 to conduct. This current will hold the keying relay operated. A received signal causes pin 5 of V-311 to go negative and this cuts off V-314. This in turn will release the relay and ground will be applied through the now closed contacts of the relay. This ground will now key the transmitter. Audio from the receiver is fed through plug P1 to the FM modulator.

The receiver will require two crystals; one



The transmitter is shown with one side removed. The 5894 final amplifier can be seen with its quarter wave tuned lines. The oscillator and multiplier stages are in the rear compartment at the left.

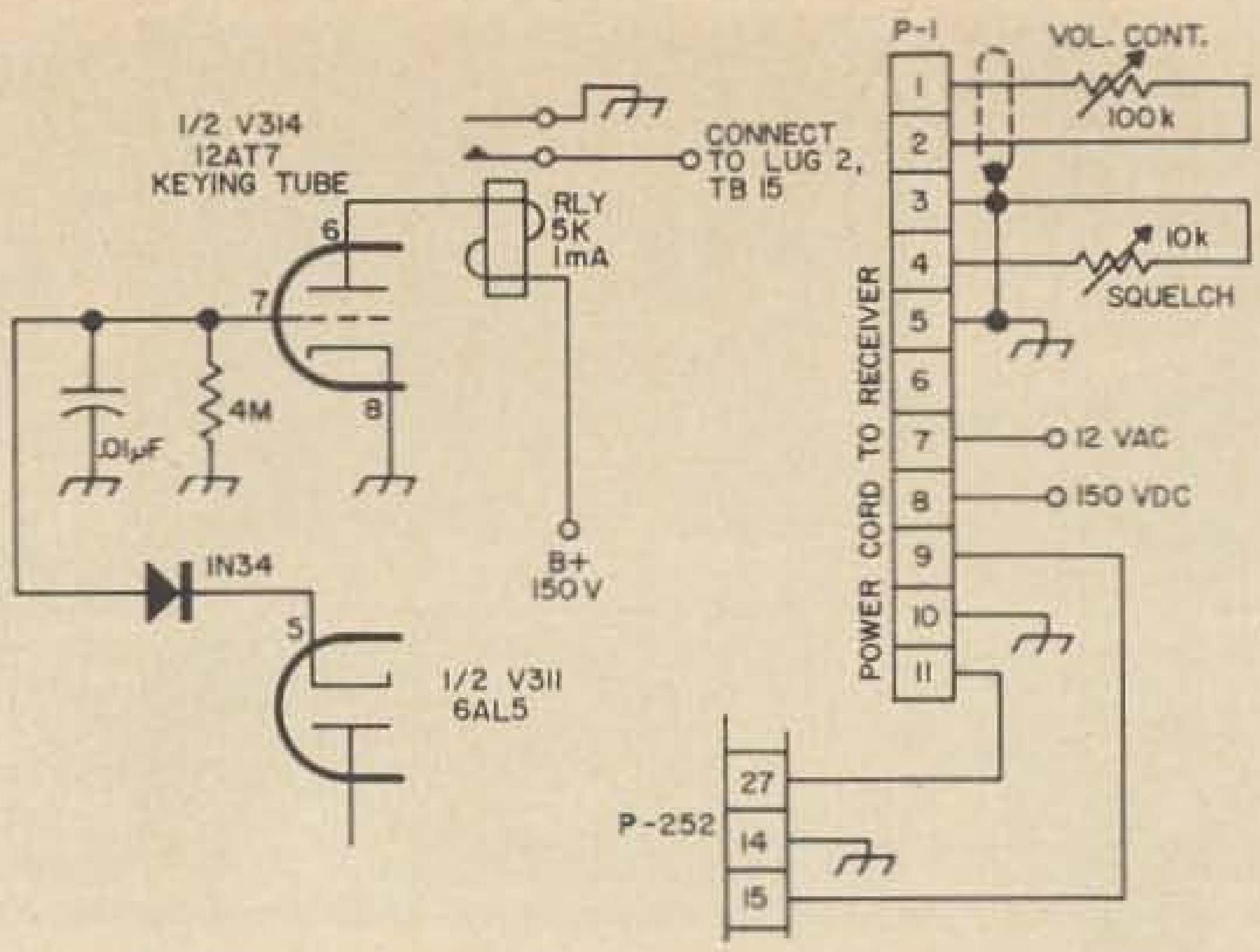


Fig. 3. Transmitter keying tube and control circuits.

for the high frequency oscillator and the other is used as a transmitter frequency suck-out crystal to place a low impedance path to ground at the transmit frequency. This crystal connected in this manner prevents the receiver from being overloaded and thus desensitized by the strong transmitter carrier. To figure the high frequency crystal use the formula below.

$$\text{crystal frequency} = \frac{\text{operating frequency} - 8.7}{12}$$

for a receive frequency of 143.46 this would be 11.23 MHz.

The transmit frequency eliminator crystal is shown in **Fig. 4.** This crystal was ordered from International Crystal Company, Oklahoma City, Oklahoma. They are familiar with this. When ordering this crystal give the following information: *Example:* 143.95 MHz third overtone crystal—This crystal will be connected from grid to ground of the 6AK5 rf amplifier in a GE 4ER25D receiver to eliminate a strong transmitter carried on 143.95 MHz. This receiver will be tuned to 143.46 MHz and a high Q coax cavity will be inserted between the antenna and receiver. This crystal is to prevent the receiver from being desensitized by the 143.95 MHz transmitter. This crystal should be ordered with wire leads. The cost $6.90.

Connect this crystal in the antenna coil can across the rf amp grid coil as shown in **Fig. 4.** On using this crystal in this manner, it can be seen that any power present here will destroy the crystal so be careful. This crystal is not guaranteed in this application but if installed and operated as shown, no problems should be encountered.

Install a phono type plug on the antenna coax that goes to A2 of P-252. This will plug into the antenna jack on the receiver. The fuse in the receiver can be mounted in the base at any convenient spot. The 0.1 μF capacitor and 4 MΩ resistor in **Fig. 3** act to hold the transmitter operated for about 1 second after the 143.46 MHz signal is gone. This was done to prevent the rapid flutter so common in two meter mobile communications from causing the repeater to chop.

Turn power on to unit and check for proper voltages. A signal generator and a vom of at least 20,000 ohms per volt is needed for alignment. Connect signal generator to P-1901 on back of cabinet and tune generator of operating frequency of receiver.

Use a 20,000 ohm/volt meter with one lead to ground and connect the other as directed:

Connect to	Adjust	Required Reading
OSC	Top OSC Coil Maximum	1.3 V
MULT	Mult Can Top and Bottom	Maximum

Feed 143.46 MHz signal at the antenna jack —increase level till LIM 1 shows indication—

LIM 1—Mult 2 both capacitors
RF amp both capacitors
Ant top and bottom

Repeat all adjustments (except oscillator coil) until required sensitivity is obtained. (Requirements .5 μV for 20 dB of quieting). With a known accurate signal at 143.46 MHz adjust the oscillator crystal frequency adjust capacitor for zero reading when meter is connected to the discriminator. This completes the receiver alignment.

Final adjustments

Remove the back cover of the FRC-27 and make the following connection to the terminal strips:

TB-1901	Connect terms	6-7
	Connect terms	8-10
	Remove wire between	2-3
TB-1902	Connect terms	2-3
	Control Unit C 844U	
TB-701	Connect terms	2-3
	Remove wire between	1-2

This completes the conversion and it is only necessary to set the levels of transmis-

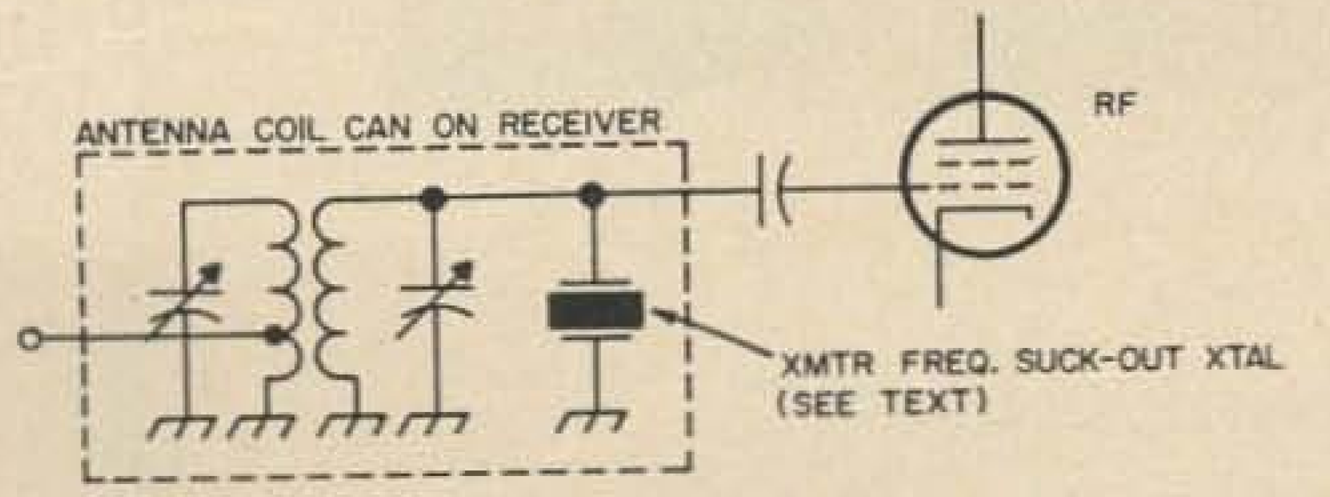
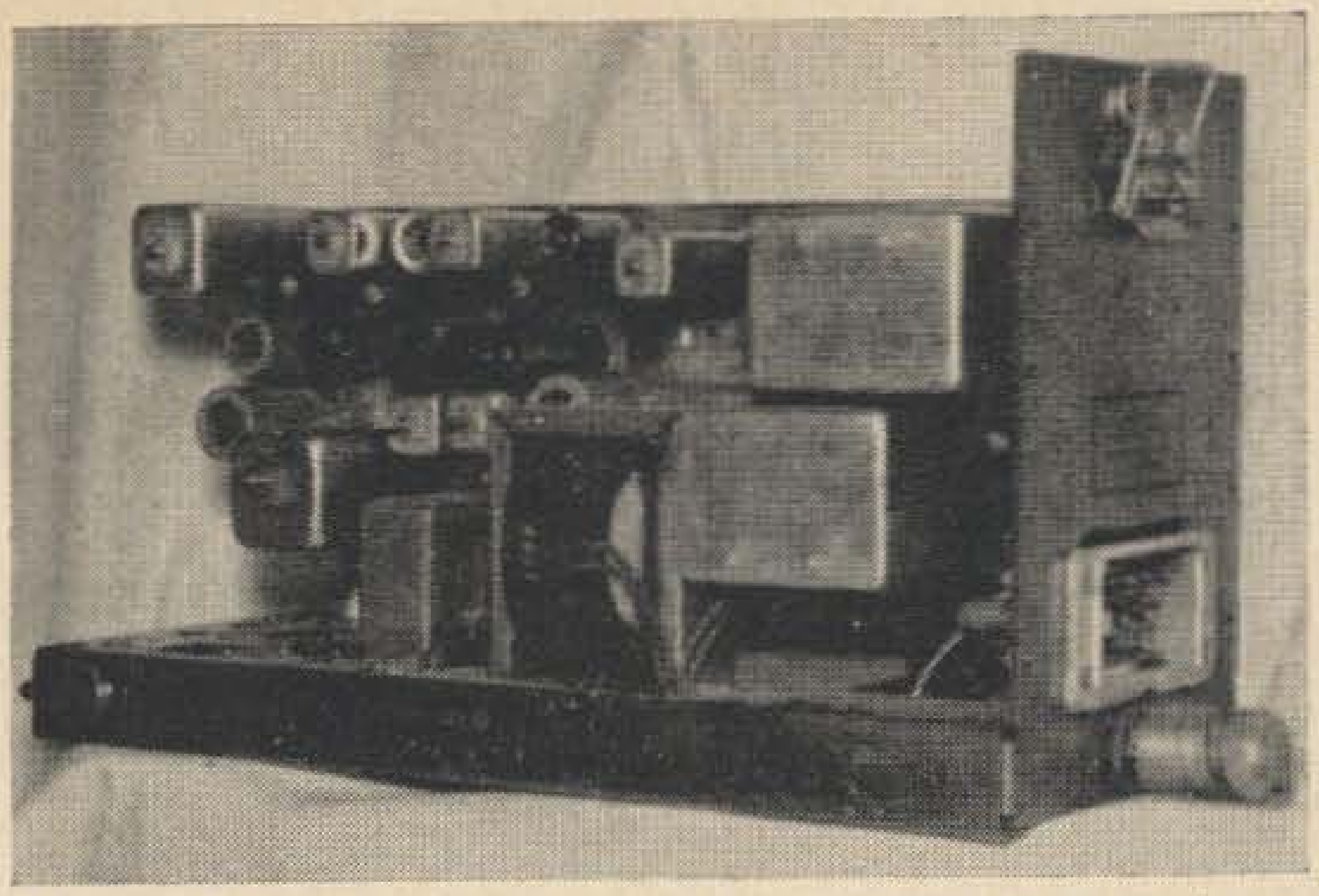


Fig. 4. Connection of the transmit suck-out crystal.


The modified GE receiver is mounted on its side so it will fit on the existing chassis. Plug P252 is shown on the back and the filament and plate transformers are visible mounted on the base plate.

sion. There will be three controls in the audio line: receiver volume, L pad in control unit and deviation control in the transmitter. As a guide to start with, keep the receiver level low as this will lessen the noise level on the transmitter audio. The L pad is a very effective impedance matching device and when used with the deviation control, it should be possible to get full deviation on most all levels of input signal. The squelch control is adjusted to the point where noise does not trip the repeater.

The antennas used here are stacked horizontally polarized big wheels separated by about twenty feet between transmit and receive.

The work in building this repeater was not done overnight and many hours of cut and try and looking into problems in other repeaters were necessary. We feel this has paid off, however, in the quality of retransmission and dependability we have obtained. The repeater at Houston is located on the KPRC-TV tower (1400 ft.) and excellent mobile coverage is obtained up to 60 miles radius. Base stations work out about 150 miles and farther in some directions. I am located 220 miles from Houston and can use the repeater most of the time.

I have worked San Antonio through the repeater on many occasions which is in excess of 400 miles from Tyler.

The holdover of the receiver gives me a constant check on the band conditions as I can listen for the repeater to drop out.

This repeater project was built by AFCS Air Force MARS people to operate on two meter MARS frequencies, and plans call for 23 of these repeaters to cover ten states in the Central United States. At this time four units are operational with five more near completion. These units were built according to these instructions, and all have worked properly.

. . . W5KPZ

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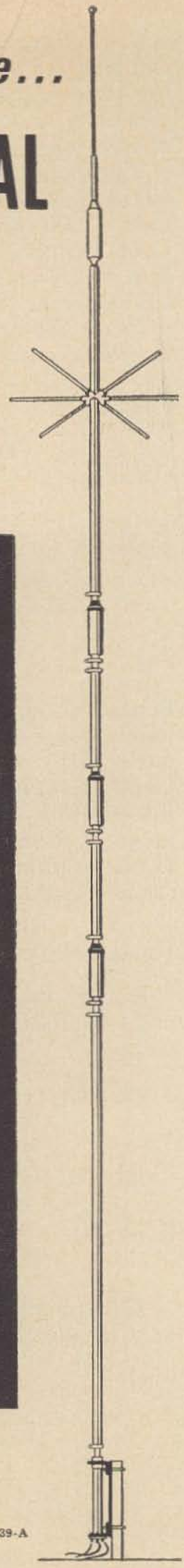

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E. M. G. Rankin W4ZUS
140 Kensington Dr.
Brunswick, Ga. 31520

Complete Overload Protection

Here's one of the more original schemes we've seen recently.

Here is a circuit that offers much for all builders and nuts that dream up rigs that are as well engineered as the state of the art. This circuit offers complete overload protection for the whole rig (including output, temperature, and VSWR as well as the more common current protection) with one, or at the most two, relays. As many sensors as wanted may be included.

The basic circuit (see **Fig. 1**) uses a silicon-controlled rectifier, or SCR, that semiconductor equivalent of the thyratron. Whenever the gate current exceeds the threshold the SCR saturates and remains conducting until the anode circuit is opened. When the SCR fires, K1 is actuated and can open the PA cathode circuit, operate a heavier relay, light an indicator lamp, or any other desired function.

With this basic actuator circuit you can use any or all of several sensors. The only requirement is that the sensor develop a few volts positive. With the unmarked junkbox SCR I use 0.2 MA of gate current, 2 volts across the 1 k gate resistor causes the SCR to fire with 10 volts on the anode (stolen from the filament transformer).

For plate current protection a 5 ohm resistor (of suitable wattage) is put between ground and the PA tube cathode (or in the B-return of the PS). For 1 ampere of plate current 5 volts are developed. (See **Fig. 2A.**) Using about 5 k for the adjusting resistor "R" you can set the voltage to the gate for any value at the predetermined plate current (for me it trips at 800 MA).

Screen protection is provided by monitoring the current drawn by the shunt screen regulator, a string of 10 watt zener diodes in my rig. (See **Fig. 2B.**) As screen current increases the regulator current decreases equally. By placing a small resistor in the ground return of the regulator you can pick off a couple of volts. Here a transistor (PNP) is used to get a phase reversal, rising positive voltage for decreasing regulator current. A blocking diode is

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Mick is an Electronics Technician Senior Chief in the U. S. Navy. He has taught electronics courses in the Navy, enjoys building and ragchewing. He's now stationed on the USS F. D. Roosevelt.

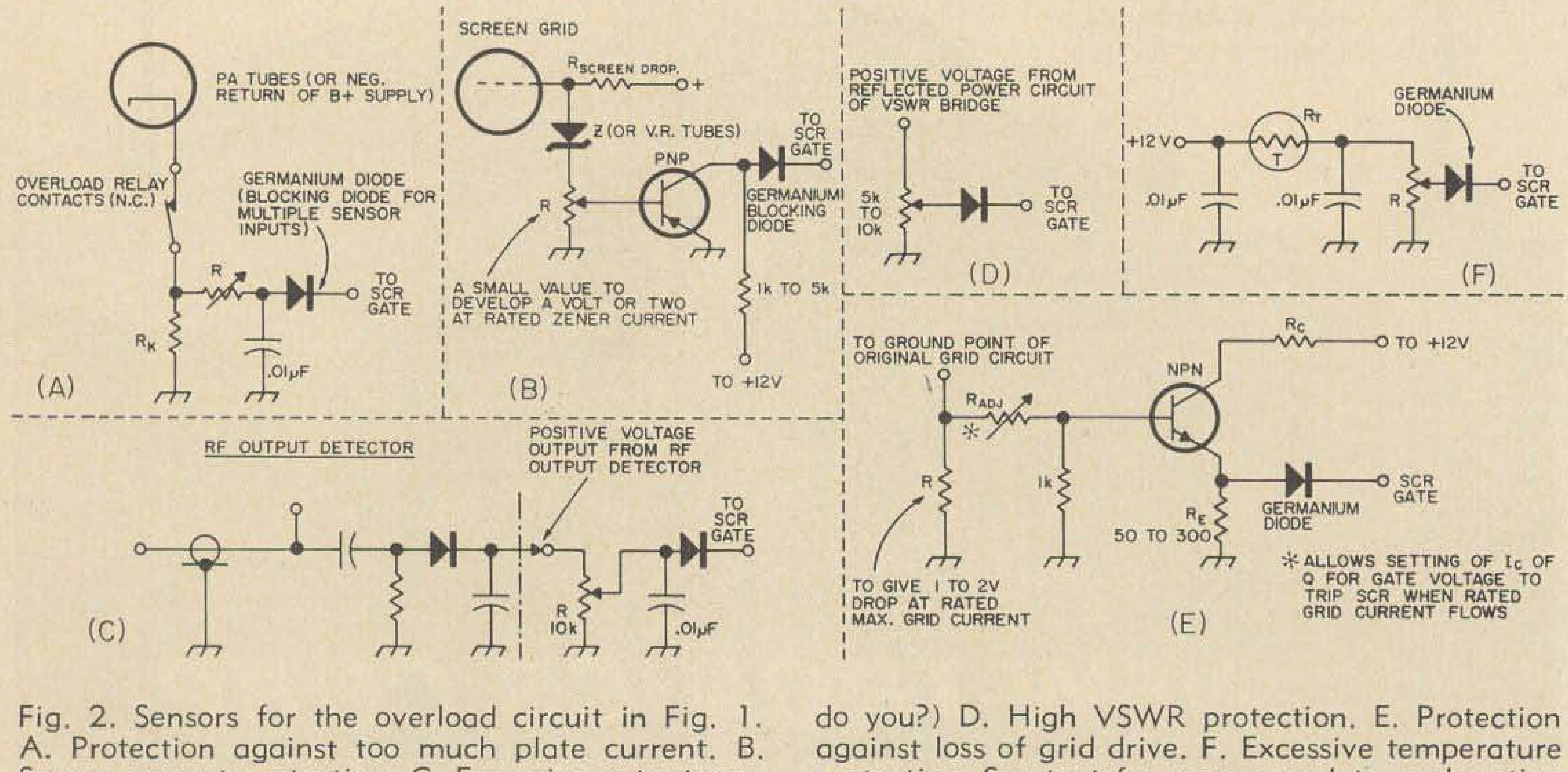


Fig. 2. Sensors for the overload circuit in Fig. 1. A. Protection against too much plate current. B. Screen current protection. C. Excessive output protection (You don't want to exceed the legal limit, do you?) D. High VSWR protection. E. Protection against loss of grid drive. F. Excessive temperature protection. See text for more complete explanation of these circuits.

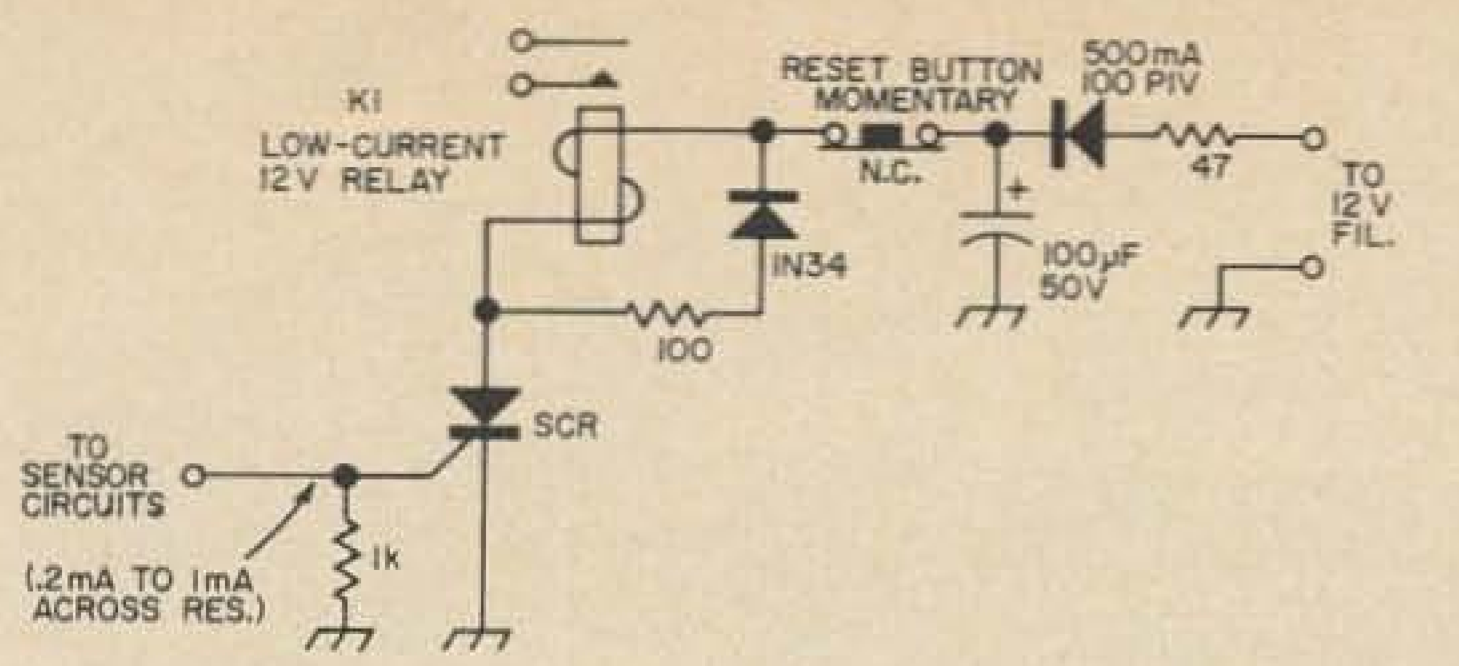


Fig. 1. Basic circuit for overload protection. This SCR and relay will turn off your transmitter (or ring a bell) when almost anything goes wrong with your station. See Fig. 2 for examples of sensors.

used on this (as well as on all the other sensors to prevent interaction between the inputs). Adding the few ohms of resistance in the screen regulator won't affect the regulation by more than a percent or so.

By using an output rf voltmeter diode circuit you can set a safe maximum power output level and protect the tubes from excessive power (or keep from running illegal power!) See **Fig. 2C.**

Another outstanding protective circuit can use the reflected power output from your VSWR bridge (positive diode polarity) to remove power in case of a damaging high VSWR. This could save a PA stage if an antenna or coax fails (or in my case if I patch the wrong antenna into the rig). See **Fig. 2D.**

Grid current can be likewise monitored, again using a transistor (NPN) to get the proper sensor output signal. See **Fig. 2E.**

Another important function can be monitored by using a thermistor of the proper temperature/resistance characteristic in a voltage divider circuit. Placing the thermistor close to the tubes or in the exhaust air stream will let the monitor keep watch on those precious bottles and shut things down before the plates melt or the seals rupture. See **Fig. 2F.**

You can probably dream up several other circuits for different applications. Using a microphone and audio amplifier with a rectified output the telephone bell or the XYL's last chow call will terminate transmission effectively.

One important point: These circuits must be carefully bypassed and shielded in most cases to prevent rf pickup and rectification by the sensors and/or the SCR.

Try this one relay, multi-function overload protector and I think you'll have as much fun and get as much peace of mind as I have. It works, smoothly and positively, is cheap and small. Its applications are limited only by your imagination.

. . . W4ZUS

Ken Cole W7IDF
P.O. Box 3
Vashon, Wash. 98070

Heathkit HM-15 SWR Meter

If you have a ten dollar imported SWR meter and like it, as I do, you may wonder if a few bucks extra for the Heath HM-15 can be justified, as I did, but you may not have an opportunity to try them side by side, as I have. (They won't measure prepositional phases, so they won't really work in parallel.) Some of the Heath meter advantages that impressed me are reflected below.

Terminating resistors are supplied for both 72 and 52 ohm operation—a worthwhile provision. To change from one to the other requires removal of the chassis from the cabinet and application of a soldering iron, but this takes only a couple of minutes, and it isn't something you would do very often. The change could be made by switching, but the instant convenience gained would be too expensive in terms of added capacitance, asymmetry and associated problems which would have to be solved. It's nice to have the two impedance ranges simply and cheaply.

Some HM-15 Specifications

Operation: Indicate percent of forward and reflected power, and voltage standing wave ratio.
Power Handling Capability: One kilowatt of rf.
Impedance: 50 or 75 ohms.
Frequency Coverage: 160 through 6 meters.
Meter: 100 microamperes.
Dimensions: 9¼ x 3⅝ x 2⅝ inches.

The cabinet is attractive, stiff, and designed to sit prettily atop your transceiver—rubber feet on the bottom and coax connectors in the back. For mobile operation the HM-15 takes little room under the dash, and if it is mounted with screws through the cabinet top you can remove the chassis in about thirty seconds by unscrewing the two self-tappers on each end.

Besides being fun, kit-building is a relatively painless educational experience, and this is one kit you really can assemble in an evening. In fact, you can put it together, squirt your transmitter through it, check the SWR, test the surplus lengths of coax on hand, confirm the non-reactive behavior of your dummy load, roundtable for an hour (while you watch the HM-15 for evidence of carrier non-suppression) and still beat the kids to bed.

The manual is a useful bonus. A thoughtful effort has been made to explain clearly the theory and operation of SWR meters. With two charts and a couple of pages of text the manual makes the most of the benefits offered by the put-it-together-yourself approach. The limitations as well as the capabilities of SWR meters are noted, and the comments may leave you with an irresistible urge to dig out 73 articles on the taming and feeding of antennas. All to the good.

At $14.95 the HM-15 is one of life's inexpensive necessities.

. . . W7IDF

1966 Eico Catalog

Eico's new 48 page catalog illustrates and describes their complete line of more than 250 products, including amateur radio equipment, test instruments and stereo hi-fi components. Copies of this new catalog are available free from Eico Electronic Instrument Company, 131-01 39th Avenue, Flushing, New York.

Creative Electronics Fabrication

If you like to make professional-looking electronic equipment, this new book by Owen Patrick should be of interest to you. The title is *Creative Electronics Fabrication* and it's published by Holt, Rinehart and Winston. Virtually all electronic construction techniques that the amateur could need are covered. You can order a copy through your local bookshop.

Radio Products Sales' Catalog

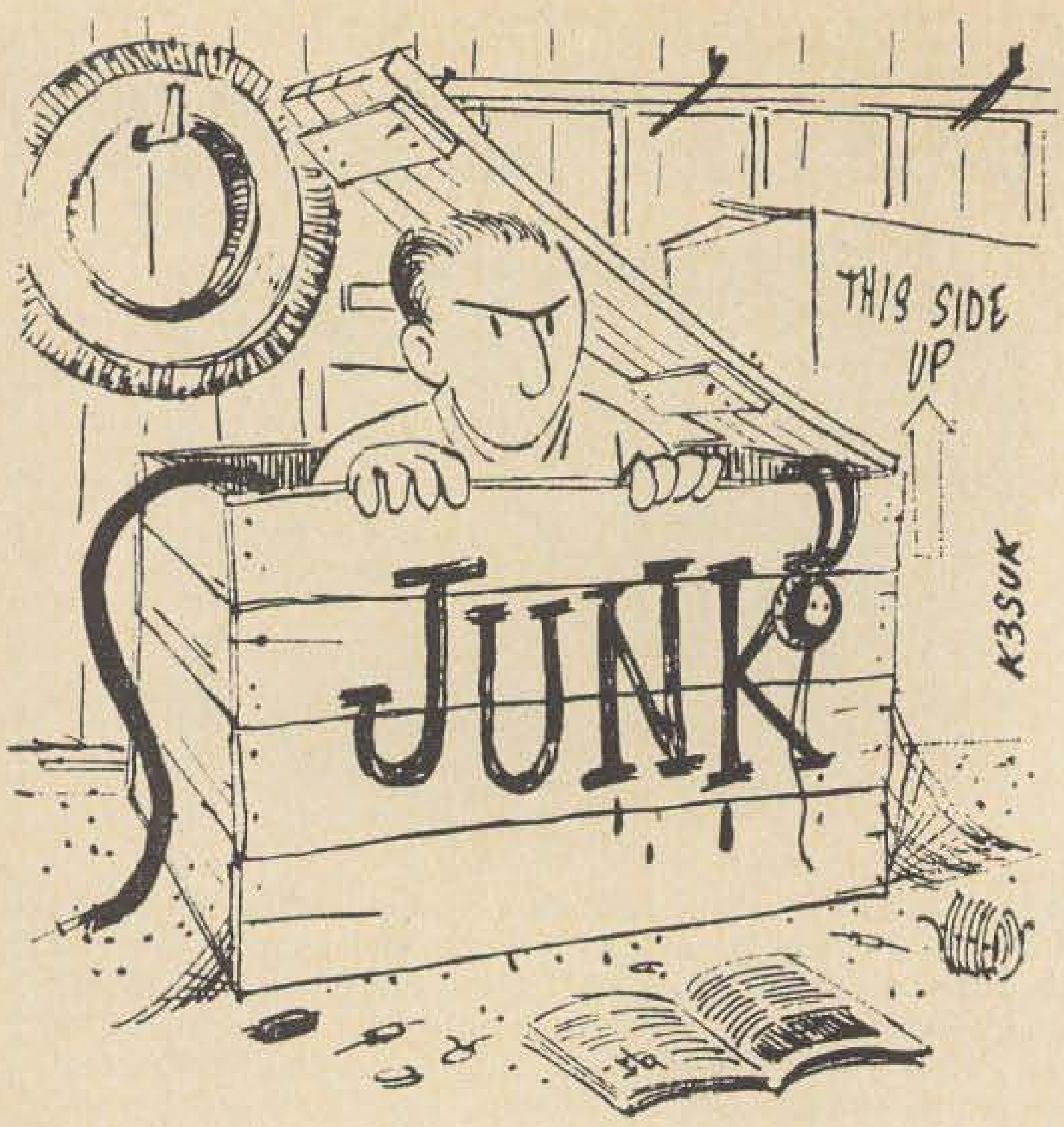
Radio Products Sales Inc., has just announced a new 300-page catalog of electronics parts and equipment. This new catalog covers a wide variety of electronic components from 86 leading manufacturers and is of considerable use to amateurs and electronics engineers. It is thoroughly and accurately indexed for easy reference, profusely illustrated and where applicable, contains industrial net prices. These new catalogs may be obtained by writing to Radio Products Sales Inc., 1501 South Hill Street, Los Angeles, California 90015.

Electronic Design Charts

Most hams seem to like to avoid using mathematical formulas and equations as much as possible, but if they do much experimenting and designing, they have to figure out many things. Graphs and nomographs are one way to find specific values for components and other electronics quantities without much math. Norman Crowhurst's *Electronic Design Charts* contains 59 useful charts that will help you design many circuits and networks. It's bound in a very convenient loose leaf fashion with complete and clear explanations and examples for each chart. Cost is $5.95 and you can buy a copy from your distributor or Gernsback Library, 154 West 14th Street, New York, N.Y. 10011.

1967 Lafayette Catalog

Lafayette's new catalog is now available at no charge. You're already familiar with them and know that it's something you'll have to have, so why not send for your copy now? Lafayette, P.O. Box 10, Dept. PR73, Syosset, N.Y. 11791.



Merritt Franken WA6JNI
3714 Mound View Ave.
Studio City, California

A Pox on Your Junk Box

Been a ham now ten or twelve years or so, give or take a bit. It all happened when I had the dubious fortune to meet Wayne Green in the living, quivering flesh. Exposed to his torrent of talk it wasn't long before I went the way of so many others and there was the code oscilator and the hand key and the books and the butterflies in the stomach at the thought of taking the test. So here I am, a decade or so later, duly licensed, poorer by several thousands of dollars, richer by a number of ham-met friends and sizzling with a long-smoldering peeve.

The peeve? Easy. It's this junk box jazz I keep reading about.

Almost the first thing I noticed when I started reading ham magazines is that they all seem to be liberal in referring me—or any other reader—to the junk box. Building an antenna, That little plastic dimity you need is bound to be in your junk box. Whacking away at a speech compressor? That capacitor you need to make your next contact think your audio sounds like the squeaks of a lovesick porpoise is in your junk box. Right on top if you'll look carefully. Etc. etc. etc.

Oh, I have a junk box, all right. Matter of fact my wife (she's a ham too and truth be known beat me to it in getting the general ticket) says I have junk boxes all over the place. In several drawers in the shack desk. A clutter in the workshop. Boxes of moldy goodies in the garage. I often wonder how come and why the XYL became a ham but it seems damn sure to me that if she hadn't there'd have been a divorce in these parts for sure.

So the other day I got to thinking about the junk box. What started me was that several articles I'd just read, each of which said the whole project would cost about 38¢ and even less if I took recourse to you-know-what, had led me down the primrose path again. As a result, I now have, in various stages of non-completion, a variety of junk box projects, including a 40 meter QRP cw rig, a transistorized keyer and a couple of others I'm too irritated to mention. What happened in each instance is that my capacious junk box wasn't capacious or junky enough and by the time I finished pricing out parts I needed I could have bought my wife a dress (as she often reminds me) or paid for a week's vacation or maybe gone to a local ham emporium and bought the thing to begin with.

That's when I came to my Big Decision. I was going to breadboard The Project, right out of my own junk box. Just start out easy and see where it led. First thing I needed was a breadboard. No problem. We got a beaut from some travelling friends a year or so ago. They sent it to us from Africa and the fact that it was ebony didn't make any particular difference to me. Next, start mounting components. That beautiful butterfly variable would look real nice in the lower right hand corner. I got that little goody when I made an ill-advised trip to a surplus joint and if you remember, the poet said, "A butterfly capacitor is a thing of beauty forever"—or words to that effect.

Next came a series of resistors, or vice versa. Got those as a going away gift from a friend when we moved to California from New York. In the hundreds of times I've needed resistors since then I've never been able to find anything even close to the sought after value in the whole batch, so might just as well get rid of them.

All sorts of goodies followed in quick succession. Some diodes I got because I thought I could use the little plastic boxes they came in; couple of transformers, one of which was painted forest green to serve a better purpose as a door stop; tube sockets; my original hand key; the first 807 to go flat in my fondly-remembered Harvey-Well TBS50D. There was still some room on the ebony breadboard so I covered some of the space with some of my old K2KEH (my New York call) QSL's I'd saved for sentimental reasons and in the remaining space I mounted some SO 239's because they looked so pretty.

That's when the XYL marched in. Neither of us said a word but I started hearing a sizzling sound and that puzzled me because I hadn't turned on the B plus. The sizzle got louder, like tube noise only more so. It stopped only when she spoke:

"What's that?" said she.

"I'm not sure," said I, "but I think it may work out to be a miniaturized digital computer. Maybe in color."

"Is that my good bread board?" said she.

"It is," said I.

"You mean it was," said she.

"Yes," said I, and now I was getting that little scary feeling that says to all married men, "Look out, chum, there's domestic QRM upcoming."

"Isn't silver an excellent conductor?" said she—a little out of sequence I thought.

"Yes."

"Then why don't you take the good sterling," she said sweetly, "and hook up all the components with it. And you can use the good china for insulators, while you're at it."

And she walked out of the room. The sizzle was S9 plus.

She came back home from mother's a few days later. She had only one suggestion for me. "If you're going to breadboard something from scratch," she said, "why don't you really start from scratch? Like go out to begin with and get me a brand new bread board."

So I went out and bought an axe and now I'm looking for an ebony tree. Africa, anyone?

A pox on your junk box.

. . . WA6JNI

Vester Scott KØEFC
2229a Marconi Street
St. Louis, Mo. 63110

Electronic Drafting for the Ham Writer

Even if you aren't a ham writer you'll find this article interesting.

It is an indisputable fact that successful communication, in even the broadest sense, is dependent upon three vital factors which are coincidentally related to amateur radio.

The first of these factors is the transmitter, or a person who speaks, writes, or in some way seeks to communicate. Here we may make an analogy to 73's authors, who are among the finest in amateur radio writing circles.

The second requirement is the receiver, or listener, or in the context of this article, the reader. Most of us read an amateur radio publication for the express purpose of educating ourselves in one way or another. No problem here, unless. . . .

Scottie is 73's main draftsman. He's the one who gets the credit for most of the excellent drawings we publish. Long time readers of 73 will notice the great improvement in layout, consistency, attractiveness, completeness and accuracy in Scottie's work over earlier drawings. Aside from his work for 73, Scottie is a design draftsman for the Security Fire Door Company of St. Louis.

You guessed it! Unless we use the wrong *third* factor, the *code*. It is essential that this code be a language which is mutually understood.

Lest I be set upon by a battalion of irate 73 authors and hanged from the corner of my drawing board, let me hasten to explain that the primary purpose of this article is to explain the standard drafting symbols and methods used in 73 and many other electronics magazines such as 73. A welcome by-product would be the successful stimulation of any potentially good but currently latent writers who hesitate to submit articles because they fear their drafting ability is not up to par.

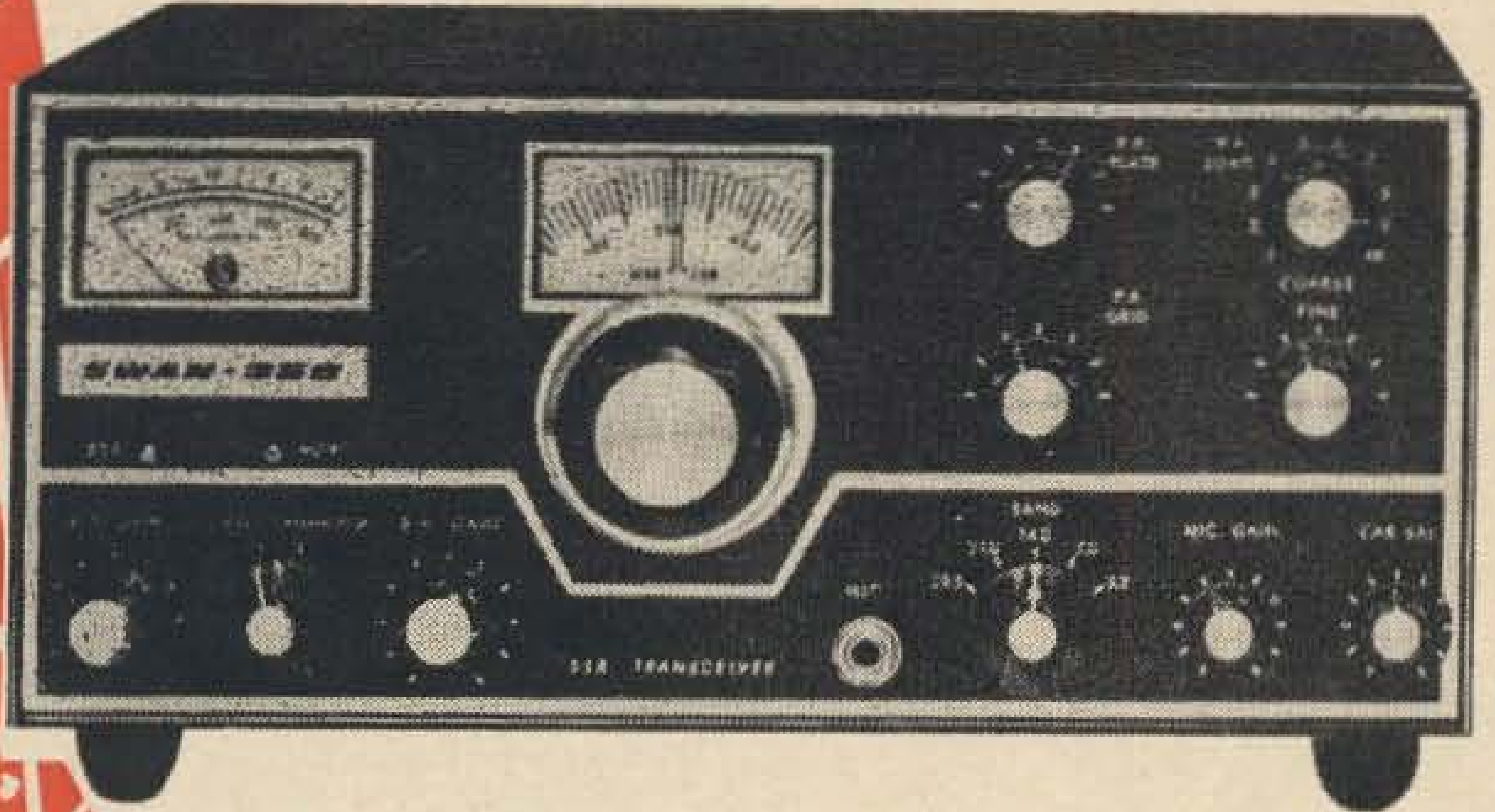
Many of us, I am sure, read 73 and build according to the schematics without giving much thought to what goes on behind the scenes. We probably concern ourselves but little about the fact that the author's original sketches might have looked somewhat different from the drawings which appeared in the magazine. This is common, the reason being that the staff artist is governed by strict policies of the magazine concerning space and shape requirements, and standardization of drafting procedures.

So, now that we agree that our drawings are going to appear in 73 in accordance with a standard format, come TVI or high water, why make the artist work so hard for his money?

Included with this article is a chart which describes most of the symbols and abbrevia-

(Text continued on page 76.)

NEW SWAN-350 TRANSCEIVER



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• SW-117XC AC P/S	$ 95
• SW-14-117 DC P/S	130
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• VX-1 VOX Unit	35

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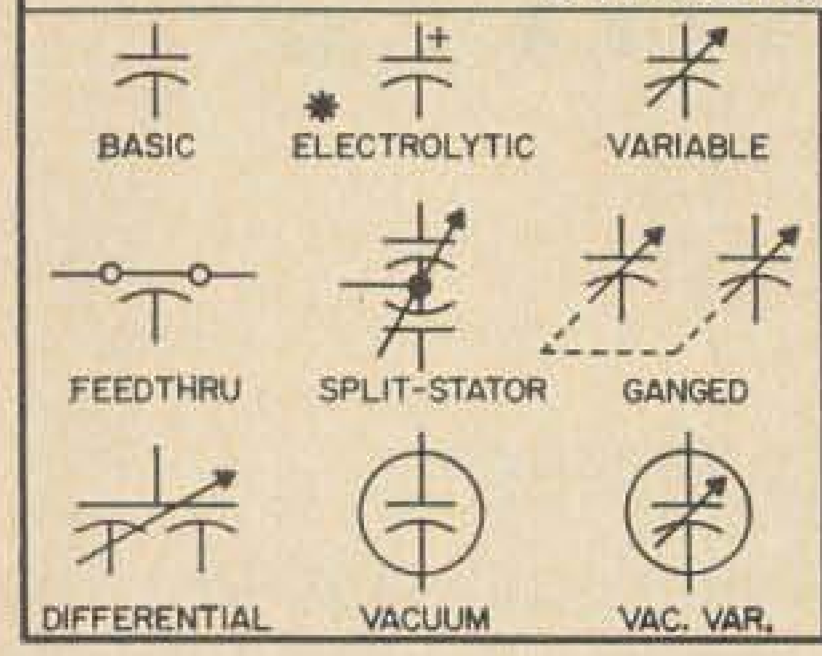
ANTENNA

NORMALLY USED IN BLOCK DIAGRAMS, BUT MAY BE USED IN ANY SCHEMATIC WHERE ANTENNA IS CONNECTED DIRECTLY TO CIRCUIT WITHOUT BENEFIT OF RF CONNECTOR

BATTERY

DO NOT FORGET TO INDICATE VOLTAGE AND POLARITY

CAPACITORS



NOTE THAT CURVED PORTION OF SYMBOL ALWAYS DESIGNATES OUTSIDE FOIL OF FIXED CAPACITORS (EXCEPT ELECTROLYTICS, WHERE IT INDICATES THE NEGATIVE TERMINAL)

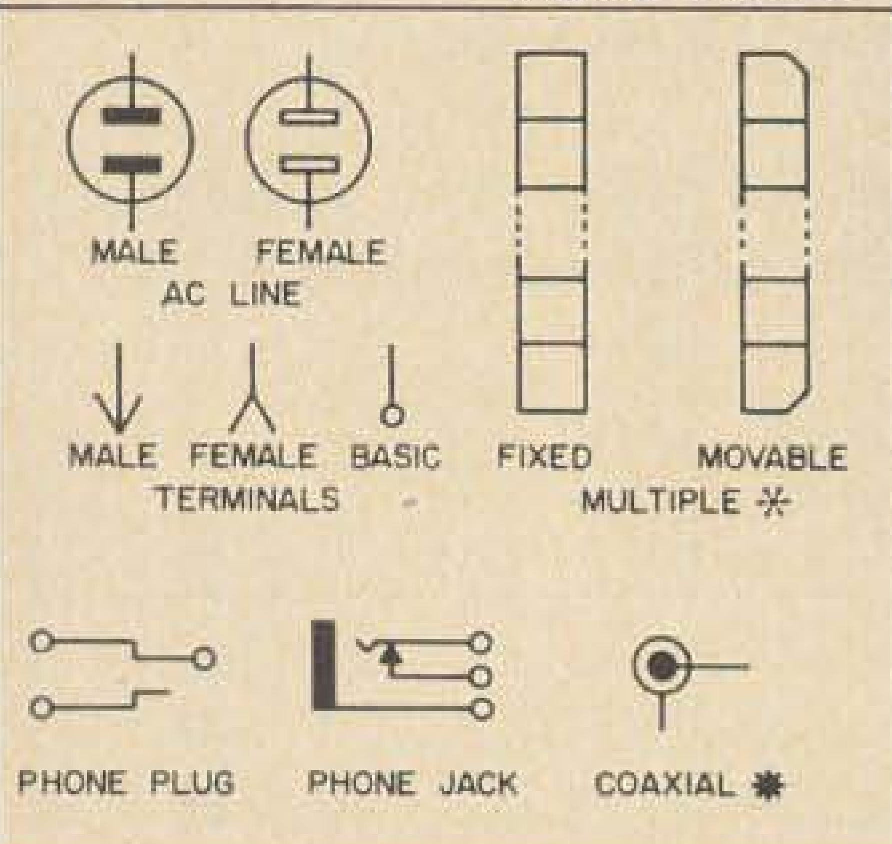
THE CURVED PORTION IN THE CASE OF A VARIABLE WILL INDICATE THE MOVABLE PART

✱ INDICATE POLARITY, AND VALUE IN μF

WHEN OTHER THAN ELECTROLYTIC, VALUES ARE ASSUMED TO BE pF WHEN 1 OR GREATER, AND μF WHEN LESS THAN 1

CONDUCTORS

CONNECTORS

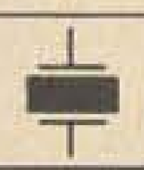


SHOULD NONE OF THE SYMBOLS DESCRIBED HERE SEEM TO MATCH YOUR SITUATION, DESCRIBE THE CONNECTOR AND/OR LIST THE MANUFACTURER'S PART NUMBER

✱ FOR ANY COAXIAL-TYPE CONNECTOR, SUCH AS RF, MICROPHONE, PHONO, ETC.

