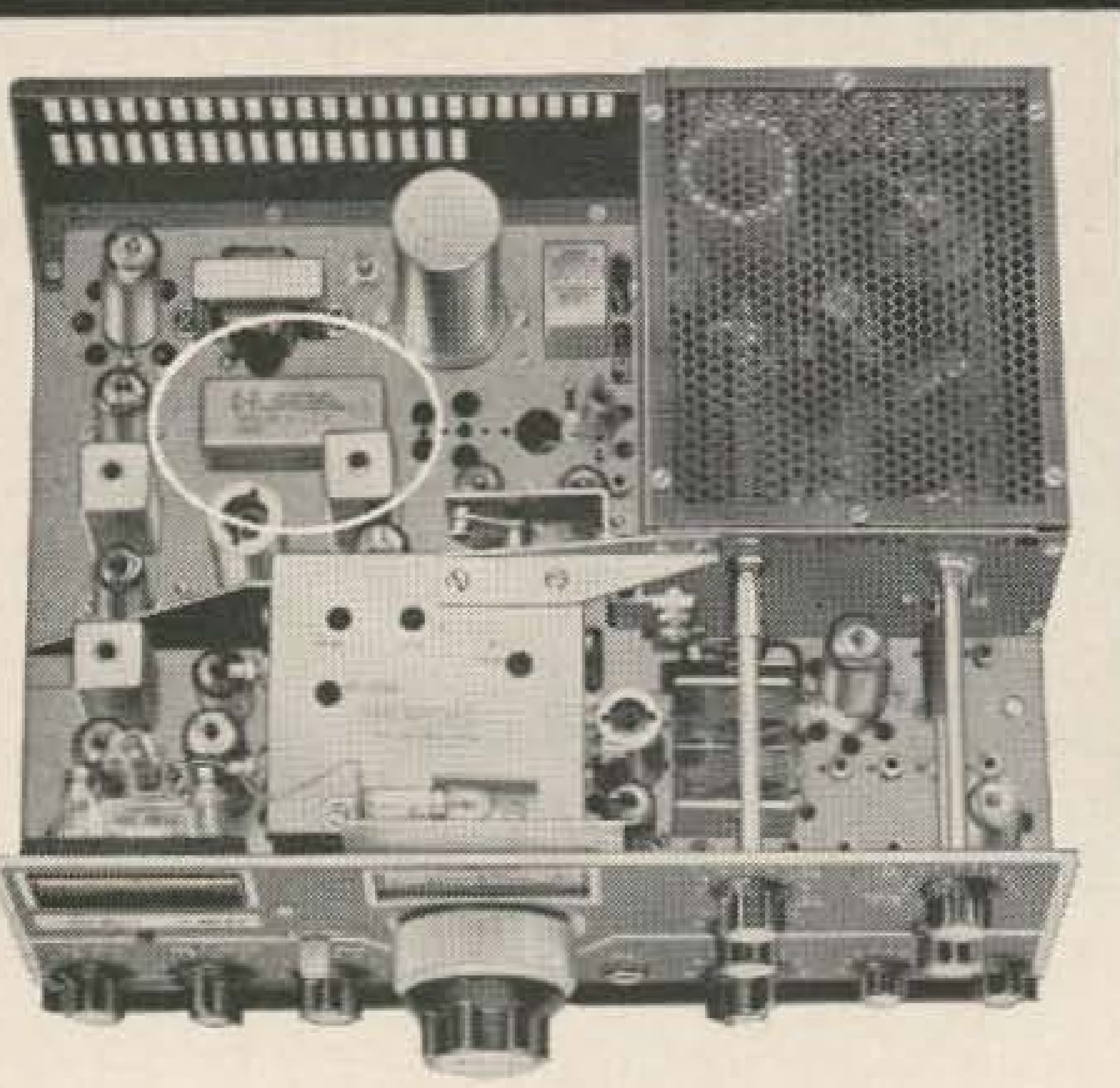
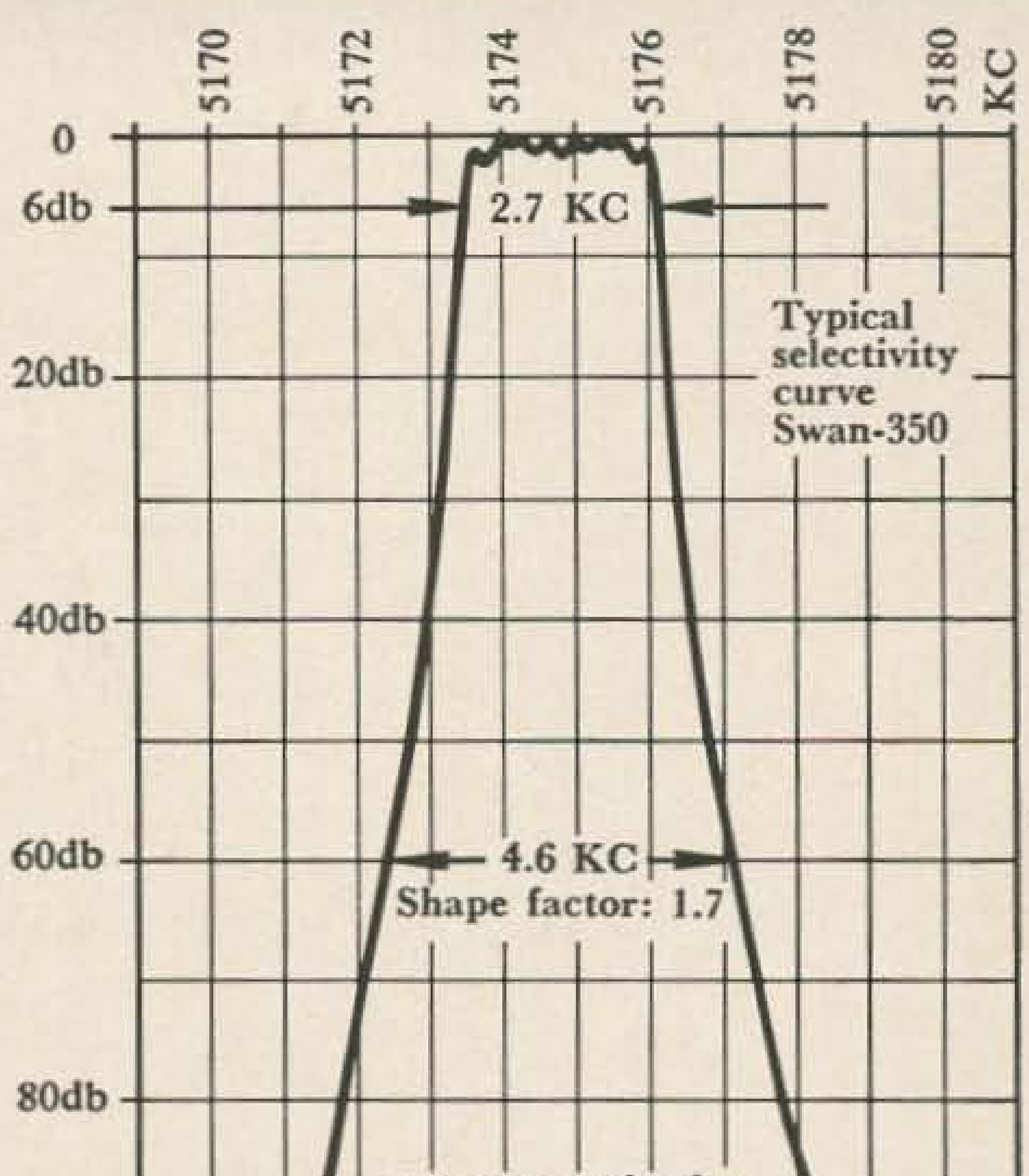

73
Amateur Radio
AUGUST 1966
A sizzling 60¢

IF YOU'RE LOOKING FOR

SELECTIVITY



LOOK INTO THE
SWAN-350
AND ITS HIGH FREQUENCY CRYSTAL LATTICE FILTER



One of the reasons why the Swan-350 is the top selling transceiver today is its exceptional selectivity provided by a new crystal filter which we began installing in all production units a few months ago. This amazing little gem is made exclusively for Swan by C-F Networks. The selectivity it provides for voice communication is as good or better than the selectivity provided in any other sideband equipment, regardless of price.

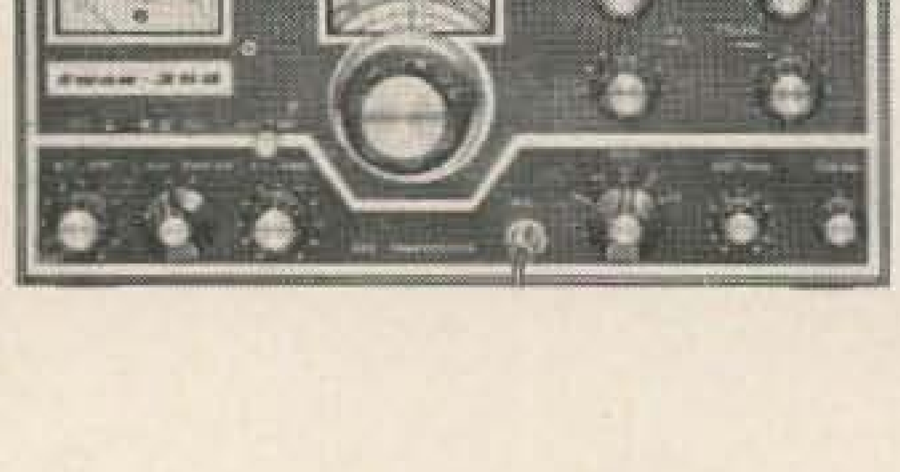
There are 3 important factors about a filter which determine what the overall selectivity will be. One of these is its *bandwidth* at the 6 db points, and here we have carefully selected 2.7 KC in order to give you good channel separation, and still retain the smooth, natural audio for which Swan transceivers are so well known.

The next consideration is *shape factor,* or the ratio between bandwidths at 6 and 60 db. In this respect the Swan filter gives you a "shape factor" of 1.7 to 1. This is substantially better than the 2 to 1 ratio of the mechanical filter, or 3 to 1 of the average 9 mc crystal filter. Best shape factors are achieved right around 5 mc, and this is one of the main reasons for selecting 5175 KC for the Swan I.F. (This choice of I.F. also permits single conversion design which results in fewer images and spurious signals. The only thing better than single conversion is no conversion at all.)

The third important factor, but by no means the least, is the measure of *ultimate rejection,* or how far the skirts fall before flaring out. Take a look at the graph and you'll see that this is better than 100 db with the Swan filter! Ultimate rejection determines how well your receiver attenuates those strong adjacent channel signals, especially the guy down the street with the big linear. In this respect, the Swan filter is superior to others being used in amateur sideband gear.

In Swan transceivers, the filter is also used when transmitting, of course, and in this mode the shape factor determines what your unwanted sideband suppression will be. We have been advertising 40 db, but this is a conservative figure, since it is really better than 50 db. Also, we've been advertising only 400 watts PEP input to the 350, but actually the average production unit peaks over 500 watts before flat-topping, which is why the 350 gets out so well, and sounds so good. Compare these features with any other sideband transceiver, and they all sell for more money!

73 Herb Johnson W6QKI



SWAN
ELECTRONICS
Oceanside, California

73 Magazine

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August 1966

Vol. XXXXI, No. 1

SPECIAL BOOK FEATURE

73 Magazine is published monthly by 73, Inc., Peterborough, N. H. 03458. The phone is 603-924-3873. Subscription rates $4.00 per year, $7.00 two years, $10 three years world wide. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in Bristol, Conn., U.S.A.

Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire. Why not make a DX friend of yours happy with a gift subscription to 73?

de W2NSD/1

never say die

. . . de W2NSD/5Z4

What started out originally to be a little visit to 5Z4ERR has grown into mammoth proportions and now consists of a three week hunting safari for four of us, a two week drive through darkest Africa, and a trip around the world via some very unusual spots. About the time you get this issue of 73 I'll be cringing in the bush of northern Kenya, peppering the landscape with bullets from my Weatherby. I think I can promise you that the animals will be pretty safe, though I just might bag a W5 or WA6, with a little luck.

The most difficult part of any trip is making the decision to go. There are so many reasons that such a thing is impossible that few get to the decision.

Once I had made the decision to go to Kenya I began to read about the country and got more and more enthused about hunting. I found that there are a lot of good reasons why people go over there and hunt. The main idea is to kill off the older male animals that are just past their prime and make room for the younger males. You don't just go over and shoot anything that moves like they do in New Hampshire during hunting season . . . you keep looking until you find an animal with outstanding antlers and try for him. If you are interested you will enjoy "Horn of the Hunter" by Ruark, the intimate story of his first hunting safari. It is a terrific story and available in paperback.

I'd heard about how horribly expensive safaris were, so I figured that this would never be for me. Then I read the Herter book on "The Truth About African Safaris, or How to Go On A Safari For $690." Seven bills I maybe could manage so I read the book and decided to have a try at it. I wrote to the outfit recommended by Herter and signed up for my first hunting trip. I've never shot anything more exotic than a hedgehog or a woodchuck, so they don't come much greener. I'll let you know how that works out, if you're interested.

My talking about the trip on twenty meters got me invitations to visit just about every country in Africa. At first I thought I might take along a couple other fellows and drive from Kenya down to South Africa. Then, when I got a closer look at the maps, I could see that this was a pretty big bite. After many more contacts with Africa and some thought the drive came down to a two week jaunt through Kenya, Uganda, Congo, Rwanda, Burundi and Tanzania. This will be plenty the first time around, I am sure.

The air fare around the world isn't that much more than the fare to Nairobi and back, so what the heck. I spun my world globe around a few times and traced out a path through some of the rarer countries, plus a trip through Australia and New Zealand. The interesting part was the long hard job of deciphering the air schedules from the book at the travel agency. Many places that I wanted to visit were out because there were either no scheduled flights or else maybe one a week . . . on a day when we couldn't make the trip without sitting around four or five days waiting for a plane. A trip that length with that many stops meant that each stop had to be for one or two days at best. Even so the trip strung itself out for almost eight weeks of flying!

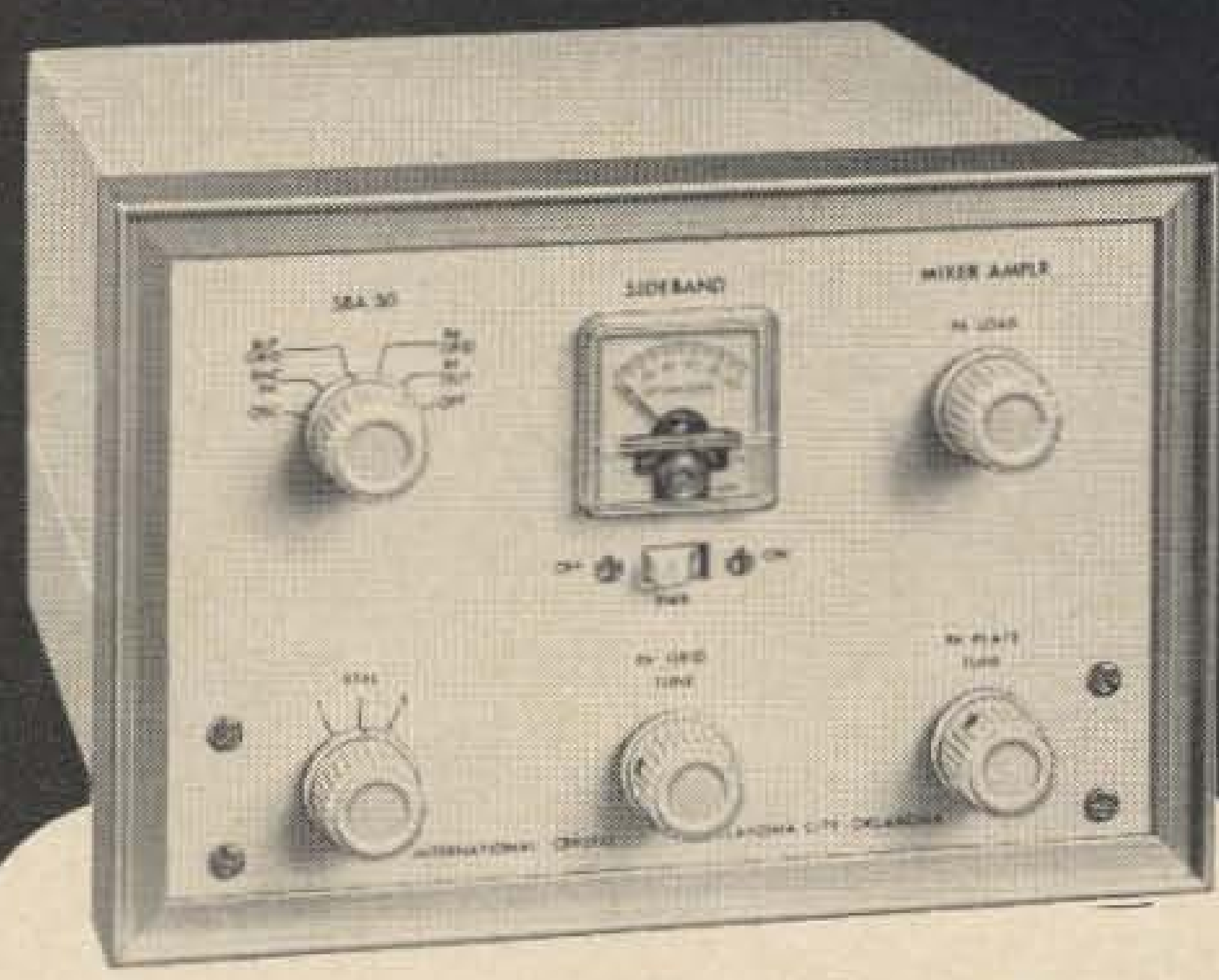
Once the itinerary was decided there was the problem of getting all the air reservations, the hotel reservations and visas from all of the countries along the route. For instance, we got the whole trip just about set when I got

(Continued on page 70)

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.
18 NO. LEE · OKLA. CITY, OKLA. 73102

Editor's Ramblings

Imitation is the sincerest form of . . .

A note in K2MGA's editorial in the June CQ states that CQ is dropping its VHF, Novice, Club Forum, RTTY, YL and Space Communications columns. Reason given? "To make room for more current items of more general interest."

Speaking of CQ, the same editorial makes gleeful note of my statement in the May 73 that we do not have the staff here to answer technical questions from readers. The truth of the matter is that we try to answer questions, but must discourage them because of our small, overworked staff. As I mentioned last month, we'd like to find a number of qualified hams around the country who will answer questions for other hams in their spare time. We'll help them out with publicity and by printing articles answering the common questions they're asked.

Readers often ask us why we don't have a question and answer column. We've had a number of offers to write one (including one from a very prominent ham who wanted to write anonymously because he writes a monthly column for one of our competitors), but aren't convinced that it would be worthwhile. Most questions could be answered after a quick look through a radio handbook, catalog or magazine index. I'd rather see articles explaining common misunderstandings than the same "buy a *** for $*** from *** and install it in your ***" over and over.

Advertising in 73

You may have noticed that 73 is running more and more advertising, while our competitors aren't. Our new advertising manager, Jack Morgan, WØRA, has been working hard—and with excellent results. I hope that you are helping him out by getting off your duff and sending for the catalogs and equipment that you've been intending to buy. Think of the many things in 73 ads that you'd like, but just haven't gotten around to ordering. Shame on you.

But there are still a number of advertising holdouts, of course. The reasons are many. In a few cases, there are political considerations. Some important people in prominent companies disagree with Wayne about some things and feel that their principles are more important than the sales their companies are losing.

Another problem: advertising agencies. Virtually all manufacturers and most other advertisers have ad agencies which plan (we hope), design, make and place their ads. These agencies are paid by the magazines they insert ads in with a 15% discount on advertising space bills. This is a very odd arrangement and would seem to encourage ads in expensive magazines. Most agencies have little experience with specialized small magazines such as 73. They tend to place advertising on the basis of a simple plan: if it costs twice as much, it must be twice as good. Obviously, this is fallacious. Many factors affect advertising results: how loyal readers are, how thoroughly they read the magazine and ads, how much money they have to spend, how active they are, how the ads are arranged, and so on. 73 excels in all of these categories. Many testimonials and studies prove this.

Another reason manufacturers don't make best use of their advertising money is similar to the above. Mail order advertisers usually code their ads. They can tell which ads bring results. The mail order advertisers tell us over and over how well ads in 73 do. On the other hand, most large manufacturers depend on sales through radio dealers. They realize that most readers will visit their local dealers if they're interested in the products advertised. How can they tell which magazines give the best results? They can't—unless they

(Continued on page 92)

Price Comparison

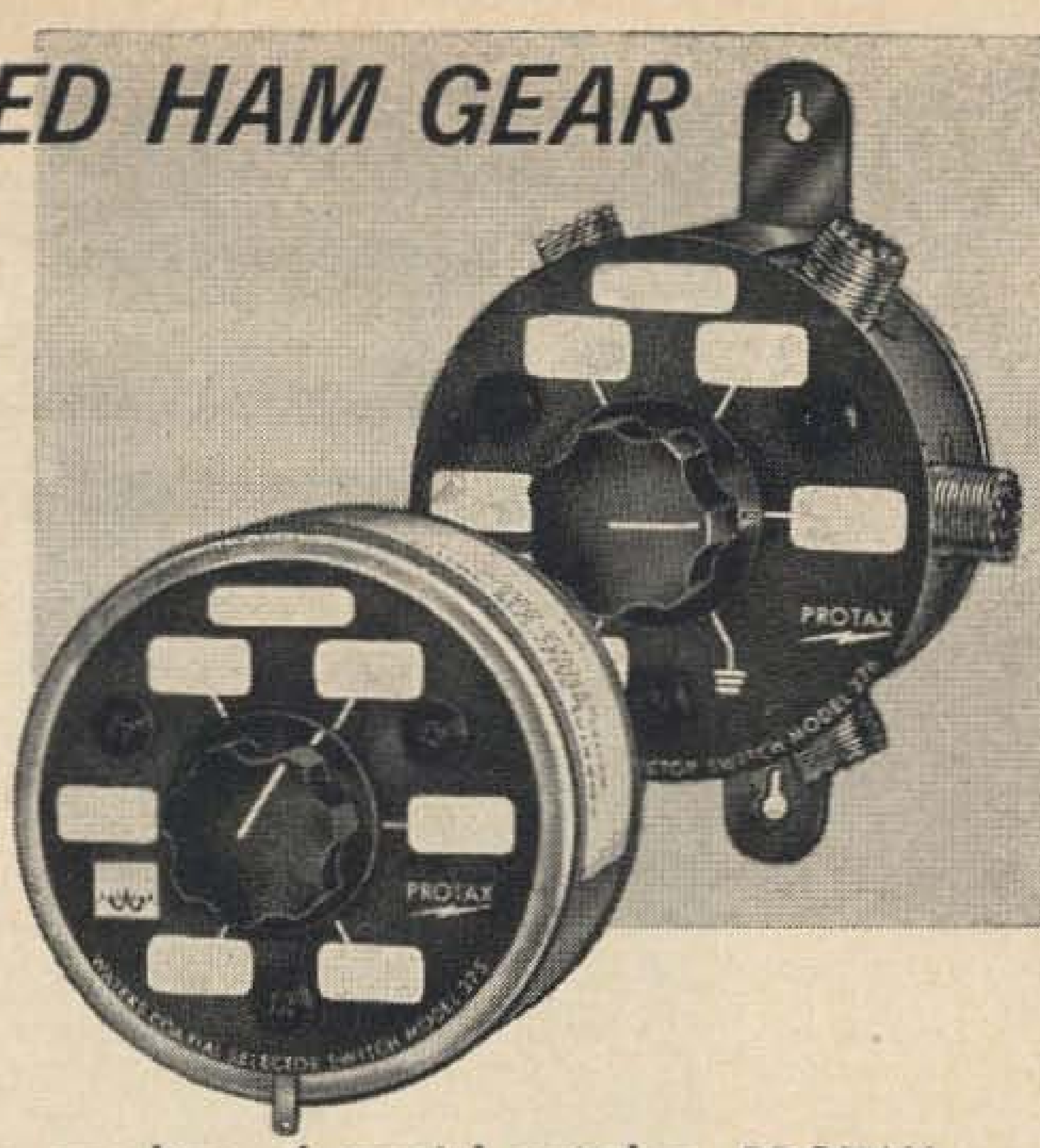
These prices are for ads with no contract.

	73	CQ	QST
1 p	$268	$475	$537.60
1/2 p	138	255	256
1/4 p	71	125	128
1/8 p	37	70	64
1/16 p	20	36	32

There is no extra charge for second color (red) or bleed (running ads to edge of page) in full page ads in 73. QST charges $80 extra for the red and $53.76 for the bleed on a full page ad. CQ charges $50 extra for full page bleeds and you have to get a price on color from them.

CONVENIENCE ENGINEERED HAM GEAR

by *Waters*



PROTAX™

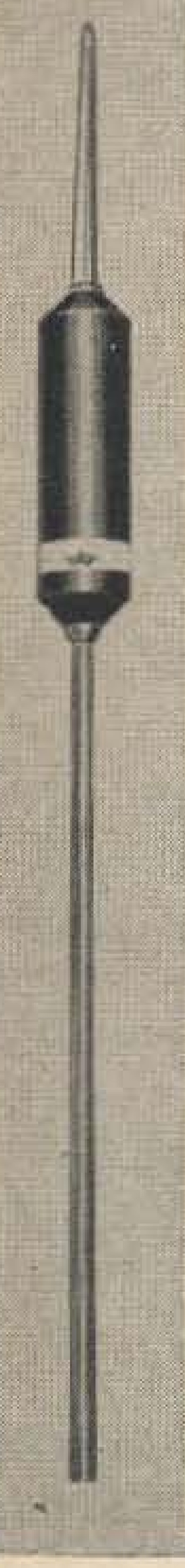
COAXIAL ANTENNA SWITCH

with

AUTOMATIC GROUNDING

Another first from Waters! Now, as easily as you switch from beam to dipole . . . from 40 meters to 75, you can switch your entire antenna system to ground with the newest addition to our line of coaxial switches, PROTAX, automatic-grounding coaxial antenna switch! Designed with the same advanced engineering skill that outmoded all other coaxial switches two years ago, PROTAX is another giant step forward in "Convenience Engineered" ham gear by Waters. In effect, PROTAX is two switches in one . . . a regular antenna-selector switch with power-carrying capacity of 1,000 watts that becomes a grounding switch for all antennas (leaving the receiver input open) when the rig is not in use. In two distinctive models: #375 — six position and ground with back connectors; #376 — five position and ground with connectors in radial arrangement. (#376 has its own wall-mounting bracket.)

Model 375 .... $13.95   **Model 376 .... $12.50**



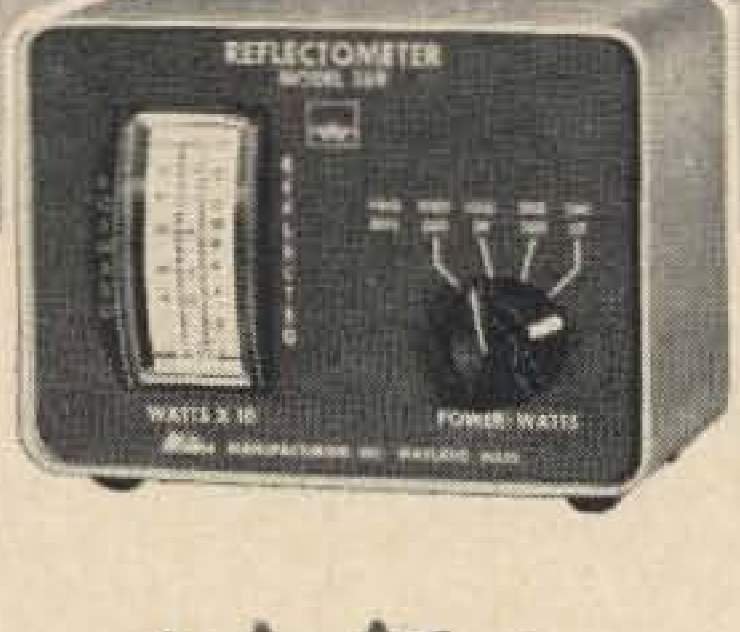
Waters

AUTO-MATCH

You'll boost your signals up to 4 db with AUTO-MATCH, the built-to-last mobile antenna. Operates all bands with only a change of Top-Center loading coils . . . has rugged new fold-over hinge . . . fits any standard base or bumper mount.

PRICES

MAST 370-1	$12.95
RADIATOR TIP 370-2	9.95
COIL 370-75	15.95
COIL 370-40	14.95
COIL 370-20	13.45
COIL 370-15	12.75
COIL 370-11	11.95
COIL 370-10	11.95



Waters

REFLECTOMETER

Amazing new REFLECTOMETER tells you *both* forward and reflected power in RF watts on every transmission. Two separate scales insure accurate readings to 1000 watts. VSWR easily determined, too! Complete with directional coupler and cable.

Model 369 ....$115.00

Model 3002

Waters UNIVERSAL HYBRID COUPLER II PHONE PATCH

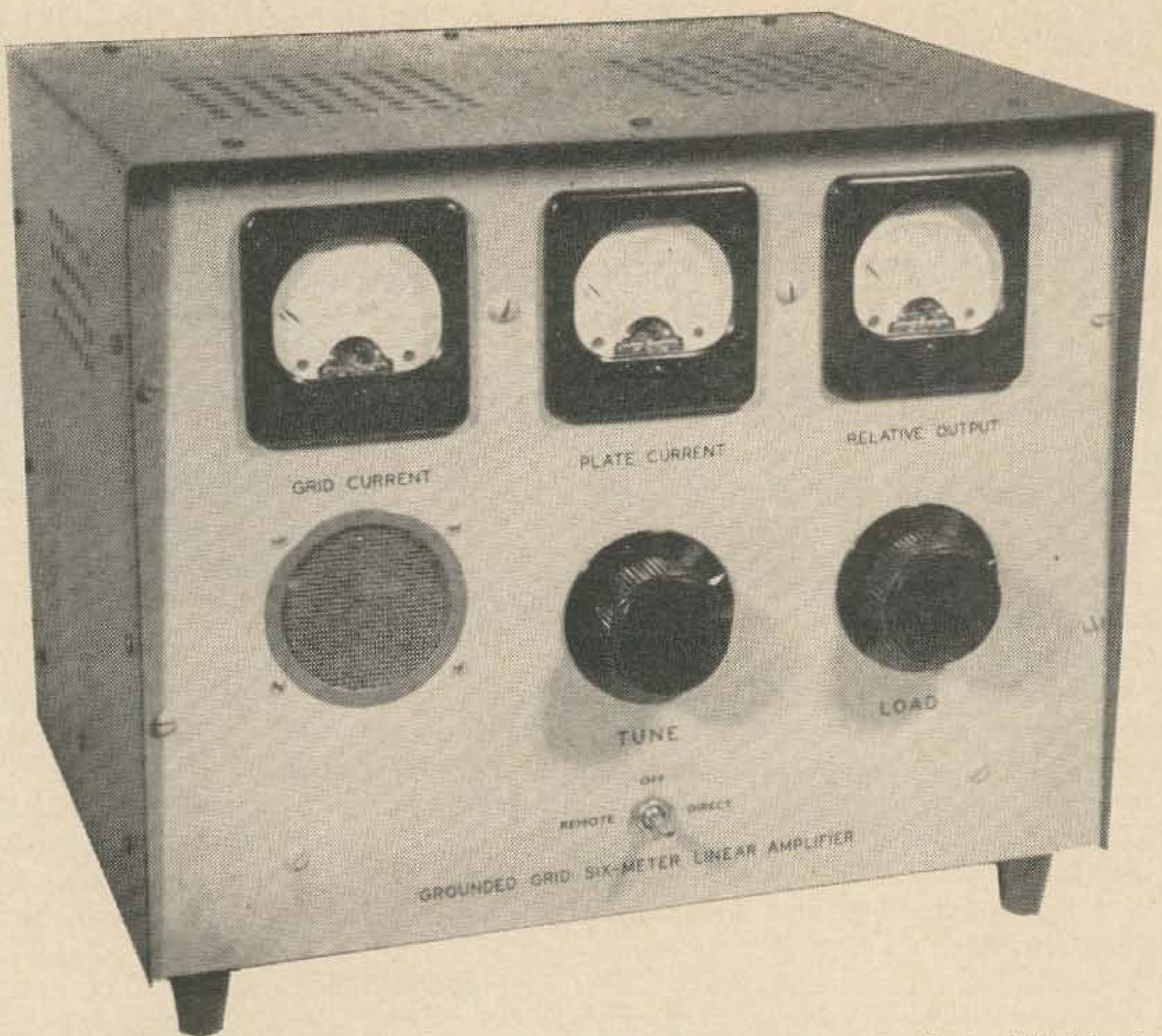
The ultimate in phone patches providing effortless, positive VOX operation . . . and it also connects tape recorder for both IN and OUT. Built-in Waters "Compreamp" increases low telephone line signals while simultaneously preventing overmodulation. "Compreamp" also operates alone (without patch) with station mike.

Model 3002 .... $69.95
(less battery)
Model 3001 .... $49.50
(without "Compreamp")

WATERS

MANUFACTURING INC.
WAYLAND, MASSACHUSETTS

WATERS PRODUCTS ARE SOLD ONLY THROUGH WATERS QUALIFIED DISTRIBUTORS



R. L. Winklepleck WA9IGU
107 Berkeley Drive
Terre Haute, Indiana

More Power on Six

There are many amateurs who operate on six meters with AM rigs in the medium power class. By medium power we're talking about thirty to sixty watts into the final. This is excellent for local rag-chews and is nothing to be ashamed of when the skip is rolling in. However, there are times when it would be very satisfying to pour on the coal and blast through the QRM. Ever notice when the skip is hot the boys with the big signals can sit on one frequency and everybody comes to them?

Probably the quickest, easiest and cheapest answer is a linear amplifier. Don't listen to the static about the poor efficiency of AM linears. This is a point on which the experts aren't in full agreement. However, a few hours of operation with a good AM linear will convince you that, regardless of the theory, this is a happy solution.

WA9IGU is the sales manager of the world's largest grower of greenhouse tomatoes and Bibb lettuce, the J. W. Davis Co. He has an MS in Agriculture from Purdue. He's written many articles on electronics, but most have been in the test equipment, photo and CB fields.

Now comes the question as to the type of linear. The more common grounded cathode configuration is good but you'd have to swamp out most of your exciter power and that's downright wasteful. Grounded grid would use all those watts, running quite a few of them right through into the antenna. If we settle on a zero bias triode for our grounded grid linear things really get simple. No screen power supply, no grid bias supply and no neutralization worries. So, let's look around for our six-meter, AM, grounded grid, three to four hundred watt linear construction plans. This poor toiler in the vineyard couldn't find a thing to fill the bill. Here's one solution, evolved from only a small measure of blood, sweat and tears, which has provided many hours of operating pleasure.

Rather than make do with compromises so we could use a surplus tube or two, an Eimac

3-400Z[1] was chosen for the job. This is a high-mu triode designed for this type of service and with a plate dissipation of 400-watts. The tube, it's socket and chimney will set you back nearly fifty bucks—half the total cost of the linear—but it's well worth it. Practically everything was new except the fan, meters and antenna relay which came from surplus.

Components are assembled on a 3"x10"x14" chassis which could be much smaller if space is a problem. The layout is shown in the photos and this isn't too critical. Front and back panels are 11"x14" aluminum and the sides and top are made from a single sheet bent to U shape. One-half inch aluminum angle stock and sheet metal screws hold it together. Drill plenty of ventilation holes. Let's consider some of the features. A triple-pole, double-throw relay cuts the linear into and out of the antenna circuit for transceiver operation. It also virtually cuts off the tube between transmissions by inserting bias resistor R5 in the cathode circuit. The surplus relay used was powered by a voltage-doubler from the filament supply. A spdt center-off toggle switch in the relay circuit permits bypassing the linear even though it is powered, or operating it either directly, or indirectly from an extra set of relay contacts in the exciter. A tuned L input matches the 50-ohm output of the exciter to the 122-ohm input of the 3-400Z. Negative high voltage is isolated from chassis. It floats by the amount of the voltage drop across R6. Plate current is metered in the negative power lead to keep the extremely high voltage off the meter and because a meter in the plate lead would indicate both plate and grid current. The output circuit is a conventional pi-net and a relative power output meter is used for tune-up since plate current dips are uncertain at best. The filament and plate chokes are wound on ½" Teflon rod. Ceramic would be OK but don't use anything else—it might melt. L2 and L3 are each 31 turns of #12 Formvar bifilar wound and separated by a length of cord about the same diameter as the wire. If a Teflon rod is used the ends of the coils can be run through holes in the rod to hold them in place. L4 is 42 turns of #22 Formvar closewound on Teflon rod which is threaded at both ends to accept C8 and C9. L5 consists of four turns of 3/16" copper tube with a 1¼" inside diameter and ¼" spacing. A "D" cell makes a good winding form for L5 and the turns can then be spaced with a scrap of ¼" dowel. The parasitic choke is simply three 50-ohm, 2-watt resistors paralleled across a loop in the ½" copper strap making up the plate lead. This may appear useless but it's quite essential for stable operation.

There are a few precautions which might

1. The Amperex 8163 is almost identical

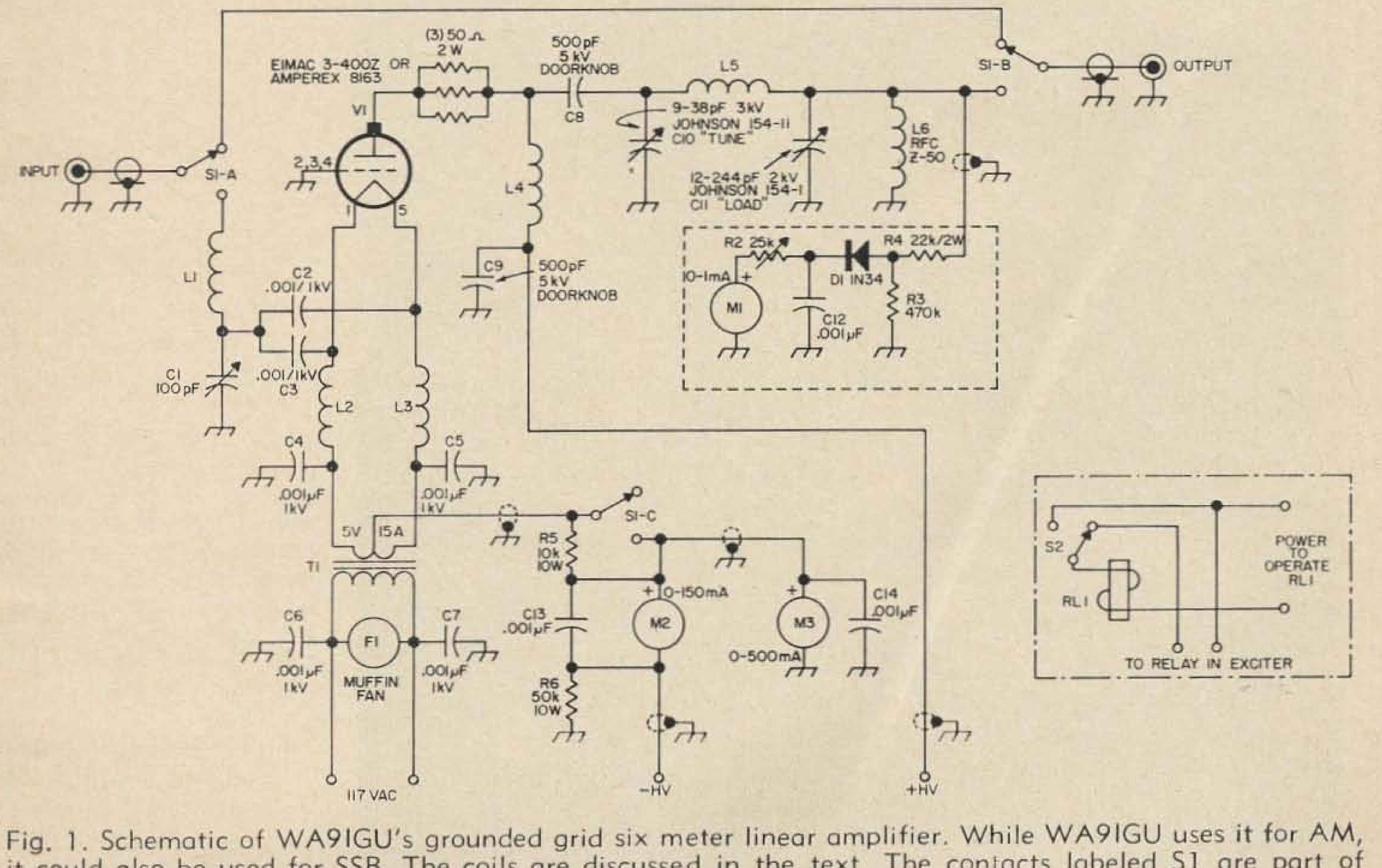
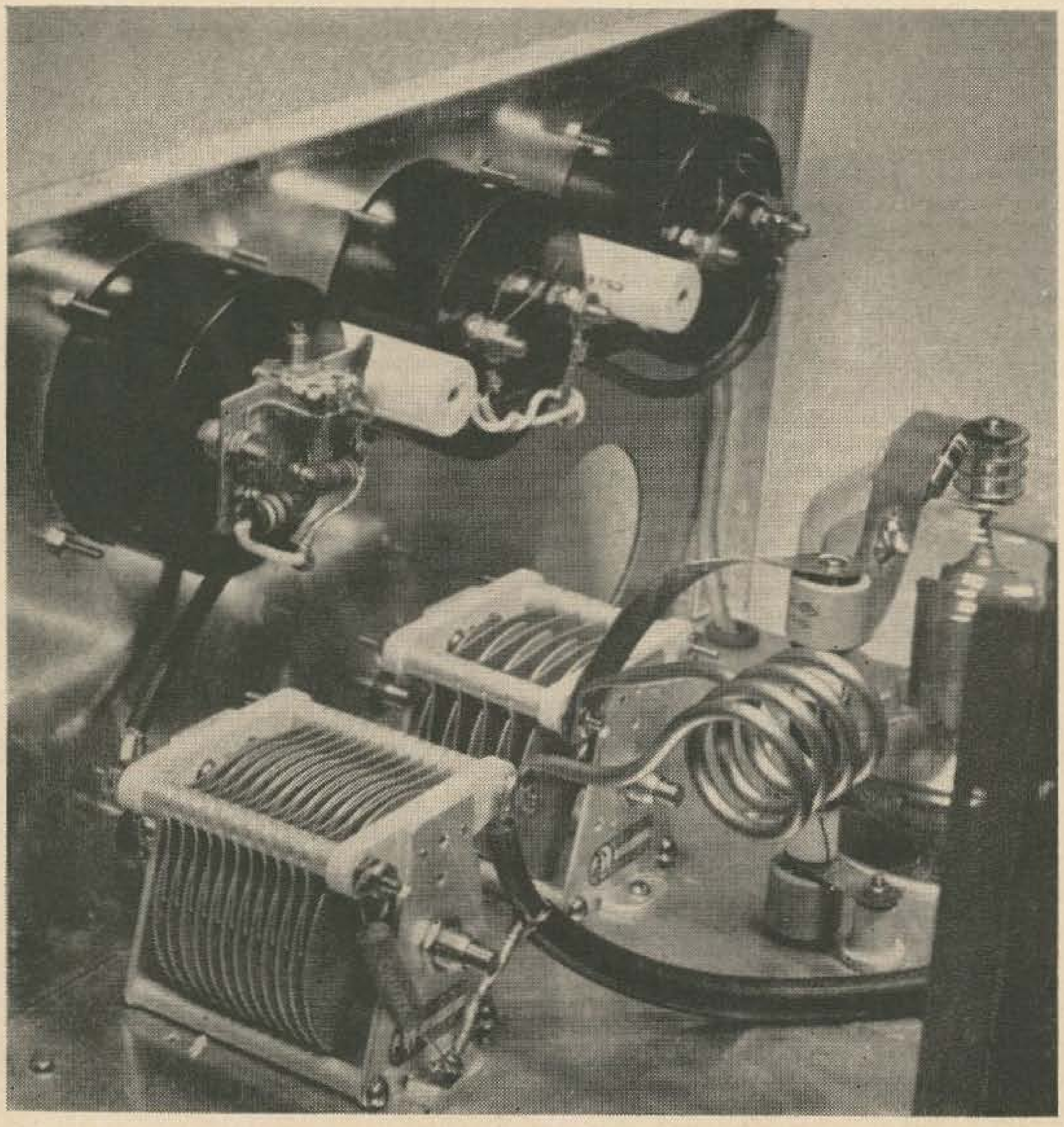


Fig. 1. Schematic of WA9IGU's grounded grid six meter linear amplifier. While WA9IGU uses it for AM, it could also be used for SSB. The coils are discussed in the text. The contacts labeled S1 are part of the transmit-receive relay RL1.

not be essential but probably will save trouble later. The three grid contacts on the socket are bonded directly through slots in the socket to chassis with the shortest possible copper straps. One-half inch copper strap is used from plate cap to the junction of L4/C8 and from the opposite side of C8 to C10. Shielded cable is used for all other power and rf leads. The heavy insulation of RG8-U is excellent for the positive high voltage lead. Try to keep the input circuit below chassis and the output above. The only exception is at the relay. The output metering circuit can be mounted on a scrap of punched circuit board which is fastened to the back of the meter by the meter terminals. One milliampere meters are used for grid and plate current by shunting them with short lengths of resistance wire to make them read the required values. Comparison with a reasonably accurate meter is used to establish the length of resistance wire to use. A U-shaped aluminum shield is installed behind the meters to prevent the radiation of rf energy through the meter holes and also to protect the meter movements from this energy. A view port in the front panel, shielded by aluminum or copper screen, is recommended. At high power the graphite anode starts to glow and it's a good idea to keep an eye on it. The bottom of the chassis is sealed with an aluminum plate in which the intake fan is mounted. Don't locate the fan directly under the tube. Mount the amplifier on one inch feet to insure adequate air movement. Observe these precautions and you should have a good, stable amplifier.

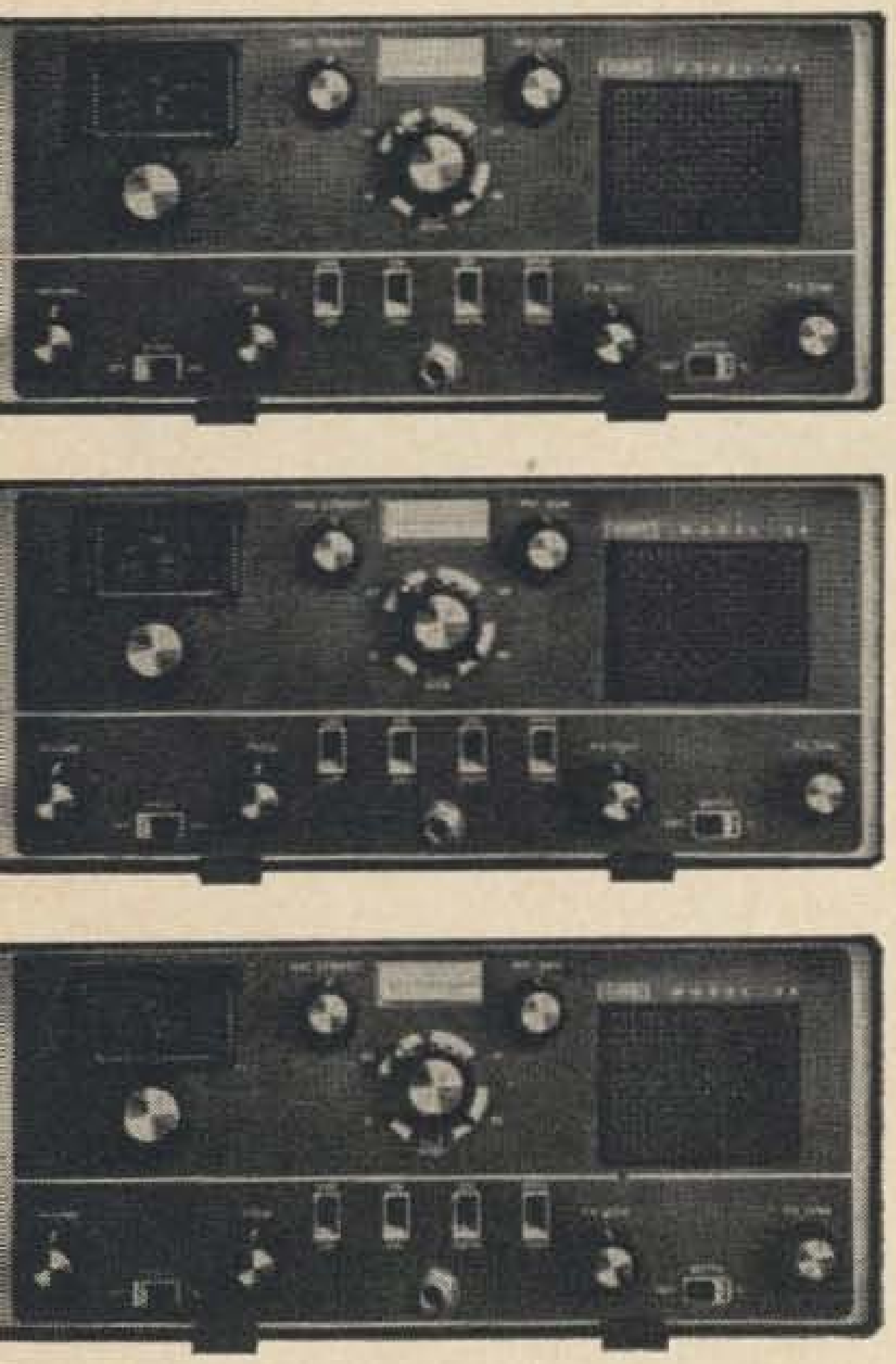
A word about the high voltage power supply, required to supply *only* the plate voltage. You'll probably want 2000 volts and you can go higher with this tube. It should be well filtered and, while you can drop it down with a light bulb in the primary of the transformer during initial testing, a variable voltage transformer is a real operating convenience. There are dozens of good power supply circuits and you may already have one which can be used. Remember that neither side of this high voltage supply is grounded. Shielded and grounded high voltage leads between power supply and linear keep both chassis' at the same potential.

Check and double-check all the wiring and please keep these precautions in mind during operation of this little bomb. Keep your hands out of the innerds except when the high voltage is definitely removed. You'll enjoy the



Layout of the components on top of the chassis. The rf output monitor circuit is located on the back of the nearest meter. The meters are normally covered by a shield.

SBE



SB-34 ...your biggest dollar value!

The price of **395.00** includes built-in, solid-state, transformer type power supply that lets you operate on **12V DC** for mobile...on **117V AC** for fixed station service. The power change is simple too—just use AC or DC cable. (Both furnished). **SB-34**, the complete SSB station, is so small, lightweight and easily carried (has a handle for this purpose) that you can readily enjoy double use of this fine SSB four-band transceiver.

More power? Just add the big-value **SB2-LA KW Linear Amplifier.**

Mobile KW? Add the compact SB2-LA Linear and SB3-DCP **Inverter.**

CW? Merely plug in the new **CODAPTER** and key away.

Write today for your copy of the new SBE brochure

HIGHLIGHTS:

- **Expanded frequency coverage • Delta receiver tuning •**
- **Solid-state dial corrector • Panel switch selects USB or LSB •**
- **Solid-state switching---no relays • Collins mechanical filter •**

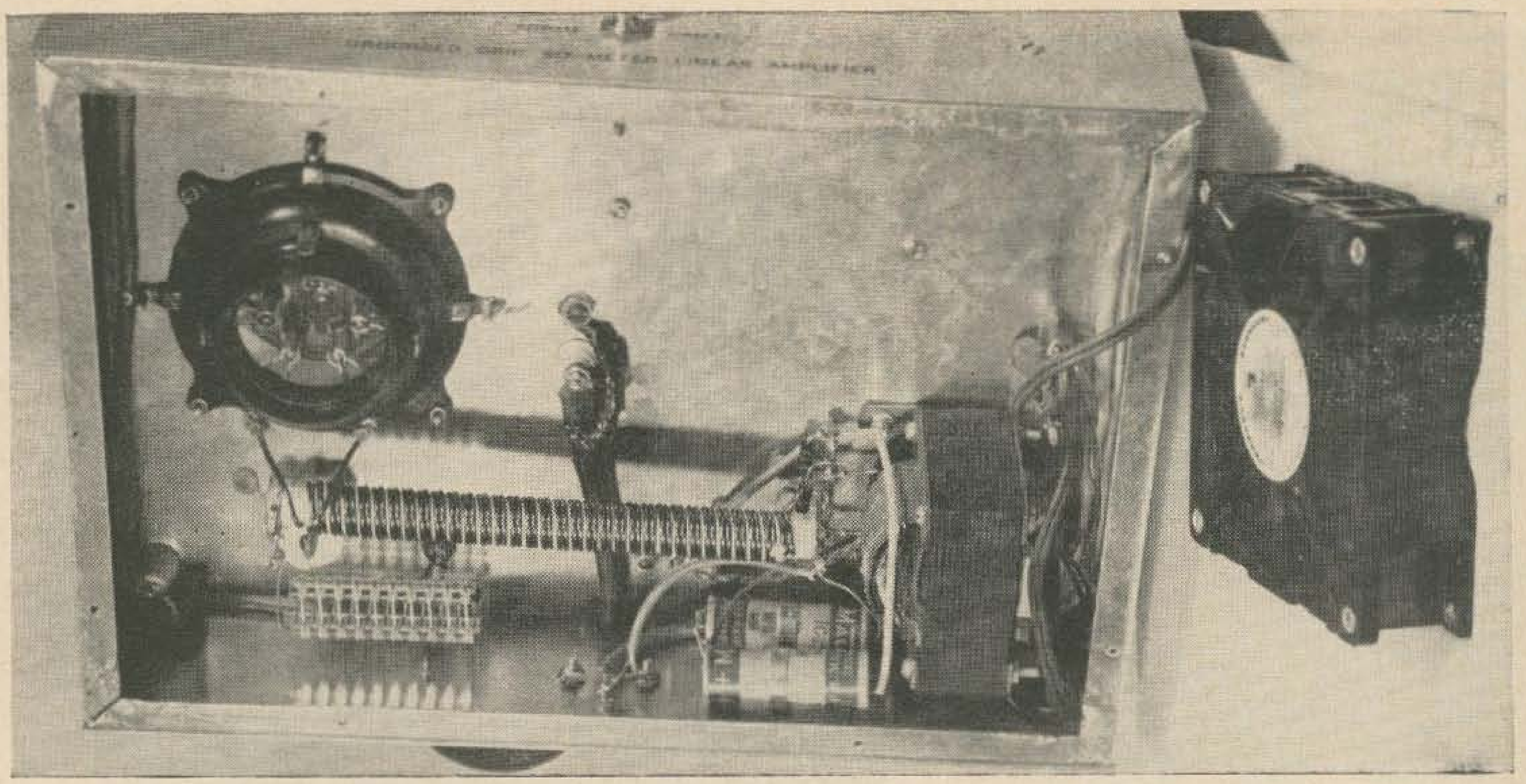
Power input: 135 watts P.E.P. input (slightly lower on 15). **Freq.range:** 3775-4025 kc, 7050-7300 kc, 14.1-14.35 mc. 21.2-21.45 mc 23 transistors, 18 diodes, 1-zener , 1-varactor , 2-6GB5's PA, 1-12DQ7 driver. **Speaker built in.** Pre-wired receptacles on rear accept VOX and Calibrator—both units optionally available. **Size:** 5"H, 11¼"W, 10"D. 20 lbs. (approx.)

SB-34 Transceiver	395.00
SB2-LA Linear ...	249.50
SB3-DCP Inverter	249.50
Codapter	39.95

SBE

SIDEBAND ENGINEERS
213 East Grand Ave.
So. San Francisco, Calif. 94080

Export sales: Raytheon International Sales & Services, Lexington 73, Mass. U.S.A. RAYTHEON



Bottom view of the six meter linear. The Miniductor is L1. The filament chokes L2 and L3 are bifilar wound on a ½" Teflon rod. The electrolytic capacitors adjacent to the filament transformer are part of a voltage doubler circuit used to operate the relay. The Muffin fan is mounted on the bottom plate.

equipment longer. Be sure the fan is operating whenever the filament is on. Warm up the tube for a few minutes before applying plate voltage. Never apply excitation without plate voltage or grid current may be excessive. Never operate the linear without an antenna or dummy load. Keep an eye on the tube, especially during testing and tune-up, and reduce voltage and/or loading if it starts getting red.

Let's first check for stability. Set C1 for about mid-range, adjust R2 to minimum value, interconnect exciter and linear with a length of RG8-U but don't apply excitation. Turn on fan and filament, apply approximately five hundred plate volts and, while watching the output meter, vary C10 and C11 over full range in various combinations. There should be no evidence of output and grid and plate meters should remain stationary with the grid meter possibly just off the peg and 20 to 25 plate mA. Increase plate voltage to operating level and go through this test again, being ready to cut the power if there is any meter movement. With 2000 plate volts you should have just a suggestion of grid current, approximately 60 plate mA and no output. Sit back and rest a minute—you were just gambling with a thirty-four dollar tube.

For final testing and tune-up you must have a dummy load. If you're new to linears you'll want to spend a lot of time learning to handle the beast and it's best to keep these struggles off the air. A scope is real handy to check linearity but it's not absolutely essential. So, connect the dummy load, cut back to about 500 plate volts, advance R2 as necessary to keep from pegging M1 and, with C10 and C11 at full mesh, apply excitation—somewhat reduced if this is convenient. At this level of operation you can be reasonably sure of not doing much damage.

Both grid and plate current will climb when excitation is applied. Reduce the value of C10 to give the maximum reading on the power output meter. Adjusting C11 will now increase this output. What we're striving for, now and forevermore, is *maximum power output with plate current three times greater than grid current.* If you don't have this ratio, increase the capacitance of C10 slightly and decrease the capacitance of C11 to peak the output. Continue this until the 1:3 ratio is achieved. Now, if you'll decrease the value of C11 just enough to drop the output by two or three percent, your amplifier should be linear. Its output should look and sound like a giant version of the input. During this tune-up you should pause to adjust C1 to produce maximum grid current indicating that your input L network is tuned to resonance. Now you're ready to gradually increase excitation and voltage, bringing the TUNE and LOAD capacitors back to resonance with each change. Keep an eye on the tube and retreat a little when it starts showing color.

This tuning technique is one which has been treated casually if at all in amateur publications. It's extremely important if you are to put a good signal on the air. Once you learn how the controls interact it goes quickly and smoothly. Now is the time to experiment and here are some general observations. They'll help you arrive at a 1:3::grid current: plate current ratio at maximum power output for the combination of excitation and voltage you're using. Increasing excitation and voltage will increase the power output of your linear; however, you probably will not run wide open all the time. Increasing the excitation should increase grid current, plate current and power output. Increasing the voltage should decrease grid current and increase both plate current and power. As LOAD capacity is reduced TUNE capacity must be increased to reach resonance as indicated by maximum output. It is the interaction of these two controls which enable you to achieve the necessary 1:3 ratio for linearity. It is the interaction of excitation and voltage which determine your output level. Increased excitation will require higher TUNE capacitance and lower LOAD capacitance. Increased voltage will require less TUNE and more LOAD capacitance. This isn't nearly as complicated as it sounds. With a bit of practice *off the air* it'll become automatic.

Let's take one brief look at this matter of efficiency. With about thirty watts of excitation from a Thor transceiver and 1250 plate volts the linear pictured draws 225 plate milliamperes when properly tuned for 280 watts input. Its output into a Cantenna is one hundred watts with no modulation. With a steady 100% tone modulation the output jumps to 190 watts! This tends to support the proponents of AM linears who claim very impressive efficiency with modulated signals. With 1500 plate volts and 230 plate mA we have 345 watts in and about 132 watts out. Put 2000 volts on the plate and it glows dully as it should while drawing 240 mA. Output into the Cantenna goes to a little over 190 watts. It looks like efficiency increases slightly with increased power but modulation boost suffers. At the 2000 volt level modulation only kicks the output forty more watts. Maybe the metering is not too accurate or maybe we don't have enough excitation for peak power output but these figures offer some idea of what to expect from this critter.

What's important is the fact that for approximately one hundred bucks (plus a power supply) you can push your medium power AM signal right through the ceiling with no more operating problems than you have with your exciter. And when you eventually go six-sideband this linear with no modification will take you to a kilowatt.

. . . WA9IGU

James Ashe W2DXH
RD 1
Freeville, N.Y.

James Dandy Mixer

What basic circuit belongs on the amateur's workbench next to the RF signal generator, the frequency standard, and the dip oscillator? Ans: James Dandy Mixer!

Two frequently performed and closely related tests are the measurement of frequency and the general assessment of stability and quality of an RF signal. Both tests usually involve mixing a good RF signal and a questionable RF signal for an audio output, and judging the result. These tests are often performed with the aid of an old receiver which may not be able to give a good test. Or perhaps it won't tune the required range, or is simply not available. But the receiver isn't required. Better results can be obtained without it!

The following circuit is useful from high audio to the VHF range. It is simple, reliable, and can be assembled very inexpensively. Its value to the user is limited only by his ingenuity and understanding of the basic principles and facts involved. Enough recommendation.

Theory

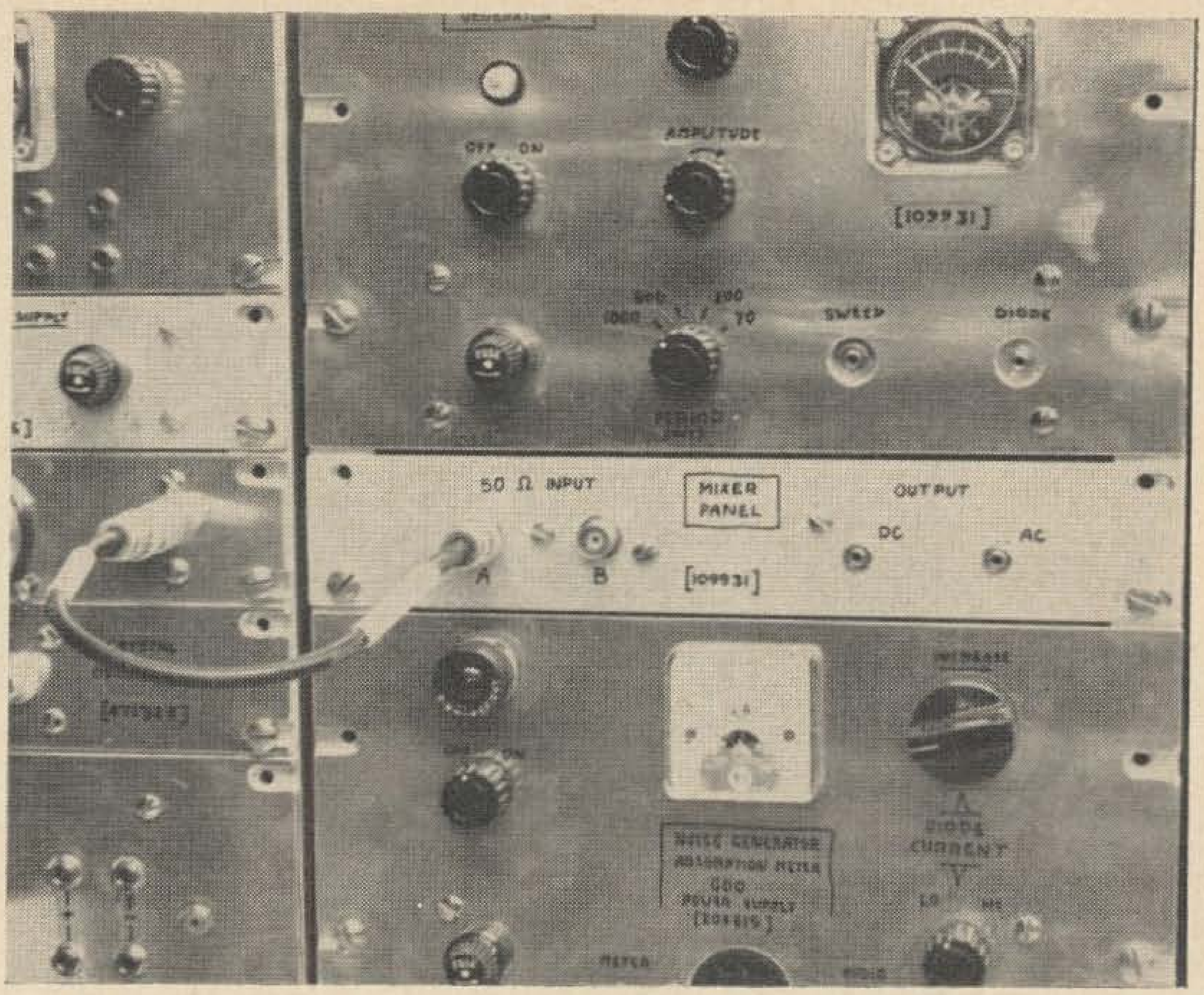
Fig. 1 shows the entire schematic of the circuit, as mounted on an R/2 (half rack) panel. There are two parts to the circuit. The first is a simple resistor network which brings the two inputs to the detector input (LH side of 22pF) in such a way that neither input is much affected by the other. The other is the detector, which provides the nonlinear mixing required to bring out the audio difference beat, or to bring up the audio signal in a single RF input. Let's examine these one at a time.

RF portion of the mixer. Note short leads and simple, open layout to minimize parasitic inductance and capacitance.

Why not tie the same piece of wire to both BNC inputs and hook the detector onto it also? Wouldn't it work? Yes, after a fashion, but if you hook two oscillator circuits together in this way, they'll fight. Since they will be trying to lock frequencies, any assessment of the individual performance of either one of them will be uncertain. Of course, you could use buffer amplifiers if you wanted to put up with the additional parts and reduced frequency range. But the resistor network is preferable for general purpose test work.

The books tell how to work out the behavior of simple voltage divider circuits. A little math will show that if you look into terminal A with terminal B open, you will see a 54 ohm load. If you short B to ground, the load at A falls to 52 ohms. Small change! With B open, 63% of the input at A appears at the detector; with B shorted this falls to 50%. Again, not a very great change. This all works out very well indeed if you want to test an oscillator without making up a lot of additional circuitry.

The diode detector action is also simple. As a mixer, the picture is not quite so clear, although by no means complicated. Suppose there are two RF signals whose frequencies are different by one cycle per second. What this means is that once per second both signals will come to a crest at the same instant, and add up. Halfway between these intervals the signals will go to a maximum opposition or interference. In the remaining time between these intervals the sum or difference is building up or decreasing. The detector sees



James Dandy Mixer goes nicely into the test panel with other half-rack gear.

the two signals as one, modulated by the difference rate, and that is what comes out!

Construction and use

This circuit is too simple to be hard to build. If the parts are good, it will work. But the greatest useful frequency can be raised by good VHF construction techniques: small components, short leads, minimum capacitance between components and to the chassis. The R/2 construction illustrated is generally used in locally built gear, and no shielding is visible because none was used. It doesn't seem to be required.

The apparent sensitivity of the mixer depends on the amplifier following it. Its voltage loss is not great, and most of the small RF voltages found in breadboard small-signal circuits are apparently considerably greater than some amateurs believe. The mixer is generally followed by a simple Lafayette audio amplifier, #99R9037 in their catalog #660. This amplifier offers adequate gain for listening to anything that can be shown to be oscillating, without much load on the oscillator. Its frequency response is zilch at low frequencies and one of the hi-fi type amplifiers might be desirable for some applications. Here are some illustrative examples.

Application #1. What is that new little oscillator doing? The tiny one, 1 mA at 3 volts? Attach signal generator to one input, hang a piece of wire from the other and bring it near the oscillator. Tune for beat, and listen. There is sufficient gain that you can ignore the mismatch. Ditto for calibration of the oscillator.

Application #2. Want to find leak in shielding. Signal generator to one input, piece of coax with pickup loop to the other input. Check for beat note, seal up the enclosure, and start searching.

Application #3. What does the modulation on the RF sound like? Pipe the RF into either input and listen.

Application #4. How well is that multiplier working? Pipe the RF to either input and put a meter on the DC output terminal.

Additional applications as required. When you have built and used one of these James Dandy Mixers, you will wonder what you did without it! . . . W2DXH

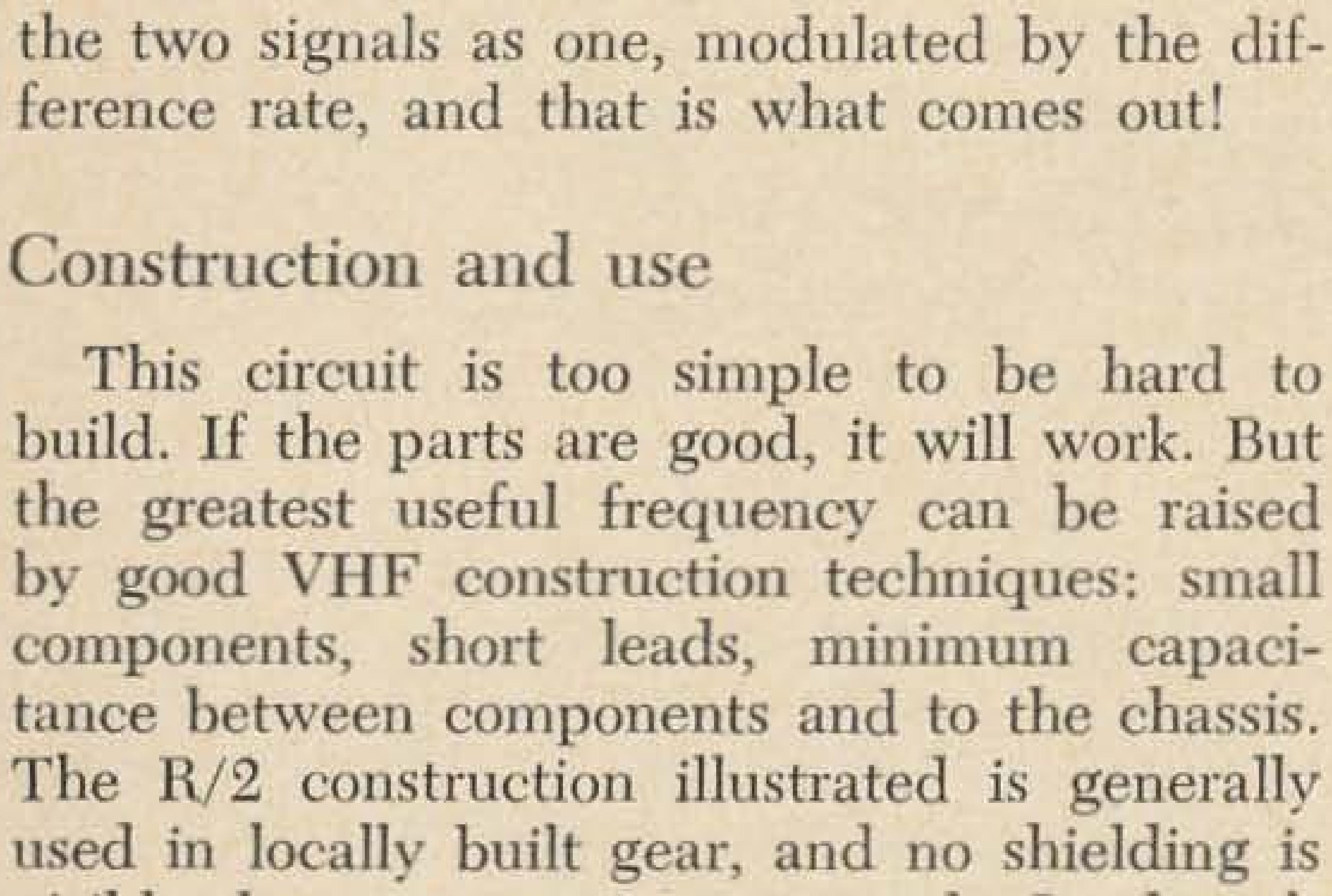


Fig. 1. Schematic of the James Dandy mixer. This little device is very useful for checking stability of oscillators, modulation, etc.

