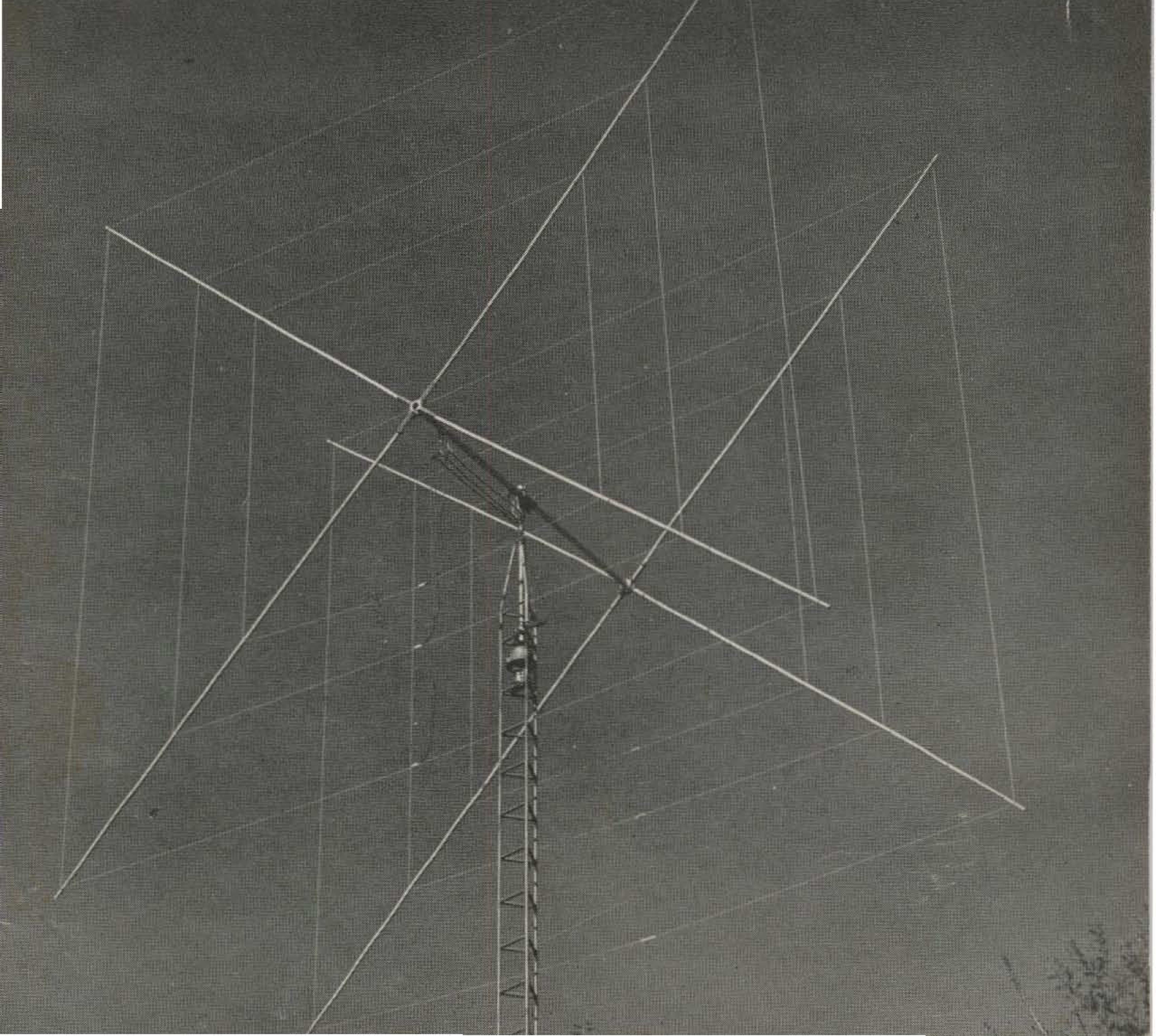
73

Amateur Radio

JULY 1963
The same 40c

QUADS



73

Magazine

Weighn Green, W2NSD/1

Editor, etcetera

July, 1963

Vol. XIV, No. 7

Cover:

Cubex Mark III

73 Magazine is published monthly by 73, Inc., Peterborough, N. H. The phone number is 603-924-3873. Subscription rates are still abysmally low at $3.50 for one year, $6.50 for two years, and $9.00 for three years in North America and U.S. possessions. Foreign subscriptions are $4.00 per year. Second class postage is paid at Peterborough, New Hampshire and at additional mailing offices. Printed in the U.S.A. Entire contents copyright 1963 by 73, Inc. Postmaster: please send form 3579 to 73 Magazine, Peterborough, New Hampshire. We told you last month to stop reading the fine print and stick to the articles and editorial.

de W2NSD

Never say die

Incentive Licensing

The editorials in QST and CQ on incentive licensing disturb me. From the mail that I have been getting on the subject it is obvious to me that many more amateurs are disturbed over this. And I might point out that many of the fellows who are upset over this write quite rational and intelligent letters. Many don't. If you are emotionally involved with this problem I suggest that you skip on to my next subject and pass over what I have to say here for once you are emotionally involved you will either agree with me without thinking or disagree with me without thinking and neither is of any value to either of us.

As I understand the background on this, there has been considerable pressure within the ARRL for QST to have something a little more controversial than their usually bland editorials. Possibly my frequently blunt editorials in 73 had something to do with this. The boss-man decided to kick off with incentive licensing as the first controversial subject and this was published in the February issue of QST.

The editorial *was* controversial, no question about it. I am pretty sure that the League has never before experienced an explosion such as they set off with that one. The editorial concluded that it was inescapable that "most amateurs want a return to the incentive system of licensing," and that "the U.S. licensing system has bred mediocrity and resulted in deterioration of the general level of our technical knowledge." They indicate that incentive licensing "would improve the quality of our signals and thus conditions in our amateur bands."

This raises several questions in my mind. First of all, is the ARRL, as it vehemently insists, speaking for its membership? Secondly, has there indeed been a breeding of mediocrity and a deterioration of technical knowledge? Thirdly, are the signals on our bands poor in quality, as they suggest? Would increased technical knowledge in fact improve these poor signals? Is this whole thing just for publicity? Are there other unstated reasons for this move?

I do not believe that the ARRL membership approves of this move. They admitted in the editorial that the extent of the sample taken before the editorial was limited to comments in their correspondence, at club meetings, conventions and on-the-air discussions. It is appalling that the ARRL should make such a sweeping move for change with such faint indications to go on. It is strange to me that my correspondence, which is not an awful lot less than theirs, has never discussed or suggested such a plan. Neither have I run into this scheme at club meetings, conventions or on-the-air discussions. Can it be that our worlds are so astoundingly different? Or are they guilty of exaggeration? If the ARRL has the courage to poll their members and make public this poll then we may find out what the members really think . . . and see if the ARRL obeys their mandate. I don't think they dare.

Now, about that mediocrity. It is fascinating to read 1935 issues of QST and find the same complaints being expressed then as today. Ham radio has carried along an assortment of lids and I doubt if the percentage is any greater today that it ever was. I have been in pretty close touch with our hobby for the twelve years that I have been writing and editing and I do not see this mediocrity. To the contrary, I have constantly been delighted to find so many technically equipped amateurs in our circles. If QST were to stop printing such an overwhelming mass of operating news and devote more space to technical and construction articles they might be in better touch with the amateurs who are interested in this phase of our hobby and appreciate more the vast engineering pool that we have. 73 has pioneered with a technical series written for the average ham instead of for the engineer (this series will shortly be available in book form)

(Turn to page 6)

AOC*

*Add - On - Circuits

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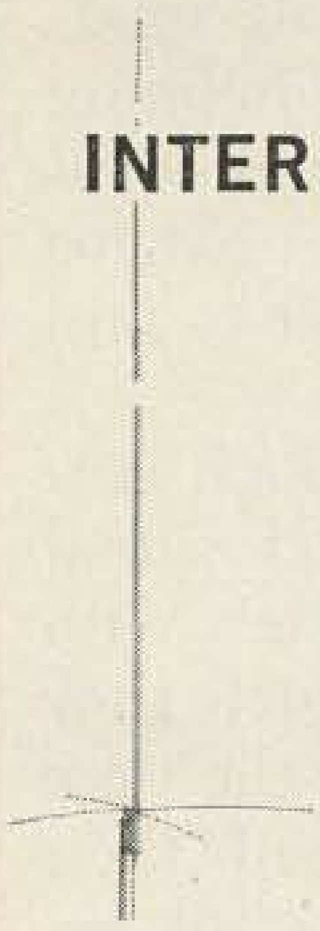