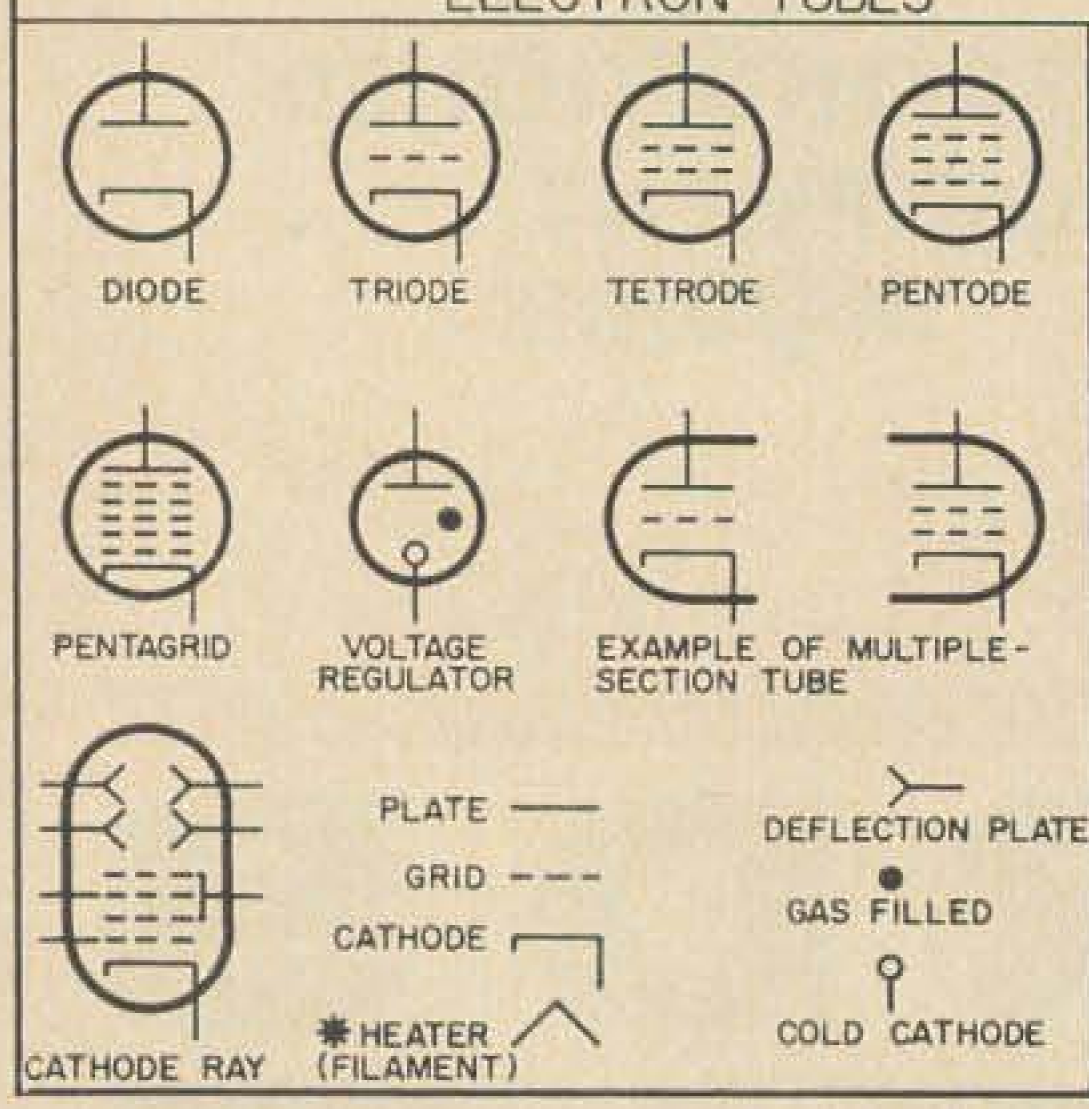
✳ NUMBER THE BLOCKS TO CORRESPOND TO TERMINAL MARKINGS, WHEN APPROPRIATE

CRYSTAL



ALWAYS INDICATE CRYSTAL FREQUENCY (IN kHz, MHz, ETC.)

ELECTRON TUBES

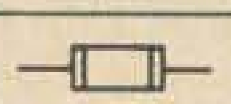


ALWAYS LABEL ELEMENTS WITH TUBE PIN NUMBERS

REFER TO TUBE MANUAL FOR DATA ON INDIVIDUAL TUBE TYPES

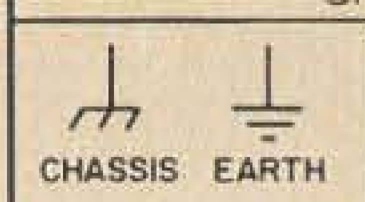
✱ FILAMENTS OR HEATERS (WITH THE EXCEPTION OF DIRECTLY-HEATED CATHODES) SHOULD BE SHOWN EXTERNAL TO TUBE CIRCLE, AND PREFERABLY IN THE POWER SUPPLY

FUSE



INDICATE CURRENT, VOLTAGE RATINGS, AND SLO-BLO, ETC., AS APPROPRIATE

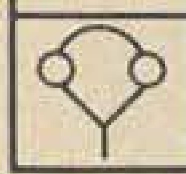
GROUND CONNECTIONS



CHASSIS GROUND SYMBOL IS NORMALLY THE ONLY TYPE USED IN SCHEMATICS

EACH GROUNDED CIRCUIT COMPONENT WILL BE SHOWN CONNECTED TO AN *INDIVIDUAL* CHASSIS GROUND, UNLESS A COMMON GROUND BUS IS ESSENTIAL TO PROPER CIRCUIT OPERATION

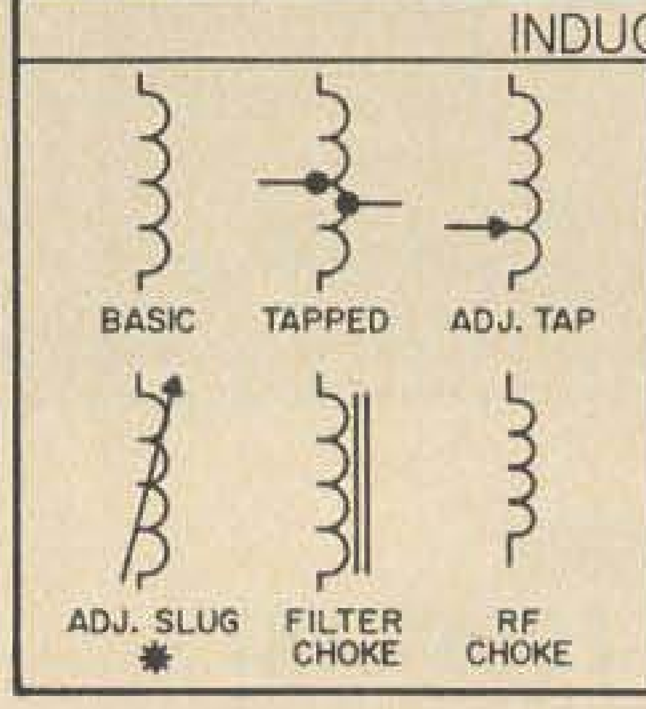
HEADSET



NORMALLY USED IN BLOCK DIAGRAMS, BUT MAY BE USED IN ANY SCHEMATIC WHERE CONNECTED DIRECTLY INTO CIRCUIT WITHOUT PHONE PLUG

INDICATE IMPEDANCE IF VALUE IS CRITICAL

INDUCTORS



INCLUDE ALL NECESSARY DATA INCLUDING ANY OF FOLLOWING INFORMATION WHICH IS APPLICABLE:

- WIRE SIZE & TYPE
- COIL OR FORM O.D. OR I.D.
- NUMBER OF TURNS AND/OR LENGTH
- MANUFACTURERS PART NUMBER
- TAP POSITION ABOVE COLD END

✱ FERRITE CORE WILL BE ASSUMED UNLESS BRASS IS SPECIFIED. INDICATE TYPE OF FERRITE, IF CRITICAL

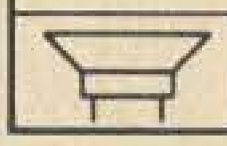
KEYS

✱ BE SURE TO DESIGNATE "DIT" & "DAH" CONTACTS

LAMPS

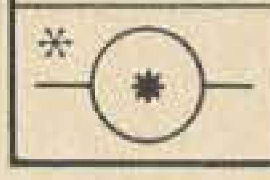
INDICATE MANUFACTURER'S PART NUMBER AND/OR VOLTAGE & CURRENT RATING

LOUDSPEAKER



INDICATE VOICE COIL IMPEDANCE & POWER RATING, ETC., WHEN CRITICAL

METERS



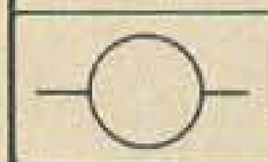
✱ INDICATE TYPE OF METER HERE (μA, mA, V, ETC.)
✳ INDICATE SCALE RANGE HERE (0-1, 0-50, ETC.)
DON'T FORGET TO INDICATE PROPER POLARITY

MICROPHONE

NORMALLY USED IN BLOCK DIAGRAMS BUT MAY BE USED IN SCHEMATIC WHEN WIRED DIRECTLY INTO CIRCUIT WITHOUT CONNECTOR

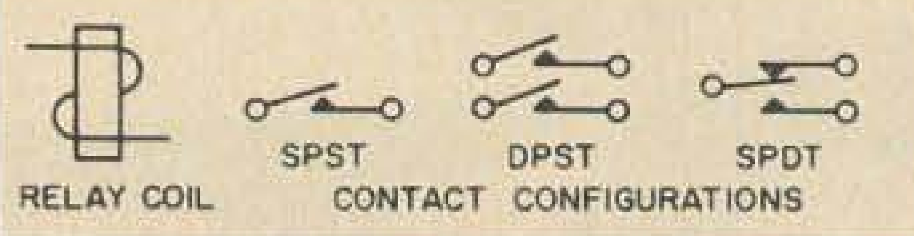
INDICATE TYPE (CARBON, XTAL, ETC.)

MOTOR



LABEL AS MOTOR, FAN MOTOR, ETC.
INDICATE OPERATING VOLTAGE & CURRENT AND/OR MANUFACTURER'S PART NUMBER

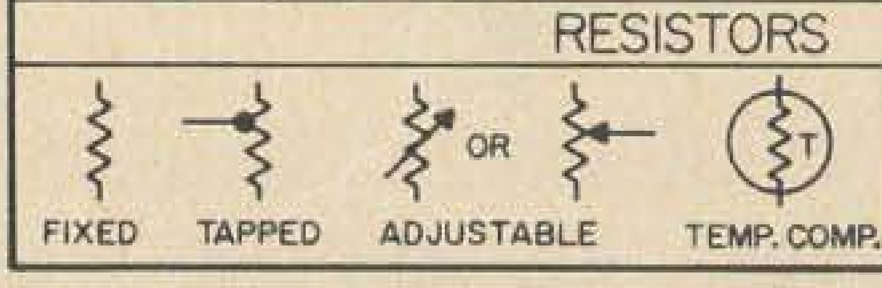
RELAYS



SPECIFY COIL VOLTAGE, RESISTANCE, ETC., AND/OR MANUFACTURER'S PART NUMBER

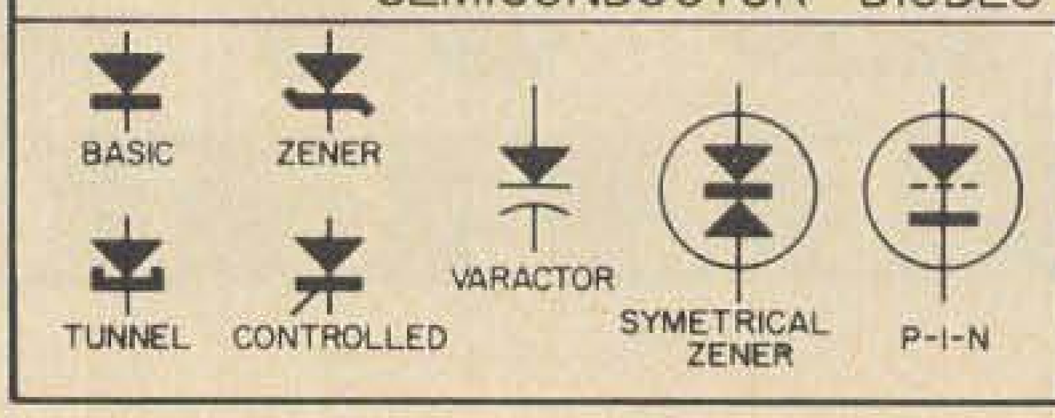
CONTACT CONFIGURATIONS SHOWN ARE BASIC AND MAY BE EXPANDED

RESISTORS



INDICATE VALUE, IN OHMS(Ω), KILOHMS(k), OR MEGOHMS(M), AND/OR MANUFACTURER'S PART NUMBER.
1/2 W 10% IS ASSUMED UNLESS OTHERWISE NOTED

SEMICONDUCTOR DIODES

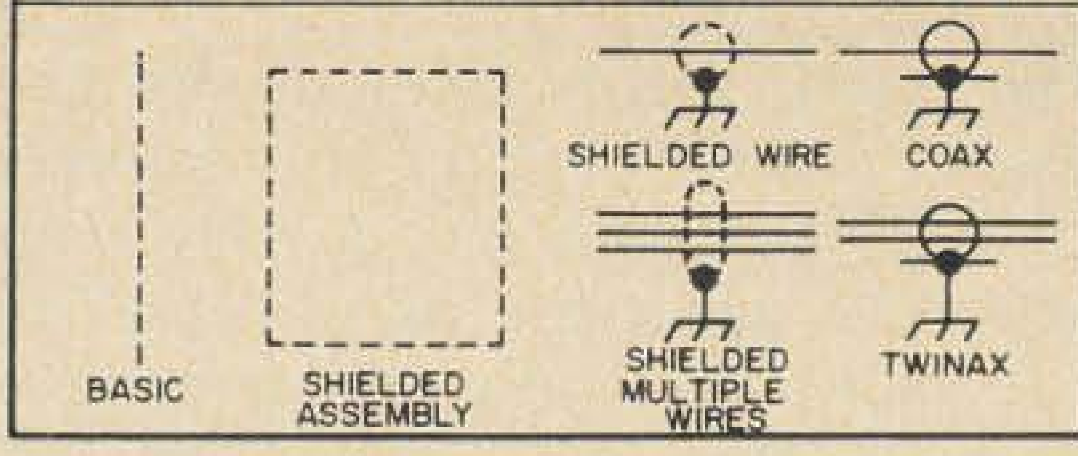


INDICATE MANUFACTURER'S PART NUMBER AND/OR APPROPRIATE RATINGS

REFER TO MANUALS FOR SYMBOLS NOT SHOWN

ELECTRONIC SYMBOLS

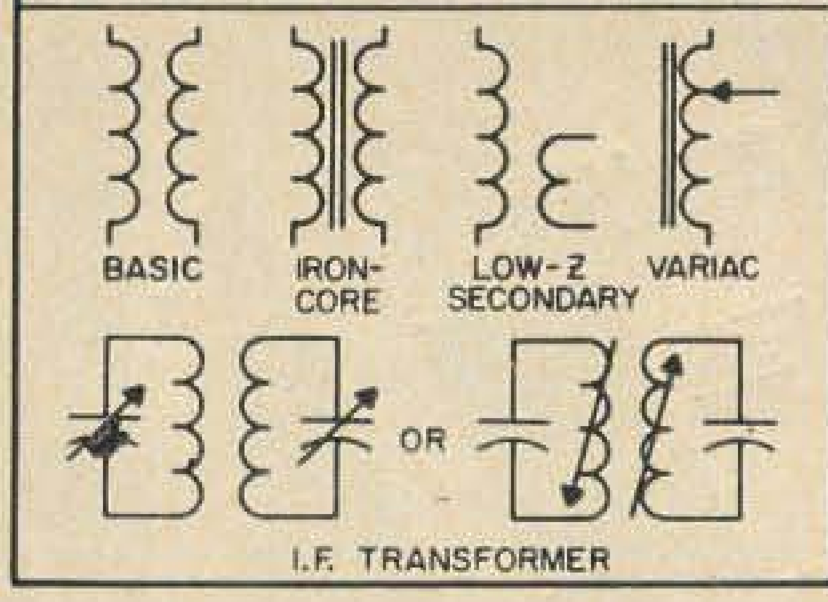
SHIELDING



SHIELDS ARE ASSUMED TO BE GROUNDED UNLESS OTHERWISE NOTED

INDICATE IF SHIELD ON CONDUCTOR IS TO BE GROUNDED ONE END ONLY, & SPECIFY WHICH END

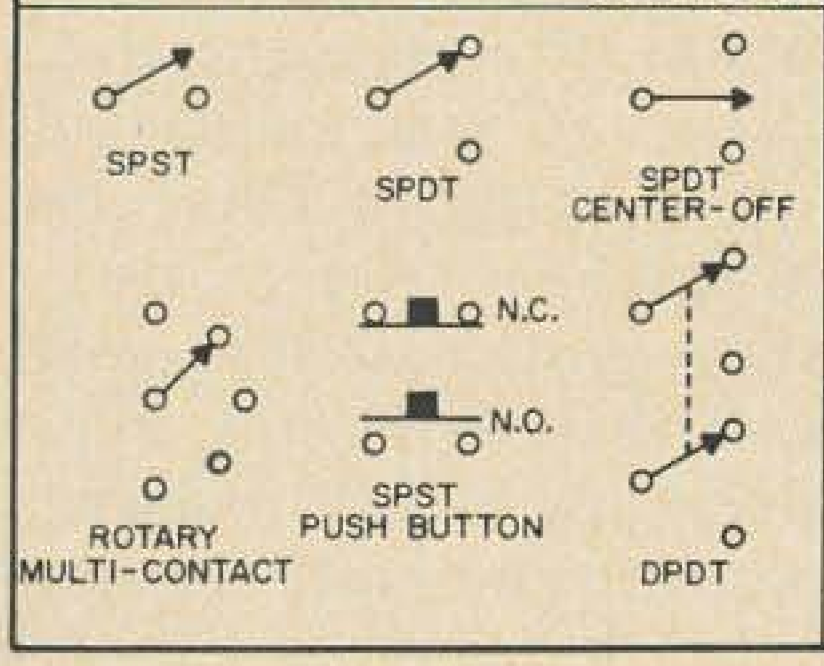
TRANSFORMERS



SHOW (4) LOOPS EACH WINDING EXCEPT (6) LOOPS ON HIGH-VOLTAGE SECONDARIES AND (2) ON FILAMENT WINDINGS AND NON-RESONANT LOW-Z RF COUPLING LINKS

TRANSFORMER DESCRIPTION SHOULD INCLUDE MANUFACTURER'S PART NUMBER AND RATINGS, OR CONSTRUCTION DATA

SWITCHES



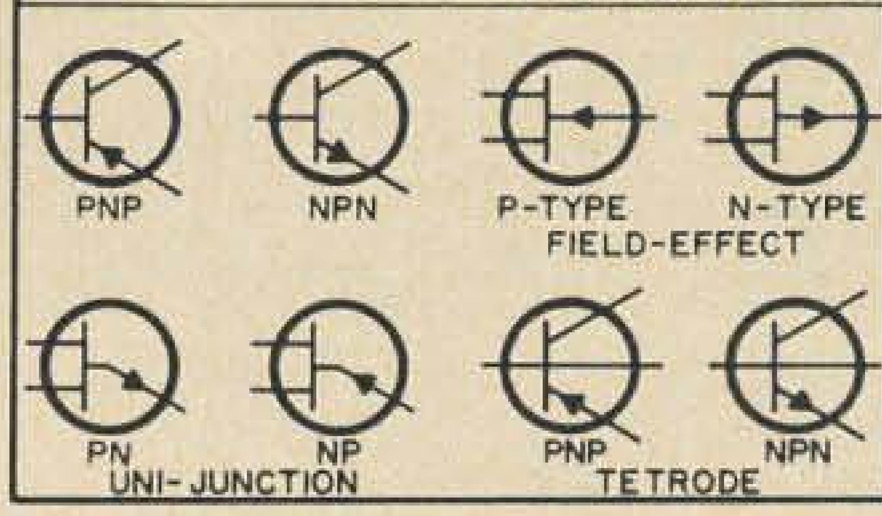
ONLY BASIC CONFIGURATIONS ARE SHOWN. COMBINE OR EXPAND AS NECESSARY TO SUIT

SELF-HOLDING SWITCH OPERATION IS ASSUMED UNLESS SPRING-RETURN IS SPECIFIED

NON-SHORTING TYPE IS ASSUMED UNLESS SHORTING TYPE IS SPECIFIED

SWITCH SECTIONS WHICH ARE SIMULTANEOUSLY OPERATED OR GANGED SHOULD BE JOINED WITH A DOTTED LINE

TRANSISTORS



SPECIFY MANUFACTURER'S PART NUMBER OR RATINGS

REFER TO TRANSISTOR MANUALS FOR TYPES NOT SHOWN HERE.

ELECTRONIC ABBREVIATIONS

(AS USED ON DRAWINGS AND SCHEMATICS)

NOMENCLATURE	ABBREVIATION(S)
ALTERNATING CURRENT	AC
AMPERE	A
AMPLIFIER	AMP
AMPLITUDE MODULATION	AM
ANTENNA	ANT
AUDIO FREQUENCY	AF
AUTOMATIC FREQUENCY CONTROL	AFC
AUTOMATIC GAIN CONTROL	AGC
AUTOMATIC VOLUME CONTROL	AVC
BATTERY	B
BEAT FREQUENCY OSCILLATOR	BFO
BROADCAST	BC
CAPACITANCE, CAPACITOR	C
CONTINUOUS WAVE	CW
CRYSTAL	X, XTAL
CURRENT	I
DECIBEL	dB
DIODE, SEMICONDUCTOR (ALL TYPES)	D
DIRECT CURRENT	DC
DOUBLE COTTON COVERED	D.C.C.
DOUBLE POLE DOUBLE THROW	DPDT
DOUBLE POLE SINGLE THROW	DPST
DOUBLE SILK COVERED	D.S.C.
ELECTRON TUBE (ALL TYPES)	V
ENAMEL COVERED	ENAM
FILAMENT	FIL
FREQUENCY	FREQ, f
FREQUENCY MODULATION	FM
FUSE	F
GROUND	GND
HENRY	H
HERTZ (CYCLES PER SECOND)	Hz
IMPEDANCE	Z
INDUCTANCE, INDUCTOR	L
INSIDE DIAMETER	I.D.
INTERMEDIATE FREQUENCY	I.F.
JACK	J
KILOHERTZ (KILOCYCLES PER SECOND)	kHz
KILOHM	k, kΩ
KILOVOLT	kV
KILOWATT	kW
LAMP	I
LOUDSPEAKER	SPKR
MEGAHERTZ (MEGACYCLES PER SECOND)	MHz
MEGOHM	M, MΩ
METER	M
MICROAMPERE	μA
MICROFARAD	μF
MICROHENRY	μH

NOMENCLATURE	ABBREVIATION(S)
MICROPHONE	MIC
MICROVOLT	μV
MICROWATT	μW
MILLIAMPERE	mA
MILLIHENRY	mH
MILLIVOLT	mV
MILLIWATT	mW
NEGATIVE (POLARITY)	−, NEG
NORMALLY CLOSED	NC
NORMALLY OPEN	NO
OHM	Ω
OSCILLATOR	OSC
OUTSIDE DIAMETER	O.D.
PICOFARAD	pF
PLUG	P
POSITIVE (POLARITY)	+, POS
POWER AMPLIFIER	PA
PRIMARY	PRI
PUSHBUTTON	PB
RADIO FREQUENCY	RF
RADIO FREQUENCY CHOKE	RFC
RECEIVE	REC
RECEIVER	RCVR
RELAY	K
RESISTANCE, RESISTOR (ALL TYPES)	R
ROOT MEAN SQUARE	RMS
SECONDARY	SEC
SHORTWAVE	SW
SINGLE COTTON COVERED	S.C.C.
SINGLE POLE DOUBLE THROW	SPDT
SINGLE POLE SINGLE THROW	SPST
SINGLE SILK COVERED	S.S.C.
SWITCH	S
TIME	t
TRANSFORMER	XFMR, T
TRANSISTOR (ALL TYPES)	Q
TRANSMIT	XMIT
TRANSMITTER	XMTR
ULTRA HIGH FREQUENCY	UHF
VACUUM TUBE VOLTMETER	VTVM
VERY HIGH FREQUENCY	VHF
VOLT OHM METER	VOM
VOLT, VOLTS	V
VOLTAGE	E
WATT	W
WAVELENGTH	λ

(Continued from page 72)

tions which have been found acceptable to the editor of 73. Relative information has been included in the chart, rather than in the text, for convenience. Should none of this information seem to suit your situation, merely make your description as complete as possible. Always bear in mind that you are seeking to communicate with the artist, and ultimately, with the reader.

Hopefully, we are still in agreement at this point. Now, let's draw all schematics with input at left and output at right. Don't hesitate to direct an explanatory note or two to the artist if you think a particular item might not be clear to him. This is especially important in the case of pictorials, where a drawing might otherwise appear in print embarrassingly unlike a photograph of the same object. Use templates if you like, but free-hand is just as good as long as it is legible. Try to include most of the information on the schematics, thereby keeping the parts list to a minimum. When finished with your drawings, inspect for errors or omissions.

If you are an old hand at writing in the electronics field, perhaps you are one of the many who already adhere fastidiously to the use of standard symbols and layouts. If not, won't you please bend a little? It *could* prevent the artist from accidentally blowing an otherwise excellent article.

Those of you who have originated interesting and useful circuits, and have never submitted them for publication, are cheating amateur radio out of the benefit of your knowledge, and yourself out of a couple of bucks. I can't tell you how to write the article because that is way out of my line. I can tell you, however, that a pencil, paper, and an unyielding determination to use standard symbols, abbreviations, and format, will satisfy the drafting requirement. Don't forget to retain a copy of everything, for reference, in case the editor wants to contact you about a point or two.

In conclusion, may I say that the objectives of this article are intended to be neither in defiance of nor in compliance with the policies of publications other than 73 magazine. The symbols and abbreviations which appear in the chart have been proven to be simple to execute, and adequately descriptive.

. . . KØEFC

References

A.R.R.L. "The Radio Amateur's Handbook," 1966 Edition, page 516

Howard W. Sams "Handbook of Electronic Tables & Formulas," 1962, pp. 82-94

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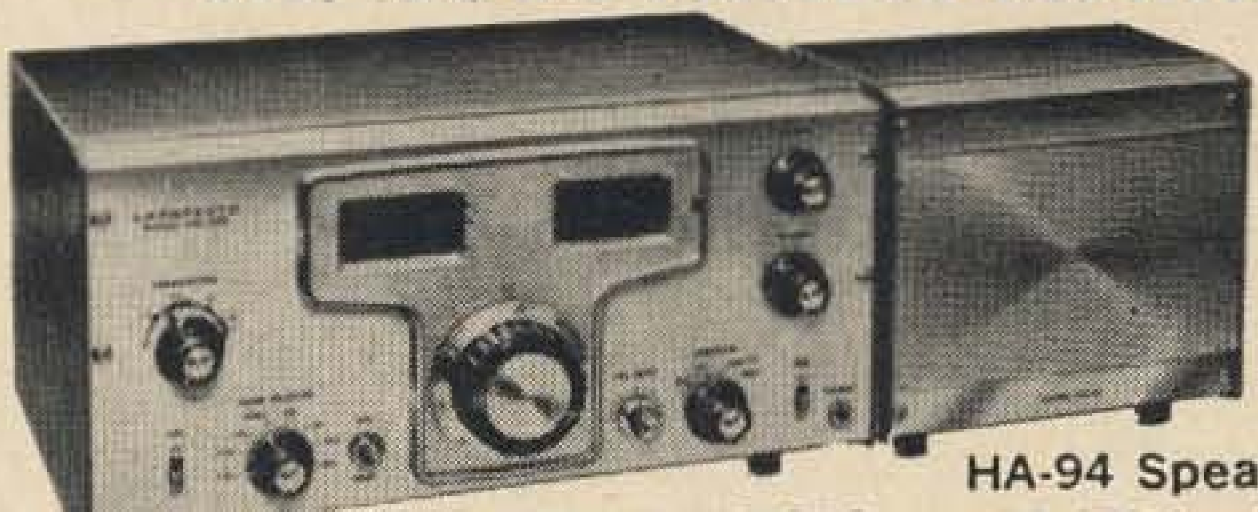
- Small . . . Compact . . . Only 2-inches High

See June 1966 QST For Details

MODEL HA-350 80-10 METER SSB/AM/CW AMATEUR RECEIVER



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The Lafayette HA-650 Six Meter Transceiver

A battery-operated portable or fixed transceiver

Most hams would like to have a completely portable transceiver. Some want to be prepared for emergencies. Some like to mountaintop. Some just like the idea of having a completely independent rig to carry around for special events or picnics. The Lafayette HA-650 is perfect for these uses. It is small, light, has a sensitive receiver, and adequate power for most of these uses. Let's take a quick look at what's in it:

The receiver uses five modern silicon transistors in a single conversion superheterodyne. The rf amplifier is protected by a diode against nearby transmitters, and the oscillator is zener diode stabilized. Two *if* stages at 1650 kHz furnish plenty of amplification. A noise limiter is wired in the circuit and the AGC has a squelch-like action: when no signals are being received, there's very little output from the speaker until a signal is received. There's plenty of audio for use except in very noisy locations when earphones would probably be worthwhile. A spot switch lets you find your operating frequency.

The transmitter uses 8 MHz crystals and sockets and a switch are provided for six crystals. Five silicon transistors are used in the transmitter and the circuit has plenty of filtering and selective circuits to prevent TVI. Both the driver and final are modulated for full modulation. There were many excellent comments on the audio. It has a very clean, communications-shaped quality and gets through interference very well.

The HA-650 operates from 12 volts or so. The package includes space for eight flashlight batteries, which seem to last quite a while, or you can install the rig in your car (positive or negative ground) using the mobile mount, power cord and instructions provided. You can also buy an AC adapter from Lafayette.

A whip antenna is built into the transceiver, and it is convenient to use for walking-portable use with the nice leather carrying case that comes with the rig. As this area is horizontally polarized, results with the whip weren't particularly dramatic, but stations 40 or 50 miles away were worked from a good location. Using the HA-650 with a beam or dipole made from a couple of Lafayette 58 inch telescoping whips is another story. We worked a number of stations 150 miles away from Pack Monadnock. Reports were S9 and better and everyone commented on the excellent modulation. The receiver stands up well to strong stations unless they are very close, when some cross-modulation becomes evident. It's not too serious though.

The instruction book is satisfactory in comparison with many other equipment manuals. It answers most of the questions you're liable to have about installing or using the rig, and also gives alignment instructions and a large schematic. Someone who isn't very familiar with semiconductors isn't going to enjoy servicing the transceiver, but otherwise it shouldn't be too bad—if service is ever needed, since everything seems to be well made and the parts

Lafayette HA-650 Specifications

Receiver

Sensitivity: better than 1 uV for 10 dB S/N ratio
Selectivity: 6 dB down at =3 kHz, 40 dB at =8 kHz
Image rejection: 55 dB
Frequency range: 50-52 MHz
Current drain: 80 mA

Transmitter

Input to final: 2½ watts
Modulation: Class B, 100% capability
Current drain: 400 mA maximum
T-R switching: relay type
Antenna output impedance: 50 ohms nominal

Miscellaneous

Power supply: 12 to 16 V dc
Dimensions: 9½ W x 5½ H x 2¼ D.
Weight: 9 pounds with battery
Price: $119.95

are conservatively rated. The driver and final transistors are made by Motorola, and the others would be easy to replace with standard American replacements if you had trouble finding the Japanese ones.

I was quite pleased with the HA-650. It's compact and well-made and offers excellent performance for its price. I think that anyone who buys or uses one will be very happy with it.

. . . WA1CCH

Removing Excess Soldering Flux

Appearance of much otherwise good electronic work is quite frequently spoiled by excess soldering flux on connections, and by the dust that eventually accumulates on the residual flux.

Larger accumulations of natural and synthetic rosin can be removed by careful scraping, followed by use of a solvent on a cotton swab or a small brush. Good solvents, in order of increasing strength, are carbon tetrachloride, denatured alcohol, rubber cement thinner, type cleaner, and acetone. All should be used with caution, with adequate ventilation, and away from flames and hot objects. Carbon tetrachloride will not burn, but oxidizes to phosgene if it falls on a hot object, such as a soldering iron.

Do not use these solvents on plastics without a preliminary test. Some plastics soften on contact with acetone and similar substances.

. . . Donald Ives

(Continued from page 2)

too well, but they are important to DXers. I would say that a lot can be done to make our QSL's more interesting. I know I keep the better ones on the wall of my shack and I like to look up at them when I am working the fellow again. In the past I was gung ho for the card with an interesting design . . . the one that really stands out on the wall. Now I'm swinging to the idea that it is nice to have a picture of yourself, your shack, perhaps your house or even your town on the card.

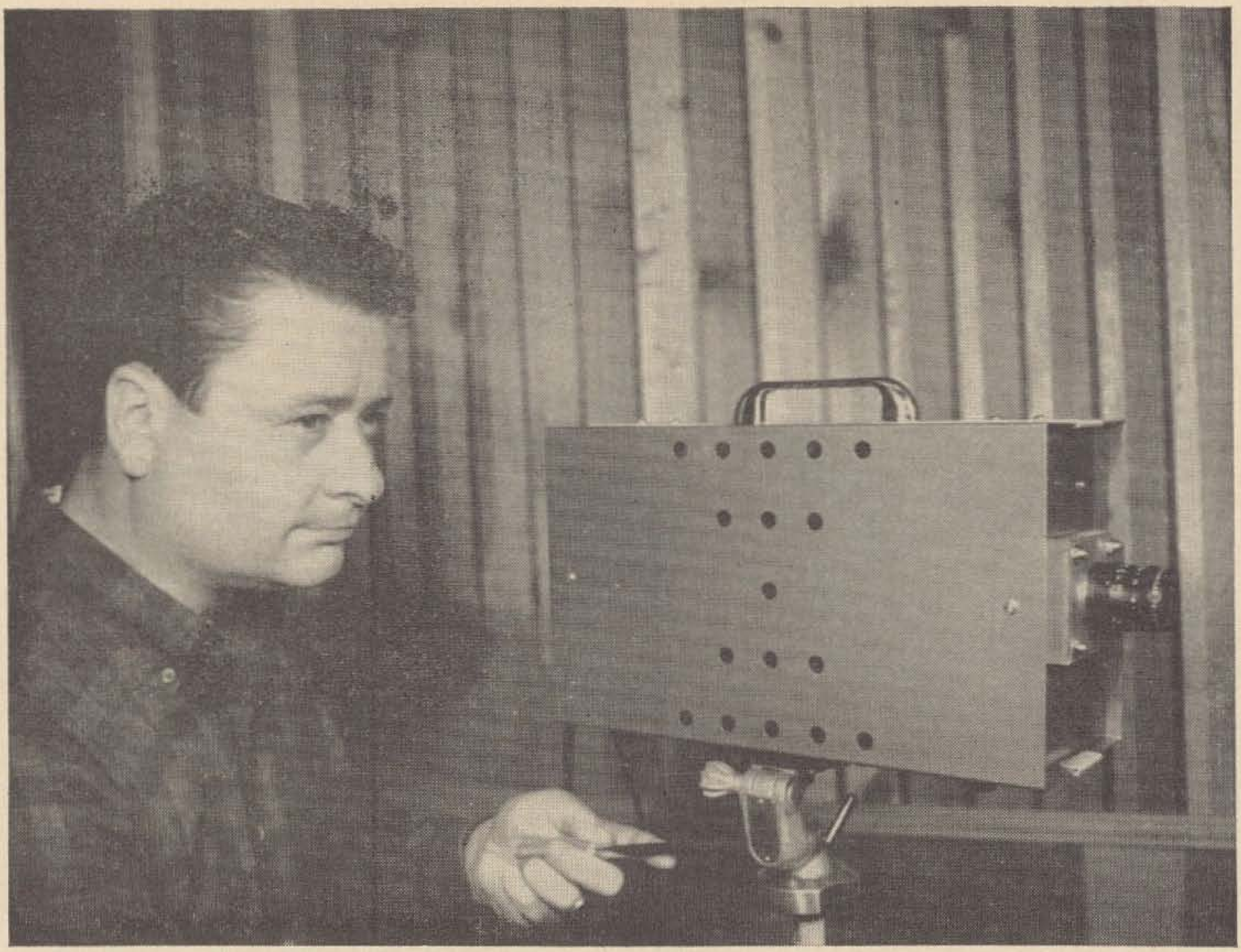
On my card I have a picture of my mountain shack with all the towers and VHF beams. It makes quite an impression, apparently, because a number of DX stations have particularly mentioned looking at it. Just last night I worked 9L1TL and he said he had seen my card at 9L1HX's! The antennas and towers draw the gasps . . . no one has mentioned the little picture of me and my two Italian Greyhounds on the other side. Aha, that gives me an idea. I'll get out the Polaroid and take a picture of myself holding a gun to my head and print a caption, "Send me a QSL or else."

No DX station has any excuse for not QSL'ing any more. The institution of the QSL manager is well accepted and there are hundreds of fellows waiting to manage someone. Some managers even print up the cards, but this is asking a lot. All a DXer has to do is send in his logs to the manager and everything is done. I know that I much prefer to deal with a manager . . . then I know that I am going to get a QSL. I have too many blank places on my wall where fellows who have promised to QSL haven't. Probably the worst of all in this category has been FY7YL. Ernest earnestly promises QSL cards to one and all, but you virtually have to go to his shack to get one. Some fellows that have sent him ready-made cards waiting only his signature, complete with a self addressed envelope with the right postage in his own stamps haven't gotten a card. Fortunately Monique FG7XL has rescued us from this monster and is busy answering the cards for Ernest. The next time you talk to Ernest try to explain to him about the importance of QSLing . . . it will cost him nothing.

Weaker DX stations get completely covered up by the calling stations and we experience the complete stupidity of many minutes of calling with no one being able to hear whether the DX station is answering or not. It would seem to me that once a DX operator finds himself in this spot he should run not walk for some help and select one of the biggest signals to MC for him and collect the calls of those trying for a contact. I would further suggest that the MC spend as little time on the air as possible . . . first get everyone on the frequency familiar with what is happening, then ask for the spread out system of ET3AC and log calls. Then read off the calls to the DX station and insist that everyone shut up until called by the DX for a report.

By the way, while on the subject, let's come to an understanding . . . either you are working DX or you are rag chewing. Why try to mix the two? That doesn't mean you can't rag chew with DX, just don't start a rag chew when a DX op is obviously trying to give out reports to a number of stations. And this, to my mind, includes such time wasters as spelling out your city, name, or remarks to the effect that you are going to keep it short because a lot of others are waiting. Give the report, say your 73 and sign off and clear and get away. Make sense? And for heaven's sake don't start asking about QSL's . . . he knows that's what you want. If you don't know where to send the card wait until you are through and ask someone else that has been doing more listening and less talking.

. . . Wayne



Kent A. Mitchell W3WTO
1760 Preston Road
Hagerstown, Maryland 21740

The Conar 800 TV Camera Kit

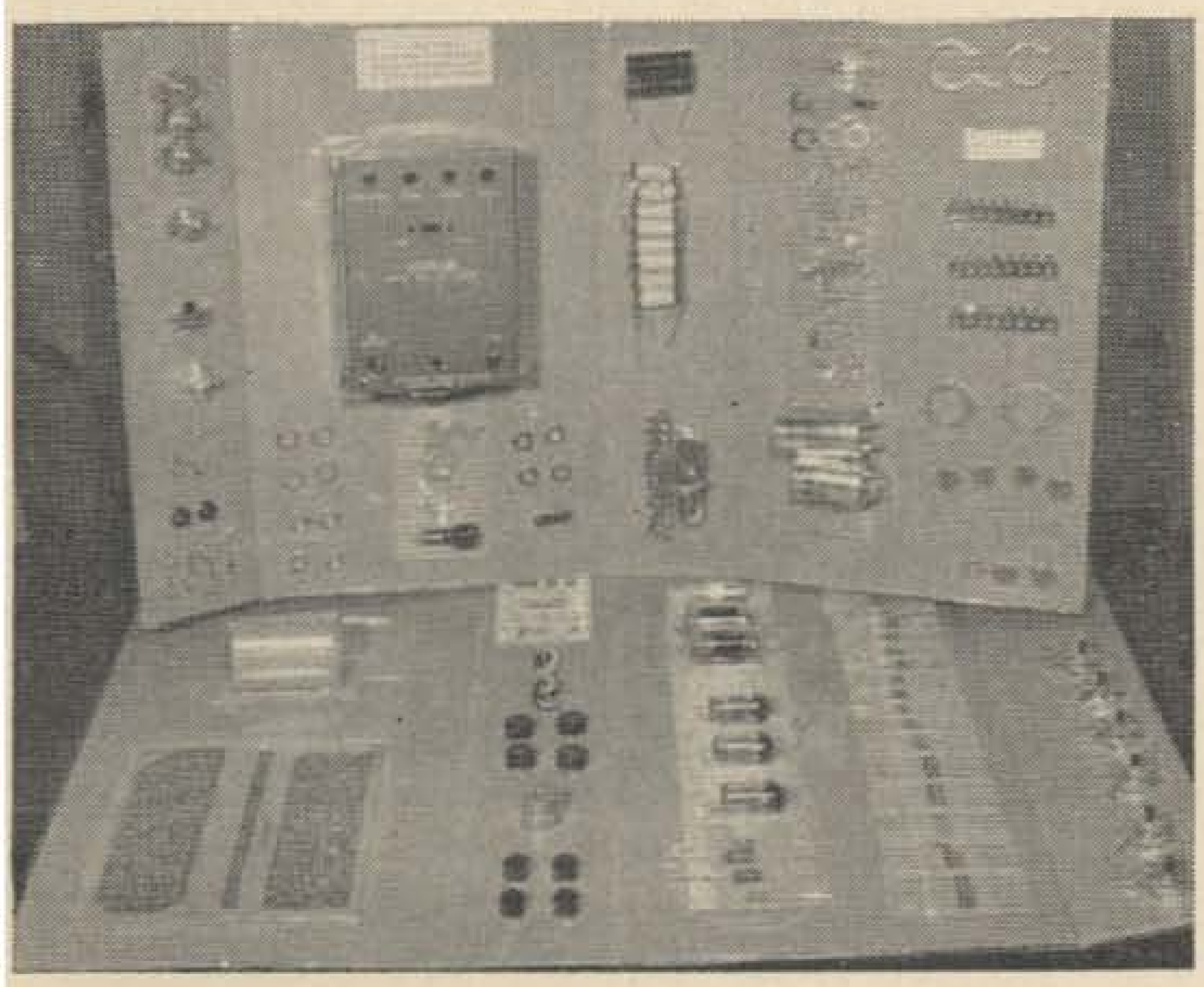
Once the word gets around, CONAR INSTRUMENTS will undoubtedly find that their introduction of the Model 800 TV camera kit has won them a permanent place in the hearts of Amateur TV experimenters. They have a real winner! Priced at $209.50 in kit form, this is certainly the lowest priced *complete* TV camera on the market today. Included as standard equipment i sa 25 mm, f1.9 lens, with wide angle and telephoto lenses available as optional accessories at a reasonable $36.00 and $28.00 additional, respectively. The all important divicon tube is the popular 7038.

While contained in a small package, the circuitry is not crowded and no problems were encountered during construction. With the exception of the power supply circuits and the rear panel controls, the majority of the components are mounted on a large, heavy foil, etched circuit board. This circuit board certainly contributes to the low assembly time of approximately eight hours. I could find no errors in the construction manual . . . but read the text carefully and don't just try to see how fast you can place your check marks next to the assembly steps. There are several areas where an inexperienced builder might have to backtrack and reposition some components because the hints hidden in the text were not followed. However, I don't suppose anyone would be building a TV camera as his first construction effort!

The kit arrived at the QTH of W3WTO in a surprisingly small and light package. Being used to watching my delivery-man trudge up the steep slope of my lawn with a kit and appearing to be carrying a carton of surplus cannon balls, I began to wonder if I was getting my money's worth! However, as you know, TV circuits don't require ultra-stable vfo's . . . and their associated boiler-plate stiff chassis, nor heavy high current transformers in the power supply section.