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A Poor Man's 220 Transmitter

Here's a simple, inexpensive transmitter for the beginner on 220 MHz. Output is only half a watt, but that can work a good distance.

Inexpensive, low power transmitters have gained popularity through proven performance on 6 and 2 meters. "Why not find just how little is needed on 220 MHz?" I thought. Perhaps it was a foolish thought—for many failures followed.

The 1¼ meter band borders on UHF. This tends to complicate circuitry. Tuned lines were not considered for the tuned circuits, but it became evident that the coils and even the wiring looked somewhat like tuned lines. Tubes—especially receiving tubes—are not efficient because interelectrical capacitances are too great. Sometimes chokes and capacitors become self-resonant, making the circuit inefficient or even inactive. Hopefully, you will be spared this grief because here is a circuit that works! It has a plate modulated straight-through final which is stable, yet simple to construct. The project should be particularly attractive to the newly-licensed technician.

Circuitry

Only two tubes are used in the RF section of this transmitter (see Fig. 1), a 6GH8 and a 12BY7A. With a triode oscillating at 73.34 MHz, the 6GH8 triples in the pentode section. The oscillator multiplier is a modified Butler circuit which satisfies the low drive limitations of the overtone crystal. A 6EA8 may be used in place of the 6GH8 if you wish. The 220 MHz output of the multiplier is RC coupled to the 12BY7A final which is screen neutralized. Incidently, the 12BY7A holds its own place among receiving tubes for low 220 MHz drive requirements. It is not efficient, but it works with upward modulation and is easily neutralized.

Let's talk about crystals for a minute since this application may be controversial. In a transmitter oscillator, the crystal is not only a frequency source, but a power source. The oscillator may be viewed as an amplifier using the crystal as the driving element in the manner of any conventional large signal RF amplifier. Now, if the amplifier has a fixed gain of 10, the output of the circuit will be 10 times the drive level of the crystal. When the crystal is driven hard, the output is proportionally greater. An 8 MHz crystal may be driven at 5 to 10 milliwatts without harm, but overtone types (20 MHz and higher) must be limited to a 1 or 2 milliwatt level. For this reason, the overtone oscillator will have an output power of 1/5 that of the fundamental oscillator. In transmitter applications, additional gain will usually be required to achieve a useful output level.

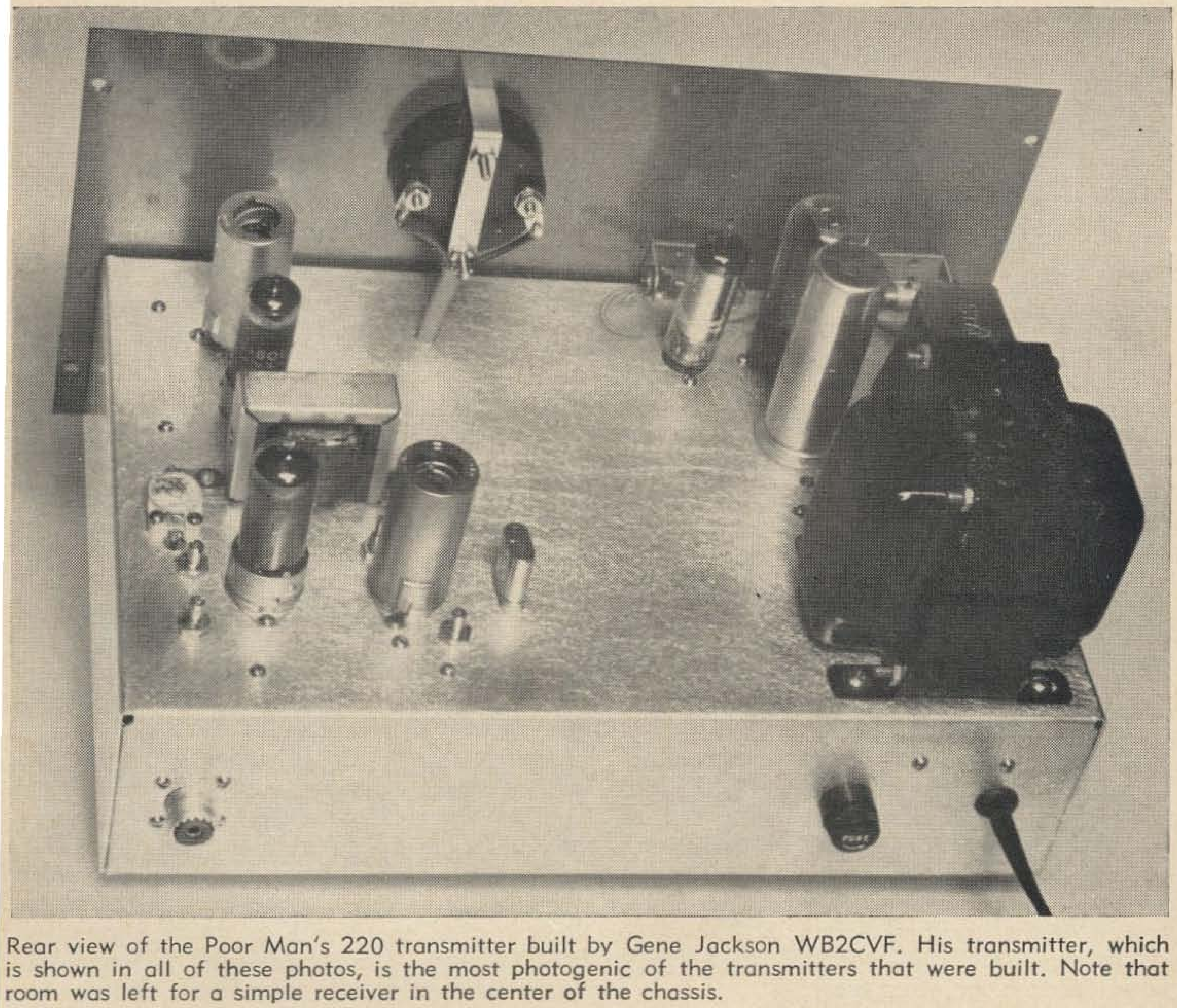
What happens if the overtone crystal is overdriven? The crystal may fracture, but more likely will be the increase in spurious responses and possibly some instability of the crystal. In the case of a transmitter, several spurious outputs at frequencies a few Kilohertz from the main carrier will be noted. In converter applications, the overdriven crystal will produce image and "out of band" reception.

Experiments with different oscillators and controlled crystal drive levels showed the Butler oscillator to be the least critical. Using a pentode in the multiplier section provided sufficient gain to drive the final PA without additional amplification.

There is nothing magic about the modulator. A two stage voltage amplifier (12AX7) is followed by a 6AQ5 power stage. Chokes in the heaters and the microphone input are used to suppress RF feedback. The modulation transformer T_2, has a slight mismatch, but more than enough audio is available to compensate for the transformer loss. While a specific transceiver transformer is called for, the system works well with any 10 W universal output transformer.

For those who prefer solid state rectifiers, any units rated at 100 mA and 1000 PIV or greater would be fine. A word of caution might be in order. Silicon rectifiers have fine efficiency, but will not stand the voltage overload as a tube will.

Actually, the only frills on this whole unit are the case and the plate current meter. You don't need either, but your wife will be impressed. Costs of both items are very reason-



Rear view of the Poor Man's 220 transmitter built by Gene Jackson WB2CVF. His transmitter, which is shown in all of these photos, is the most photogenic of the transmitters that were built. Note that room was left for a simple receiver in the center of the chassis.

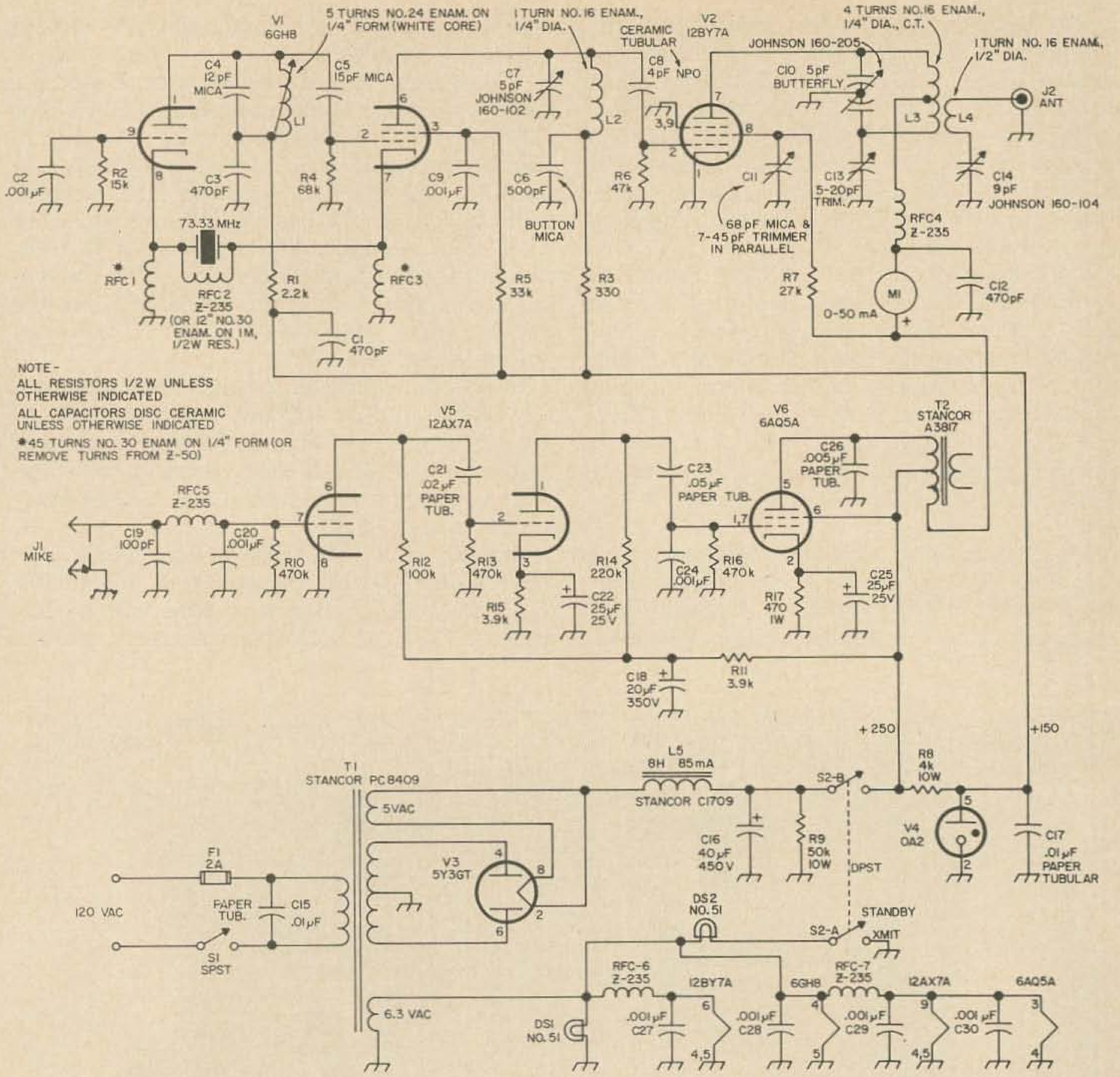


Fig. 1. Schematic of the Poor Man's 220 MHz transmitter. Output is 500 mW with 5 W input. This isn't exactly overpowering efficiency, but the transmitter modulates upward and gives excellent local coverage.

able. If a final grid current meter is desired, a 100 µA or 200 µA meter would be suitable. Those values don't come in the low cost variety, however. Grid current runs near 75 µA.

Construction details

All components are mounted on an 8 x 12 x 3 aluminum chassis which is later housed in a Bud "Shadow Box." Chassis layout is shown in **Fig. 2.** A nut is placed between the chassis and front panel on the two switches and the microphone jack to accommodate the mounting flange. When the chassis was installed in the shadow box, spacers had to be used to raise the whole chassis for alignment with the recessed frame. Shields were used on the 12AX7 and the 6GH8, but should not be used on the other tubes.

The layout of the RF section is the only critical part. Keep RF leads as short as possible and avoid unnecessary kinks in the wire. The parts layout of the RF section has been used on three transmitters with some small variations. All units produced the same results. One of the units is on a 17 x 5 x 2 chassis which was rack mounted. The original construction (only the RF section) was made on a 5 x 7 x 2 chassis. Such an idea may appeal to anyone with a separate power supply and modulator.

There is sufficient room on the chassis to add a receiver, if desired. The modulator could be switched for receiver audio. First thoughts on a receiver are to build a superregenerative type with a broad grounded grid RF stage. A converter, used with a superhet is the best path to take, but a bit large for

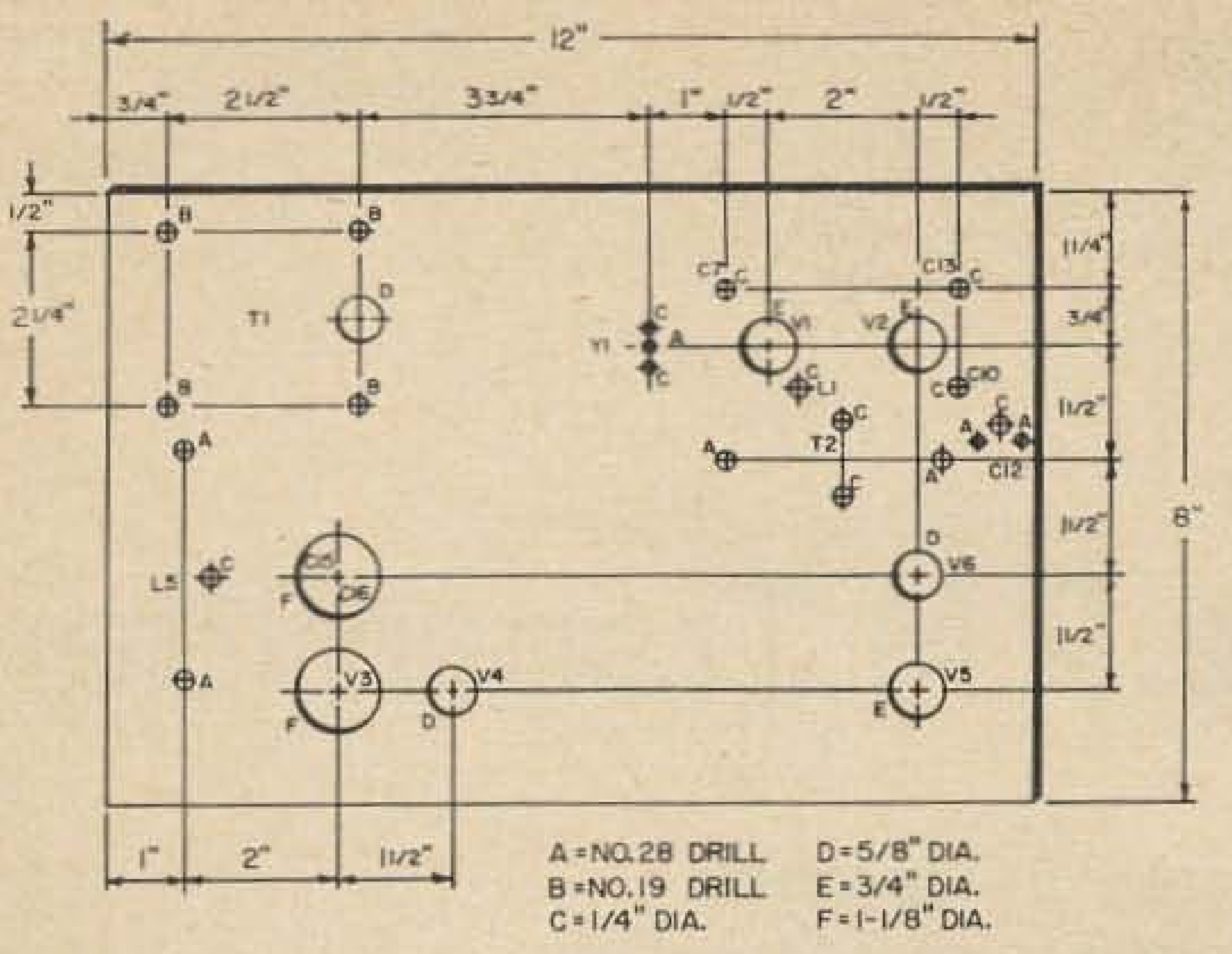


Fig. 2. Layout of the chassis of the Poor Man's 220 transmitter.

the correction. Now replace the crystal and readjust C_{10} in conjunction with C_{13} to find maximum output. C_{13} is now permanently adjusted until a new final tube is needed. Recheck neutralization, then adjust C_{14} for maximum output. Peaking of C_7 and C_{10} may be necessary. The procedure may have to be repeated several times, but once neutralization is achieved, C_{11} should not require readjustment unless the 6GH8 or 12BY7A is replaced. At optimum tuning, measured power output was 500 mW, modulation was upward, and the removal of the crystal cutoff the RF completely. The plate current is 20 mA giving a 5 W input rating. If frequency shifts during operation or spurious responses are noted, L_1 should be adjusted.

On the Air

One-half watt is Q5 at 30 miles if reasonable antenna systems and a good receiver fill the gap. (Gene, WB2CVF, holds the record of 64 miles with this transmitter.) We grant that 10% plate efficiency is nothing to brag about, but the 12BY7 performs better than several other tubes which were tried. The audio quality is excellent with 100% modulation possible. TVI is not present at the author's location. High output microphones can overmodulate the transmitter. As a builder, you might prefer to make R_{10} an audio gain control and limit peak modulation. No reduction of the voltage amplifier's gain was shown in this schematic in order not to limit the ham who has a low output microphone.

In all, the Poor Man's 220 Transmitter satisfies all its objectives. If you are a poor man, why not build one for the fun of it? You will be a little richer by the experience.

The author wishes to thank Steve Wojcik for the photography.

. . . WB2EGZ

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Another Solid State 2 M Transmitter

This simple transmitter uses inexpensive transistors for 150 mW output on 144 MHz.

The transistorized transmitter described herein was intended primarily for remote control of models but hams being what they are, the transmitter was quickly modified for short range communications on 2 meters.

Referring to the schematic, readers of 73 will recognize the oscillator-multiplier described earlier by Bill Hoisington K1CLL. Slight changes to the position of the feedback tap on the oscillator tank coil and different values of emitter resistor and tank circuit constants of the tripler stage were found necessary for best results with the type of transistor used.

The output stage uses a 2N3564 which is characterized for low level operation but with a typical F_T of 750 MHz and collector dissipation of roughly 0.3 watts with a heat sink it makes a dandy power amplifier. The input power runs approximately 35 mA at 12.4 volts for

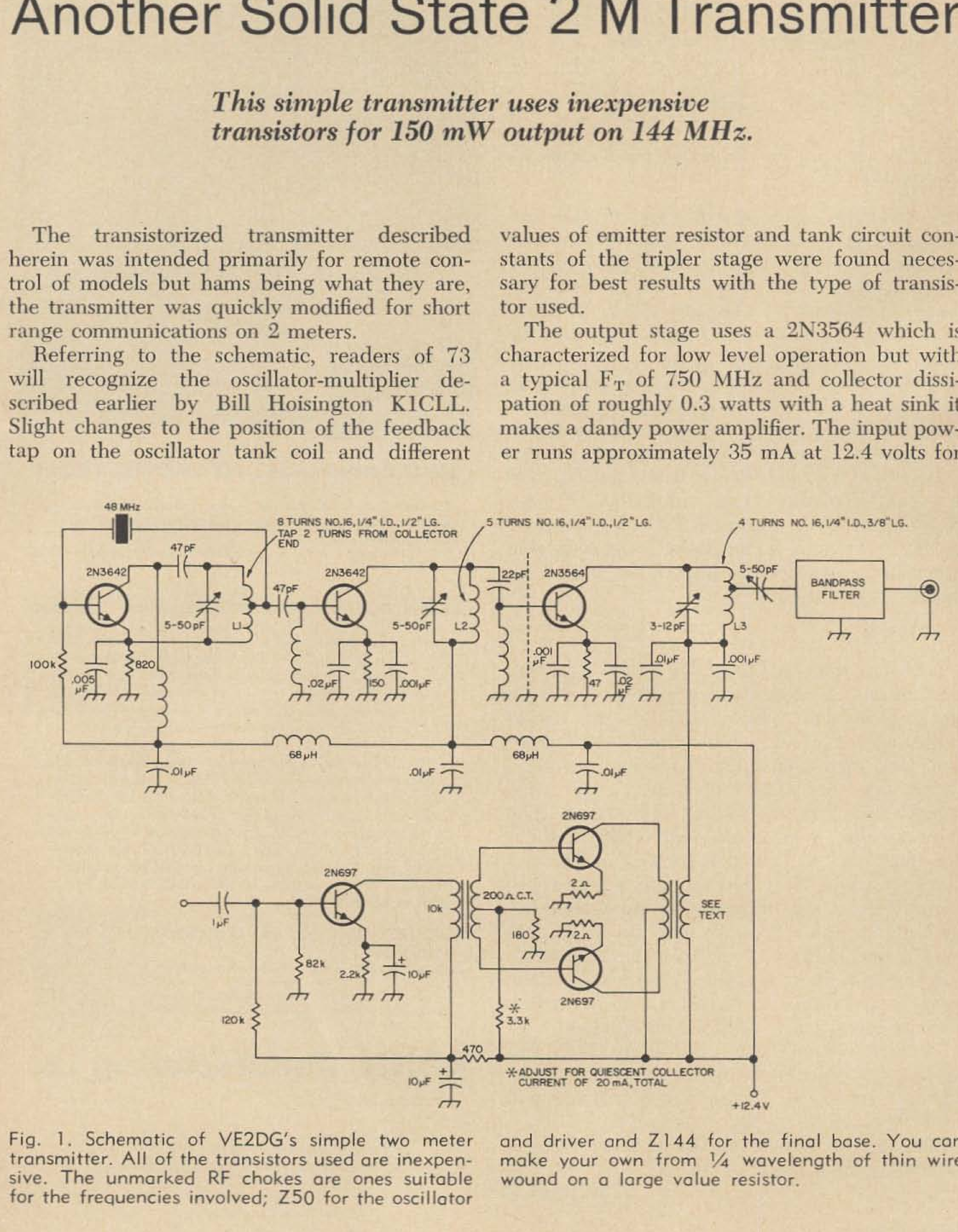
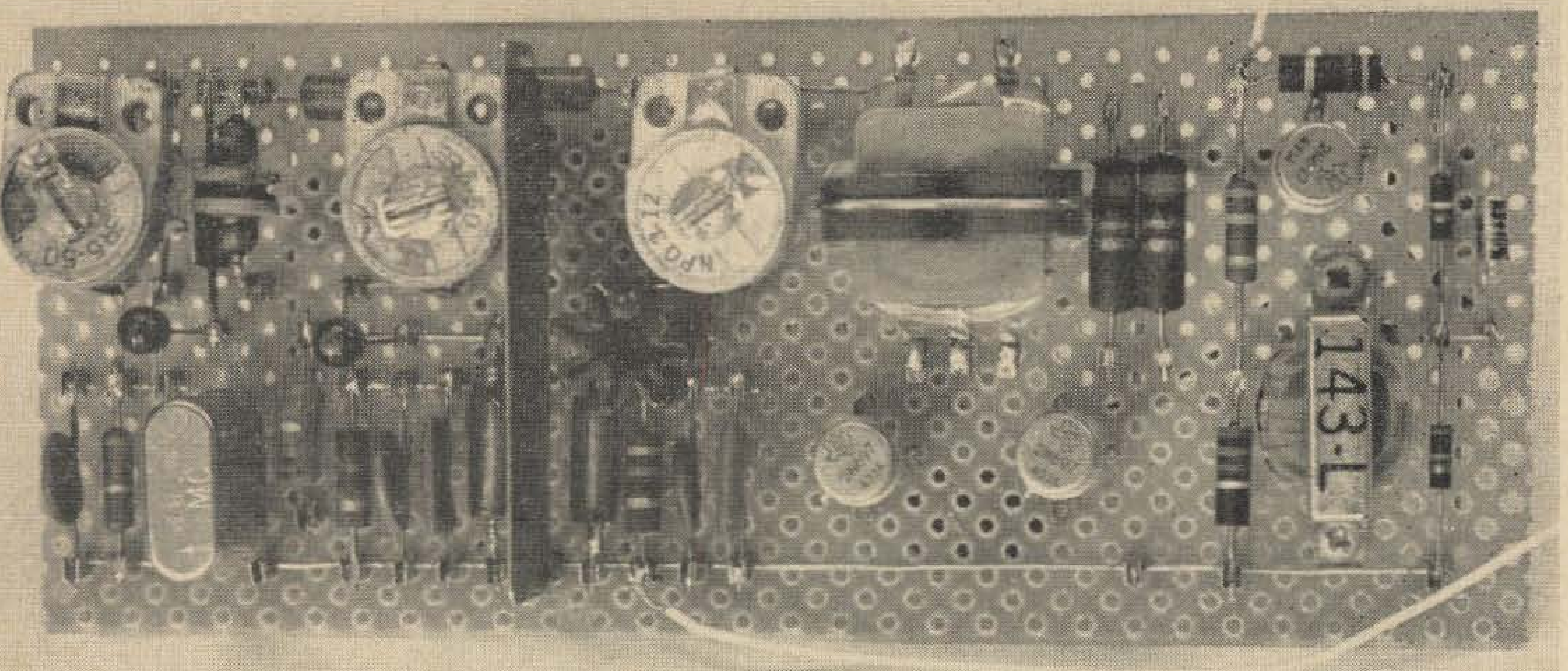


Fig. 1. Schematic of VE2DG's simple two meter transmitter. All of the transistors used are inexpensive. The unmarked RF chokes are ones suitable for the frequencies involved; Z50 for the oscillator and driver and Z144 for the final base. You can make your own from ¼ wavelength of thin wire wound on a large value resistor.



The two meter transistor transmitter is built on a small sheet of perforated board. The modulator is at the left, the power amplifier in the center, and the exciter stages at the right.

an output of 150 mW. Interstage decoupling and emitter resistor by-passing was found to be most important and the imposing number of by-pass capacitors is not fantasy, every one helps in getting the most out of every stage. Proximity of L_2 and L_3 on the finished transmitter resulted in interaction between multiplier and power amplifier but the addition of a copper shield between the two stages cleared that problem very effectively. The limited amount of filtering obtained with the small number of tuned circuits resulted in severe interference with channel 10 but was quickly dealt with by the addition of a filter in the antenna lead and since the transmitter is totally enclosed in actual operation, TVI is effectively eliminated.

The modulator is quite conventional except for the modulation transformer which is home brew, none being available commercially.

The design approach for the transformer consisted in adjusting the turns ratio for 100% modulation and NO MORE, since oversize modulators have been known to destroy many good RF transistors.

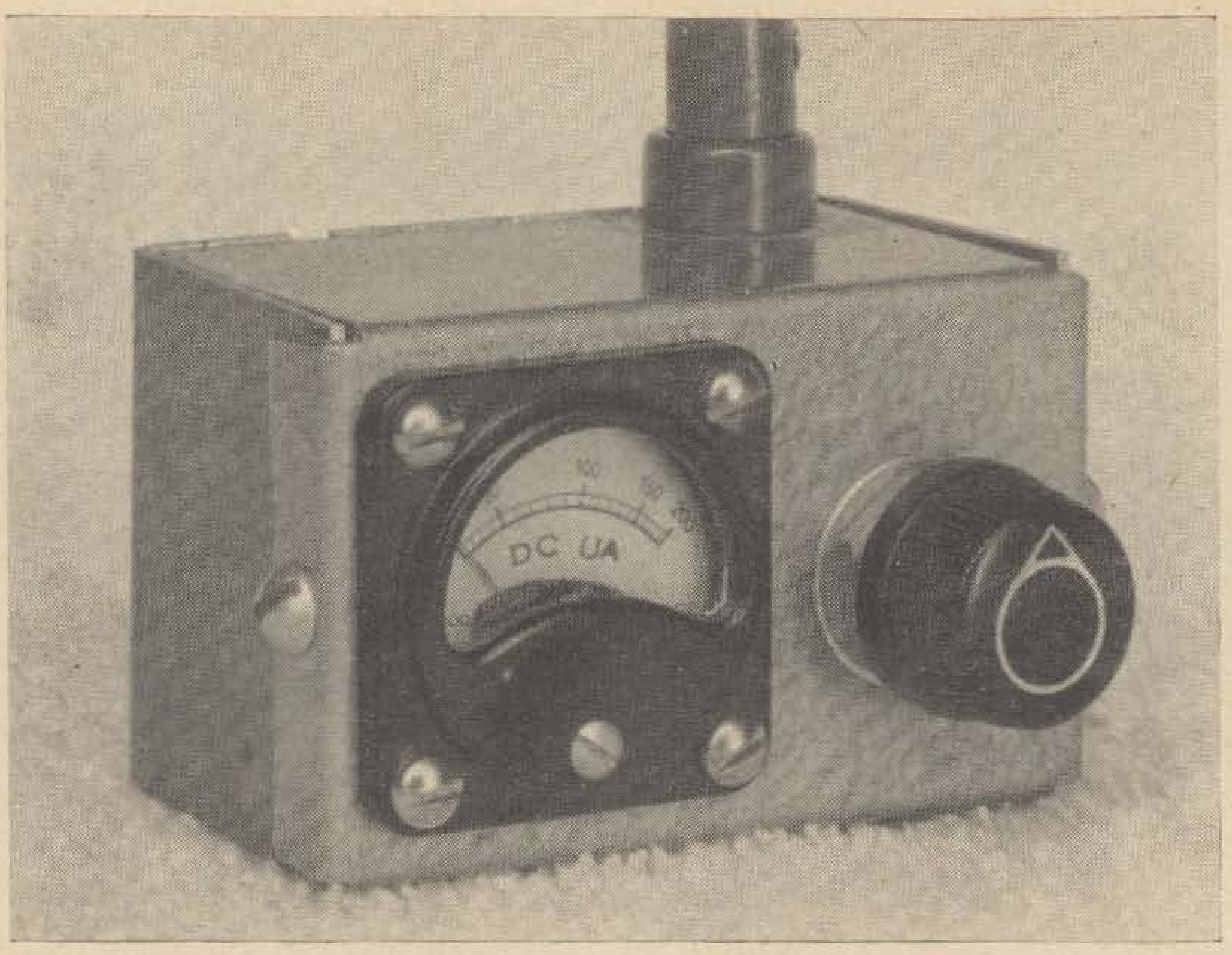
The core was obtained from a stripped down audio transformer having a center leg width of ½" and stack height of ½". The primary is wound with 405 turns of #30 bifilar, (This helps equalize the losses) and the secondary is made with 460 turns of #30. The core is assembled with the E's and I's butting against each other with a piece of cigarette paper in between.

The turns ratio given is just enough to modulate the output stage 100%; above this level, the modulator starts clipping but even under these conditions the collector breakdown voltage of the 2N3564 is exceeded. So far, the transistors used in the output are still alive after 25 hours of operation, (they sure make better transistors than they used to) nevertheless, the use of a 50 volt transistor is strongly recommended.

The audio pre-amplifier shown has enough gain to modulate the transmitter fully with an input of less than 1 mV, allowing use of low output crystal or dynamic microphones.

The modulation transformer shown in the photo is for frequencies above 1 kHz and is therefore much smaller than the one described in the text. Picture was taken before modification for voice communication.

. . . VE2DG



Don Smith W3UZN
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Hagerstown, Md.

The Mini Monitor

Build this tiny field strength meter and know what power you're putting out.

Turn on a transmitter, let it warm up, hit the transmit switch, dip the final and out goes maximum signal. Or does it? Unless you are very familiar with electronic gear, you may not know that that isn't necessarily true at all.

Any tube which may be used as the final amplifier in a transmitter, other than a triode, does not necessarily produce maximum RF output at the same tuning point as minimum plate current. Of course, if the plate is dipped, safe tube operation will result, but why not get maximum output? What it takes to do the job, is a signal strength meter—the Mini Monitor.

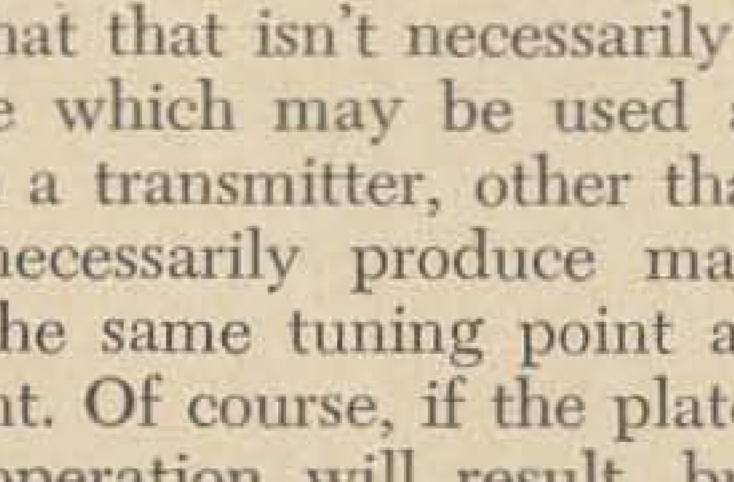
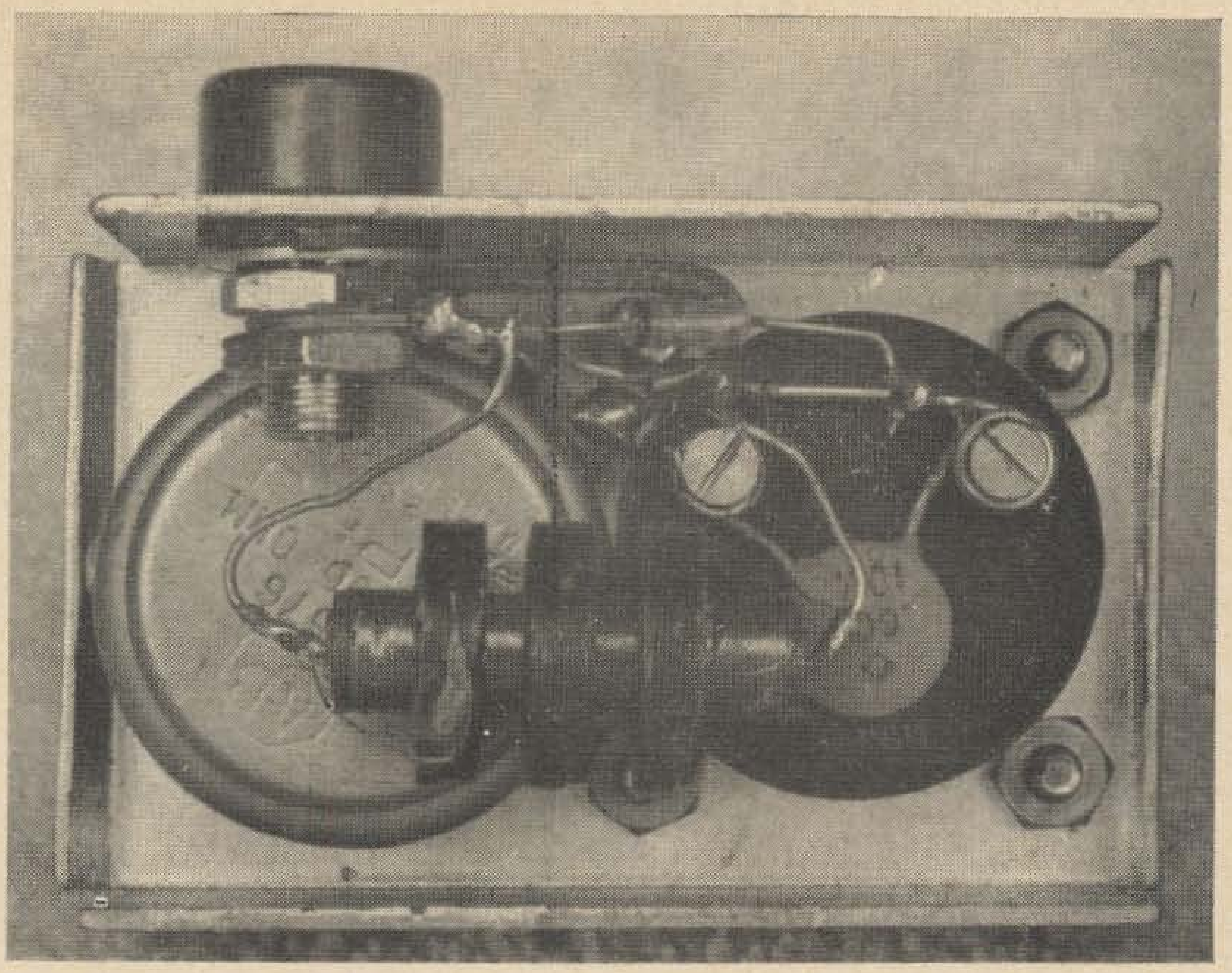


Fig. 1. Schematic of the Mini Monitor.

Such a meter is of great value in mobile operation. It really doesn't matter how much power your running, either, as you want maximum output from your rig. Space for electronic equipment in a car has always been a problem, and if you have a VW like the author, or a Porsche, like Wayne, WOW is space ever at a premium! With this in mind, I sat down and designed the smallest signal strength meter that could be built, using readily available parts.

The tiny instrument is less than 2¼ inches long, 1½ inches tall and 1⅜ inches deep! Though extremely small, it has all the advantages of much larger instruments. A sensitivity control is mounted on the front panel, next to the 1" meter, so that strong signals will not damage the meter. A banana jack is mounted on top, permitting the antenna to be plugged in when the unit is in use. At other times the unit can be placed in the glove compartment, as it won't take up much room in there, even in a Volkswagen.

The circuit is straight forward, with a radio



Back view of the Mini Monitor. The one inch meter is from Alco in Lawrence, Massachusetts.

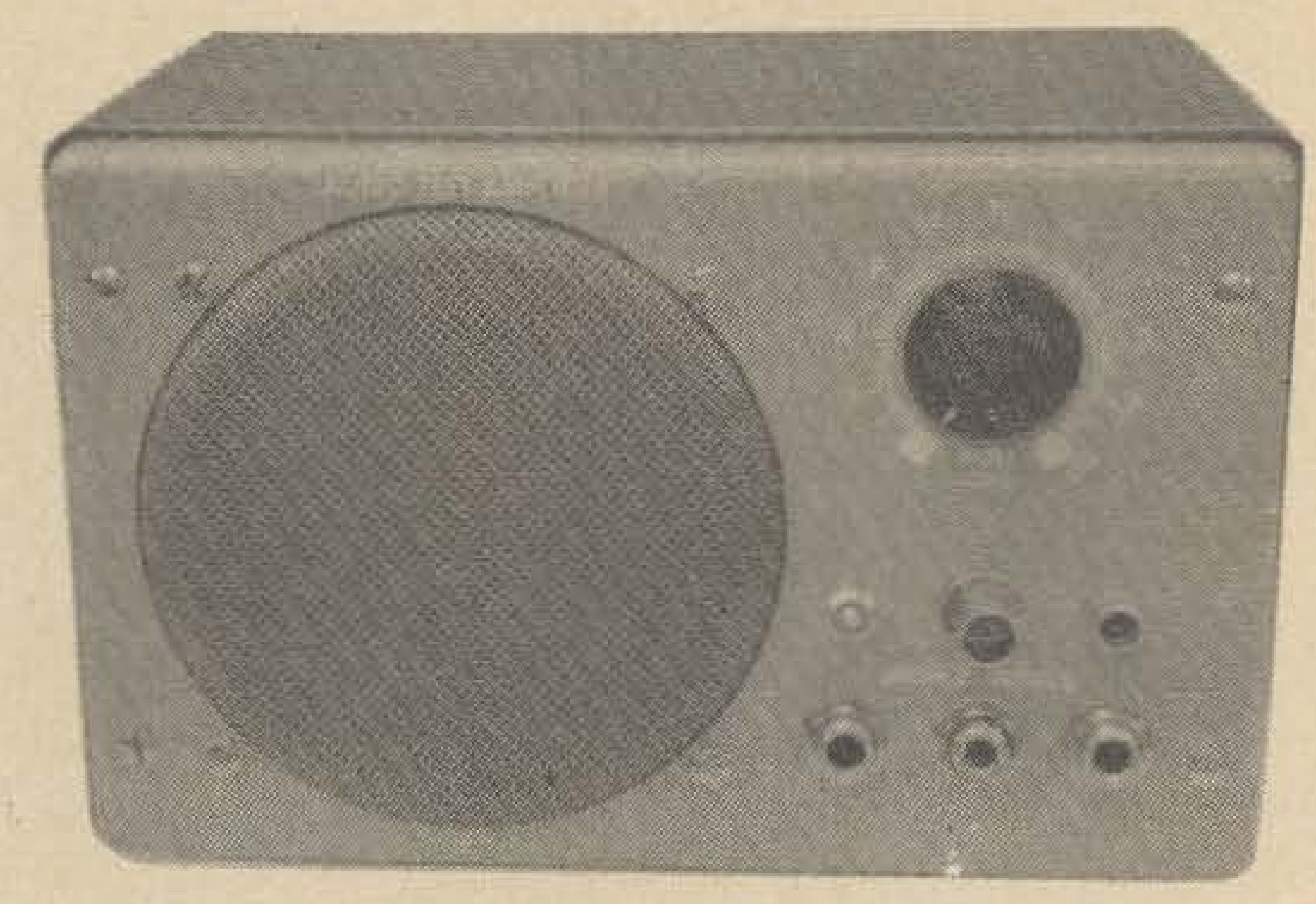
frequency choke used to develop the incoming signal across, from the antenna. The signal is rectified by a small diode, and filtered by a small disc capacitor. This small signal current then flows through the microammeter, causing a reading on the meter. The sensitivity control is placed across the meter so that the signal current flow through the meter can be controlled. On very strong signals, the sensitivity control is turned down, decreasing the resistance it places across the meter. This increases the signal current through the resistor, and thereby keeps current flow through the meter to the desired level.

An antenna for the unit can be made out of anything you happen to have lying around. An 18" piece of #16 copper wire connected to a banana jack was used on the unit shown. You could use a piece of piano wire, if you happened to have it, as it will stay straight and look like a miniature whip antenna! If you are using a transmitter with only a watt or so output, you may find the meter not sensitive enough. If so, increase the length of the antenna slightly.

Place the unit on your dashboard, or hood of the car, as this location makes it easy to watch the meter as you tune the rig. When you tune the rig for maximum reading on the Mini Monitor, you can be sure that you are putting out the greatest signal your rig can. Use the Mini Monitor for tuning up and adjusting antennas too. As you make adjustments, always work towards increasing the reading on the Monitor, without changing its location. Once you build and use this Mini Monitor, you'll never want to be without it!

. . . W3UZN

Ronald Vaceluke W9SEK
17 W 540 Hillcrest
Wooddale, Illinois



Audio Test Amplifier

Simplify your experimenting with this handy instrument.

How many times have you wished that you had a small bench amplifier? I know of many times in the past that I have had to use earphones and a blocking capacitor to check audio circuitry just because of the fact I didn't have an audio amplifier on the bench. But not again! I finally made my mind up that I would do something about it and thought I would pass this along.

The requirements were:

1. Low cost.
2. A relatively high input impedance.
3. Sufficient gain to drive a speaker.
4. Transistorized (no warm-up time).
5. Self-contained.

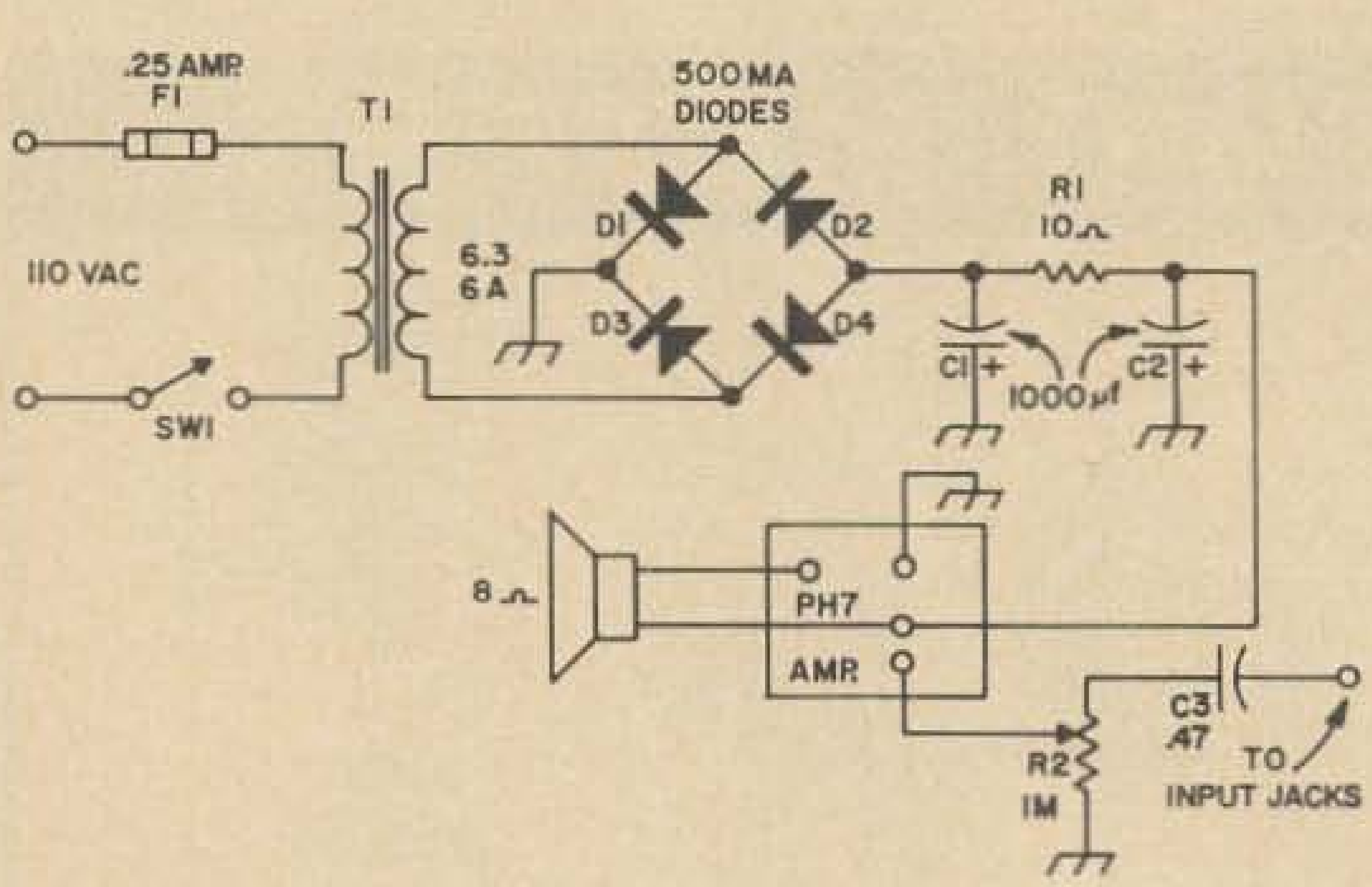


Fig. 1. Schematic of the audio test amplifier. The amplifier module is a Carl Cordover and Co. PH-7 or equivalent. Lafayette sells similar modules.

The first four requirements were met by using a commercial amplifier module and merely packaging it with a few other items into a neat package. The "other items" include input jacks and gain control, a power supply and a speaker. I used six input jacks of different configurations in order to make the unit more versatile. Any number and type of jack can be used and the choice is up to the builder.

The power supply simply uses a filament transformer with bridge rectification and filtering. The filter has an RC pi network which is relatively effective in smoothing out the voltage; however, there is still a small trace of hum. This should not prove to be a handicap unless you are trying to use the amplifier for tracing down low level hum. A more sophisticated (and expensive) power supply would then be necessary. Of course batteries could always be used but this gets to be expensive if the amplifier is used a great deal because of the rather large current that is drawn by the module.

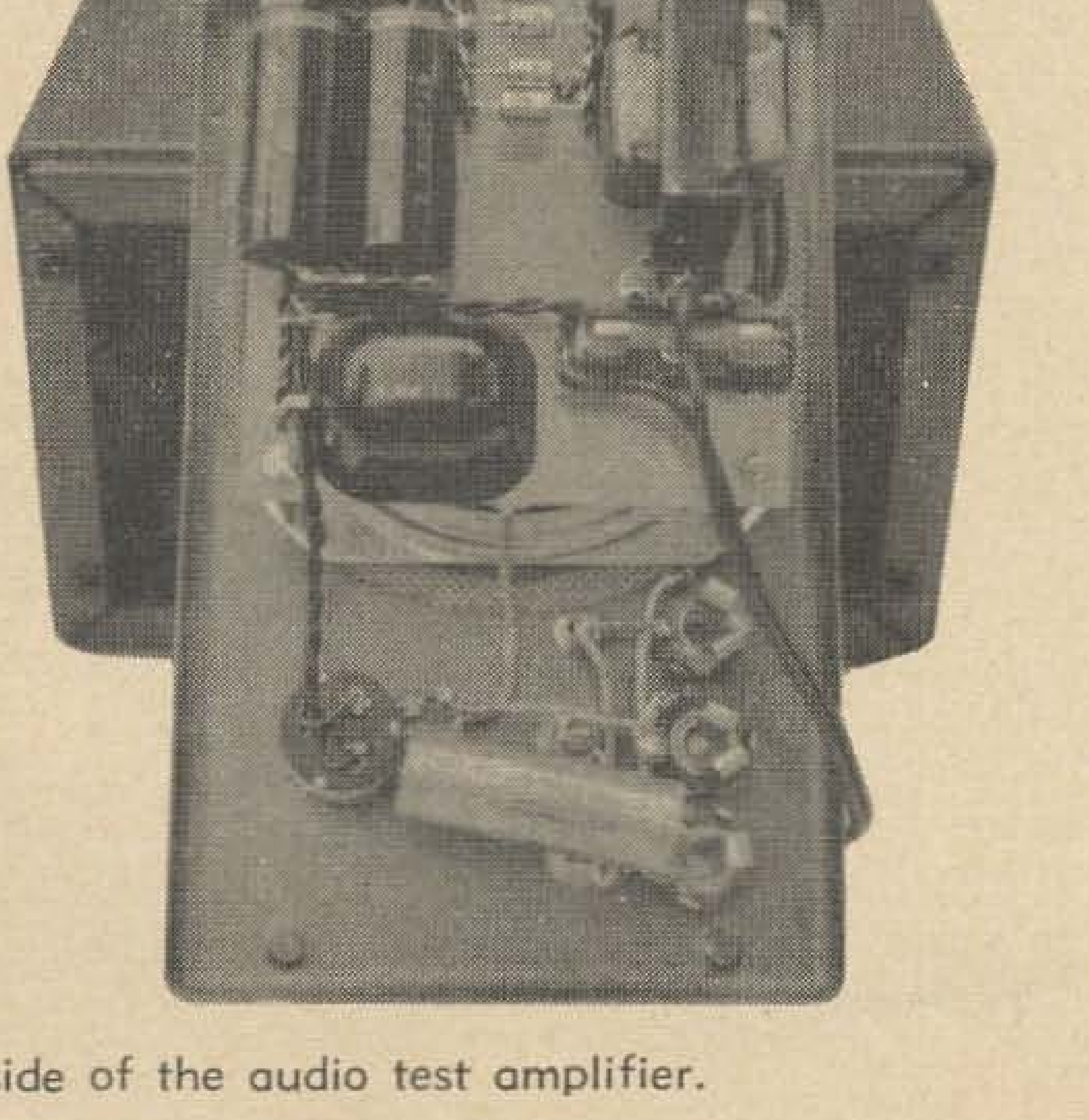
The amplifier shown was built in a Bud CU-585 cabinet which gives a neat commercial appearance and matches by other home brew test gear. If economy is a prime consideration, a lower cost Mini-box can be used. The front panel holds all the components of the unit. The speaker grill (64B890458) shown is available for $1.80 from Motorola, 4910 W. Flourney, Chicago, Illinois, and dresses the amplifier up. The only draw-back with this is that a large hole has to be cut out of the panel and may present a problem to someone that hasn't access to the proper tools for this job. An alternate method is to drill a series of holes in the panel to pass the sound from the speaker.

The module and power supply were built on a piece of 3⅞ x 3⅞ glass epoxy board that was handy, but a piece of perforated phenolic will work as well. This chassis is mounted behind the speaker by threaded bushings and secures the grill, speaker and chassis in a neat sandwich configuration. The mounting of the components is not critical; the only precaution is to keep the power transformer away from the amplifier module to keep hum from being induced into it.

After the wiring is completed be sure to check all connections for proper solder and lead dress. If all checks out then the unit can be connected to the line. When the unit is turned on a slight hum will be heard from the speaker and when a finger is touched to an input, a harsh buzz should be obtained. Now connect an audio device such as an audio oscillator or AM-FM tuner to the input. It should be heard with plenty of volume. Only one precaution must be observed and that is that no more than 400 volts DC can be connected to the input. This is determined by the voltage breakdown of C3.

Your audio test amplifier is now ready for many years of signal tracing, always ready the moment it is turned on.

. . . W9SEK



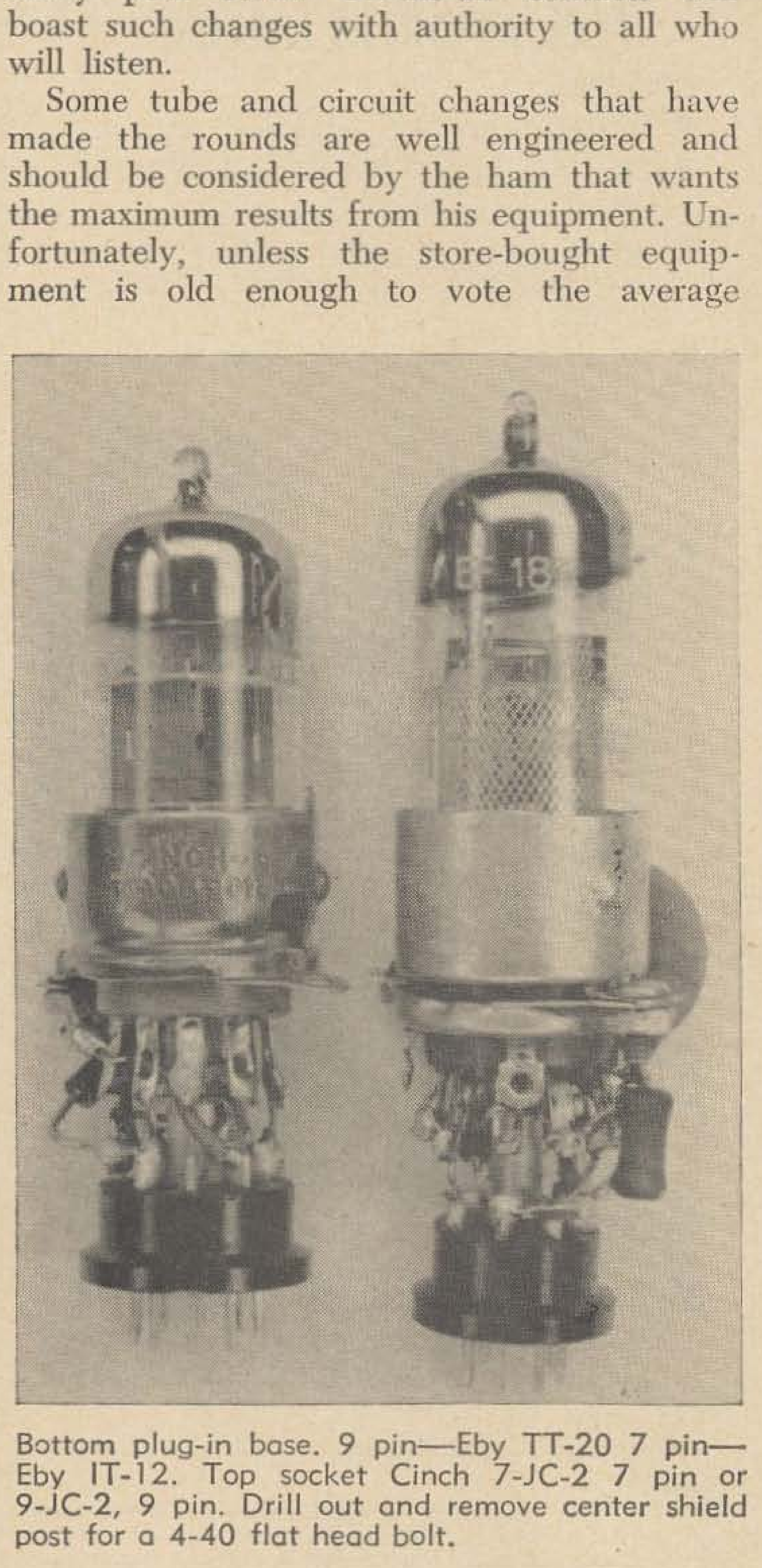
Inside of the audio test amplifier.

Wayne Cooper K4X. V
9302 NW Second Piace
Miami, Florida

The Chicken Method

Many articles have been written over the years extolling the virtues of some new tube or circuit application to improve existing equipment. The reader is often told in glowing terms how changing tubes in the front-end of his receiver will boost the signals so many "S" units or that the DX signals will really pour forth. On-the-air contacts will boast such changes with authority to all who will listen.

Some tube and circuit changes that have made the rounds are well engineered and should be considered by the ham that wants the maximum results from his equipment. Unfortunately, unless the store-bought equipment is old enough to vote the average experimental-minded ham is reluctant to dig into the set if more than a direct tube replacement is indicated.



Bottom plug-in base. 9 pin—Eby TT-20 7 pin—Eby IT-12. Top socket Cinch 7-JC-2 7 pin or 9-JC-2, 9 pin. Drill out and remove center shield post for a 4-40 flat head bolt.

The photo shows the "chicken method" of modifying a circuit, changing the tube type or operating parameters of the existing one. These adapters are easily fabricated using the appropriate tube base plug and socket bolted together with a ½" spacer. Besides making the necessary cross-connections, the spacer and the tube socket shield are connected to ground to carry on the normal shielding and isolation. One or more adapters can be made up to cover the various tube or circuit changes. These along with the original tube can be rapidly plugged in and out under the test conditions or for an on-the-air check. After the evaluation has been made, the best adapter can be left in permanently if it is not desirable to make a more permanent change.

Personally, I have no qualms about turning the finest gear into a "prototype" if tests, not hearsay, can show that a worthwhile improvement will result. The use of plug-in circuit and tube adapters came in very handy recently in improving the front-end of an otherwise well designed commercial receiver. Hearing of a new front-end tube and seeing circuits for it in a planted article in a well known publication made it impressive, though not much when a not-so-glowing report was received from the manufacturer for this particular application. But I got a tube and others to be tested and made up adapters. With the tube in question, it was like leaving the noise generator permanently connected! Combinations of the new frame grid types cut the NF to one-third of that in the original circuit. After thorough testing, the receiver was changed permanently and only once. It would have been quite time consuming and messy to have made all of those changes in the set for each tube combination. Being able to switch back and forth with the plug-in adapters makes for more convenient and convincing testing. While their use may be the "chicken method" to some, it is also a handy tool for the serious experimenter too.

. . . K4ZZV

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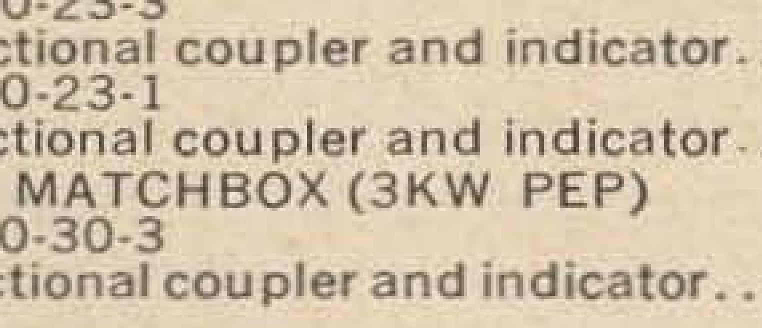

LOW PASS FILTER—Wired, pre-tuned. Handles more than 1KW RF—75 db or more attenuation of harmonics and spurious frequencies above 54 MHz.
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52 ohms, wired and pre-tuned............$14.95
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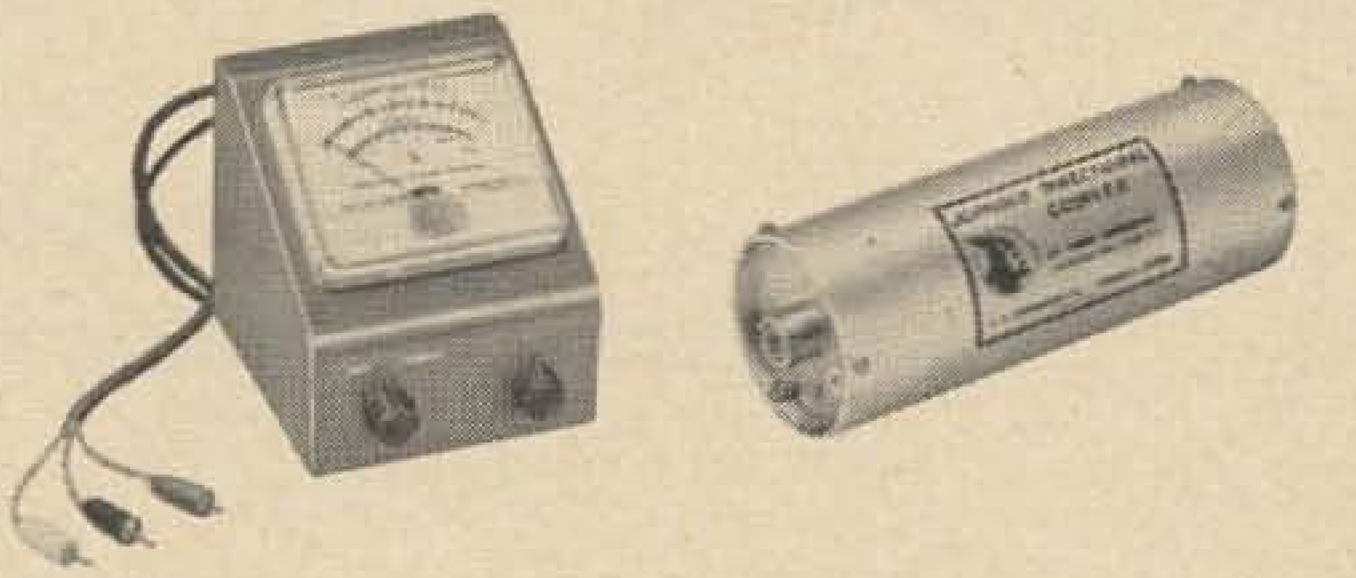
72 ohms, wired and pre-tuned............$14.95



DIRECTIONAL COUPLER AND INDICATOR—Provides continuous reading of SWR and relative power in transmission line. May be permanently installed in 52 ohm transmission line. Handles full legal power.
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Directional Coupler, wired and tested.....$11.75
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with tubes...............$59.95

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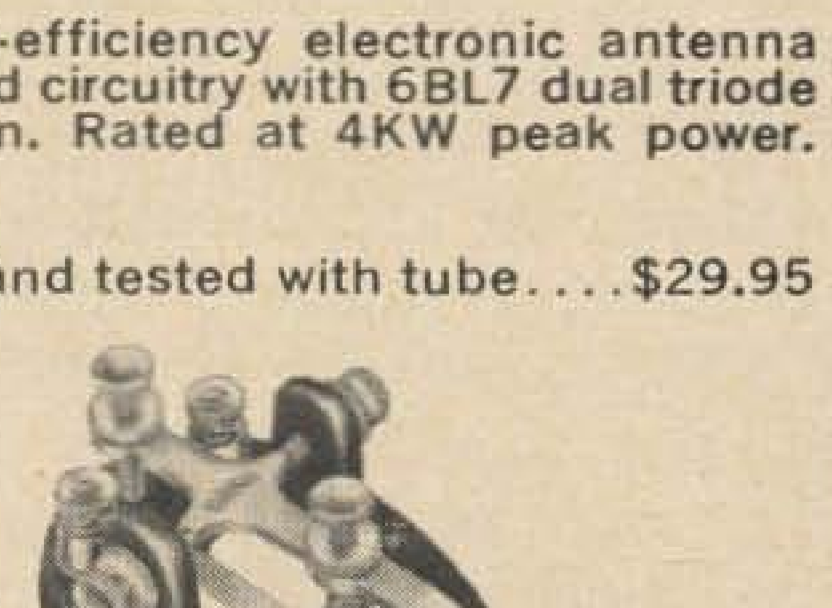
250-43-2	28 to 30 MHz
250-43-3	14 to 18 MHz
250-43-4	30.5 to 34.5 MHz

6N2 Converter, Wired and
Tested with tubes........$89.95

Cat. No.	Range
250-43-12	26 to 30 MHz
250-43-22	28 to 30 MHz
250-43-32	14 to 18 MHz
250-43-42	30.5 to 34.5 MHz

DELUXE SEMI-AUTOMATIC KEY —Adjustable from lowest to highest speed . . . smooth easy action . . . 5 adjustments . . . separate height adjustment for paddles. All parts heavily chrome plated.
Cat. No. 114-500
1/8" contacts,
black wrinkle base......$20.30
Cat. No. 114-501
1/4" contacts,
polished chrome base..$25.50



STANDARD KEY—Heavy die cast base . . . adjustable bearings . . . "Cushion-contact" offers smooth keying action. 1/8" coin silver contacts.
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no switch................$3.50
Cat. No. 114-310-3
Black wrinkle
with switch..............$4.25
Cat. No. 114-311
Chrome plated,
no switch................$5.50
Cat. No. 114-311-3
Chrome plated
with switch..............$6.50

E. F. JOHNSON COMPANY
4639 Tenth Ave. S.W. • Waseca, Minn. 56093

Walt Rogers W1DFS
24 Orient Avenue
Melrose, Mass.

Tubeless VFO for Six (or Two)

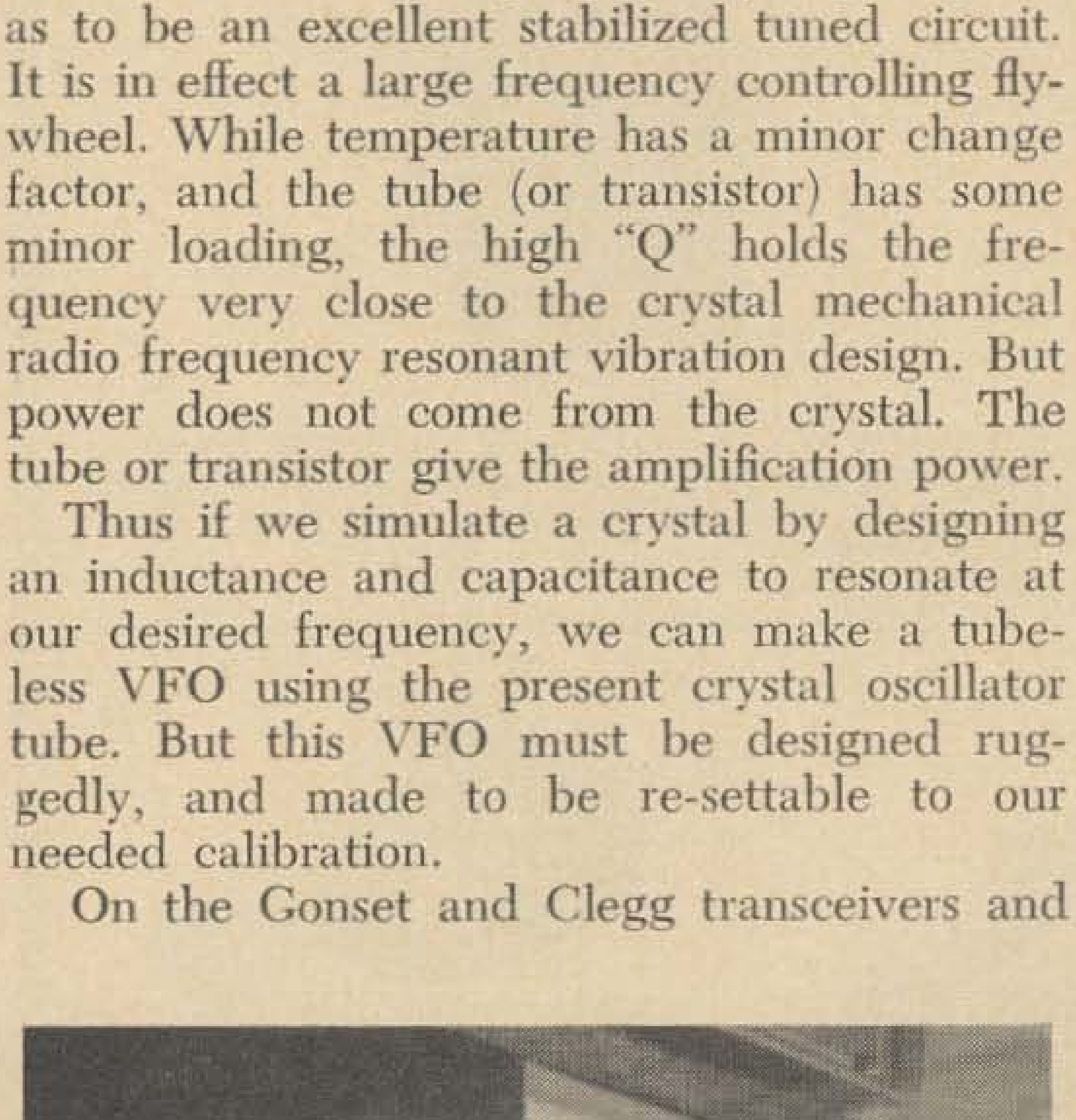
Why be satisfied with crystals when a simple tubeless VFO is so easy?

"I suppose I'll have to build a VFO with tubes or transistors so I can QSY at leisure."