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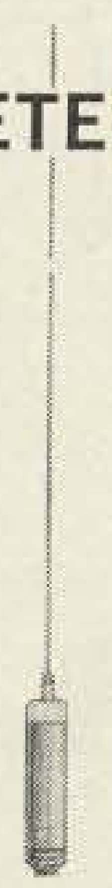

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(W2NSD from page 2)

and the response was immediate and positive. Amateurs are anxious to learn and they will read and learn if they are presented material by good writers and not engineering hacks that do not know how to explain complicated things in a simple way. Notice how seldom you find vectors and calculus in 73 . . . they just aren't really necessary and their use usually prevents the understanding that the author is attempting to achieve. The field of electronics has expanded in many directions and few old timers are able to keep up with paramps, transistors, sideband, television, RTTY, etc., on the technical level that they handled triodes back in 1932. I have been constantly amazed at the technical level of many of our newer hams. In talks at high schools I have been just about floored time after time by erudite technical questions from students. I have a great respect for them . . . and for hams in general.

Are the signals on our bands really poor in quality? Is this poor quality due to poor technical ability on the part of the ops or is it perhaps more attributable to deficiencies in the design of inexpensive commercial equipment. Would the perfection of these signals result in appreciably reduced congestion on the bands? If you do much operating you know the answers to these questions as well as I do. Sure, there are some chirps, drift and even a few rough notes. A few phone signals splatter and FM a bit. But the overwhelming number of signals on our bands are consistently good. If you eliminate the Novice bands you will have to tune quite a bit to find any really poor signals.

I am not at all sure that there is much correlation between technical ability and signal quality. Many fellows have transmitters with little flaws which cause difficulties which they could eliminate if they wanted to take the time and seriously hurt the resale value of their transmitter. Considering the profusion of articles we have published on improving commercial rigs, it is inertia and resale value that are more responsible for what few poor signals we have to endure more than technical ineptitude.

It does seem to me that any realistic examination of the problem shows us that this is largely a smoke screen. Technical training would have a slight effect on signal quality and we might find our bands slightly less congested . . . but at what a cost! Does the miniscule end justify the extraordinary means?

(Turn to page 74)