The majority of the kit's components come mounted on three folded 17½ by 30 inch corrugated cardboard sheets and are held in position by a plastic film. The plastic may be stripped away to expose only the components required during a particular phase of construction. Then too, when the evenings work is done, the remainder of the parts may be quickly removed from the kitchen table . . . or wherever else you have been incurring the wrath of your XYL.

Upon completing the assembly of the kit, all the controls are pre-set to approximate positions as per the instruction manual, a TV receiver is connected to the camera output cable, the camera power switch is placed to the ON position, and a hex alignment tool is utilized to adjust the camera rf oscillator slug-tuned adjustment to any desired channel from



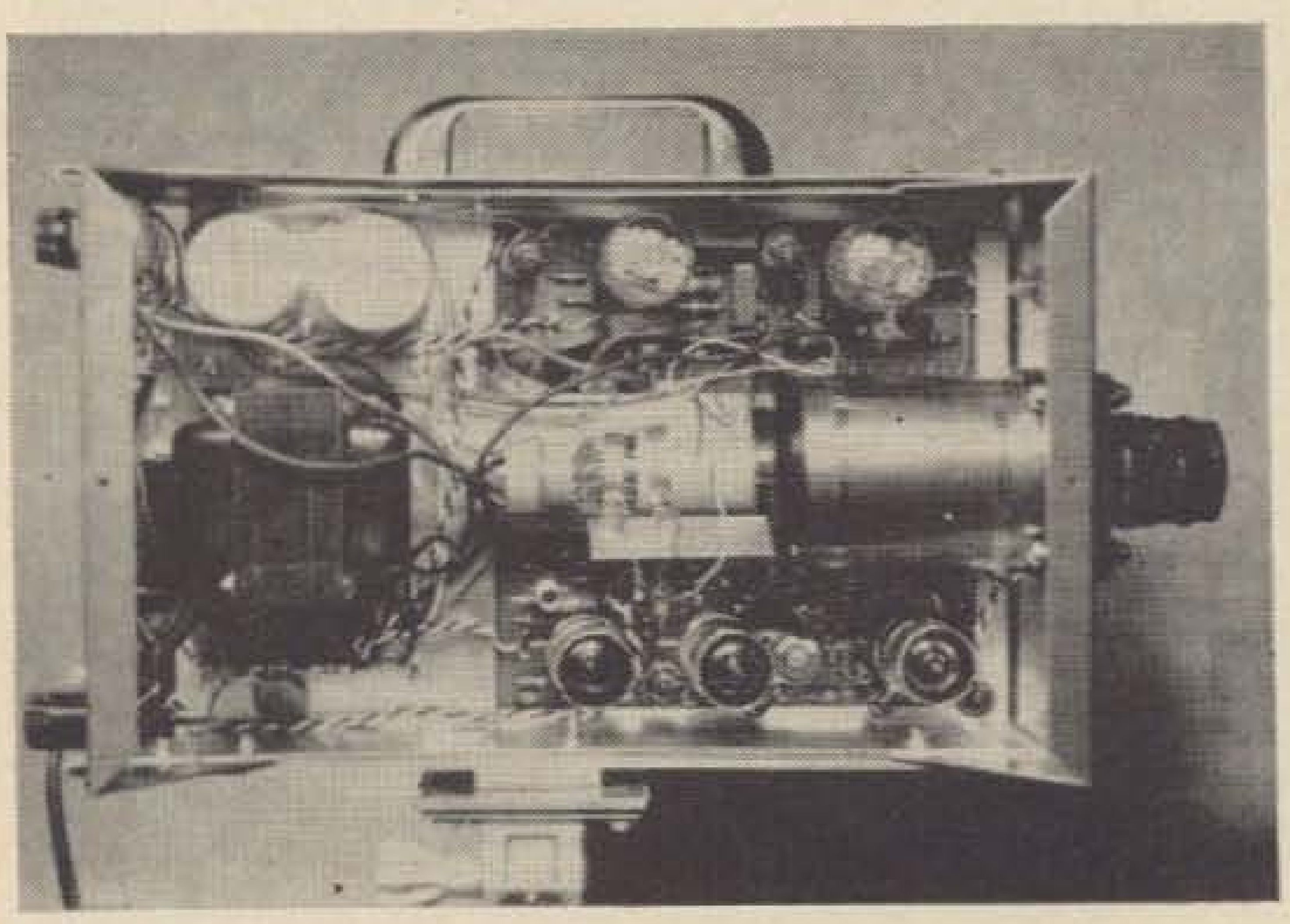
Here's what comes in the Conar TV kit. All parts including the expensive lens and vidicon are included.

Specifications

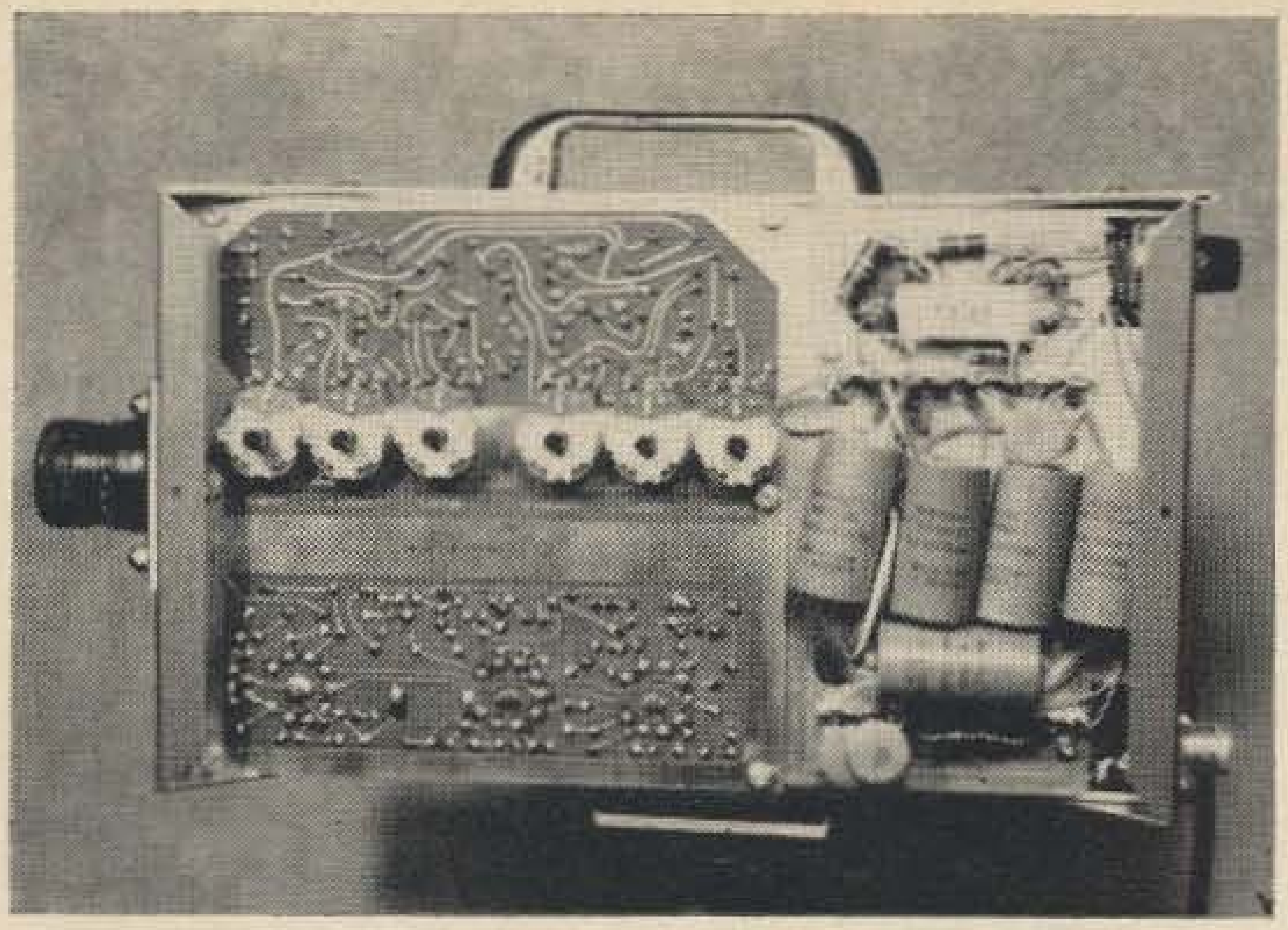
Horizontal Sweep Rate	15,750 Hz nominal
Vertical Sweep Rate	60 Hz (line locked)
Scanning	Random interlace, 2:1 ratio, 525 lines per frame, 30 frames per second.
Sync and Blanking	Combined sync and blanking signals.
Scan Failure Protection	Beam defocussing in the event of horizontal scan failure.
Output	100,000 μV of modulated rf on an adjustable carrier frequency of channel 2 to channel 6 ($\pm$2 MHz bandpass) into an output impedance of 75 ohms, unbalanced.
Resolution	240 lines (3 MHz)
Standard Lens	25 mm, f 1.9, focussing 2' to infinity.
Dimensions	5" X 7" X 12-¼"
Weight	11 pounds
Kit Price	$209.50

2 through 6. Next the HORIZONTAL control is adjusted until the camera sweep is synchronized with the TV receiver. Then, the vidicon tube is inserted into its socket, and the TARGET, BEAM, and FOCUS controls are adjusted carefully until . . . there it is!! A beautiful, clear, video picture! The thrill of looking at your first home grown video is almost akin to that of the reply to your first long shaky CQ.

Including the vidicon, there are only six tubes in the camera. The video output of the 7038 vidicon (VI) is amplified by the dual sections of the two 6U8 video amplifiers (V2 and V3) and applied to the grid of the triode section of still another 6U8 (V4A). The second half of the 6U8 (V4B) is functioning as an electron-coupled ultra audion rf oscillator. The oscillator output is coupled to the cathode of the triode section where the rf is modulated by the video. The vertical sync pulse for the camera is developed in a clever little circuit consisting of the neon pilot lamp which is



Here's the vidicon side of the camera assembled. Watch 73 for complete instructions for setting up your own amateur TV station.



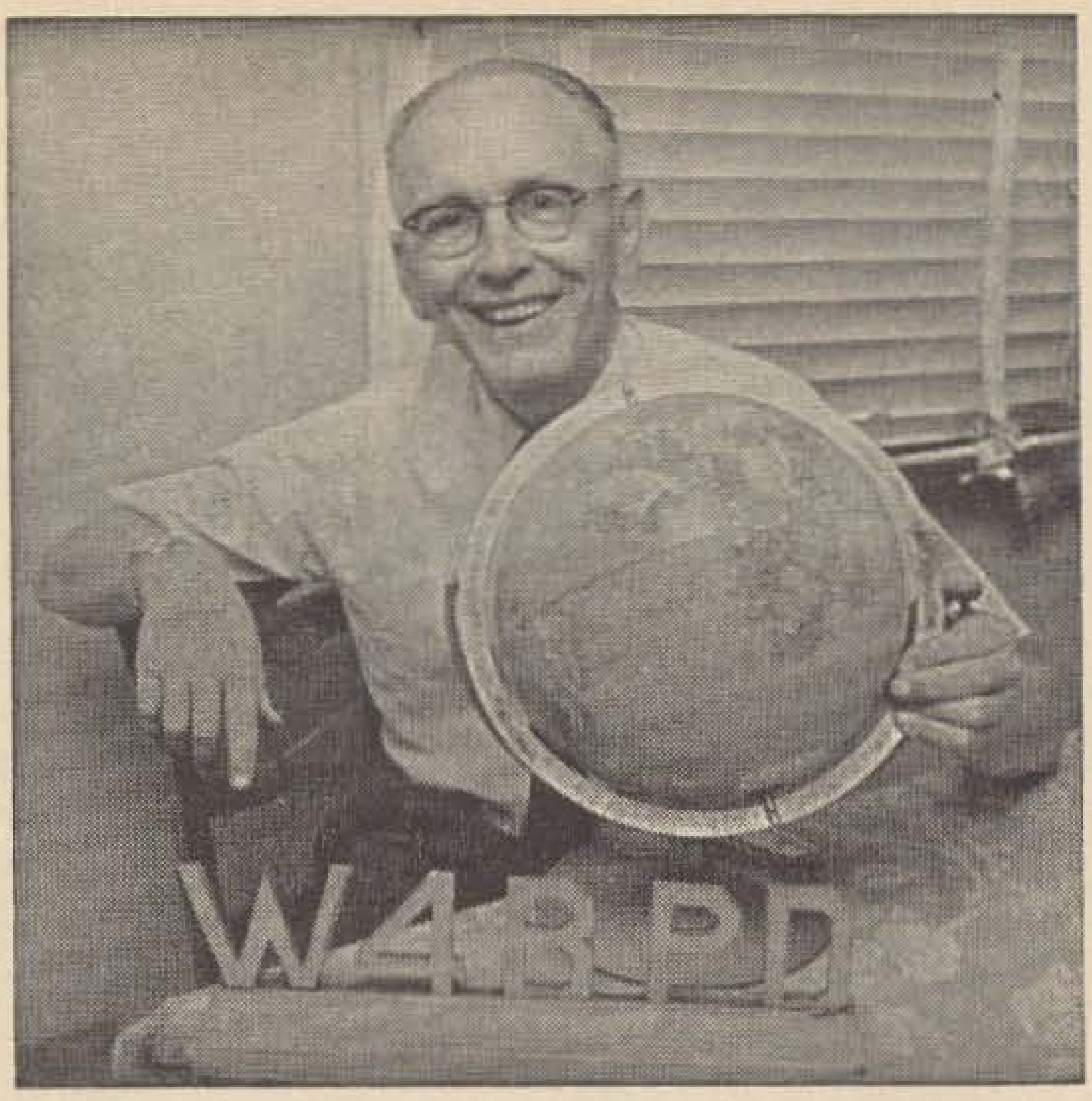
You can see from this side view that most of the parts are mounted on an etched circuit board.

fired by 60-hertz ac from the secondary of the power supply transformer and the resultant spike is utilized to drive vertical discharge tube (V5A), one half of a 6FD7, to cut-off . . . producing a more husky and better shaped pulse with which to work. The pulse, as developed across the cathode resistor of V5A, is utilized as the vertical sync pulse and the blanking pulse for the vidicon. The same pulse, as developed in the plate circuit of V5A, is coupled through a long time-constant resistor-capacitor circuit to produce a sawtooth waveform which, when amplified by V5B and applied to the vertical deflection yoke, becomes the vertical sweep. The horizontal sweep is generated by a free running multivibrator (V6A and V6B) set to approximately 15,750 cps and is applied to the horizontal deflection yoke. Should the multivibrator cease to function, the cathode current of V6B increases and since the vidicon focus coil is in series with the cathode circuit, the vidicon electron beam is defocused so that a spot will not be burnt on the target area of the tube.

After you have your camera in operation and adjusted to your satisfaction, and everyone in the family and neighborhood have made faces at themselves on the living room TV, you are ready to carry it into the ham shack for its first exposure to ATV . . . which of course means modification! However, in this case we are only speaking about the addition of a second coax jack to the rear panel of the camera so that the video may bypass the camera's rf stage and connect to your 440 mc transmitter. The video should be tapped from the grid of modulator V4A. Adequate room to mount a BNC type coax jack may be found just above the rf output jack.

See you on TV!

. . . W3WTO



The total population we found on the Aldabras were about 20 people practically 100% men. One old man I met there had been born on Aldabras some 80 years before and left the island only once, going to Mahe for only a few days. He told me he had no desire whatsoever to leave the Aldabras and see the outside world. This old man had been employed all his life on Aldabra, was sending his salary to Mahe where it was being invested for him. They said he had become quite wealthy. Can you imagine his outlook of the world? His entire world was the Aldabras and nothing else, and HE WAS VERY HAPPY. All the employees on the island are usually on an 18 month work contract to the island leasee, and are fairly well taken care of. If they don't smoke they have no use whatsoever for any money. The leasee of the island furnishes them with food and all the fish they want is also furnished them. Many other items from the sea are also furnished them, they just don't need any money at all. Most of them work hard at their 18 month contract and go back to Mahe (so I have been told) and have one or two weeks of drinking, and running around, until they are flat broke and are then ready to come back for another 18 month contract. Either to Aldabras, Farquahar, Chagoes etc. These fellows are a happy-go-lucky lot and none of the worries of the outside world bother them at all. Maybe this old fellow who was born on Aldabra has a good thing at that. There is nothing like a store on the island so you need no money.

Every night about 7:30 PM everyone gathers around the front door of the manager's and listen to the radio belonging to the manager, usually listening to Mombassa, Nairobi, Tananarive, Ceylon or at times even London.

Gus Browning W4BPD
Orangeburg, S.C.

Gus: Part 15

He has a small Japanese transistor set with short wave. These people have a good life with no worries about anything. All you need to wear on the island is a pair of short shorts. The temperature is absolutely perfect during the days and nights, I estimate it varies from 75 at night to about 90 during the daytime. If you like sea shells they are there just waiting to be picked up.

After Harvey and Jake finished eating they departed for the boat. They were going to hunt a sand bar on the other end of the island and beach the boat and repaint it from stem to stern. Since it was very high tide, and the full moon was due that night, they would not have to go too far up on the beach to be sure the boat was high and dry for they wanted plenty of time to do the boat all over. Harvey was going ashore with his tent and set up his operation from there with his wind charger, etc. They told me I would have about 14 days to operate while they were awaiting the next very high tide so they could float the boat again during the height of the tide that was about two weeks off. This suited me fine—boy 14 days of hamming from Aldabra, that suited me 100%.

After they had departed with plenty of help from the islanders I soon had up my antenna. During this DXpedition I only had horizontal dipoles. I knew nothing about the Hy-Gain Antenna Company and their fine all band vertical ground plane antennas. I wish I had known about them because I am sure I would have put out much better signals than I did. I asked the manager in what direction did the sun rise and set. Not having a compass with me I took his word and got the dipole up broadside to Europe and the USA. The old putt-putt was fired up and VQ9AA was on the air.

The fun began immediately, I mean to tell you I did business with a bang, it was one solid pile-up for over 12 hours without a let up. When I first got going, the island manager came to visit me, wanting to show the visiting American the island, its turtles, birds, etc. I could see that this fellow had the wrong impression of why I was there. He took me to be a tourist, I turned off the putt-putt and told him I wanted to have a good talk with him. We sat down on the back porch where my equipment was installed on the eating table of the guest house. I explained to him what ham radio was all about, telling him about DXers, telling him that Aldabra Island was one of the rarest spots on the world and that thousands of people all over the world were standing by to QSO me while I was there. I explained to him that lots of the expense of my getting there was paid by these fellows, and since I was an honest fellow I was obligated to do NOTHING BUT OPERATE while I was on the island. I told him if things sort of quieted down that I MIGHT HAVE TIME later on to do some visiting of the various parts of the island. I told him all I wanted to do was to sit at my operating table, hour after hour, day after day, and work the boys one after another until I had worked them all. I even asked him to have my meals at certain odd hours, during times I thought the bands' activity would be at their lowest. After that I had no more trouble with him wanting to show me around the island. After about 3 days operation I happened to notice EXACTLY where the sun settled into the sea and to my surprise it was not at the spot indicated to me before. My antennas were not broadside to Europe or the USA, they were off the ends.

The next day I changed this and all signals picked up about 2 S points from Europe and the USA. Another must for DXpeditioners—bring along your own compass and let it tell you where to squirt your signals. Don't take the words of anyone as to where is East and West, most of them don't know, they just think they do. Things were going fine with me. The food was very fine. Have any of you ever eaten real turtle steak or turtle liver? Or scrambled turtle eggs? The turtle steak is about twice as tender and twice as white as veal cutlets. The livers from these turtles are out of this world and could be cut with your fork. The eggs were about 75% yolk and were very fine when scrambled. I never did get tired of eating turtle meat, etc. Fish were prepared in many different ways. Fried, fish soup,

boiled fish, baked fish, fish curried and rice being very nice. They eat plenty of rice there and since I was from one of the rice eating parts of the world, I was right at home with it piled up high on my plate. Certain parts of coconut trees were nice, when boiled in soups, as well as bamboo shoots. I even had some sea shell soup, the sea shells are placed in boiling water, the meaty part cooked and then it sheds away from the sea shell. Maybe some people call this snail soup. They like plenty of pepper in their food. After explaining to my cook I did not like pepper he cut down from 195 degrees of pepper to about 125 degrees, explaining that he could not cook anything with less pepper. After a while my mouth got tough enough to take it OK.

I tried listening for Harvey, and finally heard him on about 14085 kHz about S 3. We were separated far enough apart so that we caused each other no QRM whatsoever since I had always used 14065 or 14035 kHz when on CW and about 14125 plus or minus when on SSB.

After about 3 days of operation my power plant konked out. Have you ever tried taking off the cylinder head of an engine with only a pair of regular pliers? Well I did. After cleaning off the surplus carbon, adjusting and cleaning the spark plug and even trying to clean up the valves the engine was put back together and still it was dead as a door knob. Plenty of spark was on the plug so it had to be the fuel system. Off came the carburetor and apart it came. One valve seat was completely plugged shut, this was cleaned and while trying to force the carburetor back together something went "crack." Apart came the carburetor again and I found that I had broken one of the needle valves that was made out of Teflon. No spare parts were along with me. It was either repair this broken needle valve or no more VQ9AA operation. I had my electric soldering iron with me but no electric current to heat it with. Try heating up your electric iron with 4 candles as I did. By being very careful I welded the Teflon needle valve back together, smoothing the welded spot with the hot iron, found that the carburetor gasket had got broken and found that a call book cover made a FB gasket for the carburetor. Back together went everything, and the putt-putt cranked up immediately, and I was back in business. The moral to this story for you future DXpeditioners—bring along at least some small spare parts and a few tools to take your power supply engine apart with. This is a MUST in my book.

At about sundown time on my first night on

Aldabra I was on the air with a big pile-up and all of a sudden I heard the doggondest noise outside. Flapping wings, squawking, screeching, thuds, etc. I rushed outside to see what was causing all this commotion and there were birds by the hundreds in what seemed to be a free-for-all. After watching this battle royal for a while I soon saw the pattern of what was taking place. The booby birds that were out fishing all day, filling their craws full of little fish for their young on Aldabra were coming home at sun-down and the other birds (let's call them falcons–they have another name; I forgot what it is) would hover way up high, spot a certain booby coming in about 50 feet above the water. The falcon would close his wings and down he would come like a stone, hitting the booby bird in the middle of his back, almost knocking the booby bird breathless I guess, this sudden jolt would cause the booby to heave up its crawful of little fish, the falcon would then curve up under the booby and grab a big mouthful of fish that had been spewed from the booby. This little episode took place every evening just before darkness came and it was better than Red Skelton on TV. I never did see any booby get thru with his crawful for the young. I was told that this has been studied and about 3 to 4% of the boobies do get thru. Whoever named these birds booby birds certainly selected a very descriptive name for them. They certainly are a booby to fish every day for the falcons to get their catch without working for it.

I soon settled down to a sort of regular operating schedule. About 5:30 AM (all these times local) I would get up, crank the power plant up, work the fellows until the band sort of leveled off at 10:00 AM; then eat breakfast; in the sack until about 2 or 3 PM, then it was dinner and on the air until about 2:30 AM a late snack to eat and to bed with the alarm clock set at 5:30 AM. This gave me enough sleep and still satisfied the gang with enough activity and openings for everyone.

After the first week the big pile had been worked down to a small one and I began to have more time to look around the island like a good tourist should. I was shown the turtle pond where they kept usually around 200 of those big turtles awaiting the boat from Mahe which came when it was available. No certain schedule at all but usually every 3 or 4 months to pick up the live turtles and take them on deck back to Mahe where they were put into the turtle pond there and sold as they were needed. Fishing on Aldabra is done on what looked to me to be a large scale. Each boat went out every day and caught a boat full of fish. It did it the hard way, by spearing the fish. When the fish are brought ashore they are cleaned up, covered with what looked like ice cream salt and put out in the sun to dry. Later on this dried fish is sent back to Mahe to be used there and some shipped probably to Africa. Copra (dried coconut meat) is done on a fairly large scale, too. No one seemed to be working very hard. They have a certain amount of work to do each day and most of them could do their daily task in about 6 hours. Of course a few eager beavers worked longer for extra consideration. But this was the exception rather than the rule.

I finally had a QSO with Harvey who was operating from the other end of the island and was told that we were going to stay there for a total of 17 days—this was indeed FB news for me. If there is ever a repeat of Aldabra I will be prepared for some 40 and 80 meter operation and thereby hand out a new country to everyone on these bands. Maybe even 160 meters. Conditions seemed very good to me while I was there, I wonder how they would sound if I were there during the good part of the sunspot cycle? Can you picture the stations you could work from there when 10 meters thru 80 opened up. Around the clock openings would really work a fellow to death. But what a FB way to die? Hi, Hi!

While on Aldabra I got a message from Peggy thru Ack that we had to build a new house. It's a long story about a land deal I will not take the time to repeat on these pages. But on account of a deal on land Peggy said a new house had to be built. I told her to go ahead and build it and to not forget THE HAM SHACK. Let me tell you I did get a ham shack built too. A lot larger and nicer than I would have had the nerve to build myself. Peggy even got my 150 tower taken down and the 5 element beam taken apart too. Boy I really found out what a nice XYL I had and to this day she has not changed in the least—in fact she gets better all the time, still bringing my breakfast into the ham shack each morning, and even supper if I ask her to. There just aren't many like good old Peggy, this I am sure of. How many of you fellows' wives would let you leave them for first 7 months, then for TWO YEARS? I think the percentage would be below 1%. Peggy says to me her first obligation in our marriage is to make me happy and she likes to also make others happy and this is her method of doing just this.

Coaxial Accessory Handbook

Jim Fisk WA6BSO

In addition to the coaxial cable and connectors required in a coaxial transmission system, coaxial relays, switches, standing wave meters, attenuators and dummy loads are often included as operating conveniences. When choosing these coaxial accessories, the operating parameters should be evaluated in exactly the same way as for the cable and connectors. If the selected accessory exhibits excessive power loss or results in a large standing wave ratio, deterioration in transmission line efficiency may be expected.

Coaxial relays

Of all the coaxial accessories available, the coaxial changeover relay is probably the most important. In almost every amateur station where a coaxial transmission line is employed, some type of coaxial relay is used to switch the antenna between the receiver and transmitter. However, the indiscriminate selection and use of a coaxial relay may lead to problems, particularly in the VHF or UHF bands or when using a transistorized rf stage in the receiver.

Generally speaking, coaxial switches may be grouped into two general categories, depending upon the switching mechanism. The more familiar of these is the bladed variety, in which the center conductor of a coaxial section is actuated by a solenoid. Most relays in current use are of this type. In the second category, a moving coaxial section (both inner and outer conductors) transfers rf power by solenoid actuated rotation. This switch is the more complex of the two and is normally used only at frequencies above 500 mc.

The contact arrangement most commonly found is the single pole, double throw (SPDT) type, but other arrangements are available for special applications. Most coaxial relay manufacturers will provide additional auxiliary contacts at a slightly higher cost. These contacts are useful for switching other circuits simultaneously with the antenna.

Once the basic type of switch and the required contact arrangement have been determined, the standing wave ratio, insertion loss and isolation of the switch should be reviewed.

The standing wave ratio is the major element of transmission efficiency through the switch. Basically, it is a comparison of the characteristic impedance of the switch to that of the transmission line into which it is installed. For most amateur applications, an SWR up to 1.5 or occasionally 2.0 is satisfactory, but seldom greater than 2.0:1.

Crosstalk is another important consideration. This is a measure of the rf leakage between the used and unused contacts of the relay. This relative isolation between contacts is expressed in "decibels down," meaning the leakage signal is down to some percentage of the operating signal. Since crosstalk is a result of the capacitive coupling between the operating and unused circuits, it increases at high operating frequencies (i.e., as the capacitive reactance decreases). At 400 mc, the single bladed coaxial switch exhibits typical crosstalk of 40 db down. To reduce crosstalk further, it is necessary to employ shorting contact construction in which the unused connector is terminated in a short-circuit. This is an absolute necessity when transistorized rf amplifiers are used in the receiver. The Dow-key DK-60G coaxial relay is of this type construction and exhibits greater than 100 db isolation at 500 mc.

Insertion loss is a measure of the power loss within the switch itself and is expressed as:

$$\text{Loss in db} = 10 \log \frac{(\text{power output})}{(\text{power input})}$$

This loss includes the resistive loss of the con-

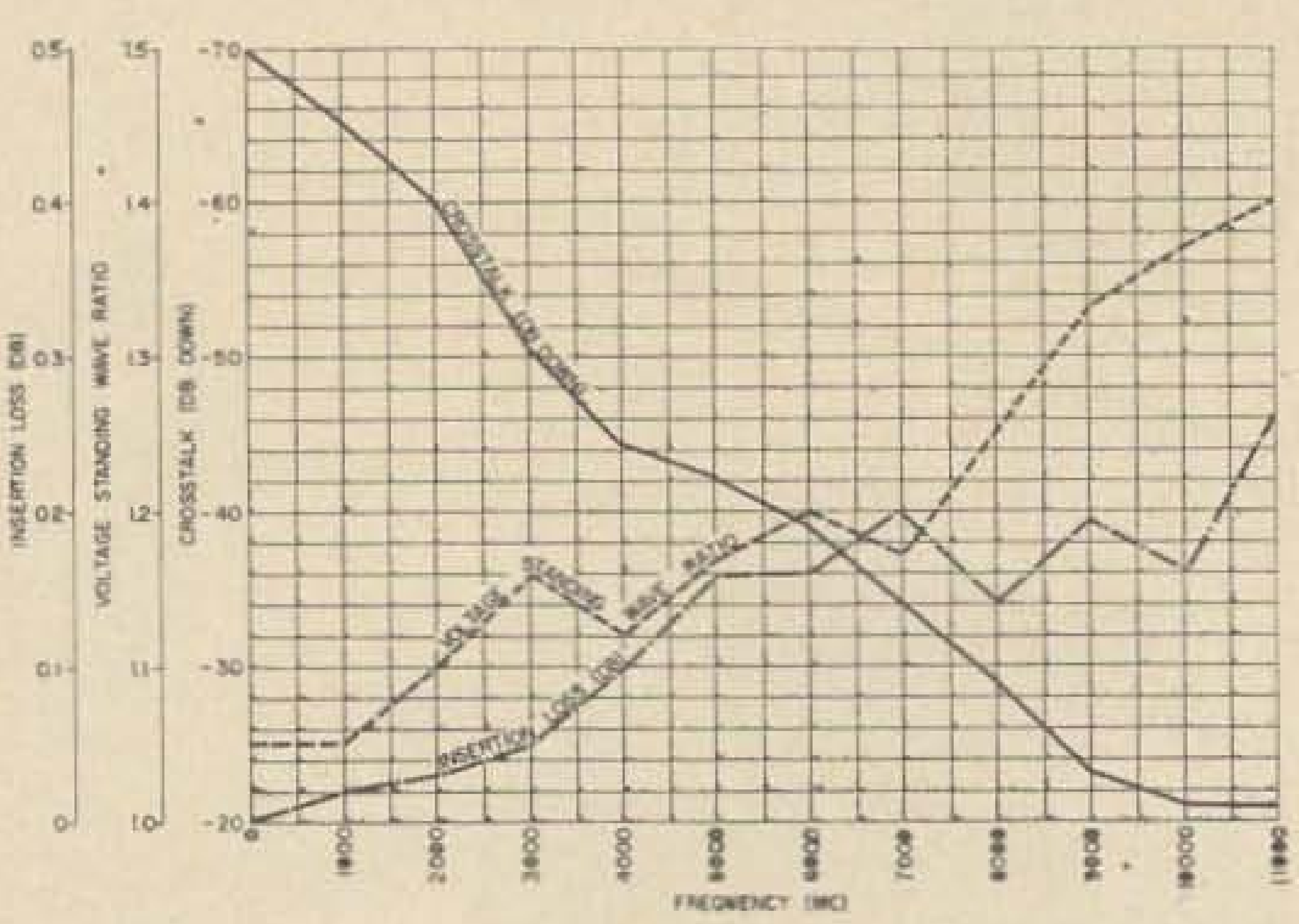


Fig. 1. Typical operating characteristics of the Transco Series-Y coaxial switches.

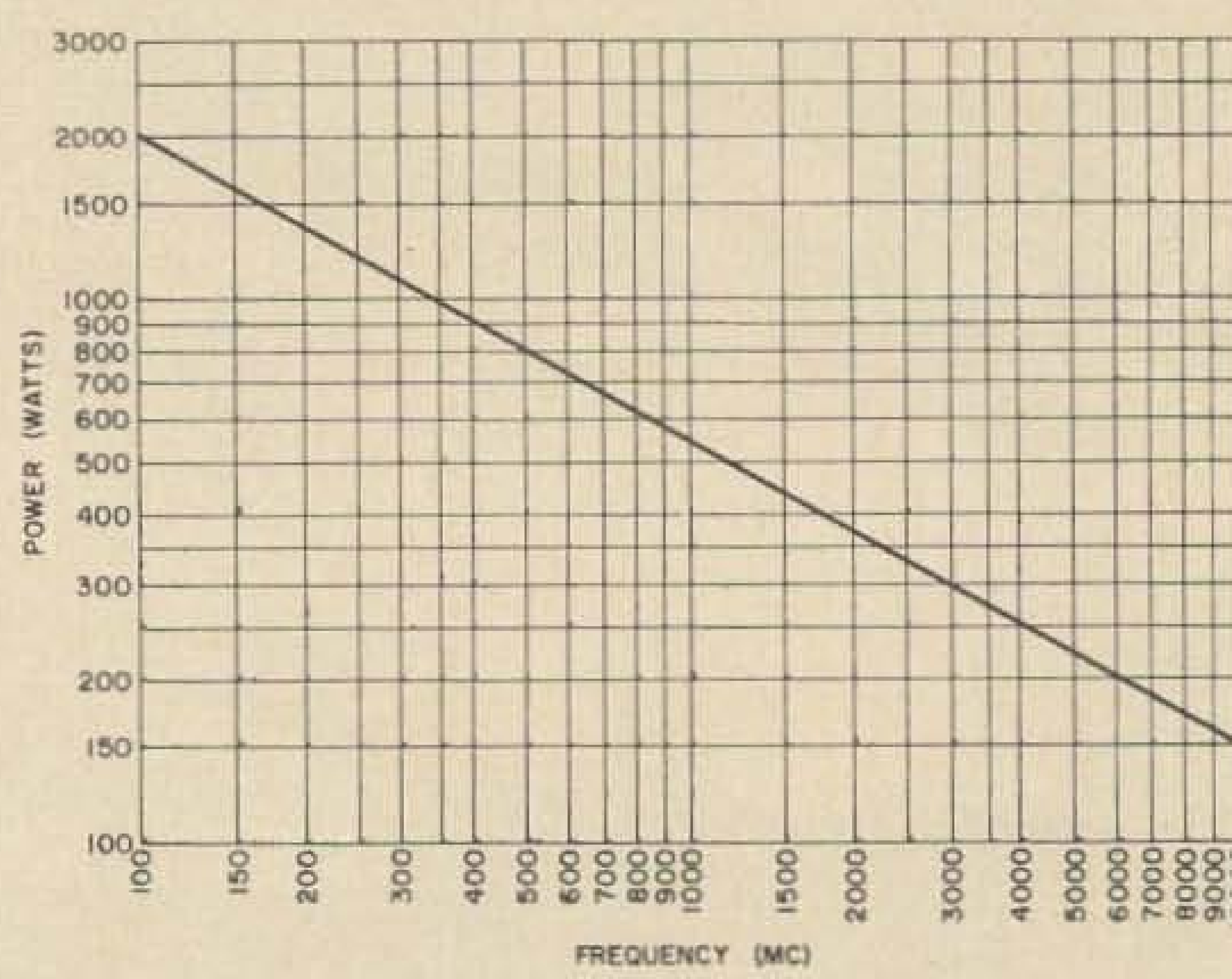


Fig. 2. Power handling ability of the Transco Series-Y coaxial switches.

Table 1. 50 ohm Coaxial Changeover Relays

Manufacturer	Switch Type	Model Number	SWR	Maximum Frequency	Power (watts)	Auxiliary Contact	Solenoid Voltages	Connector Types
Advance	SPDT	CB/1C	—	300	—	Yes	12, 24 VDC, 115 VAC	UHF
Amphenol	SPDT	315	1.15 at 500 mc	1000	100 at 1000 mc	No	6-120 VDC or AC	BNC
Amphenol	SPDT	316	1.20 at 2200 mc	2750	100 at 2750 mc	No	6-120 VDC or AC	BNC
Amphenol	SPDT	316	1.20 at 2400 mc	4000	100 at 4000 mc	No	6-120 VDC or AC	N
Amphenol	SPDT	317	1.20 at 2200 mc	2750	100 at 2750 mc	No	26 VDC, 115 VAC	BNC
Amphenol	SPDT	317	1.20 at 2400 mc	4000	100 at 4000 mc	No	26 VDC, 115 VAC	N
Amphenol	SPDT	318	1.20 at 2200 mc	2750	100 at 2750 mc	No	26 VDC	BNC
Amphenol	DPDT	321	1.15 at 500 mc	1000	100 at 1000 mc	No	115 VAC	BNC
Dow-Key	DPDT	DK2-60	1.15 at 500 mc	500	1000 at 500 mc	Yes	6-220 VDC or AC	BNC, N, C, UHF
Dow-Key	SPDT	DK-60	1.50 at 500 mc	500	1000 at 500 mc	Yes	6-220 VDC or AC	BNC, N, C, UHF
Dow-Key	SPDT	DK-61	1.10 at 400 mc	1000	100 at 1000 mc	Yes	6-220 VDC	BNC
Dow-Key	SPDT	DK-67	1.30 at 2000 mc	2000	100 at 2000 mc	Yes	6-220 VDC or AC	BNC
Dow-Key	SPDT	DK-77	1.10 at 400 mc	1000	250 at 1000 mc	Yes	6-110 VDC	BNC
Magnecraft	SPDT	128	1.25 at 500 mc	500	100 at 400 mc	Yes	12, 24 VDC, 115 VAC	UHF

tacts, the dielectric loss of the insulators and any reflective loss due to impedance discontinuities. The dielectric loss is normally quite low in modern coaxial relay design and the resistive and reflective losses contribute most to the overall insertion loss of the unit. The resistive losses are minimized by using short, silver-plated conductors but the reflective loss is more difficult to control, especially at high frequencies. However, up to about 1000 mc, the insertion loss of well designed coaxial switches is negligible when compared to the transmission lines with which they are used.

Most coaxial relay manufacturers have a wide assortment of units available which will satisfy nearly any application. These relays may be furnished with 6 volt to 220 volts ac or dc solenoids, UHF, BNC, N, or C connectors, power ratings up to 1000 watts at 1000 mc and low standing wave ratios up to 10,000 mc. Although the Dow-Key line of coaxial relays probably finds the greatest use in amateur stations because of their wide availability and relatively low cost, other manufacturers include Advance, Amphenol, Magnecraft and Transco. **Table 1** lists the operating characteristics of the major types of coaxial relays available from these manufacturers.

Whereas most of the switches in **Table 1** are of the leaf variety, the Transco relay uses a moving coaxial section for greater power handling, isolation and low SWR characteristics up to 11,000 mc. This unit was designed to meet the requirements for a small, lightweight, coaxial switch having good rf characteristics over a broad bandwidth and is widely used by the military. In the Transco switch, two independently operating solenoids allow either make before break or break before make operation. Also, rf positions may be both on or off simultaneously. For the UHF enthusiast the surplus Transco switch offers superior operating characteristics at a modest cost. Typical operating and power handling properties of this unit are shown in **Fig. 1** and **2**.

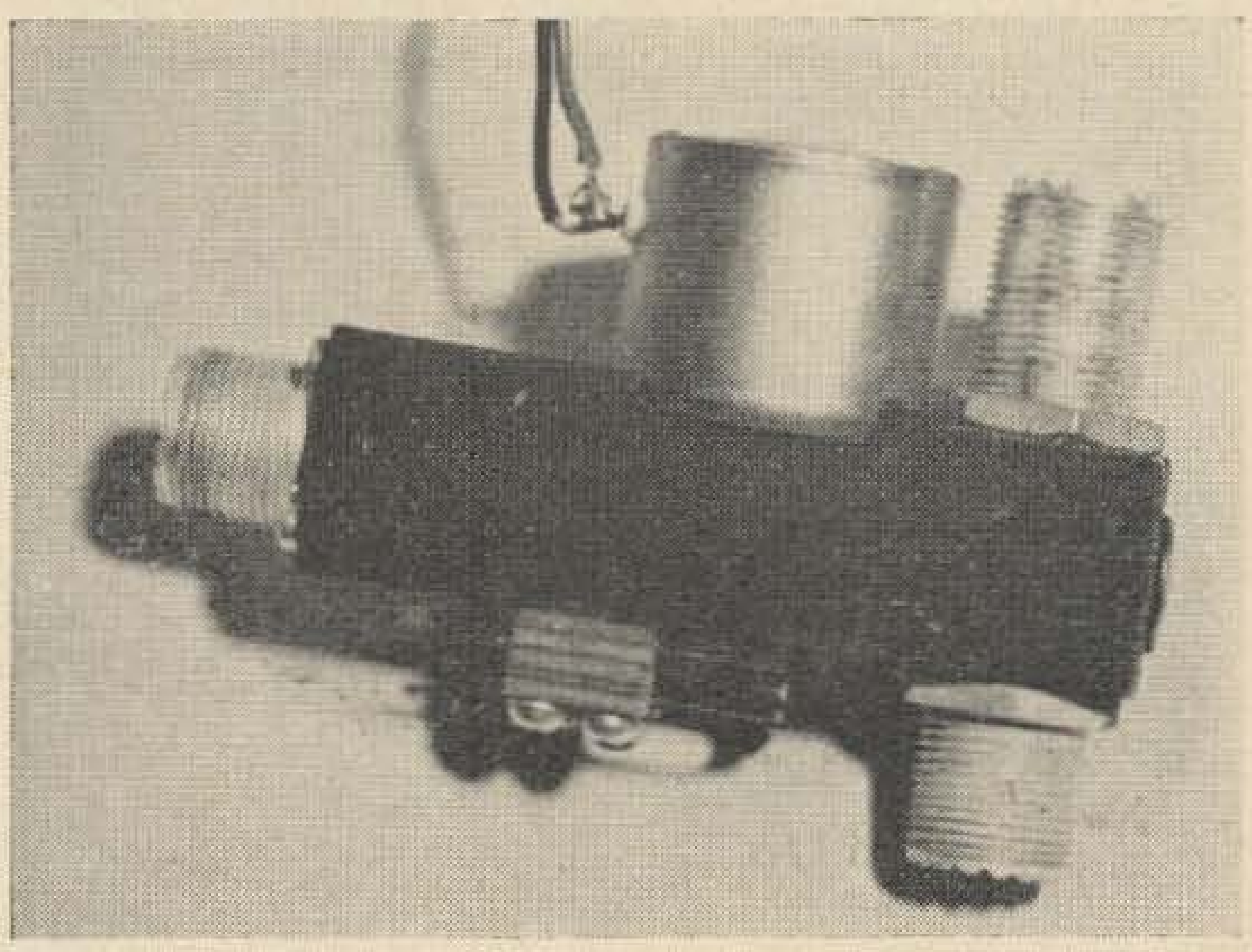


Photo by WA6IAK.

The Dow-Key Model DK60-G2C coaxial relay. The design of this unit is such that it provides excellent isolation up to 500 mc with minimum insertion loss.

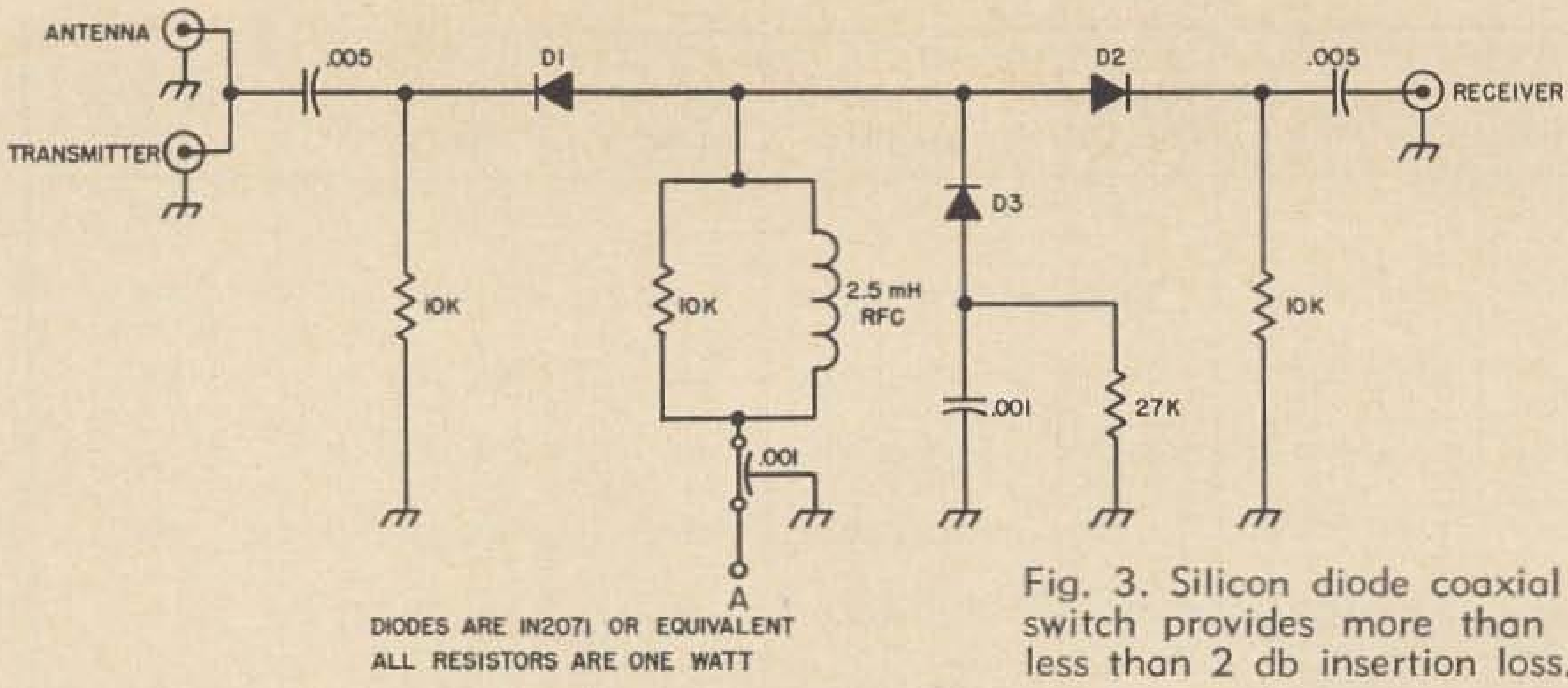


Fig. 3. Silicon diode coaxial antenna switch. This switch provides more than 80 db isolation with less than 2 db insertion loss.