Most of our rigs on six (or two) are capable of using a tubeless VFO. Many think that a crystal puts out power. A quartz, frequency-controlling crystal represents a capacitance and inductance having extremely high "Q" so as to be an excellent stabilized tuned circuit. It is in effect a large frequency controlling flywheel. While temperature has a minor change factor, and the tube (or transistor) has some minor loading, the high "Q" holds the frequency very close to the crystal mechanical radio frequency resonant vibration design. But power does not come from the crystal. The tube or transistor give the amplification power.

Thus if we simulate a crystal by designing an inductance and capacitance to resonate at our desired frequency, we can make a tubeless VFO using the present crystal oscillator tube. But this VFO must be designed ruggedly, and made to be re-settable to our needed calibration.

On the Gonset and Clegg transceivers and for six and two, we do not require the stability that is needed for sideband. And thus we can make use of simplified designs that make the construction much easier.



eeding a Clegg 99'er.

Looking at Fig. 1, there is a tuned circuit L1 with a variable capacitor controlled by a vernier drive dial, a band setting capacitor, which is variable, and a fixed mica capacitor so that the tuned circuit is rather high "C". The mica capacitor is choosen so that temperature will have minimum frequency effect.

Note also that the inductance L1 is wound on a form—ceramic in this case—so that the inductance will not vibrate mechanically and "sing" every time the unit is jarred.

Also I found that the use of the crystal socket on the Clegg, was impossible as it did not provide positive contact. Thus I used a BNC connector but for those who might not have a supply from surplus gear, the RCA audio plugs are convenient and adequate. The coaxial lead from the VFO to the rig should not be long—many suggest seven inches as a maximum—but this may be longer. I am using 15 inches. The shorter the better as this coaxial lead is a capacity loading across the frequency controlling tuned circuit.

First I mounted all the parts, keeping in mind short leads and rugged construction. This unit was rebuilt after making the mistake in trying to use a self-supporting inductance. The variable tuning slug was not needed, but as it was a part of the coil form. I did not remove it.

I found that 8 turns of 18 Formvar (enamel is ok) wire was about right so that the tuning capicitor covered the band from 10 to 80 degrees on the dial. Use a grid dip meter to regulate the band setting. The series mica and the cable, load the tuned circuit so that when they are added, the band setting capacitor is backed off a bit. It was felt that no connector

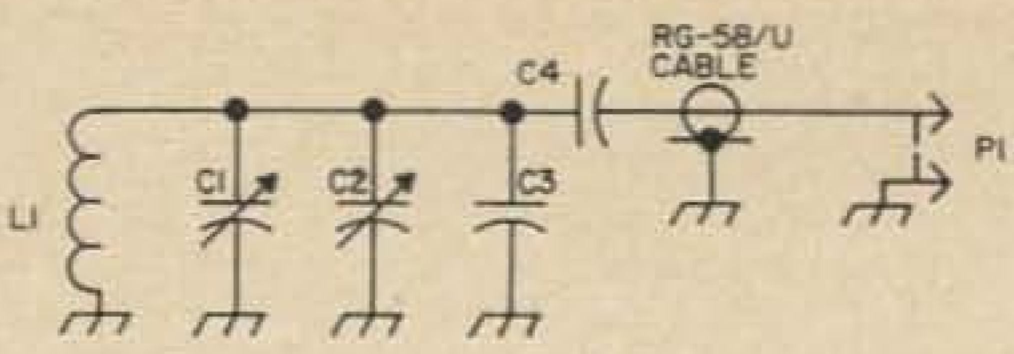


Fig. 1. Schematic of the tubeless VFO for six or two. C1 is the tuning capacitor, 3-25 pF with a shaft. C2 is the bandsetting capacitor, 4-50 pF. C3 is a 220 pF mica capacitor. C4 is a 150 pF mica capacitor. L1 is a 3/8" coil form with 8 turns of #18 Formvar on it.

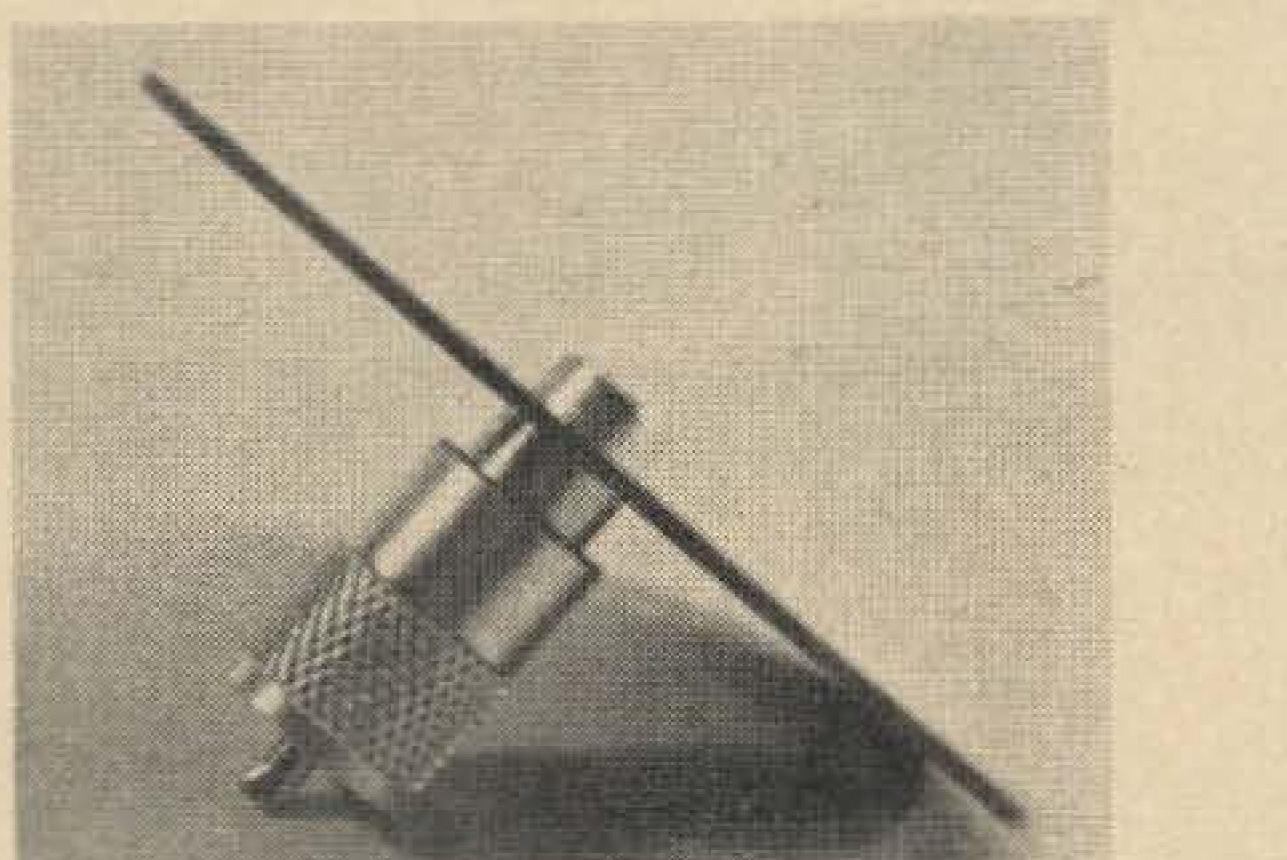
was needed at the unit, so that the RG58U was tied into the VFO and the outboard end was provided with the cable connector.

Note—for six meters the VFO should start on 12.5 MHz rather than 8.333 MHz a unit for two should be on 12 MHz rather than 8.000 MHz.

Before putting the rig on the air, I suggest that you try the unit running into a dummy antenna such as a suitable lamp, until you are sure you are stable and within the band. It is easy to pick up the 12.5 MHz signal on a general coverage receiver. I find that signals on the air drift more that the apparent drift of this VFO. A Collins 51J3 is a pretty good frequency meter—hi.

So good hunting—use what you have in your "junk box," and enjoy being able to zero in on a wanted station. With care, the tubeless VFO can be made stable enough to meet our requirements for six and two so as to add lots of enjoyment to our operation on these bands.

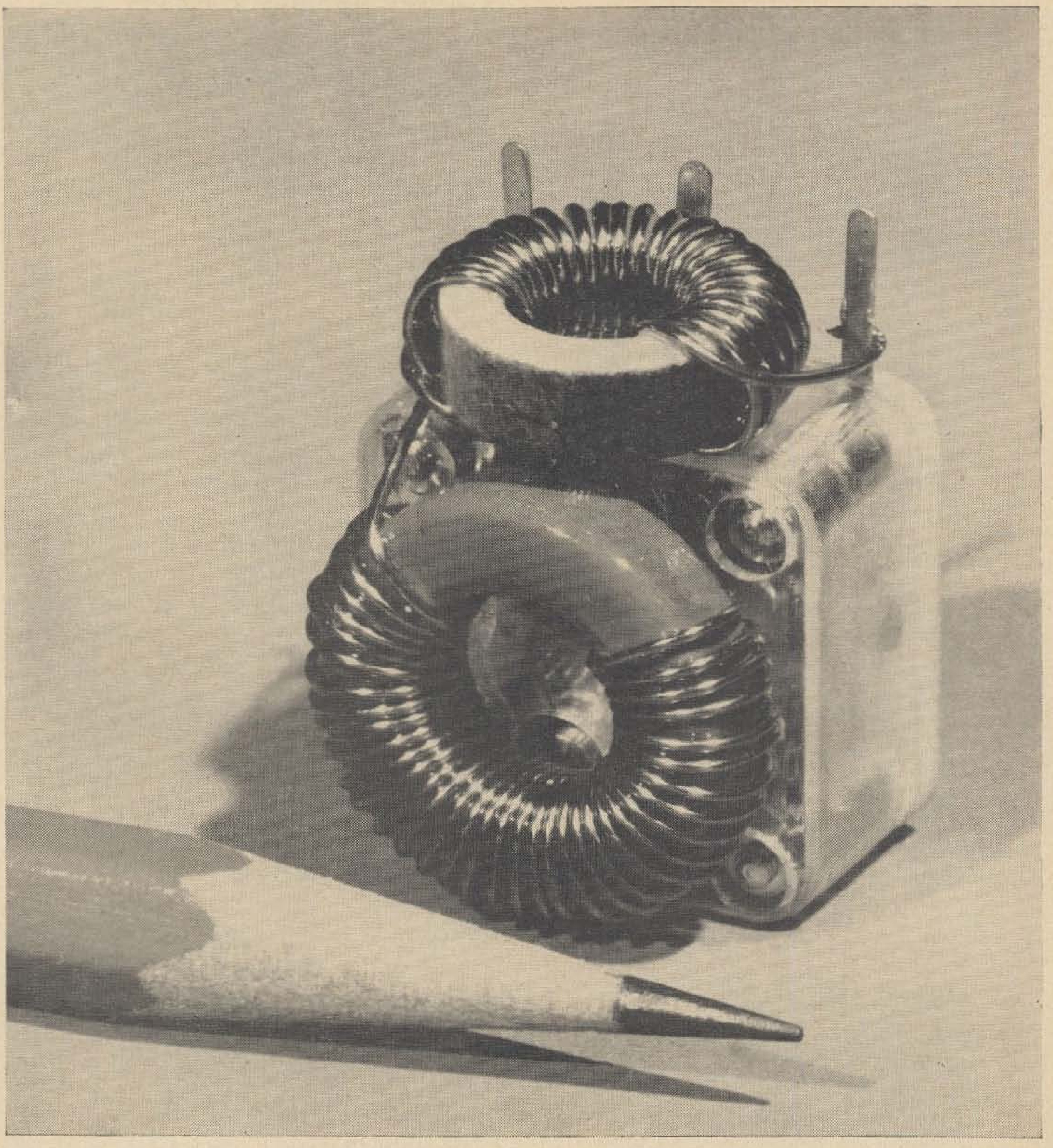
. . . W1DFS



Chassis Mounted PL-259

A chassis type male UHF connector can be improvised by using a standard PL-259 and an RG-58 or RG-59 adapter to go with it. Drill a hole large enough to pass the adapter, then pass the adapter through the hole and screw the PL-259 on from the other side of the chassis.

. . . Ed Morris WA2VLU



Joe Williams W6SFM
4150 Beck Avenue
North Hollywood, Calif.
Photo by Paul Bailey.

A Toroidal Multiband Tuner

Build this simple MBT and put it to many uses.

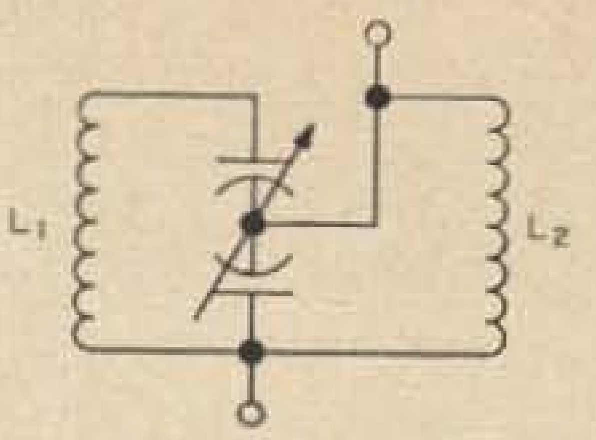


Fig. 1. Schematic of the toroidal multiband tuner. L1 and L2 are described in the text.

The advantages of the 80 through 10 Meter Miniature Multiband Tuner were detailed in the original article published in 73 for December, 1964. Here, the miniaturization is continued and the pass band is narrowed through the use of toroids.

Ham literature is carrying more and more articles about and references to toroidal inductances. To make a long story short: the toroid offers smaller size, higher Q and a more efficient transfer of signal energy. The smaller size is due to two factors. The component itself is smaller and there is no necessity for leaving a large space around the inductance to preserve the Q. This means that the stuffing ratio is improved because more parts can be packed within a given space. Toroidal RF transformers are more efficient because the magnetic energy remains in or near the center hole instead of being sprayed around the chassis. Thus more

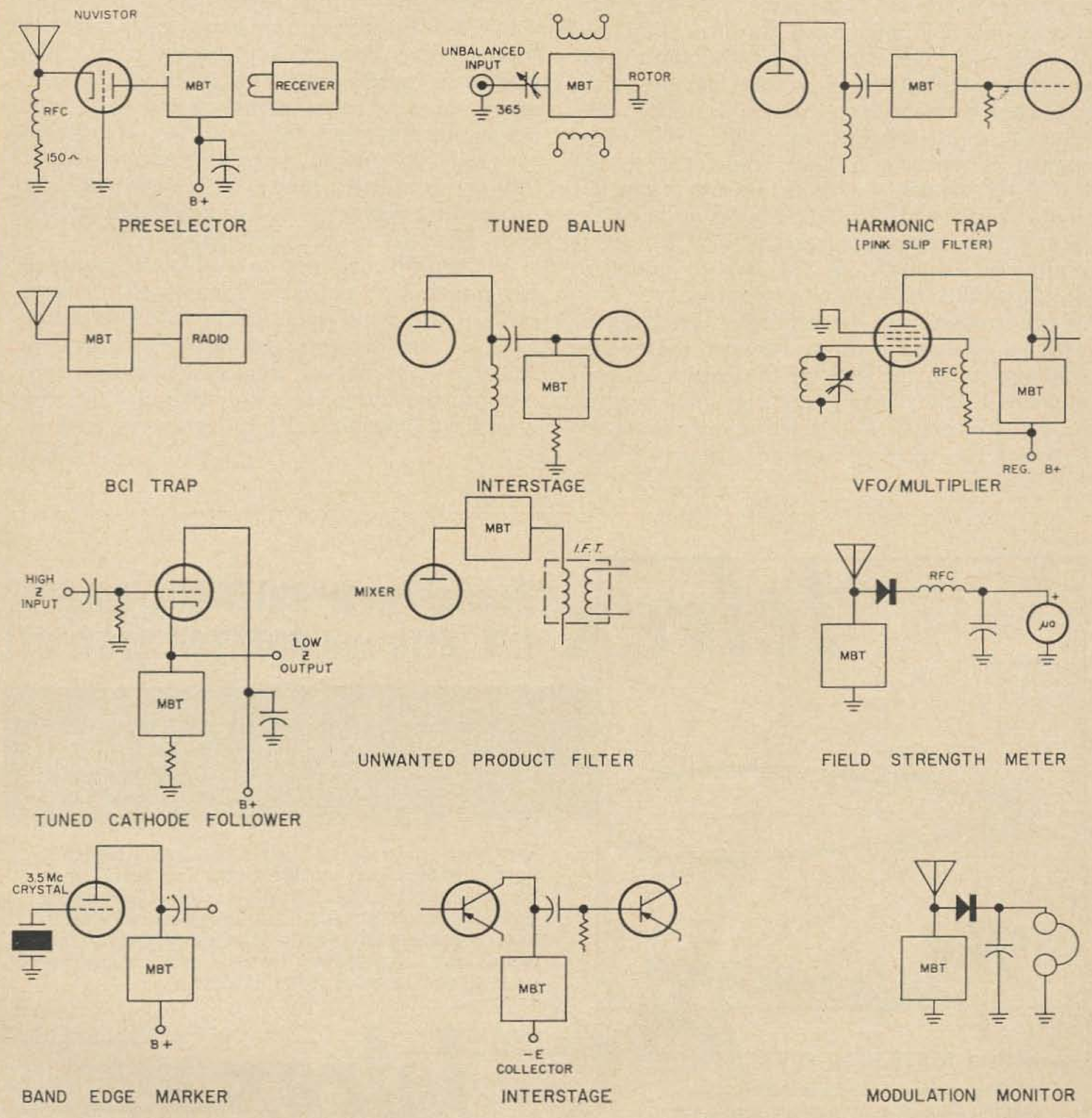


Fig. 2. Some typical suggested uses for the toroidal multiband tuner. See how many more you can think of.

signal is induced into the secondary and applied to the following stage.

The Q (z/R) of an inductance in a tuned circuit has a direct relationship to the width of the pass band of the tank. The average slug tuned inductance has a Q of about 80. RF Toroids of simple design will exhibit Q's of about twice that. The happy result is a pass band that is stopped down to a more narrow value than that of the conventional LC combination.

The toroidal multibander uses the same circuit plan as the original tuner with toroid equivalents of the air coils. The two section tuning capacitor (11 pF to 111 pF and 11 pF to 235 pF) is a CalRad CR 201 which is widely available. L1 is 23 turns on a .50" HF/VHF core of mix 'SF" and L2 is 34 turns on a mix "E" HF core. The wire size is #24. Both cores and the wire are from an experimenter's kit marketed by Ami-Tron Associates, 12033 Otsego St., North Hollywood, Calif. 91607. The smaller inductance is Duco cemented to the top of the capacitor with an unwound gap left at the back so that a link can be added if so desired. The blank spot on the L2 "E" core is positioned opposite the L1 gap to minimize the possibility of inductive coupling.

The easiest way to calibrate the tuner is with an all band receiver because the energy confinement to the hole of the core is so pronounced that it's hard to get a grid dip reading on a small toroid. The tuner is just connected between the receiver and an antenna. When

Color	Letter	Numeral	Spectral Range
Green	HA	41	Audio to 50 kHz
Blue	C	1	50 kHz to 5 MHz
Red	E	2	500 kHz to 30 MHz
White	TH	7	2 to 40 MHz
Yellow	SF	6	10 to 90 MHz
Black	W	10	30 to 200 MHz

Color code for powdered iron toroids. Optimum Q usually occurs in the middle of the spectral range.

the tuner frequency coincides with that of the receiver the incoming signals will be notched way down in amplitude.

If you have an exotic junk box and want to try some toroidal inductances in your RF circuitry **Table I** gives a few toroid code symbols that will help you pick the right cores. The powdered metals industry uses two basic means of core mix identification. One uses letters and the other uses numerals. The whole core may be colored to indicate the mix, and thus the frequency range, or the core may be a neutral color with just a small dab of the code splashed on the periphery.

RF toroids are not saturable at practical currents and do not lend themselves to circuit tricks that depend upon making the inductance "lock-up" or "flat-top" due to core saturation. But that's not all bad because a saturated core reduces the inductance considerably and the need for a "swinging" RF inductance is seldom.

. . . W6SFM

Terry Banks K3LNZ
426 Orange St., SE
Washington, D.C. 20032

The 220'er

A new horizon for the Twoer

A recent spell of trading left me with a Heath Twoer, which lay on the shelf gathering dust since I already had 100 watts and a Nuvistor converter. A casual remark to K4LHB that "I wish they made a 220'er" brought the reply, "Why not convert the Twoer, since you're not using it anyway?" A look at the schematic, plus Heath's information on possible tuning ranges as given in the manual, showed that operation on 220 was a good probability, so out came the tools and grid-dipper and a few days later I was on 220. Here's how to do it yourself.

A word of caution first. At the frequencies involved here, nothing is cut-and-dried, so a grid-dipper is indispensable, and a wavemeter (most grid-dippers will serve) quite helpful. There can be wide differences in distributed capacitance depending on who built the Twoer you are converting, so grid-dip everything as you go, lest you end up with a 288'er instead. Parts are designated as in the Heath manual, but you can still get by if you don't happen to have one.

Several methods were considered for the transmitter conversion, including use of overtone crystals to permit "straight through" operation of the final, but simplicity won out and the final decision was to *lower* all resonant frequencies to get drive on 110 MHz, and then double in the final. The super-regenerative receiver required no head-scratching, as there is only one logical method—prune the coils to resonate at 220.

The receiver was attacked first, beginning at the detector tuned circuit, L6. Disconnect the end farthest from the chassis and remove not quite 2 turns, which leaves a little over 2 turns of the original 4 turn coil. Set the slug in the coil to resonate at 220 MHz with the tuning capacitor fully meshed, and you will end up with a tuning range of approximately 220-230 MHz. If a smaller range is desired, substitute a smaller value for C27 (fixed capacitor in series with tuning capacitor) and readjust the slug which will have to go farther into L6. A test at this point revealed that the detector would no longer oscillate, so the voltage was raised by substituting a jumper for R12 (68 k) after which everything worked smoothly and the grid-dipper could be heard loud and clear.

The RF stage, L5, was pruned next by taking turns off the obvious end until 3 turns were left. This left C20 (antenna coupling capacitor) much too high for a proper impedance match, so it was moved to a new position one turn from the cold (grounded) end of the coil. From here on, proceed as per the Twoer instruction manual, adjusting L5 for best gain and then L6 to give the correct tuning range again, then back over the same process again and again until no more improvement can be obtained. The tap on L5 can also be adjusted if you want to be particular, but ours came out to just about 70 ohms and was therefore left alone.

One difficulty was encountered in converting the transmitter, and caused a lot of wasted time getting coils to resonate properly. Evidently some of the bypassing is not 100% effective, as coils would dip to the right range in "receive" but not in "transmit". The solution is simple—pull the power plug and leave the switch in "transmit" position when working on the transmitter section.

The first two plate coils, L1 and L2 (associated with pins 9 and 3, respectively of the rear 6BA8) do not need to be pruned, since they must go lower in frequency. Add 15 pF directly across the terminals of L1, which should now hit 18.375 MHz. Add 5 pF from the top (away from chassis) end of L2 to the center of the 6BA8 socket and dip to 55.125 MHz.

The driver stage plate coil (connected to pin 3 of the front 6BA8) also requires lowering in frequency, but I was unable to add capacitance anywhere and still come up with an indication on either of two different grid-dippers. Therefore, the coil was removed and a 2-10 pF piston trimmer capacitor was installed in its place. A coil of 6 turns of #20 wire was wound around a ¼ inch form and spaced to about wire diameter, then installed with the hot end connected to the tab on the piston capacitor and the other end to R5 and

C12 hanging in space. Squeeze (to lower) or spread (to raise) this coil until it will hit 110 MHz with the new capacitor near maximum capacitance.

The final tank coil was a real stinker to get to 220 MHz, due to a lot more stray capacitance than was suspected. The original 4 turn coil was reduced to about ⅝ of a turn before resonance could be obtained with the associated capacitor at minimum. In case you want to be able to restore 2 meter operation in the future, remove the final tank coil and C16 as a unit, take the coil off and save it, and substitute about 1-¾ inches of #14 wire wound to 1 turn like a pigtail. Re-connect capacitor C17 (antenna coupling) about 5/16 inch from the cold end of the new coil, which should be about right for 75 ohm use. A little closer will match 52 ohms.

With all stages converted and grid-dipped to approximate position, insert a crystal at 1/36 of the desired operating frequency (6112 kHz for low end of the band, or a surplus 6125 kHz rock will put you on 220.50) and connect an SWR bridge between the antenna terminal and a 75 ohm resistor for a dummy load (or use a #47 bulb as suggested by Heath). Using the bridge, some output was obtained immediately and tune-up was just a matter of going over all adjustments until maximum output was obtained. With a bulb, it may be necessary to fiddle a bit or work in the dark so the first faint glow can be seen. In either case, there is some interaction between the various adjustments, so repeat the process as often as necessary to get to where no further improvement is possible. An on the air check should now be performed, which may require some slight readjustment of the final tuning, and possibly adjustment of the driver tuning (the new capacitor) which always seems to give best modulation when detuned a bit from maximum output position, even as originally built for 2 meters.

Results have been all that could be expected. The receiver performs the same as on 2 meters, and what little local activity there is (and a lot of spurious junk from TV sets) can be copied on a small yagi. The transmitter puts out approximately the same amount of RF as when it was on 2 meters, due mainly to getting a lot more drive to the final which permits it to double with decent efficiency. Small yagis are available for less than $10.00, and a colinear for $12.95, or either can be built easily from old TV antenna materials. My total cost of getting on 220 was less than $35.00. See you there soon?

. . . K3LNZ

Leon Vice W5VCE/W5OBC
Communications Officer
Houston Civil Defense
724 Gillette Street
Houston, Texas 77019

The Perfect Squelch

Use a dime whistle to activate this simple tone controlled squelch.

Have you ever wished you could monitor your favorite net frequency and hear only pertinent calls without all the associated noise, QRM, idle chatter, etc.

Maybe this gadget is just what you have been looking for. Certainly it furnishes a practical method of monitoring local emergency or traffic nets.

Necessity is the mother of invention, you have often heard. This system was developed to solve a particular problem on the local 2 meter FM RACES Network. When the net consisted of only a few members the normal squelch system made channel monitoring a pleasure when compared to SSB and AM experience.

However as new members were added, the squelch soon remained open for a large part of the day as operators participated in the usual ham chatter.

In searching for a solution to this problem several approaches were considered and discarded before the present system evolved.

It becomes apparent to the discerning technician that various refinements may be added to this system but as presented it has important advantages. The receive portion can be installed in the speaker leads of any receiver with no internal connections. The tone generator is a plastic toy police whistle, available at most any dime store for, believe it or not, a dime.

This type of tone generator has no peer for mobile operation.

Now for discussion of the circuit. The surplus toroids are readily available in either the 80 mH or 88 mH sizes.

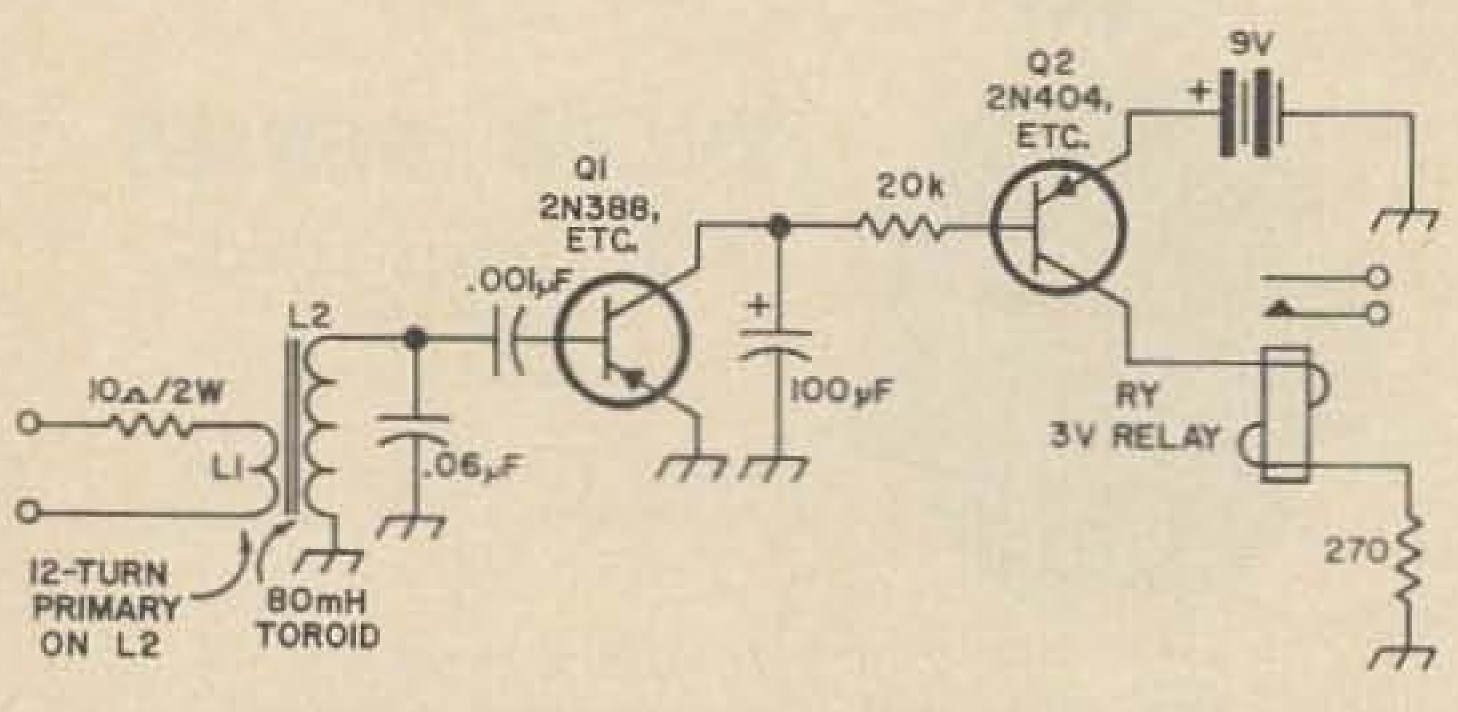


Fig. 1. The perfect squelch, a tone activated squelch that operates on a blast from a plastic whistle.

These toroids allow simple filters that will discriminate against voice frequencies, yet as used here, are not so sharp as to require precise tones to actuate.

Q1 should be a silicon transistor to prevent leakage problems; however, if you insist on a germanium type, use a silicon diode in the emitter lead and it should work fine.

Upon receiving a tone of the proper frequency, Q1 conducts and discharges C3. When the tone is discontinued, C3 recharges through R2 and the base emitter junction of Q2 keeping the relay closed during the recharge periods.

Installation of the circuit is accomplished by connecting the 12 turn link, through the 10 ohm resistor, to the 4 ohm output terminals of the receiver.

One of the speaker leads is now connected to the high side of the 4 ohm receiver output and the other speaker lead is returned to ground through the relay contacts.

The relay used here is the 3 volt relay used in the weather bureau radiosonde. These relays are available surplus at surplus prices.

However, any relay may be used that meets the requirements imposed by the supply voltage and Q2 current capacity.

On the air use of this system is as follows. Blow the whistle for 3 to 5 seconds then proceed to call your station in the normal manner. The whistle should have closed his relay and connected his speaker for approximately 10 seconds, allowing time for the call.

This time constant may be made longer by enlarging C3 or R2.

The maximum resistance used for R2 will be determined by the gain of Q2 and the required relay current.

After reading the FCC regulations it is my opinion that these signaling tones are legal on the ham bands, but maybe you should read them; you probably need to review them anyway.

The author wishes to take this opportunity to extend credit and appreciation to the members of the Houston, Texas RACES for their assistance and indulgence while this system was being developed.

. . . W5VCE

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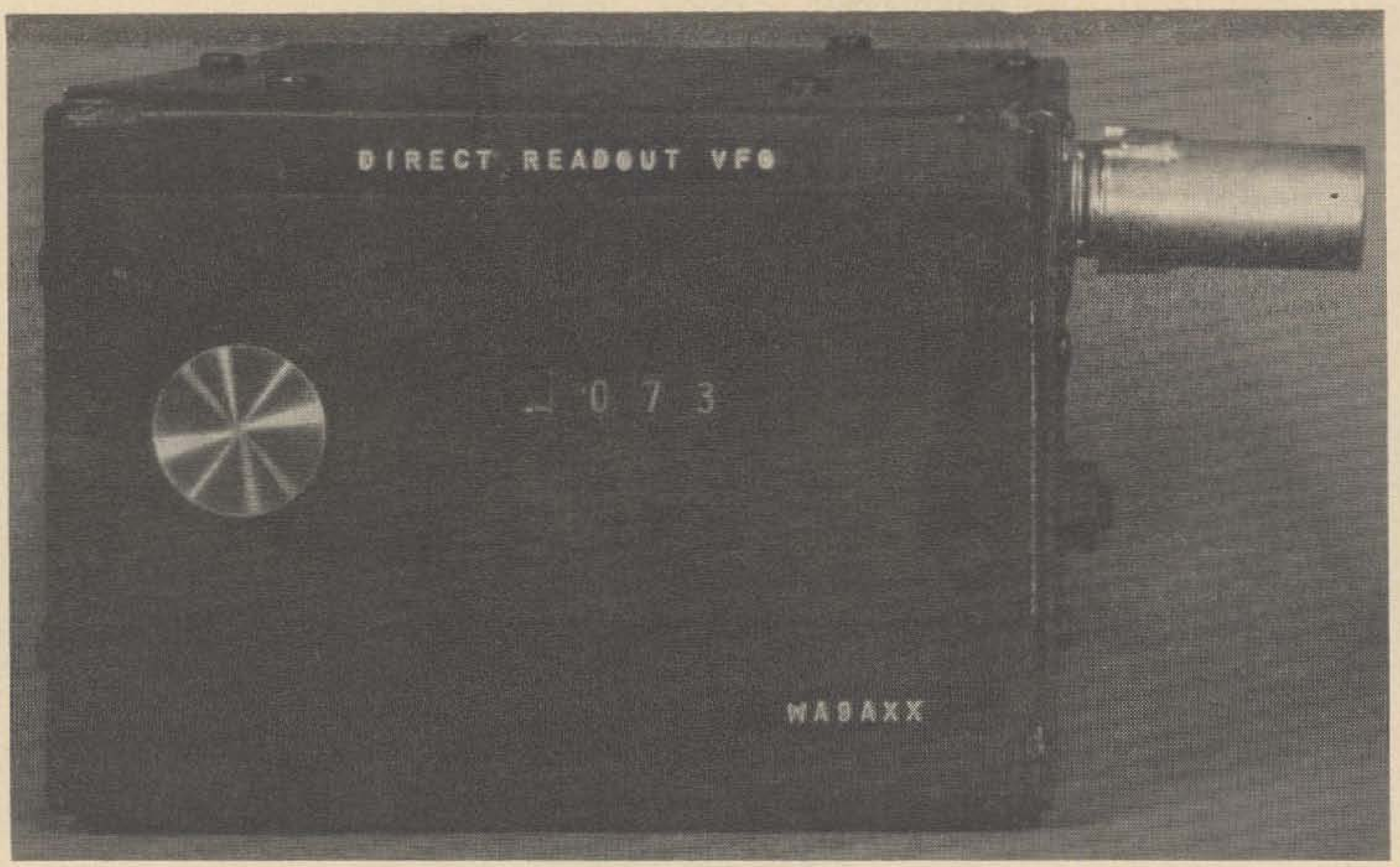


External view of WA9AXX's digital readout VFO.

Borje Ost WA9AXX
1526 Potter Road
Park Ridge, Ill. 60068

Digital Readout VFO

It is desirable in tuned rf oscillators to have a uniform tuning rate and linear frequency scale. Such a VFO permits digital readout, with advantages of clear display in a small indicating device. It can be safely assumed that we will see more of the dials with the flipping numbers in the future. The construction of a linear VFO is neither complicated nor need it be costly. The VFO shown in the photos was built a couple of years ago, using surplus parts and housed in a sturdy aluminum box. The linearity (without bending any capacitor plates) is within 2 kHz over the range 5-5.5 MHz, the standard VFO range for many 9 MHz *if* rigs. The readout is accurate to 200 Hz. There is no evidence of backlash. It was originally designed for use in a homebrew receiver similar to the SB-300, but since I acquired a Galaxy V transceiver, I am now planning to use it as a remote VFO to give a choice of two transmit and receive frequencies. The cost of the unit ran less than $10.

The heart of any VFO is the tuning capacitor or the coil, whichever is made tuneable. It is far simpler to make a capacity tuned oscillator than an inductance tuned one, especially if a linear frequency scale is attempted. A permeability tuned oscillator (PTO) coil, used to give linear frequency coverage, is specially wound with varying winding pitch. On the other hand there are capacitors generally available with rotation-capacitance characteristics that can provide linear tuning over a specified frequency range. The common formula for capacitance as a

---

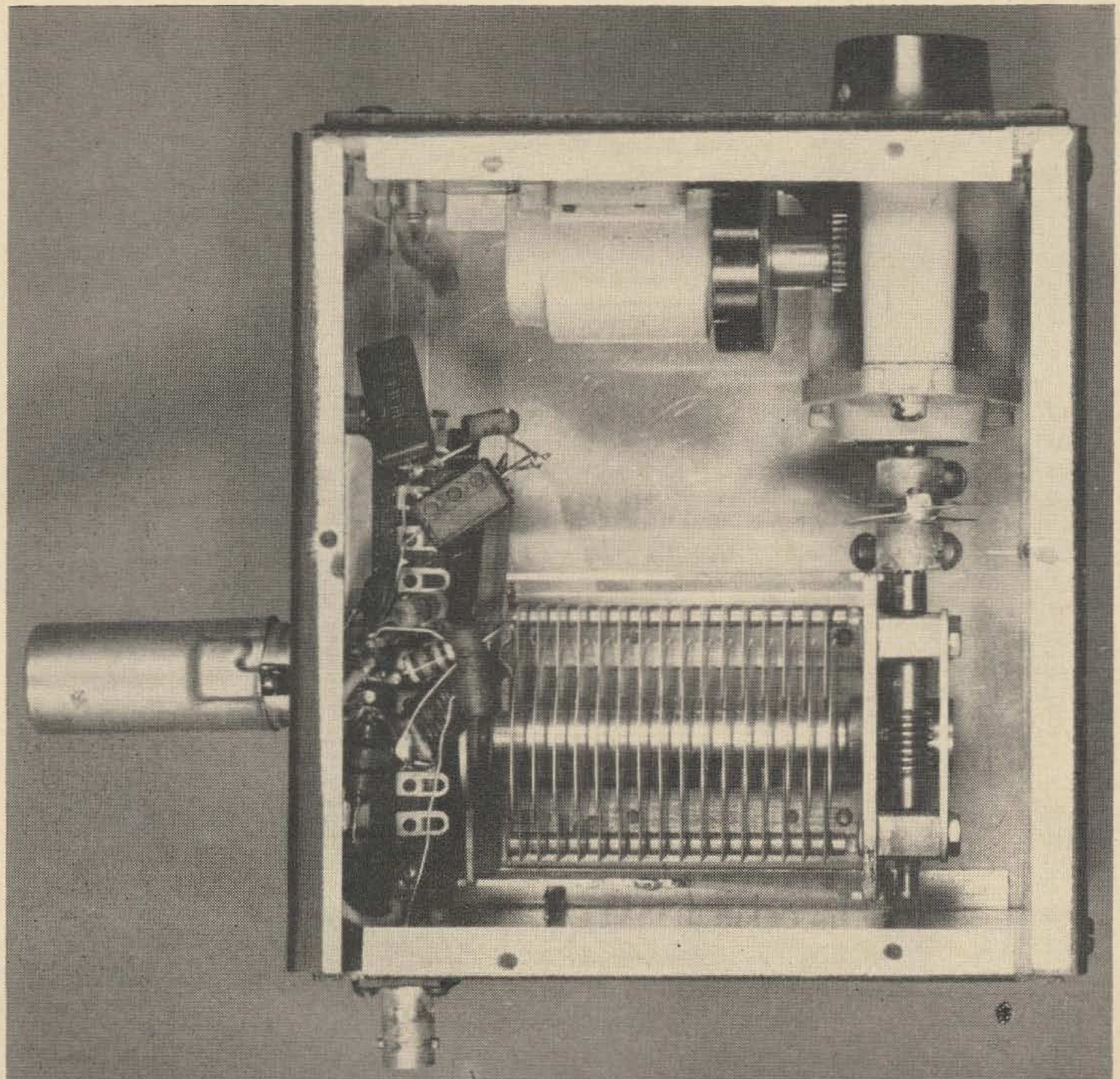
Borje is a research chemist for the Portland Cement Association (B Ph, Northwestern). He likes DX'ing and RTTY.

function of frequency and inductance:

$$C = \frac{1}{4\pi^2 f^2 L} \text{ (L being constant)}$$

shows the inverse square relationship that has to be satisfied by special shaping of the capacitor plates. Capacitors of this type are known as straight line capacitors and are available at nominal cost. The capacitor I chose was part of the ARC-5 transmitter. If you do not have an old ARC-5 that you can cannibalize for the capacitor, you can get it from one of the surplus houses for about one dollar or less. The capacitor is solidly built and already has slow tuning built in. It takes almost 50 turns of the shaft to close the capacitor.

The capacitance of the unit was measured at several settings of the shaft and was found to be as required excepting end effects when the capacitor was just opening or closing. The secret for getting a truly linear VFO is obviously not to use the extreme ends of travel of the plates. The capacitor has a nominal capacitance of 25-150 pF. To avoid any of the end effects I used only the 40-124 pF range. The circuit shown in **Fig. 1** will tune to 5 MHz with the capacitor set at 124 pF, to 5.25 MHz at 77 pF, and to 5.5 MHz at 40 pF. These values are close to optimum, but small adjustments can be made in either the tuning of the capacitor or the coil when the circuit is operational.



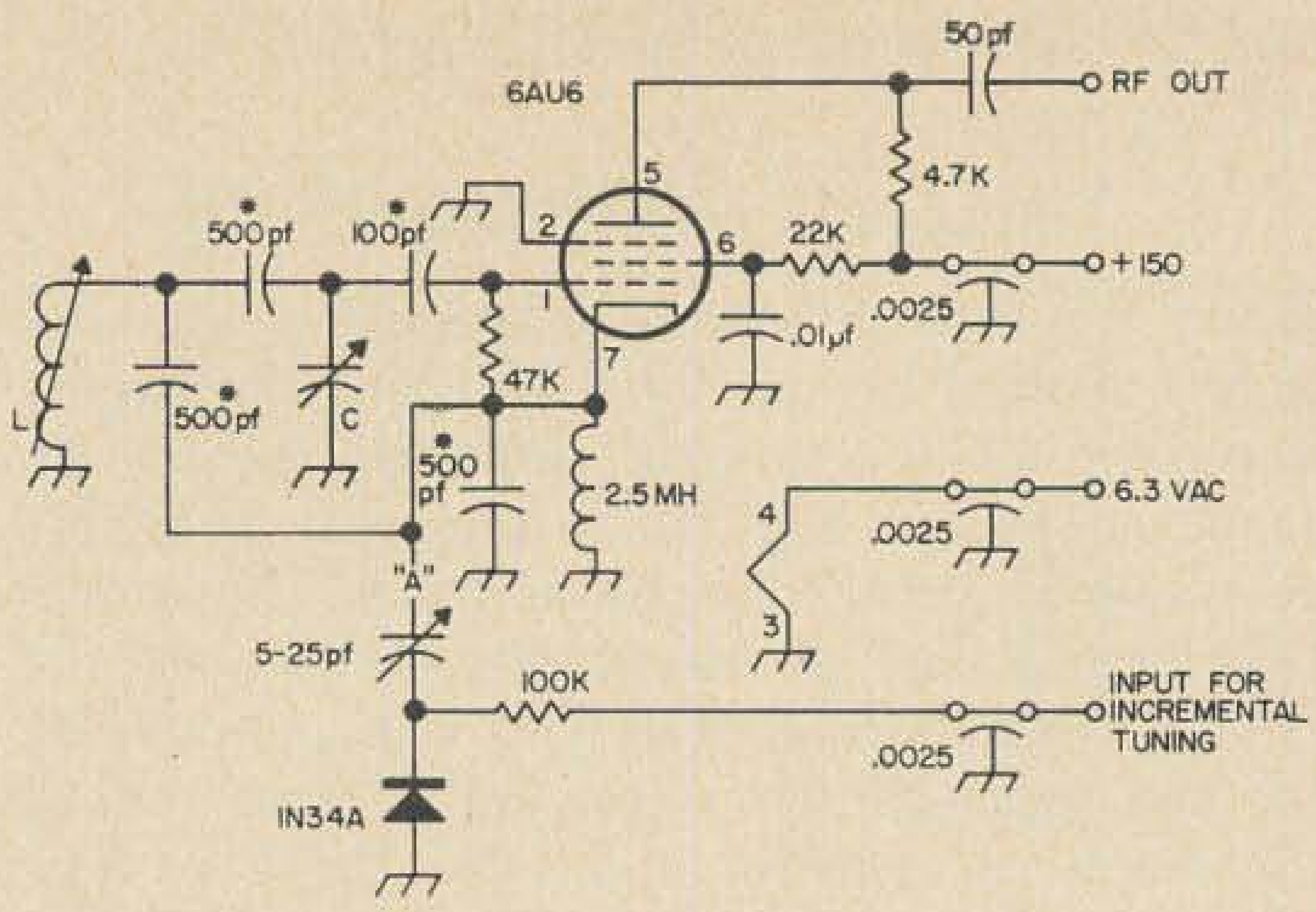
Inside of the digital readout variable frequency oscillator.

To transfer the movement of the shaft into correct readings on a counter, all that is needed is a gear with the correct number of teeth to couple the shaft to a counter. My counter (modified part from old BC-653) reads 0-500 kHz and has a large vernier wheel for visual readout to 200 Hz. The readout mechanism I used is bulkier than necessary. Suitable counters are available at low prices. Choose one with large numbers.

The linearity and frequency stability of the unit are excellent; warmup drift is of the order of a few hundred cycles, long time drift is much less. No detectable frequency modulation is caused by pounding or dropping the unit. Special attention should be given to the construction of the coil. A stable coil could be obtained by using phosphor-bronze dial cord wire wound on a ceramic coil form under slight tension. Solid construction results in stability. The heavy aluminum case, and small power dissipation inside it provide low thermal drift.

Other straight line capacitors can be used to provide linear coverage. Many of these are able to handle up to 2:1 frequency ratios and can be used in parallel-series circuits to cover the small frequency ranges usually needed in amateur gear. I have tried the ARC-5 capacitor over other frequency ranges with equal success. The choice of parameters for the linear circuits is based on an unpublished method developed by W9TO, of keyer fame. It is hoped that Jim will find time to prepare an article on the subject in the near future.

. . . WA9AXX



NOTES
C = 25-150pf FROM ARC-5 (40-124pf RANGE USED
L = 2.84μh SINGLE LAYER ON CERAMIC FORM (PREFERABLY PHOSPHOR-BRONZE WIRE)
• = SILVER, ZERO TEMPERATURE COEFFICIENT
"A"= BREAK HERE IF INCREMENTAL OR CALIBRATION TUNING IS NOT DESIRED

Fig. 1. Digital readout VFO for 5.0-5.5 MHz.

Six V Oscillator

Here is a simple audio generator that will find many uses around the shack. A glance at the circuit will show that there is no high B+. This generator has a plate supply of only 5 volts and the plate current of around 100 μA equals or betters many transistor circuits. The plate voltage is taken off the same 6 volts used for the tube's filament.

The unit was designed so that it can be run on both 6 or 12 volts and either AC or DC so it can be used in the shack or the mobile. If you plan to use it just in the shack a small 6 volt filament transformer can be mounted inside the case and J2 can be eliminated.

Power is fed in thru J2 using different cables for 6 or 12 volts. While the same cables are used on either AC or DC the cable is color coded so that when using on DC the proper polarity is maintained.

The tone output of this unit can be varied from around 20 Hz to around 12,000 Hz. The upper limit can be raised up to around 15,000 Hz by changing C1 to about .01 μF.

The unit can be put into any small aluminum box or chassis since parts placement is not critical. While the schematic shows a pot for R3, a switch and fixed resistors can be used to give specific tones.

The generator is meant to be used with a high impedance load but a matching transformer can be added if you need low impedance output.

Use an ordinary shielded cable terminated with phono plugs for audio work.

To increase audio output a pot can be used in place of R5 to set the required value for your requirements.

While the output tone is not a true sine wave, I'm sure this generator will find many uses in the shack or test bench.

. . . Don Marquardt K9SOA

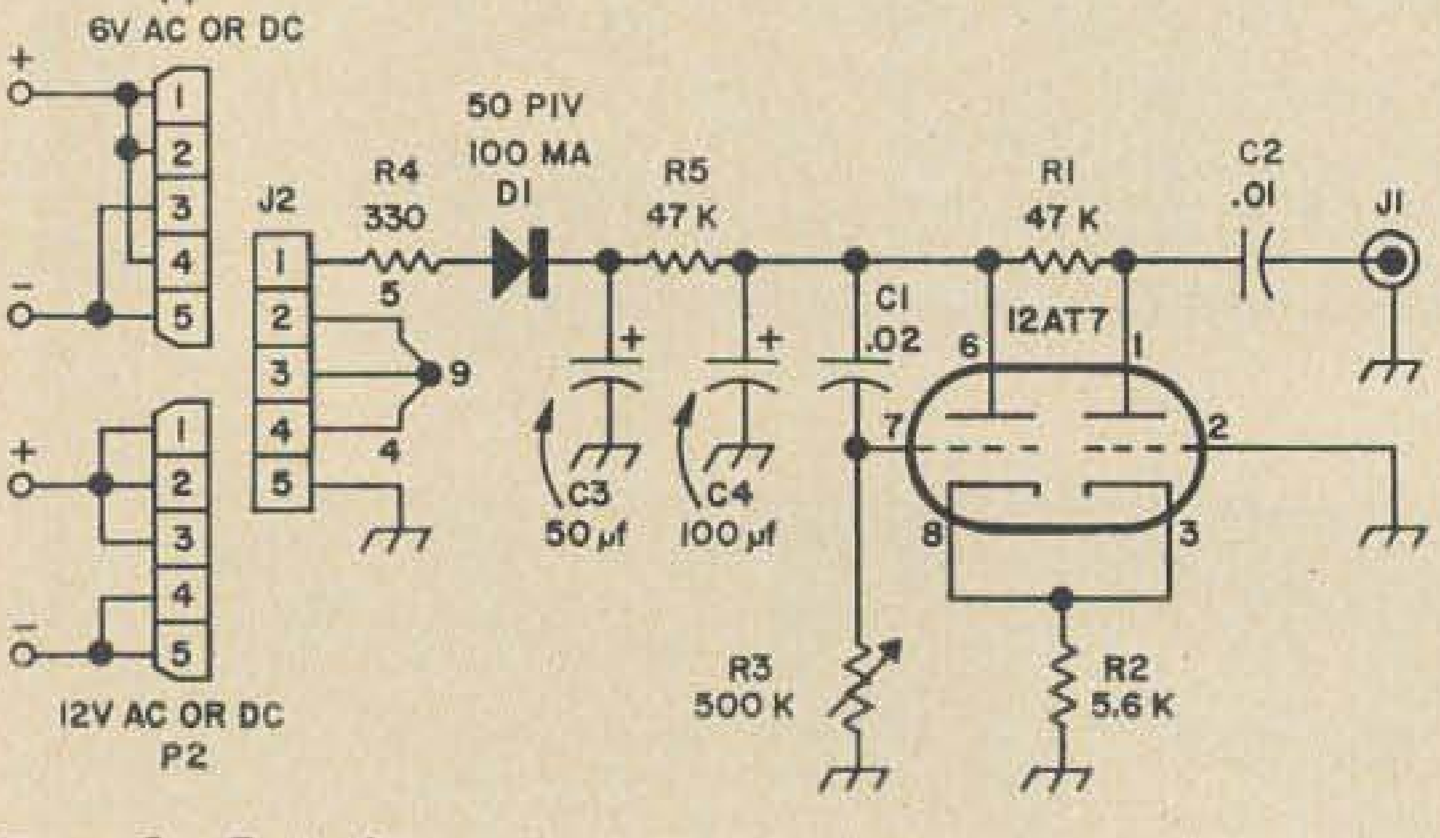
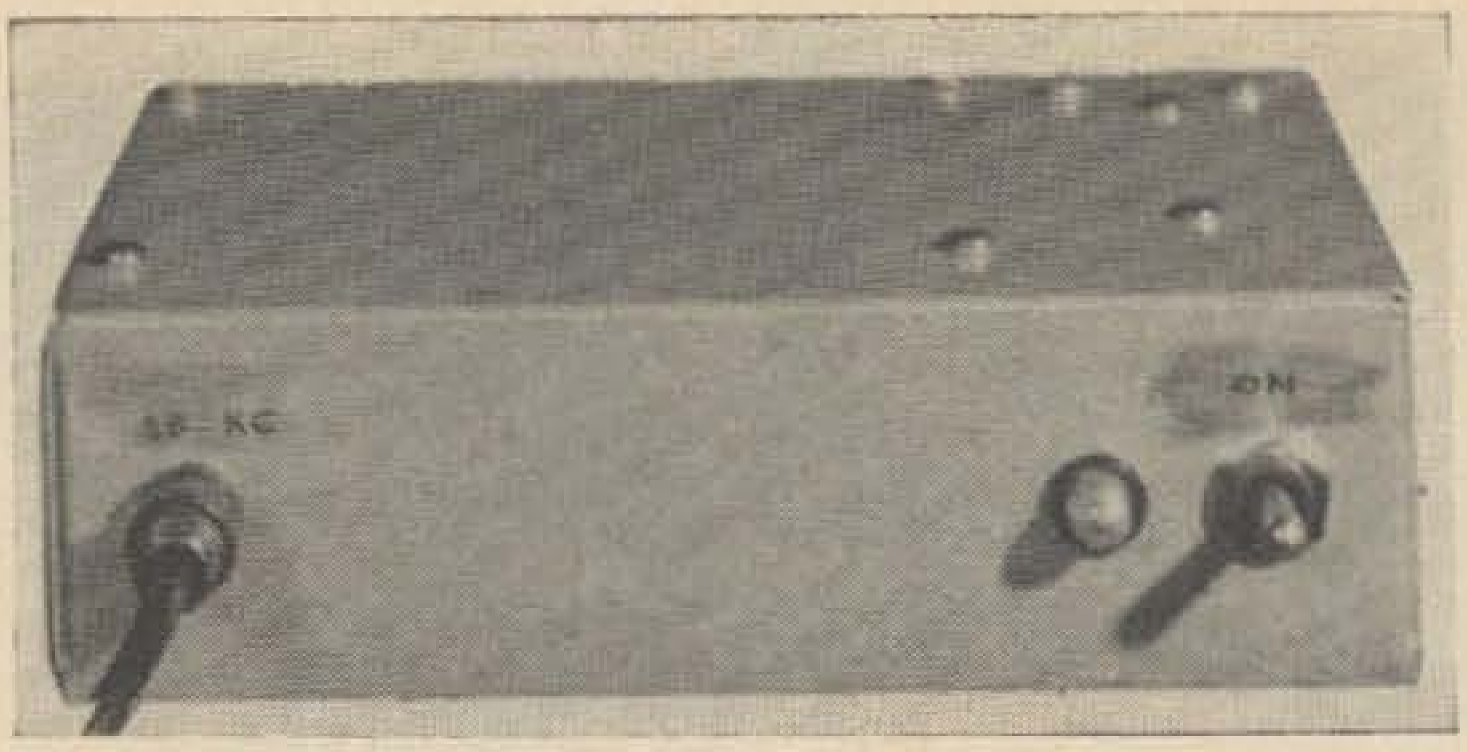


Fig. 1. Simple audio oscillator operating on 6 or 12 V.



Hank Olson W6GXN
3780 Starr King Circle
Palo Alto, California

A 50 kHz Marker Generator

Most secondary frequency standards for amateur use fall into one of three categories: those producing 10 kHz-spaced marks, those producing 100 kHz-spaced marks, and those producing 3.5 MHz and harmonics. The first type is represented by an article by Campbell, wherein a 100 kHz crystal oscillator is used to injection-lock a 10 kHz free-running multivibrator.[1] The second type is that found in most commercial H.F. receivers as the (often optional) 100 kHz calibrator—the Collins 75A2, is an example. The third type, strictly for amateur H. F. receivers, produces 3.5 MHz, 7.0 MHz, 14.0 MHz, 21.0 MHz and 28 MHz marks which identify only the *lower* edges of these five popular bands.[2]

If you are the proud possessor of one of the newer "ham-band only" receivers which have inherent good calibration, then the only type of calibrator which would interest you is the 100 kHz variety and it is probably already "built-in" or available as a plug-in unit on your receiver. If, however, you are using a BC312, BC348, a home brewed unit, or a general coverage type receiver (with separate band-spread dial), this 50 kHz calibrator will probably interest you. On the author's BC312, a 10 kHz interval generator is not too useful because on this receiver there is no band-spread tuning control and the 10 kHz marks come too close together. However, with a 50 kHz interval generator, it is much easier to tell *which* mark is really *where* on the dial.

For instance, the 3700-3750, 7150-7200, and 21,100-21,250 kHz novice-bands are well marked at their edges by a 50 kHz calibrator. Also, 14,350 kHz is marked for those with general or advanced-class licenses. The HF amateur bands, then, are completely edge-marked by a 50 kHz interval generator without using an excessively-dense family of 10 kHz intervals. If you are contemplating 160 meter operation or if you are a "VE", either of whom needs 25 kHz marks, an additional flip-flop, added to the circuit, will provide that function with no adjustment, and only 16 additional parts.

The circuit is similar to one by Grigg, in that non-critical digital circuits are used for pulse generation and frequency division.[3] The basic 100 kHz crystal oscillator utilizes an inexpensive field-effect transistor to make it possible to use the ordinary 100 kHz crystals that are available for tube circuits. One *could* buy a 100 kHz crystal (to order) from International Crystals for $15.00 and specify that it be cut to operate in the series-mode for a common-transistor circuit. Here, however, it was decided to use a $4.95 crystal from Texas Crystals, which appears to be cut for the CR37/U specifications (20 pF, parallel resonance at 100 kHz). The problems associated with crystals and crystal oscillators is more fully discussed in a previous article.[4] In short, the use of a field-effect transistor makes possible the choice of an inexpensive crystal.

The oscillator is followed by an isolation amplifier and then a Schmitt Trigger. The Schmitt Trigger drives a flip-flop (or more technically: an Eccles-Jordan bi-stable multivibrator). The output of the flip-flop is exactly one half the oscillator and Schmitt trigger frequency, and is an extremely fast rise time square wave. As a matter of fact, the output of the Schmitt trigger is also a fast rise time square wave, and *can* be used alone to generate 100 kHz harmonics. Either the trigger output or the flip-flop output square wave (there's an output jack for each) can be coupled lightly to the receiver antenna for calibrating marks. Note that it is the fast rise time of the square wave that controls the degree to which

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Hank is one of the best qualified ham authors around. He's written many excellent articles for 73 (and other magazines), all on new devices and concepts. He has an MS in EE from Stanford and is an engineer at the Stanford Research Institute.

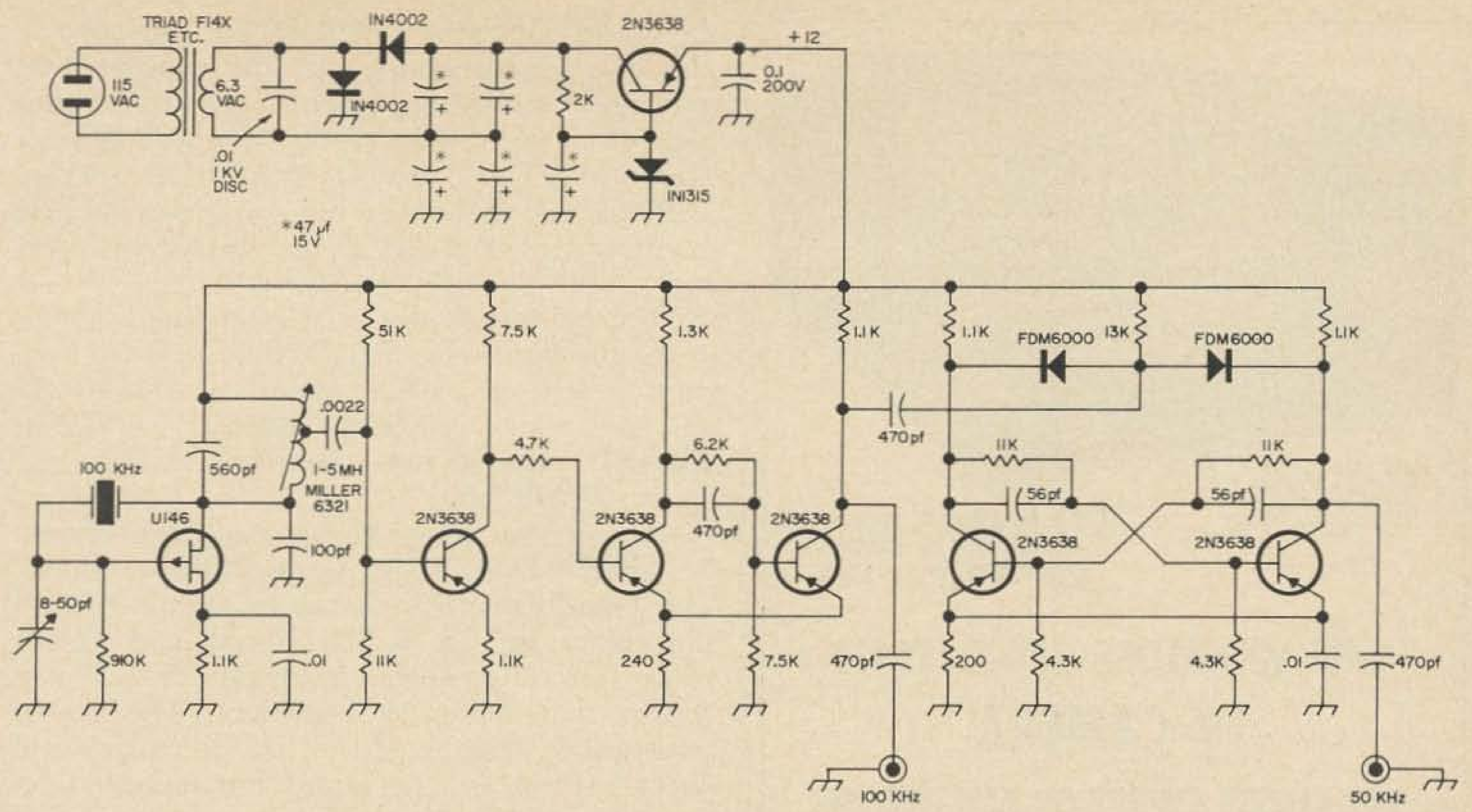
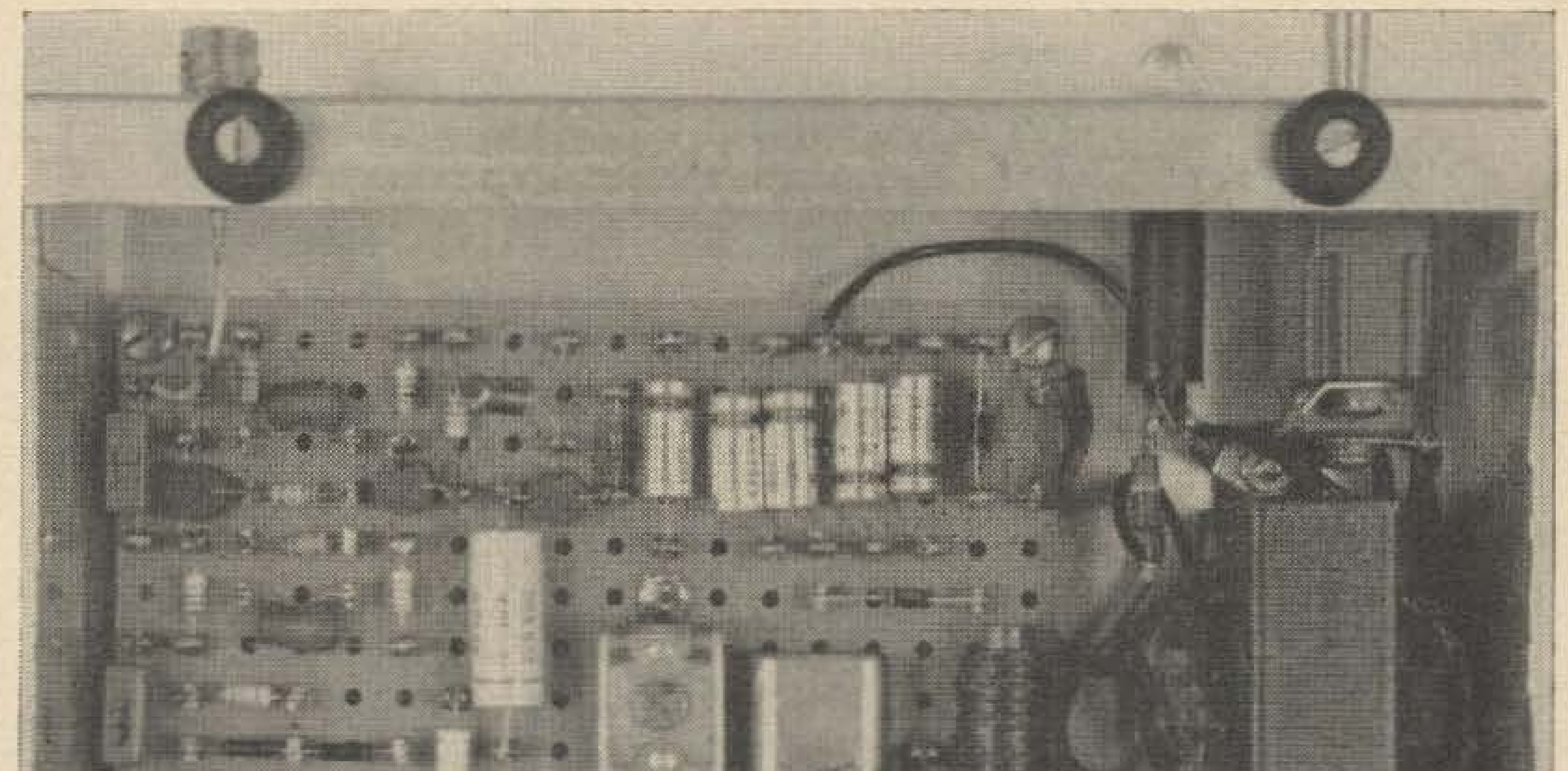


Fig. 1. Schematic of W6GXN's 50 kHz marker generator. A field effect transistor is used as the 100 kHz crystal oscillator to permit the use of a low cost crystal designed for tube circuitry.

harmonics are generated. This circuit has a rise time of about 0.1 microsecond at both the trigger output and at the flip-flop output. The harmonics generated are heard easily through the six-meter band, which should be high enough to satisfy most needs.

Note in the circuit the use of 2N3638 type silicon transistors, throughout, except for the crystal oscillator. These inexpensive little gems are advertised as "2N404 replacements" (at only $0.41 each) but are really *much* better! The 2N3638 is a silicon, PNP, switch; that is faster than a 2N404 (germanium, PNP, switch) by an order of magnitude, and hence generates harmonics more efficiently. To simplify procurement, another 2N3638 is used in



Inside of the 50 kHz calibrator. Most of the circuit is constructed on Vector perforated board.

the series regulator circuit in the power supply. It is recommended that the experimenter *not* try to substitute other transistors for the 2N3638's, especially in the flip-flop section. The author, too, had a handful of surplus 2N269's and 2N404's, but preferred to use $2.46 worth of 2N3638's for better performance.

The steering diodes in the original version, in the flip-flop, were Fairchild FD135's. However, nearly any silicon computer diode will do, including: 1N658, 1N3604, 1N4009, 1N4154, or the new inexpensive Fairchild epoxy FDM6000's.

Construction is on Vector multihole phenolic board 64A18 using Alden 651T terminals. The board layout is shown in the photo and the circuit in **Fig. 1.** The board is mounted, using four ¼" spacers, inside the 5 x 7 x 2 chassis that serves as a cabinet. The power transformer, switch, fuse holder, pilot, and jacks are not on the board but mounted on the cabinet. The finished unit as it is used is shown sitting on the author's BC312 coupled to the antenna terminal via a short length of RG58/U and a 5 pF silver-mica capacitor.

. . . W6GXN

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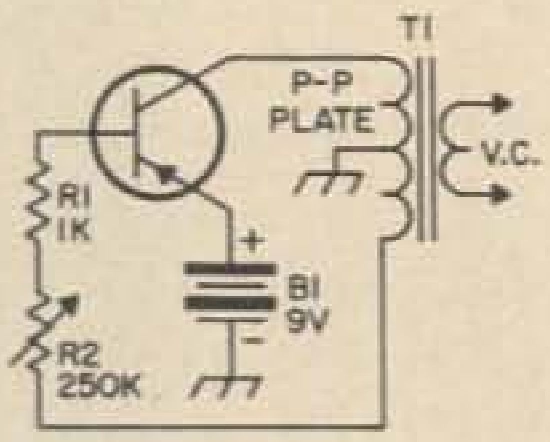
1. Campbell, "A Junk Box Frequency Standard," QST, Jan. '64, p. 22.
2. Crosby, "The HBR16," QST, October '59 P. 11
3. Grigg, J., "A Transistor Secondary Frequency Standard," QST, July '65, p. 11.
4. Olson, H., "Crystal Oscillators, Tube, Transistor, and FET" 73, March 1966, p. 14.

Simple CPO-Transistor Checker

This simple code practice oscillator also is handy for checking transistors and supplying an audio tone for testing equipment. R_2 adjusts the frequency of oscillation, which will also be affected by the transformer used for T_1. You can get high impedance output



through a .01 µF capacitor connected to the collector of the transistor. The battery polarity shown is correct for PNP transistors. Reverse it for NPN types. Most power transistors will work in this circuit. Generally speaking, transistors that oscillate in this circuit are usable.

. . . Ron Baker W8JIA

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	301-Q	144-148	14-18
	301-R	144-148	7-11
	301-S	143.5-148.5	30-35
6M	301-B1	50-51	.6-1.6
	301-B2	51-52	.6-1.6
	301-C1	50-54	7-11
	301-C2	50-54	14-18
	301-J	50-52	28-30
20M	301-G	13.6-14.6	.6-1.6
CB	301-A1	26.5-27.5	.6-1.6
	301-A2	26.8-27.3	3.5-4.0
40M	301-K	7-8	.6-1.6
CHU	301-L	3.35	1.0
WWV	301-H	5.0	1.0
Int'l. Marine	301-I1	9-10	.6-1.6
	301-I2	15-16	.6-1.6
	301-M	2-3	.6-1.6
Aircraft	301-N1	118-119	.6-1.6
	301-N2	119-120	.6-1.6
	301-N3	120-121	.6-1.6
	301-N4	121-122	.6-1.6
	301-N5	122-123	.6-1.6
	301-N6	123-124	.6-1.6
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	301-P4	154-158	104-108
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Designing a Junk Box Preamp

Build this simple preamplifier to soup up your inexpensive receiver. It's perfect for novices.