Although the coaxial type of changeover relay seems like the simplest and most direct way of switching the transmission line from transmitter to receiver, it is somewhat noisy and in some cases, slow. There have been several electronic T-R switches introduced over the past few years, first with vacuum tubes and more recently with silicon diodes, which solve these problems. The solid state diode switch for example, is extremely fast, completely noiseless, exhibits up to 80 db of isolation with only 2 db insertion loss and is very simple and economical to build. The simplest of these switches is illustrated in **Fig. 3.** This switch uses three inexpensive silicon diodes, a few bias resistors, several capacitors and a choke to perform efficient switching of coaxial transmission lines up to 30 mc. To understand the mechanics of this switch, it must be remembered that a reverse biased diode presents an extremely high impedance while the forward biased device looks essentially like a short-circuit. With these facts in mind, consider the operation of this three diode switch when a positive voltage is applied to point A; diode D1 and D2 will conduct and present a low impedance while diode D3 presents a high impedance because it is reverse biased. Under this condition an rf signal on the antenna passes to the receiver with very little attenuation.

Photo courtesy Barker & Williamson, Inc.
The B&W electronic T-R switch is an automatic unit that automatically switches the transmission line from receiver to transmitter when transmitting. This type of a switch is ideal for break-in operation and results in substantial receiver gain in most installations.

If a negative voltage is introduced at point A however, diode D1 and D2 will no longer conduct and diode D3 will present a low impedance to ground because it is forward biased. Any rf signal on the antenna is confronted by the high impedance presented by the reverse biased diode D1. A certain amount of rf energy will leak by this high impedance, but the high impedance presented by diode D2 must still be surmounted. A much easier path for the rf exists through the low impedance path to ground provided by diode D3 and the series bypass capacitor. With this type of switching up to 80 db isolation can be obtained with a minimum of effort.

One of the most important considerations in diode switches is the amount of rf power they can safely handle. Actually, there are two separate and distinct ratings that are of interest; peak power and average power. The peak inverse voltage (PIV) rating of the diode determines the maximum peak power that the diode can control. The average power which the diode can safely switch is dictated by its power dissipation and series resistance. Since the series and shunt diode circuits operate in somewhat opposite ways, it would not be unusual to expect that their power ratings might be different. This is in-

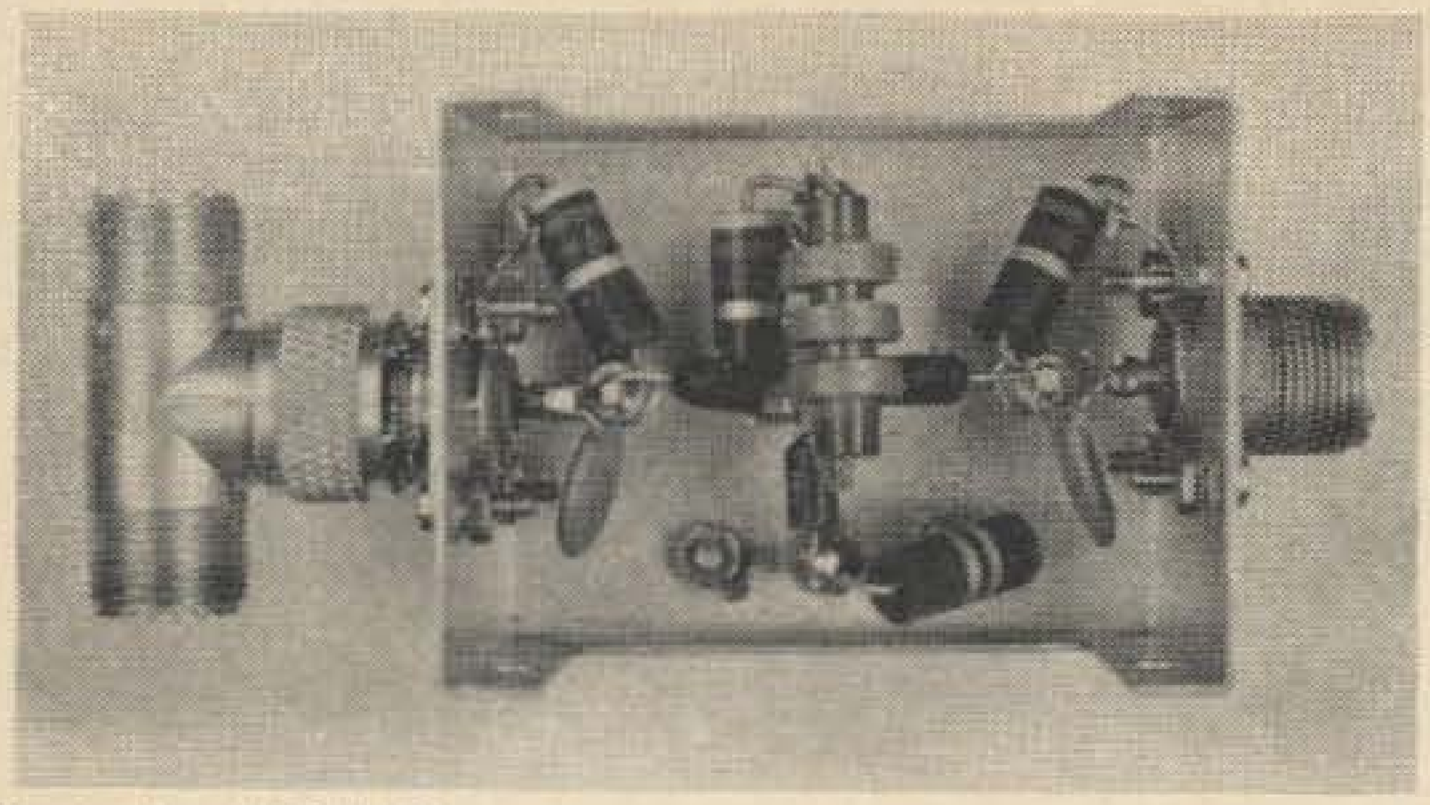


Photo by VE2AUB.

This simple silicon diode controlled T-R switch provides more than 80 db isolation and less than 2 db insertion loss from 3.5 to 30 mc. This unit uses three inexpensive silicon diodes and may be easily duplicated in the home workshop.

deed the case and it is interesting to note that although the shunt circuit has twice the peak power rating of the series circuit, its average power rating is only one-quarter as much as that of the series arrangement. For 50 ohm coaxial transmission lines operating with an SWR of 1:1, the respective power ratings may be calculated from the following equations:

Series

Peak power = $(PIV)^2/1600$

Average power = 25 Pd

Shunt

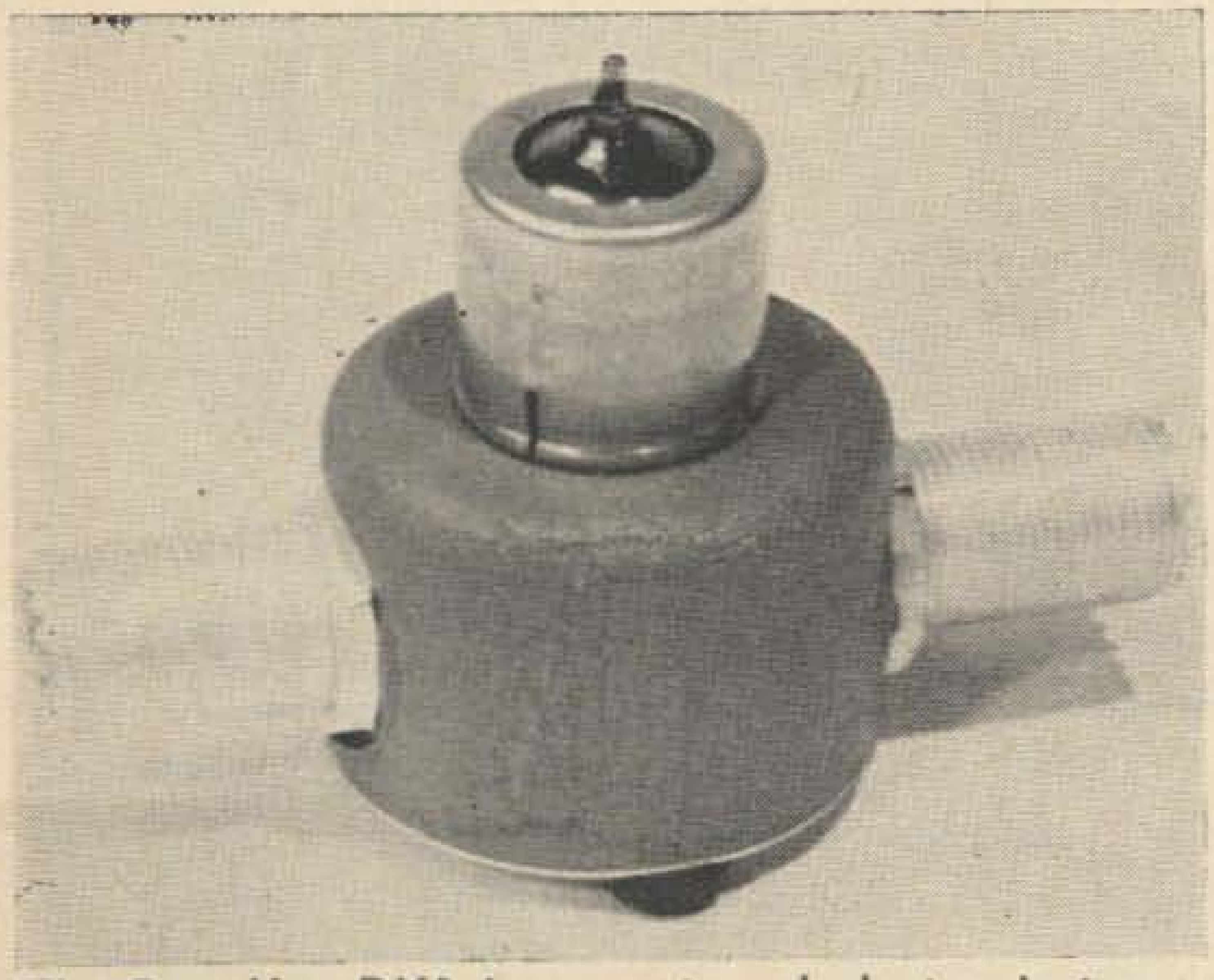
Peak power = $(PIV)^2/400$

Average power = 6.25 Pd

Where: PIV = Peak inverse rating of the diode (volts)

Pd = Power dissipation rating of the diode (watts)

From these formulas it can be readily found that to control the peak power of a 1000 watt CW transmitter operating at 70% efficiency (700 watts into the transmission line), a series diode would require a PIV of 1058 volts; under the same conditions a shunt switching diode would require a PIV of 529 volts. For insurance against blowing the diodes under peak power loads or SWR changes, a safety factor of 50% should be added to these figures. In the diode switch in **Fig. 3**, both the shunt and series diodes are used, so both of the above power formulas must be considered in using a switch of this type.



The Dow-Key DK1 is an untuned electronic transmit-receive switch for coaxial lines which may be used from 80 through 10 meters.

Coaxial switches

When it is necessary to switch several circuits simultaneously or to increase the number of throws over the simple SPDT coaxial changeover relay, the most straightforward approach is to use a rotary coaxial switch. With these units, switching may be accomplished in a fraction of a second, thereby eliminating the need for screwing and unscrewing coaxial fittings and the possibility of an incorrect connection.

These switches are available in both manual and solenoid operated versions suitable for frequencies up to 1000 mc. Usually the leaf-type wafer switch is used as the switching mechanism, but more expensive types employ a moving coaxial section similar to that illustrated in **Fig. 4.**

Selection of rotary coaxial switches is much the same as that for coaxial relays, with SWR, isolation, and power capacity being the main points of interest. For comparison purposes, the operating characteristics of various rotary

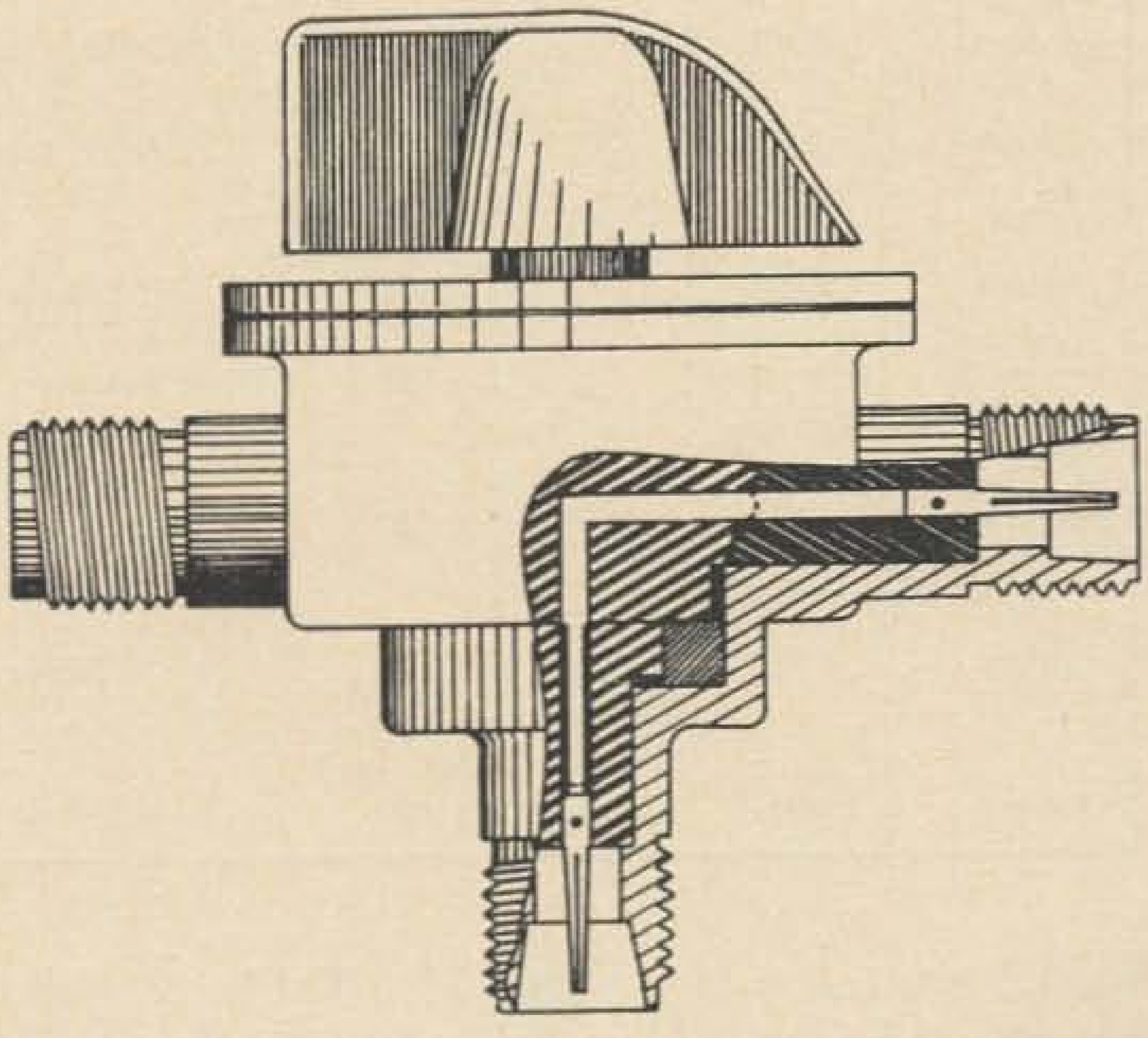


Fig. 4. Cross section of a coaxial switch which has a low standing wave ratio up to several thousand megacycles. Note that both the inner and outer conductors are switched together.

Table 2. Coaxial Switches

Manufacturer	Switch	Model Number	Impedance (ohms)	SWR	Maximum Frequency	Power (watts)	Isolation	Connectors
B & W	SP5T	550A	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	SP2T	550A2	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	Single Transfer	551A	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	SP5T	560	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	BNC
B & W	Single Transfer	561	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	BNC
B & W	SP5T	570	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	N
B & W	SP5T	580	52 or 75	—	50 mc	250 at 50 mc	45 db at 30 mc	Phono
B & W	SP5T	590	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	2P2T	591	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
B & W	SP2T	592	52 or 75	—	50 mc	1000 at 50 mc	45 db at 30 mc	UHF
Dow-Key	SPDT	DK78-2	50	1.10 at 500 mc	500 mc	1000 at 500 mc	60 db at 400 mc	UHF, BNC, C, N
Dow-Key	SP3T	DK78-3	50	1.10 at 500 mc	500 mc	1000 at 500 mc	60 db at 400 mc	UHF, BNC, C, N
Dow-Key	SP6T	DK78-6	50	1.10 at 500 mc	500 mc	1000 at 500 mc	60 db at 400 mc	UHF, BNC, C, N
Dow-Key	Single Transfer	DK78-T	50	1.10 at 500 mc	500 mc	1000 at 500 mc	50 db at 400 mc	UHF, BNC, C, N
Dow-Key	SP6T	DK71	50	1.10 at 100 mc	500 mc	1000 at 500 mc	40 db at 100 mc	UHF, BNC, C, N
Dow-Key	SP3T	DK-72	50	1.10 at 100 mc	500 mc	1000 at 500 mc	40 db at 100 mc	UHF, BNC, C, N
PIC	SP5T	PS750	50 or 72	1.2 at 100 mc	100 mc	1000	45 db at 30 mc	UHF
PIC	SPDT	PS751	50 or 72	1.2 at 100 mc	100 mc	1000	45 db at 30 mc	UHF
PIC	Single Transfer	PS752	50 or 72	1.2 at 100 mc	100 mc	1000	45 db at 30 mc	UHF
Sentry	SP3T	—	52 or 75	—	50 mc	250 at 50 mc	—	UHF
Waters	SP6T	335	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	Single Transfer	336	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	SPDT	341	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	Dual Transfer	351	50	1.20 at 150 mc	150 mc	1000	—	UHF
Waters	SP6T	375 Protax	50	1.2 at 150 mc	150 mc	1000	—	UHF
Waters	SP5T	376 Protax	50	1.2 at 150 mc	150 mc	1000	—	UHF
Waters	SP5T	378	50	1.2 at 150 mc	150 mc	1000	—	UHF

coaxial switches are listed in **Table 2.** The majority of coaxial switches currently available fall into one of the six basic switching configurations illustrated in **Fig. 5.**

Selector switches were designed primarily for switching the output (or input) of a coaxial transmission line between various antennas, or dummy loads. However, they may be used in any installation where similar type switching is desired. The single transfer

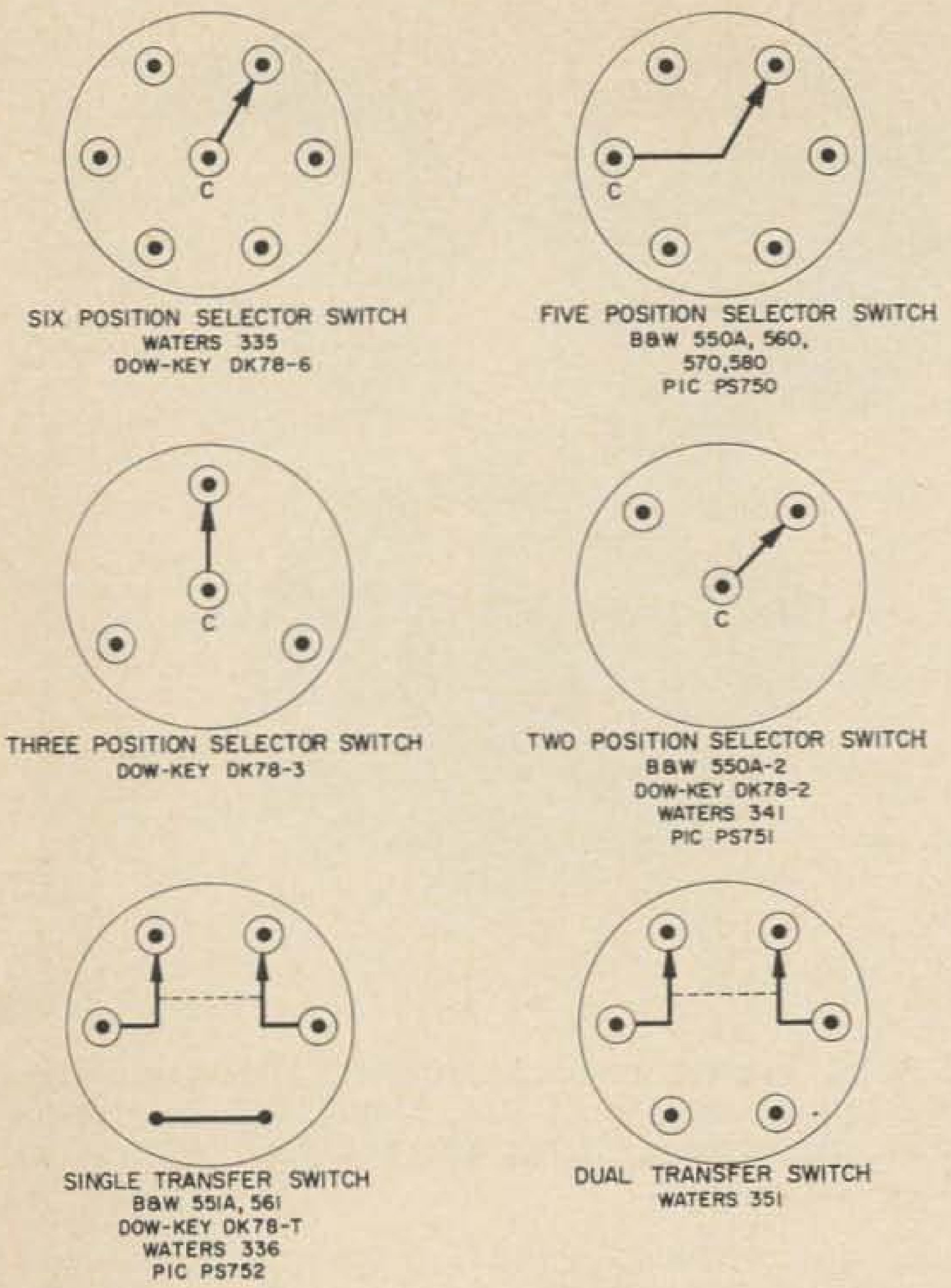


Fig. 5. Switch contact arrangements of commercial coaxial switches.

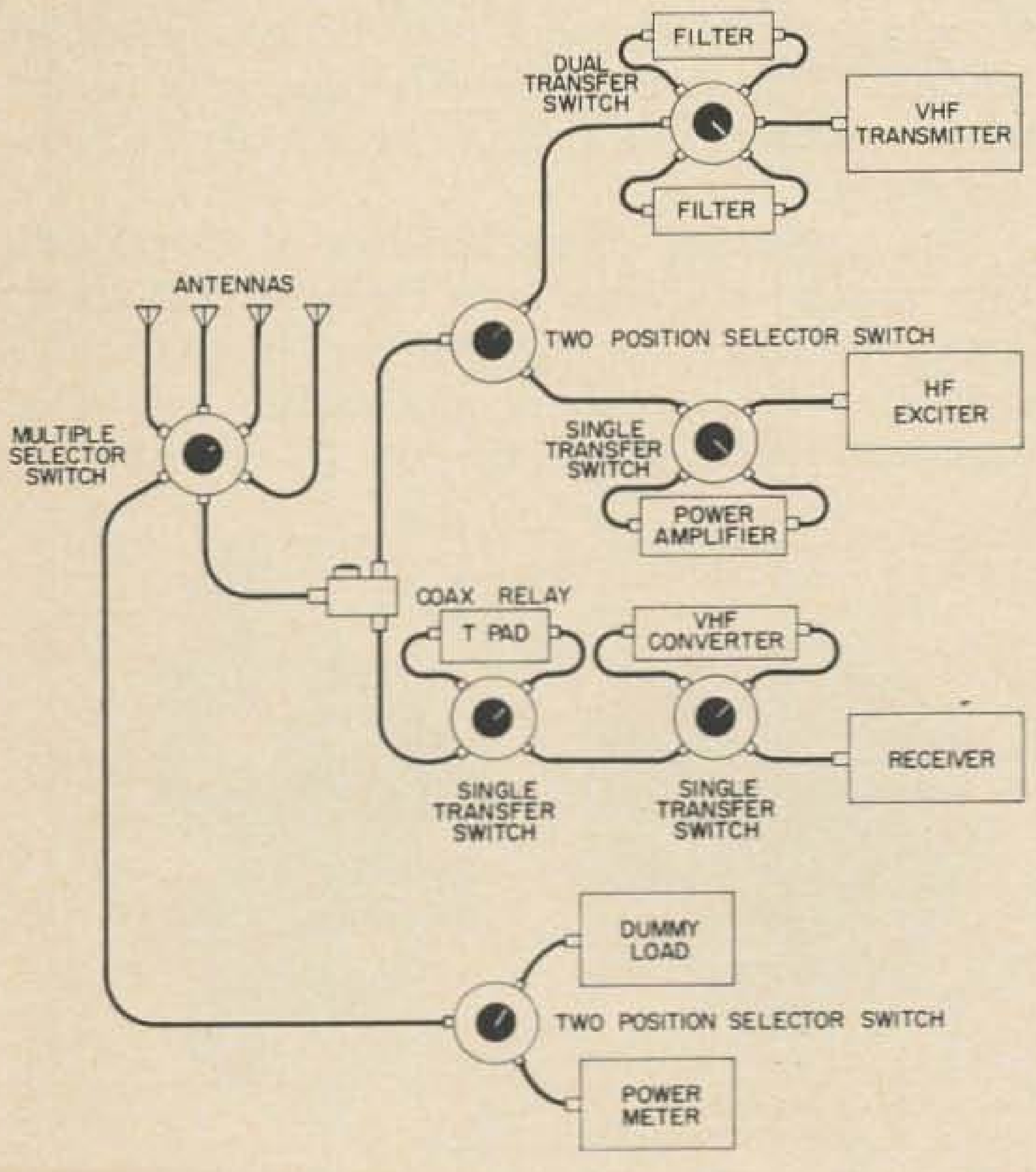


Fig. 6. A typical coaxial switching arrangement, with all the coaxial switching requirements of a ham station being accomplished with coaxial switches. This arrangement is much handier than screwing and unscrewing fittings every time you want to change a cable.

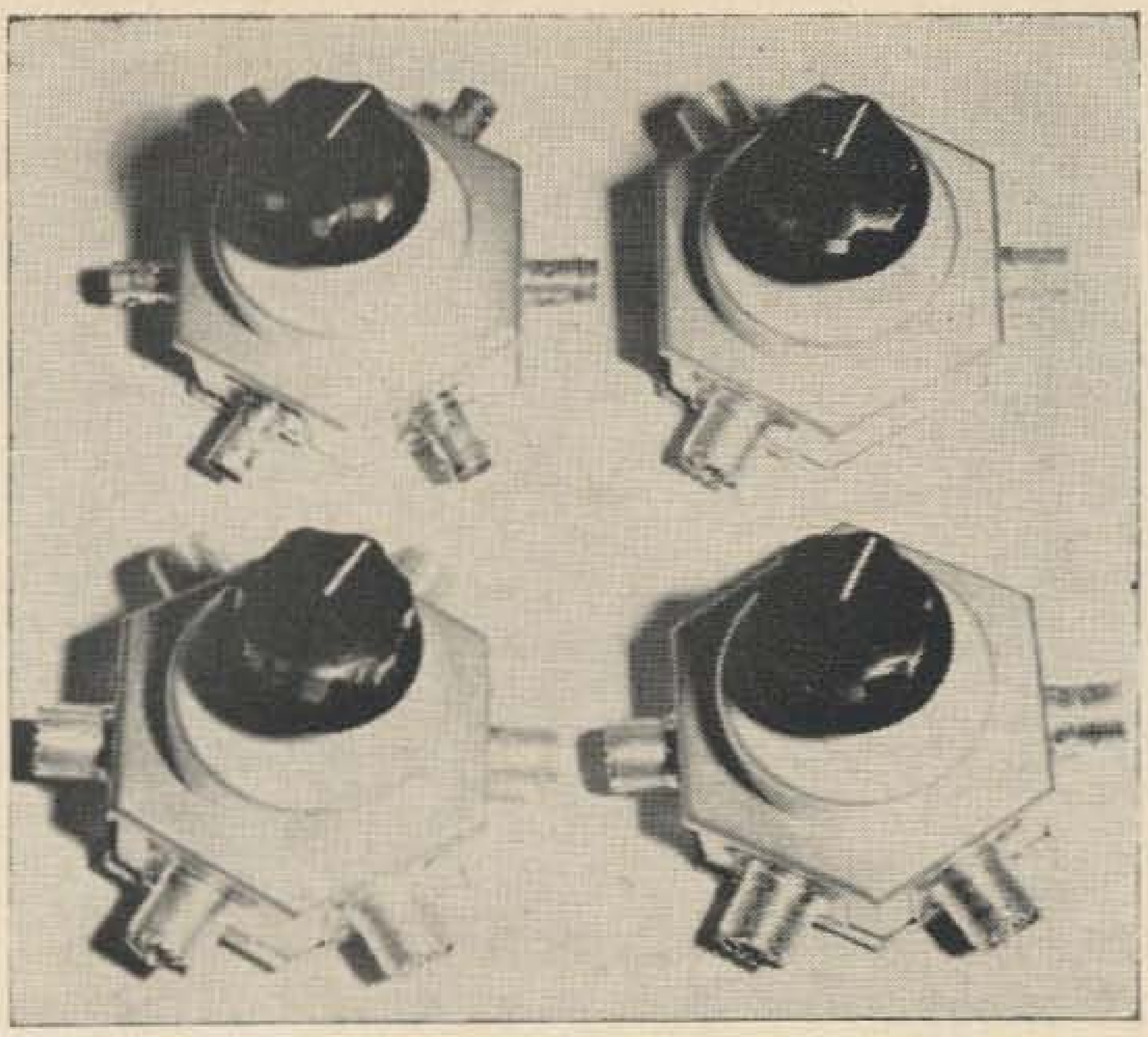


Photo by WA6IAK.

Several Barker and Williamson coaxial switches. Clockwise from the upper left: Model 560 with BNC connectors, Model 550A2 with UHF connectors, Model 551A coaxial transfer switch and Model 550A with UHF connectors.

switch is intended for switching various devices in or out of series connection with low impedance coaxial lines. Some of the uses are switching antenna current meters, antenna tuning devices, baluns, etc., in or out of the antenna feedline system. They may also be used to switch coaxial coupled power amplifiers in or out of the antenna circuit at will, thereby permitting the exciter to be connected directly to the antenna during local communications. The dual transfer switch is useful in switching converters, filters, etc., in

Photo courtesy Polyphase Instrument Co.

The PIC Polyswitch is a compact rf switch of modern design which may be used with a full 2 kilowatts PEP up to 100 mc. These switches are available in three basic models which will satisfy nearly any requirement.

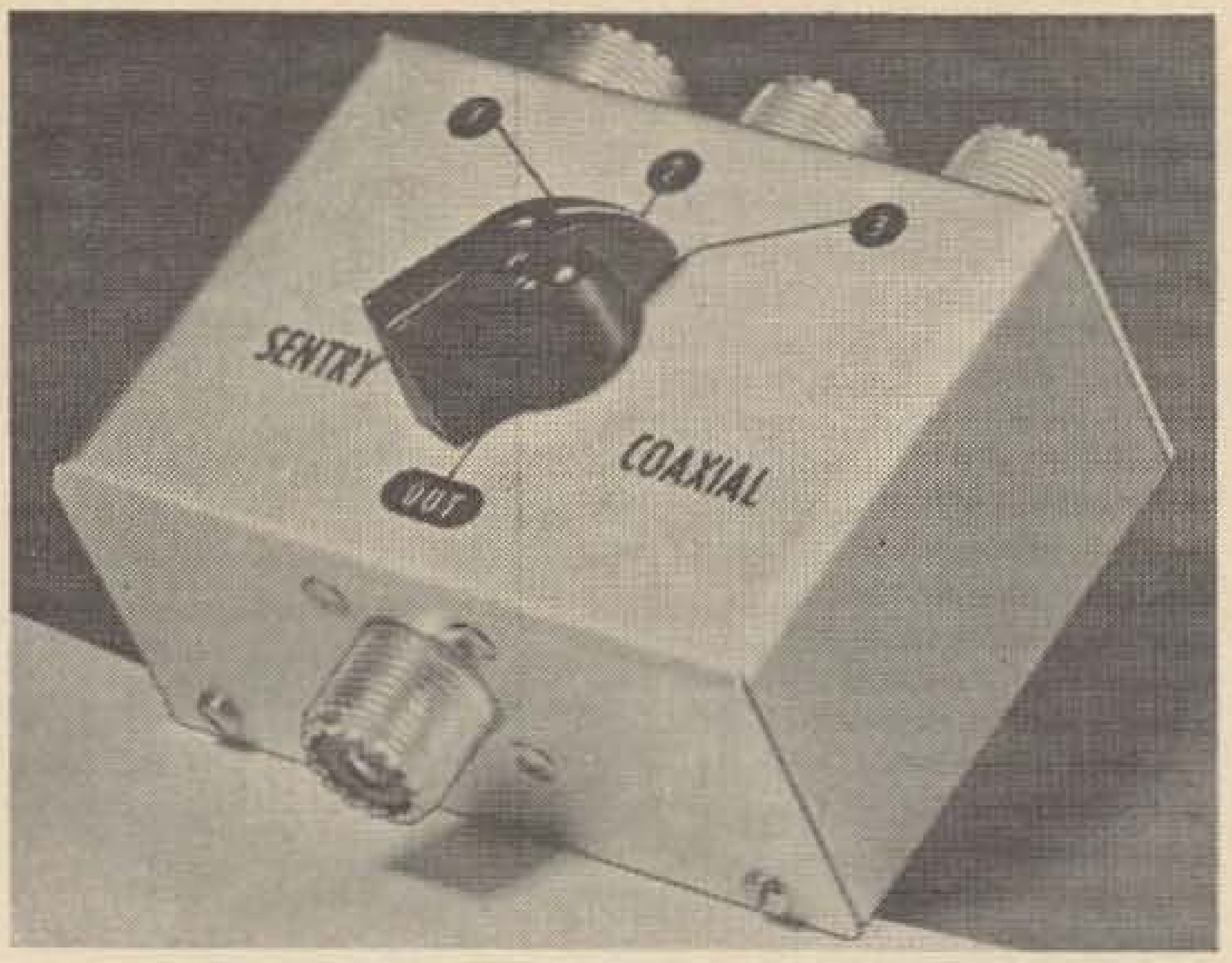


Photo courtesy Sentry Manufacturing Co.

The Sentry SP3T coaxial switch may be used to switch up to three coaxial transmission lines. It is furnished with standard series UHF connectors and will handle up to 250 watts of rf power.

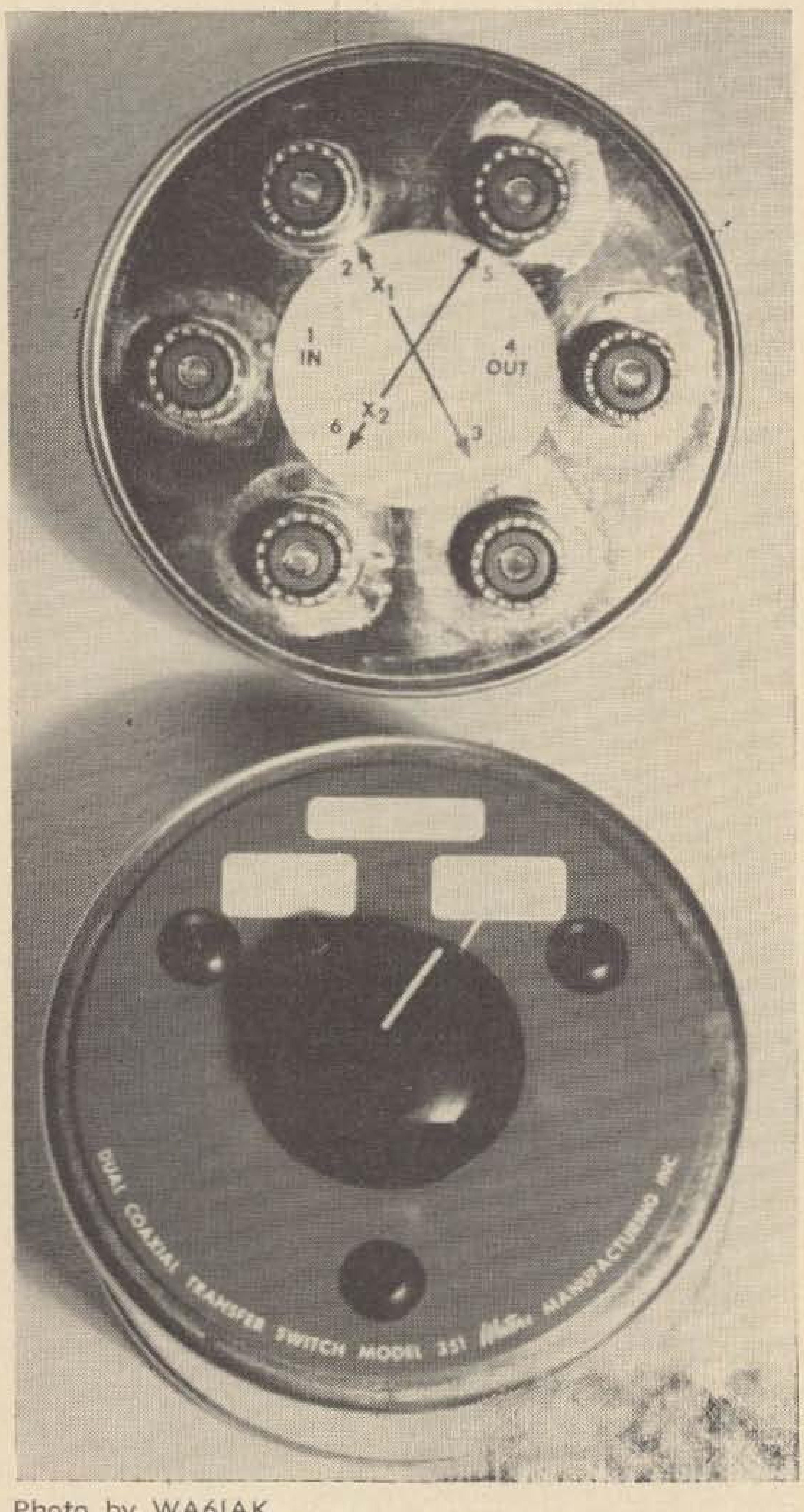


Photo by WA6IAK.
The Waters Model 351 coaxial transfer switch.

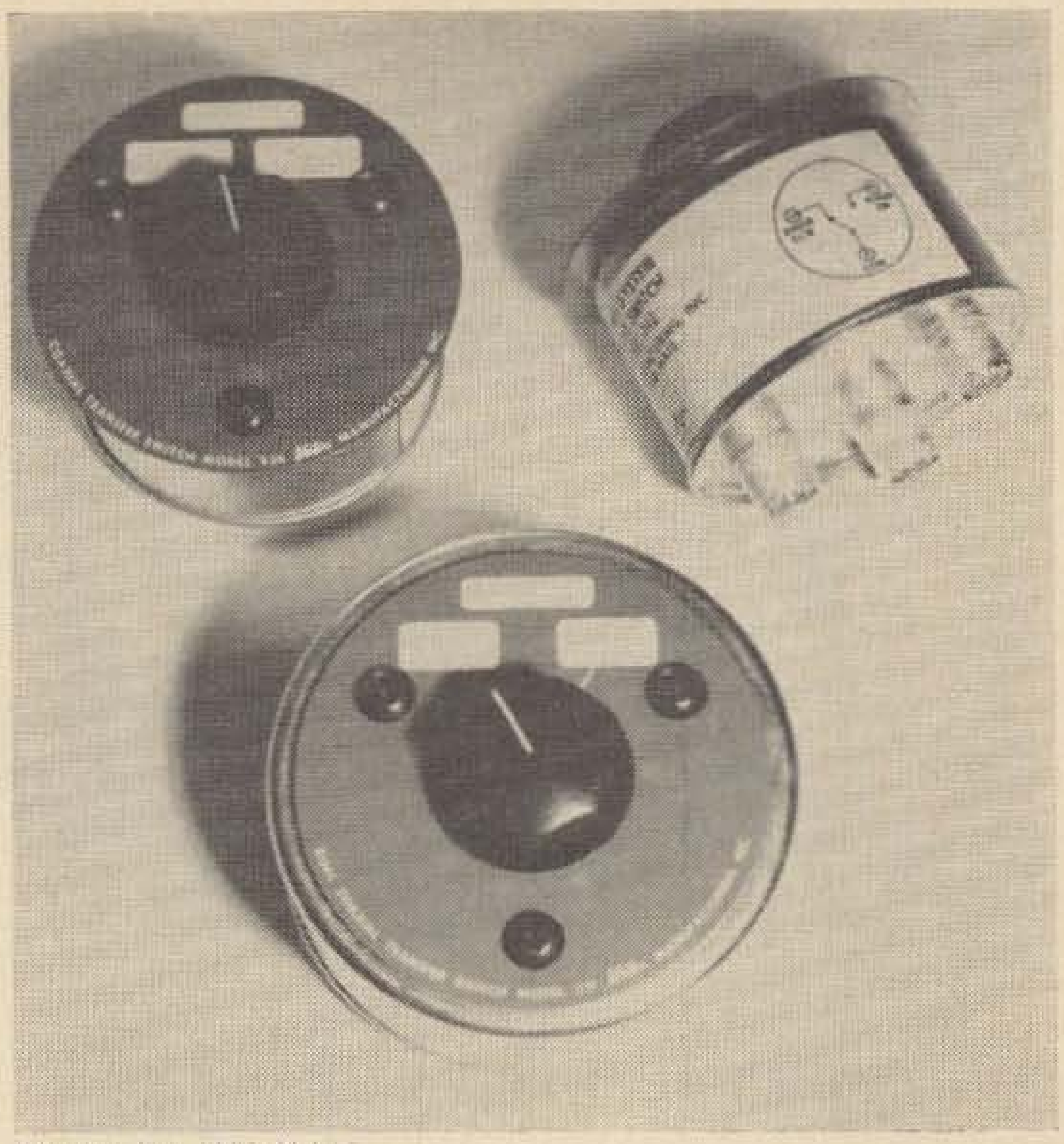


Photo by WA6IAK.
Several Waters coaxial switches. Clockwise from the upper left: Model 336, Model 341 and Model 351. All these switches are equipped with series UHF connectors.

and out of the transmission system. Some typical applications for these switches are depicted in **Fig. 6.**

In addition to their normal line of single section coaxial switches, Barker and Williamson offers multiple gang types where up to six single gang switches may be connected in tandem. This arrangement is especially useful where several circuits must be switched simultaneously.

The operating characteristics of the Dow-Key coaxial switches are charted in **Fig. 7.** These switches do not use the simple wafer switch as the switching mechanism and offer excellent rf characteristics up to 500 mc. In

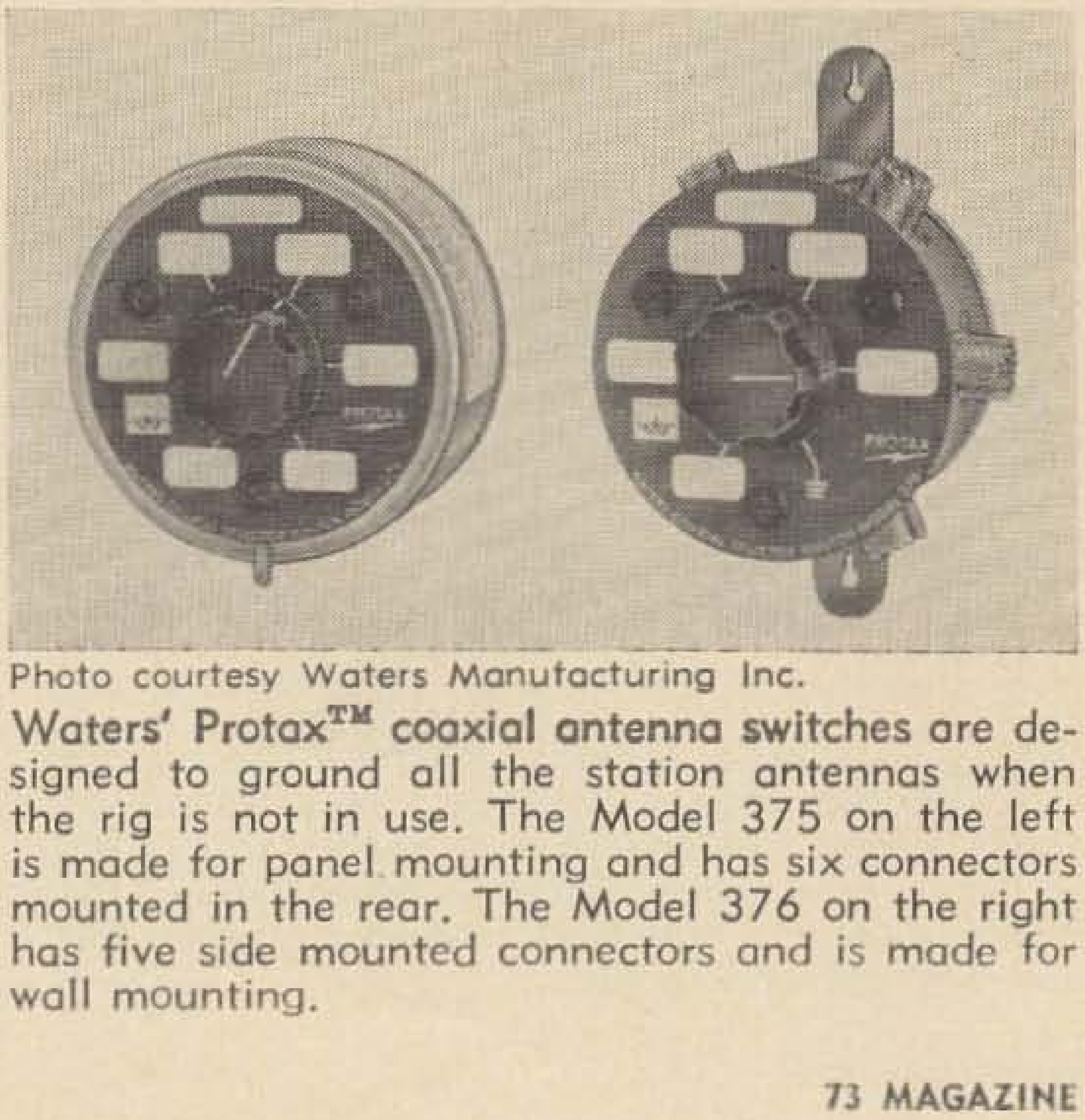


Photo courtesy Waters Manufacturing Inc.
Waters' Protax™ coaxial antenna switches are designed to ground all the station antennas when the rig is not in use. The Model 375 on the left is made for panel mounting and has six connectors mounted in the rear. The Model 376 on the right has five side mounted connectors and is made for wall mounting.

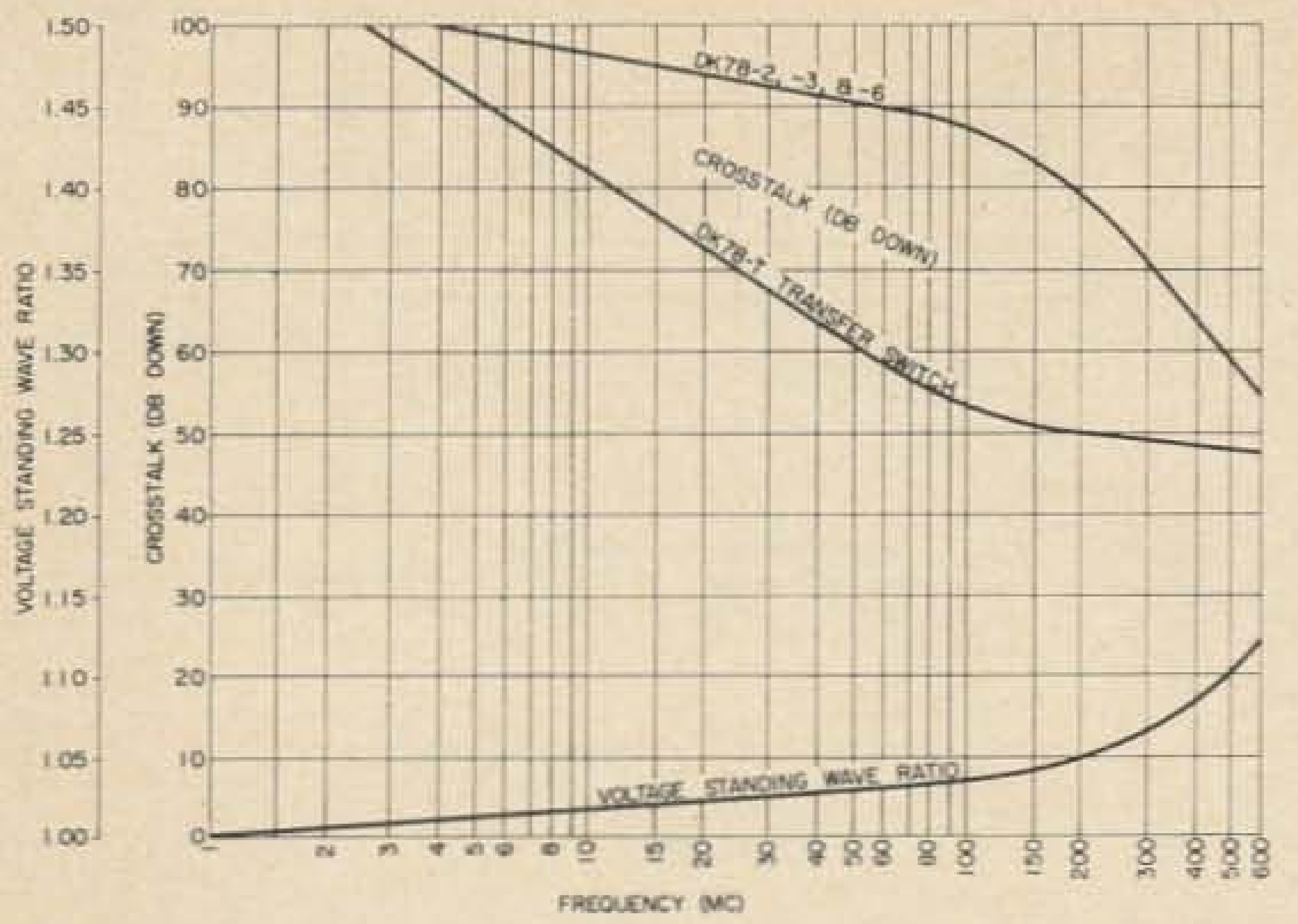


Fig. 7. Typical operating characteristics of the Dow-Key coaxial switches. Note that these switches provide low standing wave ratios and high isolation even at 500 mc.

addition to their manually operated switches, Dow-Key offers electrically operated units that may be used for remote switching of antennas, transmission lines or other equipment. These switches (series DK71 and DK72) exhibit essentially the same operating characteristics as the DK78 series (**Fig. 7**). These units are in waterproof housings with mounting straps suitable for direct installation to outdoor antenna masts. With this type of installation, up to six antennas may be fed with one coaxial line.

The Polyphase Instrument Company (PIC) offers several compact coaxial switches that will handle up to 1000 watts at moderate rf frequencies. The main advantage of these switches is their small size.

Waters coaxial switches are mounted in sealed metal cases and are furnished with an appropriate self-marking escutcheon plate and molded phenolic knob. These switches are furnished with UHF connectors mounted on the rear side of the switch; this connector arrangement minimizes behind-the-panel installation space and eliminates the necessity for auxiliary coaxial elbow fittings. Waters switches are rated at 1000 watts and exhibit an SWR of less than 1.2:1 up to 150 mc.

A recent addition to the Waters line of coaxial switches is the "Protax." Basically, this model is two switches in one; a regular antenna selector switch with a rating of 1000 watts and an auxiliary contact for grounding all antennas (leaving the receiver input open) when the transmitter is not in use. This arrangement is designed to minimize the danger of injury or fire during electrical storms. Protax switches are available in either five or six position configurations with UHF type connectors.

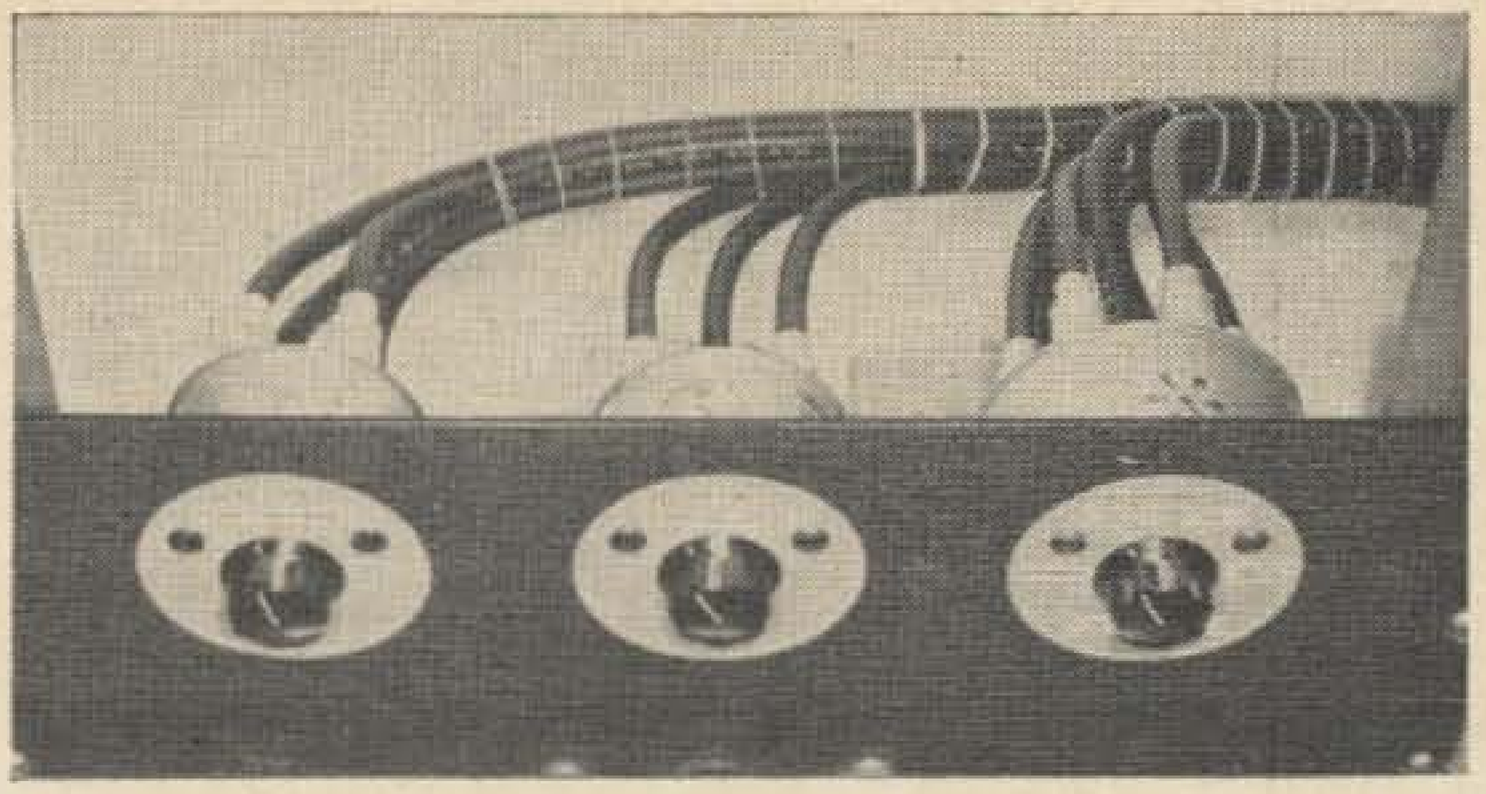


Photo courtesy Waters Manufacturing Co.

A neat coaxial switch installation. These switches are arranged for switching the receivers, transmitters and antennas in a typical amateur station.

Standing wave meters

One of the most convenient methods of monitoring coaxial transmission line operation is the standing wave meter. There are many devices available for this purpose as indicated in **Table 3**, but most of the currently available units use the familiar "monimatch" design introduced in the 1950's. Standing wave meters built using this principle may be left in the transmission line at all times without affecting line performance.

It is essential to the understanding of the directional coupler or reflectometer type of standing wave meter to realize that the current and voltage of the rf power propagating along a transmission line toward the load are in phase. On the other hand, it must be further understood that the reflected components of voltage and current are exactly 180 degrees out of phase. This may be a little difficult to envision, but none the less it is true, and al-

Photo by WA6IAK.

A surplus coaxial switch that is actuated by a toggle lever. This switch has excellent operating characteristics and may be used up to several thousand megacycles.

though it is beyond the scope of this handbook to explain wave mechanics, complete details have been included in many articles and in most antenna and transmission line handbooks.

When the load is perfectly matched to a transmission line, all the power which is transmitted toward the load (incident) is dissipated by the load. If the load does not match the transmission line however, a portion of the incident or forward power is reflected; the reflected components of voltage and current combine with the forward components to produce standing waves. The standing waves are so called because they have a fixed position for any given load impedance. When the reflected and incident components combine, a voltage (or current) maximum occurs where the two components are in phase, and where they are out of phase, a minimum occurs.

The directional coupler takes advantage of the fact that the forward components are in phase while the reflected components are 180 degrees out of phase. The pickup unit which most manufacturers are currently using was

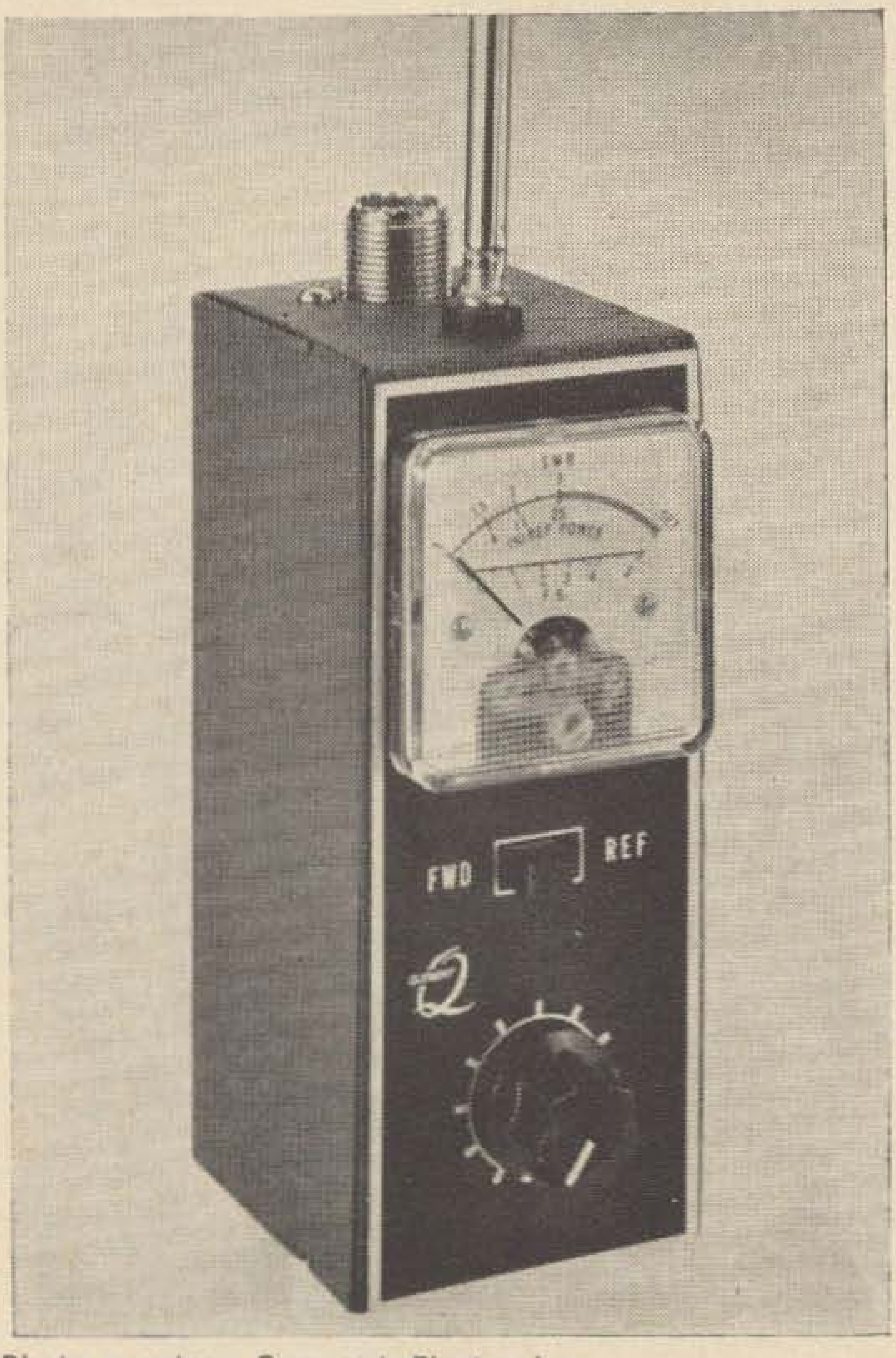


Photo courtesy Quement Electronics.

Quement Electronics' combination swr bridge and field strength meter is a compact and versatile instrument. In addition to swr measurements in 52 ohm lines, it serves as a field strength meter with the antenna provided.

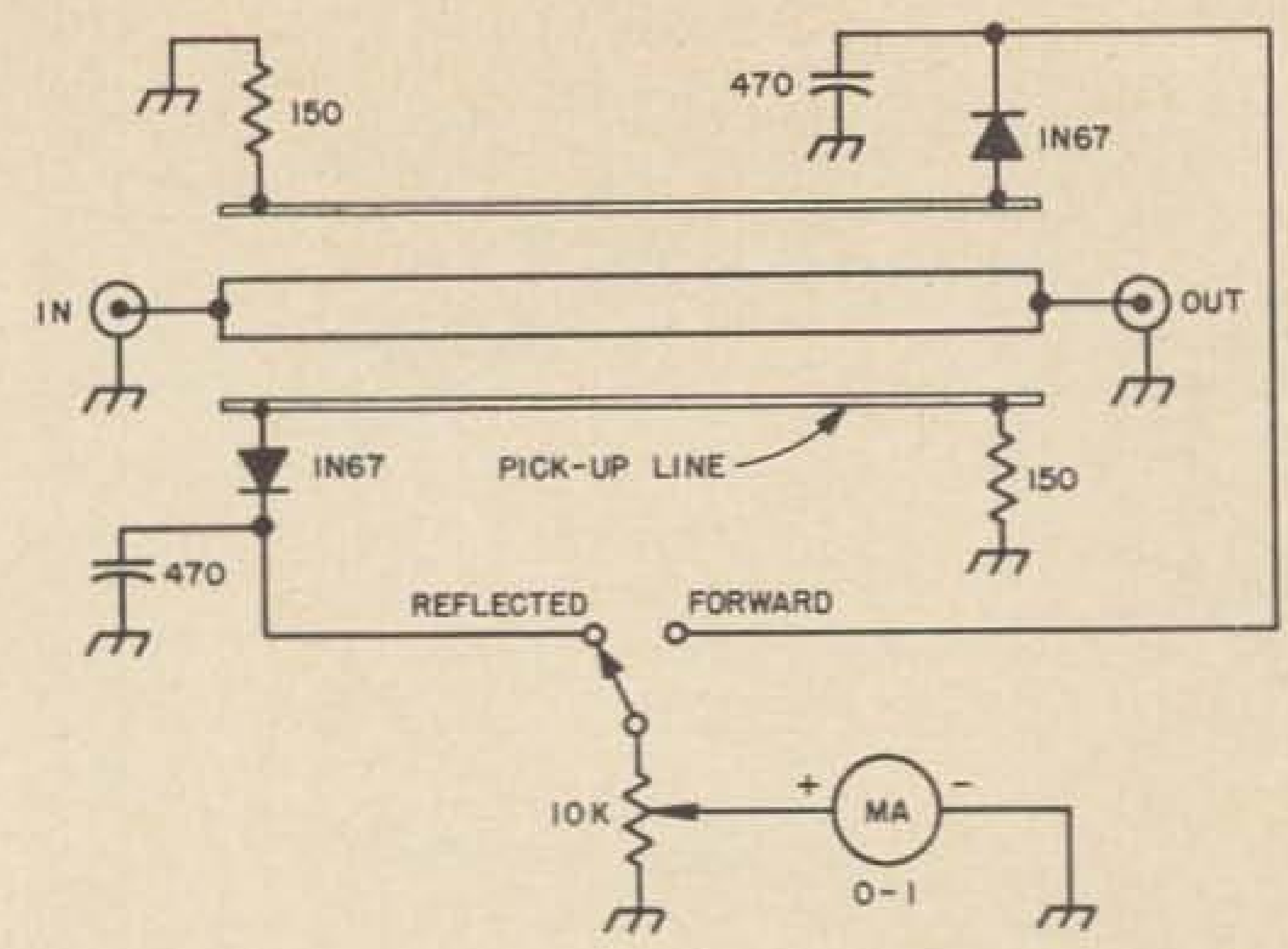


Fig. 8. Schematic of a pickup unit for the directional coupler type of swr meter.

originally developed by the Naval Research Laboratories[1] and popularized by W1ICP.[2] This device uses a pickup wire which is parallel to the inner conductor of the coaxial line as shown in **Fig. 8.** Different manufacturers use various constructional techniques, but the principle of operation remains the same. Since the pickup wire is parallel to the inner conductor of the transmission line, a small voltage is induced in it by inductive coupling. At the same time, the voltage on the transmission line is sampled by capacitive coupling of the pickup wire; due to this voltage, a current flows through the terminating resistor and there is a voltage developed across it. When the layout of the pickup unit is such that the forward components of voltage and current cause these two voltages to be in phase, the resultant output is indicated on the meter. The reflected components would have no effect on this pickup line because the two voltages would be out of phase and cancel each other out. To detect the reflected components, another pickup line has to be constructed with the terminating resistor at the opposite end; the forward components would have no effect on this line of course because the two voltages would again be out of phase and cancel out. Although the effect of both the inductive and capacitive portions of the pickup line vary with frequency, their ratio remains the same. This just means that this type of a unit is more sensitive on the higher frequencies.

Usually when designing or building a standing wave meter, the pickup unit should be made much shorter than a quarter wavelength long. The only other precaution lies in the selection of the terminating resistors. First of all, if they are too large, they will introduce a phase error in the voltage pickup and cause poor nulls. On the other hand, if it is too small,

Table 3. Standing Wave Ratio Meters

Manufacturer	Model Number	Impedance (ohms)	Connector Type	SWR Range	Maximum Power (watts)	Frequency Range (mc)
Ameco	BIU	52	UHF	20:1	1000	1.8 - 225
Bird	Thruline	50	N, C, UHF	∞:1	5000*	2.0 - 2300
Cesco	CM52	52	UHF	100:1	1000	3.0 - 200
Cesco	CM52-2	52	UHF	100:1	1000	3.0 - 200
Heathkit	HM-15	50 or 75	UHF	3:1	1000	1.8 - 56
M. C. Jones	250	50 or 72	N, C, UHF	20:1	500	3.0 - 225
M. C. Jones	260	50	N, UHF	20:1	1000	0.5 - 225
M. C. Jones	300	50	N, C, HN	20:1	120	25 - 2000
M. C. Jones	500	50	N, C, HN	8:1	1200	20 - 2000
M. C. Jones	590	50	N, C	8:1	120	1000 - 3000
M. C. Jones	700	50	N, C, UHF	100:1	1200	20 - 1000
M. C. Jones	720	50	N, C	15:1	120	1000 - 3000
E. F. Johnson	250-37 250-38	52	UHF	10:1	1000	3.5 - 150
Knight-Kit	P-2	52 or 72	UHF	20:1	1000	1.8 - 432
Lafayette	TM-28	52 or 72	UHF	20:1	1000	2.0 - 50
Lincoln	L2501	52	UHF	20:1	1000	2.0 - 200
Quement	—	52	UHF	3:1	1000	2.0 - 50
Sierra	164B	50	N, C, UHF	∞:1	5000*	2.0 - 1000

*Depends on plug-in element.

there won't be enough voltage developed across it. However, proper choice of circuit dimensions and component values will permit operation over all of the ham bands up to 50 mc; some specialized units are useable up to 1000 mc.

Of course, the accuracy of this instrument depends quite strongly on the fact that the voltage induced by the transmission line current just precisely cancels out the voltage sample. What this means is that the pickup line has to be adjusted to obtain a good null when the line is properly terminated and there are no reflected components. Another, and perhaps easier way of nulling out the pickup unit is to adjust the value of the terminating resistor[6]; by adjusting this resistor, you can set the voltage drop across it so that it exactly equals the voltage sampled.

Usually two identical pickup units are used, one for forward power, the other for reverse power. However, in some designs, only one pickup is used; it is connected in such a way that it does the work of two. This may sound like you are getting something for nothing, but although the pickup is physically only one piece, electrically it looks like two separate units.

Possibly the biggest source of error in the

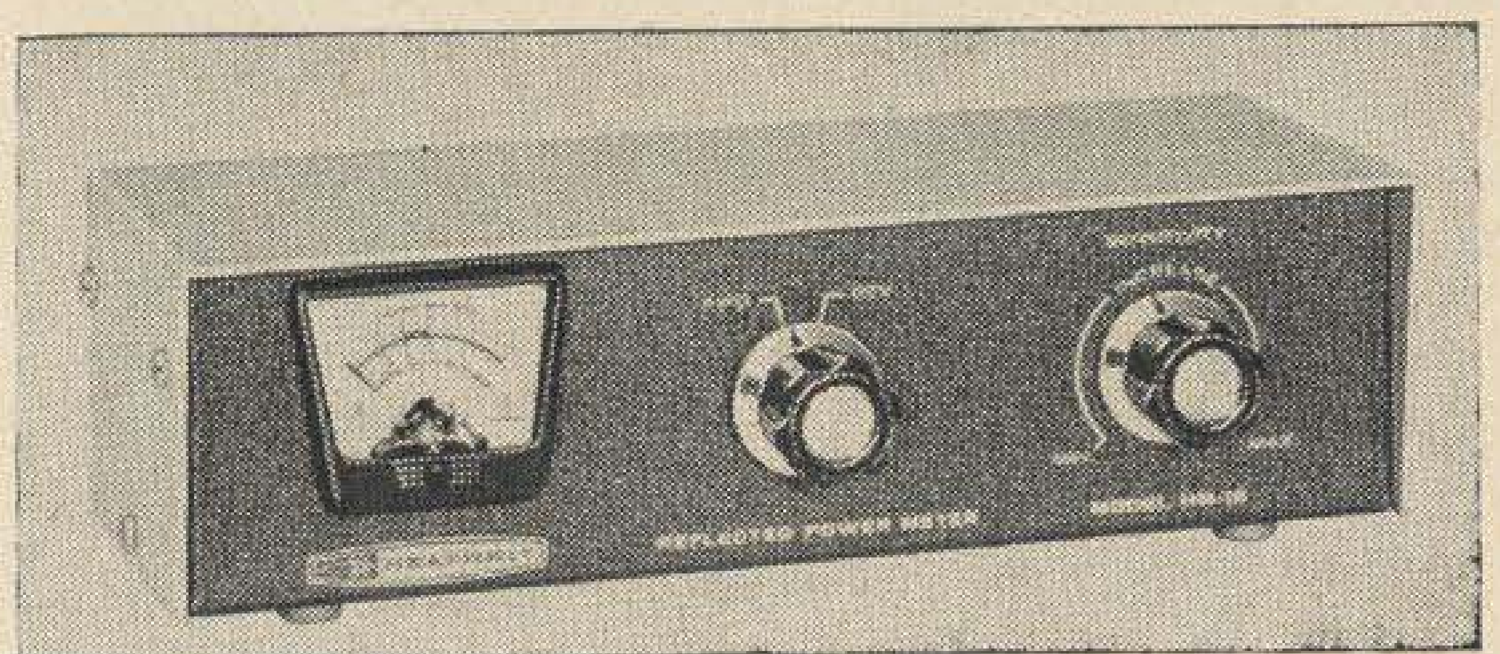


Photo courtesy Heathkit.

The Heathkit reflected power meter provides a reliable method of determining the swr on any 50 or 70 ohm transmission line up to 6 meters. It may be installed permanently in the line and permits continuous monitoring of line operation.

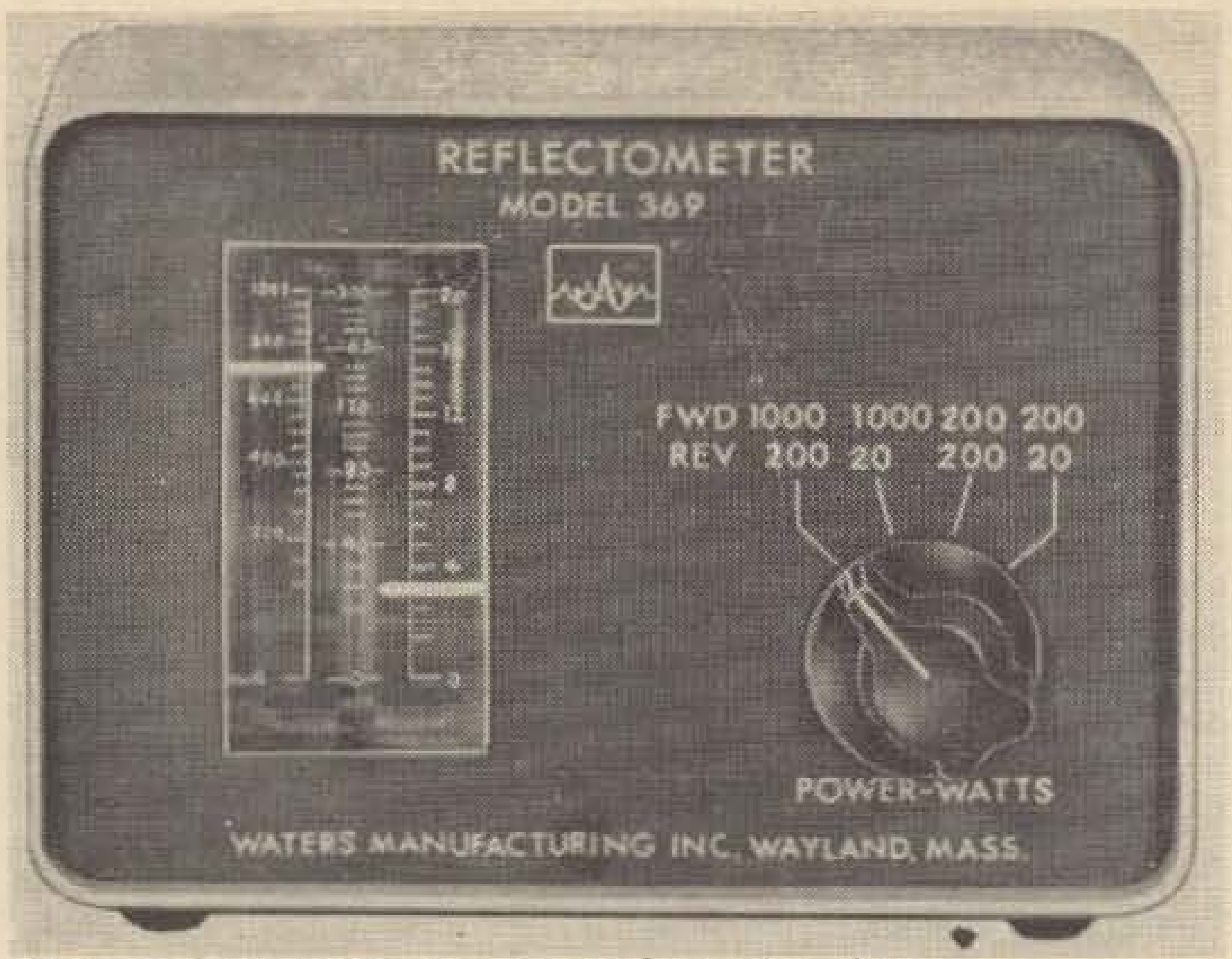


Photo courtesy Waters Manufacturing Inc.
The Waters reflectometer shows both forward and reflected power in 52 ohm transmission lines. In addition, this instrument has multiple scales that provide increased sensitivity for accurate readings of low reverse power values.

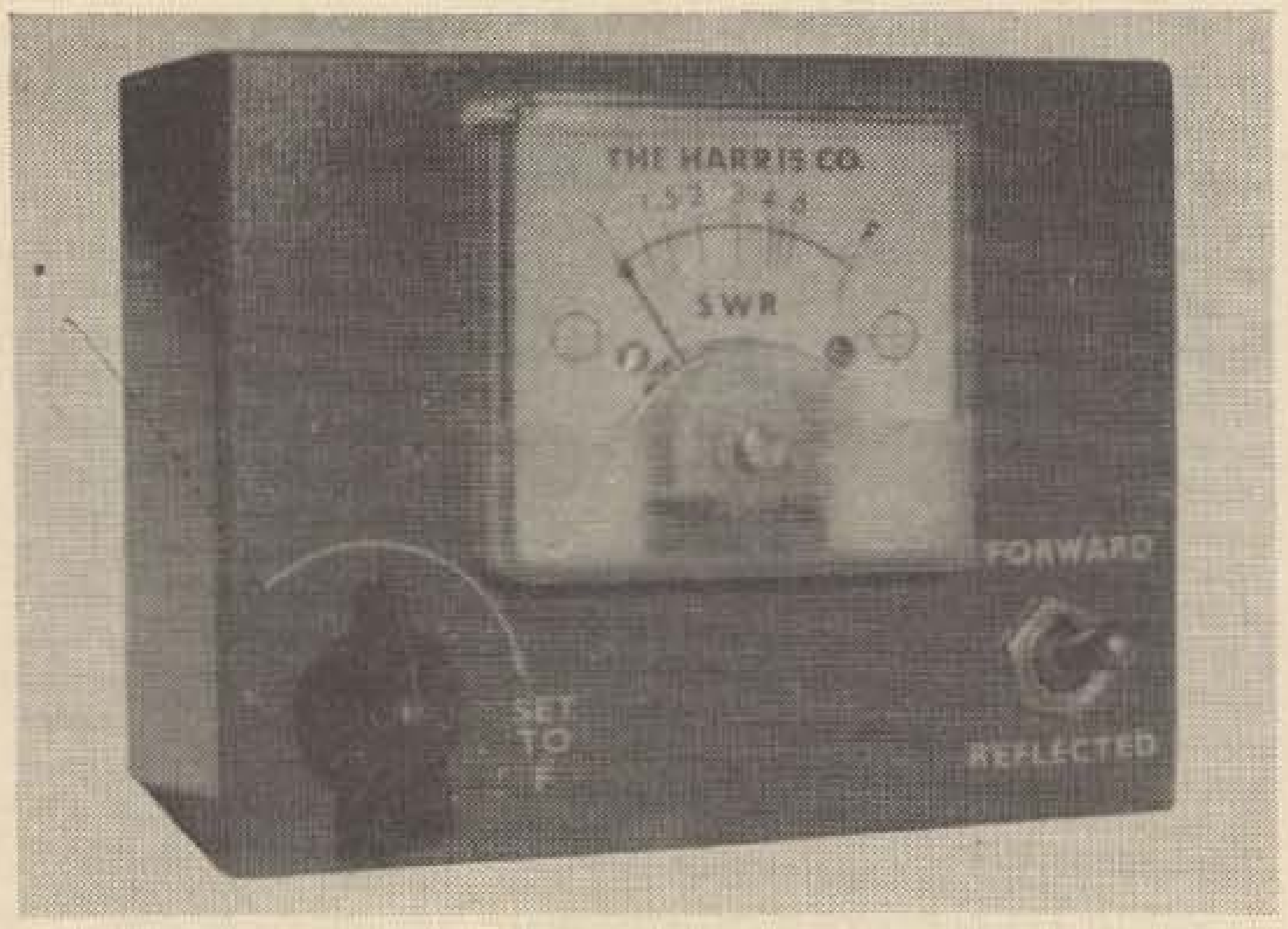
standing wave meter lies in nonlinearity of the semiconductor diodes. For this reason you might find that you don't get the same SWR readings at high power levels as you do at low levels. However, the differences are usually quite insignificant, if even noticeable at all.

Although all of the reflectometer standing wave meters of this type are identical electrically, there are any number of constructional variations. The early units consisted simply of a small loop of wire placed inside a waveguide or between the inner and outer conductors of the coaxial line. This type of construction is a little difficult to duplicate however, and later designs were laid out with the ham in mind. Perhaps the most popular of these is the trough type line with two pickup wires laid out on each side. Later variations of this theme use a piece of enameled copper wire threaded under the outer braid of a piece of RG-8A/U coaxial cable. This latter technique is quite easy to duplicate and has proven to be quite successful on the VHF bands because it preserves the characteristic impedance of the system.

Another method of construction which has been used by some manufacturers and written up in several amateur journals uses an entirely different technique. In this approach, a toroidal current transformer is very closely coupled to the transmission line. In addition, a small amount of voltage is picked off the line with small variable capacitors. This type of construction has the advantage that the current transformer may be electrostatically shielded so that it is only *inductively* coupled to the line. Furthermore, the capacitors can be laid out so that the voltage pickup may be controlled and not effected by stray capacity. In this way an instrument can be constructed which is quite accurate over a broad frequency range, and more important, provides consistent and reliable measurements.

The primary consideration in selecting standing wave meters is the characteristic impedance of the unit and its variations with frequency. The more expensive units exhibit a constant impedance at frequencies in excess of 1000 mc, but many of the inexpensive units exhibit non-constant impedance and may be used in either 50 or 75 ohm lines up to 30 megacycles with almost no detectable difference. In the Heathkit HM-15, different values of load resistors are provided to compensate for differences in 50 and 75 ohm transmission systems.

In addition to standing wave measurements, many of the instruments of this type may be used to accurately measure rf power. In the inexpensive devices, only relative power may be determined.



The Harris Company's standing wave ratio meter. This unit is unique because it uses a printed circuit pickup assembly.

Photo courtesy Allied Radio Corp.

The Knight-Kit swr/power meter is a flexible two-unit instrument that may be used on all the ham bands up to 432 mc. It is suitable for use with either 50 or 70 ohm lines and its negligible insertion loss allows it to be left in the line as a constant monitor.

Coaxial attenuators

The coaxial attenuator or pad is a device that is unfamiliar to many amateurs, but which is very useful in many applications. Basically, the attenuator consists of a resistance network which reduces the rf power between the input and output while maintaining the characteristic impedance of the transmission line. They are categorized by the amount of power loss through them in decibels; a 3 db attenuator for example will reduce the power by approximately one-half.

Accurate rf attenuators may be used in s-meter calibration, checking sideband suppression, and measuring crosstalk, receiver image and *if* signal rejection, relative antenna gain and receiver noise figure. A 20 db attenuator installed at the antenna terminals of a receiver is particularly helpful in reducing cross-modulation and overload when working local stations. Attenuators are also used between SSB exciters and linear amplifiers when the exciter output exceeds the recommended driving power of the amplifier.

The two basic constant impedance attenuating circuits are the "tee" and "pi" illustrated in **Fig. 9.** The names for these circuits were derived from the similarity of the circuits to the letter "T" and the Greek letter "π" respectively.

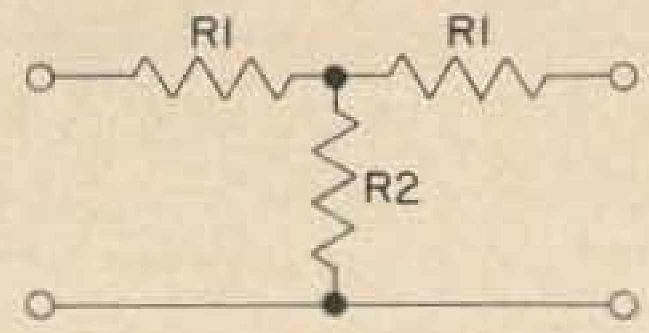
Most commercial attenuators are constructed using disc resistors as shown in **Fig. 9.** This type of resistance element presents a *sheet* of resistance to the circuit and has been used successfully at frequencies in excess of 1000 mc. However, these disc resistors are quite expensive and for amateur applications, composition resistors may be used with no noticeable effect up to about 250 mc. Above 250 mc it is difficult to predict the rf resistance of composition resistors however, and the more sophisticated disc resistors should be used.

Simple 50 ohm tee attenuators may be constructed using composition resistors as shown in **Fig. 9.** The required resistance values for various amounts of attenuation are listed in **Table 4.** These values are based on the use of standard 5% tolerance resistors and are not 100% accurate in terms of attenuation, but are within ±2% of the proper value. For other than 50 ohm systems, the required tee attenuator resistance values may be calculated from the following equations:

$$R_2 = \frac{2Z_0\sqrt{N}}{N-1}$$

$$R_1 = Z_0\left(\frac{N+1}{N-1}\right) - R_2$$

Table 6. 50 ohm T-Pad Attenuator Resistance



db	R1	R2	db	R1	R2
0.1	0.30	4300	4	11	100
0.2	0.56	2200	5	15	91
0.3	0.82	1500	6	16	68
0.4	1.1	1100	7	20	56
0.5	1.5	910	8	22	47
0.6	1.8	750	9	24	39
0.7	2.0	620	10	27	36
0.8	2.4	560	11	27	30
0.9	2.7	470	12	30	27
1.0	3.0	430	13	33	24
1.1	3.3	390	14	33	20
1.2	3.3	360	15	36	18
1.3	3.6	330	16	36	16
1.4	3.9	300	17	39	15
1.5	4.3	300	18	39	13
1.6	4.7	270	19	39	11
1.7	4.7	240	20	39	10
1.8	5.1	240	25	43	5.6
2.0	5.6	220	30	47	3.3
2.2	6.2	200	35	47	1.8
2.5	6.8	180	40	51	1.0
3.0	8.2	150	45	51	0.56
3.5	10.0	120	50	51	0.33

Photo courtesy Waters Manufacturing Co.

This Waters wide range coaxial attenuator provides up to 61 dB attenuation in 1 dB steps. It is accurate within one dB from dc to 225 mc.

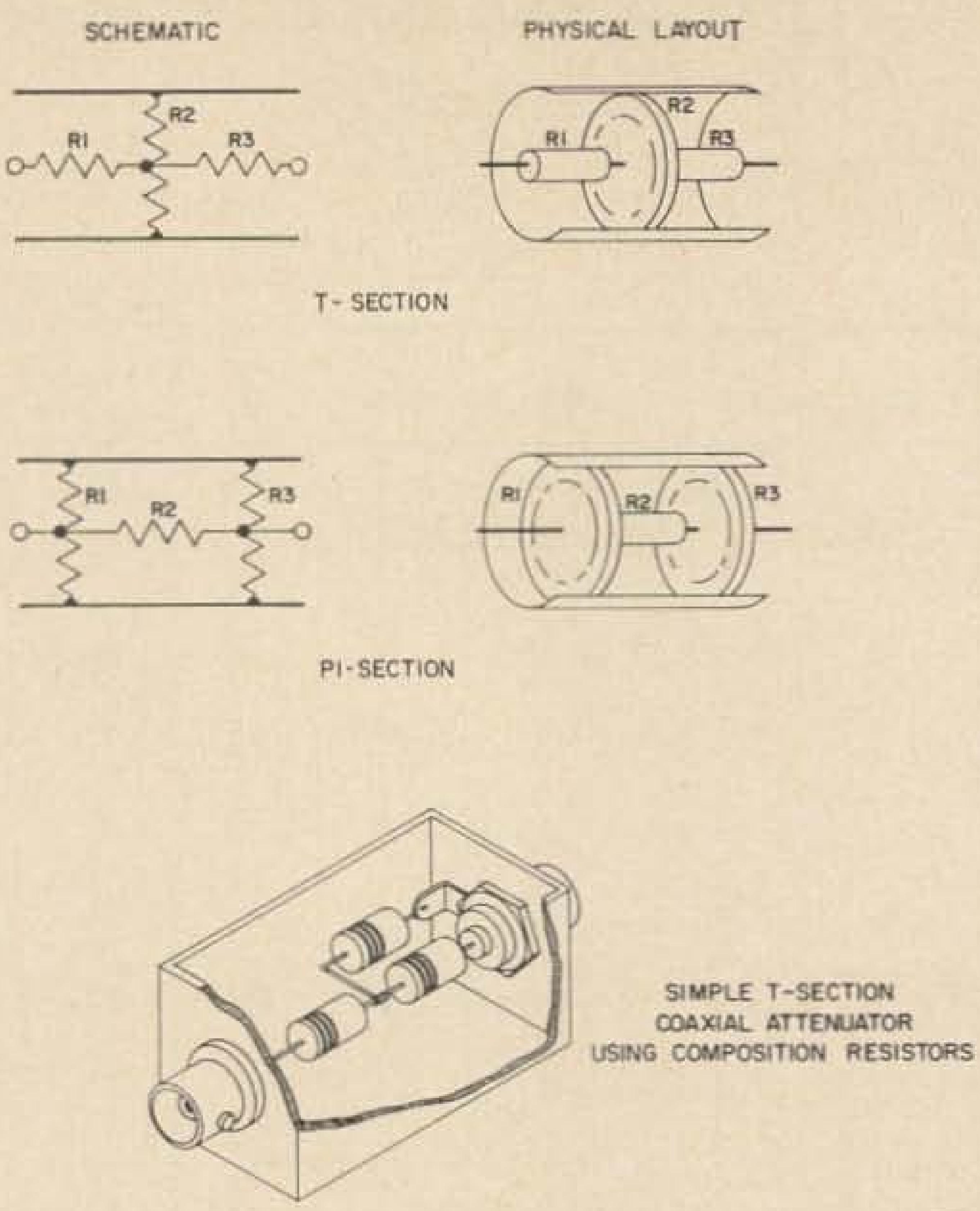


Fig. 9. Circuits and typical layout of attenuators for use in amateur equipment.

Example What resistance values are required for a tee attenuator with a characteristic impedance of 75 ohms and attenuation of 20 db? From a db-power ratio table or from the expression N = antilog (db/10), it is determined that 20 db corresponds to a power ratio of 100. Therefore:

$$R_2 = \frac{2Z_0\sqrt{N}}{N-1} = \frac{2\,(75)\sqrt{100}}{100-1} = 15.2 \text{ ohms}$$

$$R_1 = Z_0\left(\frac{N+1}{N-1}\right) - R_2 = 75\left(\frac{100+1}{100-1}\right) - 15.2$$
$$= 61.3 \text{ ohms}$$

One commercial attenuator that is designed specifically for amateur use is the Waters Model 371 Wide Range Attenuator. This unit is usable from dc to 225 mc and provides up to 61 db attenuation in one db steps.

Baluns

One of the advantages of the coaxial transmission line system is that the rf power is confined within the outer conductor of the cable. This insures that the transmission line doesn't act like an antenna, but transmits the power to the antenna where it is properly radiated; this increases the efficiency of the antenna/transmission line system and greatly reduces TVI and other sources of interference. Unfortunately however, most antennas are balanced devices and for proper operation, they should be fed with a balanced transmission line. In most amateur stations, coaxial feedline is indiscriminately connected to a dipole or multi-element array, both of which are balanced, with little thought to the balance-unbalance mismatch that occurs. The results can often be quite confusing. For instance, it is almost impossible to obtain meaningful standing wave measurements when there is a balance-unbalance mismatch in the system. Furthermore, almost all antennas, and tri-band beams in particular, display very confusing and esotoric resonance curves when fed with this type of a system. In addition, to obtain the desired pattern in high-gain antenna systems, it is imperative that a good balance to ground be preserved. When an inherently balanced antenna is fed with a coaxial feedline, the electrical feed point may be shifted away from the designed point, changing the ohmic value of the load and introducing reactance into the system.

On the other hand, when a balanced load is connected to an unbalanced transmission line, the resultant balance/unbalance mismatch may cause standing waves, cause rf currents to flow on the outside braid of the coaxial line resulting in unwanted radiation, or couple the load reactance back to the transmitter or receiver. The important point here is that this can happen even if the antenna is resistive and matches the impedance of the coaxial line.