When I began as a novice about a year ago, I realized that my Knight-Kit R-55A receiver could definitely use a bit of help in the front end. I scrounged around for a suitable circuit of a preamp. After flipping through various magazines and handbooks, I found that they all called for parts which I didn't have. So I decided to design one of my own using the parts in my junk box.

Since then, I have been asked a number of times for a good rf amplifier circuit which would be easy to put together. It seems that many novices tend to purchase budget receivers, like I did, to start off with. Once they become generals, or maybe before then, they invest in a better receiver. In the meantime, that little budget receiver causes big headaches with low sensitivity, poor image rejection, instability, and lack of selectivity. My purpose in writing this article is to end all of this searching for circuits, and to help beginners, and maybe some not so new to radio, design and build a good preamp using whatever parts they might have on hand. This will take care of the first two problems mentioned above with a minimum of expense and trouble. The other two are much harder to tackle and can run into considerable money.

It's all really very simple. First step is to find out what tubes you have on hand and if any of them can be used in the circuit. Actually, almost any rf or *if* pentode can be used. The accompanying table lists the more popular types. Notice that only pentodes and not triodes are specified. Triodes can be used and, although they have a better noise figure, it is not needed on the hf bands. They also have a lower plate resistance which loads the receiver's input circuit and reduces the selectivity and image rejection. Neutralization is also required with triodes. There is no sense in going through all that bother when there is absolutely no need for it. The pentode section of dual purpose tubes may also be used. Since there are so many of these types of tubes (such as 6U8, 6CX8, etc.), a table containing them all would take up too much room. A tube manual will be necessary if you are planning to use one of these. Some tubes are better than others and are to be preferred such as the 6AH6, 6BZ6, 6DC6, 6AK5, and 6BJ6. However, others will do almost as well.

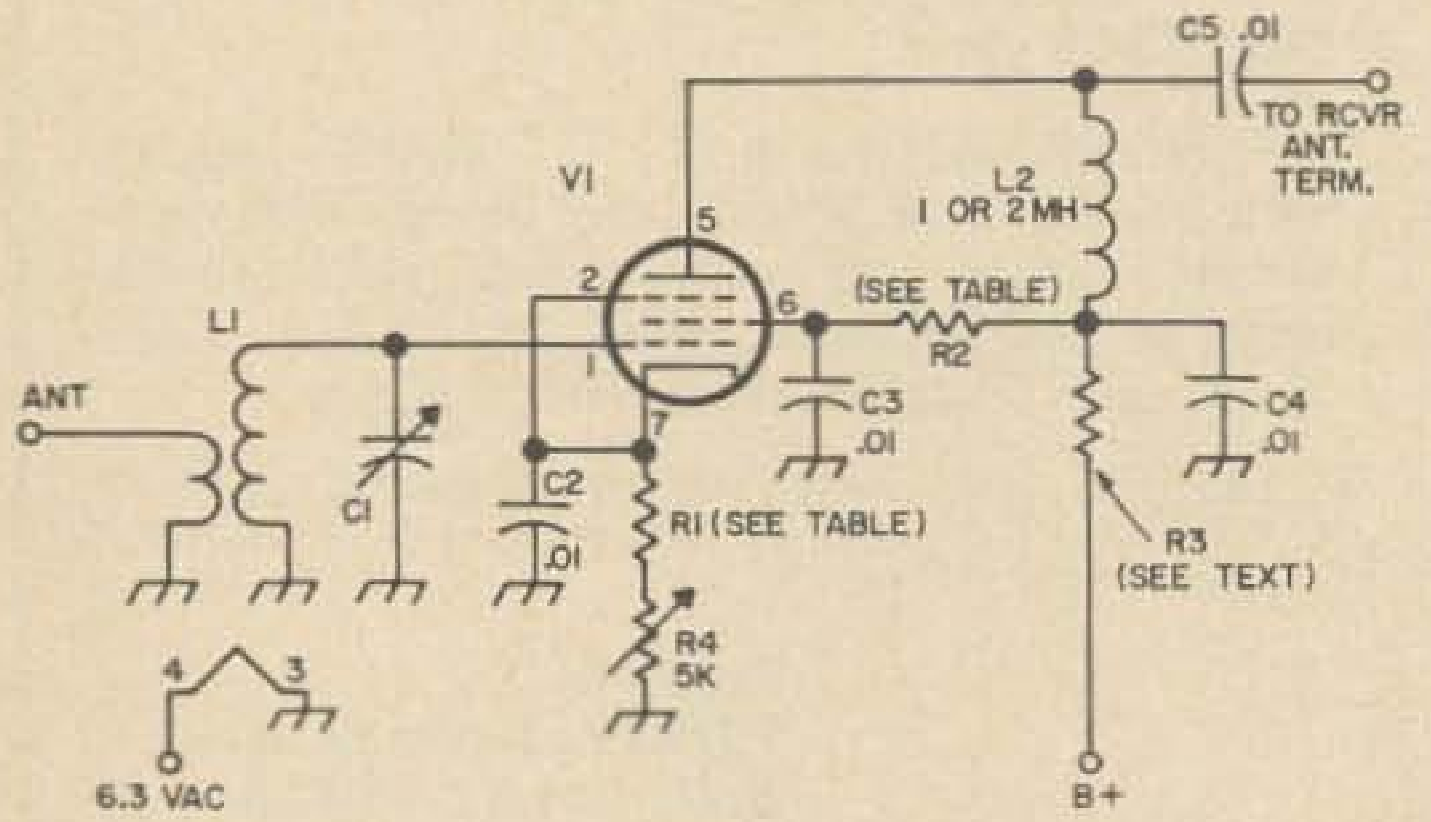
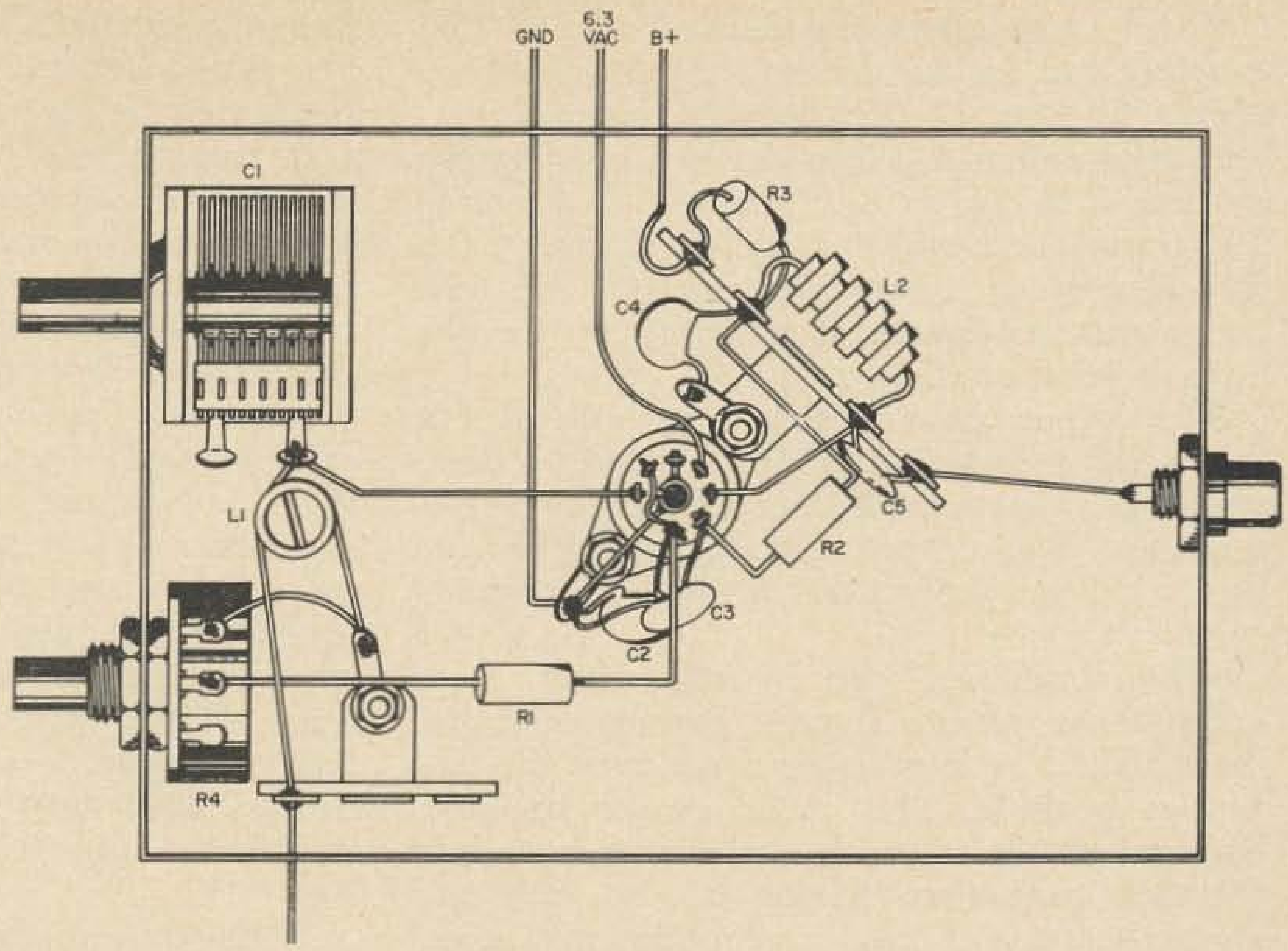


Fig. 1. Schematic of the junk box preamplifier.

Next step is to determine the supply voltage. Most receivers and transmitters can spare enough power for the tube, and those that can usually have an accessory plug in the rear. One important word of caution is in order here. Check the voltage of the transmitter's supply if you intend to use it. Don't rely on the instruction manual. The manual to my rig states that the voltage at the accessory plug is 410 volts. Taking this for granted, I hooked up the preamp and within a few days the tube went bad. Being slightly suspicious, I checked the voltage of the supply with a voltmeter and found it to be 560 volts! It seems that, when receiving, the voltage would rise and only when the rig's key is depressed does it drop to 410 volts. So be careful! In any event, if you feel that neither one can stand the added load, it would be wise to build a separate supply. Any supply delivering 300 volts at 20 mA will be entirely adequate. If your supply voltage is greater than the listed plate voltage of the tube to be used, a voltage drop-

Fig. 2. Layout of the junk box preamplifier for the high frequency ham bands. The value of L1 is discussed in the text. Almost any coil that will tune to the desired frequency with C1 is suitable.



ping resistor will be necessary. Let's take an example. Suppose we select a 6AU6 and our supply voltage is 400 volts. The plate voltage of the 6AU6 is listed as 250 volts. The necessary drop is the difference in these two voltages.

$$400 - 250 = 150 \text{ V}$$

Our dropping resistor has to develop 150 volts across it. The plate current for the tube is 10 mA. Using Ohm's Law we get for R_3

$$\frac{150}{.01} = 15{,}000 \text{ ohms}$$

The wattage is

$$150 \times .01 = 1.5 \text{ watts.}$$

A three watt resistor should be used. If the supply voltage is approximately the same as the tube's plate voltage, you need not worry about the dropping resistor.

The cathode and screen resistors can be taken directly from the table. The 5 k gain control can be left out if desired. It is used only on very strong signals and is left fully on most of the time. This control will not cut off signals completely, only reduce them. The bypass capacitor values can vary slightly from those given.

The input circuit is not critical at all. For C_1 I would recommend a broadcast replacement type, 365 pF. This large value gives a greater operating range, although tuning may be a little critical due to the sharp selectivity. You may wish to parallel it with a smaller capacitor of about 25 to 50 pF as a vernier adjustment. The coil L_1 can be just about any type of the proper value. I have used both air wound and slug tuned coils with success. A 1 to 2 μH coil should give an operating range of approximately 6 to 35 MHz. However, it may be that, after the unit has been completed, it does not cover the desired bands. In this case, a homebrew or commercial air wound coil would be ideal because the number of turns can be adjusted easily. Extra capacitance can be added across C_1, but the "Q" of the circuit might be lowered too much. Anyway, a little juggling of coils and capaci-

Preamp Design Chart

Tube 1	Plate Voltage	Screen Voltage	Plate Current (ma)	Cathode Resistor R_1 (ohms)	Screen Resistor R_2
6AK5	180	120	7.7	220	27 k
6AU6	250	150	10.6	68	33 k
6AH6	300	150	10	160	62 k
6AG5	250	150	7.5	180	47 k
6BA6	250	100	11	68	33 k
6BH6	250	150	7.4	100	33 k
6BJ6	250	100	9.2	82	47 k
6BZ6	200	150	14	56	22 k
6CB6	200	150	13	56	12 k
6DC6	200	135	9	180	24 k
6BC5	250	150	7.5	180	47 k
6BD6	250	100	9	180	47 k
6DE6	200	125	15.5	56	18 k

tors will bring about the desired results. The coupling link in the antenna circuit can be a couple of turns of hookup wire wound adjacent to or around L_1. You can also connect the antenna to a tap on L_1. It should be closer to the ground end and is usually adjusted for a fifty ohm load. About two turns for the link, and about one-fourth of the way up for the tap are good starting points.

The output choke's value is not critical, but if anything lower than 1mh is used, there might be a noticeable loss at the lower frequencies. The output should be coupled to the receiver preferably through a coaxial cable.

When building, keep all leads short, especially those of the bypass capacitors. Input leads should be kept as far away from the output as possible. This point cannot be overemphasized. It is much easier doing it right the first time than having to go back and starting all over. If no precautions are taken, the tube will most likely begin oscillating. If this happens to you, check for poor layout first, then for bad solder connections. One of the bypass capacitors might be defective. If you happen to have another tube of the same type, substitute it. This will sometimes cure low sensitivity, too. Never rely on a junk box tube too heavily, unless you are absolutely sure it is in good shape. It should be one of the first things to suspect in case of trouble.

As stated before, there are many different tubes which can be used in this circuit. If you want to use a particular tube not listed here, just look it up in a tube manual. In most cases the cathode bias resistor will be given. The screen resistor is calculated in the same manner as before. Find the difference in the plate and screen voltages and divide that value by the screen current in amps. Again, don't forget the wattage rating of the resistor, voltage times current (in amps).

Let me reiterate here that the grid tuning circuits are quite flexible, so don't be afraid to try out various kinds. Almost any coil-capacitor combination can be used, although a slight adjustment will be necessary to bring it on the desired band. Make sure you don't exceed the listed plate and screen voltages in the table. In most cases these are not maximum ratings but there is no sense in pushing them all the way. The increase in sensitivity will be negligible and in some cases will even be less because of the extra noise introduced into the circuit. Tube life might be cut down too.

If the tube in the preamp should ever happen to fail and you don't have a replacement on hand, it won't be necessary to rush down to the nearest electronics distributor. All you have to do is change a couple of resistors, and any other tube can be substituted. Some tubes have 12 volt counterparts which can be used in case a 6 volt supply is not handy. The unit can be built in a minibox, utility cabinet or even incorporated into the receiver. In any event, you will find it very helpful in pulling the weak ones from under that ever present noise, and in eliminating the annoying image on the other side of your oscillator frequency.

. . . WA4ZQO

Tap to Talk Relay

This circuit allows a transmitter to be controlled with only a momentary action of the push-to-talk switch, which should be especially convenient for mobile operation. It can be used with any leaf type push switch that does not have snap action.

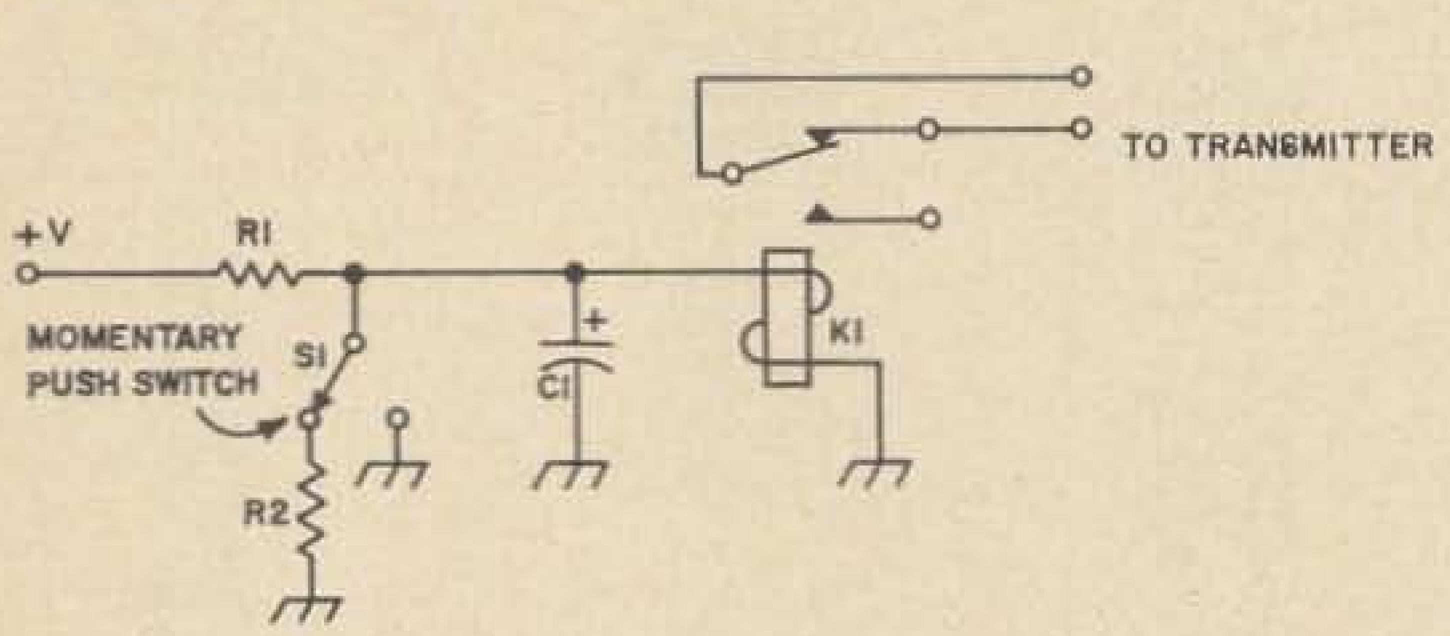


Fig. 1. Tap to talk relay. See the text for choice of components.

In Fig. 1, K_1 is a sensitive relay, such as the Sigma type 11. Select a relay that will operate on one-half the available supply voltage, or less. With R_2 disconnected adjust R_1 to just barely pull K_1 in. Select R_2 to cause K_1 to hold in once it is manually closed but to allow K_1 to remain open when manually opened. C_1 is a small electrolytic selected so that when S_1 is depressed then **quickly** released, K_1 stays closed.

K_1 is now normally closed in the receive position. To transmit, push and **quickly** release S_1. To receive only partly depress S_1 (if fully depressed by mistake, then release slowly). To transmit briefly (break) push S_1 and talk, then release slowly.

. . . Tom Lamb K8ERV

HOW WELL DO YOU KNOW YOUR GEAR?

Hams are supposed to be knowledgeable people—at least concerning radio. It always puzzles me then, particularly as a dealer in ham equipment, to find so many examples of people—hams, that is—who otherwise fail to understand the significance of what they have read. Now, I am not trying to carp or to ridicule anyone. That would be an inconsistent gesture from someone who is trying to make a living in ham radio. What I am trying to do is to make more of you aware of the need to understand what takes place in any particular piece of gear—not merely how to turn the knobs or to talk into the mike. If you want the solid satisfaction of getting the most out of your gear, then you ought to read the instruction book as often as it is necessary to understand what takes place between the oscillator and the antenna. Transmitters, and for that matter receivers, represent compromises between the ideal and that which is practical. They represent an effort by a manufacturer to produce a product that will fulfill most of your requirements and to do so at a profit for him and those who handle the gear. No commercial piece of equipment is free of bugs or shortcomings in design of one type or another—no, not even Collins is perfect. When you see the magazine writeups on new products, you hardly ever find the author describing what is wrong with a piece of gear or what its weakness is or where it could be strengthened. To do so would probably result in cancellation of the advertisements from that magazine by the manufacturer involved. It is up to you as an individual owner to learn the advantages or the disadvantages of your own set.

One specific case comes to mind and I have never seen this glossed over anywhere. I am referring now to the effect of unreasonable VSWR ratings on the transmitter that you own. Most manufacturers specify that their product is intended to operate into a load with a VSWR not greater than 2.5 to 1. If you were to buy such a product and then to operate it into a dipole coaxially fed on 80 meters and to slide up or down from 3800 to 3999 kHz, you would *have* to *have* a standing wave ratio greater than that provided for by the manufacturer in his original design. *Most hams don't realize this.* They have been told that VSWR isn't too important—that it only affects the efficiency of the radiated signal. Baaaa . . . I wish I had these individuals in our service department sometimes and could show them what happens in the tank circuit of an otherwise beautiful transmitter when they operate in this manner. You are likely to exceed the dissipation rating of the tubes; you are likely to melt or otherwise severly damage the pi coil; you are likely to burn the insulation out of the loading capacitor; and all of this simply because you do not have an understanding of what the injurious effect of high VSWR is. Remember to always operate your transmitter within that portion of the band pass of your antenna system which provides you with a VSWR of less than 2.5 to 1. A good rule of thumb is to monitor your forward and reflected power. When the reflected power equals 10% of the forward power . . . WHOA! . . . back off and tune back in frequency.

This is just one part of your transmitter and the transmitter is just one part of the station. If you want to do the best thing possible to aid your station, concentrate your efforts on your antenna and its installation; nothing else in your station will result in so marked an improvement. If you are still persistent, get the best receiver which you are capable of *understanding* and operating and if you still insist on a new transmitter, by all means buy it, but this is the one area where you will likely have the least amount of practical gain.

We are in the business of helping hams to help themselves. If you have a question concerning an element of your station, I wish you would write us. If you need an instruction book or schematic, maybe we can help and we'll do it at a nominal cost. But, if after all is said and done you still want to improve your station, my suggestion is to get the original manufacturer's instruction book out, go over it once again until the schematic is thoroughly understood. This will probably pay you off better than that TV western you were watching anyway.

73

Herb Gordon W1IBY

HERBERT W. GORDON COMPANY

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Heathkit SB-100

Heathkit, realizing the need of the Amateur Fraternity for a quality, low cost line of SSB equipment, has marketed their "SB" line. One of the newest of the SB-Series is the SB-100 all-band transceiver, which operates on all amateur frequencies between 3.5 MHz and 30 MHz. It may be used either as a fixed-station or in a car, boat or airplane as a mobile-station, with either the AC or DC external power supply, using either A-3j (SSB) or A-1 (CW) emission.

Although Heath claims that the SB-100 kit can be built in about 45 hours time, a ham inexperienced in building equipment may expect to add about 5 hours to the building time. As an experiment, my wife, who has never built any electronic gear, wired two of the larger circuit boards perfectly, following Heath's step-by-step directions.

A Waters wattmeter/dummy lead showed an output of approx. 110-watts at 7.2 MHz with a DC input of 170 watts. The CW input to the final amplifier may be "cranked-down" so that a novice can use it in accordance with the regulations regarding his license. But, you say, he must be crystal-controlled as well. Fine. Just figure (with a formula in the manual) the crystal that is required to control the transmitter section. The LMO Switch, or, as it is labeled "OSC. MODE," has three positions: LMO, in which the transmitter and receiver are both controlled by the Linear Master Oscillator; an XTAL position, where both the transmitter and receiver are controlled by the afore mentioned crystal; and AUX. T where the transmitter is controlled by the crystal and the receiver is controlled by the Linear Master Oscillator. Perfect for net control stations or novices, eh?

When operating CW a sidetone of approximately 1000 Hz is internally switched to either the speaker or headphones for monitoring your fist. Another interesting feature is that when the earphones are plugged in, the jack automatically switches the audio output from 8 ohms to 600 ohms, more closely matching the impedance of the headsets used in most ham stations.

There are no controls on the rear apron, only connectors. Some of the least used controls are mounted internally such as: VOX adjustments, headphone volume, bias, CW tone level, carrier null, neutralizing, meter zero and relative power adjustment.

On the air, I have received excellent audio reports. One of the local hams, who has a 'scope tied to his receiver said that the pattern appeared to be of the same high quality as from the "high-priced equipment." The 'scope connected to the SB-100 produced an excellent "Christmas tree" pattern.

The dial tunes 500 kHz, so that means there is no bandswitching on 80, 40, 20, or 15 meters. The 10 meter band is divided into four sections; 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5 and 29.5 to 30.0. There is also an additional 10 kHz at the top and bottom of the dial. Time and frequency checks can be taken from CHU at 7.335 MHz.

In the transmitter section of the SB-100, the audio from the speech amplifier and cathode follower, as well as RF from the carrier oscillator is fed into the ring-type balanced modulator. From there, the signal is impedance-matched to the 3.395 MHz crystal filter. The filter has a usable bandwidth of 2.1 kHz (3393.95 to 3396.05 kHz at the 6 dB points). The audio frequency range is held between 350 and 2450 Hz. An optional 400 Hz CW filter may be used instead of the SSB filter, but then operation is limited to CW only.

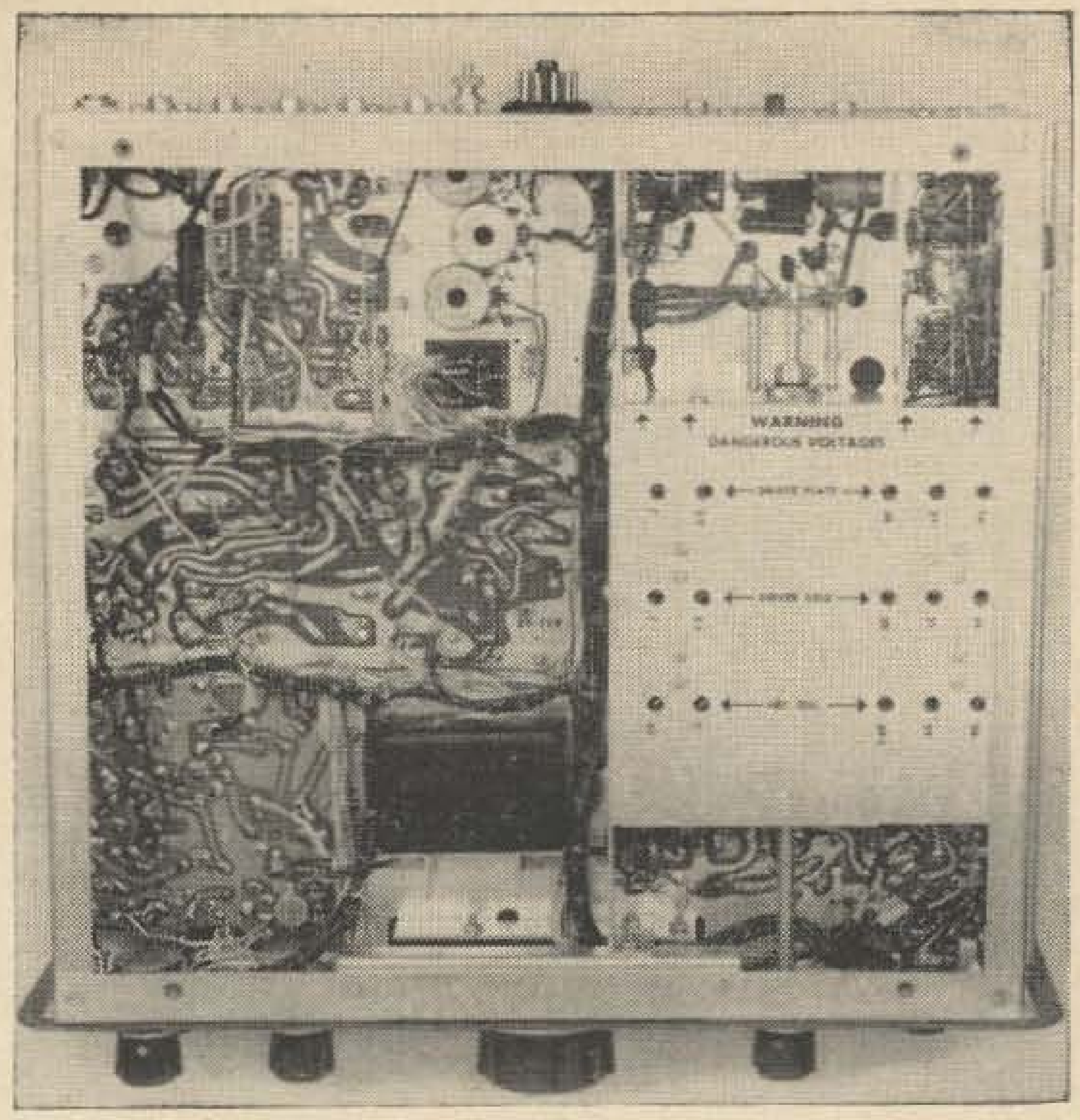
The LMO signal (between 5.0 and 5.5 MHz) is mixed with the SSB signal at the first transmitter mixer. The sum of the two signals is then fed through a bandpass filter to the second transmitter mixer, where it is then mixed with a signal from the heterodyne oscillator. The difference between these two signals produce the operating frequency.

The rest of the transmitter section is of conventional design. Two 6146's are used for the class AB1 linear amplifier. These tubes were designed for transmitter circuitry, and I'm glad to see Heath using this popular tube.

The receiver section is of conventional design, using the 2.1 kHz crystal filter to set the bandwidth. This narrow, steep-sided passband permits good selectivity in the crowded amateur bands. The audio transformer secondary is tapped to match either 600 ohms or 8 ohms.

There are five main circuit boards that are attached to the chassis, and four small boards which make up the band switch. The LMO is factory-wired and completely aligned.

The first assembly is that of the circuit boards, being careful to solder the components in their proper places. After installing some of the hardware on the chassis, the circuit boards are mated to the chassis. Two wire harnesses (one of color-coded coaxial cables) interconnect the boards, terminal points and controls. Then the chassis wiring is completed, followed by the assembly and installation of the front panel. One of the last steps in the assembly of the SB-100 is that of the Switch-Board™, which comprises of four small circuit boards, each with a switch wafer and associated components, that is used for the bandswitch.



To align the transceiver, only very basic equipment may be used, such as an 11 megohm VTVM, a 50 ohm non-reactive dummy load and a receiver that tunes the standard broadcast band. An oscilloscope is recommended, but not necessary for transmitter alignment.

In mobile operation, there is not even a hint of frequency variation, even over rough roads. The circular dial has 1 kHz divisions, and the visual interpolation is approximately 200 Hz or less. I have found that linearity of the LMO is within 150 Hz after calibration at the nearest 100 kHz point. Backlash is negligible on my unit.

All "on-the-air" reports have been excellent, either barefoot or using a linear amplifier. The CW break-in keying produced an excellent wave shape on the oscilloscope used for monitoring. A sidetone provides CW monitoring either through the speaker or headphones.

Either an AC power supply (HP-23) at $39.95, or a DC power supply (HP-13) at $59.95 is available to supply the operating voltages required. The unit, weighing only 17½ pounds, is 14⅞" wide x 6⅝" high x 13⅜" deep. A separate speaker is required, such as the SB-600, which also provides space for the AC supply.

I have worked at least 30 other SB-100's in the few months that they have been on the ket, and I have yet to hear one with poor quality. Heath Company has a winning line in the "SB-Series."

. . . K2EQB

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High Frequency Power for Standard Equipment

Don't throw away that 400 Hz generator. It's fine for Field Day.

"That high-frequency generator sure is nice and compact, and cheap, too. Pity we can't use it for Field Day. All the power transformers would burn up."

This is one of those things that "everybody knows is true," but it is more or less an old wives' tale. Actually, ordinary small transformers will run a little cooler when operated from a power source of higher than rated frequency. Low frequency is what burns up iron; if you try to feed 25 hertz power at full voltage to a 60 hertz transformer, you get a cloud of smoke and a bad smell. If you connect a 400 Hz transformer to the 60 Hz line, the same thing happens, only faster. But a 60 Hz transformer on 400 Hz power? Ok, fine business.

But doesn't the iron loss increase with frequency, and don't 400 Hz transformers use special iron? Sure they do. Where's the catch? Simply that, in a given transformer, the flux density, or magnetic intensity, in the iron goes down as the frequency is raised. If it were not for losses going up, you would expect a transformer designed for 60 Hz to have six times as much core as needed when operating at 400 Hz. Because of losses, it actually has about twice as much as needed. The special iron enables a smaller transformer to be designed at any frequency, but the benefit is greater at high frequencies and makes the extra cost of the iron worth while at 400 Hz and up. Ordinary iron works at high frequencies perfectly well if not pushed too hard, as we shall see.

Jim was first licensed as W9LZV in 1938. He's a research associate for Stanford University (BSEE, IIT 1957).

Transformer losses

The losses in a transformer are what cause it to heat up. They are of two kinds, core loss and copper loss. The copper loss depends on the current drawn from the transformer; it has nothing to do with frequency (at least in the power frequency range) so we can forget it for purposes of this discussion.

Core loss is further divided into eddy current loss (due to current flowing in the core material) and hysteresis loss (due to a sort of internal friction in the iron).

The eddy current loss, which may be 25 or 30 percent of the total core loss, is constant for a given applied voltage, regardless of frequency. That is, it goes up as the square of the frequency and as the square of the flux density, but flux goes down as frequency goes up and the two effects cancel. So we can forget about eddy current loss too.

That leaves hysteresis loss. This is proportional to frequency, and to about the 1.6 power of flux density in the working range; it goes up even faster as saturation is approached. But with a properly designed transformer, we do not get into saturation at rated frequency, and at any higher frequency the flux density goes down as we have said.

With constant applied voltage, as frequency is raised the flux drops. The losses drop 1.6 times as fast as the flux, more than taking care of the loss rising with frequency.

To sum up, hysteresis is the principal loss which changes with frequency. At lower than design frequency, it goes up. Even at maximum rated voltage, most 60 Hz transformers will hang together at 50 Hz, but not much below that. At higher than rated frequency, though, the transformer works better and better and even cools off a little. This can be raised to a frequency where leakage reactance and other side effects begin to affect the output voltage regulation. An ordinary power or filament transformer should be good to at least a couple of kilohertz, higher than any power frequency you are likely to find. Even then it won't overheat, only its output voltage will begin to sag under load.

Operating complete equipment

Does all this mean that a piece of gear made for 60 hertz operation can be plugged into a 400 hertz (or higher) source and will go to work without any fuss? In many cases, yes, but there are exceptions. Most receivers have a simple and straight-forward power supply and can be turned on without any worry. Transmitters should be looked at a little more carefully, and test equipment and other auxiliaries should be carefully and individually considered. Several types of components other than ordinary transformers will give trouble on high frequency power, and various kinds of leakage into high gain audio circuits can occur. Before firing up any piece of gear, glance over its circuit diagram for possible trouble spots.

The first thing to look for is AC motors. No AC motor will run well very far from its design frequency; if the equipment is cooled by an AC blower, this will run poorly or not at all and the whole equipment may overheat. One way around this is to rectify the AC and use DC motors. This can cause other trouble, since DC motors have brushes which need periodic attention, and they generate hash which can be very troublesome to filter out. It is possible to run the DC through a transistor inverter and make the proper frequency to run an AC motor. This is cumbersome but has been done in some commercially built equipment. The rectifier and inverter must be efficient, or they may generate as much heat as the blower will remove.

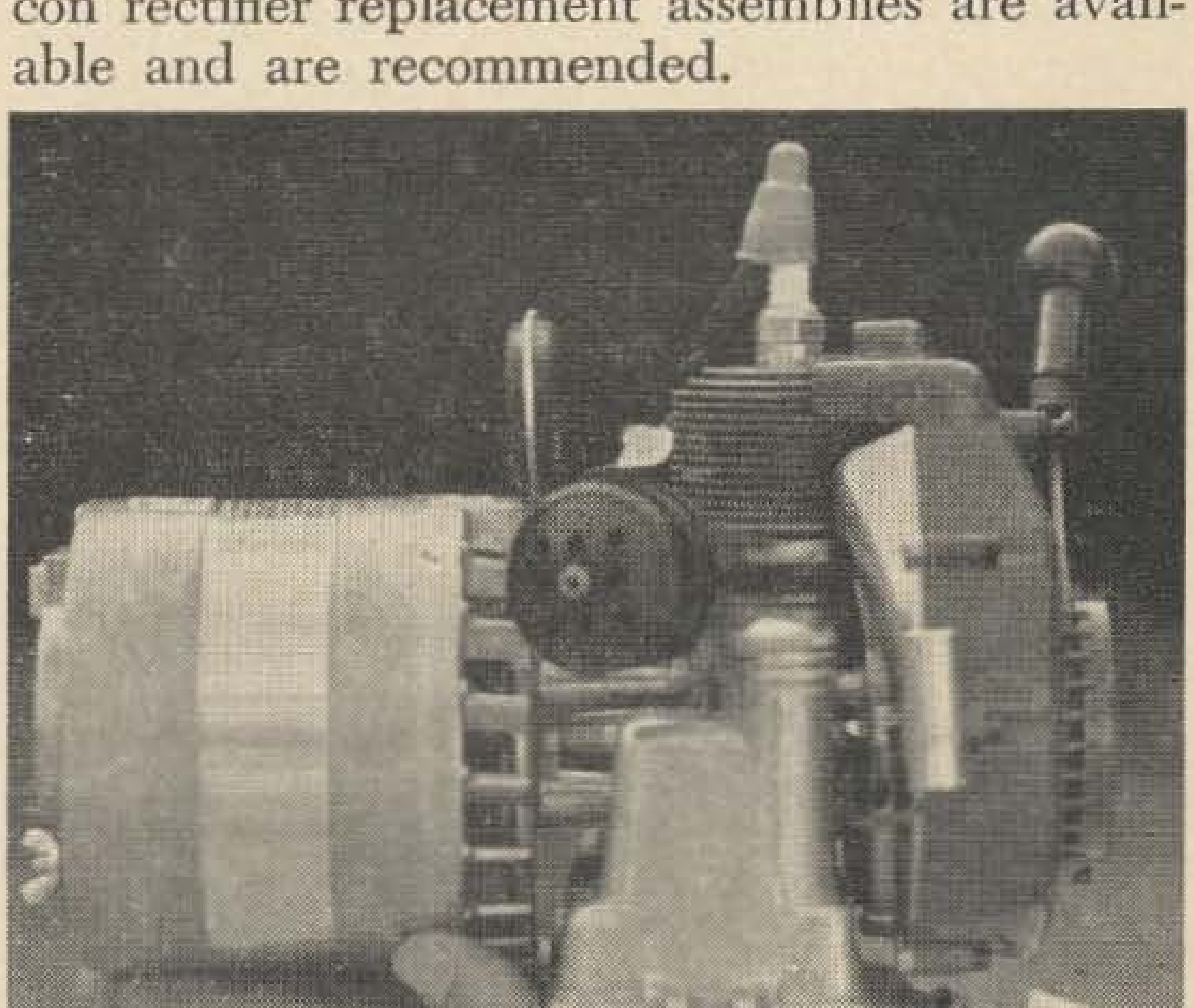
Best of all, pick equipment that uses natural cooling, and leave all the blowers home. Nasty, noisy things!

AC relays are a similar problem. It is comparatively easy to substitute DC relays and rectifiers, though, and the DC relays will be quieter as well.

Voltage regulating transformers are usually of the type whose output voltage tends to be proportional to frequency, thus are not suited to high frequency operation. These are not very common in amateur equipment, fortunately for our purpose. Electronically regulated power supplies using VR tube or zener reference are not affected by frequency, of course.

Once in a while a transformer turns up which, due to unusual secondary insulation requirements, design for current-limiting properties or just plain poor construction, has high leakage reactance. This is just another way of saying it has poor coupling between primary and secondary. Such a transformer will give reduced output voltage under load when operated from a high frequency power source.

Mercury vapor and gas rectifiers have definite frequency limitations, especially when operated near full power rating. Plug-in silicon rectifier replacement assemblies are available and are recommended.



A commercial example of a low cost, high performance, high frequency generator is the Tiny Tor. This light (12 lb.) generator puts out 350 watts of 115 V ac or 6/12 V dc. The ac frequency is around 115 cycles, which makes it useful for most ham gear. The Tiny Tor is distributed by Algert Sales, 1805 Wilshire Blvd., Los Angeles, Cal. Price is $79.50.

These are the principal component-type problems to be expected in amateur equipment. Once you have checked over a piece of gear for situations of this sort, you can hook it up to the high frequency power source with little fear of anything destructive happening.

Problems in operation

Even though nothing burns up, trouble may still pop up in practice. The common high frequency power sources, 400 to 1200 Hz or so, are right in the middle of the audio range, and are much more audible and annoying than 60 Hz. Filter circuits will work better at the higher frequency, so you would expect hum to be less. It may still be a problem in a piece of gear which has lots of audio gain, both because the high frequency is heard better and because the audio system may have reduced gain for 60 and 120 Hz hum frequencies, to get by with less filtering. At 400 Hz and up, any hum will come through at full gain. Hum may also sneak around the filter circuits by stray coupling or by heater-cathode leakage.

One insidious type of coupling occurs if the heater circuit has one side at chassis potential, and is grounded at more than one point. The heavy heater current flowing in the chassis creates a hum voltage of a few millivolts between different "ground" points on the chassis, which can get into sensitive circuits and which no amount of filtering can remove. An aggravated case of this kind is when a separate power supply is used, and the heater circuit is grounded both in the supply and in the equipment, thus putting the heater voltage drop in the connecting cable right in series with the B minus return.

Buzzing of power transformer and choke laminations may be loud enough to be bothersome at the higher frequency. Tightening the core clamping bolts and carefully pushing thin wooden wedges between the core and the coil form may help.

For that matter, it should not be forgotten that the high-frequency generator itself may be quite noisy compared to a 60 cycle unit of the same power. Be prepared to keep the generator some distance away from the operating positions, preferably on the other side of a small hill or in a hollow, and have a suitably long power cord, of large wire so that its voltage drop is not too high.

Another minor trouble that may turn up is that different power supplies in the same unit may change their output voltages by different amounts when running from high frequency power. Choke input supplies will be least affected (if the choke inductance was adequate at the lower frequency in the first place.) Capacitor input supplies will generally increase their output voltage somewhat, and small low-efficiency bias supplies, if unregulated, may put out enough extra voltage to upset the adjustment of a sensitive circuit.

Measurement of line voltage

Another point which is easy to overlook is measurement of the line voltage of the high frequency generator. High quality AC meters of switchboard type will usually not be accurate at frequencies as high as 400 Hz. Such meters will ordinarily have their frequency range marked on the dial. The much-less-expensive rectifier type meters, such as a multimeter on its AC voltage ranges, will do better. It is true that these meters have waveform error, but this should not be of much consequence for this use. As an alternative, check the DC voltage of some of the unregulated power supplies in the equipment. If they show the same DC output under load as they do with 60 Hz power, it is likely that the line voltage is close enough for all practical purposes.

Summary

With a little care, it is quite practical to run most ham equipment on 400 Hz and higher frequency power. This will make a number of surplus and aircraft generators available for use. Automobile alternators should also be usable, taking the AC power off before rectification; some of these are three-phase devices and should have the load distributed equally between phases, so be careful here. I have seen some very cute little portable generators run by a miniature gas engine like a model airplane engine and delivering 200 or 300 watts, which might make high-powered mountain top operation practical.

One last bit of advice—don't leave all the checkup and testing until the last minute. Test all the equipment you intend to use on the actual power source, hooked up the way it will be used. Leave yourself plenty of time to correct any small problems or find substitutes for any equipment that proves unsuitable. If you intend to go mountaintopping, don't forget that gasoline engines have their own little problems at altitude, and may deliver substantially less than rated power. In short, get all the stuff working *before* you head out into the boondocks!

. . . WA6NIL

Technical School for your Ham Training??

Whether or not incentive licensing becomes the law, there are many amateurs who would like to improve their knowledge, either to get a higher license for the satisfaction of it, or as a means of entering the electronics field. Novices and Technicians could find the way to General class licenses more easily by the formal training method, especially where they have no local hams to help them.

The schools listed below are correspondence schools, which means you can work while studying. There is no doubt that you will be a more prosperous citizen with such training. If you have any inclination to get ahead, we urge you to get this schooling. You will be glad you did—and we will be glad, too, if you will mention to the school of your choice that you found their name in 73 Magazine.

Alexander Hamilton Institute
235 East 42nd. St.
New York, N.Y. 10017

American Institute of Engineering and Technology
1135 W. Fullerton Ave.
Chicago, Ill. 60614

American School
58th St. & Drexel Ave.
Chicago, Ill. 60636

American School of Home Studies
127 Columbus Ave.
New York, N.Y. 10023

American Technical Society
850 E. 58th St.
Chicago, Ill. 60637

Business Electronics
209 W. Jackson Blvd.
Chicago, Ill. 60606

California Electronics & TV Institute
945 Venice Blvd.
Los Angeles, Calif. 90015

Canadian Institute of Science and Technology
617 Garden City Building
263 Adelaide St., W.
Toronto 1, Ontario

Capitol Radio Engineering Institute
3224 16th Street
Washington, D.C. 20010

Central Technical Institute
1644 Wyandotte St.
Kansas City, Mo. 64108

Christy Trades School
3214 W. Lawrence Ave.
Chicago, Ill. 60625

Cleveland Institute of Electronics
1776 E. 17th Street
Cleveland, Ohio 44114

Commercial Trades Institute
1400 W. Greenleaf Ave.
Chicago, Ill. 60626

Coyne Electrical School
1501 W. Congress Parkway
Chicago, Ill. 60607

Delehanty Institute
115 East 15th St.
New York, N.Y. 10003

DeVry Technical Institute
4141 Belmont Ave.
Chicago, Ill. 60641

DeVry Technical Institute of Canada
970 Lawrence Ave., W.
Toronto 19, Ontario

Elkins Institute of Radio and Electronics, Inc.
4119 E. Lake St.
Minneapolis, Minn. 55406

Grantham School of Electronics
1505 N. Western Ave.
Hollywood, Calif. 90027

Heald's Engineering College
Van Ness at Post
San Francisco, Calif.

Indiana Home Study Institute
Box 1189
Panama City, Fla. 32402

Indiana Home Study Institute
Eastern Division
Box 282
Saxonville, Mass. 01256

Industrial Training Institute
2150 Lawrence Ave.
Chicago, Ill. 60625

International Correspondence Schools
Scranton, Penna. 18515

Massey Technical Institute
148 E. 7th St.
Jacksonville, Fla. 32206

Milwaukee School of Engineering
1025 N. Milwaukee St.
Milwaukee, Wis. 53201

National Electrical and Television School
1298 Niagara St.
Buffalo, N.Y. 14213

National Radio Institute
3939 Wisconsin Ave.
Washington, D.C. 20016

National Technical Schools
400 S. Figueroa St.
Los Angeles, Calif. 90037

Northrop Institute of Technology
1199 W. Arbor Vitae
Inglewood, Calif. 90301

Northwest Schools
1221 N.W. 21st Ave.
Portland, Ore. 97209

Pacific International College of
Arts & Sciences
5507 Santa Monica Blvd.
Hollywood, Calif. 90038

Philco Technological Center
C and Ontario Sts.
Philadelphia, Pa. 19134

Port Arthur College
Box 310
Port Arthur, Texas 77641

Radio Television Training of America
52 East 19th St.
New York, N.Y. 10003

RCA Institutes
350 W. 4th St.
New York, N.Y. 10014

Sprayberry Academy of Radio-Television
1512 Jarvis Ave.
Chicago, Ill. 60626

Tri-State College
2436 College Ave.
Angola, Indiana 46703

Valparaiso Technical Institute
Valparaiso, Indiana 46383

Using the Tunnel Dipper on 432

Recently I contemplated building some gear for 432 MHz. Like many other hams I had invested in a 432 MHz converter to copy Oscar IV; but when I found out what a "Yo-Yo" it was I gave up building the big array with tilt and went back to my 144 MHz construction. Then I thought, "With a $55.00 converter on hand why not put a transmitter on the air?" With no feel for 432 some sort of dipper was necessary. From some recent articles I could have built one in two or three evenings; but time is at a premium at this QTH.

Heath says the Tunnel Dipper is good to 350 MHz. I made a coil of #16 wire —5/16" ID on an RCA phono connector. This coil acts as a wavemeter and dipper at 432 MHz just wonderfully. With my coil 404 MHz appears at 4.50 MHz on the red scale and 432 MHz appears at 260 MHz on the white scale.

. . . Fred Grant K6YWE

The Knight-Kit TR-106 and V-107

Knight's new six meter transceiver and matching VFO make a nice pair for six meter hamming.

Knight recently announced a new six meter transceiver kit, the TR-106, and matching VFO, the V-107. It looked like a rig many of our readers would like to know more about, so I got one to put together and try out. I found that it's a nice piece of gear and a lot of fun to build and use.

Knight-Kits have always been among the easiest kits to build. Their instruction manuals are excellent. Knight supplies pre-cut, pre-stripped and pre-tinned wires, and even expensive eutectic solder to help prevent cold solder joints. Part of the receiver—the critical first converter, was furnished pre-wired and aligned. It only took a few nights to build the kit and the alignment was a snap, too.

TR-106 Specifications

Receiver Section:
- Audio output: 5 watts or more
- Intermediate Frequencies: 15.6 to 17.6 MHz
  1650 kHz
- IF rejection: 50 dB or better for first if
  70 dB or better for second if
- Image Rejection: 55 dB or better
- Input Impedance: 50 ohms nominal
- Frequency Range: 50-52 MHz
- Selectivity: 6 dB down at 8 kHz
- Sensitivity: .5 μV for 10 dB S+N/N ratio

Transmitter Section:
- Frequency Control: 8 MHz crystals or VFO
- Frequency Range: 50-52 MHz
- Output Impedance: 30-90 ohms
- Power Input: 15 watts

Power Supply:
- All Solid State: Transistor oscillators and silicon rectifiers
- Power Requirements: 120V, 60 Hz, 90 W
  12-15 V DC, 6.8 A receive, 8.1 A transmit

Miscellaneous:
- Size: 5½ x 13⅛ x 11"
- Price: $139.95

The TR-106 and V-107 use well-tested, straightforward circuits. No tricks here. The transmitter oscillator uses 8 MHz crystals or the V-107 VFO and the exciter is bandpass coupled to the 2E26 final amplifier. Modulation is high level plate and screen with automatic limiting to prevent overmodulation. The push-to-talk microphone is included.

The receiver section of the TR-106 is a double conversion superhet with a neutralized Nuvistor rf amplifier. The first oscillator is crystal controlled. Selectivity, rejection of unwanted signals and sensitivity seem excellent. An rf gain control, to help prevent overloading, switchable ANL and a spot switch are among the controls. There's no BFO, but you can use the VFO for one on strong signals.

The built-in solid state power supply can be operated from either 115 V or 13.5 V.

The V-107 VFO plugs into the TR-106. It uses a one tube oscillator with voltage regulation and temperature compensation. One of its clever features is that you can use it on either six or two by changing the position of the dial plate and realigning the oscillator.

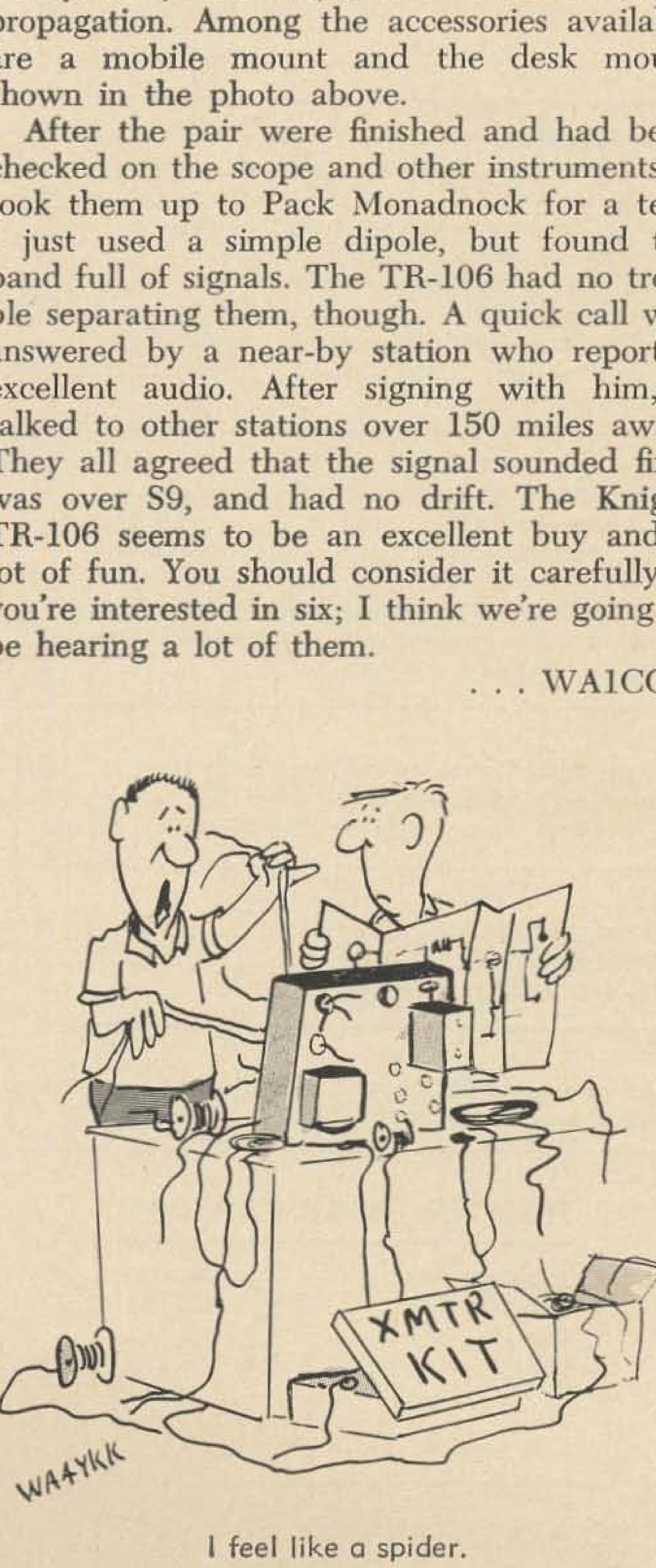
V-107 Specifications:

Frequency Coverage: 8.333 to 8.666 MHz for 6 meters
8.000 to 8.222 MHz for 2 meters
Frequency Stability: ±500 Hz per hour after 30 minute warm up
RF Output: 20 volts rms minimum into 47 k shunted by 30 pF
Power Requirements: 200 V DC, 30 mA, 12.6 V, .15 A
Size: 5½ x 4¼ x 6½"
Price: $19.95

The instruction books discuss theory of operation in stage-by-stage form, installation, alignment, troubleshooting, TVI hints (though I didn't notice any TVI), cleaning up car electric systems, antennas, mobile installation, and propagation. Among the accessories available are a mobile mount and the desk mount shown in the photo above.

After the pair were finished and had been checked on the scope and other instruments, I took them up to Pack Monadnock for a test. I just used a simple dipole, but found the band full of signals. The TR-106 had no trouble separating them, though. A quick call was answered by a near-by station who reported excellent audio. After signing with him, I talked to other stations over 150 miles away. They all agreed that the signal sounded fine, was over S9, and had no drift. The Knight TR-106 seems to be an excellent buy and a lot of fun. You should consider it carefully if you're interested in six; I think we're going to be hearing a lot of them.

. . . WA1CCH



I feel like a spider.

John Schultz W2EEY/1
40 Rossie Street
Mystic, Conn. 06355

A Curtain Going Up

Build an easy-to-construct curtain array and work that DX!

Many amateurs who have the space to erect an elevated 40 meter dipole can improve the performance of their antenna system on several bands and at minimum cost by erecting a small curtain-type array. The advantages of curtain arrays in general are discussed and several construction hints are given as worked out by the author while constructing a small Bruce array.

I transported my 20 meter beam to my new QTH, but because the house was surrounded by high trees, roof top mounting would not be effective. I didn't want to invest in a tower, so I would have to find another solution to the antenna problem.

Perhaps because of my recent association with Radio Free Europe, where a large number of modified curtain-type antennas are used for transmitting. I thought of using this type of antenna. Curtain arrays have a long history of use as commercial DX antennas. They were extensively used in the 30's for instance, for trans-Atlantic telephone service. Sterba curtains for transmitting and Bruce curtains for receiving were normally employed. However, such antennas have never been used much in the amateur field because most amateurs think that such arrays must be huge to be effective. However, even small curtains giving only moderate gain can, under the right circumstances, be an ideal amateur antenna for fixed direction work. Assuming some sort of natural support, such as trees, are available, the only investment is in wire and insulators. Most curtain designs can be used on two or more bands, by using a resonant feed line, and the direction of maximum radiation usually remains the same on different bands.

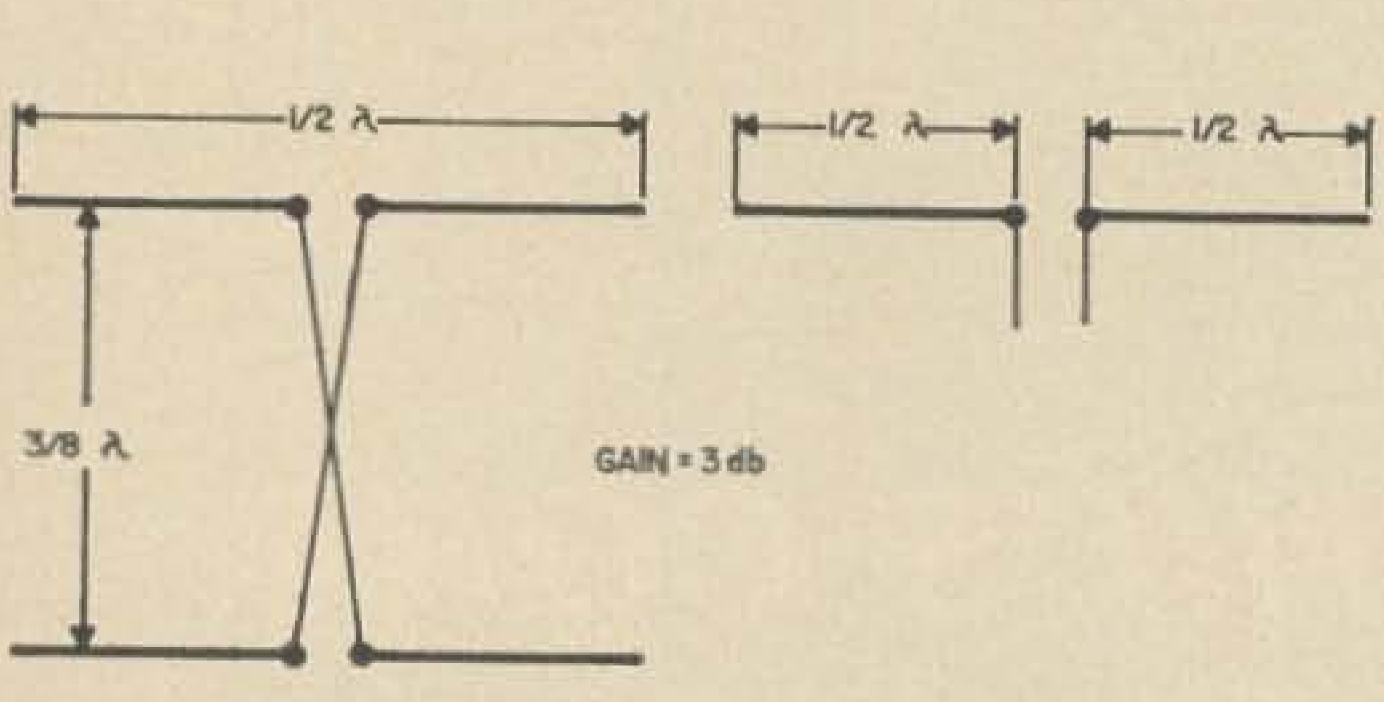


Fig. 1. Simple broadside and colinear antennas having about the same gain.

Curtains vs. long-wire antennas

Perhaps one reason why curtains, or broadside arrays in general, are not given too much consideration by amateurs is that when one looks at the gain figures for a small curtain as compared to a long-wire, the additional construction effort hardly seems worthwhile. For example, compare the gain of an elementary broadside array (stacked dipole) against a full wavelength (double Zepp) wire **Fig. 1**). Both antennas give the same gain, about 3 dB, but the broadside array is certainly more difficult to construct and support than a simple length of wire. However, the gain figure alone is deceiving unless one understands how the gain is actually achieved.

Any directive antenna, from a dipole on up, concentrates radiation in various directions. This concentration or "directivity" takes place in the horizontal and/or vertical planes. Colinear antennas, such as a long-wire, achieve gain almost solely by horizontal directivity.

John is a Civil Service Engineer with the U.S. Navy. He has a BEE from Polytechnic Institute of Brooklyn and has written a number of articles for many radio magazines.

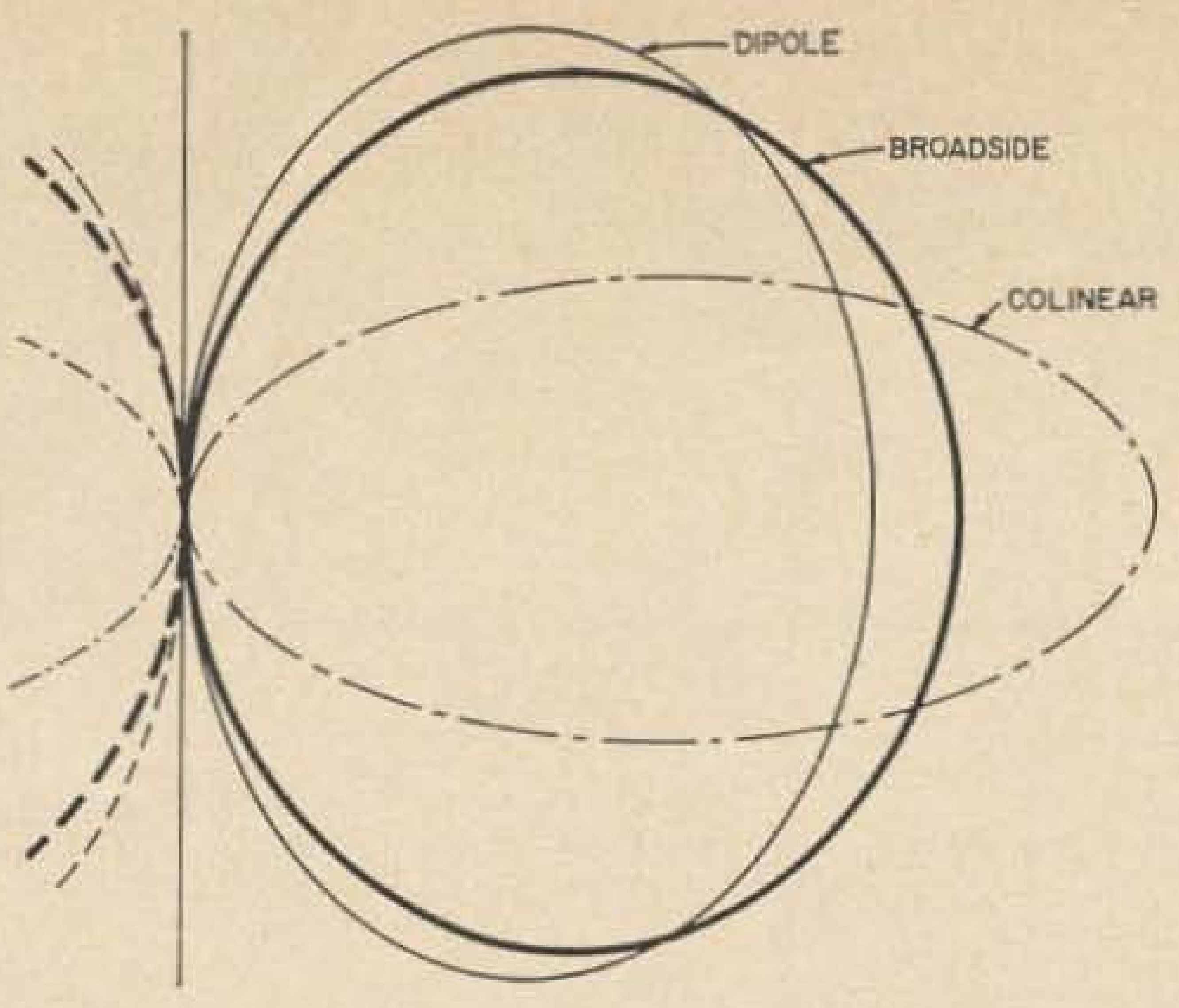


Fig. 2. Horizontal directivity patterns (only half shown.)

That is, as the antenna is made longer by the addition of correctly phased half-wave sections, the horizontal pattern (**Fig. 2**) becomes sharper and sharper. The vertical directivity (**Fig. 3**) remains, however, essentially the same as a half-wave dipole. Note what happens with a curtain. It achieves gain mainly by vertical directivity. That is, its horizontal pattern remains broad but for the elevation shown in **Fig. 3**, for instance, its vertical pattern is far superior to a colinear array. Radiation is more concentrated at the lower angles effective for DX. The point is that in a limited space one definitely ends up with a more effective DX antenna with a curtain although its gain is not more than a simple colinear antenna.

The two most common and useful types of curtain arrays are the Bruce and Sterba (**Fig. 4**). Both arrays are high-impedance devices.

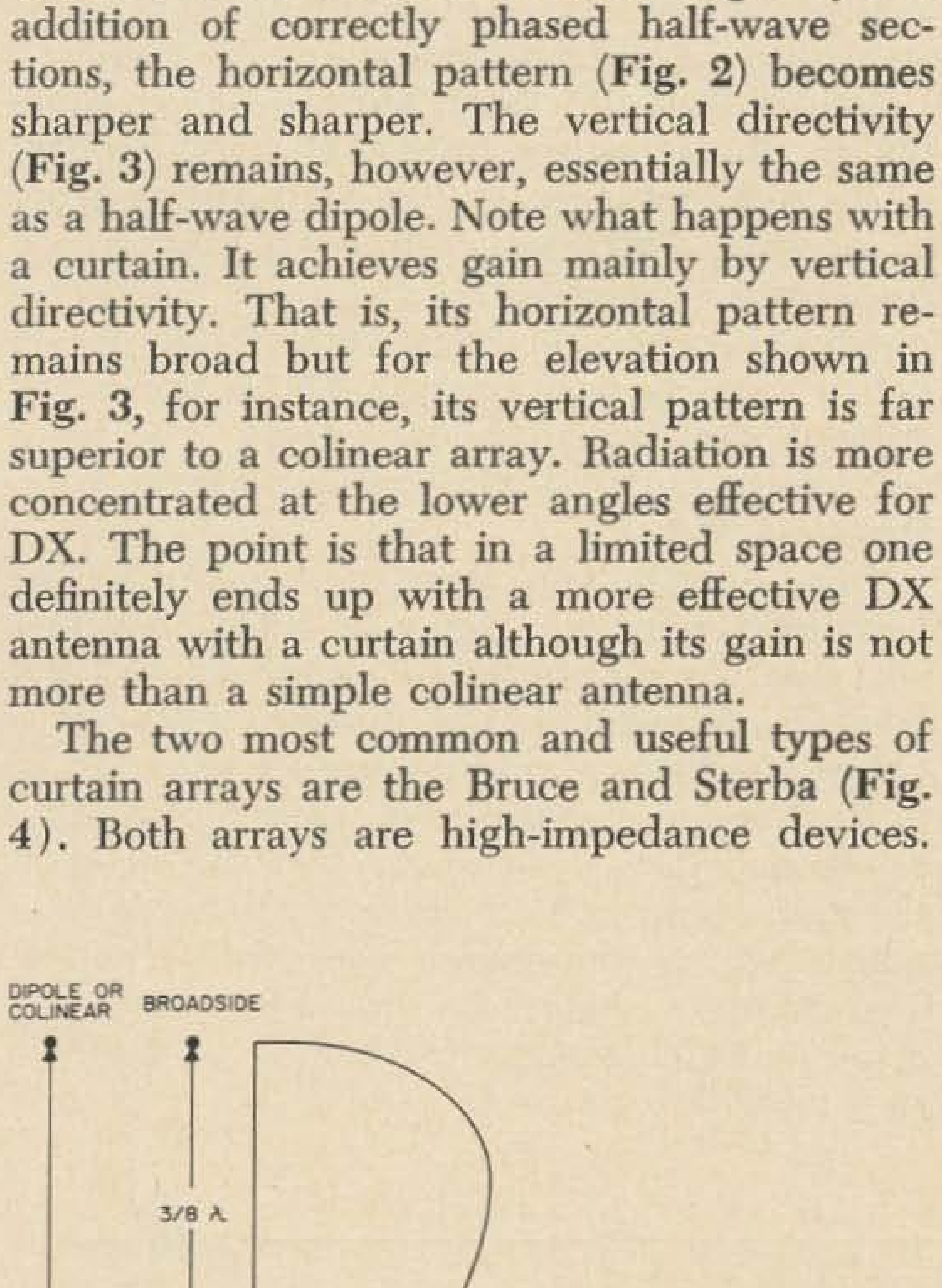


Fig. 3. Vertical directivity patterns.

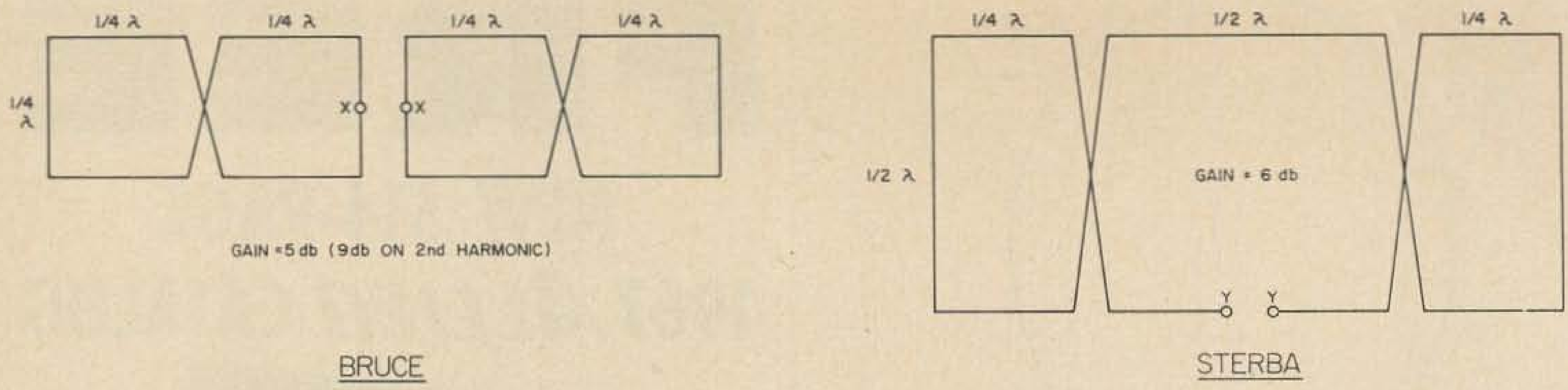


Fig. 4. Bruce and Sterba curtain dimensions. For best results the lower element of each antenna should be elevated ¼ to ⅝ wavelength above ground.