The solution to this problem of course lies in the balance-to-unbalance converter or *balun*. There are several different types of baluns, three of which are illustrated in **Fig.**

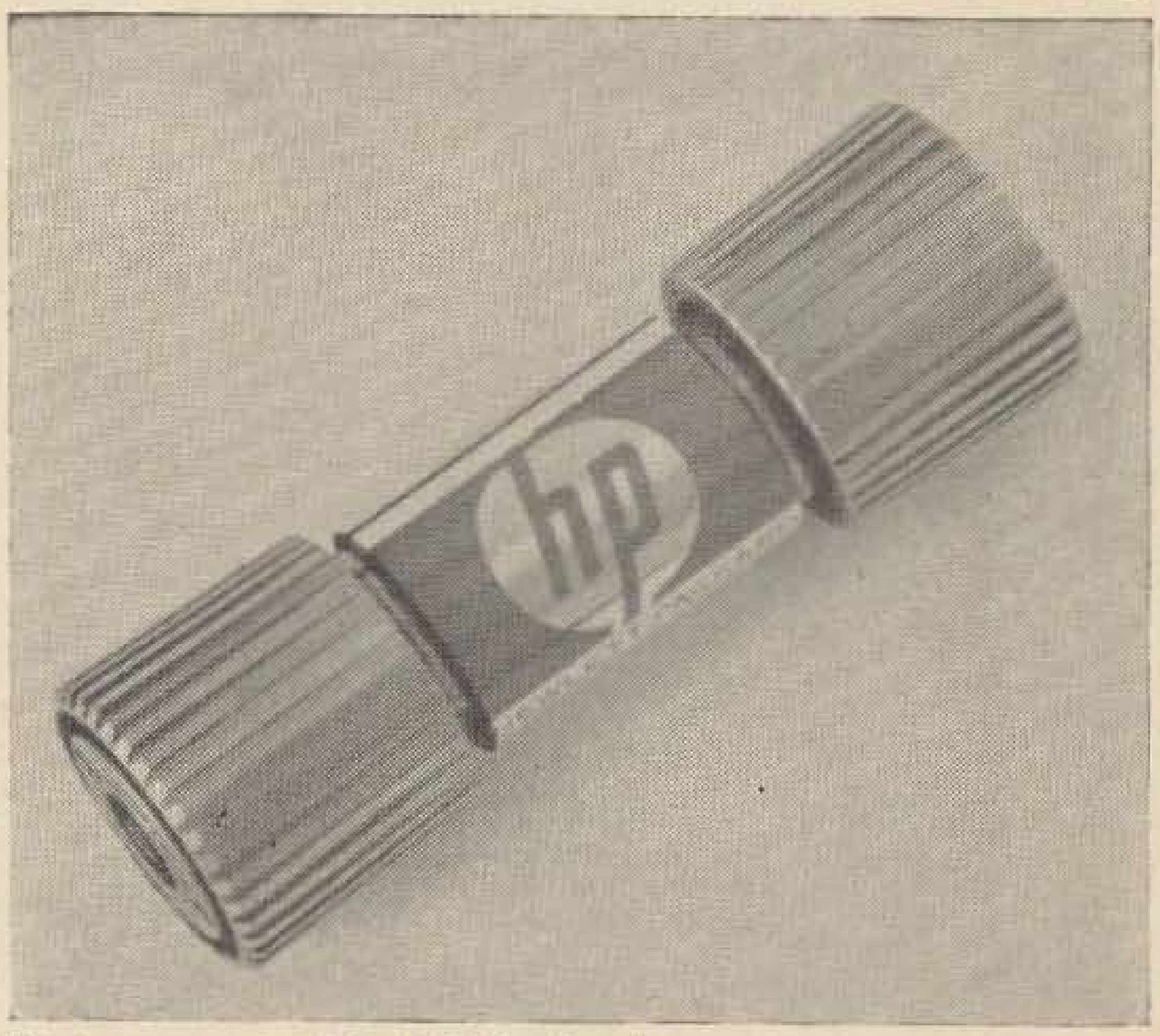


Photo courtesy Hewlett-Packard.
Hewlett-Packard fixed coaxial attenuators are representative of the types of commercial attenuators presently available. These units are available in 3, 6, 10 or 20 db attenuation and are usable from dc to 18,000 mc.

10. The coaxial sleeve balun or *bazooka* is quite popular on the UHF bands and operates on the principle that a shorted quarter-wave line presents a high impedance at the open end. A relatively high impedance exists between the inner and outer conductors of the transmission line and with the addition of the shorted quarter-wave sleeve, a high impedance appears between the outer conductor of the transmission line and the outer shell of the sleeve. In other words, the quarter-wave detuning sleeve has the effect of freeing the outer conductor of the coaxial cable from ground and if the balun is connected to a balanced load, the two output leads will assume equal impedance to ground.

Although the coaxial sleeve balun is primarily a 1:1 impedance converter, the quarter-wave sleeve and coaxial line with which it is used can be designed so that it will serve as an impedance matching transformer or Q section. By using the procedure laid out by K6HCP and WA6GYD,[13] this type of balun may be used for matching 52 ohm coaxial lines to 200, 300 or 450 ohm balanced lines. Although this type of a balance to unbalance converter is not too practical on the high-frequency bands, it has proven very useful on 144, 220 and 432 mc.

The quarter-wave open balun is nothing more than a simple method of making a quarter-wave coaxial detuning sleeve. Although this type of construction is simple and expedient, the results are not as good as those provided by the coaxial sleeve. This is because the open type construction is not as efficient in detuning as the sleeve which completely encircles the coaxial transmission line.

The balun which has been most popular with amateurs is the simple half-wave phase inverter balun shown in **Fig. 10** and **11.** This type of balun is very easy to build, but it suffers from two very serious disadvantages. First of all, it is useable over a narrow band of frequencies; whenever the length of the phasing line deviates very much from the required half-wavelength, it no longer provides the necessary balance to unbalance conversion. This means that a different balun has to be built for each ham band; on the VHF bands the line length is so critical it is nearly impossible to obtain proper operation.

This type of a balun takes advantage of the 180 degree phase inversion which takes place along a half wavelength line. When a negative peak of the sinusoidal rf current appears at A, a positive peak appears at B. Since both of these peaks appear on the center conductor, they exhibit a high impedance to ground and present a balanced output. The half-wave phase inverter balun gives an impedance ratio of 4:1 because the phase inverter provides a voltage step-up of 2:1.

Each of these three baluns depends upon a

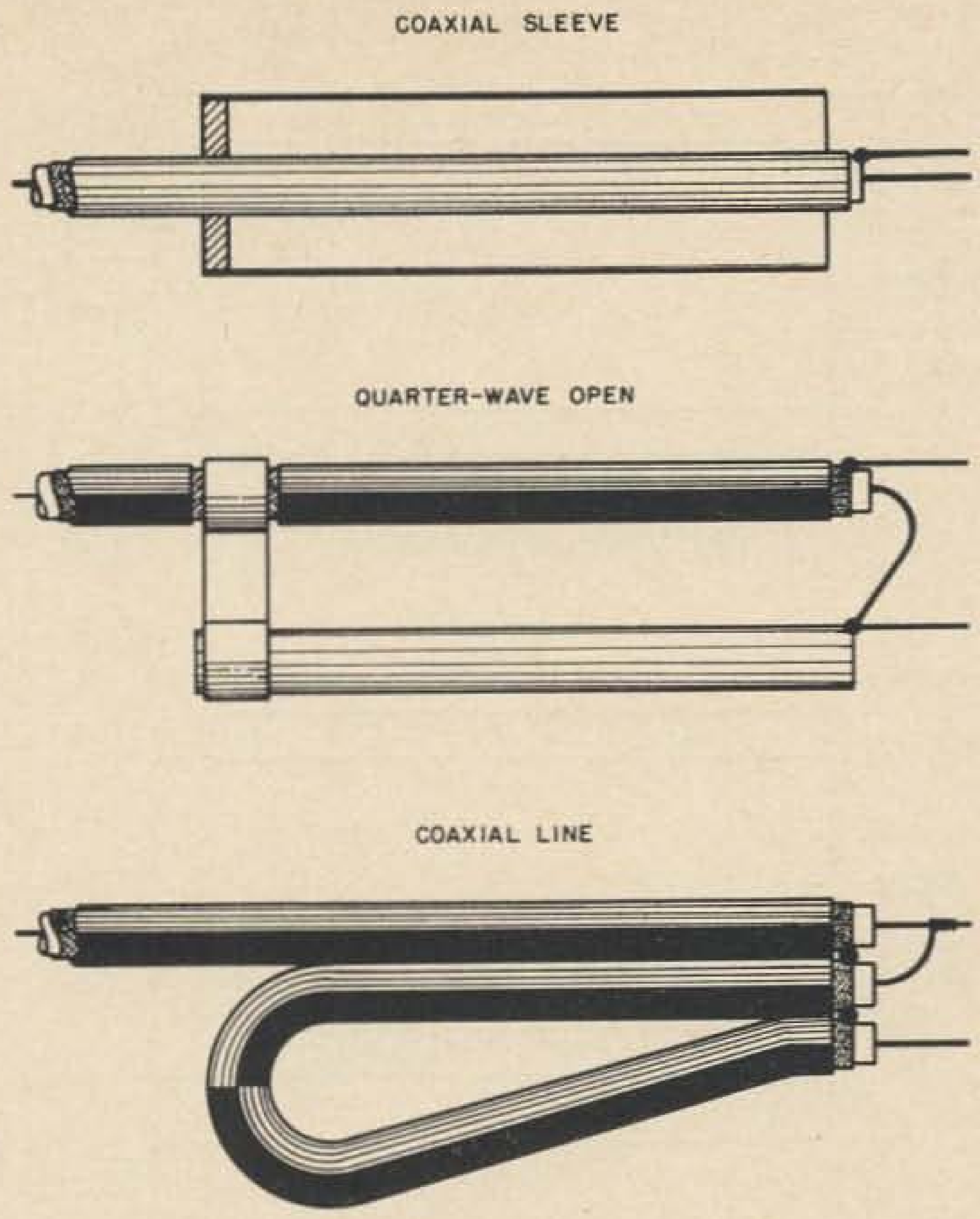


Fig. 10. Various types of balance to unbalance converters or baluns. The coaxial sleeve balun is most satisfactory for the VHF and UHF bands while the other two types find use on the high-frequency bands up to 30 mc.

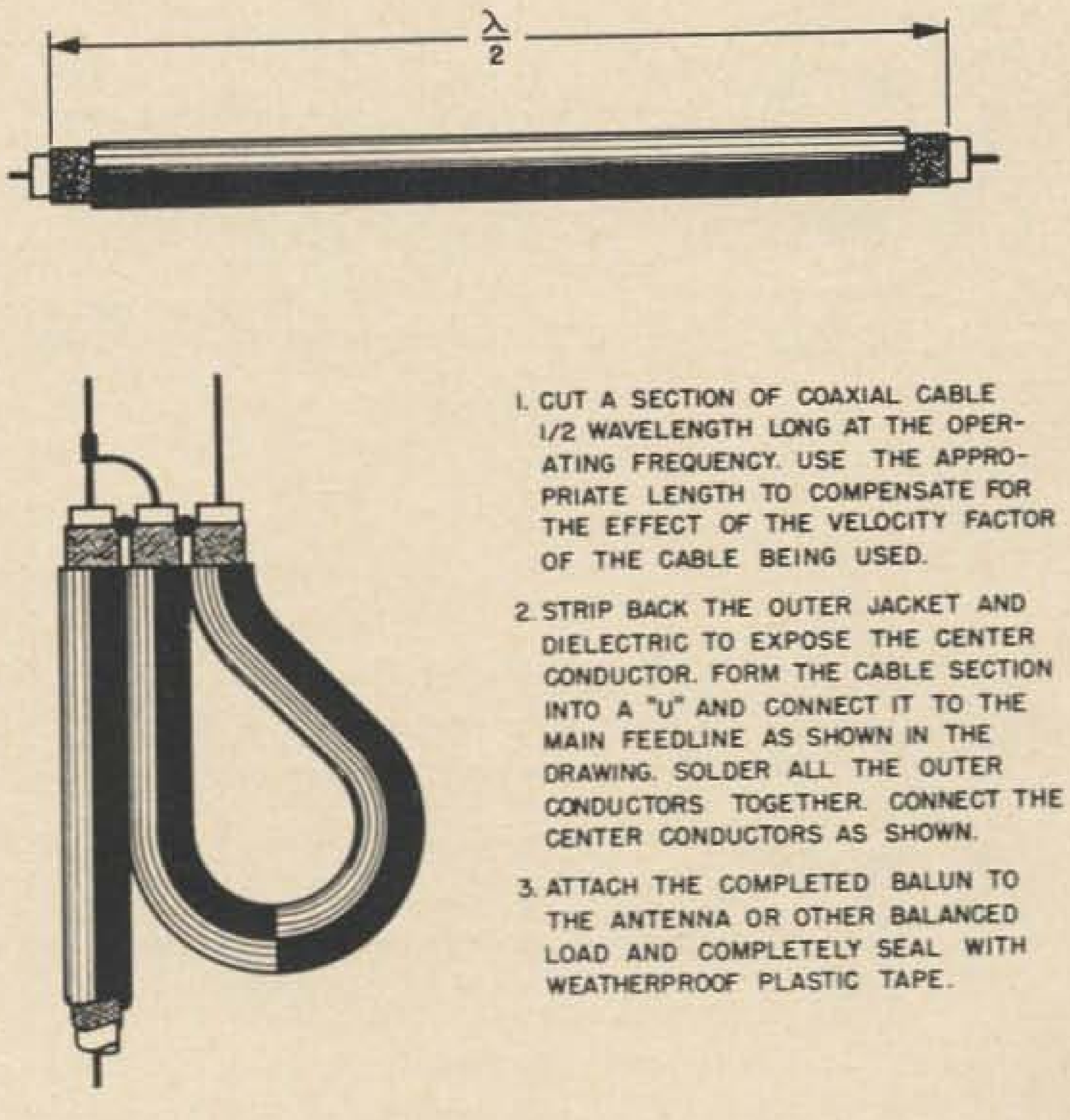
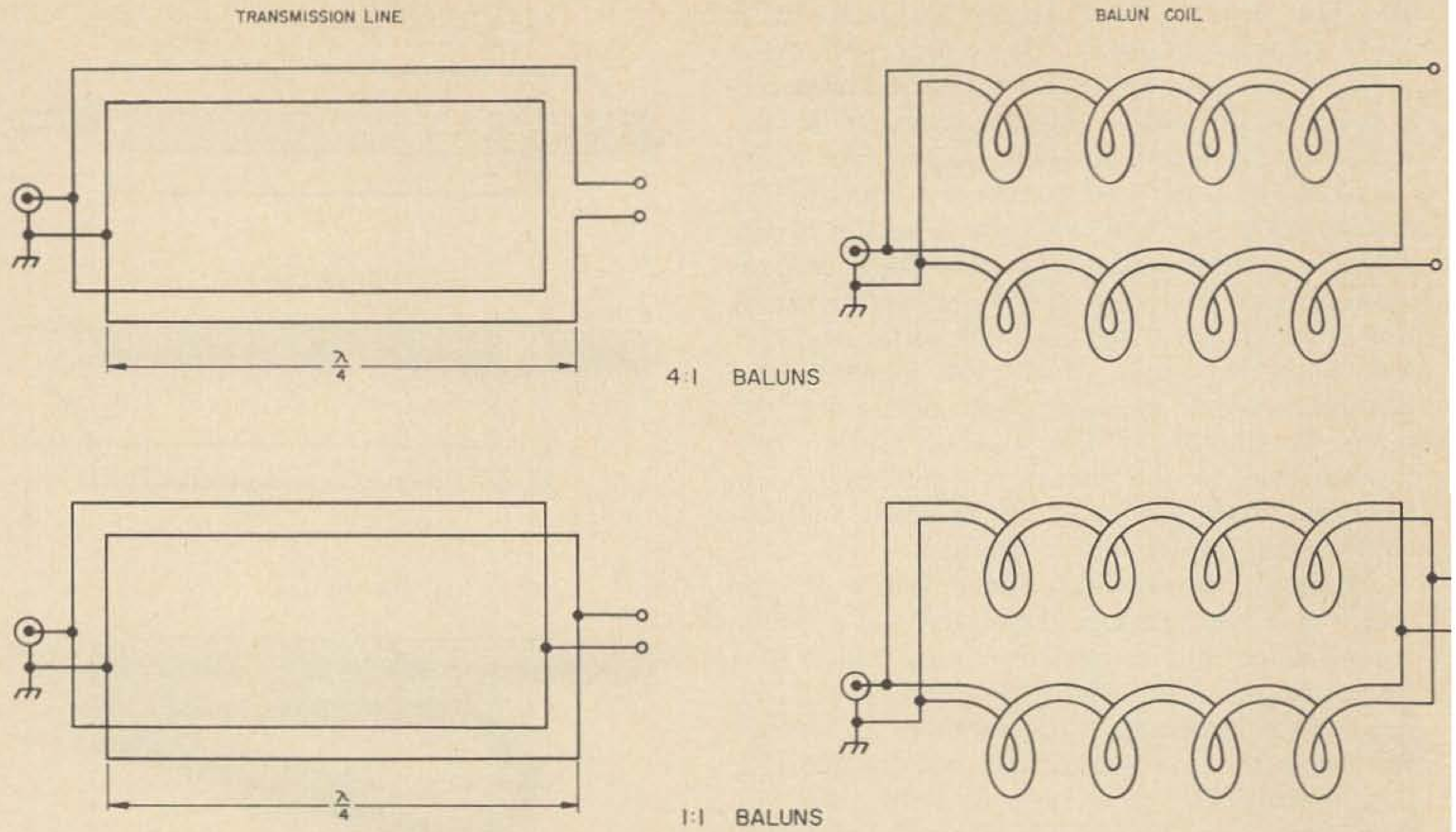


Fig. 11. Construction of the half-wave phase inverter balun. This balun is relatively narrow-banded, but it is easy to build and satisfactory for many applications.



Development of the broadband balun coil from linear transmission line theory.

frequency dependent length of transmission line. This is suitable for single band operation, but for wide bandwidths, another approach must be used. By applying a closely coupled bifilar air-wound transformer, a balun can be made that will work effectively from 3.5 to 30 mc. The air-wound balun is somewhat bulky and limited in power handling ability, but recent advances with ferrites have resulted in small, compact and efficient baluns that will work over extremely wide bandwidths.[8]

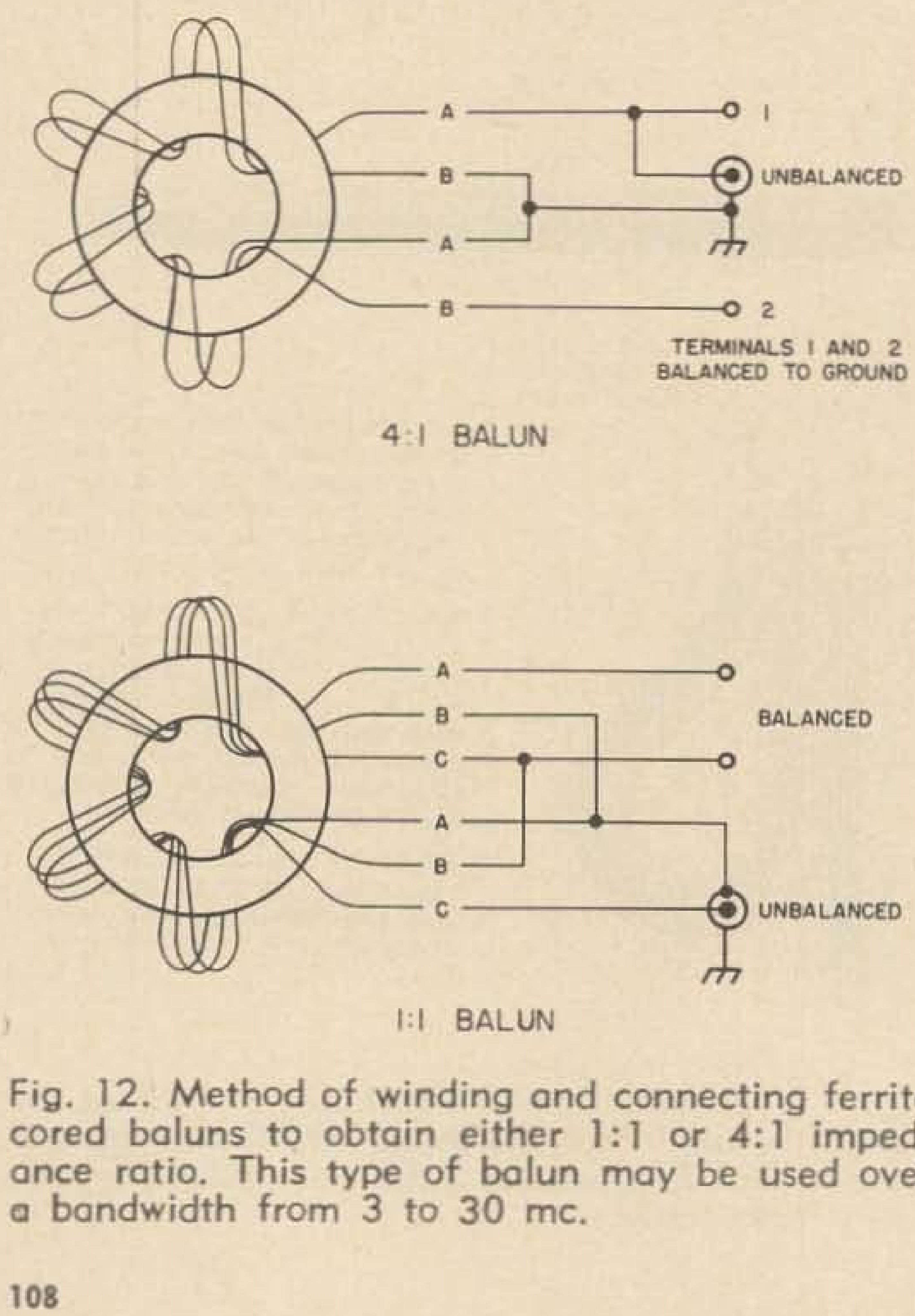


Fig. 12. Method of winding and connecting ferrite cored baluns to obtain either 1:1 or 4:1 impedance ratio. This type of balun may be used over a bandwidth from 3 to 30 mc.

To explain how these balun transformers work, we have to resort back to the transmission line for a moment. If two transmission lines of equal length which have a characteristic impedance (Z_0) of 100 ohms are connected in series at one end and in parallel at the other, at the series connected end the lines are balanced to ground and will match 200 ohms. On the other hand, at the parallel connected end the lines will be matched by an impedance equal to 50 ohms. This shouldn't be hard to understand if we remember for a moment that two resistors in series add while the equivalent resistance of two equal resistors in parallel is one half of the resistance value of the resistors. If the length of the series/parallel connected transmission lines is an odd multiple of one-quarter wavelength, one side of the parallel connected end may be grounded and the balanced end (series connected) will be effectively decoupled from it. Since the input impedance of this balun is 50 ohms and the output is 200 ohms, it exhibits an impedance transformation ratio of 4:1.

To obtain an impedance transformation ratio of 1:1 with this type of balun, the lines are connected in parallel at both ends. As previously, one side of either parallel con-

Table 5. Baluns

Manufacturer	Model Number	Unbalanced Impedance (ohms)	Frequency Range (mc)	Power (watts)	Impedance Ratio	Connector
Ami-Tron	Kit	50 or 75	1.0 - 60	1000	1:1, 4:1, 9:1	None
B&W	725	75	1.5 - 30	2000	4:1	UHF
B&W	3975	75	3.5 - 30	250	1:1 or 4:1	UHF
Fugle	—	50 or 75	3.0 - 30	1000	1:1 or 4:1	None
Millen	46672	50 or 75	3.5 - 30*	—	4:1	UHF
Telrex	1K81B	52	3.5 - 30	500	1:1**	None
Telrex	2K81B	52	3.5 - 30	1000	1:1**	None
Telrex	4K81B	52	3.5 - 30	2000	1:1**	None
Telrex	2K816B	52	1.7 - 14	1000	1:1**	None
Translab	601	50 or 75	2.0 - 30	1000	1:1	N
Translab	601A	50 or 75	2.0 - 30	1000	4:1	N
W2AU	—	50 or 75	3.0 - 30	1000	1:1 or 4:1	UHF

*Five models required to cover this range.
**Available in 4:1 impedance ratio at slightly higher cost.

nected end may be grounded, and the other end may be connected to a balanced load and be effectively decoupled from the grounded end.

Although this discussion has assumed the use of regular transmission lines, the two lines can be wound into a coil, either air-wound or ferrite cored. The inductances formed by these windings act as chokes and tend to further isolate the balanced end from the grounded end. In fact, the frequency range of this type of balun is greatly extended because of the greater isolation obtained through choke action. At the high frequency end of their range, these transformers act like transmission lines, and at the low frequency end, like very closely coupled coils.

The majority of the commercial baluns come completely assembled and ready to install, but one company, Ami-Tron Associates, provides a ferrite core and a length of number 14 wire so you can wind your own. To make a 1:1 impedance ratio balun, you wind ten trifilar turns on the core and connect it as shown in Fig. 12A; for a 4:1 impedance balun, wind ten

Photo courtesy Ami-Tron Associates.

The Ami-Tron Associates toroidal balun is furnished as a kit which may be easily made into a wide band balun. By simply changing the number of turns of wire and their connections, this kit will make either a 1:1, a 4:1 or a 9:1 balun that is usable from 160 meters to 60 mc.

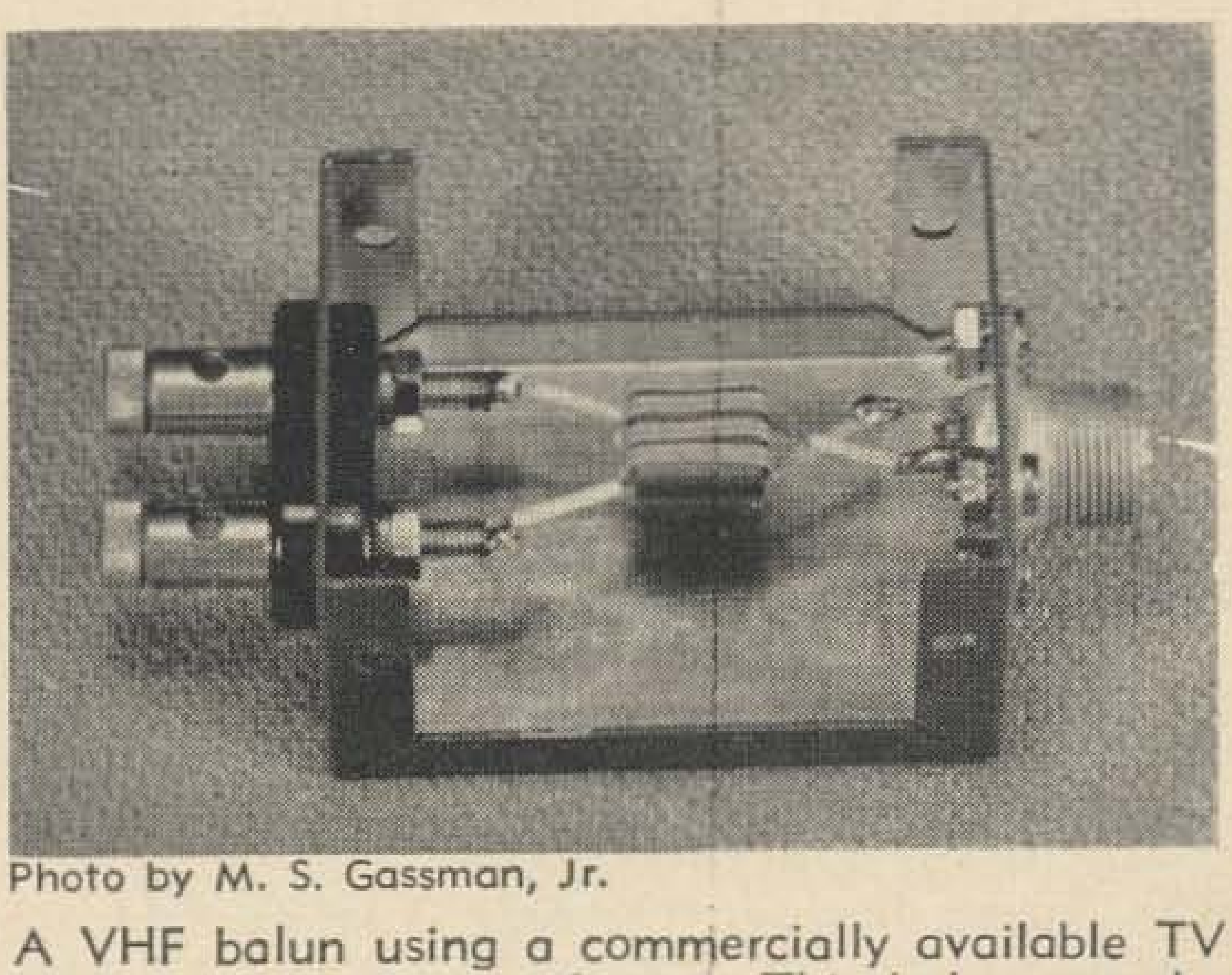


Photo by M. S. Gassman, Jr.

A VHF balun using a commercially available TV receiver antenna transformer. This balun may be used in the frequency range from 20 to 150 mc with up to 20 watts; over 20 watts of power results in excessive heating.

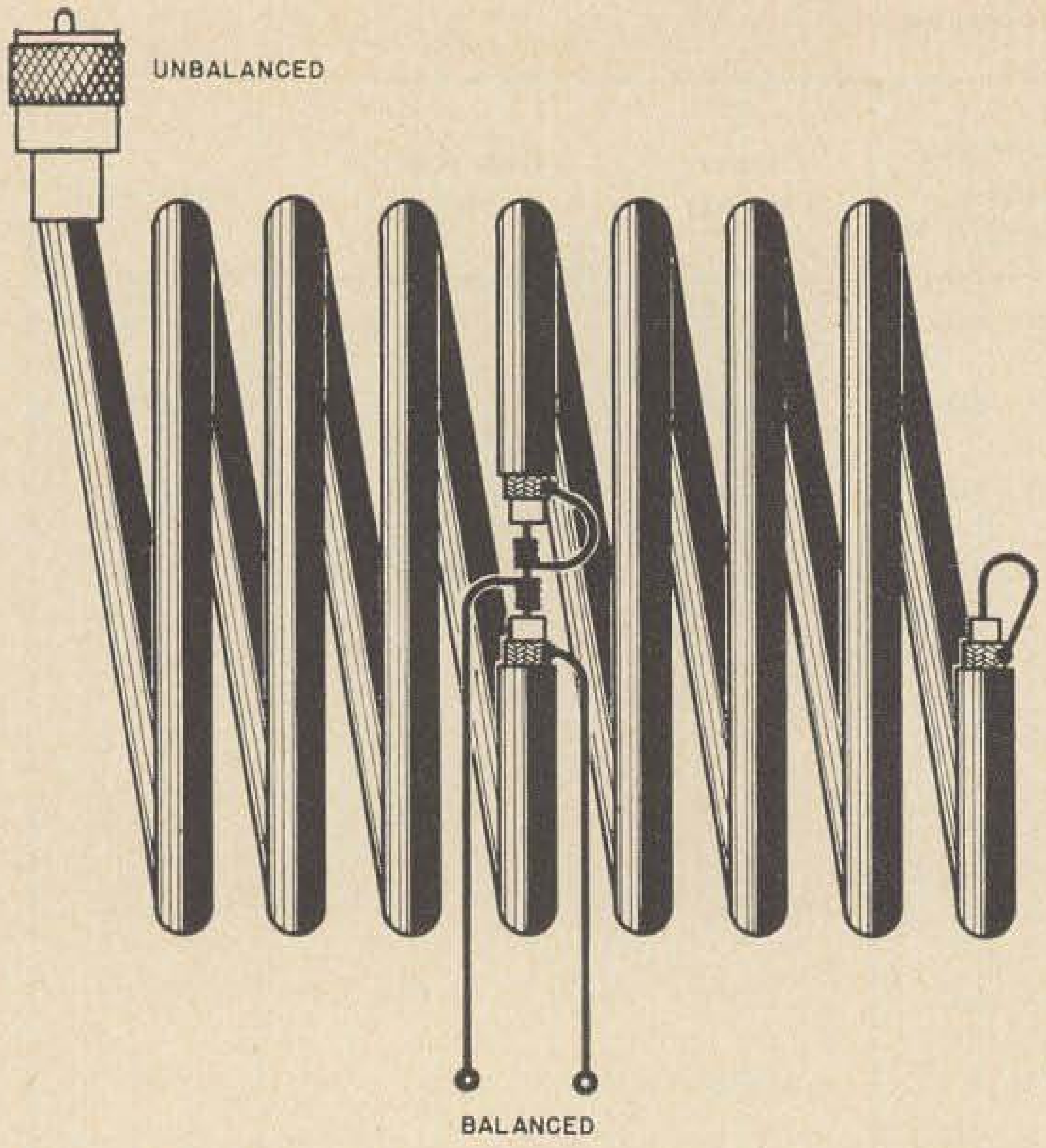


Fig. 13. A broad band coaxial balun using a length of coaxial cable. This balun may be used over all the ham bands below 30 mc with excellent results.

bifilar turns on the core and connect it as shown in **Fig. 12B**. Both of these baluns may be used over the frequency range from 3.5 to 54 mc and will handle a full kilowatt of rf.

Although the ferrite core balun is extremely compact, it is somewhat expensive, and a very reasonable way of obtaining the same electrical characteristics was described by K2HLT some time ago.[7] In his approach approximately 30 feet of RG-59/U is wound into a coil as shown in **Fig. 13.** The coil is center-tapped and the balanced output taken from the inner and outer conductors as shown in the drawing. The inner and outer conductors are shorted together on the lower part of the coaxial cable coil while the unbalanced input is at the top. Actually this balun represents a simple autotransformer, tuned to resonance at approximately 14 mc by the distributed capacity of the coaxial cable on the top half of the coil. Because the Q of the cable is in the vicinity of 200, there are very low losses associated with this type of construction. However, when the balun is loaded with a 75 ohm load, the selectivity of the circuit is broadened out to encompass a 30 mc bandpass.

The transmitter signal is coupled by the coaxial cable in the upper half of the coil to the bottom half, which is simply a coil to ground. However, the bottom coil is inductively coupled to the top coil with essentially unity coupling. Since each coil feeds one side of the balanced output and each side has equal inductance, the output is balanced.

Measurements made by K2HLT on this 72 ohm 1:1 balun indicate that over the bandpass of 1.6 to 30 mc, it has less than 0.5 db attenuation, less than 0.5 db of unbalance and a standing wave ratio less than 1.2:1. Although this balun uses the small diameter RG-59/U, larger coaxial cables may be used in a balun of this type. W6SAI has described a broadband 52 ohm balun using essentially the same technique but employing 52 ohm RG-8A/U cable.[9] This balun had an over-all passband from 6 to 32 mc and would handle a full kilowatt. Since the operation of this device is limited at the low frequency end by the inductance of the windings, the use of a longer length of cable should result in lower useable operating frequencies. The coil must be redesigned for the differences of each cable, but the required procedure is quite simple. All you have to do is adjust the length and size of the coil to resonate at approxi-

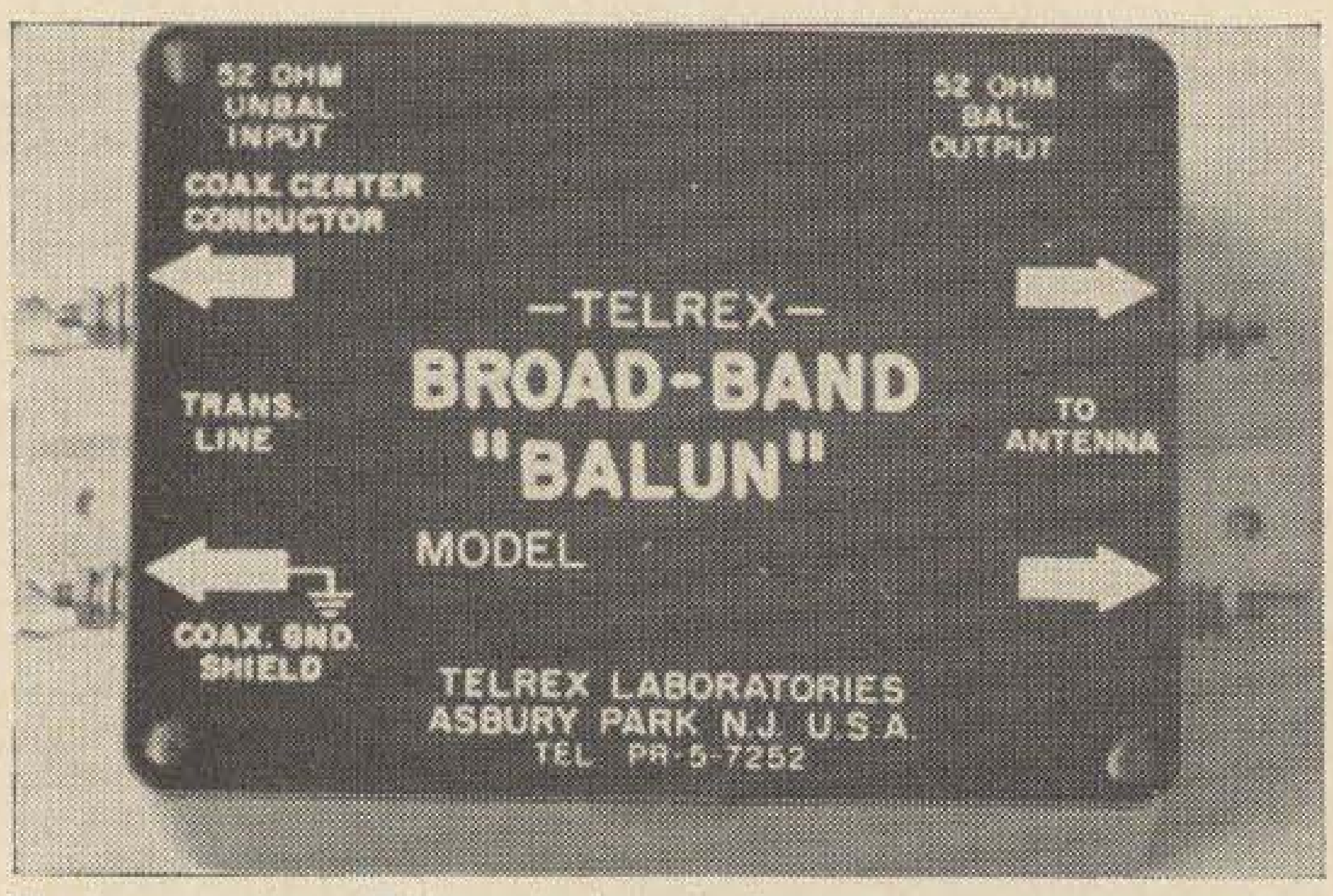


Photo courtesy Telrex Laboratories.

The Telrex broad-band baluns are available in several models that will handle up to 4 kilowatts PEP. These baluns may be mounted at the antenna feedpoint and provide a convenient and efficient method of feeding balanced antennas with coaxial transmission line.

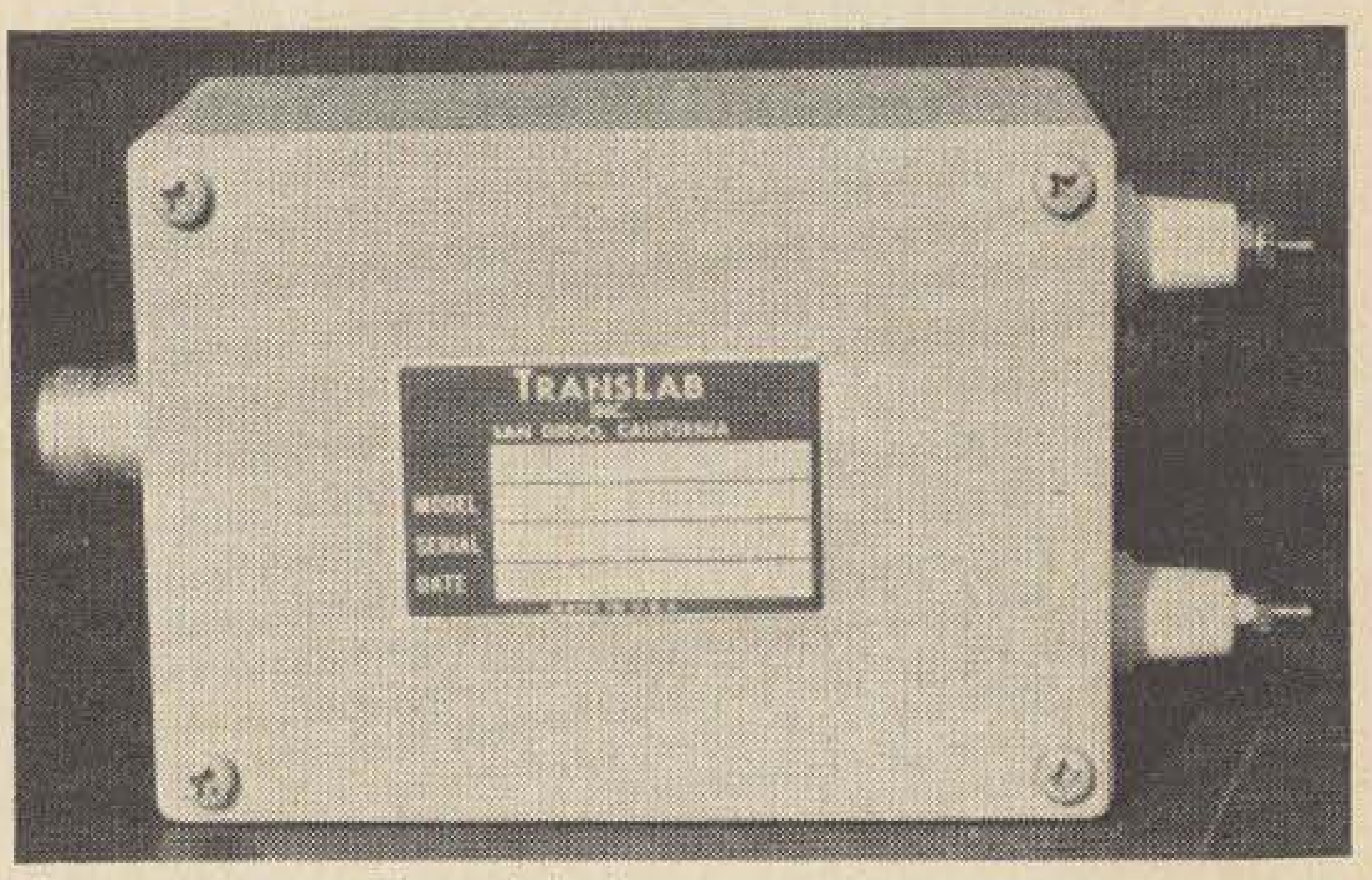


Photo courtesy Translab Inc.

Translab's broadband ferrite balun is a completely weatherproof unit which provides a balanced output from 50 or 70 ohm coaxial lines over a frequency range from 2 to 30 mc. It will handle 2 kilowatts PEP and is available with either a 1:1 or 4:1 impedance ratio.

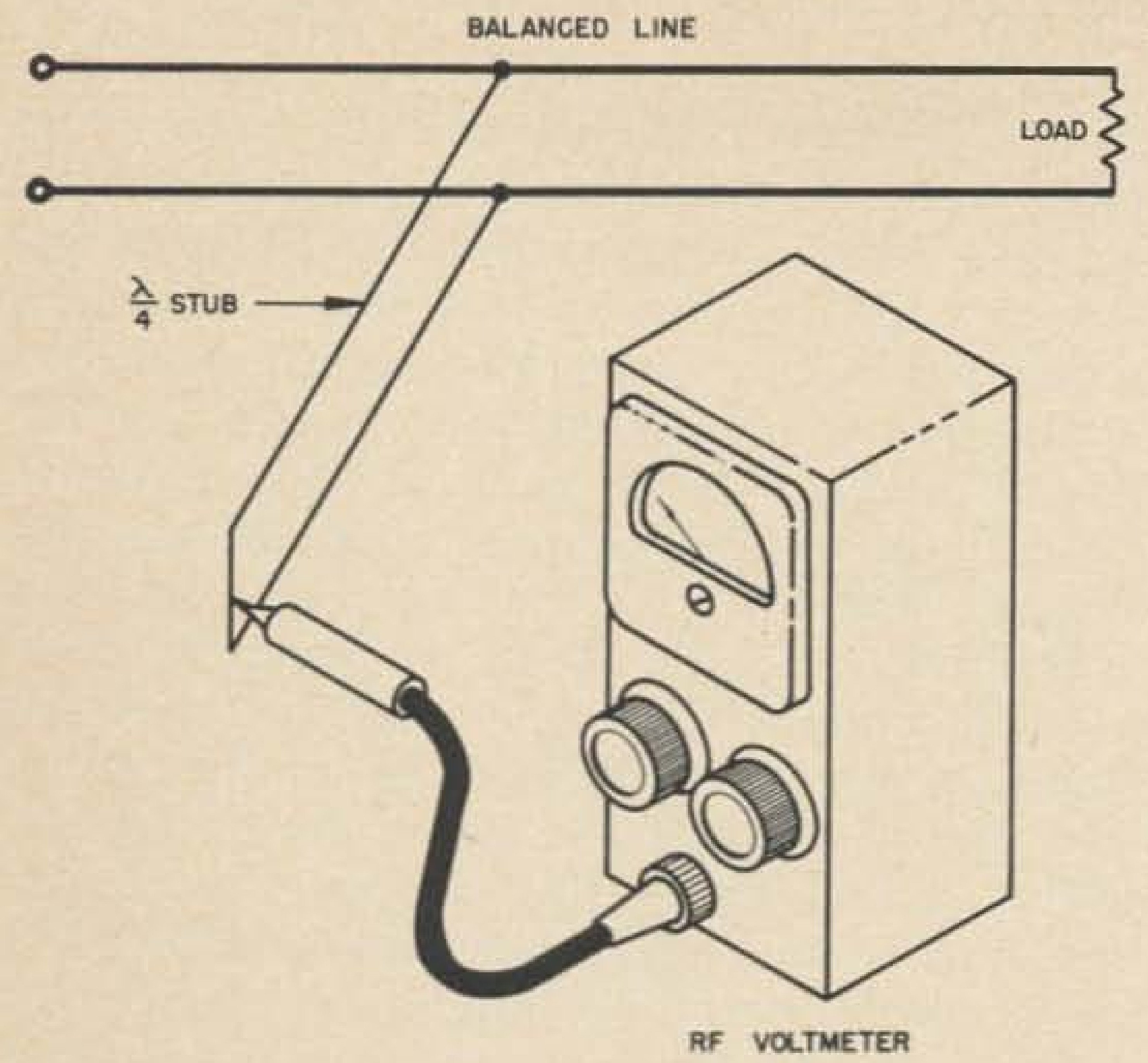


Fig. 14. Measuring the balance of the balance to unbalance converter. If the balun is providing an exactly balanced output, there will be no indication on the voltmeter.

mately 14 mc while retaining the required bandwidth under load conditions.

The chief item of concern in the performance of a balun is the amount of balance that exists on the balanced output line. This may be determined by measuring the voltages from each of the balanced conductors to ground. Many high-frequency VTVM's are suitable for this purpose, but the input impedance of the VTVM must be very high so that it will not introduce any unbalance of its own.

Since the voltmeter only gives a reading proportional to amplitude, this method will not detect unbalance in which the peak amplitudes of the voltages on the two lines are equal but do not occur 180 degrees apart in time. A better method of detecting this *phase* unbalance is illustrated in **Fig. 14.** Since the stub is short-circuited, it will present an infinite impedance to the balanced voltage. For unbalance voltages, however, the quarter-wave stub is open-circuited at its end so that the points on the dual line at which the stub is attached are short-circuited for unbalanced currents. Therefore, there will be some voltage from the end of the stub to ground if any unbalance exists on the line.

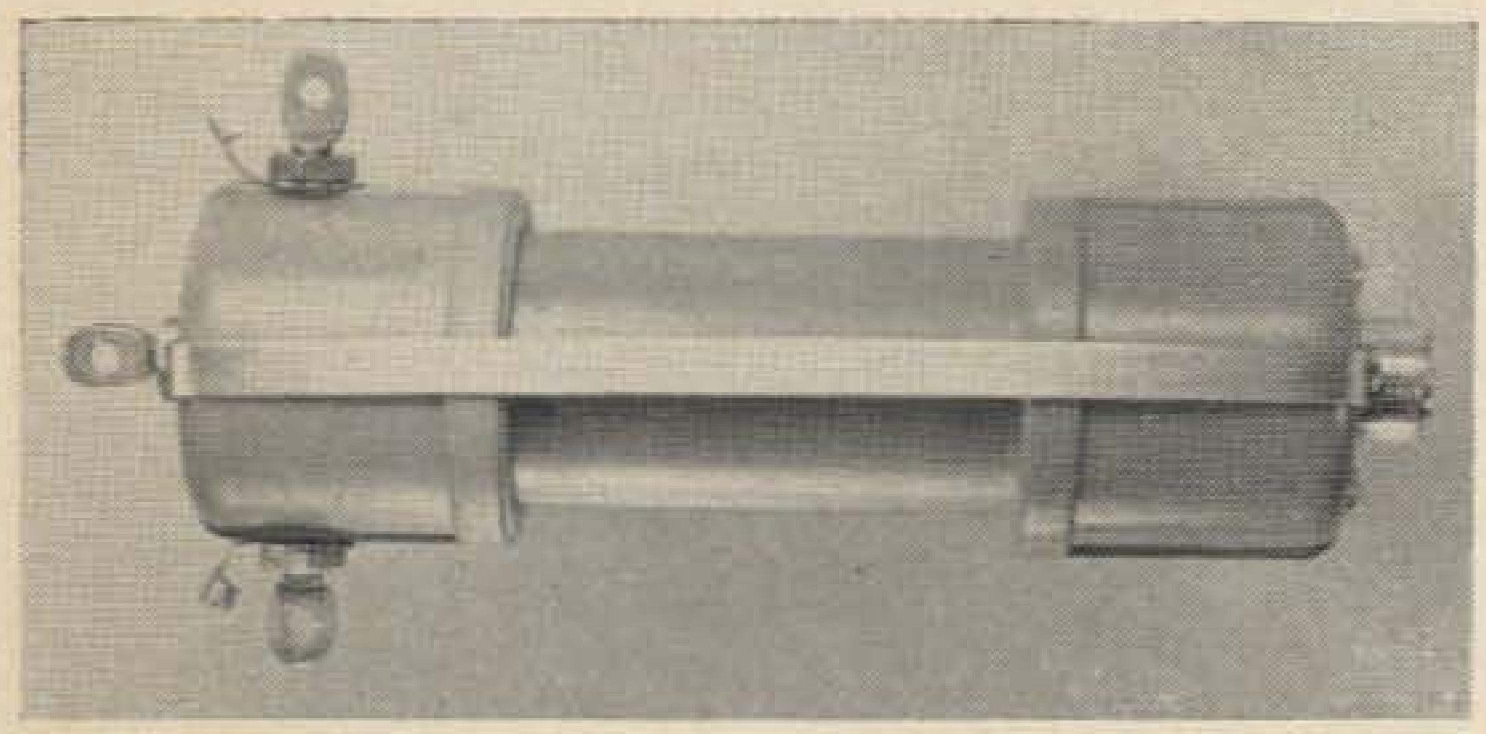
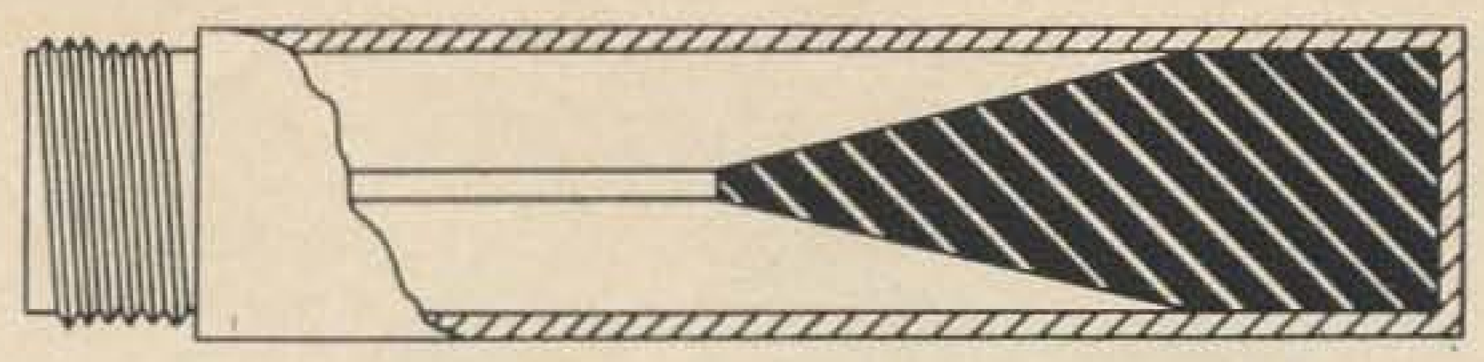
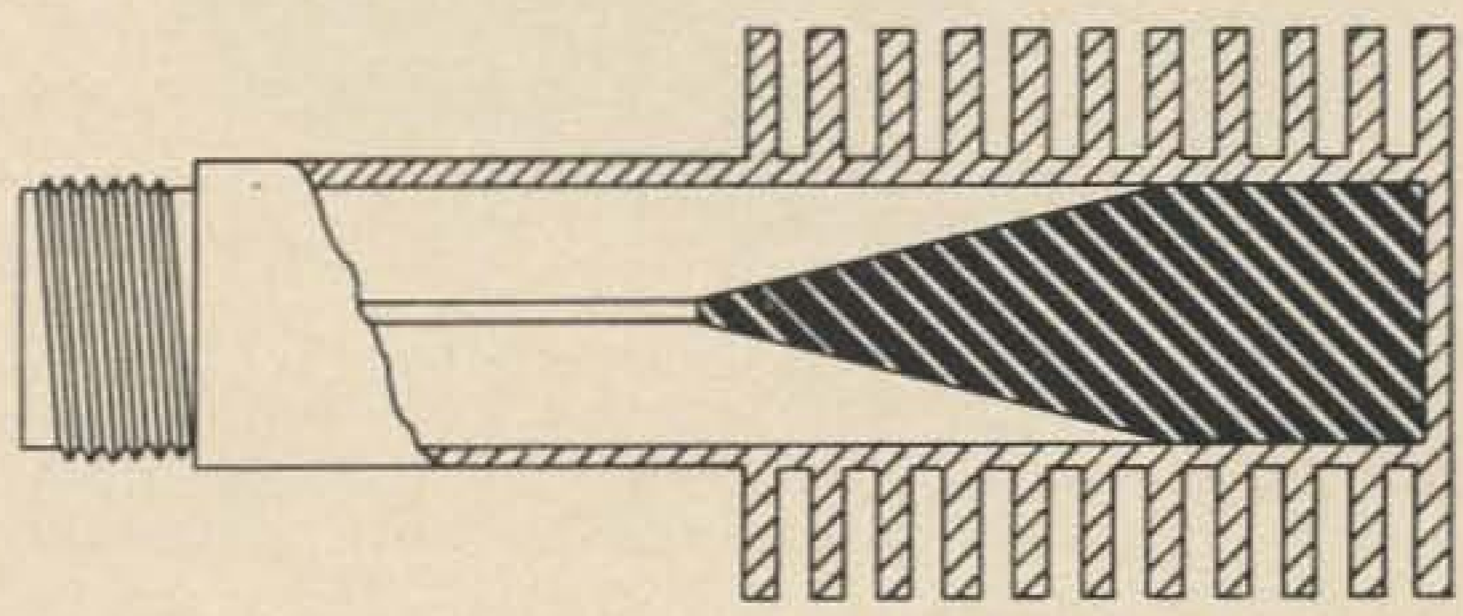


Photo courtesy Unadilla Radiation Products.

The W2AU balun is a wideband unit available in either 1:1 or 4:1 impedance ratios. It can serve as the center insulator in a dipole or inverted vee antenna and has a built in hang-up hook and lightning arrester. This balun may be used from 3 to 30 mc with 50 or 70 ohm coaxial transmission lines and will handle over 2 kilowatts PEP.



LOW POWER LOAD



MEDIUM POWER LOAD
WITH HEAT DISSIPATING FINS

Fig. 15. Construction of broad band coaxial dummy loads. The tapered resistance element of these loads insures that they will provide a matched load up to several thousand megacycles.

Dummy loads

The dummy load is an indispensible coaxial accessory which is used primarily for tuning transmitters. However, an accurate dummy load is also useful for calibrating SWR meters and measuring rf power. Although the common household light bulb is sometimes used as a load, it is not too suitable because it does not present a constant load to the transmitter. This is because as the light bulb heats up (becomes brighter), the rf impedance of the filament increases.

Commercial dummy loads suitable for use from dc to microwave are constructed as shown in **Fig. 15.** Here the resistance element consists of a conical block of resistive material mounted in the end of a metal tube. The tapered section from the center to outer conductor is used to provide a good impedance match over a broad range of frequencies. For

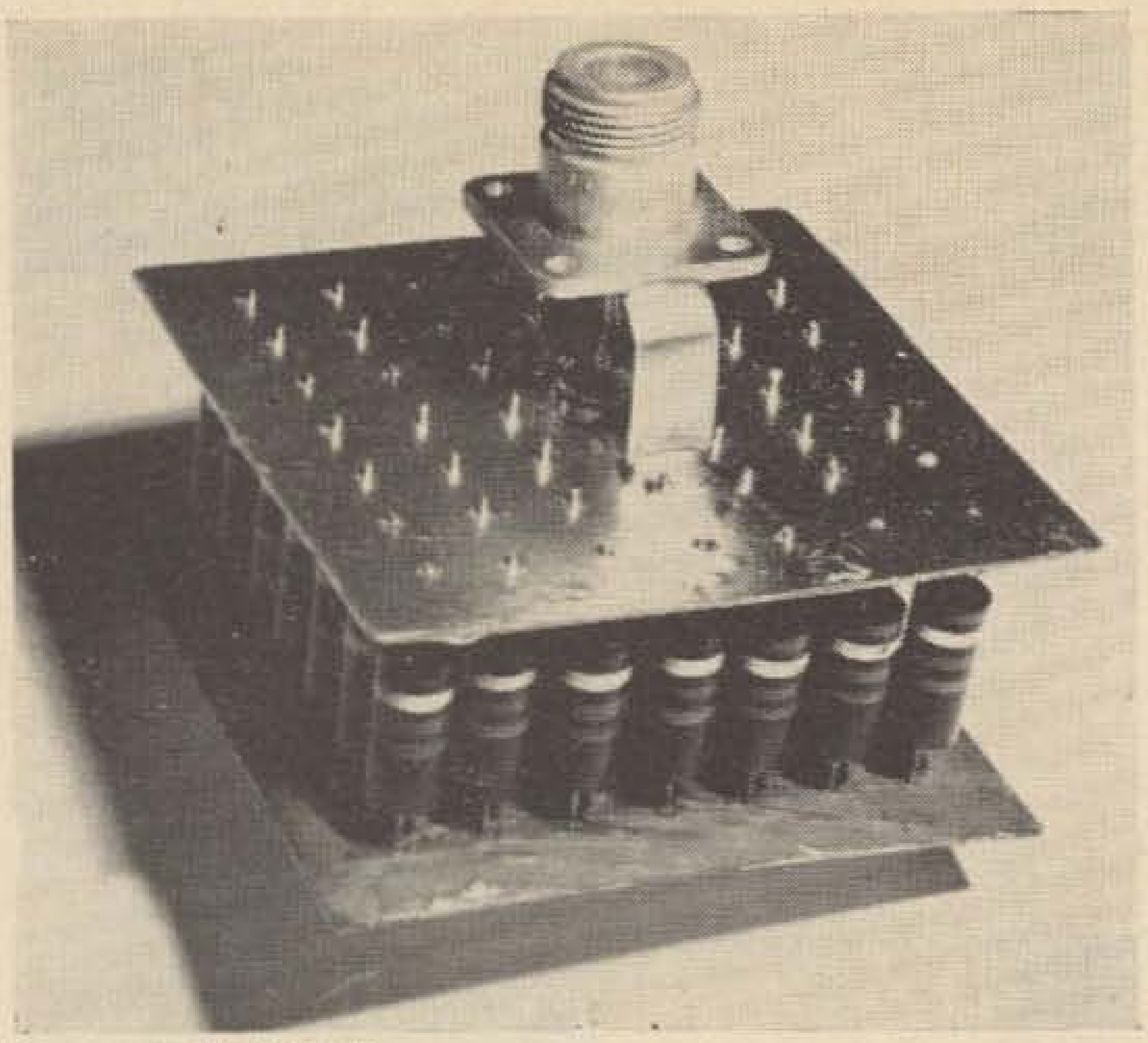


Photo by WA6IAK.

A homemade 100 watt dummy load that is suitable for use to 200 mc. This load is made by installing ordinary two watt carbon resistors between two copper plates.

higher power applications, the metal case may be provided with cooling fins or immersed in a bath of transformer oil.

For frequencies up to about 200 mc, a suitable load may be made by mounting a number of common composition resistors in parallel. In the homemade unit pictured, forty-eight 2400 ohm, 2 watt resistors are mounted between two copper sheets 2 inches square. This load will dissipate 50 watts continuously and up to 200 watts for short periods; the power capacity may be increased by simply immersing the load in a can of ordinary motor oil.

For higher power capacity, a non-inductive carborundum resistor may be used as a dummy load. The Heathkit HN-31 "Cantenna" uses this type of construction to provide a dummy load that will dissipate up to 1000 watts ICAS (intermittent commercial or amateur service) and provide an SWR of less than 2:1 all the way up to 400 mc. The Cantenna has a continuous power rating of 200 watts, but when cooled with transformer oil, it will dissipate 1000 watts for periods up to 10 minutes. Actually, up to about 50 mc this dummy load exhibits an essentially resistive characteristic; above 50 mc it begins to show a small amount of reactance that causes the standing wave ratio to be greater than unity. The overall effect is not too severe on 50 mc, but at 432 mc an SWR of 2:1 can raise havoc with power and SWR measurements. K6MIO has shown[12] that the Cantenna is slightly inductive at 432; by placing a small variable shunt capacitor across the load, this inductive reactance can be nulled out. Installation of a variable 20 pf capacitor will allow the Cantenna to be tuned for minimum SWR over the entire VHF range. Furthermore, tests have shown that this capacitor has almost no effect on the operation of the load below 30 mc.

The Gentec dummy loads are hermetically sealed, nonreactive loads with a nominal impedance of 50 or 70 ohms, depending on the model. The excellent rf characteristics of these loads are a result of the film-type resistors which are mounted in a coaxial cavity inside the can. Radiation fins and ribbed surfaces permit good heat radiation. The model 525 (50 ohm) and 725 (70 ohm) loads will dissipate 125 watts continuous and 250 watts ICAS. For higher power applications, the model 510 will handle 500 watts continuous or 1000 watts ICAS. The model 525 and 725

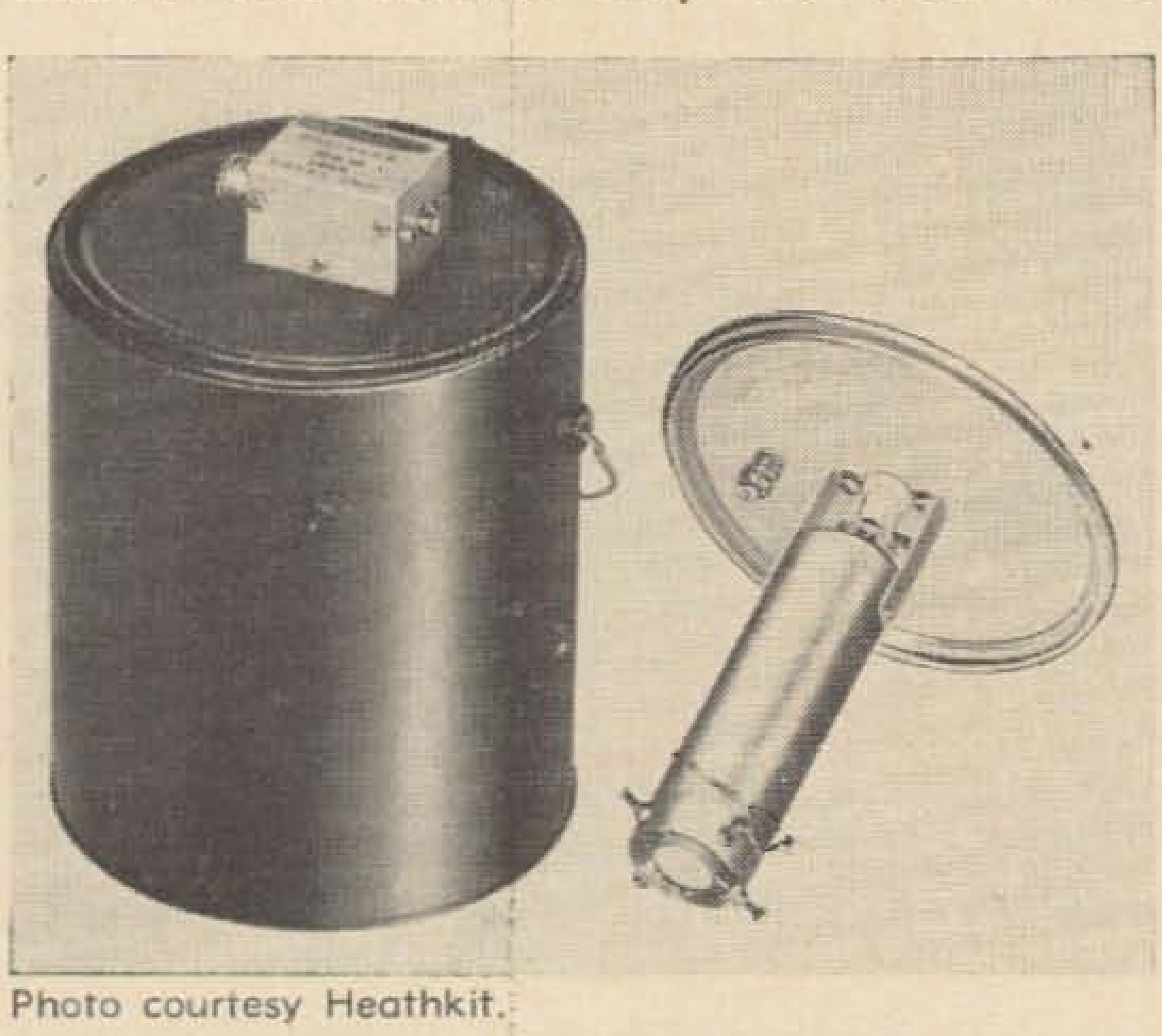


Photo courtesy Heathkit.

The Heathkit "Cantenna" is a dummy load which will dissipate up to a kilowatt for short periods of time. An rf sampling probe is mounted on the top of the container for measuring power output.

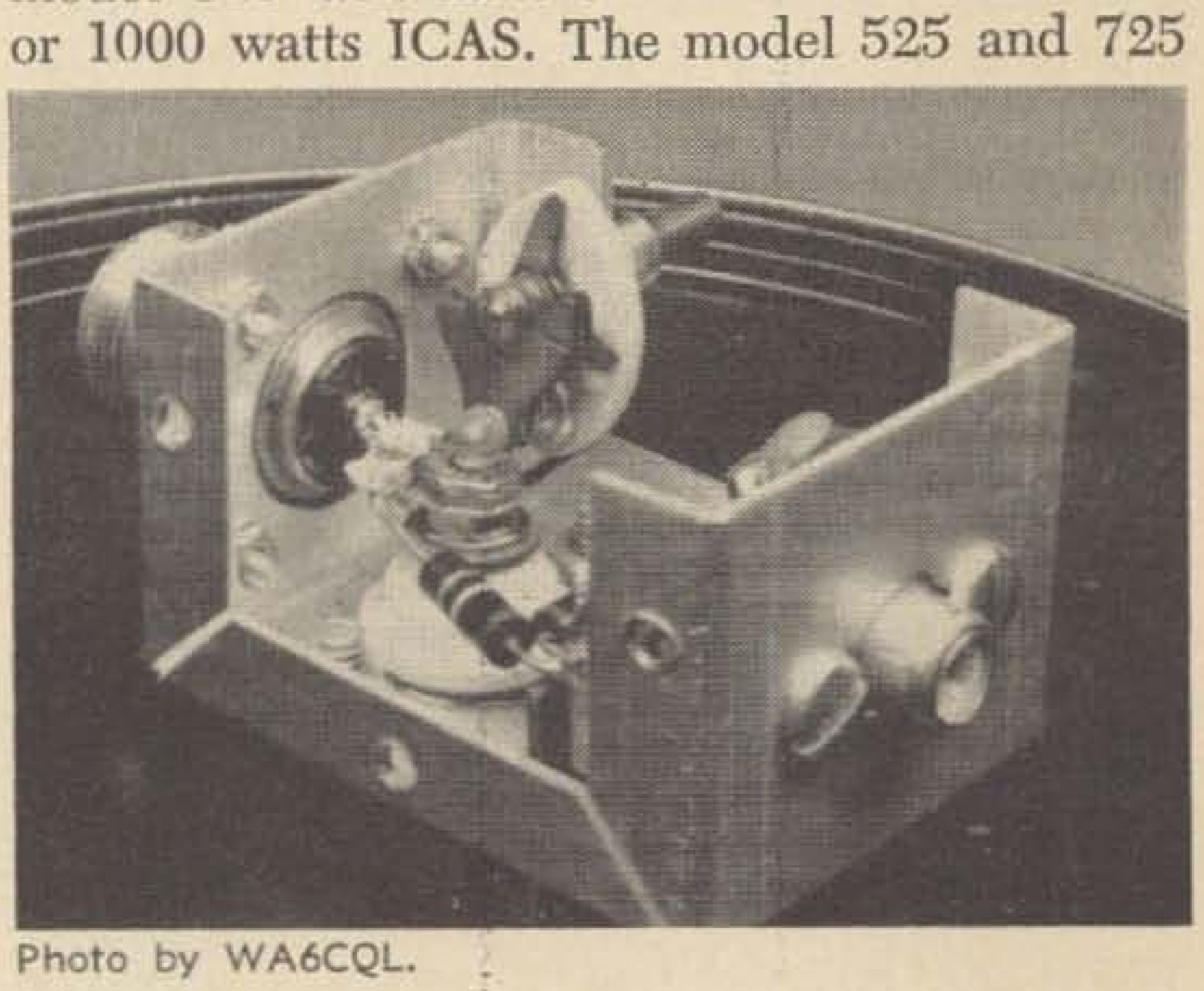


Photo by WA6CQL.

Installation of a 15 pf variable trimmer in the Heathkit HN-31 "Cantenna." This capacitor cancels the slight amount of inductive reactance that is present in the range from 220 to 450 mc so that the "Cantenna" presents an essentially resistive 50 ohm load at 432 mc.

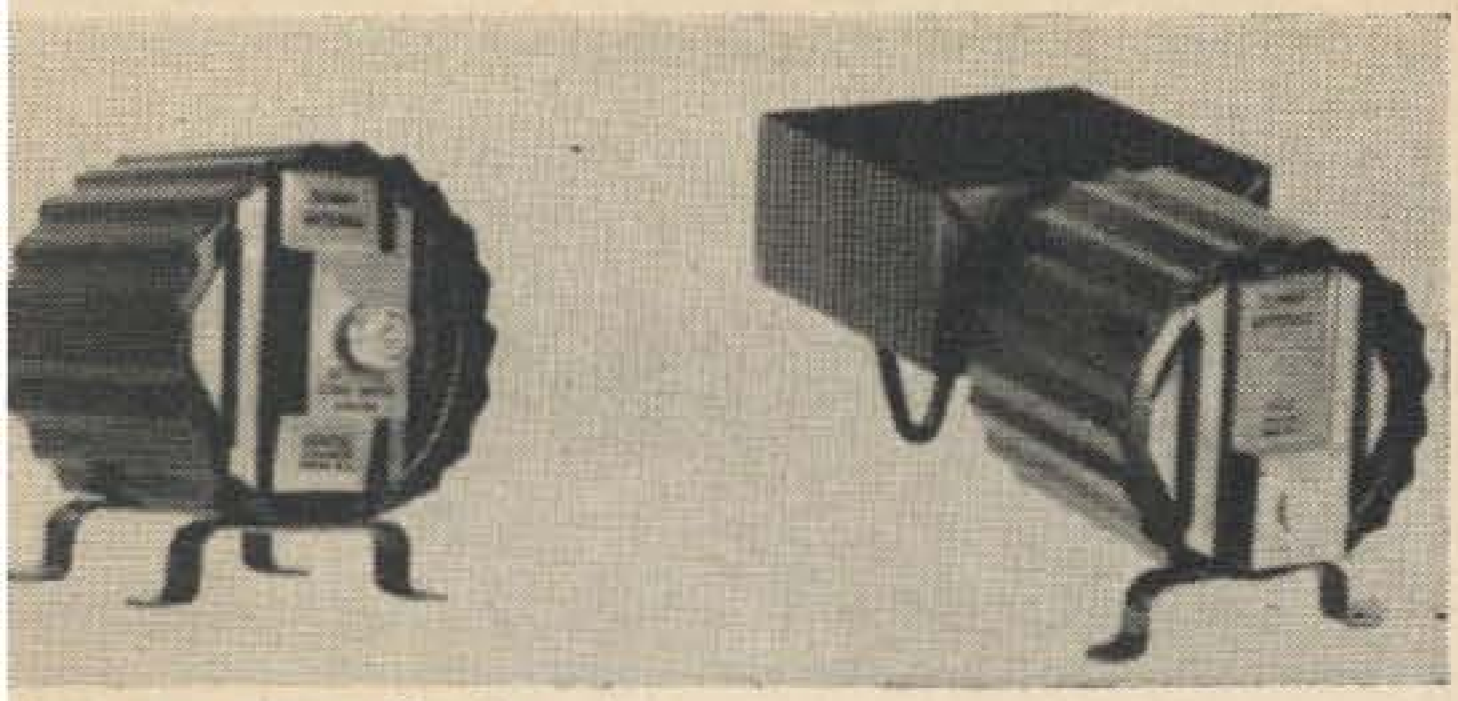


Photo courtesy Gentec, Inc.

The Gentec dummy antennas are hermetically sealed nonreactive loads designed for use from dc to 250 mc. The Model 525 on the left will dissipate 250 watts ICAS; the higher power Model 510U on the right will handle 1000 watts ICAS.

loads are furnished with type UHF connectors, but the model 510 is available with either UHF, N, or BNC fittings. For low power applications, the Gentec model 507 (50 ohms) and 707 (70 ohms) exhibit an SWR of less than 1.05:1 from dc to over 250 mc and have a continuous power rating of seven watts.

The Radiation Devices Company's coaxial terminations are typical of commercial dummy loads designed to work well into the microwave region. These loads have an SWR of less than 1.05:1 from dc up to 1300 mc and less than 1.15:1 up to 4000 mc. These precision loads are constructed around special microwave film resistors which are carefully mounted in machined assemblies. These loads are available in a low power model (LP-1 series) which has the characteristics noted above, and a higher power version, the MP-1 series, which will dissipate up to 12 watts; 25 watts dissipation may be obtained by mounting the MP-1 series load on a suitable heat sink. The MP-1 series exhibits a maximum SWR of 1.1:1 from dc to 1300 mc and 1.2:1 maximum up to 2000 mc.

Another type of dummy load that has proven to be particularly useful, especially for high power above 300 mc, is the lossy coaxial cable load. In this type of a load, a long length of coaxial line is terminated with a low-wattage, non-inductive 50 or 70 ohm resistor. The length of the line is chosen so that the loss at the frequency of operation is such that only a small portion of the incident power reaches the resistor termination. The loss of RG-8A/U at 432 mc for example is pretty close to 5 db per 100 feet; 600 feet of RG-8A/U then has a total loss of 30 db. This means that if 1000 watts of power is pumped into the input end of the cable, only one watt will be dissipated by the small terminating resistor at the opposite end. The beauty of this type of load is that it is almost purely resistive and exhibits a low SWR up to several thousand megacycles. However, before constructing a load of this type, consult the coaxial cable power charts to determine the maximum amount of power the cable can handle at the desired operating frequency.

If the impedance of the load is properly matched to the transmission line, the rf power being dissipated in the load may be determined by measuring the rf voltage across the load and using the relationship:

$$P = E^2/Z$$

Where: P = Rf power in watts
E = Rf voltage across the matched load (RMS)
Z = Rf impedance of the load in ohms

Example If the rf voltage across a 50 ohm load is 75 volts, what is the rf power?

$P = E^2/Z = (75)^2/50 = 5625/50 = 112.5$ watts

The Waters model 334 Dummy Load/Wattmeter was designed specifically for amateurs and combines a non-inductive, oil cooled load with an integral direct reading rf wattmeter. This instrument may be used to accurately measure rf power up to 1000 watts from 2 to 230 mc.

A more accurate method of measuring power that requires a little more equipment is the standard *calorimetric* technique.[14] In this method of measurement, the dummy load is cooled by the flow of coolant over it. The average power dissipated by the load can then

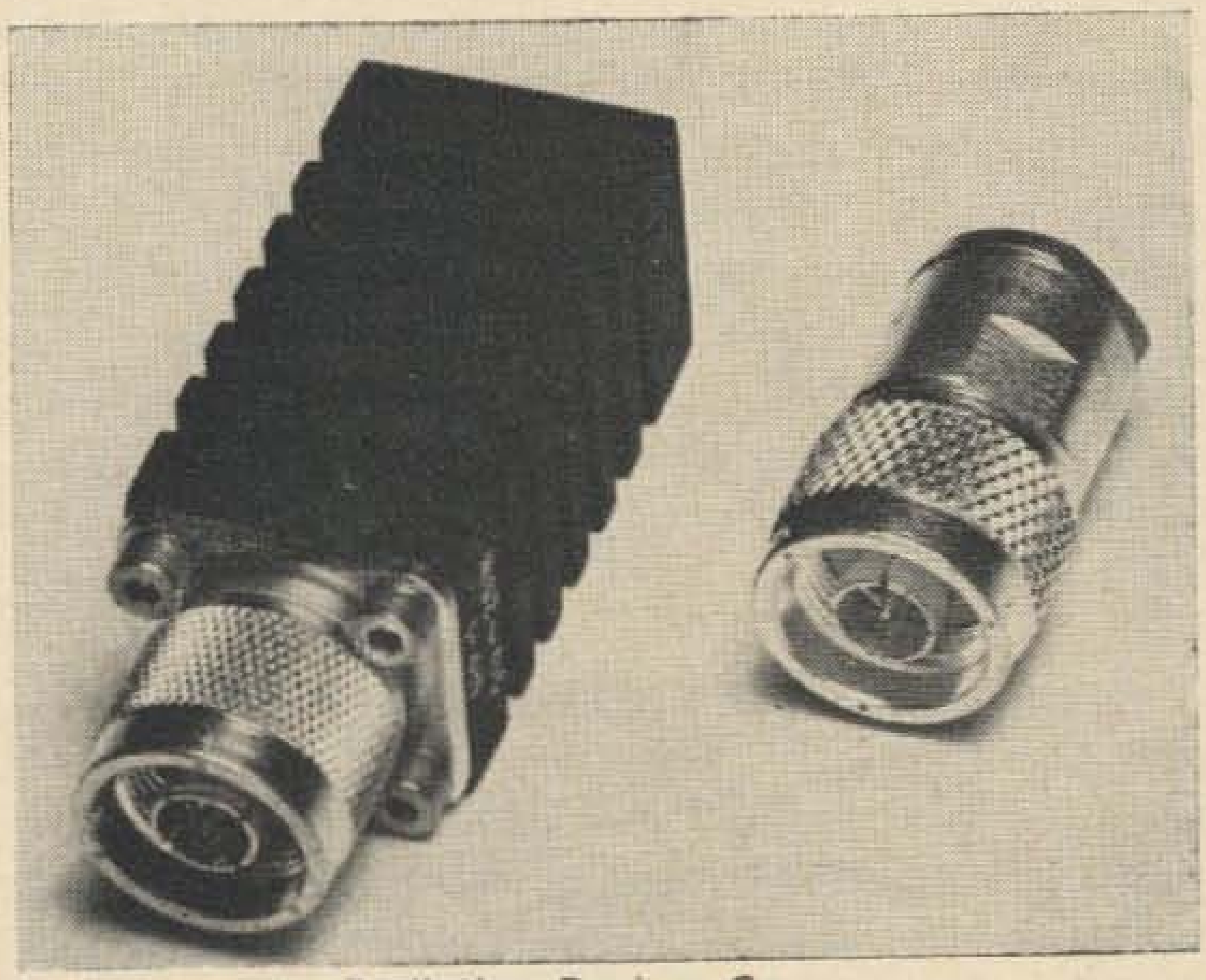


Photo courtesy Radiation Devices Co.

Radiation Devices' precision coaxial terminations. The model on the left will dissipate 12 watts while providing a matched load up to 2000 mc; the dissipation may be increased to 25 watts by mounting the load on a larger heat sink. The load on the right provides a matched load up to 4000 mc and will dissipate one watt.

Photo by WA6IAK.

This commercial dummy load for 50 ohm lines provides a matched load up to 12,000 mc.

be determined by measuring the rate of flow and temperature rise of the coolant and using the following formula:

$$P = 264\ Q\ g\ S\ (T_o - T_i)$$

Where: P = Average power dissipated in watts
Q = Rate of coolant flow in US gallons per minute
g = Specific gravity of the coolant
S = Specific heat of the coolant
T_o = Outlet temperature of the coolant °C
T_i = Inlet temperature of the coolant °C

If distilled water is used as the coolant, this formula reduces to the following:

$$P = 264\ Q\ (T_o - T_i)$$

The accuracy of this technique is highly dependent upon the accuracy of the rate-of-flow and temperature measurements, but with the proper instruments, this is not too difficult to obtain. One other important point when using this method is to insure that the heat loss between the input and output measurement points is absolutely negligible; otherwise, erroneous power measurements will result. Also, sufficient stabilizing time must be allowed before the temperature measurements are made because the thermal time constant of this type of equipment is quite long.

Example A dummy load is immersed in a container of distilled water which is being pumped by the load at the rate of 0.5 gallons per minute. If the inlet temperature of the water is 22°C and the outlet temperature is 28°C, what is the average power being dissipated by the load?

$$\begin{aligned} P &= 264\ Q\ (T_o - T_i) \\ &= 264\ (0.5)\ (28 - 22) \\ &= (132)\ (6) \\ &= 792 \text{ watts} \end{aligned}$$

Transmission line filters

A *low pass* filter is placed between the transmitter and antenna to prevent harmonics of the transmitter from interfering with television reception. After the transmitter has been completely shielded and all the power leads bypassed, the only way that interfering harmonic energy can be radiated is through the antenna. By placing a low pass filter in the transmission line, this type of interfering signal may be effectively controlled. For transmitters operating on the ham bands up to 30 mc, a low pass filter is usually designed so that it has a cutoff frequency of approximately 45 mc. With this type of cutoff, maximum attenuation occurs in the middle of channel 2 and TVI is minimized.

For the operator who is interested in operating on six meters, the problem is somewhat more complex. Since the six meter amateur band is immediately adjacent to television's channel 2, it is difficult to design a filter that is effective in eliminating radiation only two megacycles away. Unfortunately, filters are just not that good. However, by limiting six meter operation to the first one megacycle of the

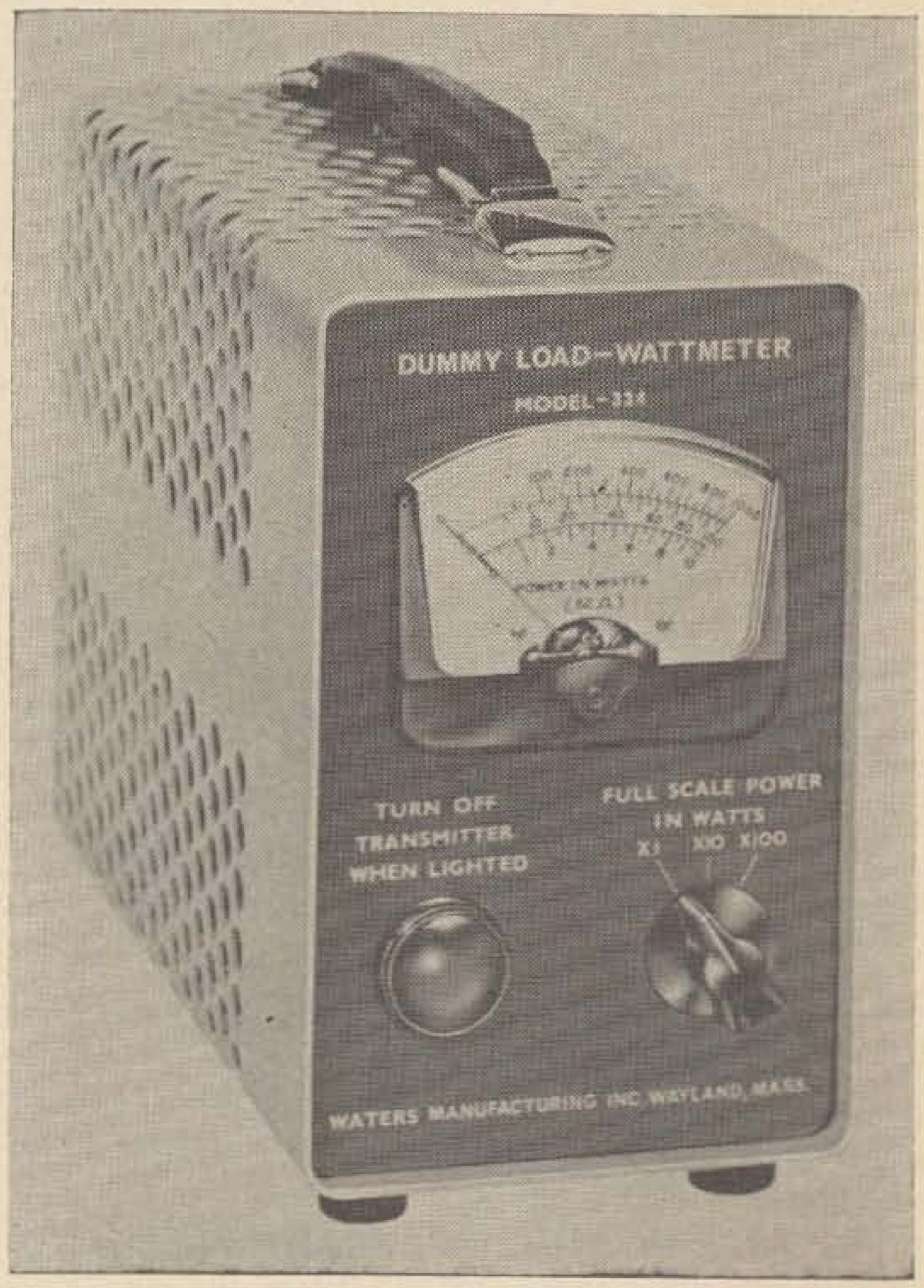


Photo courtesy Waters Manufacturing Co.

The Waters dummy load—wattmeter is an rf power absorption device with an integral direct reading rf wattmeter. It is rated at 50 watts continuous duty or 1000 watts intermittent over a frequency range of 2 to 230 mc.

Table 4. Low pass filters

Manufacturer	Model Number	Impedance (ohms)	Attenuation	Maximum Power (watts)	Cutoff Freq. (mc)	Connectors
Ameco	LN-2	52	35 db above 50 mc	200	40	UHF
Bud	LF-601	52 or 72	85 db above 54 mc	1000	42	UHF
B&W	423	52 or 75	50 db above 62 mc	100	54	UHF
B&W	424	52 or 75	50 db above 54 mc	100	40	UHF
B&W	425	52	85 db above 54 mc	1000	40	UHF
B&W	426	75	85 db above 54 mc	1000	40	UHF
B&W	427	52 or 72	60 db above 62 mc	1000	54	UHF
Clegg	372	52	40 db above 68 mc	240	54	UHF
R. L. Drake	TV-1000-LP	52	60 db above 57 mc	1000	52	UHF
R. L. Drake	TV-100-LP	52	60 db above 57 mc	100	52	—
R. L. Drake	TV-CB-LP	52	60 db above 50 mc	100	43	UHF
E. F. Johnson	250-20	52	75 db above 54 mc	1000	45	UHF
E. F. Johnson	250-35	72	75 db above 54 mc	1000	45	UHF

band, it is possible to employ filters that have a cutoff frequency at 53 mc. These filters don't have as much attenuation on channel 2 as do those with a cutoff frequency of 45 mc, but they will eliminate many cases of television interference. However, since the cutoff frequency is so close to the operating frequency, effective low pass filters for six meters will not handle a full kilowatt with realistically sized components; most are limited to approximately 200 watts.

Although low pass filters are by far the most common transmission line filters used in amateur stations, *band pass* filters are very useful in many applications. When operating on VHF and UHF bands, in many cases there are interfering signals from FM stations, television stations and radar installations which are using assigned channels very close to the amateur frequencies. In some cases these interfering signals completely obliterate signals on the amateur bands. By installing a band pass filter in the feed line, this type of interference may be minimized. Other places where band pass filters are helpful are in local oscillator chains for 432 and 1296 mc converters and

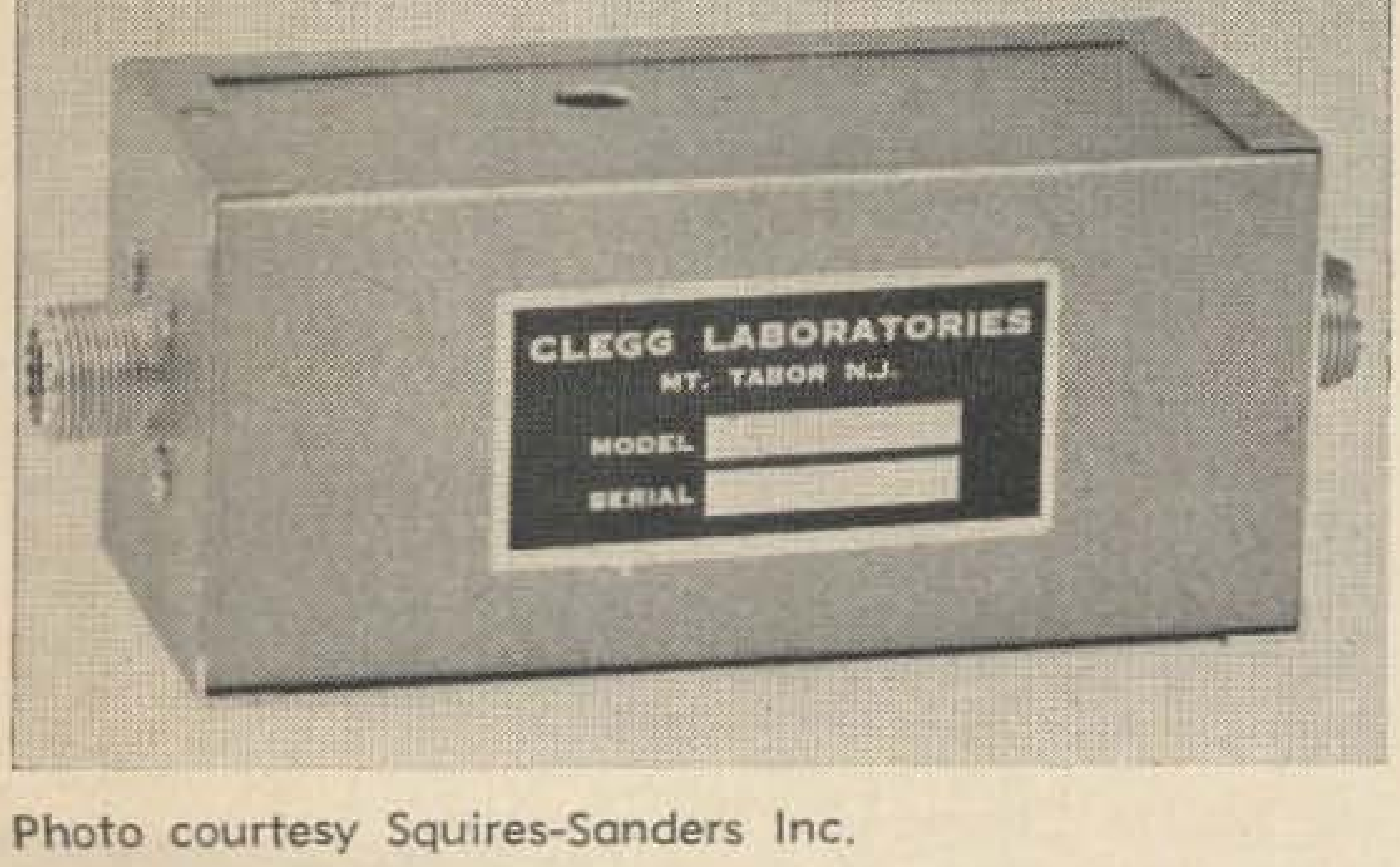


Photo courtesy Squires-Sanders Inc.

Clegg Laboratories low pass filter for 52 ohm lines provides more than 28 db rejection from 55 to 68 mc; more than 40 db rejection on any TV channel above 68 mc. A built in notch filter may be adjusted to provide up to 35 db rejection from 55 to 68 mc.

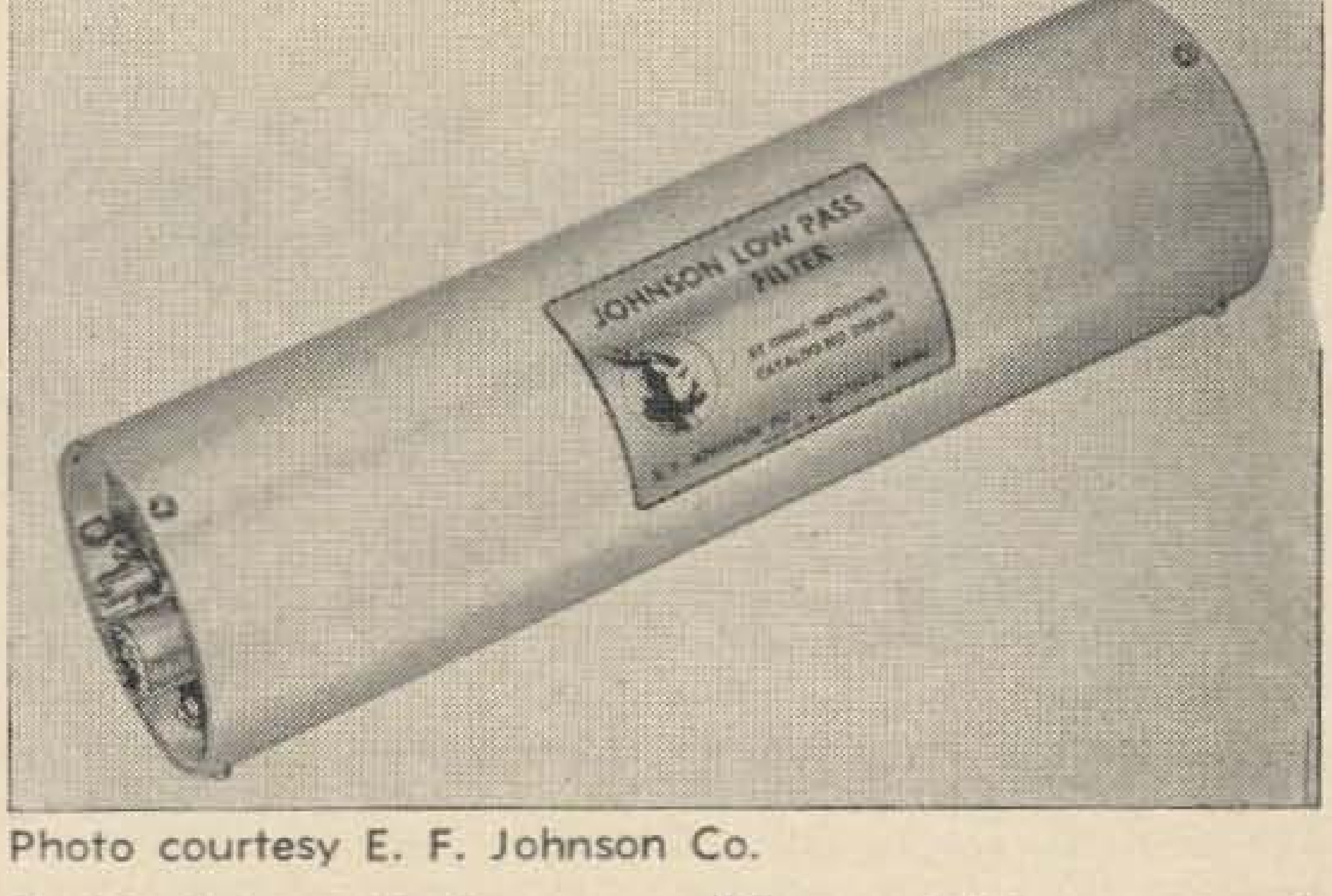


Photo courtesy E. F. Johnson Co.