The dimensions are not critical, and if fed with a non-resonant line for one band operation, a low SWR will result over the entire band. Both arrays may be used for multiband operation (on 10 and 40 if cut for 20 meters, for instance). The Sterba array will give slightly more gain on its design band and better performance at half-frequency compared to the Bruce array.

The feed-point impedance of the Bruce array (xx in **Fig. 4**) on its design band is 750 ohms and the Sterba shows about 300 ohms (yy in **Fig. 4**). Either antenna can be fed with a flat 72 ohm transmission line for one band operation by using one of the matching transformers shown in **Fig. 5**. For multiband operation, 300 ohm twin-lead can be used as a resonant feed line for powers up to 600 watts PEP.

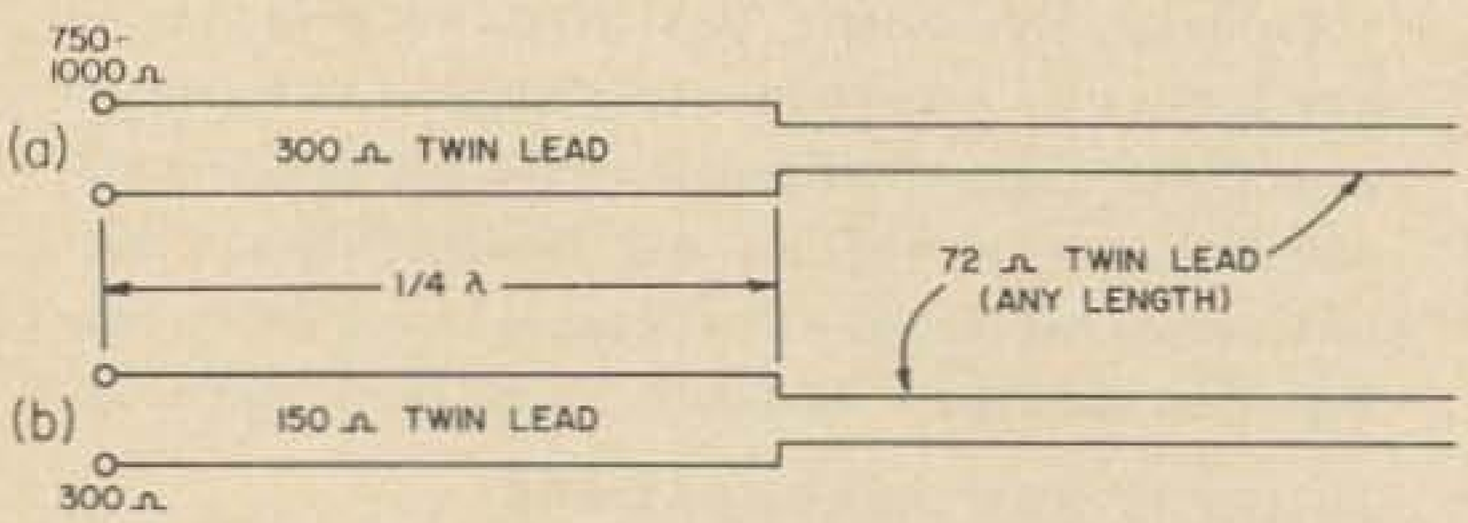


Fig. 5. Simply constructed matching transformers that can be used to feed a Bruce or Sterba curtain for single band operation.

I decided to construct a Bruce array as best fitting into the space I had available. In my first attempt at construction of the array, I made all the elements from 7 x 20 stranded wire with insulators as necessary at the crossover points between bays. Upon erection, however, I quickly learned that unless extensive rigging is used or a great number of insulators put in, the crossover lines between bays will easily twist together. I then reconstructed the array using 300 ohm twin lead, twisted one turn, for the crossover lines between bays. This greatly simplified the construction and appears not to degrade performance. **Fig. 6** shows the antenna dimensions for 20 meters. The twinlead ways taped to the spacing insulators as shown in **Fig. 7**.

The antenna was first constructed in the basement with the elements rolled together and then the assembly laid on the ground and hoisted into position. The springs shown in the upper guy line are 6" compression units ($0.35 in boat supply houses). The springs are absolutely necessary to prevent wire breakage if the guy ropes run over the upper limbs of trees which sway to any degree during bad weather. The feedline should be run away from the array at right angles for a half wavelength or so if possible.

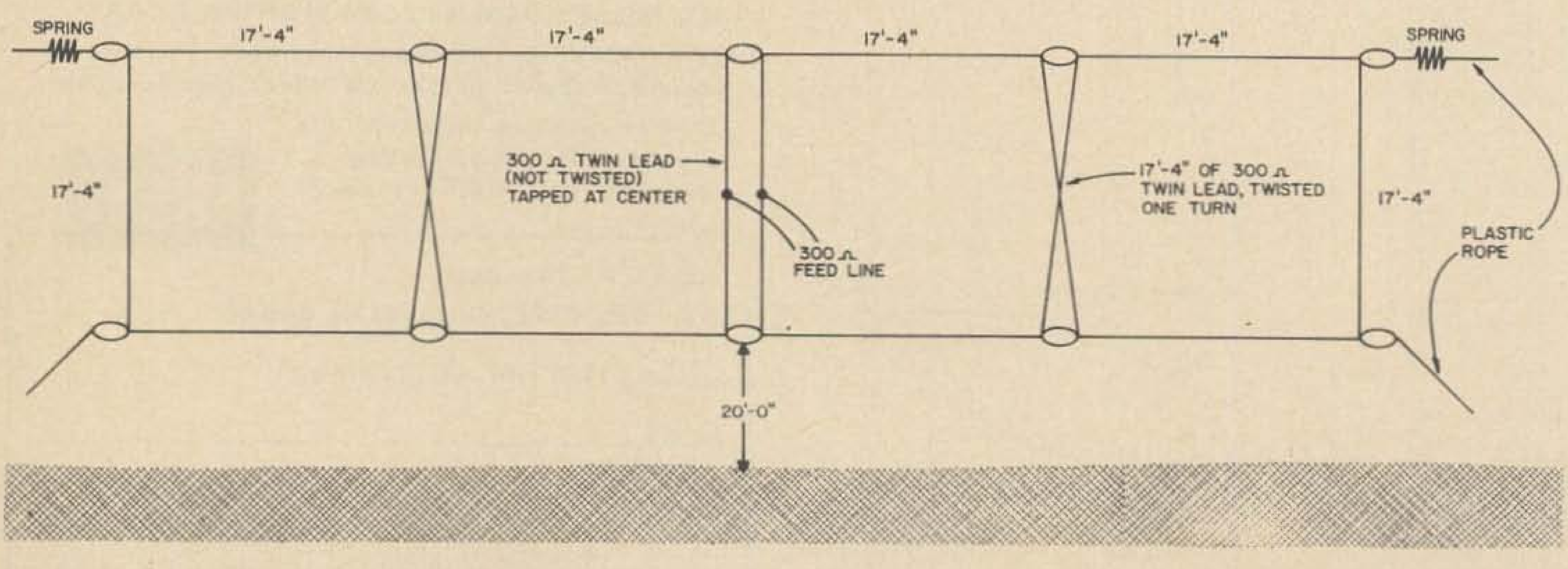


Fig. 6. Dimensions for the Bruce array for 20 meters

I fed the array for one band operation using the matching transformer (a) in **Fig. 5.** SWR was not worse than 1.2 to 1 over the entire band.

Construction of a Sterba curtain should easily be possible using the same construction techniques.

For the investment in parts, probably no other antenna gives so much value. My antenna was oriented for Europe. Signal reports have been consistently good and certainly equal, for the same transmitter power, reports received by other stations using three element beams at the same average elevation (29′) as the curtain.

. . . W2EEY/1

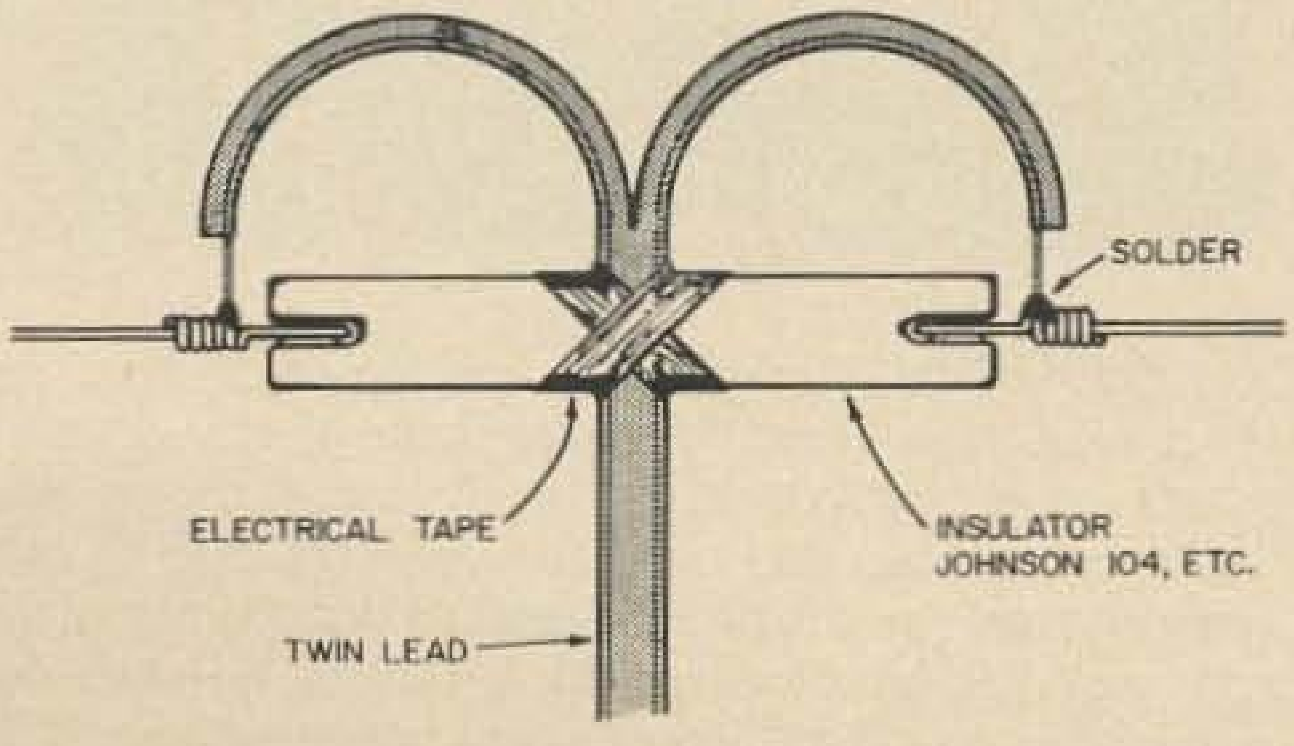


Fig. 7. Simple method of fastening twinlead to insulators.

Seen at the Disneyland ARRL convention: WN6SSZ, Mary Lou Stockstill, a deaf and blind amateur who communicates via CW over the air and by Braille-writer in person. Mary Lou speaks very well and is a truly amazing person. Talking to her here is Bill Welsh WA6VTL. Next to Mary Lou is Ray Meyers W6MLZ, the past director of the division, and talking with him is Dave Abramowitz WB6JEV who, years ago, in his SWL days, used to come bouncing over to my house in Brooklyn on his bicycle.

(Continued from page 2)

a letter from the safari outfit saying that they had made a little mistake and couldn't take us the first of August as planned . . . could we make it July 15th instead. Oi. I called Jim Cotten W5PYI and Larry Frank WA6TCI, who had answered my editorials asking for volunteers to go on the trip and found that they could somehow change their plans and start two weeks early.

The visas are a whole galaxy of problems in themselves. You see, before you can get into most countries, you have to have a little stamp in your passport issued by the consulate for that country giving you permission. This can be rough. The fees, even for a one day visit, run up to $5 and over. Then you have to have a health certificate for some showing that you are prepared to ward off yellow fever, small pox, typhoid, tetanus, cholera, plague, typhus, and other darbs. Most of them want you to fill out one, two or three forms, complete with photographs. Most of them want to look over all this, along with your passport, for 24 hours . . . or longer. Sudan requires three days and Burma wants six months if you are going to stay more than 24 hours in the country. A letter from your local police chief attesting to your character is required by some . . . and several want a letter from your travel agent saying that you have a ticket to get you out of their country and enough money to take care of yourself during your visit.

The 23 countries we planned to visit looked like a six months visa program . . . and I only had a few weeks, so I hopped down to New York and went around personally to get forms from those consulates who hadn't bothered to even answer my written request. There is no way to describe the frustration of this process. I had to start out by visiting the U.S. Passport Agency to get my passport extended for another two years since it was scheduled to run out the day after our return . . . and several countries won't issue a visa unless the passport is good for at least six months after your visit. Our agency has a very hot and incredibly crowded office in Radio City. I picked a short line so I only had to stand there for a little over an hour. I slipped them a dollar extra to get them to rush things and I was thus able to swing in the next afternoon and pick up the passport. Nice, but since most of the consulates and U.N. mission offices close at 1 PM, it was too late to get any visas that day.

The next morning I got right over town and started with the last stop, Tahiti. Since a number of countries won't issue a visa unless you already have one for the next country it seemed prudent to work my way back up the list. The French Consulate handles Tahiti. I handed over all the forms, the payment, the photographs, and my passport. How long was

Don W9WNV/everywhere showed at the Anaheim convention and flabbergasted all with his slides of recent DXpeditioning. He has been working his way across the country visiting DX clubs on his way down to Heard Island. Watch for an interesting series by Don in 73 when he gets through traipsing. Since all of you DXers have worked Don, we thought you might like to see what he looks like.

James Ashe W2DXH
R.D. 1
Freeville, N.Y.

Another Look at the Like New Circuit

A low distortion low noise mixer for those who use tubes

It's always nice to find a better circuit. Improving the operation of a piece of gear is in more ways than one a rewarding activity. And also in constructing new homebuilt items a new circuit may mean the difference between poor and good performance or enable the builder to eliminate a tube or two.

A very good practice before firmly committing yourself on a new circuit is to try it out on a breadboard. With a little care its normal operating conditions can be approximated well enough to give a good idea what it will do when installed in the finished chassis. Experience gained during breadboarding is likely to be valuable during the final debugging session and helps in planning circuit layout.

Simple circuits, if they will do the same job, are generally preferable to complex ones. One such circuit is the Like New circuit presented in the October 1961 issue of 73 Magazine. This uses a twin triode to replace the complex and noisier pentagrid converter. Requiring a simpler tube and only one supply voltage, it offers the same or better performance. A good trade!

But the circuit as originally presented seemed to suffer from two shortcomings. These were, loading of the local oscillator and a question of its stability with tube and component aging.

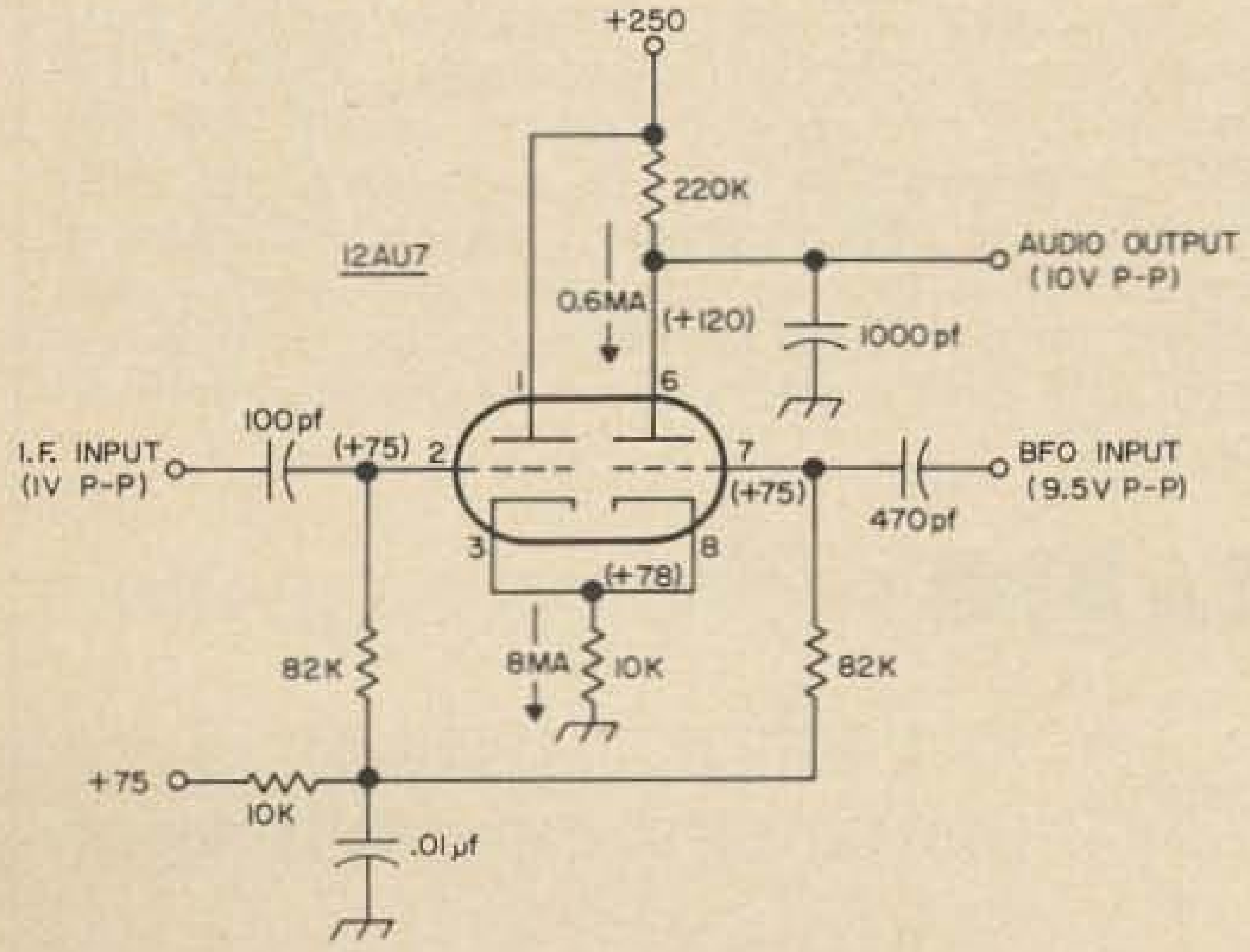


Fig. 1. Modified Like New mixer circuit.

With the local oscillator grid resistor returned to the cathode rather than ground, there is no bias on the second triode unless the local oscillator is running. The bias comes from grid rectification so there is some loading on the oscillator.

The small resistor carrying cathode current has little control over how much current is flowing. If the vacuum tube properties change, so must the cathode current and the operating point.

This circuit looked like a good bet for a project of building a specialized receiver. It was not clear how it worked, but the glowing description was most encouraging. So a little thinking about it brought out the idea that it was very similar to a difference amplifier and as such might turn out to be a real linear mixer.

To make a long story short, it is not a linear mixer. The circuit, to work properly, must have a nonlinear element: the plate characteristics of the second triode appear to be in a region where an approximate square law transconductance rule holds. Of this more later.

Fig. 1 is a diagram of the completed circuit as used. Although it looks rather different from the original Like New circuit, the changes are really only skin deep. It is arranged to have improved resistance to overloading, better bias stability, and does not require any power from the local oscillator to generate its bias voltages.

The biasing system will look strange to the amateur eye. It is not a conventional practice to operate grids at plus 75 volts and use great big cathode resistors. However, this works out well.

The values shown are those that were obtained using a 12AU7 twin triode and the circuit resistances shown. Also indicated are circuit currents and the peak to peak values of the signal voltages. Both inputs were slightly

I going to visit Tahiti? Five days. Oh, you don't need a visa for any visit under ten days. She didn't know why there had been no mention of this in the instruction sheet I'd been sent.

I hiked up and down Manhattan for several days, gradually getting more and more visas stamped in my passport. Finally I gave up, seeing that this was going to string out for two weeks or so longer and I dug up a travel agency to take over the foot work from there. As a rule of thumb I would say you should allow at least one working day for each visa you are going to need for a trip.

Below is the schedule for the trip. We'll be getting on the air from every stop we can manage . . . you might keep an ear peeled on 14230, since this is a favorite frequency of mine. While I've made arrangements in a few places to see local ops, I would appreciate it if you would keep my schedule handy and let amateurs in any spot we'll be visiting know when and on what flight we will arrive so we can have a chance to meet them.

There will be just two of us on the round-the-world flight. Jim Cotten W5PYI and myself. WA6TCI will be on the safari, but has to get back earlier and thus has to pass up the long flight.

. . . Wayne

Itinerary

	Date	ETD	ETA	Flight
Boston to Rome	12 July	2100	1030	AZ 623
to Nairobi	13 July	1220	2215	AZ 518
to Addis Ababa	20 Aug.	1340	1525	MS 760
to Khartoum	22 Aug.	1100	1125	ET 781
to Cairo	23 Aug.	0900	1125	SD 102
to Beirut	24 Aug.	2130	2140	ME 301
to Baghdad	26 Aug.	1930	2200	ME 320
to Tehran	29 Aug.	0940	1125	IR 406
to Kabul	31 Aug.	0500	1030	FG 204
to New Delhi	1 Sept.	0800	1200	FG 302
to Katmandu	3 Sept.	1300	1640	RA 040
to Calcutta	5 Sept.	1535	1830	IC 248
to Rangoon	7 Sept.	1210	1605	IC 295
to Bangkok	8 Sept.	1400	1545	TG 302
to Singapore	11 Sept.	1820	2055	QF 740
to Perth	13 Sept.	1935	0105+1	BA 712
to Melbourne	15 Sept.	1315	1940	TN 507
to Sydney	17 Sept.	1000	1125	AN 308
to Aukland	20 Sept.	1000	1442	OF 852
to Noumea	28 Sept.	1100	1455	TE 402
to Naud	28 Sept.	1455	1740	UT 1586
to Suva	29 Sept.	1715	1800	FJ 132
to Apia	1 Oct.	0800	1310+1	FJ 952
to Pago Pago	1 Oct.	1700	1745	PH 266
to Papeete	4 Oct.	1500	1850	PA 809
to Los Angeles	7 Oct.	0900	2010	UT 1588
to Boston	9 Oct.			

IMPORTANT PROGRAMMED LESSON

Please follow instruction carefully.

1. I received this copy of 73 in the mail. Yes ...... No ......
   If the response is Yes, please continue to item 2.
   If the response is NO, please see A below.

2. I live in a place with U.S.A. mail delivery. Yes ...... No ......
   If the response is Yes, please continue to item 3.
   If the response is No, continue to another feature in this 73.

3. The wrapper this 73 came in has the proper zip code on it. Yes ..... No .....
   If the response is Yes, please continue to another feature in this 73.
   If the response is No, please write the proper zip on the part of the wrapper with the address on it and send to Linda, c/o 73, Peterborough, N.H. 03458.

4. I paid 60¢ for this copy of 73 at a radio dealer or newsstand.
   Yes ...... No ......
   If the response is Yes, you paid almost twice as much for this as a one-year subscriber. He pays about 33¢. A two year subscriber pays less for two years than a newsstand buyer does for one. Continue to item 5.
   If the response is No, you are a freeloader. Continue to item 5.

5. Please fill in this information:

   Name .... Call ....

   Address ....

   City .... State .... Zip ....

   Then continue to item 6.

6. Please tear this sheet out of the magazine. Place it with a check or money order for $4 in an envelope addressed to 73, Peterborough, NH 03458 and mail.

Congratulations. You have completed the programmed instruction correctly. The first of twelve certificates of achievement will reach you in six to eight weeks.

below 6 MHz, with frequencies a few hundred cycles apart. It was used as a second detector, conversion of an *if* signal to audio.

A good place to start in discussing this circuit is the biasing system. A constant-current or long-tailed bias network sets the tube operating points. This name refers to the large resistor from cathodes to ground, which determines the tube current. An indication of how powerful its control is may be found by supposing the tube current to be momentarily disturbed by a 1 mA increase.

This will produce a 10 volt voltage change on top of the resistor. With a transconductance of around 5 mA/V, the 1 mA increase in current will cause the tube to turn off about 50 mA. If any change in cathode current is countered by a change 50 times greater in the opposite direction, the long-term stability of the current will have to be pretty good.

This resistor is selected by, first, deciding how much current is to flow. Then a convenient grid voltage is decided on—something like ten times the anticipated grid-to-cathode voltage is a good choice. This sets the cathode voltage roughly and a plate characteristics

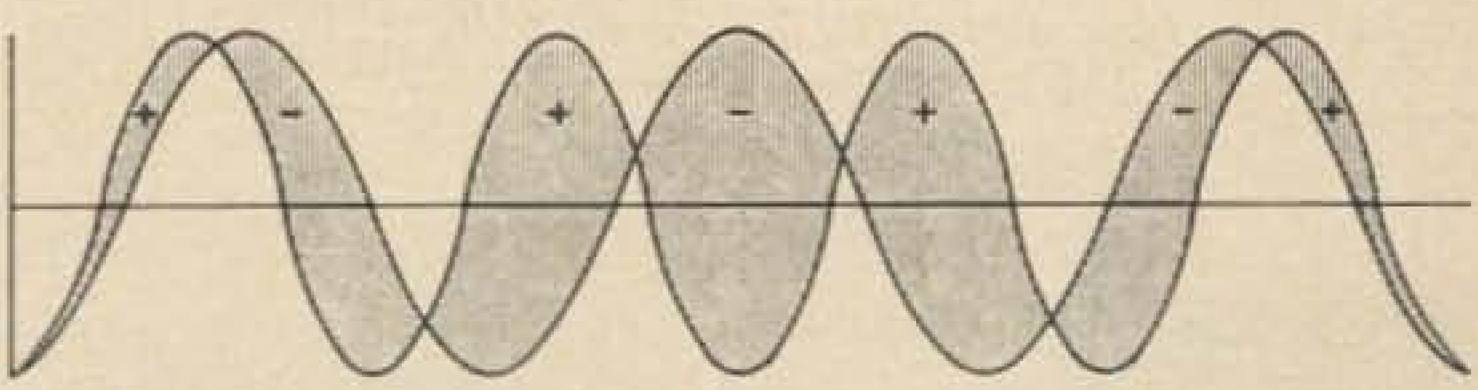


Fig. 2. Result of perfect addition of two sine waves of slightly different frequency, but the same amplitude.

chart together with an educated opinion about the anticipated size of the anode resistor locates the quiescent point which in turn locates more exactly the grid to cathode voltage.

The cathode must be positive with respect to the grid. So the required bias voltage is added to the previously fixed grid voltage, which gives the cathode voltage. The cathode voltage is divided by the cathode current to obtain the size of the cathode resistor—and there you have it. With this resistor in place, the anode current will show considerable resistance to being changed by various sizes of anode load resistance.

Since the grids do not draw any current, a resistance divider carrying a mil or so supply lines can fix the grid voltages. But in order to avoid coupling from one grid to the other through the bias network, there should be a generous bypass capacitor to ground.

Now let's look at what goes on in this circuit. There are two conditions to consider: DC conditions with no signal at all on either grid, and the slightly revised operating conditions when signals are coming into both grids. Since these conditions are not very different, it is simplest to discuss only the operating conditions.

Although both cathodes are connected together and both grids are biased to the same voltage, the two triodes are in very different parts of their operating regions. There is over 7 mA flowing through the left triode and about 0.6 mA flowing through the right one. This is because of the difference in plate voltages: most of the current is going to the triode with highest anode voltage. Consequently the LH triode is a strong, healthy cathode follower and the RH triode is a weak, nonlinear amplifier working into a very large load resistor.

Fig. 2 shows why this is required for best operation. The two sine waves are of slightly different frequencies. The chart is constructed by drawing them both same size and shading in the area between them, marking these areas plus when one curve is on top and minus when the other is on top. This situation repeats itself periodically and may be charted out to extremely long times if desired. However the main ingredients of the situation appear quite early.

Namely, if we use a circuit that puts out the exact instantaneous difference voltage of these two frequencies, the output isn't going to be of much value. But if somehow one kind of difference—say the one labeled plus—can be emphasized over the other, the result will be a signal emphasizing the real difference between the two frequencies.

This explains why the second triode must be operated at a very small plate current. In this region it is near cutoff and its curve of plate current as a function of grid to cathode voltage is strongly curved. If the grid to cathode voltage goes more negative, the anode current can change only a little—if it goes more positive, the anode current can increase considerably.

In short, this circuit is a nonlinear amplifier of the difference between two frequencies. I have to admit to Jim Kyle that my previous understanding of how this circuit worked was wrong!

This leaves only the function of the second anode bypass capacitor to discuss. It is necessary to bypass RF from the second anode to ground. In another way of speaking, it smooths out the anode current so that the following circuit sees only the average current. It does not need to be a very large capacitor since the second triode has a high output resistance and it would not be very hard to bypass its entire output to ground. A properly chosen capacitor can give a rolloff curve to de-emphasize the higher frequencies, a simple step for reducing the effects of noise.

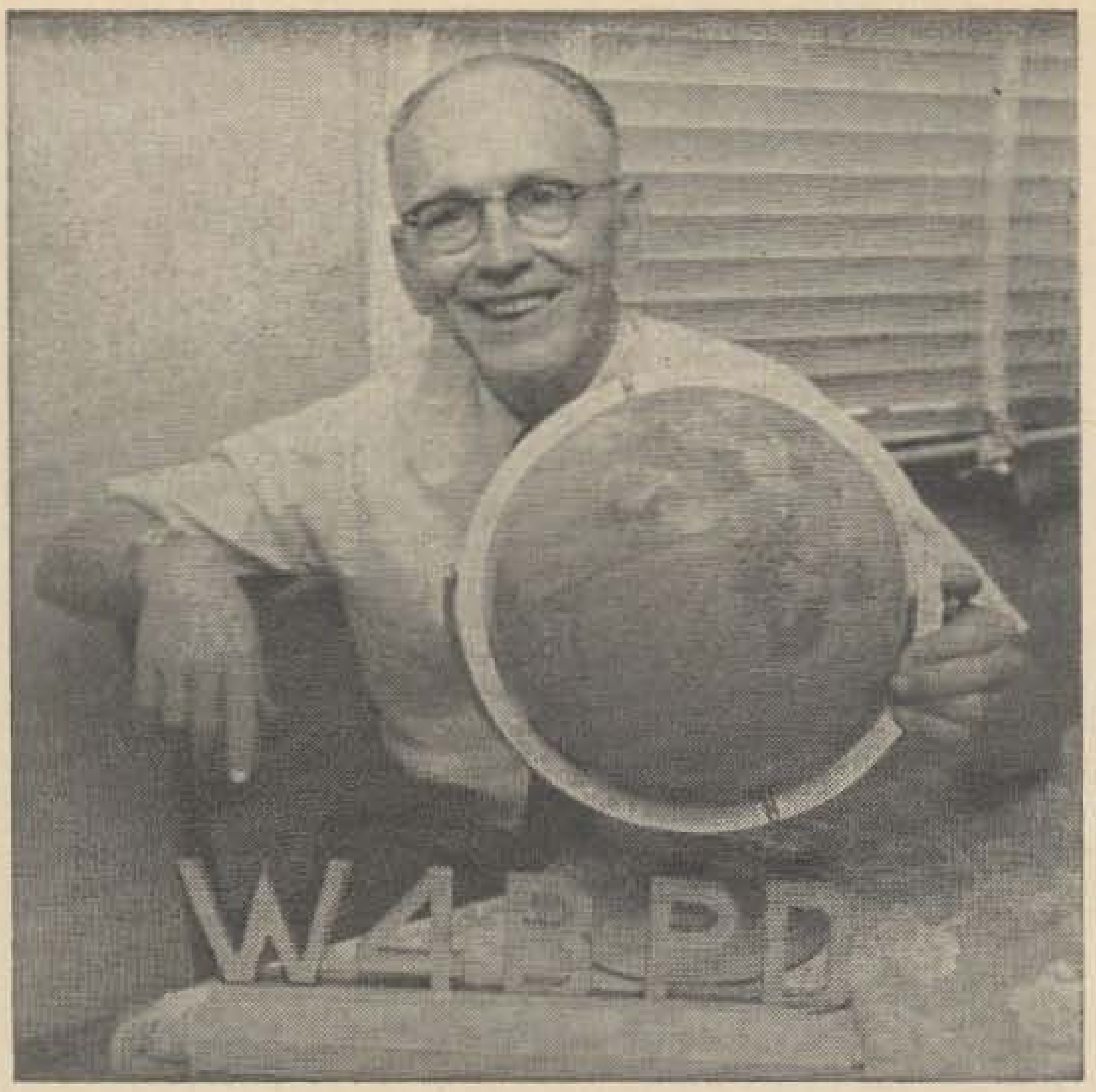
As it is presently being used, this circuit gives good gain, is immune to the blocking effects of noise, and appears to be as good as it is supposed to be. It makes a much better second detector than the converter tube it replaced. With appropriate revisions it can be used as a first detector which brings us full circle since that is the originally described application!

With this circuit available, the amateur builder can develop and build a really good receiver with only one or two kinds of tubes —all triodes. For instance, the input RF amplifier would be a cascode. This would feed some version of the 73 mixer circuit, with a triode local oscillator. From here we would go to a crystal *if* as described in the April 1961 issue of 73. This would then feed a twin triode circuit similar to that just described, and one or two more triodes would make up the output stages.

If this were properly done, only three tuned circuits would be required in the entire receiver. They would be, the input circuit, the RF to mixer interstage coupling, and the local oscillator tuning circuit. The BFO would be a crystal oscillator. For the higher frequency ham bands or as a narrow-range receiver fed by a converter it would be necessary to tune only the local oscillator. The first *if* input? Use a resistor! Think about it—it can be done!

. . . W2DXH

Gus Browning W4BPD
Orangeburg, S.C.



Gus: Part 14

In the last installment I was on the Seychelles, getting ready for my trip to the Aldabra Islands. You would be surprised to see the number of different things that have to be done when you are preparing for such a trip. For one thing the word had got out on Mahe that we were going to be on our way in a few days. Everyone who had any relations on any of the other islands along the way all gave us mail and other items to be dropped off along the way, and some fresh food was also taken. This made a good sized little pile of items to be placed upon the boat. This along with the supplies we would need just about filled the boat to the brim. We even took along quite a number of live chickens, looked like we were going on a sort of "chicken eating" DXpedition, which is a very common thing for a Baptist. But evidently the Catholics also practice this business of "chicken eating," since the Seychelles are predominantly Catholic, I suppose something like 98%.

Harvey was busy getting his "wind charger" oiled up and in good working condition since his equipment at that time was mostly of the 12 volt DC variety. All day and all night he had the wind charger going full blast charging his various batteries, he wanted to start with all of them fully charged. Jake (the owner of the Lua-Lua) was busy seeing that his little diesel was in tip top condition. While all this was going on I was quite busy myself getting my "putt-putt" mounted on the rear of the boat with the exhaust sticking out towards the rear so the noise would not disturb Harvey and Jake when they wanted to sleep. The rig was strapped down on the eating table so that it would not slide off in case of rough seas. NOTE—Be sure to have a very good, wide, deep funnel to pour your gasoline into the putt-putt because those high winds and pitching boat can cause you to lose lots of gas.

When everything was placed on board, all fastened down, and we were ready to go, the harbor safety man came aboard to look everything over before he gave us our final clearance. These safety men are very careful and do a good job; you don't fool these fellows at all. We three got on board early in the morning, and of course Harvey had his fish-eating black cat along with him as I knew he would. Harvey doesn't go anywhere without his black cat, and a big supply of tea and hard tack. that seems to be "the staff of life" to Harvey, (and it turned out that it was also our staff of life). You should have seen the gimbal-mounted gasoline cook stove, which would stay level if the boat pitched any direction. Both Harvey and Jake had their sextants and their own charts along with them; Harvey also had his pair of FB field glasses. Harvey predicted that the seas were going to be rough, and we found out that Harvey was 100% correct.

After a last minute check-up on everything, and another round of tightening up all ropes on the items in the hold of the Lua-Lua, we were ready to lift anchor and be on our way to Aldabra Islands. The three of us—Harvey, Jake (the owner of the Lua-Lua) and I, along with Harvey's black cat, went aboard. The little diesel was cranked up, the anchor lifted, and all ropes taken in from the dock. We backed the boat away from the pier and the gear was shifted into "forward" and we were off for the Aldabras, the islands of giant turtles, thousands of birds, and BEST OF ALL A RARE DX SPOT. This was one DXpedition

I firmly had made up my mind NO ONE was going to make us turn back from. After reaching the deep channel the sails were raised and the diesel cut off, and from then on it was a sail boat. Usually the diesels on these boats are used for landing and departing, basically this was a sail boat. This little Lua-Lua had a very deep keel and, for its length, a high sail. According to Jake it was practically impossible for this boat to capsize. I for one hoped he was right. I knew the boys all over the world, and especially back in the States, were all QRX for this brand new country I so badly wanted to put on the air.

As usual the first few hours out from Port Victoria sailing was very smooth since we were pretty well shielded from the big swells of the ocean by Mahe island. I fired up the rig and let loose with my first CQ signing VQ9A/MM and had one of the doggondest pile-ups you ever heard. Everyone wanting to know when would we arrive at the Aldabras. Considering the fact that the sunspot cycle was not at its best, the way signals came thru really fooled me. I hoped conditions would stay like that when we got to the island. The band (14mc) stayed wide open almost around the clock. I suppose being nearly on the equator did make a big difference. It was agreed before we departed that each of us would take his turn at the wheel. But with conditions so good on the air my turn at the wheel never did come up because I was very QRL when it did. So in the end the chore of handling the wheel was always Harvey's and Jake's. An issue was never made about this so all the way down I got in plenty of operating.

When we finally got out from the shadow of Mahe Island into the deep blue sea all the smooth sailing changed to just the opposite. Each wave had its own white cap, the swells were wide apart and the little boat would glide down into each valley of those swells and then all you could see was water looking like mountains all around the ship. Those big sails put the boat into 45 degree lean nearly all the time. I soon found out that this fellow Jake was about as good a sailor as Harvey. This was going to be a Good DXpedition I could see. I used to watch the little stove going back and forth, and then side to side, everytime the boat tossed or pitched. It was hard to believe that the tea kettle would sit on that stove with so much motion.

Harvey's black cat was very busy as usual scampering all over the deck looking for flying fish. Harvey kept one eye on his cat and the other on the compass when he was on the wheel. We all were having a very fine time, and everything was going smoothly. Harvey was always looking for one of those "stormy petrels," small birds that skim the tops of the waves, sort of following the boat, which according to him indicated bad weather was coming. So far we had not seen any of them, but we did see plenty of other birds. At times we saw a great many birds, especially when one of them spotted a school of fish. Suddenly from out of nowhere would appear hundreds of birds. They dived into the school, each of them squawking just before it hit the water. There would be a steady stream of these birds pouring into the school of fish, and another stream flying back into the air so they could hit the water again and catch another mouthful of fish. Occasionally we would see a whale in the distance. They could be easily spotted when they came to the surface to "blow."

Thank goodness there was no sign of seasickness on board this time. The toilet was flushing OK and even the bilge pump was working properly. Each of us had his own little cabin down below deck with his own private port hole. The bunks were pretty well padded and had good high side boards so we would not be tossed out when the ship heeled far over. My bunk was just the right length so that I could wedge myself in and not slip and slide from foot to head when the boat pitched back and forth. Things can get pretty rough when you are about a foot too short for your bunk and you start sliding back and forth with the movements of the boat. Specially me with my practically bald head. Give me a bunk that's my exact length every time in rough seas. The sideways motion of the boat was better than sleeping pills to put you to sleep. I mean when the swells were wide apart and the motion was like clockwork. At other times when the sea was not in a good mood, getting to sleep was a problem. The further South we went the more vicious the seas became. But still no sign of seasickness which was FB with us all. Even Harvey's cat did not get seasick as it did on our attempt to sail to Agalega on the other trip. OH, YES! cats do get seasick—at least Harvey's black cat did. It's sort of messy too and smelly. A seasick cat—ug UG UG. I wonder if fish ever get seasick? Hi! Hi!

After 3 days at the wheel both Harvey and Jake were pretty well pooped out, so when we pulled into the coral reef that's all around Desroches Island and delivered the mail there, we waited so that the people who received mail could answer it. We walked around the island, had a fairly good meal and back to the boat with the outgoing mail. We arrived on board a little before sundown. Harvey and Jake decided to spend the night inside the coral reef and get some rest from their turns at the wheel for the past 2 days. Just when it got dark, down to their cabins they went for a long night's rest. For myself I cranked up the little putt-putt and went on the air signing VQ9A/MM. 20 meters stayed open until about 2AM. Down to my little cabin I went after turning off the power plant. Since the boat was pretty well screened by the island there was very little air moving down below deck. So I decided to sleep out under the stars on one of the padded portions of the rear deck. Both sides were padded and comfortable, one on each side of the boat with the wheel in between the two. It seemed as if I were going to have a nice quiet sleep out under the stars. After lying down and doing a little thinking, I wondered what my wife Peggy was doing at that very moment; if the phone patch net across the USA would be ready to go into action when I arrived at Aldabra, and what channel "A" were saying to each other. I also wondered why they did not count Desroches as a new one (not knowing that one day it would be a new one). I could have so easily gone ashore and had some nice pile-ups, and told everyone to date his QSO for late 1966 so that they would have themselves a new one. Hi, Hi. When you are lying on the topside of a small boat at anchor late at night so far from home you have time to think of a lot of things. For a while I even watched to see if there was any flying saucers anywhere around. When I did finally get nearly to sleep, it seemed as if I were hearing some sounds that I had not heard before; the boat seemed to be moving a little bit more than it had before. For a while I just lay there listening very closely and SUDDENLY I DID HEAR some strange sounds like a wet mop was being dragged across the boat somewhere near me, and then I started to hear some sucking sounds, sort of like something was trying to suck water from a bottle, something that had about 6 or 7 mouths at the same time. As my eyes had become accustomed to seeing in the starlight, I sort of opened them both, not knowing what I would see, and looked right across from where I was and only about 6 feet from me there was something that looked like an elephant trunk moving around the other padded seat right across from me. I let loose a loud yell, and some unprintable words probably along with the yells. Jake and Harvey came tearing up the steps from below and one of them yelled "It's an octopus." They grabbed some oars from the life raft and began to pound and pry loose that elephant-trunk-looking thing, finally it came loose and was tossed overboard. Then they told me there was 7 more of those tentacles that would have whipped onto the deck if that one I saw had found something to wrap itself around. I was sure glad that the one I saw had picked the left side of the boat instead of the right-hand side where I was lying. This could have brought this DXpedition to a sudden stop. After things sort of quieted down I went to my cabin this time, and even shut the door and my porthole too. I forgot all about how hot it was down there. But I never did go to sleep. Every movement of the boat I heard, and a few times I am sure something was trying to come on board the ship. They say an octopus never leaves the water. This one must have been a large one judging from the size of that one arm I saw. Things were getting interesting now. At sunrise the next morning we lifted anchor and away we were again for Aldabra. Plenty of high winds and big high waves all the rest of the way down. No stormy petrels were seen so, as was expected, no storms were encouncountered. One day out from the Aldabras we began to see the Booby birds out catching their small fish for their young back on Aldabra. At times we could see some of those high flying albatrosses. They never seemed to flap their wings.

It was always interesting to me when it came time to "shoot the sun," or maybe it was "shooting Venus," to get our bearings. I would listen to BBC and give the exact time, just a few seconds off and your QTH would be a few miles off course. Remember you don't see these flat islands in this area if you are more than 4 or 5 miles off course. Harvey and Jake both used their own sextants and did their own figuring. Most of the time both came up with the exact same QTH. You try measuring the exact angle of the sun or a star from a tossing and pitching ship. A sextant you know has two images on it, one is the horizon and the other you see the object you are shooting, such as the Star, Moon, Sun etc. You are interested in the EXACT number of degrees this object is above the horizon at a certain exact second. I tried it myself a few times and doggoned near fell overboard. When the ship leans to the left you lean to the right, etc. It still looks impossible to me. You really have to have "sea legs" to keep your body always at a 90 degree angle from the horizon. Harvey's black cat did catch a few flying fish that landed on deck, slipping and sliding all the way, and Harvey saying "look at that crazy cat." Harvey first spotted the Island, and neither Jake or I could see it. When these islands are just on the horizon, being flat, they are nearly impossible to be seen by an untrained eye. When first seen they are actually part of the horizon but just a little darker in color from the sea. Of course in about one hour both Jake and I could see the island. Out came the maps of the Aldabras and we decided just where we wanted to land, or at least unload my equipment. We pulled up opposite the inhabited part of the island—the island is sort of horseshoe shaped, some 15 or 20 miles from tip to tip. The inhabited portion is near one end, most of the rest has birds as inhabitants, mostly those booby birds we had seen fishing when we neared the island. By the time we arrived at the place we wanted to take my equipment ashore to many of the small pirogues met us from the island. We were the first boat they had seen for a number of months. My letter of introduction was produced and shown the island manager; this letter I brought along with me was from the leasee of the island who lives on the Seychelles. Aldabra is crown property and cannot be bought like most of the other islands, I suppose that's why its considered a new country. We all went ashore, had a very fine lunch, we gave the island manager the mail we had brought along to the islanders from Mahe.

Next month I'll talk about the visit on Aldabra.

Around the U.S.A.

I am writing this episode of my story while in the middle of my trip around the USA and Canada showing my color slides and telling the boys of my experiences on overseas DXpeditions. Peggy is doing the same for the ladies. At this point in our travels we have stopped at Richmond, Va., Washington, DC, the Pittsburgh area, Dayton, Ohio, at their big annual get together, Detroit, Buffalo, N.Y., The big one at Boston and then up to Montreal with the VE2 boys and down to Toronto with the VE3 fellows and on to Philadelphia. Then the Potomac Valley and Frankford Radio Clubs have their annual get-together.

Peggy and I are having a wonderful trip meeting the fellows I have QSO'ed from so many places. Of course all their calls are being placed in my little WHITE BOOK for possible future use. I will be forever obligated to the many friends I have for making this trip around the country possible for Peggy and me. I am about to start putting some antennas up when we return back home on July 4th or 5th. Am taking my old 5 element yagi apart and using the boom for a new U.S. Fiberglass 4 element 3 band quad. I want to see how it will stack up on DX work. At this moment I am not sure just how long I will be at home before another DXpedition gets under way.

With the all new W T W now on, almost any place I go will be a new one for nearly everyone. From the sounds of the bands the little bit I have been able to listen it seems that W T W has begun to catch on very nicely and I think when it gets in full swing things will be popping for some time. With awards for each band and with Phone and CW separated we think we have a good thing. The full W T W Country list is not yet complete. We are still QRX for the countries that a few of the larger national societies have to send us. As a rough estimate it looks as if there will eventually be something over 400 in the W T W list. We have begun with the ARRL DXCC list and adding to it those countries suggested by national societies. We refuse to be asked embarrassing questions as to why such and such a place is on our country list. We will refer all questions to the national society that suggested them to us. That will be the end of any questions asked us. We are letting everyone except ourselves make up the W T W country list.

A few pages of this episode is being written while we stopped by the home QTH on our way from Philadelphia to Little Rock where Peggy and I will be stopping by to visit old Moritz-WA5EFL, for one night, then on to Houston and my old buddy Frank W5IGJ, that gud guy with those fast dots on his bug, and the West Gulf boys. Then continue on West from there, on up to Canada, might be able to operate a little signing /VE8 I hope. Peggy and I sure are seeing the USA and Canada this time. We are driving our little new Mustang that we got from W4YJQ that DXer in Orlando, Florida. It runs like a sewing machine and purrs along in fine shape. We have air conditioner in it so will be prepared for the hot weather we expect before we get back home in July. The gang and I are having many late eye-ball QSO's in the wee hours of the night and I am very pleased to know many of them are getting into our all-new W T W with gusto.

Many of them have expressed their thanks for something really new being started in the way of a good DX award. All QSO's must take place you know after 0001 GMT May 1, 1966, to count towards the W T W.

It certainly is great meeting all my good friends in person all over the country. It's very good to know that Peggy and I have so many really sincere friends in every state; it makes us both fell very good to have all these fine friends everywhere we go. One of the highlights of our trip so far has been our visit to Peterborough, New Hampshire, and the home of 73 magazine, where we were welcomed by the whole crew there including Wayne and Paul. You know Wayne has a 37 room house there and the entire works for publication of 73 is under just one roof. Looked like only about 9 employees do the whole job. Each person knows what his or her job is and they do it. No rushing around like some places, everyone seemed to be taking it easy, doing their job. I wonder how many people it takes to put out QST or CQ? I would think it's a lot more than 9 people at each place. It seems that the crew at 73 must be very efficient to turn out such a good magazine with so few people. There was a big difference in the temperature in New Hampshire from what is was when we left Orangeburg, South Carolina, a few weeks before. The weather the night we stayed there dropped down to the thirties and the TV weather man said the South Carolina weather that day went up into the 80's. We certainly were treated very fine at 73 magazine and hope some day to return for another visit there. Wayne certainly should be congratulated for the job he is doing there with so few people. All I can say Wayne is "keep up the FB job you are doing in 73 magazine."

Oh yes I got to add two new call signs to my list, by operating as both /VE2 and /VE3, now the total is 119 different call signs for me. Have any of you fellows ever seen a ham station that uses 16 one-hundred-and-thirty-foot towers? Well that's what Clem-W1EVT uses. Did any of you know that Chas-W1FH carries a pistol while working at his package shop—it's located in one of the toughest spots it Boston. Many such interesting things were found out about different people here and there along our route. A new president was needed by ARRL and there was a lot of talk in the many hotel rooms as to who the new president would be. By the time this is in print this will be old news. It was interesting to see and hear this being discussed by so many people. Probably the new man was chosen that Saturday night in Boston in the various hotel rooms. High politics are quite interesting to watch and hear discussed. As usual I drank many Coco Colas at this convention and other places along the way. Of course many other drinks were drunk by others, some quite a bit stronger than Cokes, too!

. . . Gus

Protect Your VTVM!

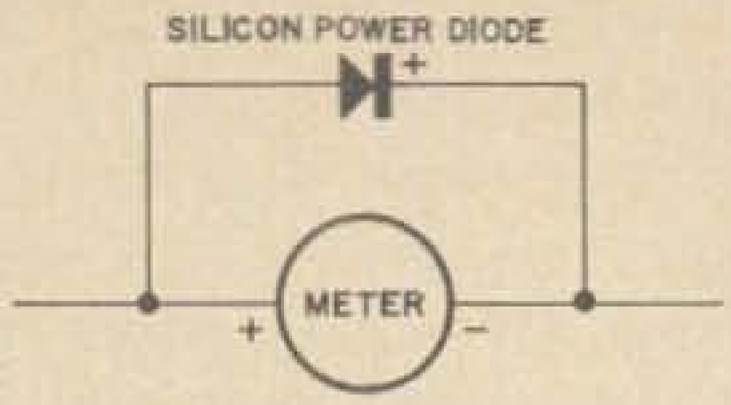


Fig. 1. Using the forward voltage knee of a silicon diode to protect a sensitive meter movement.

Since the rise of the Zener diode, meter-protection circuits using such a semiconductor across the meter movement to short everything out in the case of too much voltage have been flooding the literature.

Not so well known, however, is the fact that an ordinary silicon power rectifier has a "Zener break" in its forward characteristic at approximately one-half volt which can be put to similar use.

It's especially adaptable to protection of VTVM meter movements, which typically use 200 microamp ratings. Though they are advertised as "burnout-proof," which they are, these meters can still be damaged by severe overvoltage which slams the needle against the stop so hard that the needle bends.

But an ordinary silicon diode parallelled across the meter as shown in **Fig. 1** prevents such damage. During normal operation, the diode is effectively an open circuit since voltage across the meter coil doesn't rise above 0.2 volts, while the diode won't conduct below 0.5 volts. But with over-voltage applied, the diode goes into conduction at half a volt and shorts out the meter. This prevents the needle-bending slam across the scale, yet the half-volt present across the coil will shove the needle far enough offscale to tell you something's wrong.

In one VTVM circuit with which the idea was tested, the meter survived a 30-time overvoltage with no trace of damage. Coil current was limited to 250 microamps by the diode, which is only a 20-percent overload. With the scale of the VTVM set for 0-3 VDC, this corresponds to a 90-volt input. Try it with an unprotected meter (if you've got plenty of money to replace movements) and see what happens!

. . . Jim Kyle K5JKX

Resistors

We do not usually think of the lowly resistor as having any special characteristics to give it personality. I am sure most of you will be surprised, as I was, to find that the common carbon resistor is more than just a resistor. Did you know that it has inductance and capacitance so that it has a self resonance frequency?

The capacitance between the granules of a composition resistor tends to cause the reactance and resistance to drop with frequency. The skin effect tends to increase the reactance with frequency.

Resistor manufacturers are constantly striving to make better resistors. The best high frequency characteristic in a fixed composition resistor is achieved when the ratio of cross-sectional area to the length of the resistor is minimized. Small cross-section and fewer carbon binder contacts improve the high frequency characteristics. A standard ½ watt 1 megohm resistor will drop to only 10 percent of its DC resistance at a frequency of 500 MHz. A 1000 ohm ½ watter will hold 100 percent to 50 Mhz and drop to 85 percent at 500 MHz.

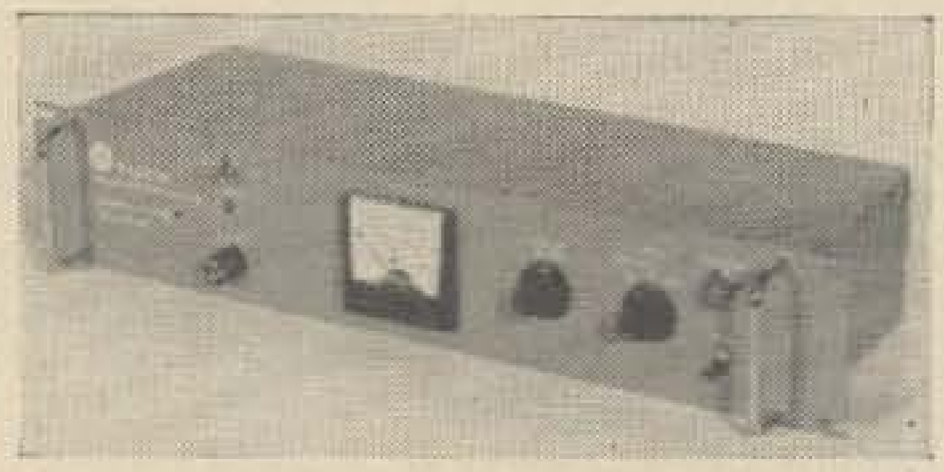
Various methods are used to get rid of the heat, and this is important because the resistance value will change with heat. The change is not too great (maybe 4 percent) but if it gets too hot it will not return to its original value. In operation, most of the heat (60 percent) is removed by conduction through the leads and 35 percent by convection to the surrounding air and the balance by radiation. It is not a bad idea to try to keep the heat down when soldering resistors because of the possible change. Use long leads if possible. The little clips used for soldering diodes and transistors will help.

Wire-wound resistors have always been considered as having inductance unless they are specials. The newer low wattage units look like composition, but you can tell them apart because the first color band is extra wide. These resistors can be used as low Q chokes if you can tolerate the resistance. Some typical values for a ½ watt and a 2 watt wire-wound would be as shown in the table below:

Resistance Ohms	Inductance ½ Watt/µH	Inductance 2 Watt/µH
0.5	0.04	0.12
1.0	0.04	0.09
5.0	0.10	0.18
10.0	0.09	0.24
100.0	0.75	0.80
1000.0	1.50	3.40

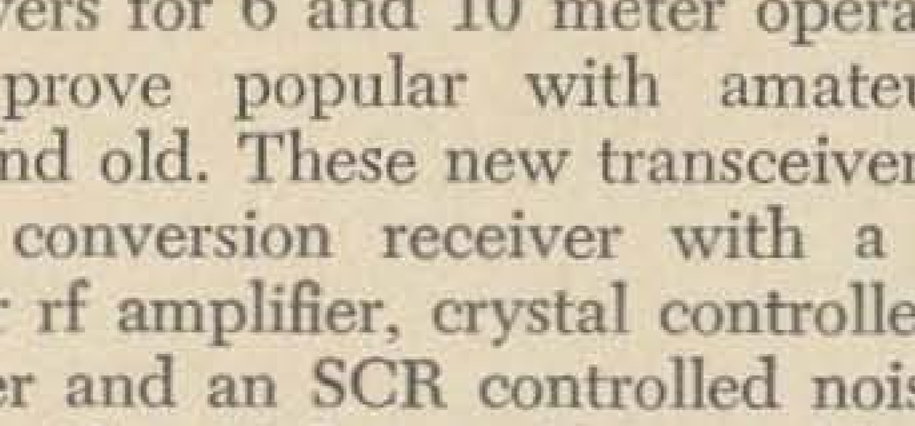
Ralph Hanna W8QUR

NEW PRODUCTS



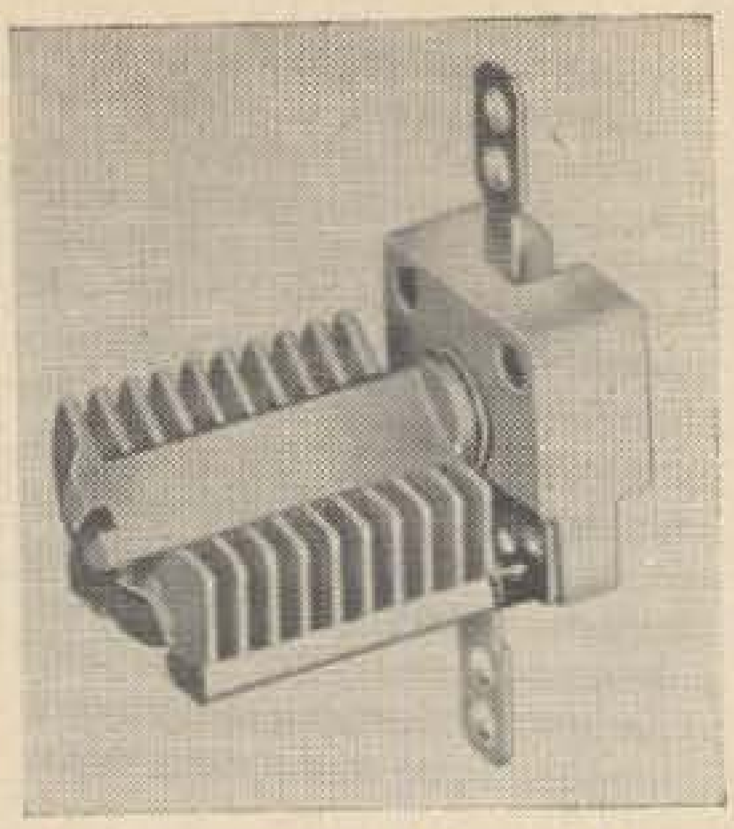
Tuck Model 103 High Frequency Exciter

Tuck Electronics has just announced a new series of solid-state high-frequency exciters that provide 2 watts output over a frequency range from below 1 MHz to above 30 MHz without tuning. Although the Model 103 illustrated above has a two position crystal oscillator, other models are available with up to ten crystal positions. For the RTTY enthusiasts a special crystal oscillator is available with provisions for frequency shift. Complete details on this unit and the entire Tuck line is available from Tuck Electronics, 2331 Chestnut Street, Camp Hill, Pennsylvania 17011.



Lafayette 6 and 10 Meter Transceivers

Lafayette has just introduced a new line of transceivers for 6 and 10 meter operation that should prove popular with amateurs both young and old. These new transceivers feature a dual conversion receiver with a sensitive Nuvistor rf amplifier, crystal controlled second converter and an SCR controlled noise limiter that provides high sensitivity *without* harsh noise. The transmitter runs a full 20 watts input and has a built-in VFO, low pass filter, and both AC and DC power supplies. In addition, a push-to-talk ceramic mike and mobile mounting bracket are included in the package. Although a VFO comes with the transmitter, provision is made for crystal control with standard 8 MHz crystals. The Model HA-460 covers 50 to 52 MHz and the Model 410, 28.0 to 29.7 MHz. Price: $149.95. For more information, write to Lafayette Radio, 111 Jericho Turnpike, Syosset, L.I., New York.



Johnson Capacitors

With the new Type "U" high-density capacitor, Johnson has expanded its air variable capacitor line to include more than eleven basic types in a wide selection of single- and dual-section, butterfly and differential units. Models in the line range from miniscule subminiature types to large, heavy-duty units rated up to 1700 pF and 13,000 volts peak. The unique design of capacitors machined from solid brass bar stock provides wide tuning range, uniformity and stability that is ideally suited to all types of tuning and trimmer applications. The larger plate area of the new Type "U" capacitor provides a 28 per cent increase in capacitance with no increase in size. These units require less than 0.2 spare inches for mounting and exhibit "Q" greater than 1500 at 1 MHz. Complete details on these capacitors and other components in the Johnson line are provided in the company's new 36-page Catalog No. 700. Write to E. F. Johnson Company, Waseca. Minnesota.

Eklind Allen Wrenches

The Elkind Tool and Manufacturing Company has come up with a set of T-Handled hex keys that you can really get a good grip on. These new wrenches come in three lengths, 3, 6 and 9 inches, and in eleven sizes from 5/64 to 3/8 inch. Eklind Tool and Manufacturing Co., 2627 N. Western Avenue, Chicago, Illinois 60647.

E-Z Mobile Antenna Mount

The new E-Z Mobile Antenna Mount provides a neat way of attaching your antenna to your mobile without drilling any holes. This new mount attaches to your trunk lid in minutes and in many cases provides increased radiation efficiency because the trunk deck exhibits a superior ground plane. These mounts are available over the conventional bumper mount with various antenna mounting holes including 3/8", 3/4", and small or medium ball. $8.95 from your local dealer or write to E-Z Mobile Antenna Mount Inc., P.O. Box 277, Algonac, Michigan.

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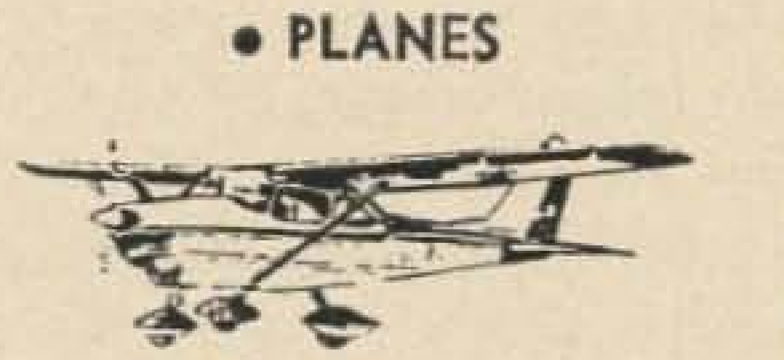
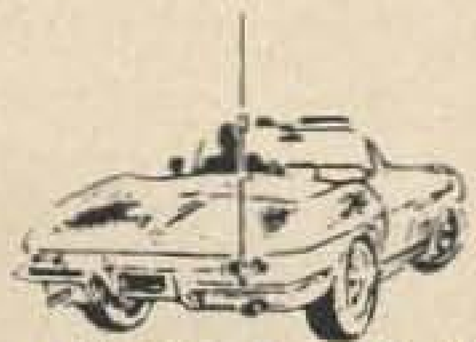


• PLANES



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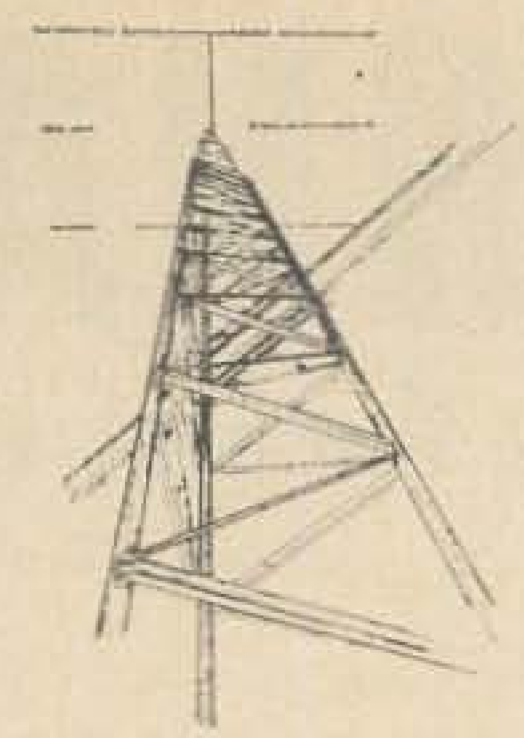


Tristao CZ-454 Crank-up Tower

The Tristao Tower Company has just announced a new crank-up tower that is especially suited for the ham with a *problem* installation; the operator who wants his antenna 60 feet in the air but has little or no room for guys. The new Tristao CZ-454 tower is attached to a building 10 or 15 feet above the ground and has sufficient stiffness to support an average tri-bander beam when fully cranked up. The diagonal steel bracing and heavy channel step bracing provide the strength to withstand strong winds even with a tri-bander on top. The new geared winch features an automatic locking disc brake. This brake provides constant safety in both the lowering and raising positions because whenever the handle is released the brake locks the winch. In addition it may be padlocked to prevent unauthorized use. These towers are hot dip galvanized after fabrication for maximum durability and a hinged base, house mounting bracket and rotator mounting plate are included with each tower. $349.95 from your local distributor or write to Tristao Tower Company, 415 East Fifth Street, P.O. Box 115, Hanford, California 93231.

Amperex 8643 Twin Tetrode

Amperex has just announced the new 8643 mobile power tube which incorporates a new type of cathode which is relatively immune to variations in battery supply voltages. With this new design, the cathode can deliver 90% of the rate power without damage even though the supply voltage varies from as much as 16 volts or as little as 10 volts. Actually the 8643 is the first in a family of Amperex twin tetrodes that feature this new cathode design. It is indirectly heated tube, designed for use as an RF power amplifier, oscillator or frequency multiplier up to 175 MHz. Under ICAS conditions it will produce 123 watts with 3.5 watts drive. For more information write to Amperex Electronic Corporation, Tube Division, Hicksville, Long Island, New York 11802.

Field Effect Transistors from Motorola

Two new lines of N-channel field effect transistors for rf and audio work have been introduced by Motorola Semiconductor Products Inc. The main feature of these new FET's is their relative low cost. The audio and general purpose 2N4220-22 are priced at $2.85 in small quantities and the rf types 2N4223-24 as low as $3.65; compare this with the 1965 average of $7.00 for all FET's. In applications such as tone control for hi-fi audio amplifiers, the high input impedance of the 2N4220 series allows for vacuum tube design principles in the selection of tone control elements. As a result, high resistance values and small, low-cost, more reliable capacitors may be used. In addition, the low noise of these transistors provides a definite advantage over conventional transistors.

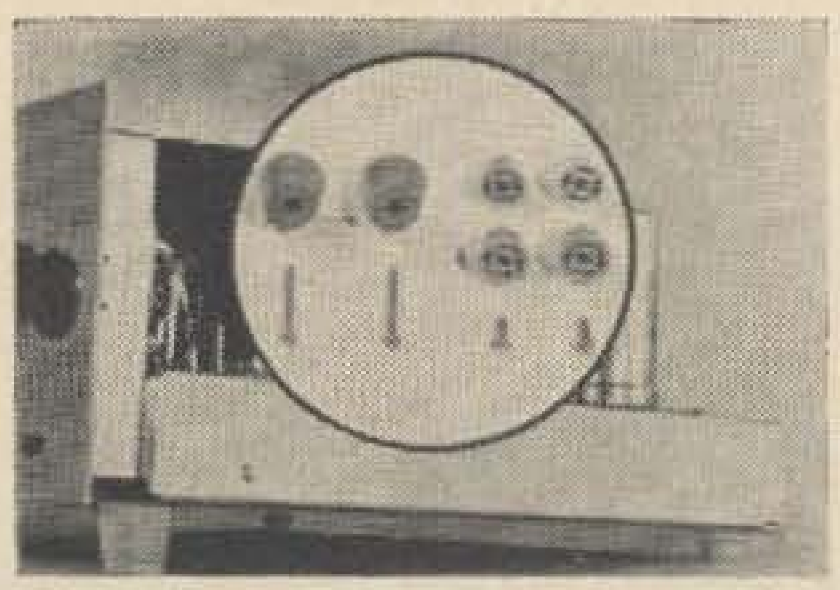
For applications in low-noise rf amplifiers, the 2N4223-24 types offer low cross-modulation and intermodulation distortion, a maximum noise figure of 5 dB at 200 MHz, plus a minimum gain of 10 dB at 200 MHz. Consequently it is now possible to construct rf amplifier circuits with the assurance of minimum distortion and low noise, as well as good gain with the advantages of small size. These new devices are available from any Motorola Franchised Distributor or District Office. For more complete information write the Technical Information Center, Motorola Semiconductor Products, Inc., Box 955, Phoenix, Arizona 85001.

Heath SB-600 Communications Speaker

The Heathkit SB-600 Communications Speaker features styling to match the Heath SB-Series line of amateur equipment and matches the 8 ohm audio output from the SB-100, SB-110 and SB-300. This new speaker had an audio response from 300 to 3000 Hz and it is especially well suited for single sideband communications where the audio pass band is relatively narrow. The interior of this unit is quite large and includes space for mounting the fixed-station HP-23 power supply, which is used with the SB-100 and SB-110. $17.95 from the Heath Company, Benton Harbor, Michigan 49022.

Heath HD-15 Hybrid Phone Patch

The new Heath HD-15 Hybrid Phone Patch provides swift, efficient coupling of your equipment to the phone lines. It includes complete facilities for the monitoring and control of transmitted and received signals with separate controls for receiver-to-line and line-to-transmitter audio levels and a panel-mounted VU meter. This new patch matches 3-16 ohm speaker circuit and high impedance transmitter input circuits to the 600 ohm telephone lines. The hybrid circuitry permits use with VOX controlled equipment as well as push-to-talk operated transmitter. The HD-15 features low-silhouette styling and color scheme to match the Heath SB-Series equipment. $24.95. For complete specifications write to Heath Company, Benton Harbor, Michigan 49022.



Budwig Cabinet Mounts

The new Budwig cabinet mounting feet and extenders make it simple to create convenient tilted-front panels. Each 89¢ kit includes four soft plastic feet, two rigid polypropylene extenders and the mounting screws. Details are available from the Budwig Manufacturing Company, P.O. Box 97, Ramona, California 92065.

General Electric Hobby Kit

The article on Vectorboards in the issue of 73 probably has a lot of you anxious to try them out. Unfortunately, many radio distributors around the country don't carry them in stock. But GE is now selling a small kit of a punched board, a number of terminals, and even feet for the board for only 98¢ at their many distributors. It's made for the projects in their new Hobby Manual, but the kit is also ideal for other small circuits. Look for the kit at the GE hobby display at your local wholesaler.