E. F. Johnson's low pass filter exhibits a cutoff frequency of 45 mc and provides maximum attenuation at 57 mc, the center of TV channel 2. This filter will handle a full 1000 watts of AM or 5000 watts peak SSB.

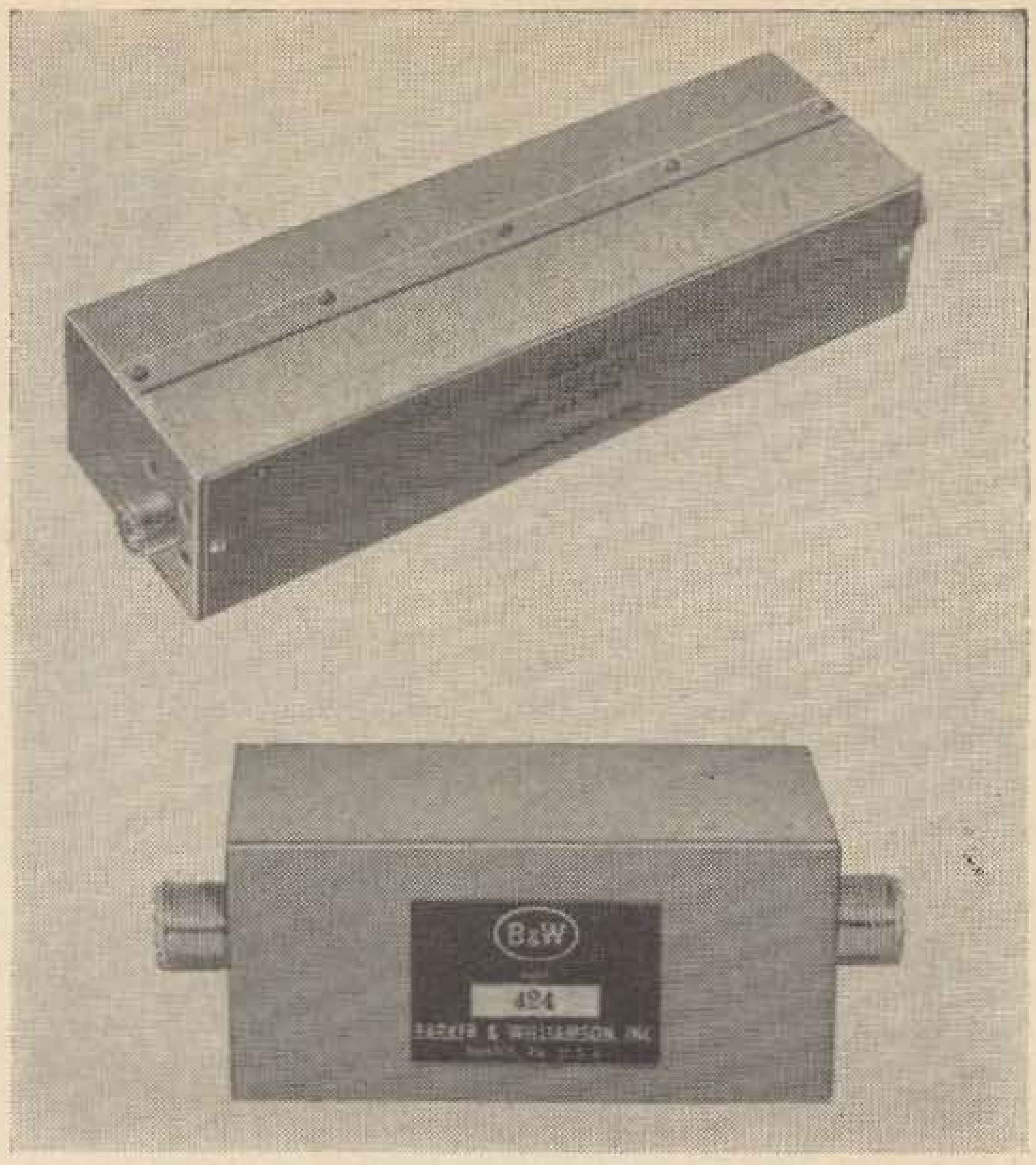


Photo courtesy Barker & Williamson, Inc.

These B&W low pass filters prevent the radiation of spurious and harmonic rf energy which causes TVI. The Model 425 on the left will handle the legal limit while the Model 424 in the foreground is limited to 100 watts.

Photo courtesy R. L. Drake Co.

These R. L. Drake low pass filters are designed to prevent TVI from amateur transmitters operating up through 6 meters. The TV-1000-LP filter in the center will safely handle a full kW on the bands up to 10 meters and 200 watts on 6 meters. The smaller TV-100-LP is capable of 100 watts below 30 mc and 20 watts on 6 meters.

when tripling from 144 to 432 mc or from 432 to 1296 mc. In these cases the band pass filter will eliminate birdies in the receiver and/or undesirable out-of-band radiation.

A properly designed filter will introduce very little loss into the transmission system, typically 0.5 db or less. However, to obtain proper filtering, it is imperative that the filter operate into a matched transmission line. If the SWR on the transmission line is greater than about 2:1, the filter will not operate properly and the insertion loss will rise astronomically. Also, if there is a high SWR on the line, irreparable damage may occur to the filter because of the higher effective voltages and currents associated with the high SWR.

Antenna tuners

Antenna tuners are often included in an antenna/transmission line system so that the transmitter and receiver will look into the proper load. However, it should be emphasized that the installation of an antenna tuner is not a cure-all for high standing wave ratios and mismatched antennas; all the antenna tuner can do is provide the transmitter with the load that it was originally designed for. In this respect it will lower the SWR that the transmitter must work into. However, only changing the antenna matching system or the transmission line or both will lower any standing waves that may be residing between the antenna tuner and the antenna.

The addition of an antenna tuner in the line is particularly advantageous when it is desirable to use a low pass filter with a high SWR on the antenna feed line. As has been

Photo courtesy James Millen Mfg. Co.

The Millen Company's Transmatches are designed to provide a match from the 50 to 70 ohm output of a transmitter to unbalanced loads from 10 to 500 ohms. The Transmatch on the left will handle 2kW peak, while the Transmatch Junior on the right will handle 300 watts peak. Both of these units have a built in reflectometer for measuring swr.

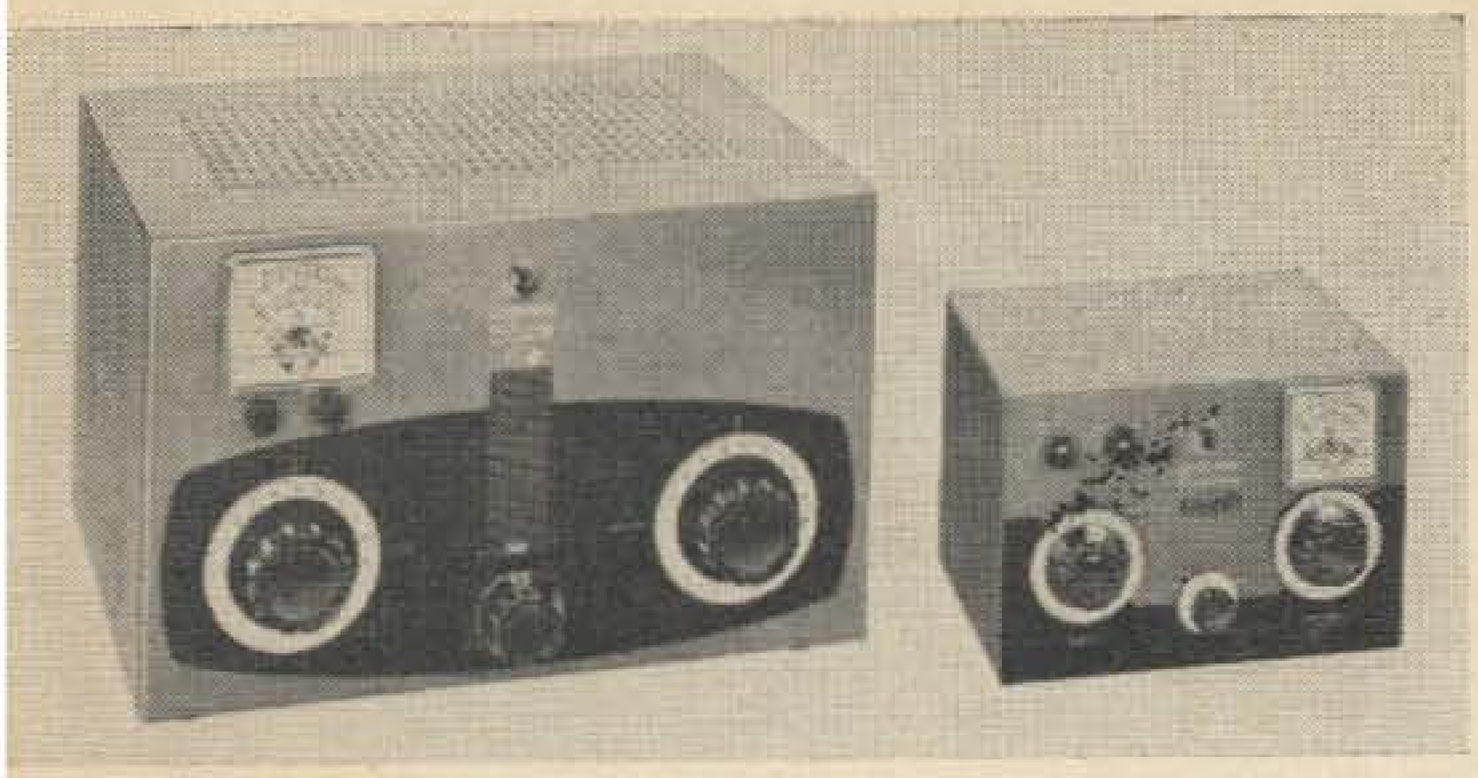


Photo courtesy E. F. Johnson Co.

The Johnson "Matchboxes" are designed to match 52 ohm coaxial line to both balanced and unbalanced reactive and non-reactive loads. These units will operate throughout the 3.5 to 30 mc amateur bands and are available with built-in swr indicators. The kilowatt "Matchbox" on the left will take the legal limit while the smaller unit on the right is limited to 275 watts.

previously noted, the filter must be properly terminated if it is to work properly. If the filter is installed between the transmitter and the antenna tuner, and the tuner is properly adjusted, the filter will be properly terminated and will exhibit the proper cutoff and insertion loss characteristics. Often the inclusion of an antenna tuner in the system is helpful in the reduction of harmonics. This is because the natural Q of the tuned circuits used in the tuner inherently discriminate against frequencies other than those to which they are tuned.

The James Millen "Transmatch" is designed to convert the impedance of any 15 to 500 ohm unbalanced coaxial fed antenna system to 50 ohms so that the transmitter will load properly. Actually, on the lower bands the impedance range of the Transmatch is higher, going up to 4000 ohms, but on ten meters it is somewhat lower. This is because the reactance of the components used in the tuner change with frequency.

There are two models of the Transmatch available, the regular model which is capable of handling the full legal limit and the Transmatch Junior, which is limited to 300 watts peak. A reflectometer is built into each of these units as a constant monitor of line SWR and as an aid in tuning them on each of the bands.

The E. F. Johnson "Matchbox" is an antenna matching and switching system which is designed to match 50 ohm coaxial lines to reactive or nonreactive loads, either balanced or unbalanced. The Matchbox is also designed to provide a separate matching network for the station receiver. A built-in antenna changeover relay is included and it has a provision for muting the receiver when transmitting. The Kilowatt Matchbox antenna changeover system includes a time delay circuit for the relay, providing fast make-slow break action that

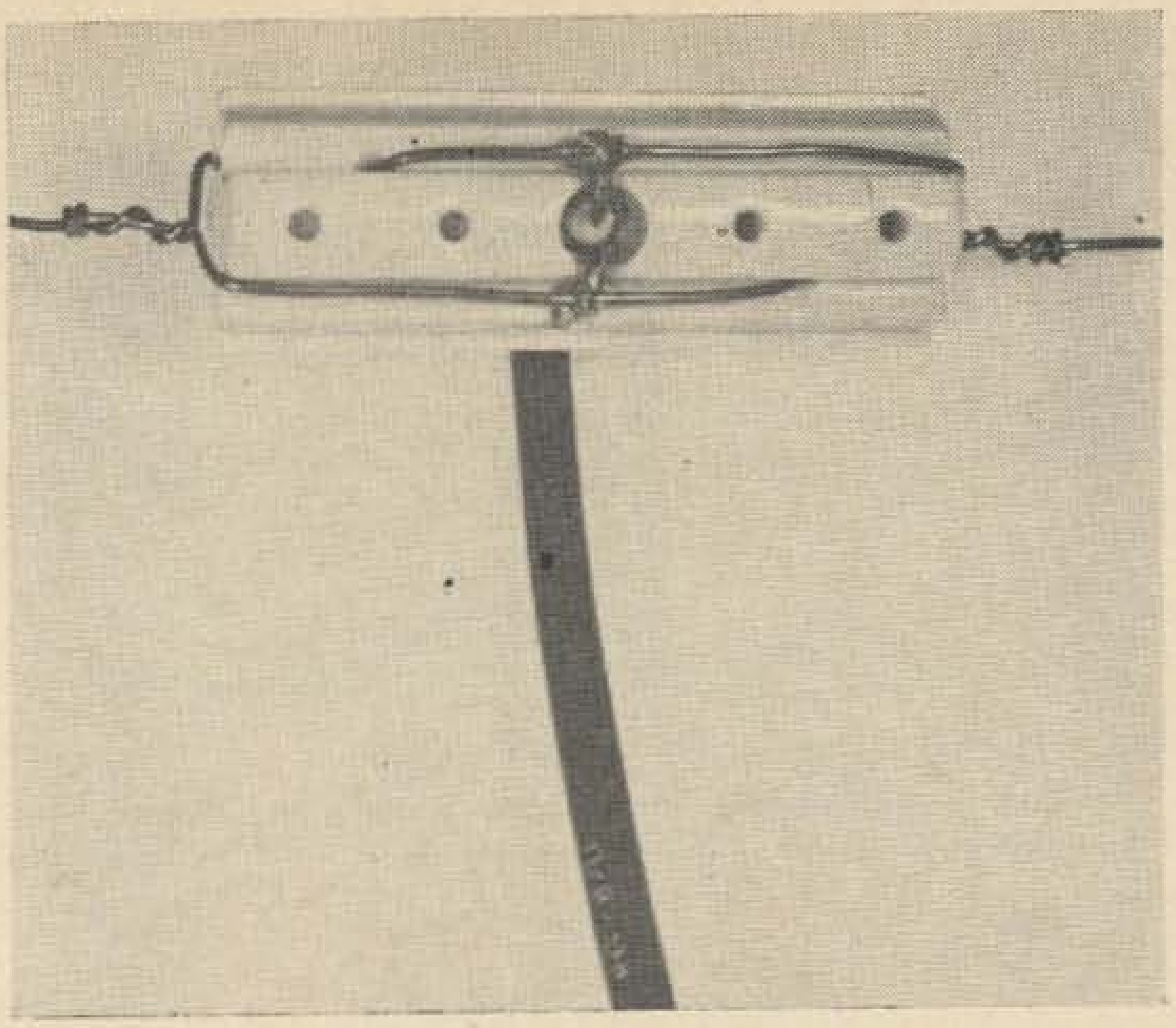


Photo courtesy Yatter Laboratories.

A Yatter Laboratories solid porcelain strain insulator provides a neat and economical method of feeding a dipole antenna with coaxial line. This strain insulator has provisions for mounting a 1:1 coaxial balun, loading coils or even open wire line. When assembled according to the manufacturer's instructions, the completed unit is permanently weather proof and cannot be pulled apart.

prevents arcing or sticking of the relay contacts. This also protects the receiver from high voltage transients which might occur during the antenna changeover from the transmitter. A self-contained directional coupler provides a constant monitor of line operation.

The 275 watt Matchbox is a smaller version

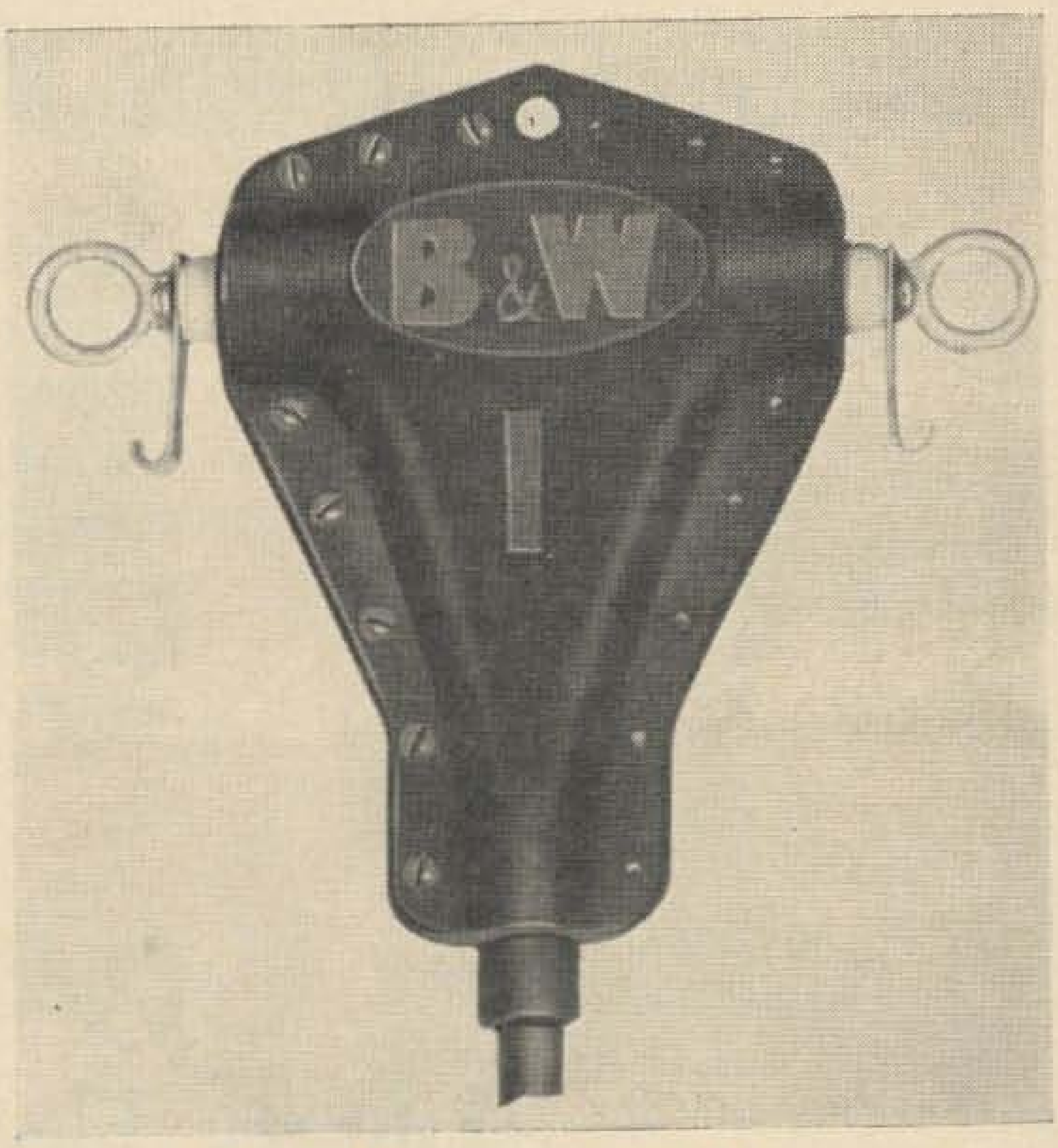


Photo courtesy Barker & Williamson, Inc.

This B&W coaxial cable connector provides a strong, weatherproof connection between the coaxial feed line and the center of a dipole antenna.

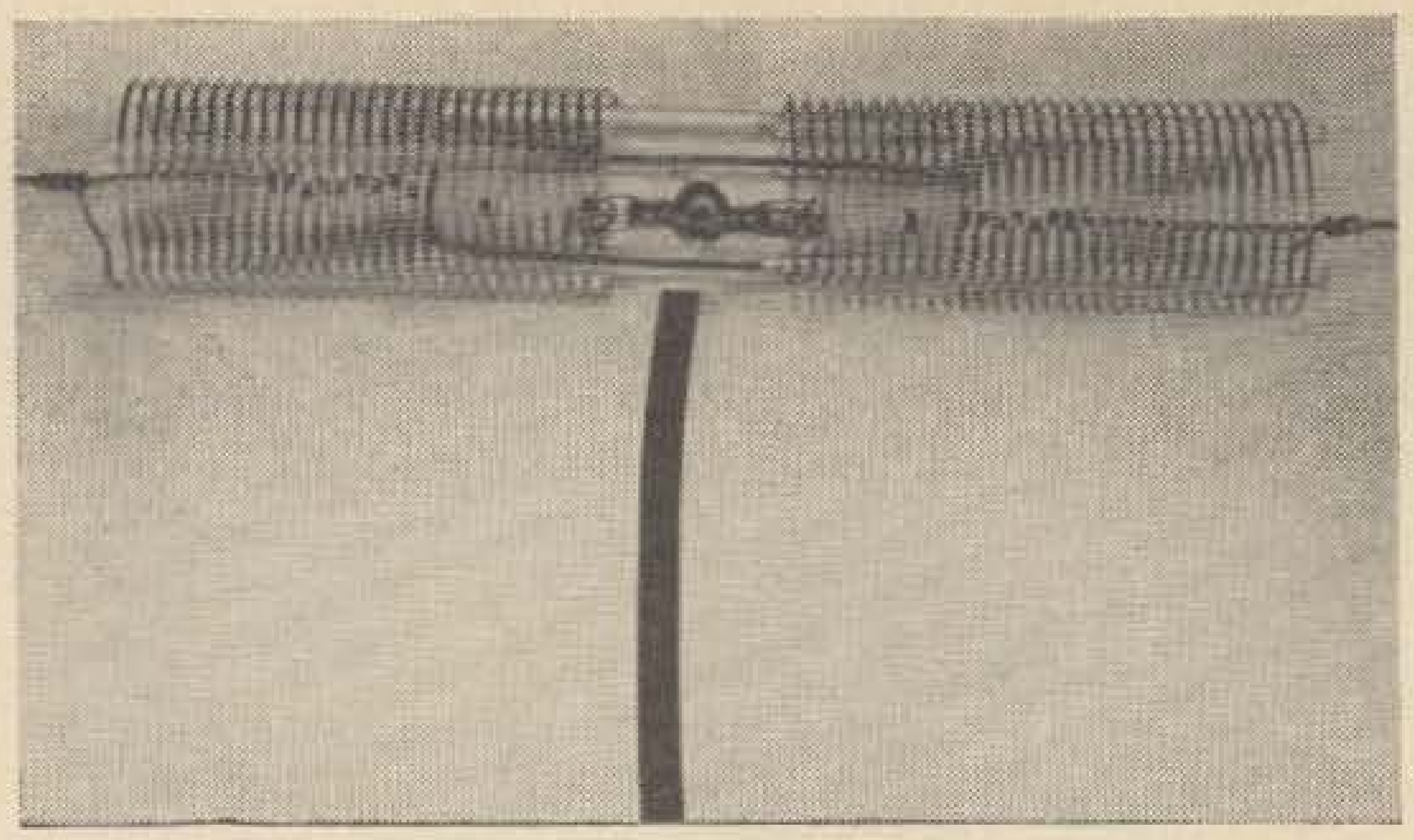


Photo courtesy Yatter Laboratories.
A Yatters Laboratories strain insulator, showing the installation of loading coils and coaxial feedline.

of the kilowatt unit for lower power applications where the high power capabilities of the larger unit are not required. The small unit is almost identical to the larger unit except that it is available with or without the directional coupler.

The World Radio Laboratories MM-100 "Mini-Matcher" is designed to match the low impedance output of an amateur transmitter to a high impedance antenna. This is particularly useful when using an end fed antenna; in many cases the installation of an end fed antenna is more practical than the common center fed doublet. The Mini-Matcher may be used with transmitters that have input powers up to 100 watts SSB/CW or 75 watts AM.

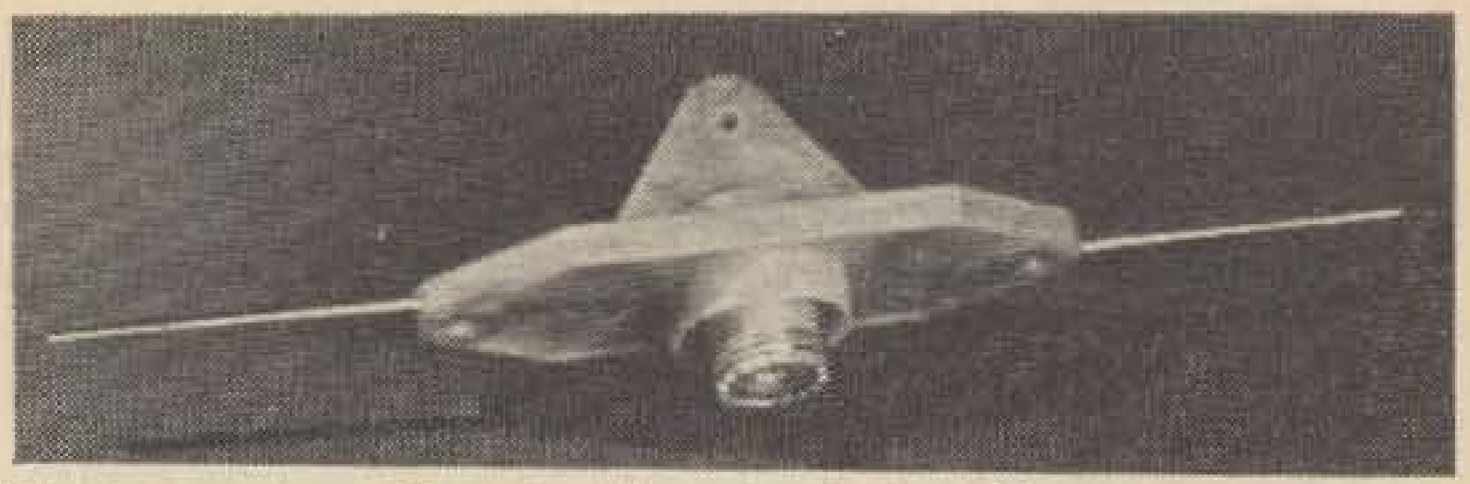


Photo courtesy Budwig Manufacturing Co.
The Budwig antenna-coax connector. This molded unit features holes at both ends for element tie points and has molded-in copper leads for connection to the UHF coaxial connector.

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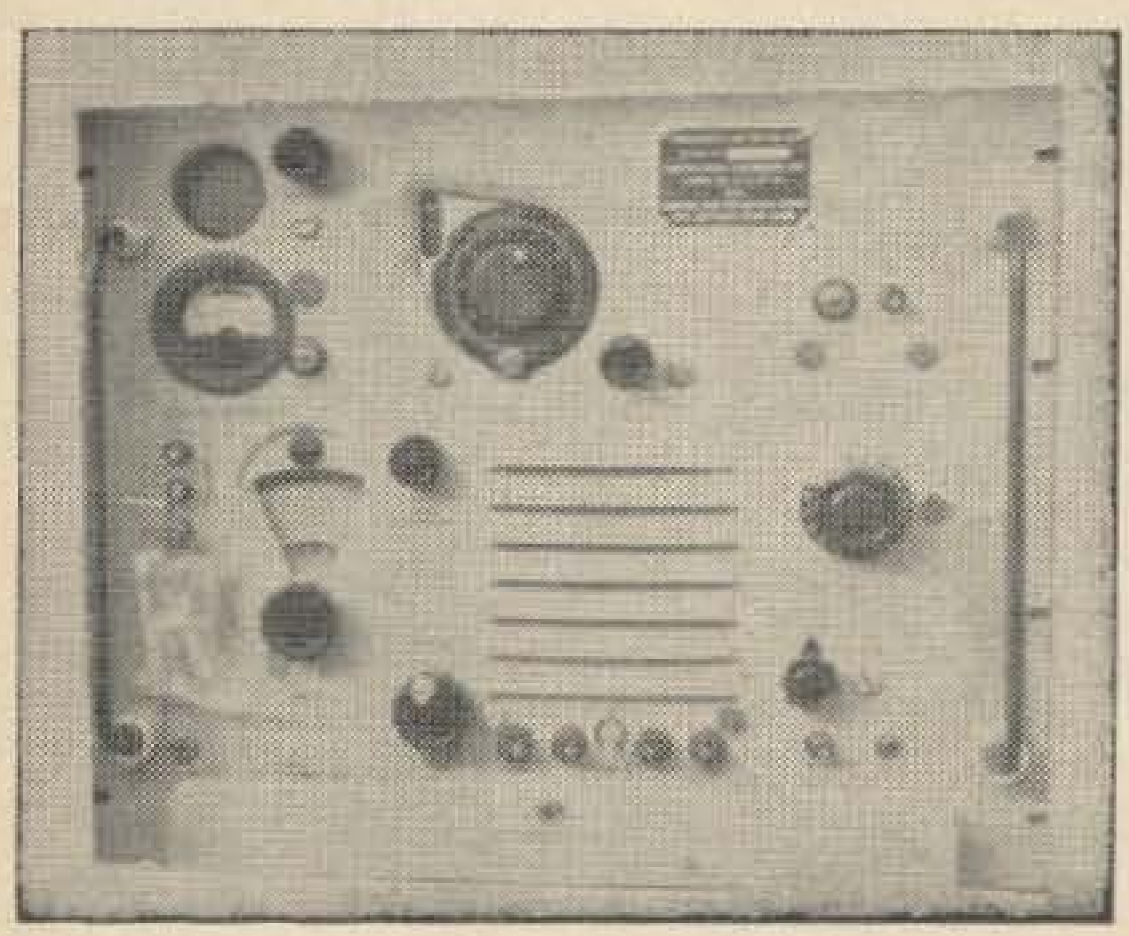

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Fairchild has reduced the already-low prices on the integrated circuits used in WB6AIG's Kindly Keyer in the July issue. The old price on the JK Flip Flops was $3.95; the new is $1.50, not a bad price for a tiny package containing 12 transistors and 16 resistors. The Dual Two Input Gates were $1.65. Now they're only 80¢.

Somehow the price and source of the etched circuit board used in this keyer was left out of the article. The board is small and a real horror to make and drill with its 120 tiny holes (part of them number 60), so it would probably be a lot better to buy than make. At any rate, the fiber glass board with all holes drilled is $4.95. You can buy it from Harris Company, 56 E. Main Street, Torrington, Conn.

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KW PARTS: Jennings UCS-300 vacuum variable \$40.00; B&W Model 852 Inductor (slight mechanical modification) \$40.00 postpaid. Make me an offer: National RDZ Receiver; I-193 RTTY Test Set; Lambda Model 440 Power Supply. Edgerton, K1ZCC, 32 Hereford St., Boston, Mass. 02115.

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GET OUT with perfect HT-37, SX-1Ø1A: \$240 apiece. In so much better condition than average gear, I'll guarantee them for 30 days. Sam Butler, WA5AXS; 618-18th Ave. N.; Texas City, Texas.

HEATH HO-13 Spectrum Monitor wired by engineer for 455 kc, parts included for other IF frequencies, \$65.00. WØICR, Rte 1, Box 357, Parker, Colo. 80134.

WANTED: Military, Commercial, SURPLUS . . . Airborne, Ground, Transmitters, Receivers, Testsets, Accessories. Especially Collins. We pay freight and Cash. RITCO Box 156, Annandale, Virginia (703) 560-5480 COLLECT.

BOEHME MORSE tape reader and motor drive. McElroy perforator. 25 rolls of tape. \$45. LOCAL SALE ONLY. John Riley. Telephone 845-3880. Burbank, Calif.

TELETYPE WANTED—M28 typing units, parts, ASR cabinet, keyboard. Sell 28, 15, 14 machines, gears, motors, parts. W4NYF, 405 NW 30 Ter., Ft. Lauderdale, Fla. 33311.

SELL—SRT-14 subchasses, precision potentiometer set, audio frequency meter; magazines: Electronics, Control Engineering, IRE Proceedings, etc. W4NYF, 405 NW 30 Ter., Ft. Lauderdale, Fla. 33311.

EICO 753; Like new \$150.00, AC power supply \$70.00, with manual and original cartons, W5BGW Box 62, Yellville, Ark. 72687.

SB-300: CW, SSB, AM filters; 75 S-1; noise blanker; \$250.00 each f.o.b., Ed Jurow, 20314 Harding, Olympia Fields, Ill.

GALAXY V, Remote VFO, VOX, AC Supply, and Speaker-Cabinet \$495. Gonset GSB-201 \$190. All offers considered. John T. Null, 407 38th Street, Vienna, West Virginia 26101, 304-295-5616.

SP-600-JX-1 receiver with manual \$275.00, Valiant F/W \$200.00, HQ-145C with speaker \$160.00. Want KW power supply. K1NLW, Glenn Edson, 16 Monticello Dr. Paxton, Mass. 01612.

BUILD A CODETYPER. Transistorized electronic computer-typewriter for Morse teaching or keying your rig with fb fist. For schematic, parts list and technical dope send \$2 to Computronics Engineering Box 6606 Metropolitan Station Los Angeles 90056.

MOHAWK RECEIVER and matching speaker for sale. Moved into housing project and cannot use. Excellent condition. \$150. Brooklyn, N.Y. Call 996-7837 after 7 or weekends.

TECH MANUALS: Special $3.00 each—ARC-27, CV-116/URR, ARN-30, TS-186D, BC-1031. Many others, list 10¢. S. Consalvo, W3IHD, 4905 Roanne Drive, Washington, D.C. 20021.

EICO 723 $35, Mosely TA-33 Jr. tribander $45. Both nearly new. Or swap for 2 meter transmitter, converter. Pete Hunt, 41 Woodcock, Levittown, N. Y. 11756.

YOUR CALL LETTERS on a 7x2½ steel plate, white on red, weatherproof. For car and shack. Limit 5 characters. $2.00ppd. 2 for $3.75ppd. METHODS 1011A Bush St. San Francisco, CA 94109.

WRL'S BLUEBOOK SAVES YOU MONEY! These prices without trades: KWM2—$675.00; NCX3—$197.10; GALAXY 300—$161.10; NCL2000—$399.60; HT37—$233.10; HX20—$152.10; GLOBE KING—$179.10 up; 75S1—$278.10; SX117—$206.10; PMR8—$67.50; HQ170C—$197.10; 2A—$161.10. Hundreds more, free list. WRL, Box 919, Council Bluffs, Iowa 51501.

LI'L LULU 6 METER TRANSMITTER. Purchased Spring of '65, like new, never mobile. Complete details on request. WAØILV, Frank Miller, Clarkson, Nebraska 68629.

COMPLETE STATION: Knight T-60, R-55A receiver, Eico 722 VFO. All excellent, $100 or $35 each. Charles Jimenez WA4ZQO, 17001 Northwest 53rd Court, Opalocka, Florida 33054.

HW-22 with HP-23 power supply. Sell or trade for comparable value receiver. W. Ellinwood W1MPY 758 Pleasant St. Athol, Mass. 01331.

FM FOR 2, 6 AND 432. Motorola 150MC base stations (140BY) $140. Motorola 432MC transceivers T44A6A 6/12V. These are clean and complete, with every tube, crystal, cable, control head, mike, speaker and case. Guaranteed operating. Complete manuel with every unit. Rated 18-20 watts output. Require no modification to get on 432MC. $75 each. Go where the action is: get on 432.9 wideband FM. Over 25 stations in Detroit area on this frequency. 432.9MC xtals available for most FM equipment (inquire). Just arrived: lots of clean 150MC 12V transceivers, with manuels. Send for latest list (S.A.S.E. appreciated). Newsome Electronics (Ray, K8TJP), 2670 Pinetree, Trenton, Mich. 48183.

HAVE COLLINS 75S3, 32S3, 62S1 and 516F2, Johnson 6N2 Thunderbolt. WANT 16 mm movie outfit. K71MH James F. Bingham, P.O. Box 516, Beaverton, Oregon. 97005.

EICO 753 TRANSCEIVER with transistor V.F.O. $180.00. EICO mobile transistor power supply $70.00. Both excellent. Don Norman K8LLZ, 204 Emerson Court, Elyria, Ohio.

TWO BEDROOM FRAME HOUSE on large 52' by 170' lot. Land values are still climbing. Has good potential. Will sell completely furnished (ham gear not included but will consider leaving 60' tower, rotor and beam behind) panoramic view of downtown. Good residential neighborhood. Stores, schools, etc. close. Asking $26,900. Call or write Iverson, WA6ZCQ 1312 Micheltorena Street, Los Angeles 90026. Phone No. 3 1581.

SB-33 SB1LA L.P. filter, New condition with manuals—original boxes. Transceiver tunes I 50KC of transmitter freq. $350. W1DFN 59 Tahattawan Rd. Littleton, Mass.

WANTED: TELETYPE EQUIPMENT R-388, 51J-3 R-390A. Cash, or trade for new amateur equipment. Alltronics-Howard Co., Box 19, Boston, Mass. Tel-617-742-0048.

NCX5 TRANSCEIVER—NCX-A Power Supply, Perfect—used 20 hours $425.00 WA4GYA, 2207 Harvard, Ft. Myers, Fla. 33901, Phone WE. 6-1726.

WANTED: BC 221—Original-Calibration Book—Accurate—Good condition. No modifications. Full details and price. Tel 899-7570. Howard Ell, 206 Pearce Ave. Point Pleasant, N.J.

LIKE SIDEBAND? SWAP like new HT37 for Heath Apache or Viking Valiant. C. J. Dixon, K9BQW, 18136 Chicago Ave., Lansing, Illinois 60438.

300 WATTS SSB TRIBAND transcriver galaxy 300 with power supply—excellent condition, $250—Tony Assenza, 10724 Campana Way—Rancho Cordova, Calif. 95670.

LOW MILEAGE DELUXE DRAKE 2B and HT-37 with coax-relay, microphone. $450 firm. HO-10 excellent, $45. B. Binder, 26 Sarah Drive, Spring Valley, N. Y. 10977. 914-352-1482.

DRAKE 2A RECEIVER, speaker $125. C. E. 20A and VFO $75. Sorry no shipping. R. Mensing 3160 Waverly, Palo Alto, Calif. 326 5884.

QSL CARDS????? WHOLESALE prices. "America's Finest" Samples 25¢ DeLuxe 35¢. Sakkers Printery, W8DED, Box 218, Holland, Michigan 49423.

TO 18 FIELD EFFECT TRANSISTORS $1.95, resistors, capacitors, transistors, diodes, and many other bargain packs send for list to: Solid State Pax. P.O. Box 206, Dorchester, Mass. 02014.

ESTATE SALE and bargain list. Send for it and include SSAE. Write Paradd Sales and Engineering Service, 280 Route 10, Dover, N. J. 07801.

TRADE: Preamp CQ May '63 3 nuvistors 10-80M; Wen 2 speed ⅜" drill Wlacc; Hy-Gain 4BD W1100' RG 59 u 6-20 M. OFFER: Stephen Clifton, 800 W. End Ave., N. Y., N. Y. 10025.

RTTY GEAR for sale. List issued monthly. 88 or 44 Mhy toroids five for $1.75 postpaid. Elliott Buchanan, W 6 VPC, 1067 Mandana Blvd. Oakland, Calif. 94610.

FOR SALE: BC610E; BC 614 Speech Amp; KWS1; 32V1; ART 13; R388 Recv'r. W2ZOL.

EXCESS GEAR AND PARTS, vac, variables, variable coils, tubes, meters, transformers, 2kw linear, diodes (HV), etc. Stamp for complete list. W6MCS, Rt. 1, Box 666, Arroyo Grande, Calif.

FOR SALE: COLLINS STATION $1100.00. 75S-1 with Waters Q-multiplier, matching speaker $325.00. 32S-1 with 516F-2 power supply $450.00. 30L-1 Linear $425.00. Purchased new. Kept in air conditioned quarters. Absolutely perfect, mint condition. Will bear most scrupulous inspection. New Avionics gear considered. K9DMG, Perry Mowery 21 Waibel Road, Bartonville, Illinois, Phone 697-6597.

FANTASTIC HAM LOCATION atop 1000' hill 180° view of Pacific Ocean Antenna OK Two story 3 bdrm 2½ bth. 2 dens 2 yrs old. shop area B. Ward WB6DLQ 3149 Altalaguna Blvd. Laguna Beach, Calif. Tel (714) 494 6110

SBE-33 with mike and DC supply $250.00; SB1LA matching Linear $150.000; DX60A $65.00; HG-10 VFO $30.00; WØNAE, James R. Boyer, R.R. #3, Watertown, South Dakota, 57201.

WANTED: MODEL 28 TELETYPE, R-388, R-390A, cash or trade for new amateur equipment. New NCL-2000, $500. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

STARTING HAMMARLUND HX-50; HX-50A; Problem Information Group. What problems-troubles have you had??? Data will be tabulated and available no charge. WA3CJC- 218 Cook Avenue, Ridgway, Pennsylvania, 15853

1296 MC MOONBOUNCE EQUIPMENT, crystal control, receiver, transmitter, paramp, 16 foot fiberglass dish, SCR-584 autotrack, pedestal; offer over $1,400 takes, F.O.B. Chiloquin, Oregon, Steve Mieth, K7VXC, Box 324.

EXCEPTIONALLY GOOD EQUIPMENT. Hallicrafters SX-101A-$250, Johnson Valiant—$250, Hy-Gain TH4 & Ham-M with cables—$110, RCA 155 C oscilloscope $25. Will negotiate on the lot. Substantial associated equipment. Bob Yarmus, K2RGZ, 532 Lefferts Ave., Bklyn, N. Y. 884-6336 or SL6-7044 after 6 P.M.

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Propagation Chart

AUGUST 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7*	7	7	7	7	7	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	21	21	21*	21
AUSTRALIA	14*	14*	14	7#	7#	7	7	14	7#	7#	14	14*
CANAL ZONE	21	14	14	7*	7	7	14	14	14	21	21	21
ENGLAND	14	7	7	7	7	14	14	14	14	14	14	14
HAWAII	14	14	14	7#	7	7	7	7#	14	14	14	14
INDIA	14	14	7#	7#	7#	14#	14	14	14	14	14	14
JAPAN	14	14	7#	7#	7	7	7	14	14	7#	14	14
MEXICO	14	14	14	7	7	7	14	14	14	14	14	14
PHILIPPINES	14	14	7#	7#	7#	7#	14	14	14	14#	14#	14
PUERTO RICO	14	14	7	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7	7	7#	7#	14	14	14	14	14	21	14
U. S. S. R.	7	7	7	7	7	14	14	14	14	14	14	14
WEST COAST	14	14	14	7	7	7	7	14	14	14	14	14

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	7	7	7	7	7	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	14	21	21	21	21*
AUSTRALIA	14*	14*	14	14	14	7	7	14	7#	7#	14	14*
CANAL ZONE	21	14	14	14	7	7	14	14	14	21	21	21
ENGLAND	14	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14	14	14	14	7	7	7	7	14	14	14	14
INDIA	14	14	7#	7#	7#	7#	14#	14	14	14	14	14
JAPAN	14	14	14	7#	7	7	7	14	14	7#	14	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7#	7#	14	14	14#	14#	14
PUERTO RICO	14	14	14	7*	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7	7	7#	7#	7#	14	14	14	14	14	14
U. S. S. R.	7	7	7	7	7	7	14	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21*	21	14	14	14	7	7	14	14	21	21	21*
AUSTRALIA	21*	21*	21*	14	14	14	14	7	7#	7#	14	21
CANAL ZONE	21	14#	14	14	14	7	7	14	14	14	21	21
ENGLAND	14	7	7	7	7	7	7	14	14	14	14	14
HAWAII	21*	21*	21	14	14	14	7*	7	14	14	14	21
INDIA	14	14	14	14	7#	7#	7#	7#	14	14	14	14
JAPAN	14	14	14	14	14	7	7	7	14	14	14	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	14	7#	7#	7#	14	14	14#	14
PUERTO RICO	21	14	14	14	7*	7	7	14	14	14	14	14
SOUTH AFRICA	14	7#	7	7#	7#	7#	7#	14	14	14	14	14
U. S. S. R.	7	7	7	7	7	7	7	7*	14	14	14	14
EAST COAST	14	14	14	7	7	7	7	14	14	14	14	14

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1-3, 6-8, 14-18, 21-27
Fair: 4, 5, 9, 13, 19, 20, 28, 30
Poor: 10-12, 29
VHF DX: 8-10, 14-17, 21, 29, 30

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12	.30	.50	.70	.85
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45	.80	1.25	1.80	2.25
150	2.50	2.90	3.50	4.50
240	3.75	4.75	7.75	10.45

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12	1.10	1.30	1.55	1.75
18	1.50	2.00	2.70	3.40
45	3.25	3.50	3.90	4.50
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Piv/Rms 800/560 .40	Piv/Rms 900/630 .50	Piv/Rms 1000/700 .55	Send 25c for Catalog

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Cndsr Oil 10Mfd x 600 $1 @, ..4/$3, 12/$5
Cndsr Oil 6Mfd @ 1500V $4 @, ..5 for $10
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Synchro Differentials C78249/115VAC 60 Cycles Less Back Plate @,............$5
Bendix Auto Syns "AY" Series ......2/$2

PL259A & SO239 CO-AX M&F ....3/$2
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FT243 Xtals & Holders...............2/$1
Insltd Binding Posts ....20/$1
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