New Books

RCA Transistor Manual

The new RCA Transistor Manual, the SC-12, has been expanded by more than 20 per cent from previous editions. This new 480 page manual covers many new semiconductor devices and applications, a *streamlined* data section with more extensive data on active transistors, up-to-date transistor selection charts, and information on mounting hardware, mil-spec transistors and circuits. In addition, the SC-12 contains 145 pages of text which has been written to bring the reader up to date on the latest semiconductor technology and applications. Included is a completely new chapter on MOS field effect transistors, as well as information on transistor frequency converters, rf power amplifiers, detection circuits, power switching circuits and TV sync and deflection circuits. The circuits section has been revised to include more than 40 transistor circuits, complete with parts lists. Copies of this new manual may be obtained from RCA Distributors or by sending $1.50 to Commercial Engineering, RCA Electronic Components and Devices, Harrison, New Jersey 07029.

Electronic Construction Techniques

This book is just what the doctor ordered for the ham who builds his own gear. George L. Ritchie, the author, has had many years of experience teaching electronics construction at San Jose City College in California, so he is well qualified to point out many of the subtleties of building electronics equipment. This book is not just a wiring and soldering manual, but includes details on electronics drafting, bending and forming all types of chassis, making printed circuit boards, mounting components and using all types of tools, including the lathe. If you have ever tried to make up your own chassis and didn't know exactly where to start, this book will tell you; and after the chassis is made, you can find complete details on how to finish it whether it be paint, anodize or alodine. Although most of the author's construction techniques are based on the use of metal brakes, shears and punches, with a little ingenuity the average ham can duplicate any of these procedures with a pair of aviation snips and a couple of hardwood boards clamped in a bench vise. $4.95 from your local bookstore or through the publisher, Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017.

Basic Electricity for Electronics

Like the old adage says, "The hardest thing about ham radio is getting started." However, this new book by Robert Middleton and Milton Goldstein removes some of the pain of getting started. Although not written exclusively with the radio amateur in mind, it covers electronics in a thoroughly enlightening and interesting manner that should appeal to novices and beginners. There is almost no math in the text and the authors have provided lots of illustrations, so many of the important points are immediately brought home. One advantage this new 694 page volume has over previous books of the same nature is its coverage of semiconductors and transistors; however, vacuum tubes are not completely forgotten and there is a chapter on them too. By in large though, the main body of the book is devoted to the more basic aspects of electronics, including dc and ac circuits, transformers and tuned circuits. In addition, the appendix in the back of the book is chock full of useful electronic data. $9.95 from your bookstore or write to the publisher, Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017

Transistor Circuit Analysis and Design

Here is an easy-to-use reference for amateurs and technicians interested in transistor circuitry. Except for the first chapters of the book which discuss basic semiconductor physics, this book is completely practical in nature and John J. Corning, the author, presents an easy-to-read approach to all types of transistor circuit design. Unlike many books which were written with only the professional design engineer in mind, all you need is a knowledge of algebra and basic electrical circuits to successfully use this book. The author discusses dc bias techniques at great length, and then thoroughly covers low frequency (audio) amplifiers, large signal amplifiers, high-frequency amplifiers, oscillators, pulse circuits and power supplies. In each of these discussions, the operation of each of the circuits is completely analyzed and complete details are provided. In addition, the effect of different component values, particularly bypass and coupling capacitors, is described in detail. All in all, this book is a very complete manual of transistor circuit design that should appeal to anyone interested in designing their own transistor circuits. Available from your local bookstore or write to the publisher, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Motorola Semiconductor Handbook

Motorola's new 216-page Silicon Rectifier Handbook provides all the information required in the intelligent selection and application of silicon rectifiers. This new handbook is particularly valuable because all phases of the rectifier art are completely covered; all types of rectifier circuits as well as voltage multipliers and regulation circuits, arc suppression and other specialized circuits are described and analyzed. It is available for $1.50 from your local Motorola Semiconductor distributor or from the Technical Information Center, Box 955, Phoenix, Arizona 85001.

First-Class Radiotelephone License Handbook

Since the FCC has revised its requirements for the First-Class Phone license to include a thorough understanding of semiconductors and their circuit applications, a new license manual which covers these facets of electronics has been sorely needed. Edward M. Noll's First-Class Radiotelephone License Handbook not only fills this need, but also explains the practical skills and know-how the technician or amateur must have as a qualified broadcast technician or engineer. Although this book contains a comprehensive question-and-answer section, it is far more than an exam preparation manual and includes chapters on all phases of radio communications. Copies are available for $4.95 from your electronics parts distributor or from the publisher, Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Indiana 46206.

Allied Electronics Data Handbook

The fifth edition of Allied's popular Electronics Data Handbook has been revised and enlarged to include new and up-dated material for use in electronics. This handy little reference book has sections on electronics math, radio and electronic formulas, transmission lines, vacuum tubes, transistors and 70-volt speaker matching systems. Included are attenuator networks, coil winding formulas, wire table, charts for inductance, capacitance and resistance, metric conversions, logarithms, trigonometric functions, and much more. All of the material in the handbook was compiled with the cooperation of technical specialists on the staffs of electronics manufacturers and publishing houses, so it contains just about all the reference material ever needed in the ham workshop. This new handbook is available for 75 cents from Allied Radio Corp., 100 N. Western, Chicago, Illinois 60680.

go in for fairly sophisticated research that seems to be uncommon in the small ham radio field. So they fall back on the old dodge that if it costs twice as much, it must be twice as good.

Why don't we double our rates? Because the advertisers would realize that we weren't delivering twice the value to them. But on the other hand, one of our competitors with falling circulation (both competitors are in this category, so I'm not telling tales) raised its rates a considerable amount last year! Of course, their advertising is down, but we can't be positive that there is a direct relationship because of other factors.

We don't get the big mail order dealers with their fat catalogs because they get poor returns on the coupons they insert in 73. The reason was plain after we evaluated a poll we took a year or so ago: most 73 readers are active hams. They already have most of the catalogs. But many readers of some other electronics magazines are not active, or serious about their hobby. They don't have many catalogs, so often request them. And nothing is more difficult than convincing some advertising managers that they'd be better off selling merchandise than free catalogs!

Advertising is a fascinating subject. Editors aren't supposed to concern themselves with advertising, but this is a small magazine. We can see the results of ads very quickly. More ads mean more pages, more articles. If any of you are considering advertising in a ham magazine, I would suggest that you write or call WØRA for more information. We also have a small booklet on the mechanics of inserting ads in 73. You might like a copy if you're serious about getting into national advertising.

Well informed hams

The June 13, 1966, issue of Newsweek gave ham radio a nice plug:

People-to-People Radio

> An elaborate study by the Pentagon's Advanced Research Projects Agency has singled out what may be the best-informed group of citizens in the Soviet Union: the 15,000 to 20,000 Russian radio hams. Besides tuning in on the Voice of America and the BBC, the hams converse with short-wave operators around the world. The ARPA study was designed to learn how best to communicate with people in closed societies.

Current events

Letters wondering what happened to the semiconductor column I wrote last year suggest that there's a need for a monthly column devoted to all sorts of new technical developments. Among the things it might discuss are new transistors, hints on antennas, new surplus, frequencies for technical nets, questions and comments about 73 articles, addresses of technical clubs and so forth. Why not send in items of this type that you think might interest other technically-minded hams.

2300 MHz moonbounce?

With 144, 432 and 1296 under their belts, moonbouncers are zeroing in on the next higher ham band, 13 cm (2300 to 2450 MHz). This band has some advantage for moonbounce over lower bands, but also has two prominent disadvantages: the difficulty of generating high power and high noise figure in receivers. Neither seems to be insurmountable, though. High power klystrons are "available" for serious UHF'ers and a paramp for 2300 apparently isn't that much worse than one for 1300. A universal frequency like 432 or 1296 hasn't been accepted yet, but 2304 MHz (the 16th harmonic of 144) has been suggested. We'd like to hear from you 2300 boys so everyone will know what you're up to.

Insert booklets

This month we're running the second of our booklet-length feature articles. It's the middle of a three part series by WA6BSO on coax systems. Next month's booklet will be devoted to coax accessories such as switches, relays, baluns, SWR bridges, and dummy loads. A number of other booklets are in the planning stages. If you have any suggestions for 16 to 48 page booklets, or are interested in writing one, please get in touch.

We originally planned to have the books bound separately and inserted in the magazine so that they could be removed easily, but the post office foiled that. They have some very peculiar regulations.

Writing for 73

Authors and prospective authors are invited to send a self-addressed stamped 10¢ business envelope for our new booklet "Writing for 73." I think you'll find it useful.

Note for editors

A recent issue of *Better Editing* includes an article with a provocative title: "If You Go Riding off on a White Horse, Don't Forget Your Tin Pants."

. . . Paul

Coaxial Connector Handbook

Jim Fisk WA6BSO

Photos by Jim Harvey WA6IAK

Coaxial Connector Handbook

At the lowest audio frequencies and dc, coaxial cable connections consisting of simple solder joints to both conductors are sufficient in many cases. However, as the frequency of operation is increased into the low megacycle range, such connections allow leakage of rf energy and it is necessary to provide 360° contact with the outer conductor to completely contain the conducted electromagnetic field within the confines of the cable. At these frequencies the characteristic impedance of the section of line represented by the inner and outer diameters of the connector is generally not too important; the familiar series UHF connectors or "phono" connectors are illustrative of connectors suitable for these frequencies.

As the frequency of operation is increased beyond 150 mc, it becomes increasingly important that the characteristic impedance of the connector be the same as that of the cable. Also, any physical discontinuities such as the pin diameter of the connector differing from the cable inner conductor diameter must be held to a minimum. Common physical discontinuities such as steps or radial grooves in conductors act like shunt capacitors or series inductors respectively.

The adverse effect of these reactive components increases with frequency; therefore, to maintain a given standard of performance, the physical size of the discontinuities must be effectively made smaller and smaller as frequency is increased. Unfortunately it is not always possible to avoid all discontinuities and at the same time maintain a strong mechanical joint. In those cases where it is impossible to avoid discontinuities in the connector, they are compensated for by deliberately placing another compensating discontinuity in the same vicinity.

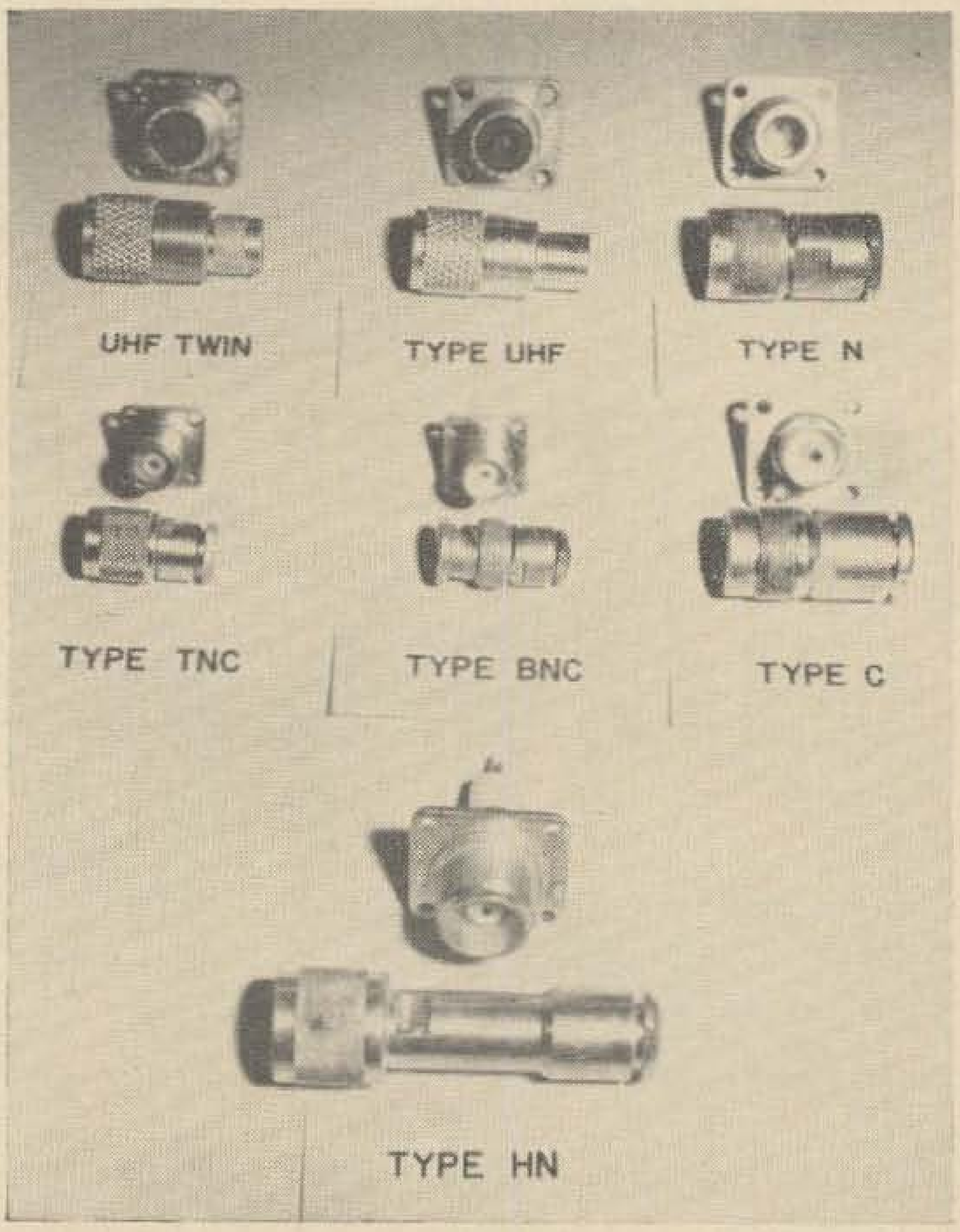
Types of coaxial connectors

Standardization of coaxial connectors has immeasurably aided in the selection and use of these devices. A direct result of this standardization is that a connector made by one manufacturer is directly interchangeable with similar connectors made by any other company.

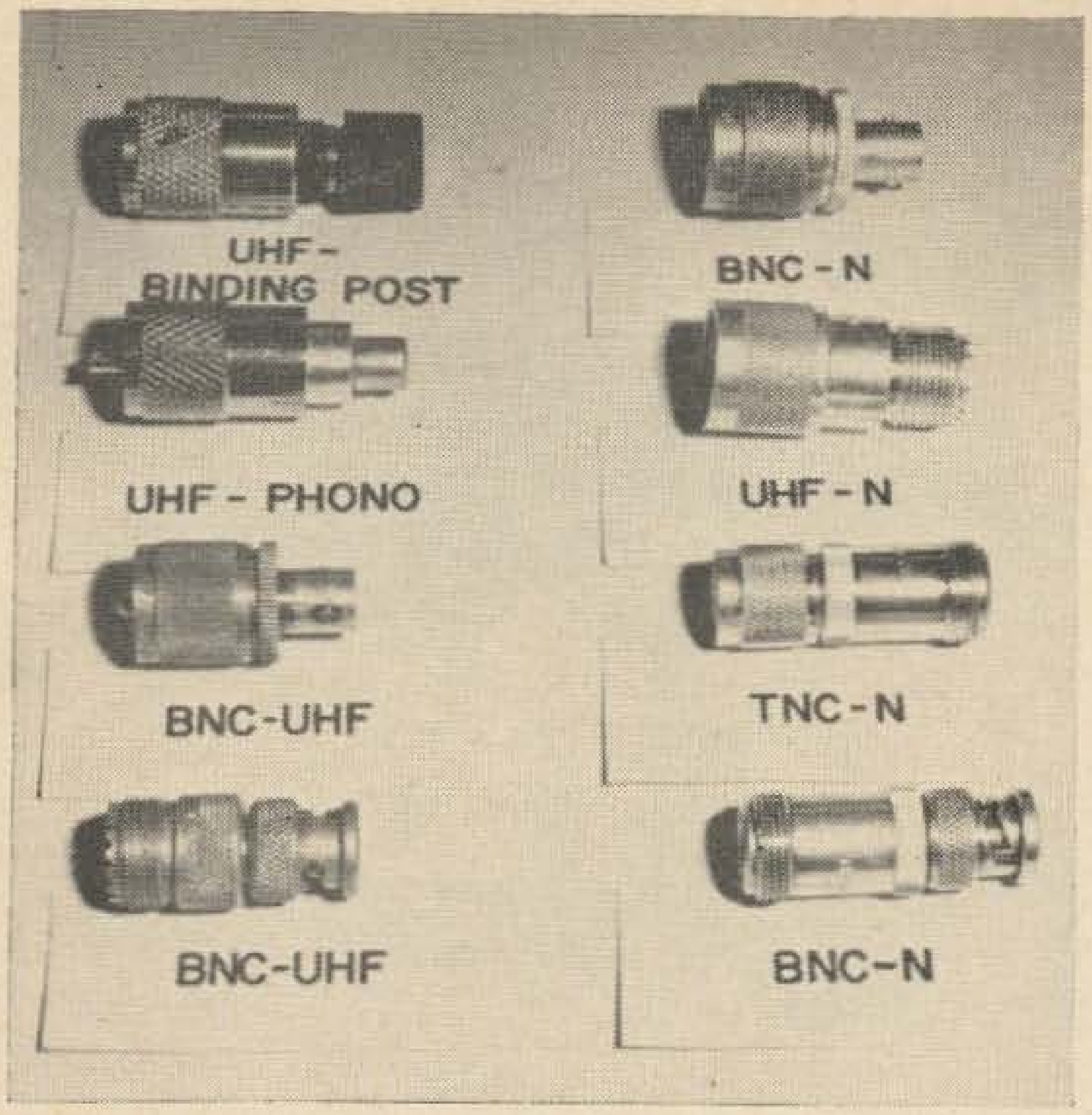
Coaxial connectors may be categorized by the method of coupling and cable size with which they may be used as shown in **Table 1.** Essentially, there are three methods of coupling; threaded, bayonet, and push-on. The five major cable sizes are subminiature, small, medium, medium-large and large. Although the various coaxial connectors were designed specifically for the cable sizes shown in **Table 1**, some types may be used with other cables. The Type N for instance, is available in configurations that are suitable for small, medium, medium-large and large coaxial lines.

Most major types of connectors are available in several different configurations within the series, based upon contact arrangement and cable clamping mechanisms. The three main divisions are "standard," "improved," and "captivated contact."

The "standard" connector employs a sleeve type or grooved silicone gasket which allows metal-to-metal braid clamping. The "improved" type used a "V" groove silicone rubber gasket which also provides metal-to-metal clamping but provides a better grip on the cable with minimum braid deformation and better SWR. In most cases the improved connectors may be used at considerably higher



Various coaxial connectors.



Straight between-series adapters.

frequencies than the standard versions. For example, standard Type N connectors have an upper frequency limit of 3500 mc whereas the improved version may be used to 10,000 mc.

"Captivated contact" connectors were designed to keep the center contact in a fixed position within the connector. This type is recommended for cables using Teflon dielectric and Teflon or fiberglass jackets. These cables, although excellent for high temperature applications, are difficult to use because the inner conductor has a tendency to shift when subjected to rapid environmental changes or mechanical stresses. The technique for captivating the contact provides protection against undesirable equipment disconnections.

Connectors are also available with clamping devices for subminiature cables and semi-flexible cables such as Phelps Dodge Foamflex. Coaxial connectors are attached to these cables through the use of barbed collets or clamps within the connector. The barbs may be machined into the clamp or a helically grooved sleeve is screwed over a barbed, helically coiled wire wound around the cable. The barbs are embedded in the cable's outer conductor and provide a rigid base for mounting the desired connector.

In addition to these variations, many manufacturers have "polarized" connectors available for the more popular types. These connectors are used to prevent careless or improper connections. The polarization is accomplished by reversing the normal insulation and inner contact assemblies. These connectors will not mate with normal connectors and the selected mating connector must also be polarized.

Two other types of connector construction that are worthy of mention are the crimped and wedged clamping types. The crimped connectors require no soldering and assembly time is reduced as much as 60%. These connectors are often used in large production facilities, and are the least expensive and simplest to assemble of all the connectors that require special tools. Unfortunately, the tools required are quite expensive and the crimped connectors are economical only where large quantities are involved.

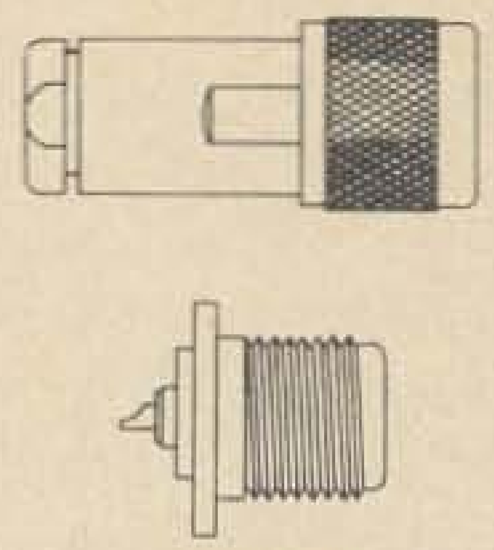
One type of wedged clamping connector available is Automatic Metal Products "Wedge-eze" illustrated in **Fig. 1.** This connector is economical, simple to assemble and does not require special tools for assembly. Another advantage over standard crimp types is that these connectors may be reused whereas the crimp styles are usable only once. In the Wedge-eze connector, the wedge-body assembly is placed over the cable dielectric, forcing the braid and outer jacket up over the conical section of the body. The nylon wedge cap then effectively clamps the braid and jacket to the connector as it is screwed on.

Types of connectors

SERIES UHF

UHF The UHF series was originally designed for use with medium sized cables such as RG-8/U, but reducing adapters were later introduced to permit usage with smaller cables. These non-constant impedance, non-weatherproof connectors are generally satisfactory for use up to about 200 mc and in some specific non-critical cases up to 500 mc. They may be used at peak voltages up to 500 volts. These connectors are made in two sizes, UHF small which is ⅝ inch in diameter and UHF large, one inch in diameter. Plugs, receptacles and adapters were included in the original design, but jacks were not in demand and were not developed. This series also includes twin contact connectors (both large and small) for use with twin coaxial cables such as RG-22/U.

Although this series is the most common coaxial connector found in amateur equipment, it is no longer approved for use on any new equipment built for the Armed Services. The complete family of UHF (single contact) connectors is illustrated in **Fig. 2.**

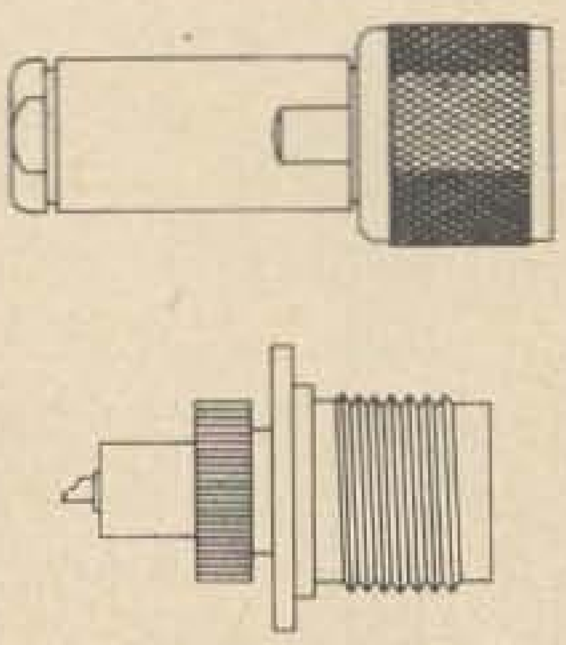


SERIES N

SERIES N Series N connectors are recommended where a medium size, weatherproof connector with a screw type coupling is desired and it is one of the most widely used series of connectors. They are general purpose connectors with constant impedance characteristics and may be used in 50 ohm circuits employing medium sized cables such as RG-8/U. However, when matching requirements are not critical, they may also be used with larger or smaller cables.

The original Series N design used a polystyrene bead as the dielectric material and the connectors were widely used because they were made in 50 ohm, 70 ohm, weatherproof and non-weatherproof varieties. The 50 ohm connectors will not mate with the 70 ohm connectors; however, 50 ohm connectors may be used with 70 ohm coaxial cables where impedance matching is not important. These connectors have a maximum voltage rating of 1500 volts and a practical upper frequency limit of 10,000 mc. They are gasketed for weatherproof operation and are available with various types of metal-to-metal clamping devices.

The complete family of type N connectors is shown in **Fig. 3.** This drawing rather graphically illustrates the versatility of this series with the many configurations available.



SERIES HN

SERIES HN Series HN connectors are medium-large weatherproof connectors for the same size cable as series N. The difference being that the dielectric material is tapered to permit their use at higher voltages. The latest version of these connectors employs a step design in lieu of tapering the cable dielectric. These connectors have a nominal impedance of 50 ohms, screw-type coupling and metal-to-metal braid clamping in standard, improved and captivated contact types.

Series HN connectors were originally designed for use in high voltage applications up to 5000 volts peak; however, results of tests conducted by the U. S. Navy indicate that at rf frequencies, the voltage characteristics of the HN connectors are no better than those

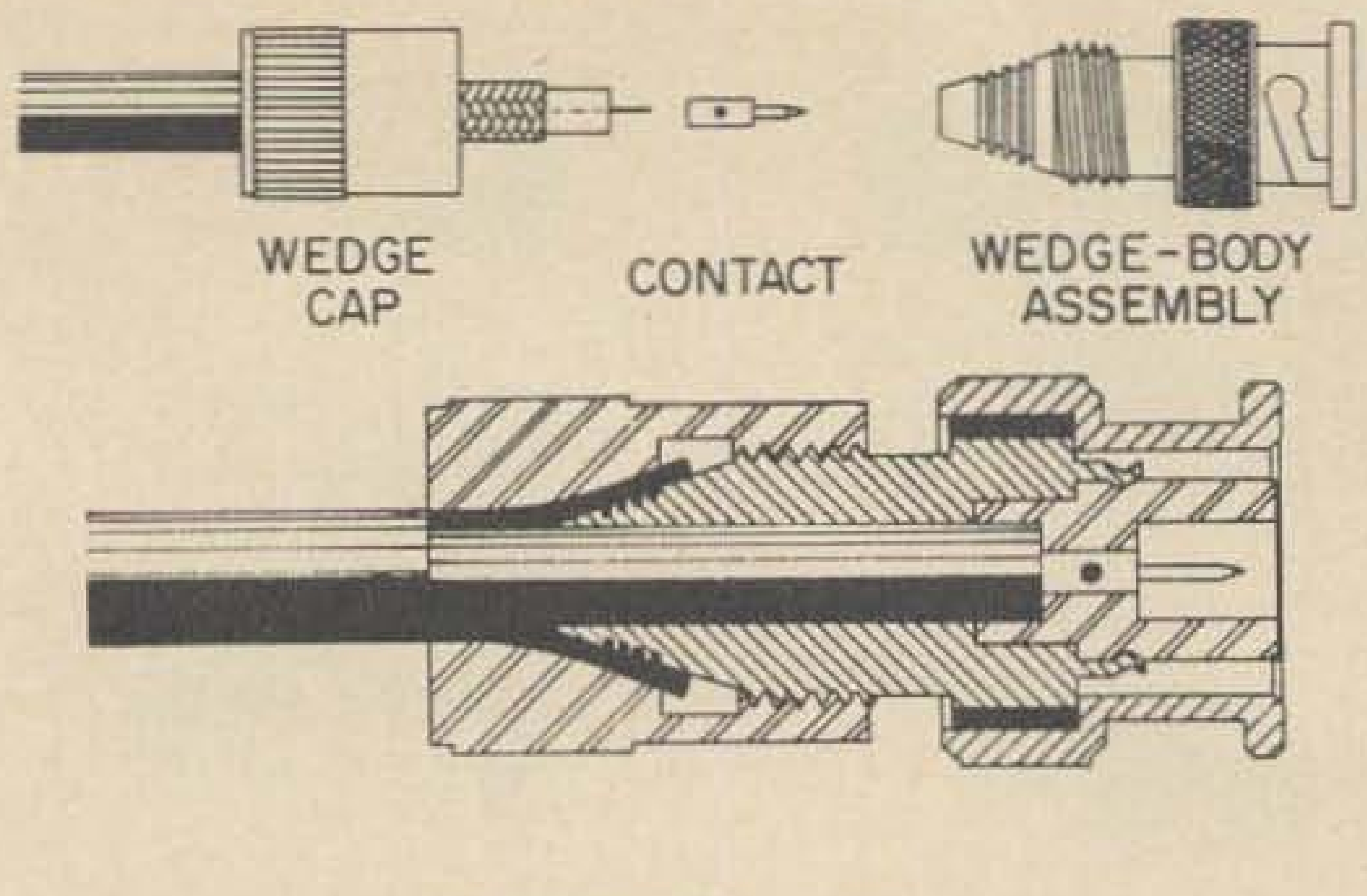
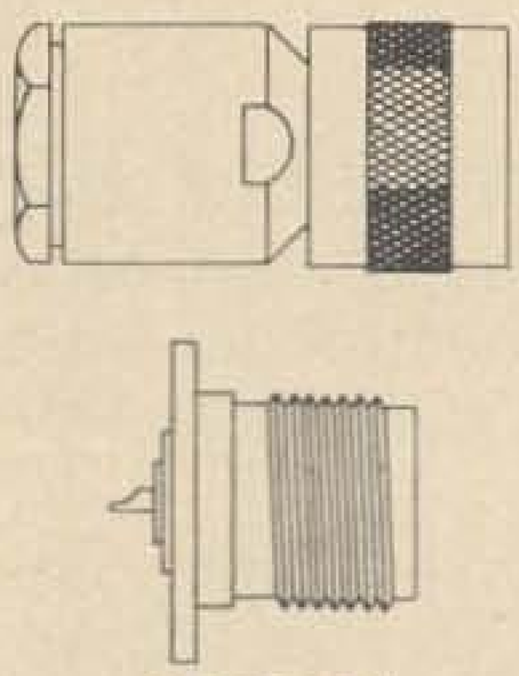


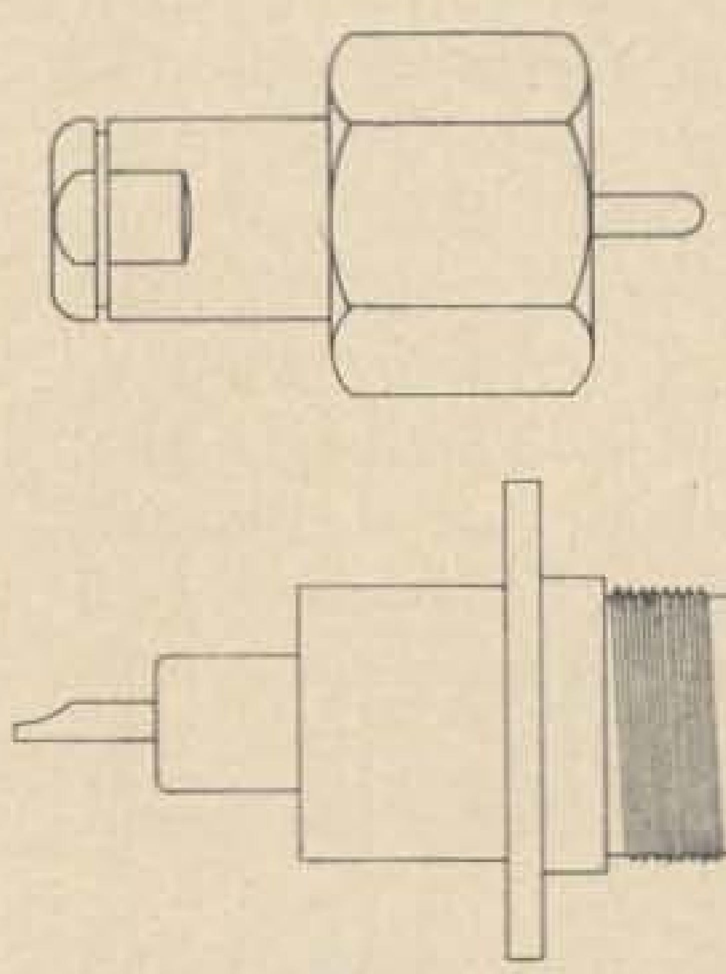
Fig. 1. Typical Wedge-eze construction.

of the C or N series. Consequently, HN connectors should be used for replacement purposes only.



SERIES LN

SERIES LN The series LN connectors are essentially nothing more than an oversized "N" connector originally used with the larger rf cables such as RG-14, -74, and -94/U. These weatherproof connectors have a nominal impedance of 50 ohms and an approximate peak voltage rating of 1000 volts. This series has been replaced by two plugs, UG-204A/U in the N series and UG-494/U in the HN series. Consequently, very few LN connectors are found in present day equipment.



SERIES LC-LT

SERIES LC-LT LC connectors are large-size weatherproof, 50 ohm connectors for RG-17, -18, -19 or -20/U coaxial cables employing screw-type coupling. They are intended for high power rf transmission up to 1000 mc. A jack was not originally designed for this series and it wasn't until the early 1950's that one was introduced.

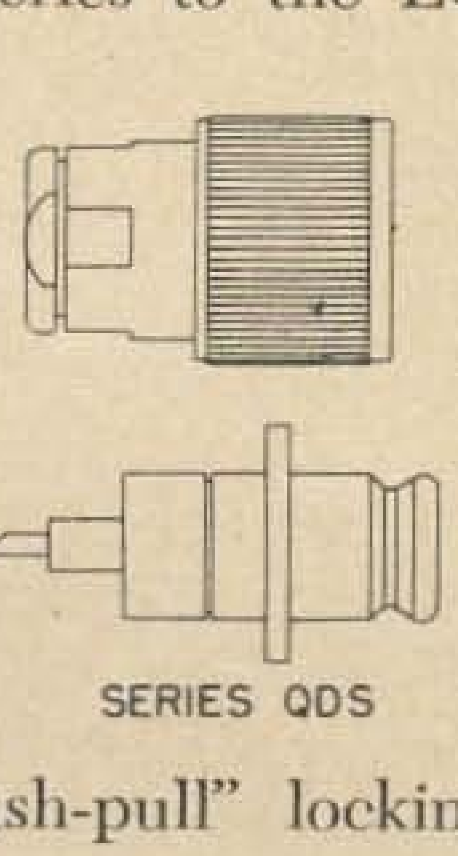
Two groups of LC connectors are available; group LC-1 which will withstand peak voltages of 500 volts and the slightly larger LC-2 which will withstand voltages in excess of 10,000 volts. Where it is desired to operate

	THREADED COUPLING				BAYONET COUPLING				PUSH-ON COUPLING			
Cable Size	Type	Thread	Impedance (ohms)	Max Freq (mc)	Type	Coupling	Impedance (ohms)	Max Freq (mc)	Type	Coupling	Impedance (ohms)	Max Freq (mc)
Sub-miniature	SM	1/4 X 32	50	1000	TPS	3 prong	50	10000				
Small	BN	3/8 X 32	50	200	BNC	2 prong	50	10000	Phono	Not Detented	Not Matched	200
	TNC	7/16 X 28	50	10000	MHV	3 prong	50	50				
	SKL	3/8 X 32	50	—								
Medium	N	5/8 X 24	50	10000	C	2 prong	50	10000	QDS	Ball Detent	50	10000
	UHF (Single)	5/8 X 24	Not Matched	200								
	UHF (Twin)	5/8 X 24	Not Matched	200								
	SC	11/16 X 24	50	10000								
Medium-Large	UHF (Single)	1 X 20	Not Matched	200								
	UHF (Twin)	1 X 20	Not Matched	200								
	LN	3/4 X 27	50	1000								
	HN	3/4 X 20	50	3500								
Large	LC-1	1 1/4 X 18	50	1000					QDL	Ball Detent	50	1000
	LC-2	1 3/4 X 16	50	1000								
	LT	1 1/4 X 18	50	2500								

Table 1. Coaxial connectors charted by cable size and coupling method.

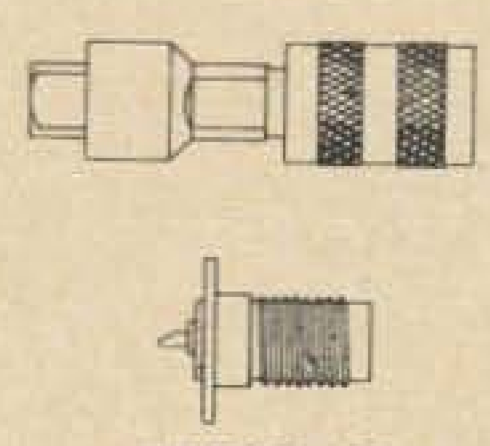
the LC series as a low voltage connector, the cable dielectric is butted flush against the dielectric in the mating connector. For high voltage applications, a counterboring operation is performed on the end of the cable dielectric with a special tool. Ignition sealing compound, such as Dow-Corning No. 4 should always be used on the faces of the dielectric mating parts of these connectors.

LT series connectors are actually an extension of the LC series designed to accept RG-117 and -118/U size cables. They have been improved greatly by specialized design, and several models are now manufactured for use at elevated frequencies. It should be noted that the LT series is similar to but not interchangeable with the LC series; an adapter is available which allows connection of this series to the LC series.



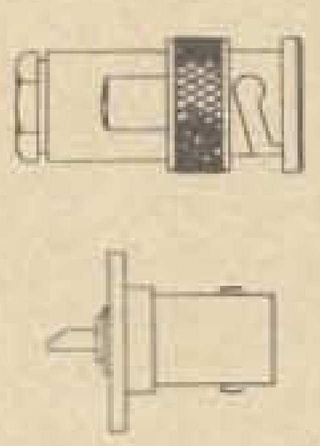
SERIES QDS

SERIES QDS The QDS series of connectors is an advanced version of the QDL series which was designed primarily for use aboard submarines to replace the LC series. This series uses a "push-pull" locking ball coupling arrangement similar to that found on air line hoses. This arrangement reduces coupling-decoupling time considerably. The QDS series are weatherproof, 50 ohm connectors for use with medium sized coaxial cables such as RG-8/U. These connectors are rapidly connected and disconnected and overcome the "rocking" tendency found in the bayonet type C and BNC series. QDS connectors employ an improved metal-to-metal cable clamping mechanism that provides a practical upper frequency limit of 10,000 mc.



SERIES BN

SERIES BN BN series connectors are small, lightweight connectors designed for use with small cables such as RG-58 and -59/U. Actually, they might be called small-size "N" connectors. They may be used for video, *if*, and other low power rf applications. These connectors are not electrically matched or weatherproof, and therefore are not recommended for applications at frequencies in excess of approximately 200 mc unless the electrical requirements of the circuit are not critical. They may be used at peak voltages up to 250 volts. Since the advent of the BNC connector, their use has been virtually eliminated except for replacement purposes on very old equipment.

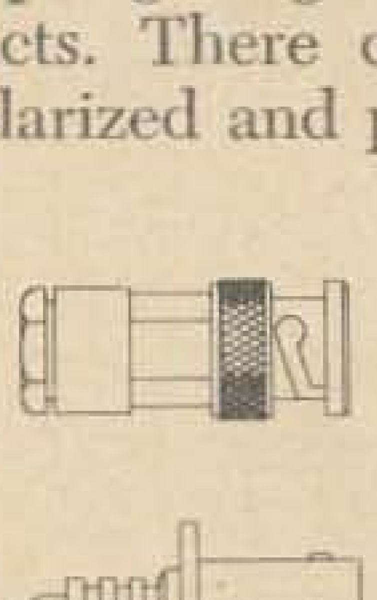


SERIES BNC

SERIES BNC This small connector design is probably the best known series in use at the present time. It was the first reliable quick connect and disconnect series; all the other connectors in early use used screw coupling. The bayonet coupling permitted rapid connections to be made and as such they made a tremendous hit in the test equipment field. These connectors are similar in size to the BN series but electrically they are greatly improved; original designs showed them to have an SWR of 1.15 from 1 to 3000 mc.

BNC connectors are of constant impedance with a nominal value of 50 ohms, and introduce little discontinuity in 50 ohm coaxial circuits employing small cables such as RG-58/U. Where some electrical mismatch is allowable, they may be used with other small and medium sized cables.

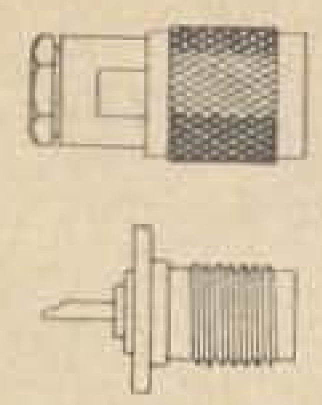
These connectors are fully weatherproofed and rated for use where the maximum voltage does not exceed 500 volts. They are available in standard, improved and captivated contact clamping arrangements. The improved connectors have been redesigned to give low standing wave ratios up to 10,000 mc in 50 ohm circuits. They are available with Teflon insulators which allow high temperature operation, and feature heat-treated beryllium copper spring fingers for both inner and outer contacts. There connectors are also available in polarized and pressurized versions.



SERIES MHV

SERIES MHV MHV series connectors are miniature high voltage connectors employing a bayonet-lock coupling similar to the BNC series. They are designed for small cables such as RG-58/U, and may be used at frequencies up to 50 mc. They may be used at peak voltages up to 5000 volts with a maximum current rating of 5 amps.

These connectors are similar to, but will not mate with, the series BNC connectors. They are weatherproofed with silicone rubber gaskets and feature the same metal-to-metal cable clamping mechanism used in the improved BNC series.

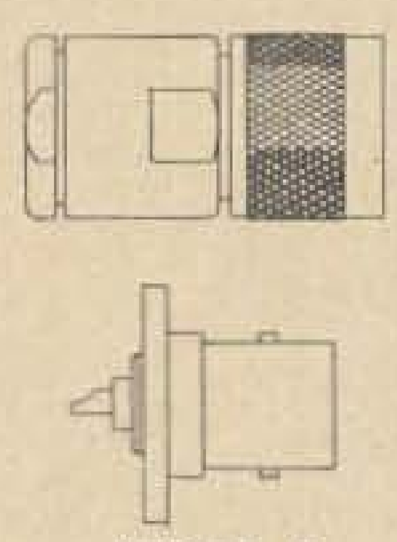


SERIES TNC

SERIES TNC Where in previous years great emphasis was put on ease of connection, the advent of high speed aircraft and missiles with their inherently stringent environmental requirements forced a return to the more positive vibration-proof threaded coupling. As a result the TNC series was created. Originally merely a threaded version of the BNC series prescribed for moderate frequency applications, increased usage at elevated frequencies through 10,000 mc has required manufacturing techniques far beyond those originally required for the BNC series.

The threaded coupling and safety wire provisions of the TNC series insure locking and secure mating under the most severe conditions of vibration and shock. Heat-treated beryllium copper spring fingers are used for both inner and outer contacts, thus providing positive contact during vibration and a substantial reduction in noise level.

These connectors are rated at 500 volts and have been designed to give low standing wave ratios at frequencies up to 10,000 mc in 50 ohm circuits. They feature clamping of the improved BNC type and are gasketed for weatherproof operation. Normally the TNC series is not used except in the stringent environmental conditions encountered in high speed aircraft or missiles.



SERIES C

SERIES C When originally designed the C series represented a big step forward in electrical performance at the higher frequencies. These connectors are for use with the same size cables as the N series but employ the mechanical advantage of bayonet coupling. This series introduced the new improved cable clamping mechanism wherein the cable gasket is actually cut when the clamp nut is tightened. This action gives good electrical contact for the cable shield and improves cable retention.

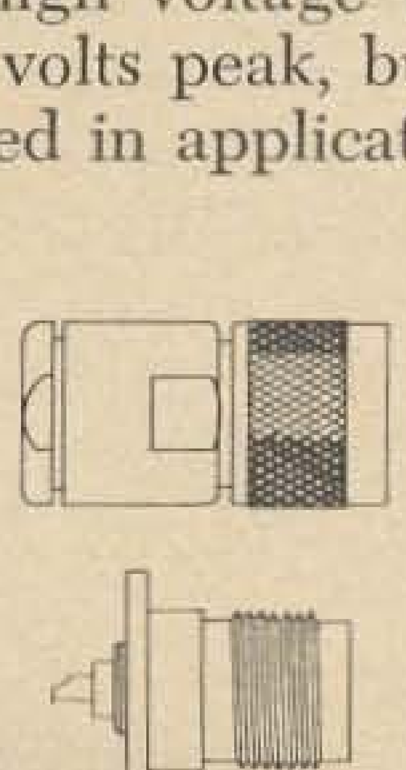
The C series is recommended where fast connection and disconnection by means of the bayonet lock coupling is required. For these purposes, this series is ideal. They are of constant impedance and may be used with minimum mismatch in 50 ohm circuits employing medium size cables such as RG-8/U. However, where matching requirements are not critical, they may also be used with either

Description					Military Number	Engineering Data
BNC	Female	to	C	Male	UG-636A/U	
BNC	Female	to	HN	Male	UG309/U	
BNC	Female	to	N	Male	UG-201A/U	
BNC	Female	to	N	Female	UG-606/U	
BNC	Female	to	QDS	Male	UG-1146/U	
BNC	Female	to	SM	Female	UG-690/U	Not Weatherproof
BNC	Female	to	SM	Male	UG-691/U	Pressurized
BNC	Female	to	UHF	Female	UG-255/U	Not Weatherproof
BNC	Female	to	UHF	Male	UG-273/U	Not Weatherproof
BNC	Female	to	Banana Jacks		UG-1035/U	
BNC	Male	to	C	Female	UG-635/U	
BNC	Male	to	HN	Female	UG-559B/U	Right Angle
BNC	Male	to	N	Female	UG-335/U	Flange Mounting
BNC	Male	to	N	Female	UG-349B/U	
BNC	Male	to	N	Male	UG-1034/U	Not Weatherproof
BNC	Male	to	QDS	Female	UG-1136/U	
BNC	Male	to	Banana Jacks		UG-978/U	
BNC	Male	to	Banana Plugs		UG-987/U	
BNC	Male	to	Binding Post		UG-282/U	
N	Female	to	BN	Male	UG-605/U	
N	Female	to	BNC	Female	UG-606/U	
N	Female	to	BNC	Male	UG-335/U	Flange Mounting
N	Female	to	BNC	Male	UG-349B/U	
N	Female	to	C	Male	UG-565/U	
N	Female	to	HN	Female	UG-1107/U	
N	Female	to	HN	Male	UG-1108/U	
N	Female	to	LC	Male	UG-999A/U	
N	Female	to	LN	Female	UG-108A/U	
N	Female	to	QDS	Male	UG-1144/U	
N	Female	to	UHF	Male	UG-83B/U	Not Weatherproof
N	Male	to	BNC	Female	UG-201A/U	
N	Male	to	BNC	Male	UG-1034/U	Not Weatherproof
N	Male	to	C	Female	UG-564/U	
N	Male	to	LN	Male	UG-213A/U	
N	Male	to	QDS	Female	UG-966/U	
N	Male	to	UHF	Female	UG-318/U	Not Weatherproof
N	Male	to	UHF	Male	UG-146A/U	Not Weatherproof
UHF	Female	to	BN	Male	UG-241/U	Not Weatherproof
UHF	Female	to	BNC	Female	UG-255/U	Not Weatherproof
UHF	Female	to	N	Male	UG-146A/U	Not Weatherproof
UHF	Female	to	Twin	Male	UG-970/U	Right Angle
UHF	Female	to	Banana Jack		UG-1017/U	
UHF	Female	to	Brittish 10H588		UG-197/U	
UHF	Male	to	BNC	Female	UG-273/U	Not Weatherproof
UHF	Male	to	C	Female	UG-637/U	Not Weatherproof
UHF	Male	to	N	Female	UG-83B/U	Not Weatherproof
UHF	Male	to	N	Male	UG-318/U	Not Weatherproof
UHF	Male	to	Binding Post		UG-332/U	
UHF	Male	to	British 10H365		UG-171/U	

Table 2. Coaxial connector guide adapters between different series.

larger or smaller cables.

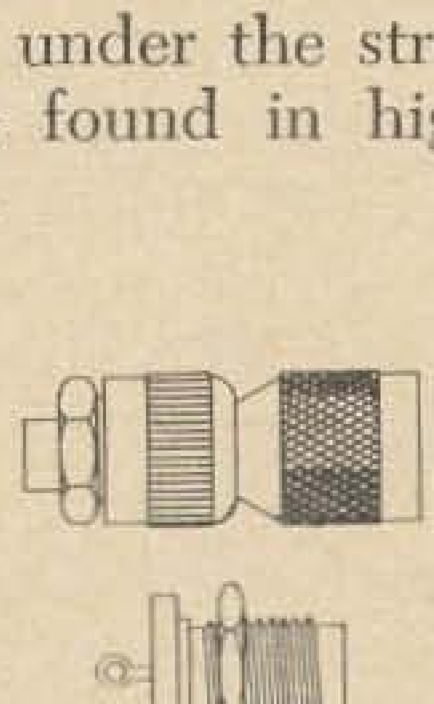
These weatherproof connectors have a maximum peak voltage rating of 1500 volts and a practical frequency limit of 10,000 mc. There is a high voltage version made for use up to 4000 volts peak, but this connector should not be used in applications above 2000 mc.



SERIES SC

SERIES SC SC Connectors are a threaded coupling version of the C series and represent an upgrading of the C connectors similar to the BNC-TNC improvement. The threaded coupling and safety wire provisions insure locking and secure mating under the most extreme conditions of vibration and shock.

This series has a maximum peak voltage rating of 1500 volts and provides low standing wave ratios at frequencies up to 10,000 mc in 50 ohm circuits. Like the TNC series, these connectors are not ordinarily used except under the stringent environmental conditions found in high speed aircraft and missiles.



SERIES SM

SERIES SM This series was designed for use inside equipment which does not require the weatherproof features found in present connectors. They employ the screw type design similar to the old BN series and in some ways could be called improved BN connectors. They were developed to fulfill the

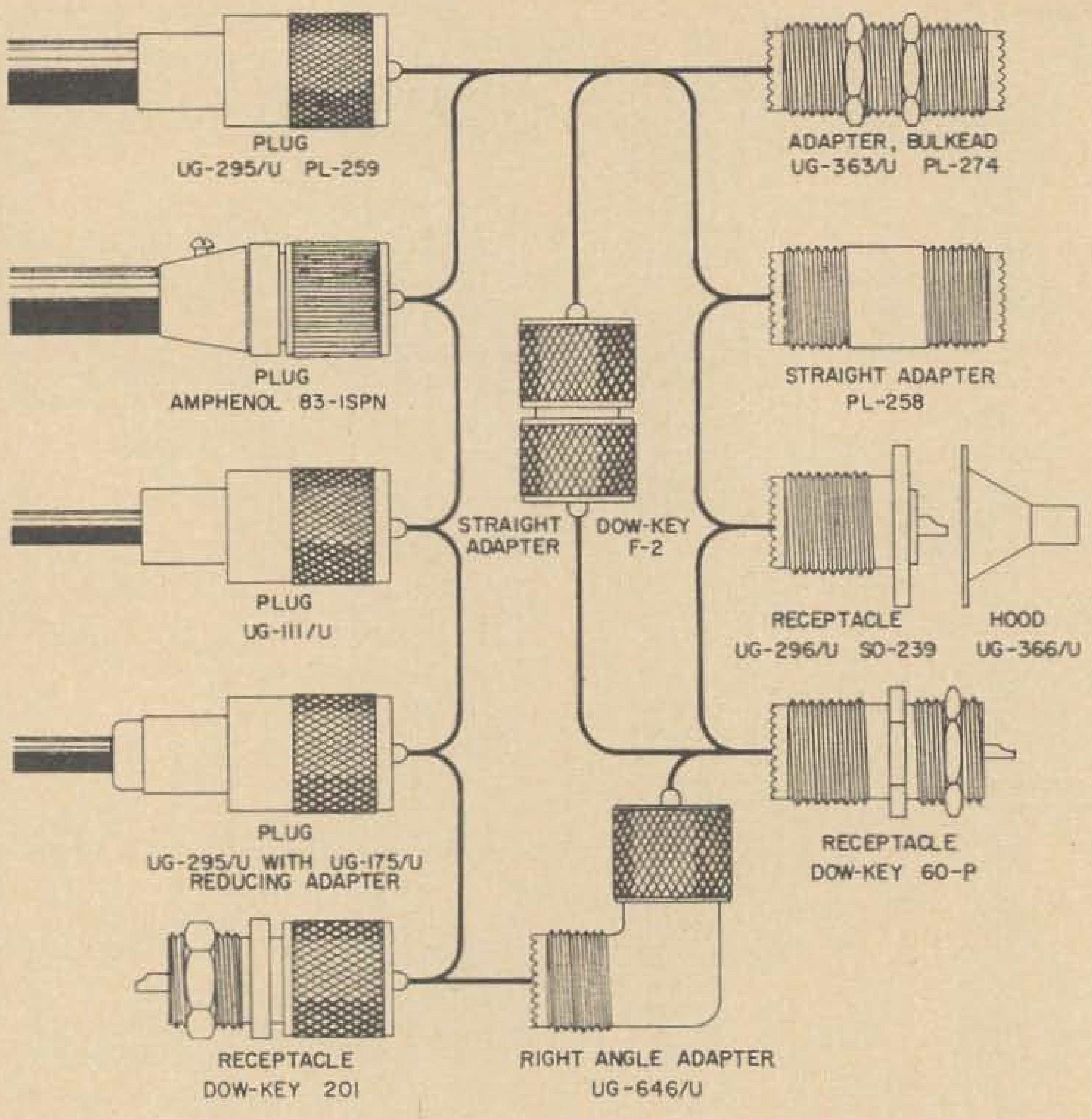
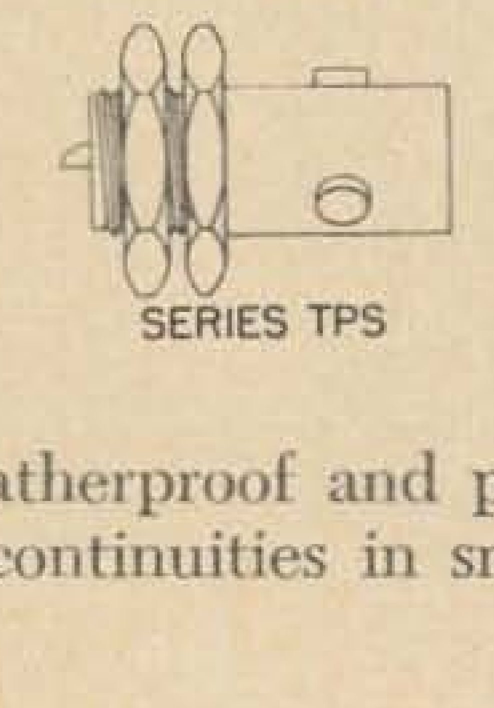


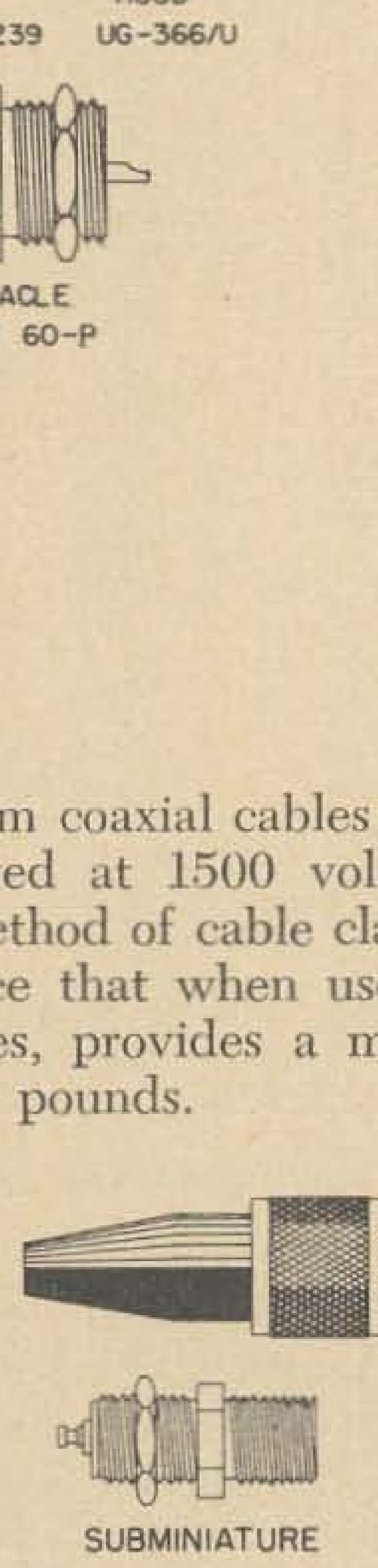
Fig. 2. UHF connector family.

need for a small rf fitting for use with coaxial cables of ¼ inch overall diameter and smaller. They should not be used where electrical matching is required.

SM connectors are considerably smaller and contain fewer parts than the BNC series; for simplicity of design, they employ a female contact on the plug and a male contact on the jack and receptacle. The SM series has the advantage of positive braid clamping and does not use the inner conductor of the cable as the center contact. These connectors are not intended to replace the BNC series except for internal equipment connections where weatherproofness is not required. Its useful range is presently limited to frequencies below 1000 mc and peak voltages below 100 volts.



SERIES TPS A recent development of the Signal Corps, this three-pronged bayonet coupled series is slightly smaller than the BNC series and larger than the SM series. These connectors are weatherproof and produce minimum electrical discontinuities in small size solid dielectric 50 ohm coaxial cables up to 10,000 mc. They are rated at 1500 volts RMS at sea level. The method of cable clamping is a wedge type device that when used with RG-59/U type cables, provides a minimum cable retention of 45 pounds.



SUBMINIATURE Because of the tremendous number of subminiature connectors manufactured by the various connector companies, it is impossible to cover all of them here. The inset drawing is just representative of the many varieties available. The majority of these connectors are recommended for use in test equipment, video leads, communications receivers. *if* and rf circuits or wherever miniaturization is a factor. In fact, several manufacturers have printed circuit models of receptacles and terminations.

Subminiature connectors are available in threaded, bayonet, push-on and snap on versions with nominal impedances of 50, 75 and 93 ohms. Some units are weatherproof and various sizes are made to accommodate cables to ¼ inch in diameter. Because of their small

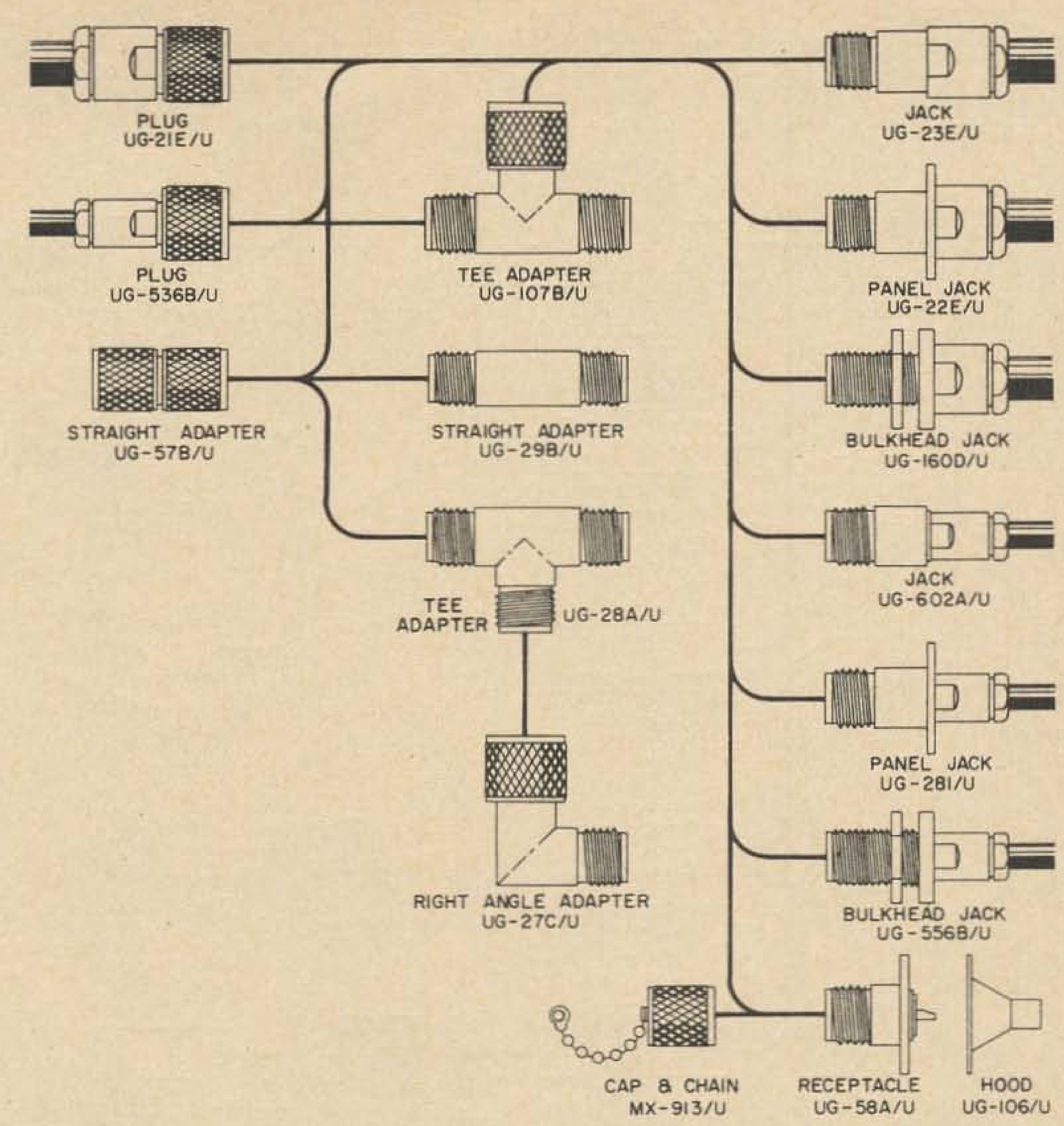
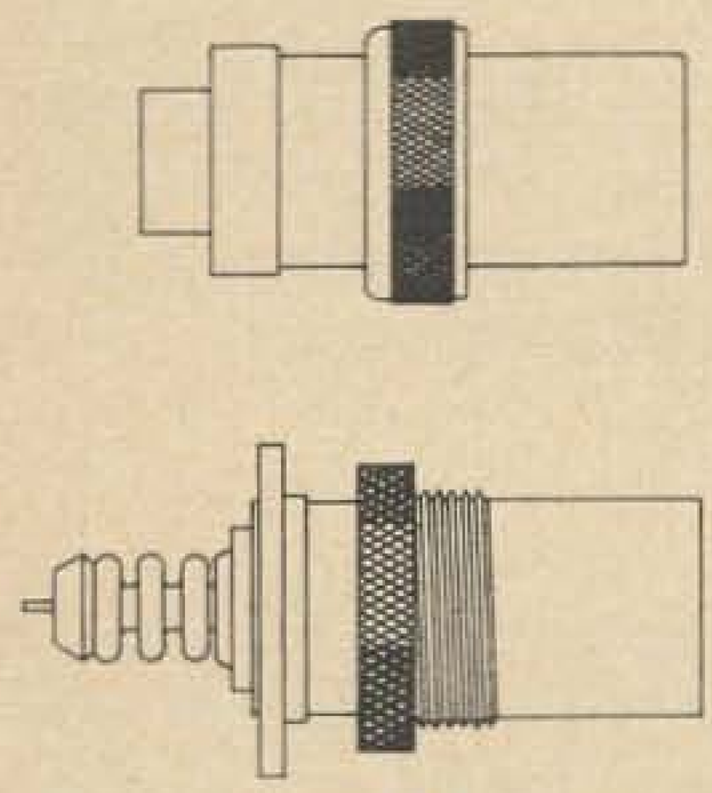


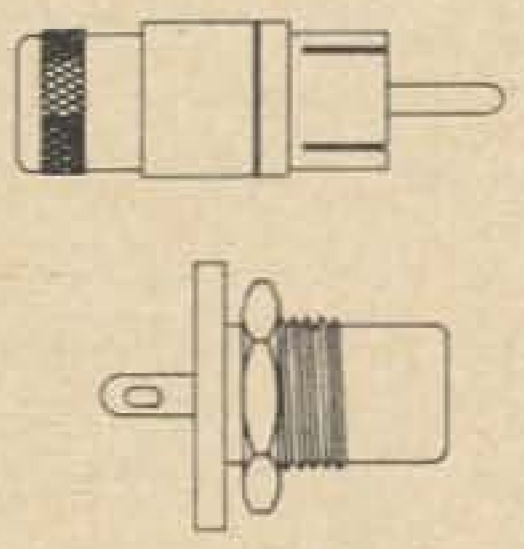
Fig. 3. Series N connector family.

size, many of these connectors are usable up to 3000 mc. Typical of these connectors are the Sub Minax series by Amphenol, the BSM and MTM series by Automatic Metal Products and the OSM connector made by Omni Spectra, Inc.



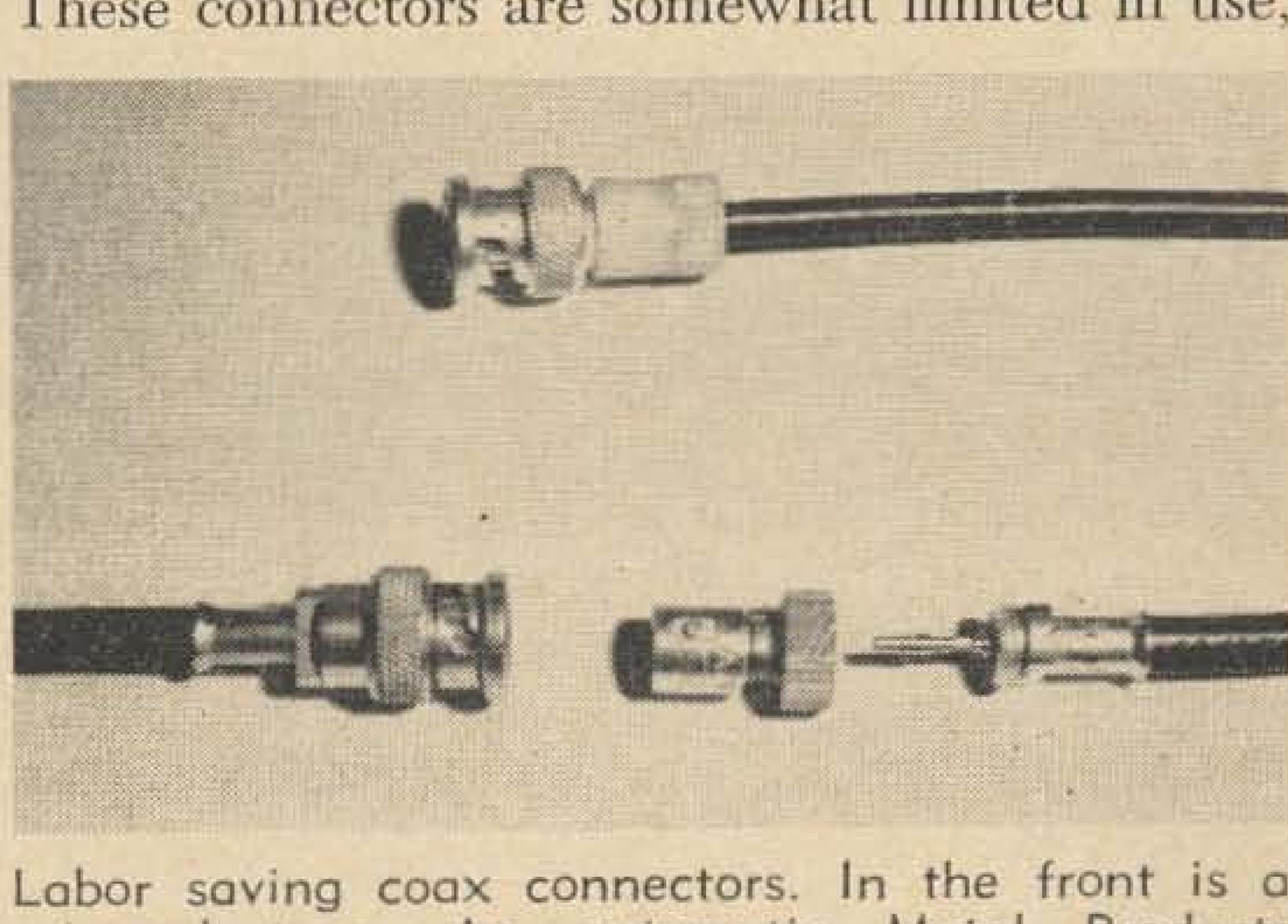
PULSE

PULSE Several varieties of connectors have been developed for high voltage pulse applications, particularly for radar. The pulse connectors with ceramic inserts are divided into two groups known as types A and B. The Pulse A connectors are widely used on U. S. Navy aircraft and at high altitudes they occasionally arc across the ceramic dielectric. However, as soon as the voltage stress is removed, they are again usable. The chief difficulty of the Pulse A connector is that inadequate bonding between mating connectors creates excessive noise when used near communications equipment. Pulse B connectors are considered standard for shipboard and ground equipment and may be used up to 15,000 volts peak. The Pulse B connectors also suffer from the tendency to leak noise.



PHONO

PHONO Phono connectors were originally designed for interconnection of shielded audio cables, but modern versions with nylon and ceramic insulation are suitable for low-power rf applications. These connectors are somewhat limited in use,



Labor saving coax connectors. In the front is a crimped type. An automatic Metal Products "Wedge-eze" is in the rear.

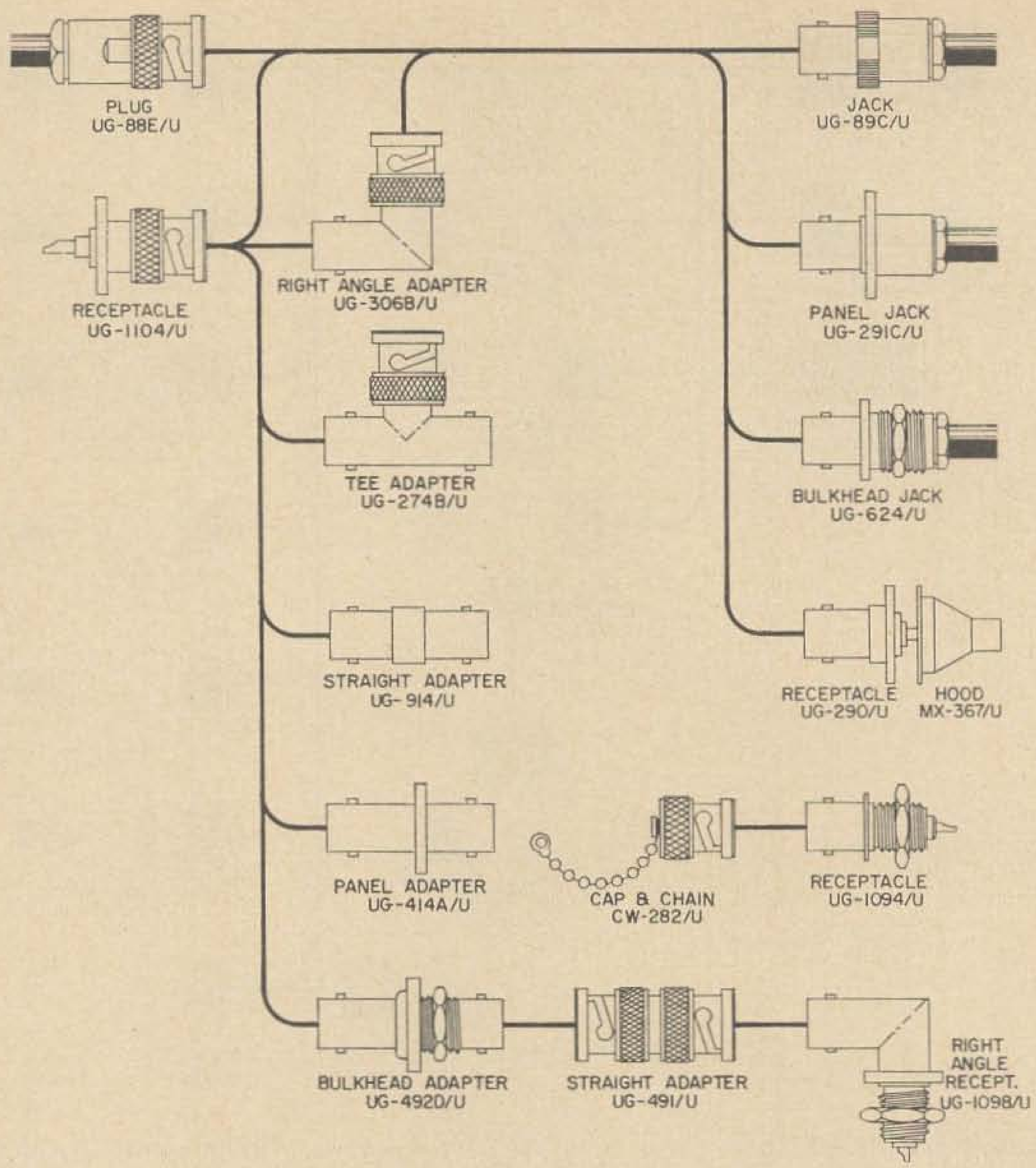


Fig. 4. Series BNC connector family.

but are economical, easy to assemble and provide a simple method for interconnection of receivers, VFO's, *if* strips, and other low-power equipment. These connectors do not provide 360° contact with the cable braid so there is some radiation loss at frequencies above one megacycle. They are not moisture-proofed and are intended only for indoor applications. Photo connectors have been used to a limited extent up to 150 mc, but the BNC, N or even UHF series do a better job and should be used instead of the photo connector in all but the least critical areas.

SERIES QL and QM (Not illustrated) These connectors are a recent development of the Signal Corps which feature a quick lead thread and are intended for high power, high voltage, low SWR connections with large size coaxial cables such as RG-217, -218, -219, -220, and -221/U where LC, LT, C and N connectors have been used in the past. These connectors provide a maximum SWR of 1.27:1 in mated pairs of cable assemblies up to 5000 mc.

SERIES SKL (Not illustrated) This type connector was originally designed to provide connections to klystron tubes, and various modifications were subsequently added to provide general-purpose cable to cable connections. Unfortunately, some of these connectors are still in use today even though the BNC would do a much better job. Furthermore, existing standard types such as the BNC and N perform the same function and are more generally available than the SKL series.

Special connectors

There are several special types of coaxial connectors and adapters that should be mentioned. Perhaps the most important of these are the between series adapters. These adapters provide an efficient electrical and mechanical transition between two different rf series. They are of non-constant impedance, but are designed so that the inherent electrical discontinuities are minimized. Although the straight adapter is the most common, other configurations are available to satisfy nearly any requirement; from straight and bulkhead adapters to angles, crosses and tees. A complete listing of between series adapters for BNC, N and UHF to other types is listed in **Table 2.**

Transitions and splices

Terminations or end seals are a very helpful class of connector not normally encountered by amateurs. These devices provide a convenient, mechanical method for securing the end of a coaxial cable. A neat, connector-type braid clamp grounds the braid to the chassis terminal and allows the cable dielectric and inner conductor to extend for any convenient length for direct connection to a component. A variety of mounting arrangements are available as shown in **Fig. 5.** BNC or N connector techniques are employed in the assembly of these units.

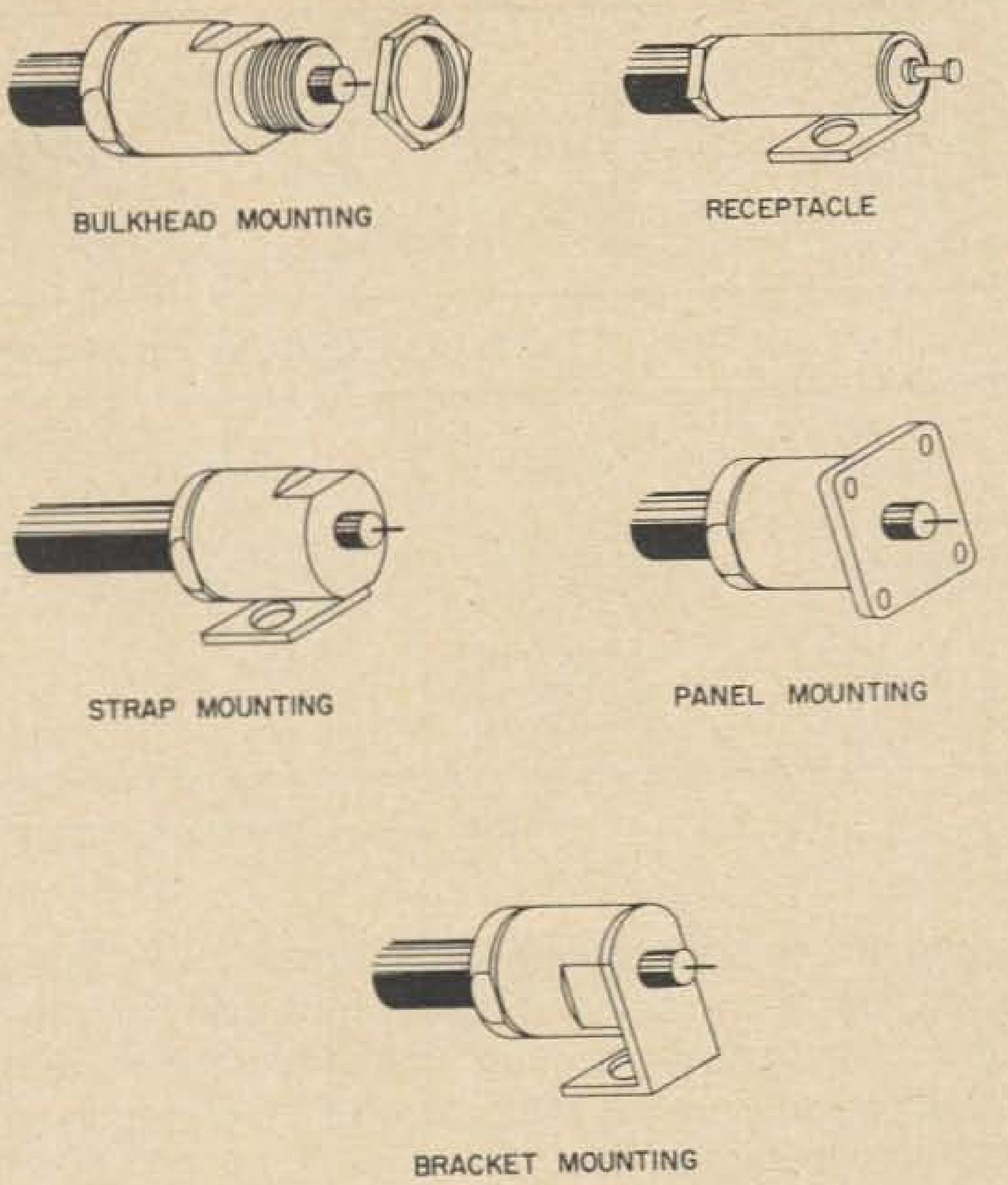


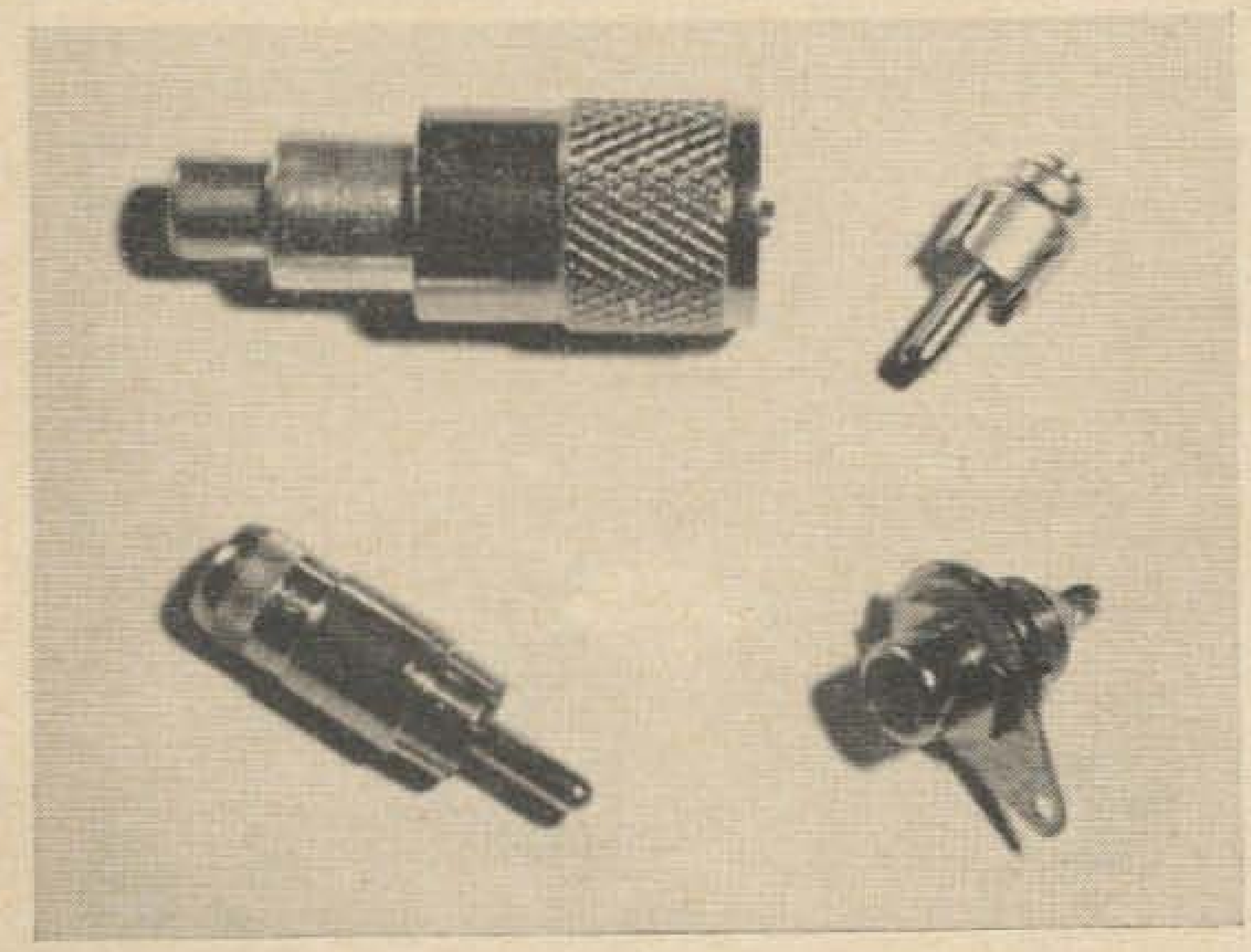
Fig. 5. Terminations.

Cable end seals are usually used in one of two ways; either as a termination or for strain relief. The termination is designed so that the jacket and braid of the cable are clamped within the body of the connector, while the dielectric and inner conductor are allowed to continue through. The strain relief variety is used for support only and the entire cable is allowed to continue through the body of the connector.

Cable splices are another class of connector which is not too familiar. These special connectors provide a convenient and neat workmanship method of joining two, three or four coaxial cables with a minimum of impedance mismatch. Splices are available in three basic configurations: tee, cross and transition as shown in **Fig. 6.** The tee and cross versions provide an efficient junction point for three or four cables and are especially useful in antenna phasing assemblies or similar applications. They may be used for continuation of the cable shielding or for inserting instruments in the circuit. They are also used for locating resistors and other components within the splice, or simply to save time and work in the repair of defective coaxial cable. The transitions may be used for splicing two similar or dissimilar cables. Normally the tees and crosses are gasketed for weatherproof operation while the transitions are non-weatherproof.

Coaxial connector selection

Because of their importance in high frequency connector work, a considerable amount of experimental data on coaxial cable discontinuities has been accumulated and rather



Phono connectors. Clockwise from upper left: phono to series UHF adapter, cable plug, chassis receptacle and improved cable plug.

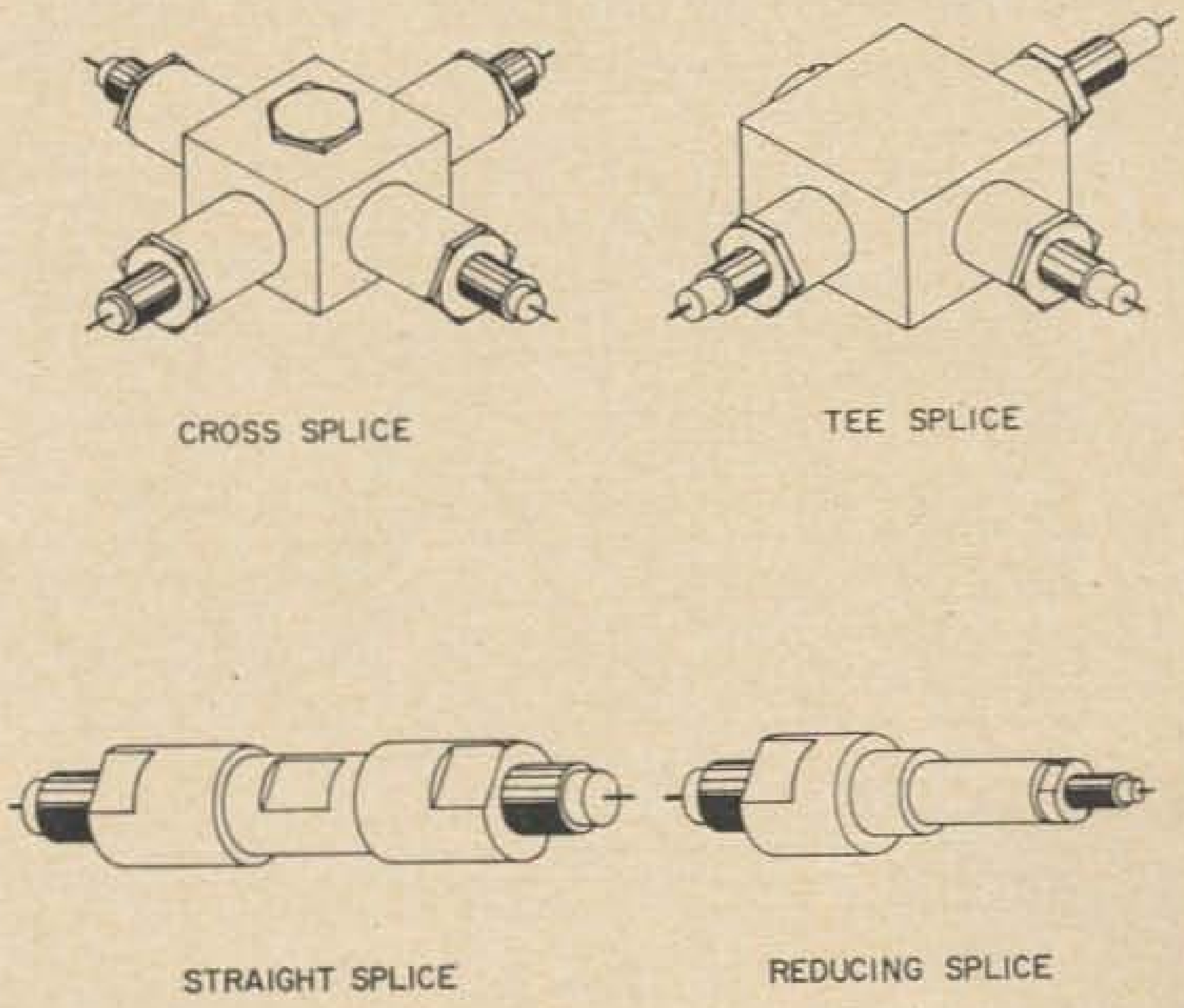


Fig. 6. Coaxial cable splicing hardware.

For RG/U Cables	Plug	Jack	Panel Jack	Bulkhead Jack	Hood	Engineering Data
RG-8/U	UG-959/U	—	—	—	—	
RG-58/U	UG-88E/U	UG-89C/U	UG-291/U	UG-909B/U	MX-195A/U	
RG-59/U	UG-260D/U	UG-261C/U	UG-262/U	UG-910B/U	MX-195A/U	Non-constant impedance
RG-122/U	UG-1082/U	UG-1056/U	UG-1055/U	—	MX-195A/U	

Table 3A. Coaxial connector selection guide for BNC series.

For RG/U Cables	Plug	Jack	Panel Jack	Bulkhead Jack	Hood	Engineering Data
RG-5/U	UG-626B/U	UG-633A/U	UG-629A/U	UG-630A/U	UG-570A/U	
RG-8/U	UG-573B/U	UG-572A/U	UG-571A/U	UG-937A/U	UG-570A/U	
RG-11/U	UG-573B/U	UG-572A/U	UG-571A/U	UG-937A/U	MX-1144/U	Impedance Mismatched
RG-17&U	UG-708B/U	—	—	—	—	
RG-58/U	UG-709B/U	—	—	—	MX-1870/U	
RG-59/U	UG-627B&U	—	—	—	MX-1870/U	

Table 4A. Coaxial connector selection guide for series C.

sophisticated matching techniques have been used by the connector manufacturers to produce connectors having high electrical and mechanical qualities for almost every coaxial cable in common use.

The large variety of connectors and cables, each designed to fit a specific need, and the almost infinite number of combinations available from them, indicates that the problem of selecting the proper connector is unique to the type of service required. Essentially, the selection of a cable connector boils down to the same requirements as the selection of the transmission line; i.e. SWR, attenuation, mechanical strength, and power and voltage limits. Since the desired operating requirements usually contain some conflicting requirements, such as long cable length and low attenuation, the most successful approach is very often to find the best compromise in available cables and connectors to fit the specific application.

One of the best criteria on which to base connector selection is that of the standing wave ratio at the frequency of operation. Fig. 7 charts the nominal standing wave ratio

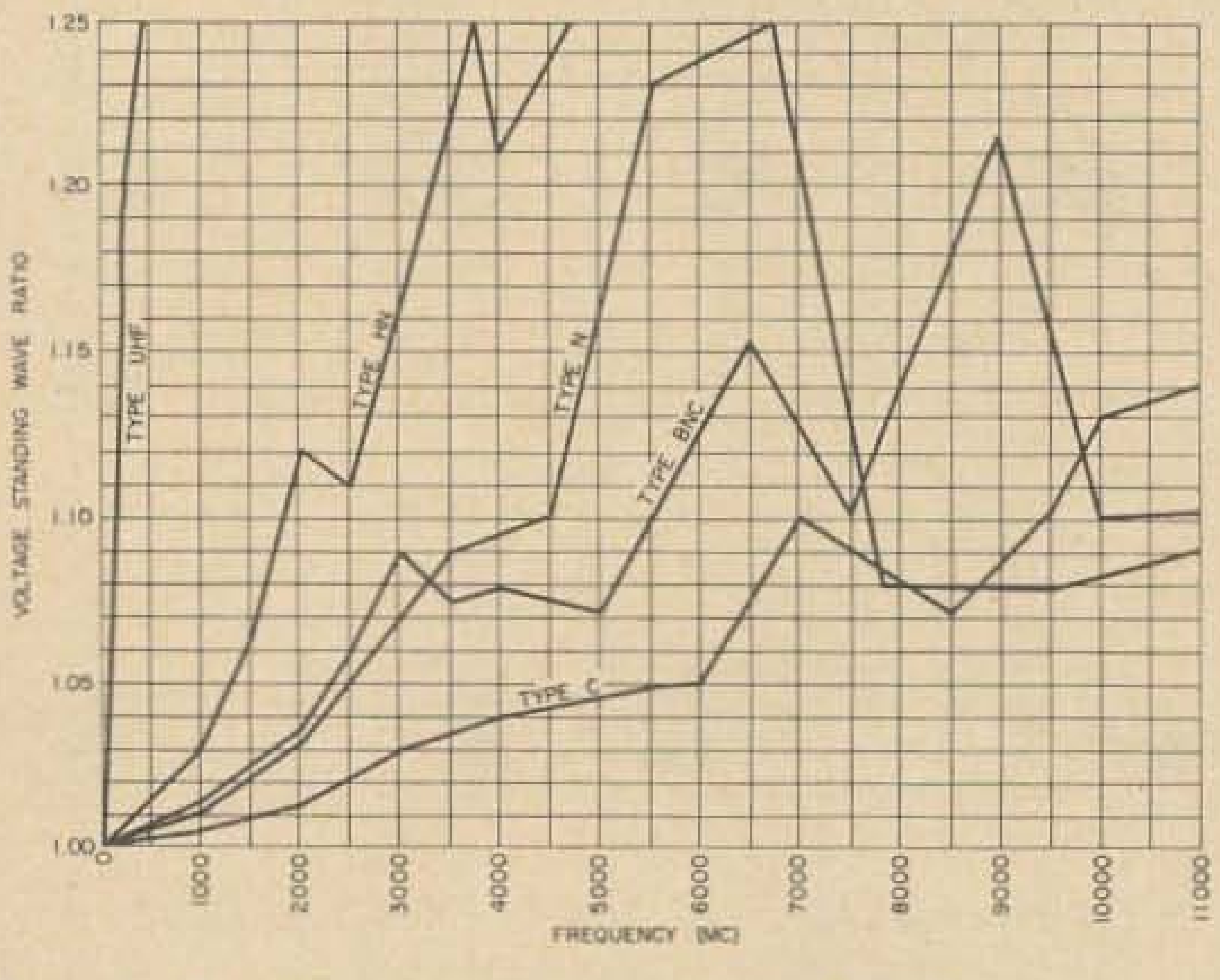


Fig. 7. Typical coaxial connector VSWR.

Description	Military Number	Engineering Data
Adapter, Binding Post	UG-282/U	
Adapter, Bulkhead (F-F)	UG-492D/U	Pressurized
Adapter, Feedthrough (F-F)	UG-914/U	
Adapter, Feedthrough (F-F)	UG-414A/U	Flange Mounting
Adapter, Right Angle (M-F)	UG-306B/U	
Adapter, Straight (M-M)	UG-491B/U	
Adapter, Tee (M-M-F)	UG-274B/U	
Cap and Chain (F)	CW-282/U	
Cap and Chain (M)	CW-123A/U	
Receptacle	UG-185/U	Flange Mounted
Receptacle	UG-290A/U	Teflon Insulation
Receptacle	UG-928/U	Rexolite Insulation
Receptacle, Bulkhead	UG-1094A/U	3/8" Thread Mounting
Receptacle, Male	UG-1104/U	3/8" Thread Mounting
Receptacle, Pressurized	UG-912A/U	7/16" Thread Mounting
Receptacle, Pressurized	UG-625B/U	1/2" Thread Mounting
Receptacle, Pressurized	UG-911A/U	Flange Mounted
Rectptacle, Right Angle	UG-535/U	3/8" Thread Mounting
Rectptacle, Right Angle	UG-1098A/U	

Table 3B. Miscellaneous series BNC connectors.

Description	Military Number	Engineering Data
Adapter, Bulkhead (F-F)	UG-701/U	Pressurized
Adapter, Bulkhead (F-F)	UG-1138/U	
Adapter, Right Angle (M-F)	UG-567A/U	
Adapter, Straight (F-F)	UG-643/U	
Adapter, Straight (M-M)	UG-642A/U	
Adapter, Tee (F-M-F)	UG-566A/U	
Cap and Chain (M)	UG-1142/U	
Cap and Chain (F)	UG-1143/U	
Receptacle, Bulkhead	UG-569/U	3/4" Thread Mounting
Receptacle, Bulkhead	UG-705/U	Presusrized
Receptacle, Panel	UG-568/U	

Table 4B. Miscellaneous series C connectors.

For RG/U Cables	Plug	Jack	Panel Jack	Bulkhead Jack	Hood	Engineering Data
RG-5/U	UG-18D/U	UG-20D/U	UG-19D/U	UG-159C/U	UG-106/U	
RG-6/U	UG-91A/U	UG-92A/U	UG-93A/U	—	UG-106/U	70 Ohm Connectors
RG-8/U	UG-21E/U	UG-23E/U	UG-22E/U	UG-160D/U	UG-106/U	Improved Type
RG-8/U	UG-1185A/U	UG-1186A/U	UG-1187/U	—	—	Captivated Contacts
RG-11/U	UG-94A/U	UG-95A/U	UG-96A/U	—	UG-106/U	70 Ohm Connectors
RG-17/U	UG-167E&U	—	—	—	--	
RG-58/U	UG-536B&U	—	UG-1095B/U	UG-556B/U	UG-177/U	
RG-59/U	UG-603A/U	UG-602A/U	UG-593A/U	—	UG-366/U	

Table 5A. Coaxial connector selection guide for series N.

For RG/U Cables	Plugs	Reducing Adapters	Hoods
RG-8/U	PL-259, PL-259A, UG-295/U	—	MX-543/U, MX-372/U
RG-58/U	UG-175/U adater to PL-259	UG-175, UG-410/U	UG-177/U, MX-539/U
RG-59/U	UG-73/U, UG-111/U, UG-203/U	UG-176/U	UG-239/U, UG-366/U

Table 6A. Coaxial connector selection guide for series UHF.

Description	Military Number	Engineering Data
Adapter, Bulkhead (F-F)	UG-30D/U	Pressurized
Adapter, Right Angle (M-F)	UG-27C/U	
Adapter, Right Angle (F-F)	UG-202A/U	Panel Mounting
Adapter, Straight (F-F)	UG-29B/U	
Adapter, Straight (F-F)	UG-1018/U	Not Weatherproof
Adapter, Staright (M-M)	UG-57B/U	
Adapter, Tee (F-F-F)	UG-28A/U	
Adapter, Tee (F-F-M)	UG-464/U	
Adapter, Tee (F-M-F)	UG-107B/U	
Cap and Chain	MX-913/U	
Receptacle	UG-58A/U	70 Ohm Impedence
Receptacle	UG-231/U	With Hood
Receptacle	UG-357/U	
Receptacle	UG-680A/U	Pressurized
Receptacle, Right Angle	UG-997A/U	

Table 5B. Miscellaneous series N connectors.

Description	Military Number	Engineering Data
Adapter, Bulkhead (F-F)	UG-224/U	Rexolite Insulation
Adapter, Bulkhead (F-F)	UG-300/U	
Adapter, Bulkhead (F-F)	UG-363/U	Polystyrene Insulation
Adapter, Bulkhead (F-F)	PL-274	
Adapter, Right Angle (M-F)	UG-297A/U	
Adapter, Right Angle (M-F)	UG-646/U	Polystyrene Insulation
Adapter, Straight (F-F)	UG-299/U	
Adapter, Straight (F-F)	UG-360/U	Polystyrene Insulation
Adapter, Straight (F-F)	PL-258	
Adapter, Straight (F-F)	UG-307/U	Panel Mounting
Adapter, Tee (F-M-F)	UG-298/U	
Receptacle	UG-296/U	
Receptacle	SO-239	
Receptacle, Bulkhead	UG-223/U	
Receptacle, Pressurized	UG-266/U	Rexolite Insulation

Table 6B. Miscellaneous series UHF connectors.

of the more popular coaxial connectors at frequencies up to 11,000 mc. These curves are based on actual laboratory measurements of improved versions of connectors properly assembled to RG-8A/U cable except for the BNC connector which was assembled to RG-58/U cable. The non-constant impedance UHF series is shown for information purposes only, but it becomes quite obvious why this connector is not recommended for use at frequencies above 200 mc.

When selecting coaxial connectors, many factors must be considered; first of all, the coupling mechanism of the connector should be selected in accordance with the intended service. Where long, massive cables are to be joined, the coupling nut and associated retaining rings must be correspondingly strong such as those in **Fig. 8A**. When the completed assembly is to be used under conditions where frequent movement or vibration is anticipated, the connection must be strong, positive and vibration proof (**Fig. 8B** and **C**). For light duty where frequent connections and disconnections are required such as for test equipment, the connection should be quick and positive such as illustrated in **Fig. 8D.** Where severe space limitations prevent the use of threaded or bayonet mechanisms, push-on connectors with detent arrangements are useful (see **Fig. 8E**). In some applications "phono" connectors provide a simple and economical push-on connector (**Fig. 8F**).

Since final connector selection is essentially an electrical problem, transmission line practice is normally employed to determine the basic line parameters of impedance and SWR once the characteristic impedance of the system is known. When the ideal solution of these parameters has been found, average power, peak voltage and permissible power loss must be considered. In this phase, con-

For RG/U Cables	Plug	Panel Jack	Hood	Engineering Data
RG-22/U	UG-102/U	UG-103A/U	UG-106/U	Not Weatherprof
RG-22/U	UG-421B/U	UG-423B/U	—	Weatherproof

Table 7A. Coaxial connector selection guide for UHF twin series.

nector-cable combinations must be chosen that satisfy the operating requirements; at this point it is often necessary to make compromises in the final choice.

Connector-cable combinations that appear satisfactory from the standpoint of the electrical requirements should then be analyzed for operating temperature, mounting methods and coupling requirements. Many connectors that are employed internally do not require weatherproofing and a less expensive connector can frequently be used. In general, connectors which are used outside must be weatherproofed.

To reduce the SWR and impedance discontinuities to a minimum, coaxial connectors must be designed to have the same characteristic impedance as their mating cable. Actually, the objective is to make the connector a homogenous electrical extension of the cable itself. In this way the practical upper frequency limit of the complete assembly often exceeds 10,000 mc. Expansion, due to temperature, may cause a discontinuity by separating the cable from the clamp within the connector. For this reason, great emphasis is put on the metal-to-metal braid clamping mechanism using large contact areas. In some cases it is advantageous to insure that the center conductor is mechanically held in a fixed position by a captivated contact arrangement.

Additionally, coaxial connectors must be designed so that they operate safely at the maximum rating of the cables with which they are used. The most difficult of these requirements is the peak voltage rating. This is accomplished in several ways. First, physical changes where high voltage gradients might occur must be kept to a minimum; and second, a good high-quality dielectric must be used throughout the connector. Also, provisions should be made to avoid the development of air pockets at the mating boundaries of connector pairs.

Actually, connector selection is not nearly as complex as it might sound at first. For amateur application, there are only three types of connectors that are generally used; series UHF, BNC and N. These series will satisfy nearly any amateur requirement, but series C or phono connectors may be useful in some special applications.

The "Connector Selection Guides" in **Tables 3** through **7** were prepared as an aid in the selection of connectors for use with specific cables. The cables listed are those that are most apt to be used in amateur work. When selecting a connector for use with coaxial cables not listed in the "guide," reference to the "Coaxial Cable Assembly Groups" chart in **Table 8** may be helpful. In essence, there are fourteen main groups of RG-/U cables within the large number available. For example, RG-8A/U belongs to cable group "F" as do RG-9, -31, -87, -165, -213, -214 and -229/U. Therefore, connectors listed in the guide for RG-8/U may also be used with any of the other coaxial cables in the same assembly group.

Description	Military Number	Enginering Dat
Adapter, Right Angle (M-F)	UG-104/U	Not weatherproof
Adapter, Right Angle (M-F)	UG-931/U	Weatherproof
Adapter, Straight (F-F)	UG-105/U	Not weatherproof
Adapter, Straight (F-F)	UG-493A/U	Weatherproof
Adapter, Tee (F-M-F)	UG-196/U	Not weatherproof

Table 7B. Miscellaneous series UHF twin connectors.

Coaxial connector installation

It must be remembered that the primary function of the coaxial cable connector is electrical and every available provision should be made to support it mechanically. Occasionally, the mounting environment will prevent supporting the cable at intervals as often as desired and a larger, stronger connector must be used. In addition, the cable may be required to follow the contour of a building or corner or roof peak; in such a case, larger connectors should be used to preclude premature failures.

Many connectors are attached to panels or bulkhead partitions. There are three standard methods for attachment of these fittings. The most common is the "single hole mount"; the connector has an external thread and is locked to the panel with a hex nut and lock-washer. In some cases a method of keying the connector to the panel is employed. The three main types are single flat on the connector body requiring a "D" hole in the chassis, a

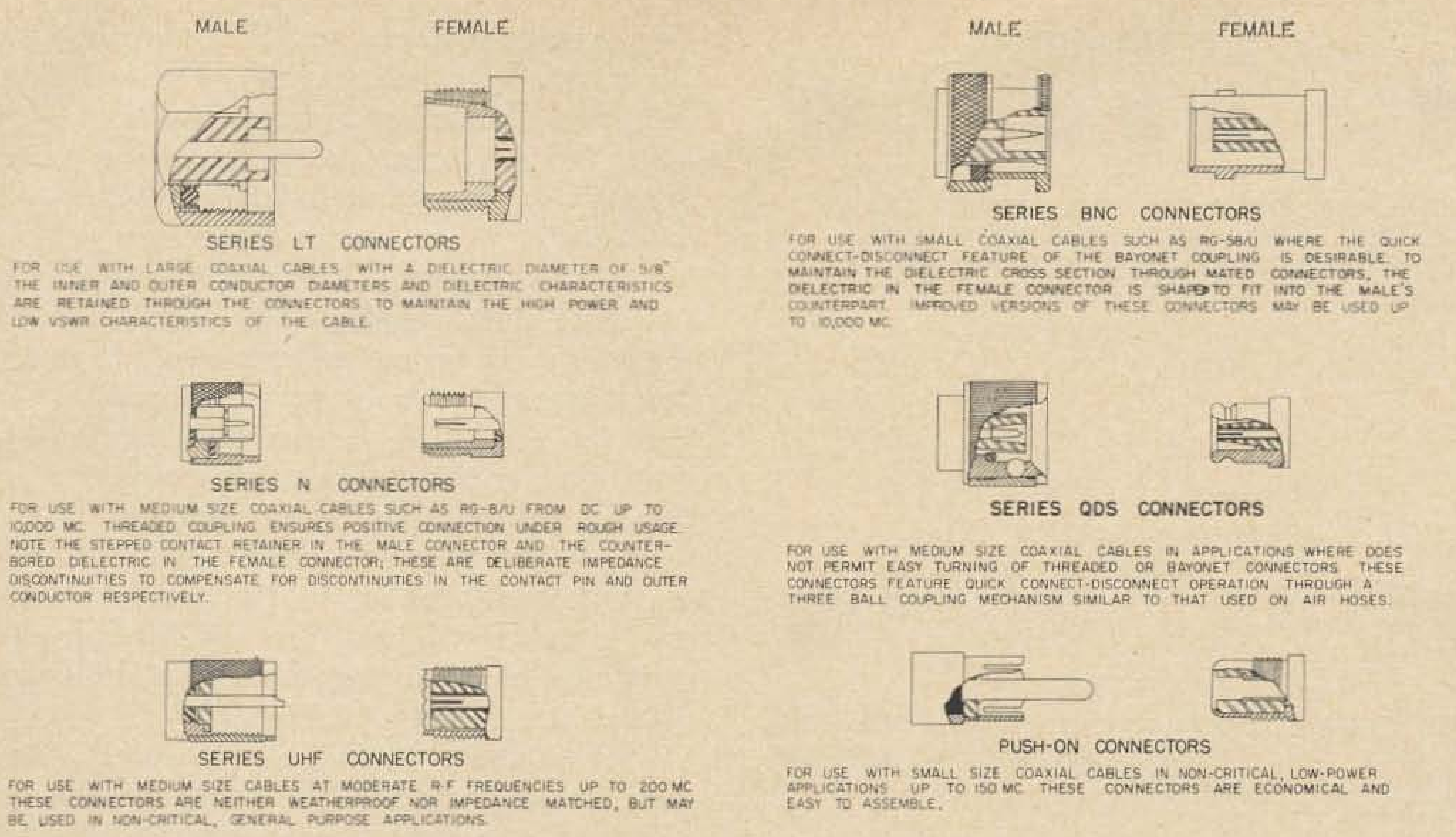


Fig. 8. Cutaway drawings of series LT, N, UHF, BNC, QDS and push-on connectors.

double flat requiring a special hole in the panel or a bent tab on the connector requiring a notched hole in the chassis. When large thick chassis are used, the connector may be screwed into, press fit or soldered to the chassis as desired.

Outdoor use of connectors

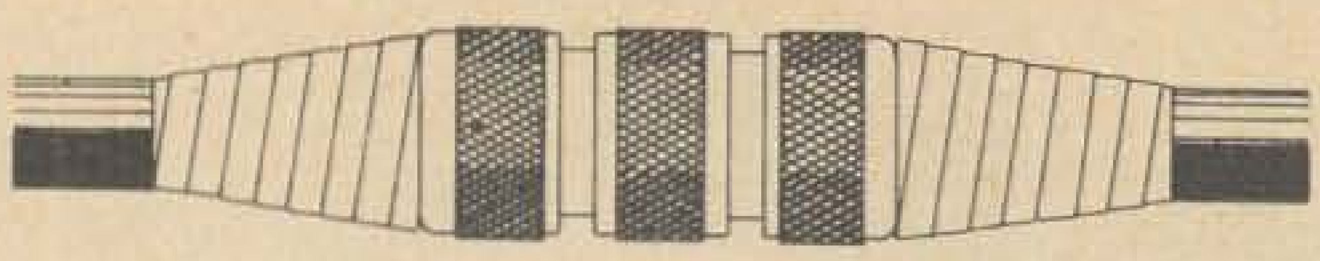
While steps have been taken in all of the more modern coaxial connectors to achieve moisture-proofing, none of the connectors may be classified as entirely waterproof and suitable for outdoor use unless protected by additional coverings. The most common practice used to protect the mating surface between plug and receptacle is to pack one side with silicone grease. The connectors are then mated and any excess grease is forced to the outside of the connector where it may be wiped off. The grease tends to dry and form voids after a period of time however, and should be replaced periodically. If not replaced, the voids within the grease may become water traps during periods of temperature change with high humidity. In some cases packing will adversely effect the operation of the cable at UHF frequencies. This is because matched connectors for use above 1000 mc utilize high impedance compensating air sections at the mating surfaces. Silicone grease has a greater dielectric constant than air and packing the mating surface results in a low impedance section with resultant mismatch.

An alternate and preferred method of weatherproofing is to utilize connectors with threaded mating surfaces such as type N or UHF. The mating threads on the receptacle side can be coated with a waterproof varnish such as Glyptal just prior to making the connection. Then, after assembly, the outer surface of the mated pair may be covered with the same varnish. UHF series connectors may be coated with varnish on the outside but not on the threaded surface, because in these connectors the rf current path takes place along the threaded surface. Unfortunately, the use of Glyptal varnish may only be used once since it renders connectors useless for future mating.

A third method of waterproofing coaxial connector assemblies is to wrap a good quality pressure-sensitive vinyl tape over the junction as shown in **Fig. 9.** As in the case of silicone grease protection, the tape should be periodically replaced.

For best results, the tape wrap should be installed in the following manner:

1. After the two lengths of cables are connected together, tightly wind tape behind each connector to obtain a smooth contour between connector and cable.
2. Tightly wrap several layers of tape over the entire assembly. Use a 50% overlap and wind each of the layers in opposite directions; a minimum of four layers should be used for maximum protection.
3. The completed tape covering should extend beyond each connector a minimum of eight times the diameter of the cable.



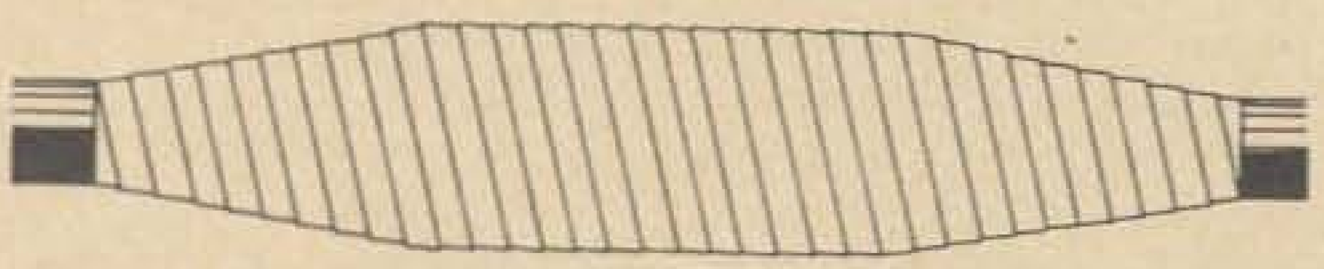


Fig. 9. Taping coaxial cable junctions.

The best method to remove the tape is to unwrap it. A knife may be used for this purpose, but care must be taken not to cut into the plastic jacket of the cable. The recommendation here is to cut the tape in the immediate vicinity of the metal connector and peel it off.

Coaxial connector assembly

The coaxial connector is a highly engineered device and even the smallest mechanical dimension or material characteristic may be of great electrical or mechanical significance. Accordingly, the cable assembly operation must carry out the objective of the original design if the connector is expected to operate to its fully intended capabilities.

Where the assembly instructions show the cable's dielectric butting the connector's dielectric, every precaution should be taken that the assembly method insures a positive butt. If the connector is to be used at ultra high frequencies with a low SWR, the development of air pockets because of loose butt joints or rounded dielectric corners will give rise to impedance mismatches proportional to the frequency of operation. In high voltage cables air pockets or loose joints materially reduce the peak voltage capability of the entire assembly.

Loose butt joints usually develop unless the dielectric trimming process is made one of the last assembly operations. Rounded corners develop because of excess heating during soldering or through a mistaken notion that all "sharp edges should be avoided." It is extremely important that the dielectric be cut at perfect right-angles to the center conductor; no notches should be permitted. Correct methods of stripping the cable dielectric and jacket are shown in **Fig. 10.**

Air pockets between the inner conductor and the dielectric of the cable usually develop due to excessive heat when soldering the center contact of the connector onto the inner conductor of the cable. Some of the dielectric is softened, and through movement of the inner conductor, a larger hole is formed.

Finally, precautions should be taken during the assembly process to insure that the center contact of the connector rests at its proper lateral position as shown in **Fig. 11.** In many connectors, the exact axial distance between a point on the connector shell and the tip of the pin is an electrical matching circuit. In type N connectors this is the case where the male pin steps down before entering the female pin of the mating connector, leaving a deliberate radial notch—compensated by the overhung iris in the inside dimension of the outer conductor.

Many times, misalignment results from assembling connectors to both ends of a relatively long cable while it is still coiled. When

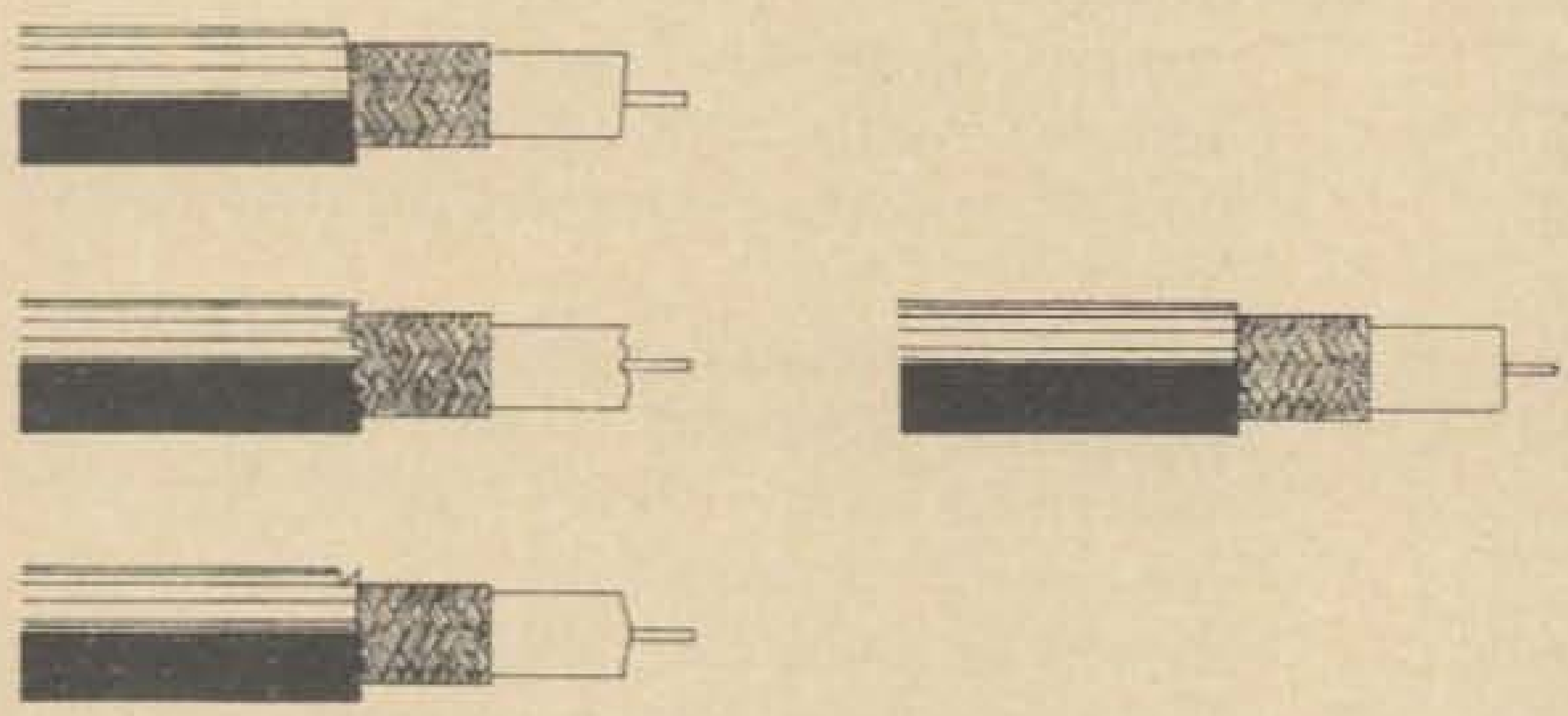


Fig. 10. Stripping coax cable jacket and dielectric.

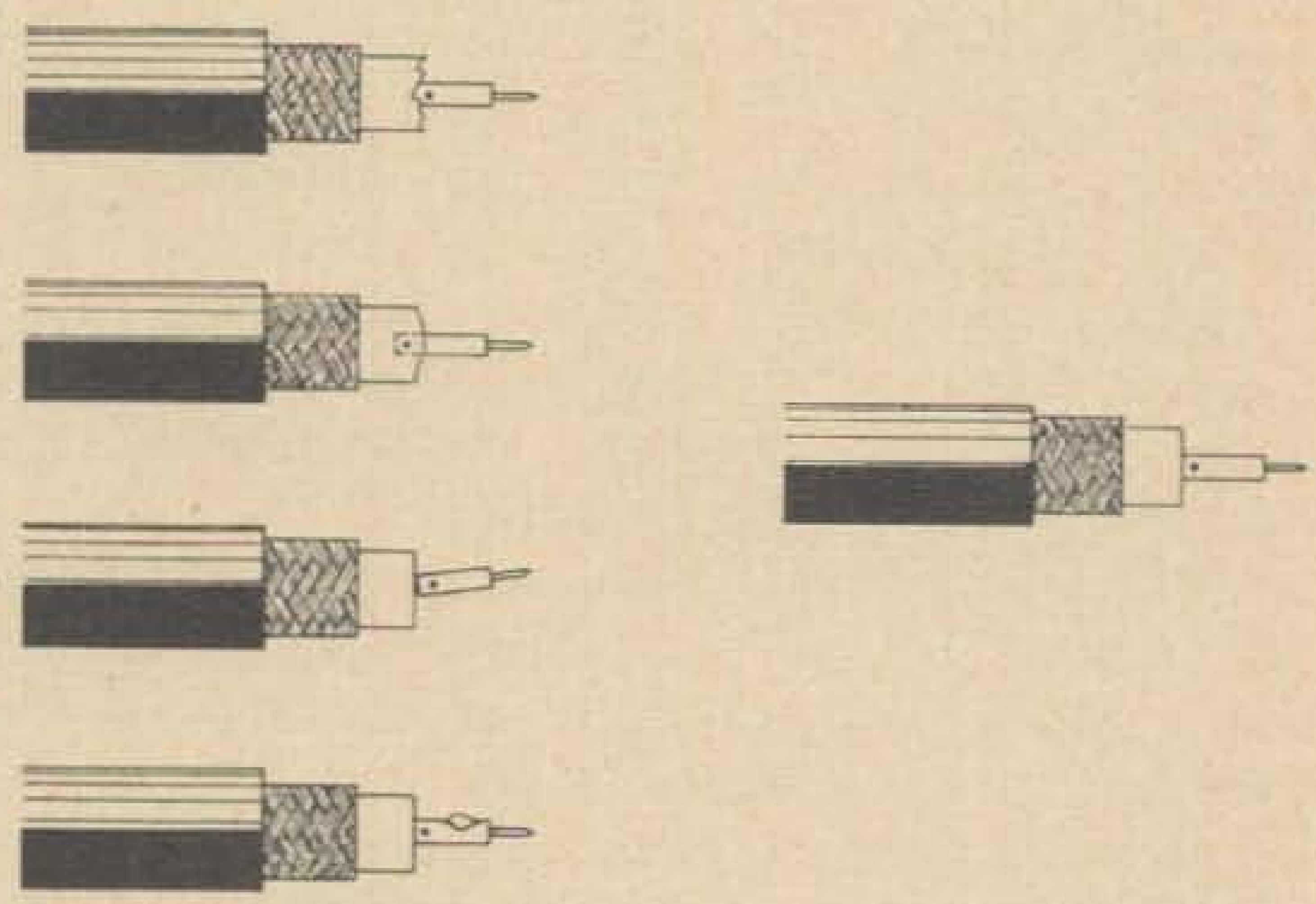


Fig. 11. Installing center contact.

RG-/U	Cable Group	RG-/U	Cable Group	RG-/U	Cable Group
5	D	62	B	148	H
6	E	63	J	149	H
8	F	71	B	159	A
9	F	79	J	164	N
10	G	81	K	165	F
11	H	82	M	166	G
13	H	87	F	210	B
17	N	89	J	212	D
18	P	100	C	213	F
21	D	114	J	214	F
29	A	116	G	215	G
31	F	118	L	216	H
32	G	124	B	218	N
35	P	133	J	219	P
38	D	140	B	222	D
39	E	141	A	223	A
55	A	142	A	225	F
58	A	143	D	227	G
59	B	144	H	228	L

Table 8A. Coaxial cable assembly groups.

it is uncoiled, the ends of the center conductor may assume a different position with respect to the ends of the outer braid. For similar reasons, a connector should not be assembled to cable under temperature extremes.

Except for the UHF series of connectors, the only soldering operations encountered during connector to cable assembly is in joining the center contact of the connector to the inner conductor of the cable. However, there are two major precautions which must be observed during this operation. It is imperative that a good solder bond be made between the pin and the inner conductor of the cable over the entire depth of the pin. Otherwise, a significant inductive reactance may be created because the hole in the pin and the inner conductor form the conductors of a miniature short-circuited coaxial line having significant electrical length at UHF frequencies.

Also, any excess solder must be removed so that the step contour between the pin and the cable conductor corresponds essentially to the original dimensions. A change in dimensions because of excessive solder acts like a shunt capacitor and is in effect a circuit change within the connector.

Complete assembly instructions for type BNC, N and UHF connectors are provided in **Fig. 12** through **22.** Note that standard series N connectors come in two different versions, one with a v-groove gasket, the other with a cylindrical gasket, but that the assembly sequence is basically the same.

During connector assembly, there are five basic rules which must be followed to obtain proper operation.

1. Closely follow the recommended assembly instructions to insure proper SWR and voltage ratings.
2. Do not apply more heat than necessary during soldering operations. Use crimped or clamped connections on cable braid to prevent heat distortion of the dielectric.
3. Do not exert excessive force in tightening fittings containing rubber or plastic gaskets as permanent deformation will result; occasional light retightening is preferred.
4. Carefully remove all filings, loose solder and other foreign objects from the connectors prior to assembly; observe cleanliness during all operations. Extraneous matter in connectors reduces power and voltage ratings and increases the SWR of the assembly.
5. Use extreme care in the assembly and grounding of connectors operating at high voltages to reduce corona and radiated noise.

Cable Group	Center Conductor	Maximum Dimensions				RG-/U Cables	Impedance (ohms)
		Dielectric	Braid	Jacket	Armor		
A	0.040	0.121	0.177	0.216	—	29, 55, 58, 141, 142, 159, 223	50
B	0,030	0.151	0.206	0.251	—	59, 124, 140 62, 71, 210	75 93
C	0.096	0.151	0.206	0.251	—	100	35
D	0.061	0.194	0.263	0.342	—	5, 21, 38, 143, 212, 222	50
E	0.030	0.194	0.263	0.342	—	6, 39	75
F	0.096	0.295	0.357	0.435	—	8, 9, 31, 87, 165, 213, 214, 225	50
G	0.096	0.295	0.357	0.435	0.511	10, 32, 116, 166, 215, 227, 229	50
H	0.061	0.295	0.357	0.435	—	11, 13, 144, 148, 149, 216	75
J	0.030	0.295	0.357	0.435	—	133 63, 79, 89, 144	95 125
K	0.081	0.334	0.379	—	—	81	50
L	0.198	0.640	0.670	0.745	0.813	118, 228	50
M	0.127	0.650	0.755	—	—	82	50
N	0.198	0.695	0.761	0.888	—	17, 218 164	50 75
P	0.198	0.695	0.761	0.888	0.963	18, 219 35	50 75

Table 8B. Coaxial cable assembly groups.

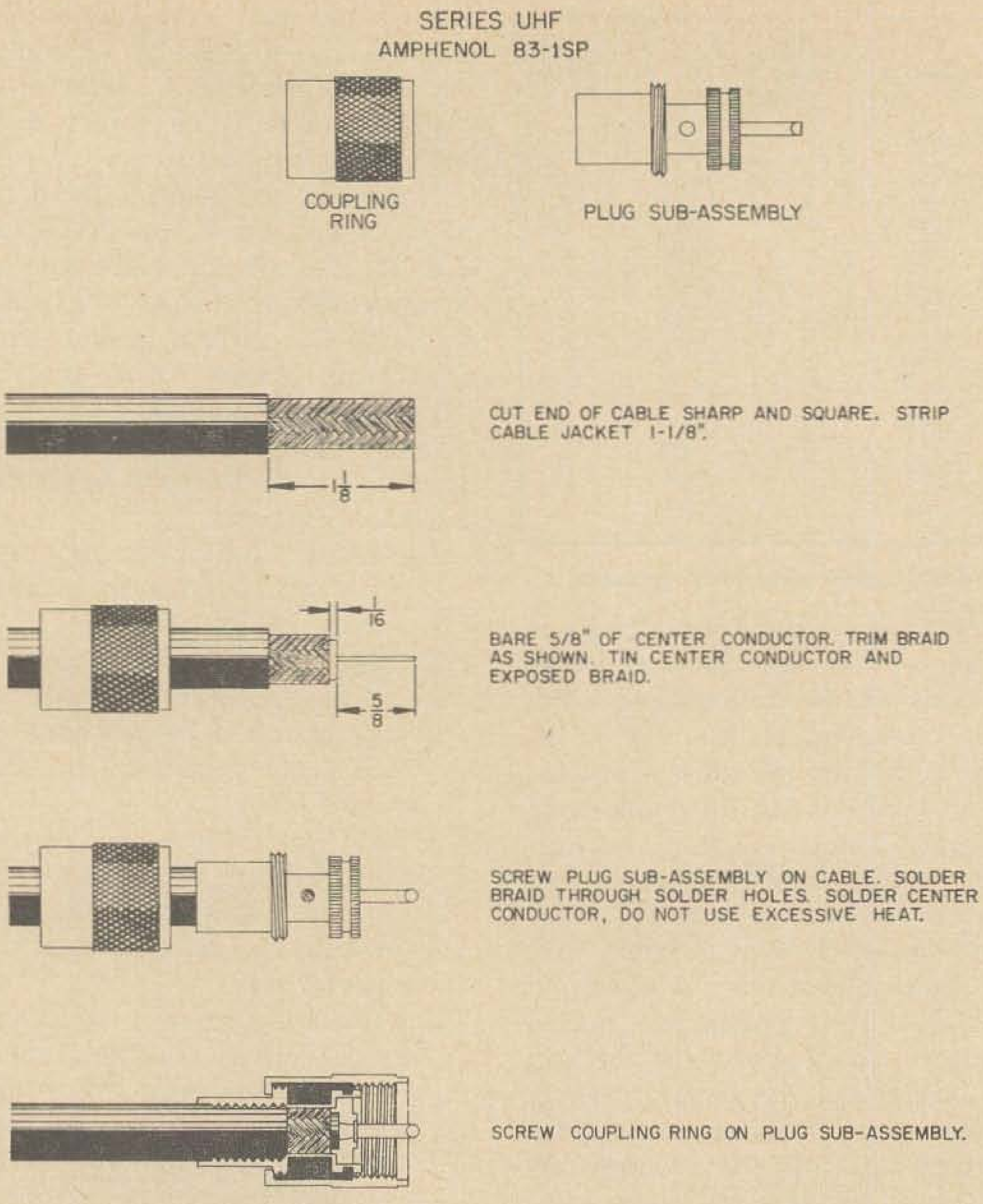


Fig. 12. Series UHF assembly instructions for Amphenol 83-1SP.

Coaxial connector assembly group charts

The "Coaxial Cable Assembly Group Charts" in **Table 8** are useful in selecting coaxial connectors for various size coaxial cables. The first part of the charts list 57 of the most popular coaxial cables and the lettered assembly group to which they belong. RG-8/U for example, is in assembly group "F."

The second part of the chart lists the dimensions of each of the cables within a group and their characteristic impedance. Cables within group "F" for example, include RG-8, -9, -31, -87, -165, -213, and -214/U.

The primary use of these charts is in the selection of coaxial connectors. In the "Coaxial Connector Index" in **Table 9,** only one type of RG-/U cable is listed for each connector. However, the same connector may be used with any other coaxial cable in the same assembly group. For example, the UG-21E/U type N improved plug is listed for cable type RG-8/U. This indicates that the UG-21E/U plug is suitable for any of the other cables in the "F" assembly group.

These charts are also useful when selecting connectors for cables which are not listed. In this event, the various dimensions of the cable are compared to the group chart to determine which group is most applicable; suitable connectors are then selected accordingly.

As an aid in connector selection, identification and assembly, the "Connector Index" in **Table 9** lists all of the type BNC, N and UHF coaxial connectors currently available along with description, type, equivalent Amphenol part number and applicable RG-/U cables. Many of these connectors have very subtle differences which may be recognized only from the information in the "engineering data" column of the table.

Type designation refers to standard (S), improved (I) and captivated contact (CC) assembly techniques. This index is indispensable in determining what method to use when assembling a particular connector.

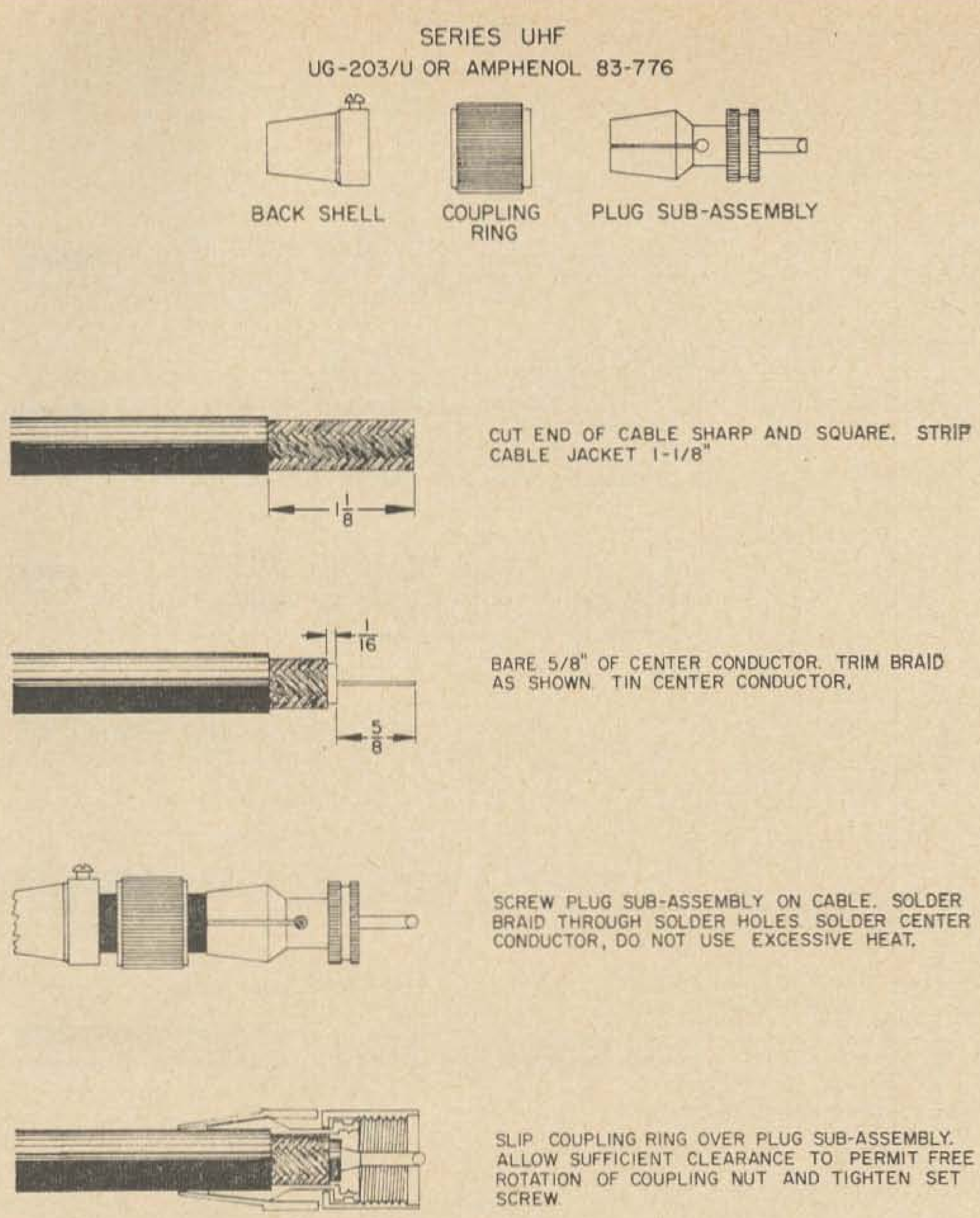


Fig. 13. Assembly instructions for **UHF series UG-203/U.**

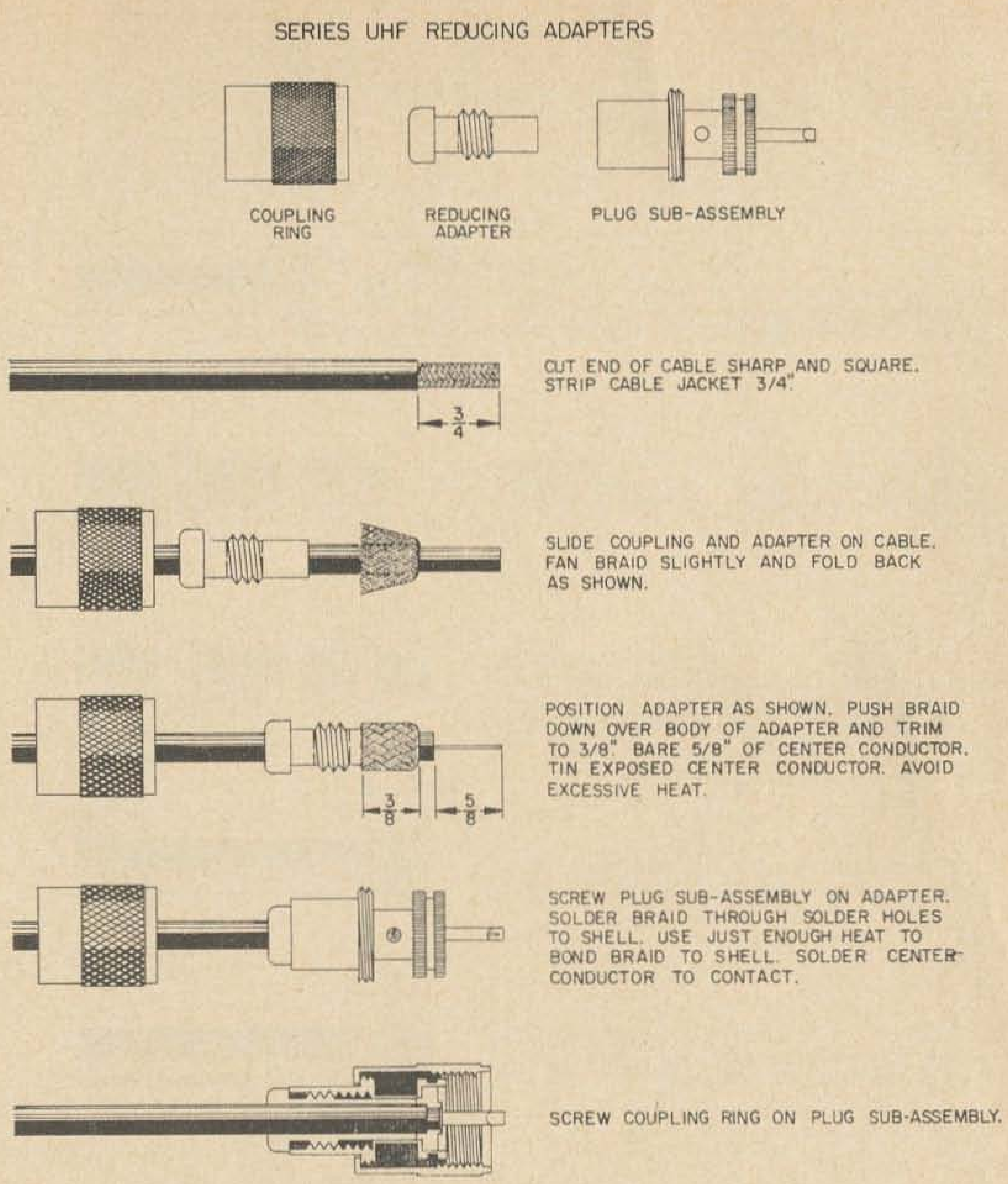


Fig. 14. Assembly instructions for **UHF series reducing adapters.**

SERIES UHF HOODS

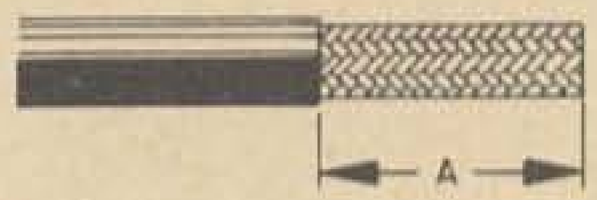
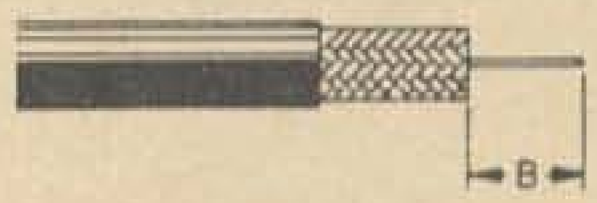
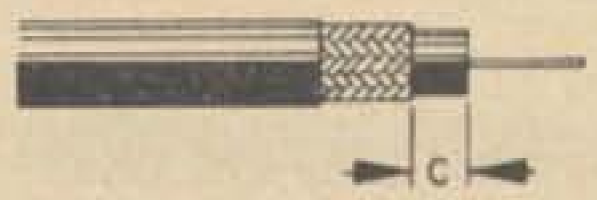
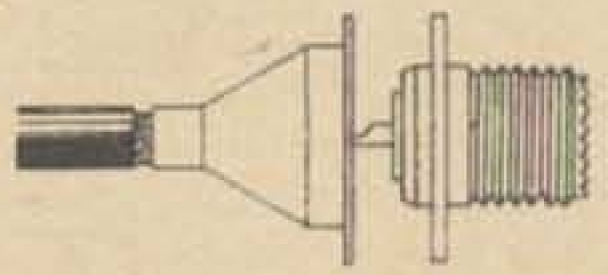
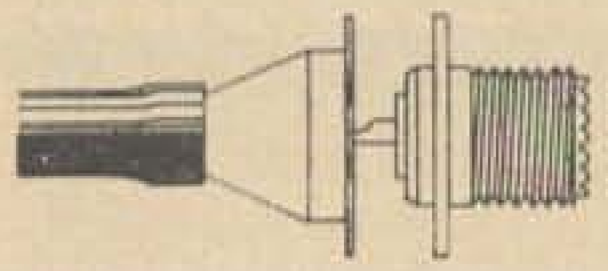
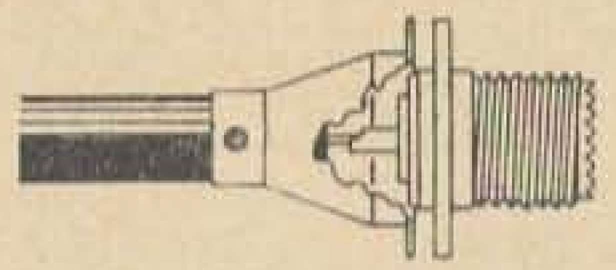
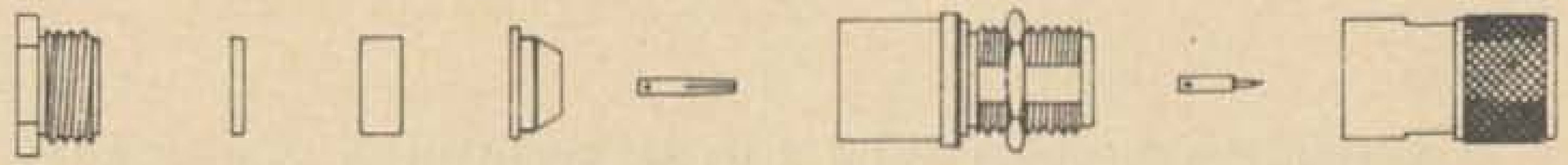
		UG-177/U	UG-106/U	UG-372/U
	CUT END OF CABLE SHARP AND SQUARE. STRIP JACKET TO APPROPRIATE LENGTH	3/4	5/8	3/4
	REMOVE BRAID AND DIELECTRIC TO DIMENSION SHOWN. TIN CENTER CONDUCTOR.	5/16	5/16	5/16
	STRIP BRAID FROM DIELECTRIC TO DIMENSION SHOWN. TIN BRAID.	3/8	3/16	3/8
	SLIDE HOOD OVER BRAID. SOLDER CONDUCTOR TO CONTACT. SLIDE HOOD FLUSH AGAINST RECEPTACLE AND TACK-SOLDER HOOD FLANGE TO RECEPTACLE FLANGE. SOLDER HOOD TO BRAID.	x		
	SLIDE HOOD OVER BRAID AND FORCE UNDER JACKET. SOLDER CONDUCTOR TO CONTACT. PUSH HOOD FLUSH AGAINST RECEPTACLE. TACK-SOLDER HOOD TO BRAID THROUGH SOLDER HOLES. WITH DOUBLE BRAIDED CABLE HOOD GOES OVER INNER BRAID ONLY. OUTER BRAID IS SOLDERED TO OUTSIDE OF HOOD.		x	
	SLIDE HOOD OVER BRAID. PUSH RECEPTACLE FLUSH AGAINST HOOD. SOLDER CONDUCTOR TO CONTACT AND HOOD TO BRAID.			x

Fig. 15. Assembly of UHF series hoods.

SERIES N



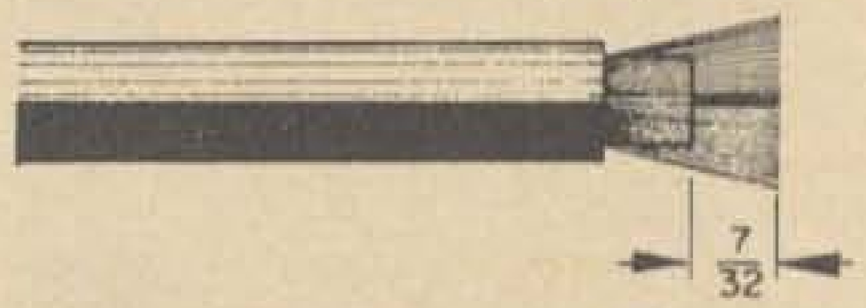
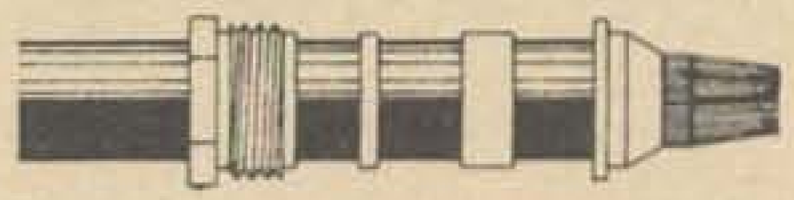
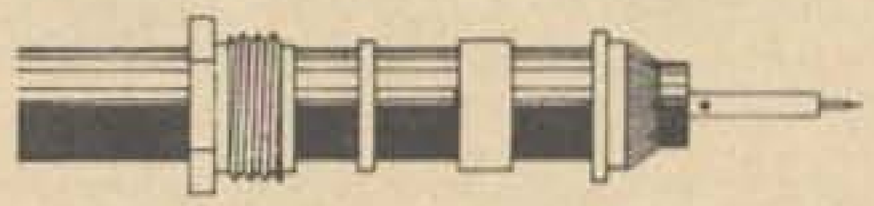
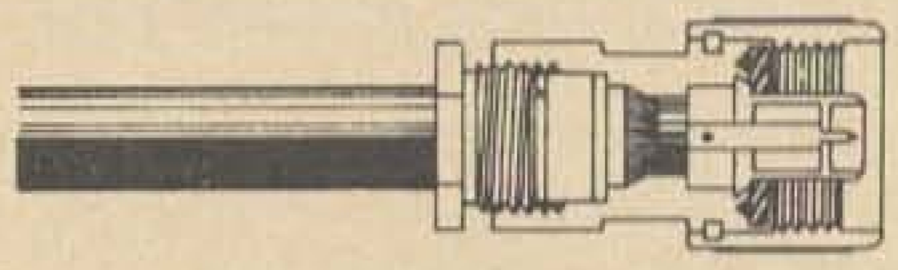
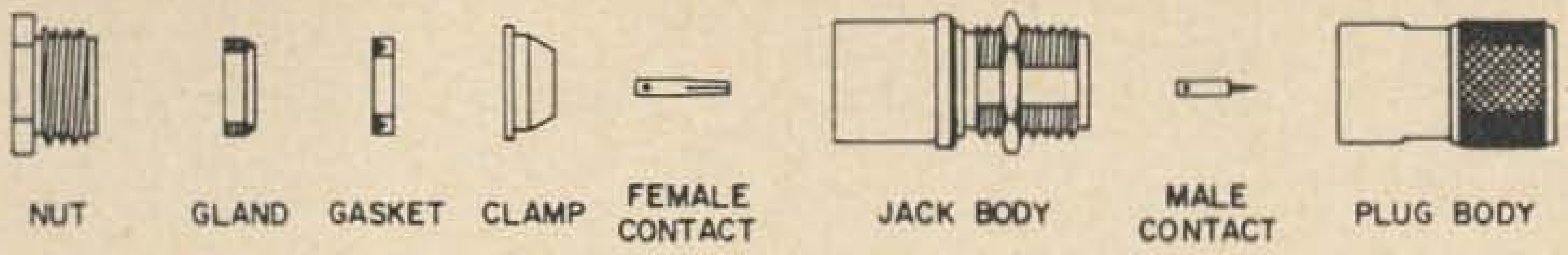
	CUT END OF CABLE SHARP AND SQUARE. STRIP JACKET 9/16". STRIP 5/8" WHEN USING DOUBLE SHIELDED CABLE.
	COMB OUT BRAID AS SHOWN. STRIP DIELECTRIC 7/32" FROM END. TIN CENTER CONDUCTOR.
	TAPER SHIELD AND SLIDE NUT, WASHER AND GASKET OVER JACKET. INSTALL CLAMP SO THAT ITS INNER SHOULDER FITS SQUARELY AGAINST END OF CABLE JACKET.
	FOLD BRAID BACK AS SHOWN AND TRIM PROPERLY. SOLDER CONTACT TO CENTER CONDUCTOR. AVOID EXCESSIVE HEAT.
	SLIDE ASSEMBLY INTO CONNECTOR BODY. FACE OF DIELECTRIC MUST BE FLUSH AGAINST INSULATOR. INSERT NUT, SCREW IN PLACE AND TIGHTEN WITH WRENCH.

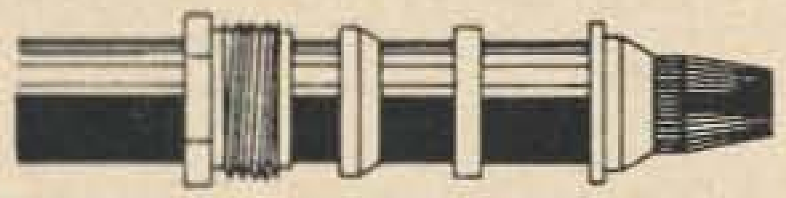
Fig. 16. Assembly of series N connectors.

SERIES N

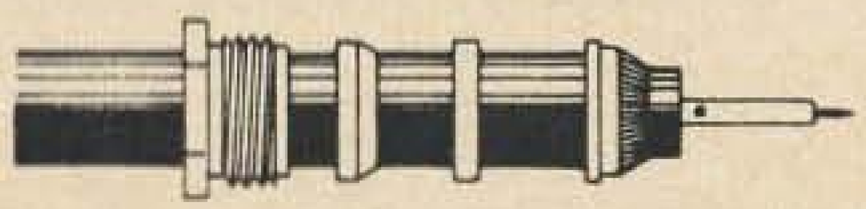


CUT END OF CABLE SHARP AND SQUARE. STRIP JACKET 9/16". STRIP 5/8" WHEN USING DOUBLE SHIELDED CABLE.

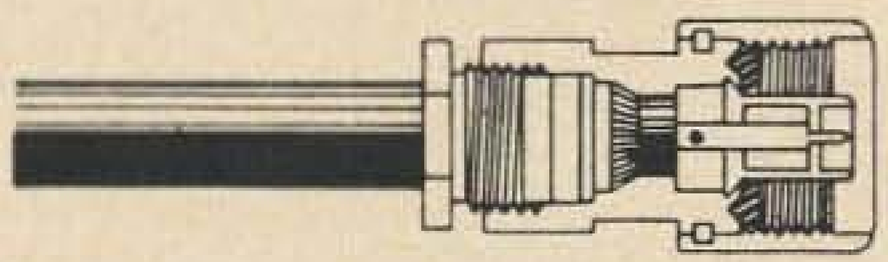
COMB OUT BRAID AS SHOWN. STRIP DIELECTRIC 7/32" FROM END. TIN CENTER CONDUCTOR.



TAPER SHIELD AND SLIDE NUT, GLAND AND GASKET OVER JACKET. INSTALL CLAMP SO THAT ITS INNER SHOULDER FITS SQUARELY AGAINST END OF CABLE JACKET. MAKE SURE KNIFE-EDGE OF GLAND IS TOWARD END OF CABLE AND MATES WITH GASKET.



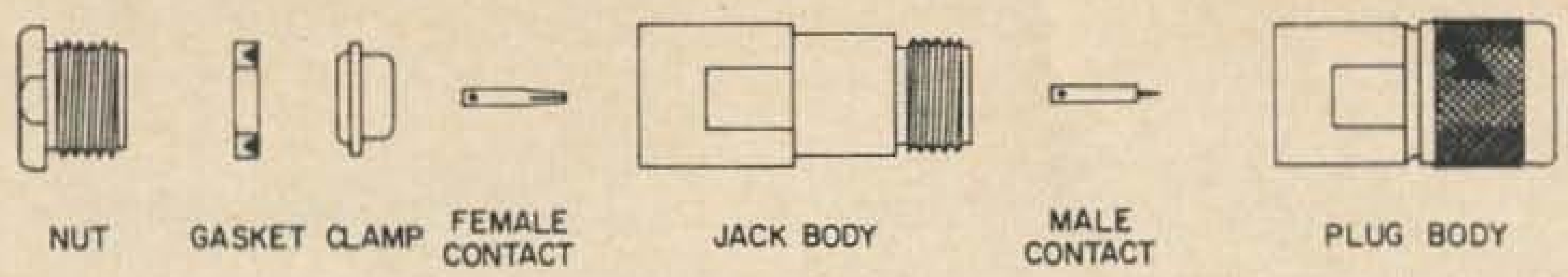
FOLD BRAID BACK AS SHOWN AND TRIM PROPERLY. SOLDER CONTACT TO CENTER CONDUCTOR. AVOID EXCESSIVE HEAT.



SLIDE ASSEMBLY INTO CONNECTOR BODY. FACE OF DIELECTRIC MUST BE FLUSH AGAINST INSULATOR. INSERT NUT, SCREW IN PLACE AND TIGHTEN WITH WRENCH. KNIFE-EDGE OF GLAND SHOULD CUT GASKET IN HALF WHEN SUFFICIENTLY TIGHTENED.

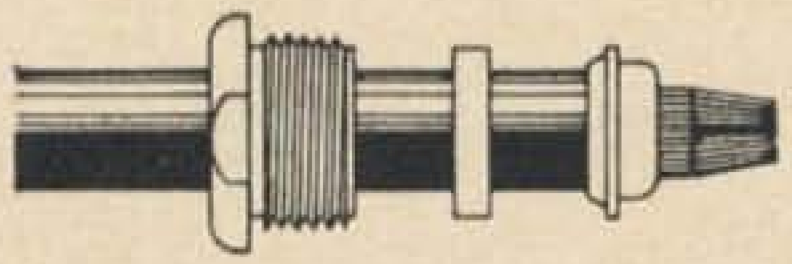
Fig. 17. Assembly of series N connectors.

SERIES N IMPROVED

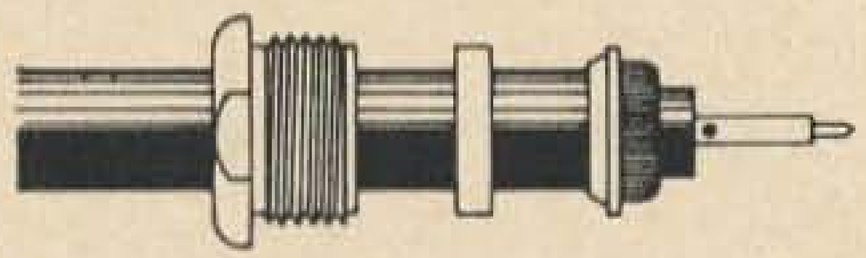


CUT END OF CABLE SHARP AND SQUARE. STRIP CABLE JACKET 9/32".

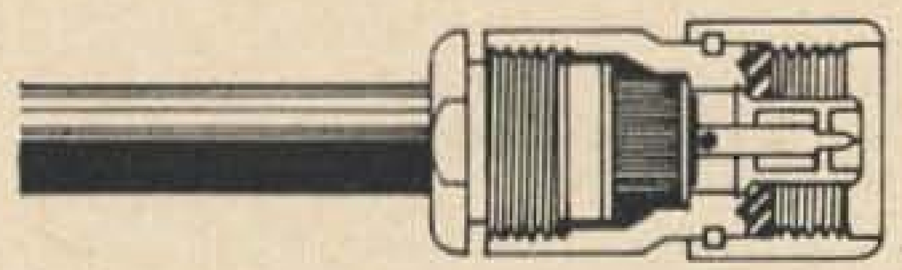
COMB OUT BRAID AS SHOWN. CUT OFF CABLE FLUSH 1/8" FROM END OF JACKET. TIN CENTER CONDUCTOR.



TAPER SHIELD AND SLIDE NUT, CLAMP AND GASKET OVER JACKET. INSTALL CLAMP SO THAT ITS INNER SHOULDER FITS SQUARELY AGAINST END OF CABLE JACKET.



FOLD BRAID BACK AS SHOWN AND TRIM PROPERLY. SOLDER CONTACT TO CENTER CONDUCTOR. AVOID EXCESSIVE HEAT.



SLIDE ASSEMBLY INTO CONNECTOR BODY. FACE OF DIELECTRIC MUST BE FLUSH AGAINST INSULATOR. MAKE SURE SHARP EDGE OF CLAMP SEATS PROPERLY IN GASKET. INSERT NUT, SCREW IN PLACE AND TIGHTEN WITH WRENCH.

Fig. 18. Assembly of series N improved connectors.

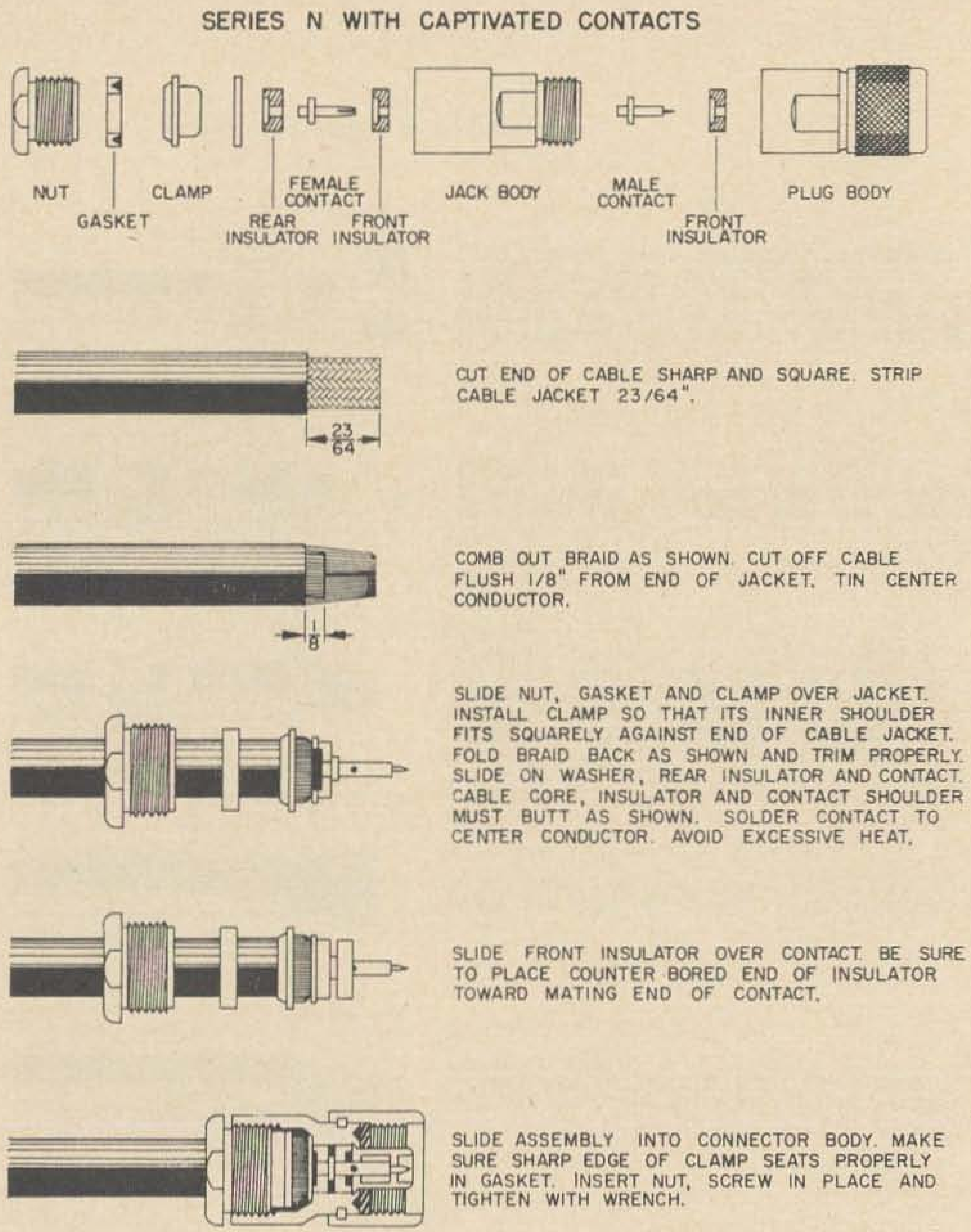


Fig. 19. Assembly of series N with captivated contacts.

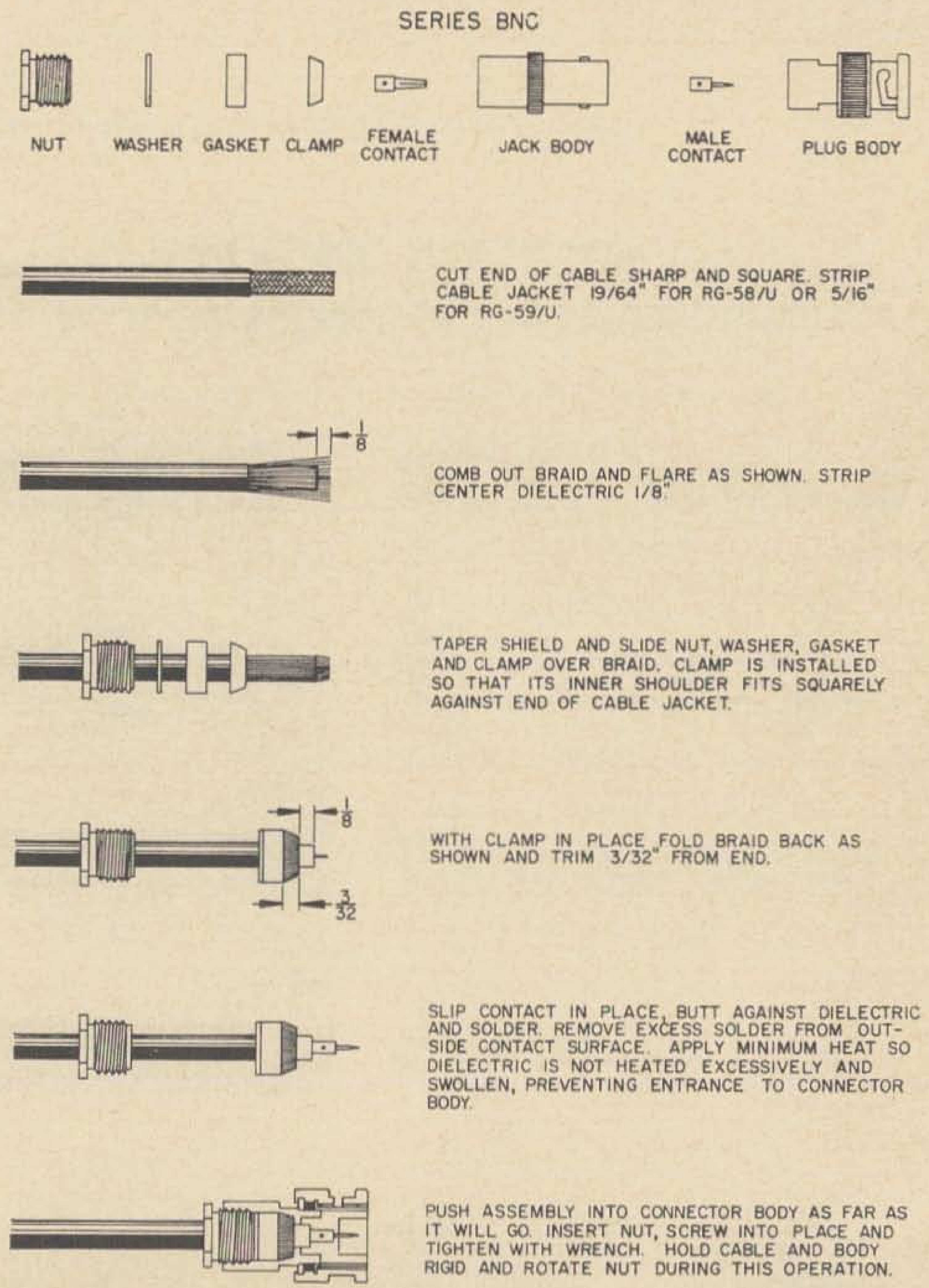
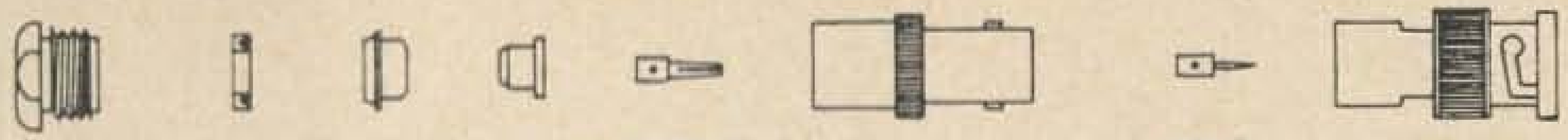
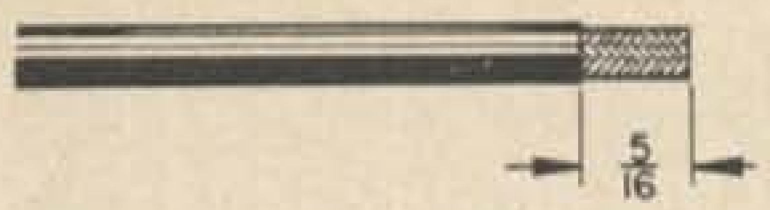


Fig. 20. Assembly of series BNC connectors.

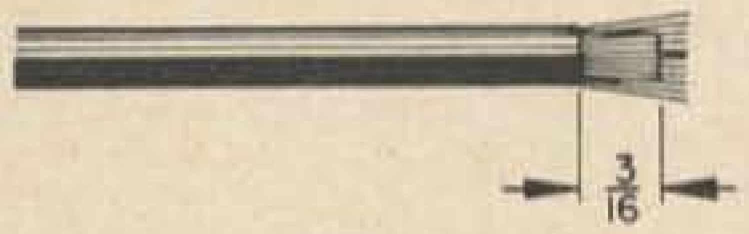
SERIES BNC IMPROVED



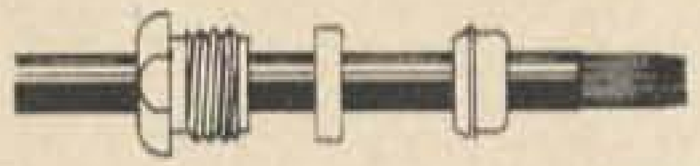
*FOR RG-62/U CABLES



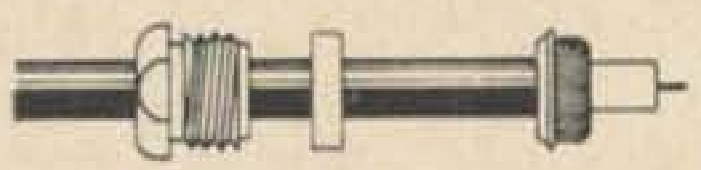
CUT END OF CABLE SHARP AND SQUARE. STRIP CABLE JACKET 5/16"



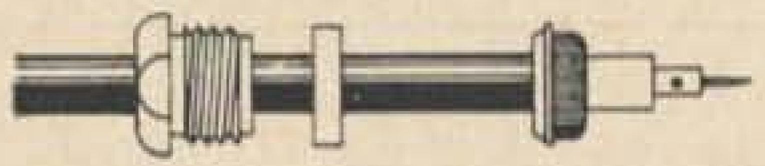
COMB OUT BRAID AND FLARE AS SHOWN. CUT CENTER DIELECTRIC 3/16" FROM EDGE OF JACKET. TIN CENTER CONDUCTOR.



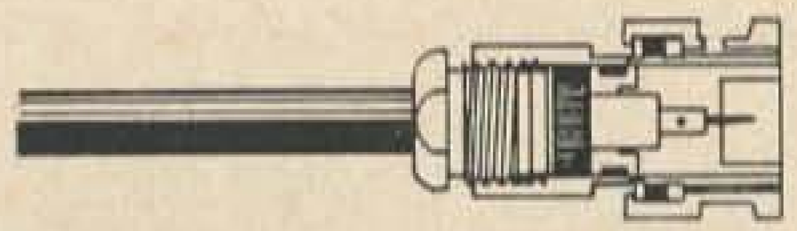
TAPER SHIELD AND SLIDE NUT, GASKET AND CLAMP OVER BRAID. PUSH CLAMP BACK AGAINST JACKET.



WITH CLAMP IN PLACE FOLD BRAID BACK AS SHOWN AND TRIM TO PROPER LENGTH. ADD BUSHING FOR RG-62/U TYPE CABLE.



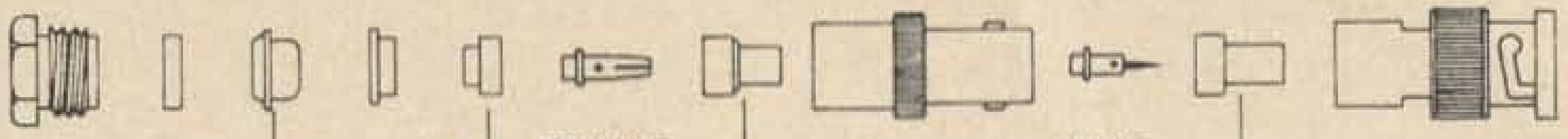
SOLDER CENTER CONDUCTOR TO CONTACT, AVOIDING EXCESSIVE HEAT WHICH MIGHT SWELL CABLE DIELECTRIC.



PUSH ASSEMBLY INTO CONNECTOR BODY AS FAR AS IT WILL GO. MAKE SURE SHARP EDGE OF CLAMP SEATS PROPERLY IN GASKET. TIGHTEN NUT.

Fig. 21. Assembly of series BNC improved connectors.

SERIES BNC WITH CAPTIVATED CONTACTS



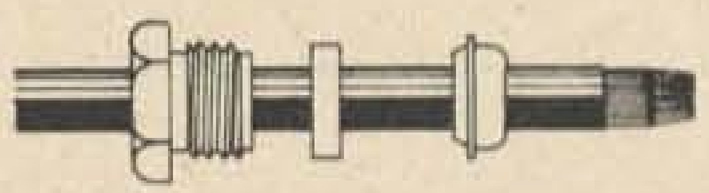
*FOR RG-62/U CABLES

STRIP CABLE JACKET TO "A" SHOWN IN CHART BELOW. CUT END OF CABLE SHARP AND SQUARE.

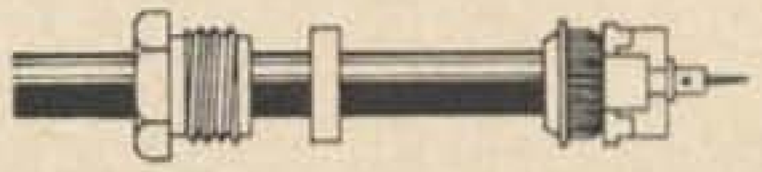
	31-301, 31-304	ALL OTHERS
"A"	27/64"	3/8"

COMB OUT BRAID AND FLARE AS SHOWN. CUT CENTER DIELECTRIC TO DIMENSION "B" SHOWN IN CHART BELOW.

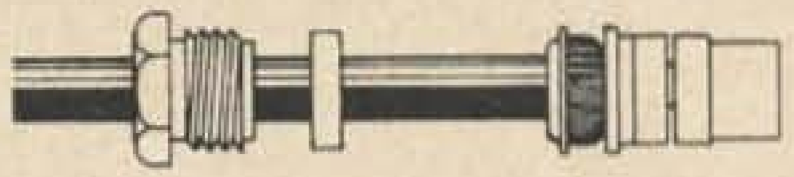
	RG-58/U, 59/U	RG-62/U
"B"	3/16"	5/32"



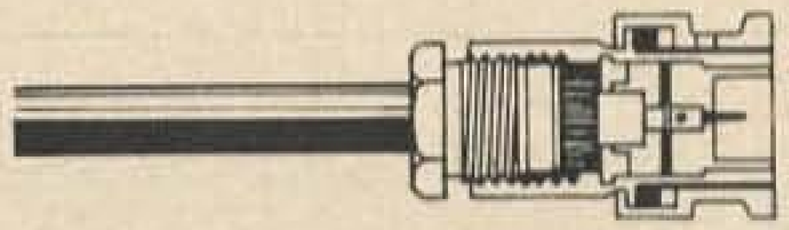
TAPER SHIELD AND SLIDE NUT, GASKET AND CLAMP OVER BRAID. PUSH CLAMP AGAINST JACKET. TIN CENTER CONDUCTOR.



FOLD BRAID BACK AS SHOWN AND TRIM TO PROPER LENGTH. SLIDE ON BUSHING, REAR INSULATOR AND CONTACT. THESE PARTS MUST BUTT AS SHOWN. SOLDER CONTACT TO CENTER CONDUCTOR. APPLY MINIMUM HEAT SO CENTER DIELECTRIC IS NOT HEATED EXCESSIVELY AND SWOLLEN, THEREBY PREVENTING ENTRANCE TO THE CONNECTOR BODY.



SLIDE FRONT INSULATOR OVER CONTACT AND BUTT AGAINST CONTACT SHOULDER. DO NOT REVERSE DIRECTION OF INSULATOR.



PUSH ASSEMBLY INTO CONNECTOR BODY AS FAR AS IT WILL GO. MAKE SURE SHARP EDGE OF CLAMP SEATS PROPERLY IN GASKET. TIGHTEN NUT.

Fig. 22. Assembly of series BNC connectors with captivated contacts.

Table 9. Coaxial connector index. Charted by cable size and coupling method

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-9/U	N	Plug	S	5	—	
UG-10/U	N	Panel Jack	S	5	—	
UG-11/U	N	Jack	S	5	—	
UG-12/U	N	Jack	S	5	22000	Rexolite Insul.
UG-13/U	N	Panel Jack	S	8	—	
UG-14/U	N	Jack	S	8	—	
UG-15/U	N	Plug	S	5	—	
UG-16/U	N	Panel Jack	S	5	—	
UG-17/U	N	Jack	S	5	—	
UG-18/U	N	Plug	S	5	3400	Not Weather-Proof
UG-18B/U	N	Plug	S	5	82-86	Teflon Insul.
UG-18C/U	N	Plug	I	5	82-203	Teflon Insul.
UG-18D/U	N	Plug	I	5	82-3203	Teflon Insul.
UG-19/U	N	Panel Jack	S	5	3500	Rexolite Insul.
UG-19B/U	N	Panel Jack	S	5	82-87	Teflon Insul.
UG-19C/U	N	Panel Jack	I	5	82-207	Teflon Insul.
UG-19D/U	N	Panel Jack	I	5	82-3207	Teflon Insul.
UG-20/U	N	Jack	S	5	42000	Rexolite Insul.
UG-20B/U	N	Jack	S	5	82-88	Teflon Insul.
UG-20C/U	N	Jack	I	5	82-210	Teflon Insul.
UG-20D/U	N	Jack	I	5	82-3210	Teflon Insul.
UG-21/U	N	Plug	S	8	3900	Rexolite Insul.
UG-21B/U	N	Plug	S	8	82-61	Teflon Insul.
UG-21C/U	N	Plug	S	8	82-96	Teflon Insul.
UG-21D/U	N	Plug	I	8	82-202	Teflon Insul.
UG-21E/U	N	Plug	I	8	82-3202	Teflon Insul.
UG-22A/U	N	Panel Jack	S	8	7500	Rexolite Insul.
UG-22B/U	N	Panel Jack	S	8	82-62	Teflon Insul.
UG-22C/U	N	Panel Jack	S	8	82-95	Teflon Insul.
UG-22D/U	N	Panel Jack	I	8	82-208	Teflon Insul.
UG-22E/U	N	Panel Jack	I	8	82-3208	Teflon Insul.
UG-23/U	N	Jack	S	8	48000	Not Weather-Proof
UG-23A/U	N	Jack	S	8	7600	Rexolite Insul.
UG-23B/U	N	Jack	S	8	82-63	Teflon Insul.
UG-23C/U	N	Jack	S	8	82-94	Teflon Insul.
UG-23D/U	N	Jack	I	8	82-209	Teflon Insul.
UG-23E/U	N	Jack	I	8	82-3209	Teflon Insul.
UG-27A/U	N	Right Angle Adapter	—	—	82-64	
UG-27B/U	N	Right Angle Adapter	—	—	82-98	
UG-27C/U	N	Right Angle Adapter	—	—	82-213	
UG-28A/U	N	Tee Adapter (F-F-F)	—	—	82-99	
UG-29/U	N	Straight Adapter	—	—	15000	Rexolite Insul.
UG-29A/U	N	Straight Adapter	—	—	82-65	Teflon Insul.
UG-29B/U	N	Straight Adapter	—	—	82-101	Teflon Insul.
UG-30/U	N	Bulkhead Adapter (F-F)	—	—	82-66	Rexolite Insul.
UG-30C/U	N	Bulkhead Adapter (F-F)	—	—	82-201	Glass Insul.
UG-30D/U	N	Bulkhead Adapter (F-F)	—	—	91100	Glass Insul.
UG-57/U	N	Straight Adapter (M-M)	—	—	16000	Rexolite Insul.
UG-57A/U	N	Straight Adapter (M-M)	—	—	45250	Teflon Insul.
UG-57B/U	N	Straight Adapter (M-M)	—	—	82-100	Teflon Insul.
UG-58/U	N	Receptacle (70 ohm)	—	—	82-24	
UG-58A/U	N	Receptacle (70 ohm)	—	—	82-97	
UG-73/U	UHF	Plug	—	59	—	
UG-83/U	—	Adapter, N (F) to UHF (M)	—	—	14000	Rexolite/Teflon Insulation
UG-83A/U	—	Adapter, N (F) to UHF (M)	—	—	16150	Rexolite/Bakelite Insul.
UG-83B/U	—	Adapter, N (F) to UHF (M)	—	—	34125	Teflon Insul.
UG-88/U	BNC	Plug	S	58	31-002	
UG-88A/U	BNC	Plug	S	58	14525	
UG-88B/U	BNC	Plug	S	58	31-018	
UG-88C/U	BNC	Plug	I	58	31-202	
UG-88D/U	BNC	Plug	I	58	31-2202	
UG-88E/U	BNC	Plug	I	58	31-3202	
UG-89/U	BNC	Jack	S	58	31-005	
UG-89A/U	BNC	Jack	S	58	31-019	
UG-89B/U	BNC	Jack	I	58	31-205	
UG-89C/U	BNC	Jack	I	58	31-2205	
UG-90/U	BNC	Panel Jack	S	59	1300	
UG-91A/U	N	Plug (70 ohm)	S	6	7200	
UG-92A/U	N	Jack (70 ohm)	S	6	7700	
UG-93A/U	N	Panel Jack (70 ohm)	S	6	7800	
UG-94A/U	N	Plug (70 ohm)	S	11	82-84	
UG-95A/U	N	Jack (70 ohm)	S	11	82-89	
UG-96A/U	N	Panel Jack (70 ohm)	S	11	82-90	

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-106/U	N	Hood	—	—	83-1H	
UG-107/U	N	Tee Adapter (F-M-F)	—	—	4800	Rexolite Insul.
UG-107A/U	N	Tee Adapter (F-M-F)	—	—	82-36	Teflon Insul.
UG-107B/U	N	Tee Adapter (F-M-F)	—	—	82-102	Teflon Insul.
UG-111/U	UHF	Plug	—	59	83-750	Filled Bakelite
UG-146/U	—	Adapter, N (F) to UHF (M)	—	—	4400	Not Weatherproof
UG-159A/U	N	Bulkhead Jack	S	5	17500	
UG-159B/U	N	Bulkhead Jack	I	5	15550	
UG-160A/U	N	Bulkhead Jack	S	8	82-67	
UG-160B/U	N	Bulkhead Jack	S	8	82-93	
UG-160C/U	N	Bulkhead Jack	I	8	—	
UG-160D/U	N	Bulkhead Jack	I	8	91025	
UG-167A/U	N	Plug	S	17	82-104	
UG-171/U	—	Adapter, UHF to British	—	—	—	
UG-173/U	UHF	Reducing Adapter	—	38	—	
UG-175/U	UHF	Reducing Adapter	—	58	83-185	
UG-176/U	UHF	Reducing Adapter	—	59	83-168	
UG-177/U	UHF	Hood	—	58	83-765	
UG-185/U	BNC	Receptacle	—	—	4500	
UG-188/U	N	Plug	S	58	23250	Not Weatherproof
UG-197/U	—	Adapter, UHF to British	—	—	—	
UG-201/U	—	Adapter, N (F) to BNC (M)	—	—	31-830	
UG-201A/U	—	Adapter, N (F) to BNC (M)	—	—	31-216	
UG-202/U	N	Right Angle Adapter (F-F)	—	—	—	
UG-203/U	UHF	Plug	—	59	83-776	Filled Bakelite
UG-204A/U	N	Plug	S	14	82-105	Rexolite Insul.
UG-204C/U	N	Plug	I	14	82-214	Teflon Insul.
UG-223/U	UHF	Bulkhead Receptacle	—	—	—	
UG-224/U	UHF	Bulkhead Adapter (F-F)	—	—	29500	Rexolite Insul.
UG-231/U	N	Receptacle	—	—	2750	With Hood
UG-239/U	UHF	Hood	—	59	—	
UG-253/U	BNC	Bulkhead Jack, Presurized	—	58	—	
UG-254A/U	BNC	Receptacle, Presurized	—	—	31-016	Rexolite Insul.
UG-255/U	—	Adapter, BNC (F) to UHF (M)	—	—	2900	
UG-260/U	BNC	Plug	S	59	31-012	Rexolite Insul.
UG-260A/U	BNC	Plug	S	59	31-021	
UG-260B/U	BNC	Plug	I	59	31-212	Teflon Insul.
UG-260C/U	BNC	Plug	I	59	31-2212	Beryllium Contacts
UG-261/U	BNC	Jack	S	59	31-015	Rexolite Insul.
UG-261A/U	BNC	Jack	S	59	31-022	Rexolite Insul.
UG-261B/U	BNC	Jack	I	59	31-215	Teflon Insul.
UG-262/U	BNC	Panel Jack	S	59	31-011	Rexolite Insul.
UG-262A/U	BNC	Panel Jack	S	59	31-023	Rexolite Insul.
UG-262B/U	BNC	Panel Jack	I	59	31-211	Teflon Insul.
UG-266/U	UHF	Receptacle, Presurized	—	—	4575	Rexolite Insul.
UG-273/U	—	Adaptr, BNC (M) to UHF (F)	—	—	31-028	Non-constant Impedance
UG-274/U	BNC	Tee Adapter (F-M-F)	—	—	31-008	Rexolite Insul.
UG-274A/U	BNC	Tee Adapter (F-M-F)	—	—	31-208	Teflon Insul.
UG-281/U	N	Panel Jack	S	58	3525	Rexolite Insul.
UG-282/U	—	Adapter, BNC (M) to Binding Post	—	—	—	
UG-290/U	BNC	Receptacle	—	—	31-003	Rexolite Insul.
UG-290A/U	BNC	Receptacle	—	—	31-203	Teflon Insul.
UG-291/U	BNC	Panel Jack	S	58	31-001	Gold Plated Contacts
UG-291A/U	BNC	Panel Jack	S	58	31-020	Not Weatherproof
UG-291B/U	BNC	Panel Jack	I	58	31-201	
UG-295/U	UHF	Plug	—	8	—	
UG-296/U	UHF	Receptacle	—	8	—	
UG-297/U	UHF	Right Angle Adapter (M-F)	—	—	—	
UG-298/U	UHF	Tee Adapter (F-M-F)	—	—	—	
UG-299/U	UHF	Straight Adapter (F-F)	—	—	—	
UG-299/U	UHF	Straight Adapter (F-F)	—	—	—	
UG-300/U	UHF	Bulkhead Adapter (F-F)	—	—	—	
UG-306/U	BNC	Right Angle Adapter (M-F)	—	—	31-009	
UG-307/U	UHF	Straight Panl Mounting Adapter	—	—	—	
UG-314/U	—	Adapter, N (F) to UHF (M)	—	—	—	
UG-318/U	—	Adapter, N (F) to UHF (F)	—	—	26700	
UG-332/U	—	Adapter, UHF (M) to Binding Post	—	—	5800	Rexolite Insul.

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-335/U	—	Adapter, N (M) to BNC (F)	—	—	3025	Rexolite/Teflon Insulation
UG-349/U	—	Adapter, N (M) to BNC (F)	—	—	2975	Rexolite/Teflon Insulation
UG-349A/U	—	Adapter, N (M) to BNC (F)	—	—	31-217	Teflon Insul.
UG-357/U	UHF	Receptacle	—	34	83-21R	
UG-358/U	UHF	Plug	—	34	83-21SP	Filled Bakelite
UG-360/U	UHF	Straight Adapter (F-F)	—	—	83-21J	Polystyrene Insulation
UG-363/U	UHF	Bulkhead Adapter	—	—	83-1F	Polystyrene Insulation
UG-365/U	BNC	Receptacle	—	—	4650	Turret Terminal
UG-366/U	UHF	Hood	—	—	—	
UG-367/U	N	Receptacle	—	—	—	
UG-372/U	UHF	Hood	—	8	83-1HP	
UG-414/U	BNC	Flanged Feedthrough Adapter (F-F	—	—	47000	
UG-447/U	BNC	Receptacle	—	—	31-817	Rexolite Insul.
UG-464/U	N	Tee Adapter (F-F-M)	—	—	—	
UG-483/U	N	Jack	S	81	14175	Not Weatherproof
UG-484/U	N	Jack	I	82	—	
UG-486/U	N	Plug	I	81	—	
UG-487/U	N	Plug	I	81	—	
UG-491/U	BNC	Straight Adapter (M-M)	—	—	8425	
UG-491A/U	BNC	Straight Adapter (M-M)	—	—	31-218	
UG-492A/U	BNC	Pressurized Bulkhead Adapter (F-F)	—	—	31-220	Glass/Teflon Insulation
UG-492B/U	BNC	Pressurized Bulkhead Adapter (F-F)	—	—	31-2220	Glass/Teflon Insulation
UG-527/U	BNC	Plug	—	100	—	
UG-535/U	BNC	Right Angle Receptacle	—	—	5675	
UG-536/U	N	Plug	S	58	3400	Rexolite Insul.
UG-536B/U	N	Plug	I	58	34025	Teflon Insul.
UG-556/U	N	Bulkhead Jack	S	58	35250	
UG-556A/U	N	Bulkhead Jack	I	58	—	
UG-557/U	N	Plug	S	118	—	
UG-557A/U	N	Plug	I	118	—	
UG-589/U	BNC	Plug	—	—	—	For Single Wire
UG-593/U	N	Panel Jack	S	59	35500	
UG-593A/U	N	Panel Jack	I	59	—	
UG-594A/U	N	Right Angle Jack	I	8	15425	
UG-602/U	N	Jack	S	59	36500	Rexolite Insul.
UG-602A/U	N	Jack	I	59	36525	Teflon Insul.
UG-603/U	N	Plug	S	59	34500	Rexolite Insul.
UG-603A/U	N	Plug	I	59	34525	Teflon Insul.
UG-604/U	BNC	Receptacle	—	—	—	
UG-606/U	—	Adapter, N (M) to BNC (M)	—	—	—	
UG-624/U	BNC	Bulkhead Jack	S	59	2075	Rexolite Insul.
UG-625/U	BNC	Receptacle	—	—	5575	Rexolite Insul.
UG-625B/U	BNC	Receptacle	—	—	31-236	Teflon Insul.
UG-646/U	UHF	Right Angle Adapter (M-F)	—	—	83-1AP	Polystyrene Insulation
UG-657/U	BNC	Pressurized Receptacle	—	—	31-102	Rexolite Insul.
UG-680/U	N	Receptacle	—	—	82-811	Glass/Teflon Insulation
UG-909/U	BNC	Bulkhead Jack	S	58	31-206	½" Thread Mounting
UG-909B/U	BNC	Bulkhead Jack	I	58	—	½" Thread Mounting
UG-910/U	BNC	Bulkhead Jack	S	59	31-207	
UG-910B/U	BNC	Bulkhead Jack	I	59	—	
UG-911A/U	BNC	Pressurized Receptacle	—	—	31-237	Glass/Teflon Insulation
UG-912/U	BNC	Pressurized Receptacle	—	—	31-238	
UG-913/U	BNC	Right Angle Plug	S	58	31-204	
UG-913A/U	BNC	Right Angle Plug	I	58	—	
UG-914/U	BNC	Feedthrough Adapter (F-F)	—	—	31-219	
UG-928/U	BNC	Receptacle	—	—	1100	Rexolite Insul.
UG-935A/U	N	Panel Jack	I	10	82-211	
UG-936A/U	N	Bulkhead Jack	I	8	16250	
UG-940A/U	N	Jack	I	8	82-212	Armor Clamping
UG-941A/U	N	Plug	I	8	82-204	Armor Clamping
UG-959/U	BNC	Plug	S	8	6775	
UG-959A/U	BNC	Plug	I	8	—	
UG-978/U	—	Adapter, BNC to Banana Jack	—	—	—	
UG-982/U	N	Plug	I	17	92125	Armor Clamping
UG-987/U	—	Adapter, BNC to two Male Banana Plugs	—	—	8975	
UG-997A/U	N	Right Angle Receptacle	—	—	84975	
UG-1003/U	N	Plug	S	63	12400	Armor Clamping

Military Number	Series	Description	Type*	For RG/U Cables Type	Amphenol Number	Engineering Data
UG-1006/U	N	Plug	I	74	—	
UG-1017/U	—	Adapter, UHF to Banana Jack	—	—	—	
UG-1018/U	N	Straight Adapter	—	—	—	
UG-1033/U	BNC	Plug	I	122	84975	
UG-1034/U	—	Adapter, BNC (F) to N (F)	—	—	5225	
UG-1052/U	N	Panel Jack	I	58	36000	Rexolite Insul.
UG-1055/U	BNC	Panel Jack	I	122	84625	
UG-1056/U	BNC	Jack	I	122	84650	
UG-1082/U	BNC	Plug	I	122	—	
UG-1094/U	BNC	Receptacle	—	—	31-221	
UG-1095A/U	N	Panel Jack	I	58	36250	
UG-1098/U	BNC	Right Angle Receptacle	—	—	31222	
UG-1104/U	BNC	Male Receptacle	—	—	—	
UG-1174/U	BNC	Right Angle Receptacle	—	—	38425	
UG-1185/U	N	Plug	CC	8	82-312	
UG-1185A/U	N	Plug	CC	8	82-3312	
UG-1186/U	N	Jack	CC	8	82-313	
UG-1187/U	N	Panel Jack	CC	8	82-314	
UG-1195/U	N	Plug	CC	18	—	
MX-367	BNC	Hood	—	59	10925	
MX-539	UHF	Hood	—	58	5375	
MX-543	UHF	Hood	—	8	5475	
MX-913	N	Cap and Chain (M)	—	—	82-106	
MX-195A	BNC	Hood	—	58	87175	
PL-258	UHF	Straight Adapter (F-F)	—	—	83-1J	
PL-259	UHF	Plug	—	8	83-1SP	Filled Bakelite
PL-259	UHF	Plug	—	8	83-822	Teflon Insul.
PL-259A	UHF	Plug (Clamp set screw)	—	8	83-1SPN	Mica Filled
PL-259A	UHF	Plug (Clamp set screw)	—	8	83-756	Teflon Insul.
PL-274	UHF	Bulkhead Adapter (F-F)	—	—	83-1F	
SO-239	UHF	Receptacle	—	—	83-1R	Mica Filled
SO-239	UHF	Receptacle	—	—	83-1RTY	Polystyrene
SO-239A	UHF	Receptacle	—	—	83-798	Teflon Insul.

Corrections

After the July issue went to press, we received some interesting comments on our FET articles from one of the engineers at Siliconix (manufacturer of the U-112 and U-110 field effect transistors).

1. In K3CLU's Field Effect Voltmeter on page 34, the values of R16 and R17 should be set so that there is −6 volts on the drains of the FET's and +3 volts at point F. In addition, to improve linearity, R10 and R14 should be changed to 5 k, R12 to 5 k or 10 k and R13 should be eliminated entirely.

2. In K3CLU's Transistor Analyzer on page 30, the voltmeter circuit may not operate properly with **all** 2N2498's. If the device ie near the center of the spread in operating characteristics, it will work fine; if not, the completed unit may exhibit poor linearity.

3. The Audio Compressor by K3VNR may operate somewhat better if a U-112 or U-148 is used for Q4. Also, C7 does not have to be as large as that shown in the schematic if R9 and R10 are increased to maintain the same time constant.

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PNP 2N670/300Mw 35c @, ... 5 for $1
PNP 2N671/1 Watt 50c @, ... 3 for $1

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2N1038 6/$1, 1039 4/$1, 1040/$1
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18**	.20	.30	.75	1.10
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

D. C. Amps	400Piv 280Rms	500Piv 350Rms	600Piv 420Rms	750Piv 525Rms
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
150	5.40	6.50	7.50	12.00

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Cndsr Oil 6Mfd @ 1500V $4 @, ... 5 for $10
880 Vct @ 735Ma for SSB $12 @, ... 2/$22
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10 Vct @ 5A & 7.5Vct @ $5 @, ... 2/$9

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SELLING OUT. NCX-3, NCX-D, Heath AC P/s, used 10 hours, best offer over $340. Apache (needs $13 xformer) $94. Ranger I, $98. Computer test P/S (good for parts) $8.50. Selectric typewriter keyboard for that code machine project, $15. PMR6A receiver & 12 VDC supply (used but electrically very good) $65. Perfect AC supply for PMR6A, $40; both $90. Send S.A.S.E. to Jim Beistle, 3728 Wilkie Way, Ft. Worth, Texas.

HALLICRAFTERS SX101A $215, HT32A $290, HT32 $270, SX62A $110, excellent shape, just factory reconditioned; still in sealed cartons with receipts. No price compromise and you must pay shipping. Joe K9VAR, 1851 North Rutherford, Chicago, Illinois 60635.

MARK III RF IMPEDANCE Bridge, reprinted from August '61 73 Magazine; excellent article plus 13 enlarged diagrams available for $1. 73 Magazine, Peterborough, N.H. 03458.

WANTED: Topcon Super D camera, Topcor lenses, or any accessories. Cash or will trade QST/CQ collection, lab test equipment, or electronic parts. Box 55, c/o 73 Magazine, Peterborough, N.H. 03458.

WANTED GOLDKIT THRILLER transceiver. Box 211, Wilmington, N.C.

PHASEMASTER II 160-10 meter phasing type SSB exciter. 75 watts PEP; unit complete with Band-Hopper VFO. Unit is in good condx, only $100. 73 Magazine, Peterborough, N.H. 03458.

GERMAN OM looks for "Hints and Kinks" to modify an SP 600 JX (military model). BRUNS, Bielitzerstr. 8, 8000 Munich 55, Germany.

NC 303 GOOD CONDX, must sell for college expenses, $165 here or $175 shipped. Wes Canfield WA4EPB/Ø, 2325 Carpenter, Des Moines, Iowa 50311.

YORK COUNTY HAMFEST. The 11th Annual Hamfest will be held Sept. 4 on the Adams County Fair Grounds, 4 mi north of Abbottstown, Pa. Registration starts at 9 AM. Talk-ins on 145.62 and 50.62 mc. Xmtr hunt, games, free drawings, auction. Write K3POR, 170 S. Albemarle St., York, Pa.

SURPLUS HANDBOOK Volume I, covering receivers and transceivers; just a few available at $3 each. 73 Magazine, Peterborough, N.H. 03458.

QSL CARDS???? Made-to-order!! Samples 25¢ Sakkers, W8DED, Holland, Michigan 49423. (mention 73).

SONAR 80-10 METERS TRANSMITTER with matching VFO; uses efficient 5894 in the final. $100 with power supply. 73 Magazine, Peterborough, N.H. 03458.

2 METER SPECIAL. Narrowband hiband base station, 30 watt Bendix in good shape $59. Now on 160 mc—send self-addressed envelope for listing. All sales FOB Ft. Worth, Texas 76100.

CANADIANS—New Bud deluxe cabinet 21x13x15 deep. Partially completed transmitter to fit; 814 tube; 19 set; Hammond 762 plate transformer; CQ's-QST's 58-61. Sell any best offer. VE7CT, 3636 West 17th Ave., Vancouver 8.

BROADCAST STATION FOR SALE. 250 watt Gates never unpacked, or share in station after intensive investigation. Gene Markos K9JFE Litchfield, Illinois. 324-3178 after 6 PM.

SIX ASSORTED ISSUES of ATV Experimenter, circa '64-'65, $1 from 73 Magazine, Peterborough, N.H. 03458.

WANTED: Link power amplifier type 1908 with tubes. Advise price, condition. W8ACP, 960 W. Milton, Alliance, Ohio

CQ-QST. CQ 1948-1960, 118 issues; QST 1953-1960, 64 issues. Either or both to highest bidder. K5DZM, 1112 Bellaire, Grapevine, Texas.

DELAWARE HAMFEST. The amateur radio clubs of Delaware have joined together to put on the 1966 Delaware Hamfest in Wilmington, Delaware on August 14. For more info contact Bill Robinson K3UHU, 204 W. Delaware Ave., Wilmington 19809.

SCHEMATICS FOR either the ARC-508, or the ARR 15, both described in June '65 issue of 73, only 50¢ each. 73 Magazine, Peterborough, N.H. 03458.

CHRISTIAN HAM FELLOWSHIP now being organized for tract, missionary and fellowship among Christian hams. Donations for the work appreciated. Christian Ham Callbook $1 donation. Send for free details from Christian Ham Fellowship, Box 218, Holland, Michigan 49423.

DRAKE 2-B $170, Bud low pass filter $5, Lafayette phone patch $12, Dow-Key relay $5. Dr. Marvin Lee, 5219 Nichol Ave., Anderson, Indiana 46011.

RELIABLE SSB EXCITER, the Phasemaster Jr., produces 60 watts PEP; phasing type of sideband generation. $75. 73 Magazine, Peterborough, N.H. 03458.

SURPLUS PARTS salvaged from power supply including: voltage regulator 0-130 volts. Write Philip Hunrath, 47 Parker Pl., Shrewsbury, N.J. 07704.

HT 33B, EXCELLENT CONDX. Tube practically new. Asking $425. H. J. Nadley, W3INH, 307 Woods Road, Glenside, Pa. 19038. Day phone 215-LO3-5579.

PEORIA HAMFEST September 18, Peoria, Illinois, Peoria Area Amateur Radio Club, advance registration $1.50. Write Ferrel Lytle, W9DHE, Stonegate Road, Peoria, Illinois 61614.

BARGAINS! Transmitters, Receivers, Test Equipment offered, wanted in ham's trading paper. Next 12 interesting issues $1. Sample copy free. "Equipment Exchange-Ham Trader", Sycamore, Illinois.

INTERESTED IN VHF? Flexible converter covers 6, 2, and 1¼ meters; it's made for the NC-300, but is useable with any receiver covering 30-35 MC. $50. 73 Magazine, Peterborough, N.H. 03458.

80 METER crystal controlled converter to BC band. 12 volt, just plug into antenna lead and connect to battery lead. $5 delivered. Jack Morgan WØRA, Greenfield, N.H. 03047.

WANTED case for Morrow receiver. WA1CCH, c/o 73, Peterborough, N.H. 03458.

NEW 55 AMP DELCO-REMY alternators with matching regulators; $37.50 per set. R. F. Bevington, Blytheville, Ark.

COMPLETE CONVERSION instructions for the AN/VRC-2, just $1 while the supply lasts. 73 Magazine, Peterborough, N. H. 03458.

TELETYPE SYSTEM-Perforator with keyboard $69. Distributor transmitter (reads and sends tape) $35. Printer perforator (no motor) $25. Distributor for sync. $15. First come, first served any or all. Jack Fisher 579 Royalton Dr., New Haven, Ind. 46774.

AUDIO FILTERS 300 cycle to 3600 cycle passband. 500 ohms in, 10K out, 15 watt max. FB for phone patch, inverted audio SSB, A.F. Q5er. Unused surplus commercial units $2.50 each postpaid. Lock City Electric, P.O. Box O, Freeland, Mich. 48623.

SURPRISE PACKAGE—For only one dollar you receive a goody box of electronic parts worth many times above price. Quaker Electronics, P. O. Box 215, Hunlock Creek, Pa. 18621.

WANTED 3CX2500, 3CX10,000/8159, 4CX10,000/8171 power transmitting tubes, used TV and commercial pullouts. Price must be reasonable. Bill Smitherman WA4YFC, Rt. 2, East Bend, N. Carolina.

HX30 HEATHKIT SSB 6 transmitter, new $140. Clegg Zeus modulator power supply $325. Interceptor $200. Globe High Bander $65 and Globe Chief $65. Hammarlund 100AC receiver. Smitty K1BWX, 81 Lenox Ave., Providence, R. I.

WANTED TELETYPE EQUIPMENT, especially model 28. Cash or trade for new amateur equipment. Alltronics-Howard Co. Box 19, Boston, Mass. 617-742-0048.

6288 FEET HIGH for 6 & 2 DX on Mt. Washington, N.H. Take your gear on Cog RR from base station. Food and facilities available at Summit House, also bunks for overnight.

DETAILED CONVERSION instructions for a surplus two meter transceiver similar to Bendix MRT-9. 50¢ each from 73, Peterborough, N.H. 03458.

CALL LETTER BILLFOLDS—Handtooled—Men's economy $6.50, Ladies or Men's Deluxe $8.00, Keycases $3.50, prepaid. Jane Freestone, WAØEHS, P. O. Box 82, Peru, N.Y. 12972.

LONG ISLAND HAMFEST & PICNIC sponsored by the Federation of Long Island Radio Clubs will be held Sunday July 17th. at 9AM. COME ON DOWN with the entire family for a pleasant day. Picnic pavilions, Swimming, Playgrounds, Charcoal grills, Technical talks, Manufacturers displays, Prizes, Mobile judging contest, Auction and more.

SCHOOL CLUB would appreciate your old Handbooks, code records, crystals, other small gear; 73's, QST's, even CQ's. W5OPX Nolan High School, Fort Worth, Texas. 76103.

SCHEMATIC DIAGRAM for ARC 27 GUARD RECEIVER only 50¢, as offered in June '66 issue. 73 Magazine, Peterborough, N. H. 03458.

TWO METERS $48.00. Over fifty-five dollar value Heathkit Twoer and Ameco nuvistor preamp. Both new—in excellent condition. Arthur Karis 14 Caldwell St., Fitchburg, Mass.

WANT: Kilowatt Matchbox. Virgil Talbott, W6GTE 1175 Longhill Way, Monterey Park, Calif. 91754 AN-88868

WANTED: Military, Commercial, Surplus. Airborne, Ground, Transmitters, Receivers, Testsets, Accessories. Especially COLLINS. We pay Freight and Cash. RITCO POB 156, Annandale, Virginia 22003 (703) 560-5480 COLLECT.

WRL's BLUEBOOK SAVES YOU MONEY. Take these prices without trades! KWM-2—$675.00; 30L1—$341.00; G50—$197.10; HT37—$242.10; SX99—$89.10; SX101A—$188.10; SR150—$341.10; HW12—$107.10; AF67—$44.95; King 500A—$233.10; HQ110—$120.60; R4—$269.10; Galaxy 300—$161.10. Hundreds more—free list. WRL, Box 919, Council Bluffs, Iowa 51501.

PROVEN PERFORMERS both of them, the DX-35 and DX-20 are good Novice CW transmitters. DX-35 $25, and DX-20 just $20. 73 Magazine, Peterborough, N.H. 03458.

SX 101-3-A—matching speaker $150.00 pick up only. Martin Rexsen W2FEI 493 Oxford Road, Cedarhurst, N.Y. 11516. Tel. 516-Ce 9-2411.

FOR SALE: Collins 32S-3, 75S-3B with 200 cy and 4 kc filters, 30L-1, 312B-4, and 516F-2 without cabinet. Excellent condition. Best offer over $1,650.00. Jim Taylor, W8EEC, 23874 Oak Lane, North Olmstead, Ohio.

TOROIDS, 88mh uncased, 5/$2.50. RTTY Filters, pretuned and mounted on tiny printed circuit board, with socket $4.25 ea. Humphrey WA6FKN Box 34, Dixon, California 95620

SWAN 350 with calibrator and 117XC power supply. Both purchased new 1-15-66. Sell both for $400. Bob Gaskill. 2105 Arthur. Wichita Falls, Texas.

ANTENNAS AND HIGH POWER! 40 foot 2-section crank-up tower with TR-44A rotator, cables, coax, triband quad: $100. 14AVS: $15. Heath SWR bridge: $7. 7 foot deluxe rack cabinet, KW supplies, 3KV silicon bridge, linear amplifier, monitor scope, station control system, transistorized keyer, 24-hour clock, A.M. components, reconditioned Messiner "Signal Shifter" VFO, and much more: inquire and offer. J. D. Kronman, 14612 Hamlin St., Van Nuys, California 91401 Tel: (213) 786-7663.

NATIONAL NC-270 Excellent, $135—HallicraftersHT-18 VFO exciter $30, GE 12 volt, two piece FM, 52.525 MHz complete, $55—AN/VRC2 FM, rcvr converted, xmtr part converted to 6m, with Motorola control head, $40—4ES-12A3 12 volt 2m FM, no acc $35—BC-459, converted to 6&2 VFO, $10. All FOB Pontiac, Michigan. Charley, K8LKV, 359 Grand Traverse, West; Union Lake, Michigan.

BACK ISSUES

Back Issue Bonanza

Curl up in your hammock these hot days with twenty assorted fascinating back issues of 73. They'll keep your mind, imagination and soldering iron active through the sweltering weather. Our choice (but a good one) at this low price. 20 issues for $5.

Dottie's Special

Get eight fabulous back issues of our choice for only $2.

Single Back Issues

Individual back issues other than 1960 ones are 50¢. 1960 issues cost $1. January 1961 isn't available.

Bound Volumes

All we've got right now are 1963 bound volumes. They're beautiful and cost $15.

Binders

Binders for all years are available: 1960-61, 1962, 1963, 1964, 1965 and 1966. They're $3 apiece and a nuisance to wrap, so order a bunch at once, please.

All of the offers above are postpaid in the U.S.A. and Canada. Please include postage on overseas orders.

73 Magazine **Peterborough, N.H. 03458**

INDEX TO ADVERTISERS

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	21	21	21*	21*	21*
AUSTRALIA	14*	14	7#	7#	7	7	7	14	7#	7#	14	14*
CANAL ZONE	21	14	14	7*	7	7	14	14	21	21	21*	21
ENGLAND	7*	7	7	7	7	7*	14	14	14	14	14*	14
HAWAII	14	14	7*	7	7	7	7	7#	14	14	14	14
INDIA	7*	7#	7#	7#	7#	7#	14	14	14	14	14	14
JAPAN	14	14	7#	7#	7#	7#	7*	7*	7	7#	14	14
MEXICO	14	14	7	7	7	7	14	14	14	14	14*	14*
PHILIPPINES	14	14	7#	7#	7#	7#	7*	7*	7*	14	14#	14
PUERTO RICO	14	7*	7	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	14	7	7	7#	7#	14	14	14	21	21*	21	14
U. S. S. R.	7	7	7	7	7	7#	14	14	14	14	14	7#
WEST COAST	21	14	14	7	7	7	7*	14	14	14	14*	14*

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7*	14	14	14	14
ARGENTINA	21	14	14	14	7	7	14	21	21	21	21*	21*
AUSTRALIA	21	14	14	7#	7#	7	7	14	7#	7#	14	21
CANAL ZONE	21	14	14	14	7	7	14	14	21	21	21	21*
ENGLAND	7#	7	7	7	7	7	14	14	14	14	14	14
HAWAII	14*	14	14	7	7	7	7	7#	14	14	14	14
INDIA	7*	7*	7#	7#	7#	7#	7#	7#	14	14	14	14
JAPAN	14	14	14	7#	7#	7#	7	7*	7*	7#	14	14
MEXICO	14	14	7	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	7#	7#	7#	7#	7*	7*	14	14#	14
PUERTO RICO	14	14	7*	7	7	7	14	14	14	21	21	21
SOUTH AFRICA	14	14	7	7#	7#	14	14	14	14*	14*	14*	14
U. S. S. R.	7#	7	7	7	7	7#	7#	14	14	14	14	7#

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	14	7	7	7	7	14	14	14	14
ARGENTINA	21*	21	14	14	14	7	7#	14	21	21	21*	21*
AUSTRALIA	21*	21*	21	14	14	14	7	7	7	7#	14	21*
CANAL ZONE	21*	14	14	7*	7	7	7	14	14	21	21*	21*
ENGLAND	7#	7#	7	7	7	7	7#	14	14	14	14	14
HAWAII	21*	21	21	14	7*	7	7	7	14	14	21	21
INDIA	14	14	14	7#	7#	7#	7#	7#	7*	14	14	14
JAPAN	14*	14	14	14	7*	7	7	7	14	14	14	14
MEXICO	14	14	7	7	7	7	7	7*	14	14	14	14
PHILIPPINES	14*	14*	14	14	14	7	7	7	14	14	14#	14
PUERTO RICO	21	14	14	7*	7	7	7*	14	14	21	21	21
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#	14	14	14	14	7#
EAST COAST	21	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, 3-9, 15-20, 23, 24, 30, 31

Fair: 11-13, 22, 27-29

Poor: 2, 10, 14, 21, 25, 26

VHF DX: 6-9, 15-18, 28-31

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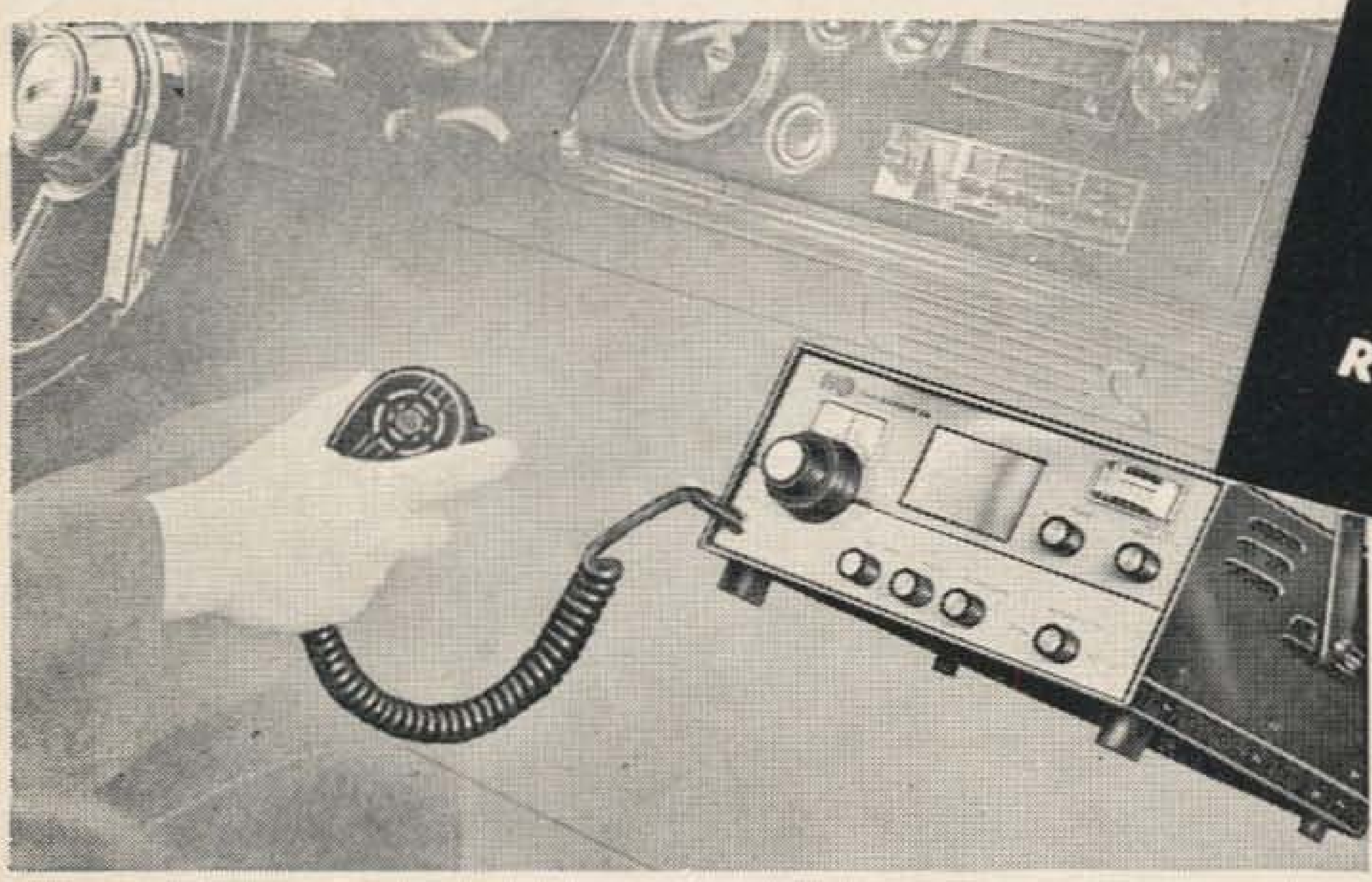

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