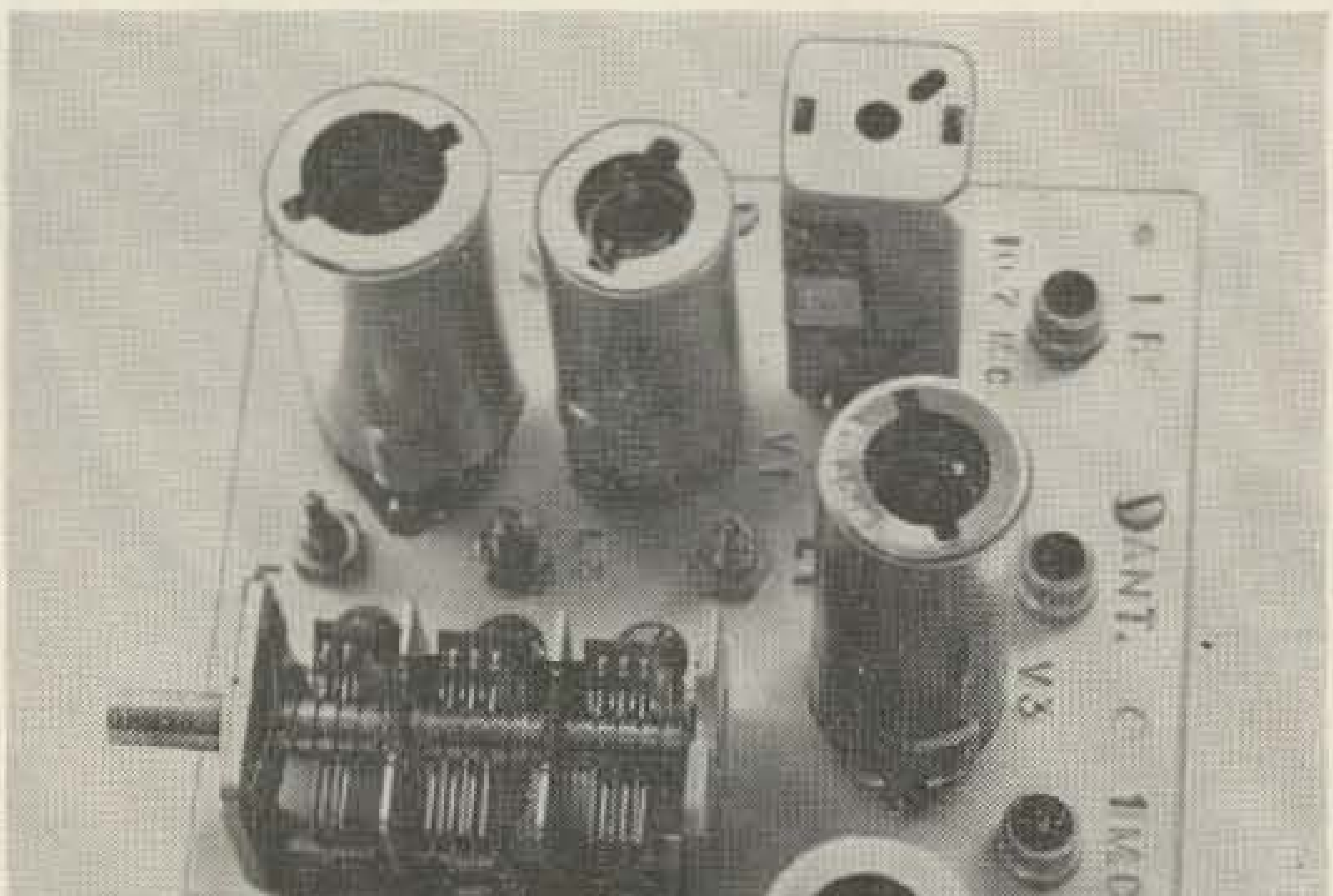
Sizzling Six

John Wonsowicz W9DUT
4227 N. Oriole Ave.
Norridge, Illinois

Parts kit available

Photos by Howie Trieb K9EPB

As the name implies, the tunable front-end herein described is HOT! In fact it is super sensitive and has to be tamed down with the aid of an rf gain control when tuning across the local signals or high power carriers. Six meter boys will be happy to use it as the front end of a receiver and the boys in the two meter or higher frequency range can use this module as the tunable if with their crystal controlled converters. This unit was designed as part of a new VHF receiver, but can be used with any superhet that tunes to 10.7 mc. An extra feature that can be incorporated, if desired, is the TMCS (Tone Modulated Crystal Standard) shown in the lower section of the photo. The construction of this unit appeared in Oct. 62 issue of 73. This small addition is worth the effort when it comes to calibrating the dial in one megacycle segments and later can be used to spot check the points and make corrections during tube changes.



Top view of the chassis showing the location of components: Tube in the upper left is the 6U8 oscillator and mixer, next to it is the 6EW6 rf amplifier and to its right is the J. W. Miller No. 1463 if transformer. The tube in the center of the chassis is the OB2 voltage regulator.

Circuit

The module uses only two tubes in the circuit. A 6U8 as the oscillator and mixer, and a 6EW6 as the rf amplifier. The 6EW6 with its low plate and screen voltage and its high gm (14000 micro mhos) falls in as a natural in high frequency application. Of course normal precautions should be observed in isolation between the input and output circuits of this tube, otherwise it will take off and no amount of by-passing will cure it; however, if the schematic is followed and the layout is close to the pictorial view, no trouble will be encountered with oscillations and you will come up with an excellent unit.

The original module when completed and optimized exhibited unusual sensitivity and a very good noise figure. Although the noise factor was not measured, it appears to be exceptionally low to be able to detect signals as low as .1 micro-volt throughout the entire tuning range of the module. Gain measured, using a Model 80 signal generator with accurately calibrated attenuator and a VTVM with an rf probe indicated to be 27 db. This is not outstanding and it wasn't meant to be, because emphasis was placed on sensitivity and low noise rather than gain. Gain can always be increased, by the addition of another stage in the if strip that follows, with no difficulty.

As noted on the schematic, link coupling is used in all critical portions of the circuit to prevent any feed through of stray signals.

These links were wound on the cold end of the coils and later connected by twisted leads to the link terminals on the coils forms. The system of making inductors with links, using J. W. Miller coil forms No. 41A000CB1 was described in the Nuvistor pre-amplifier in the past issue of 73.

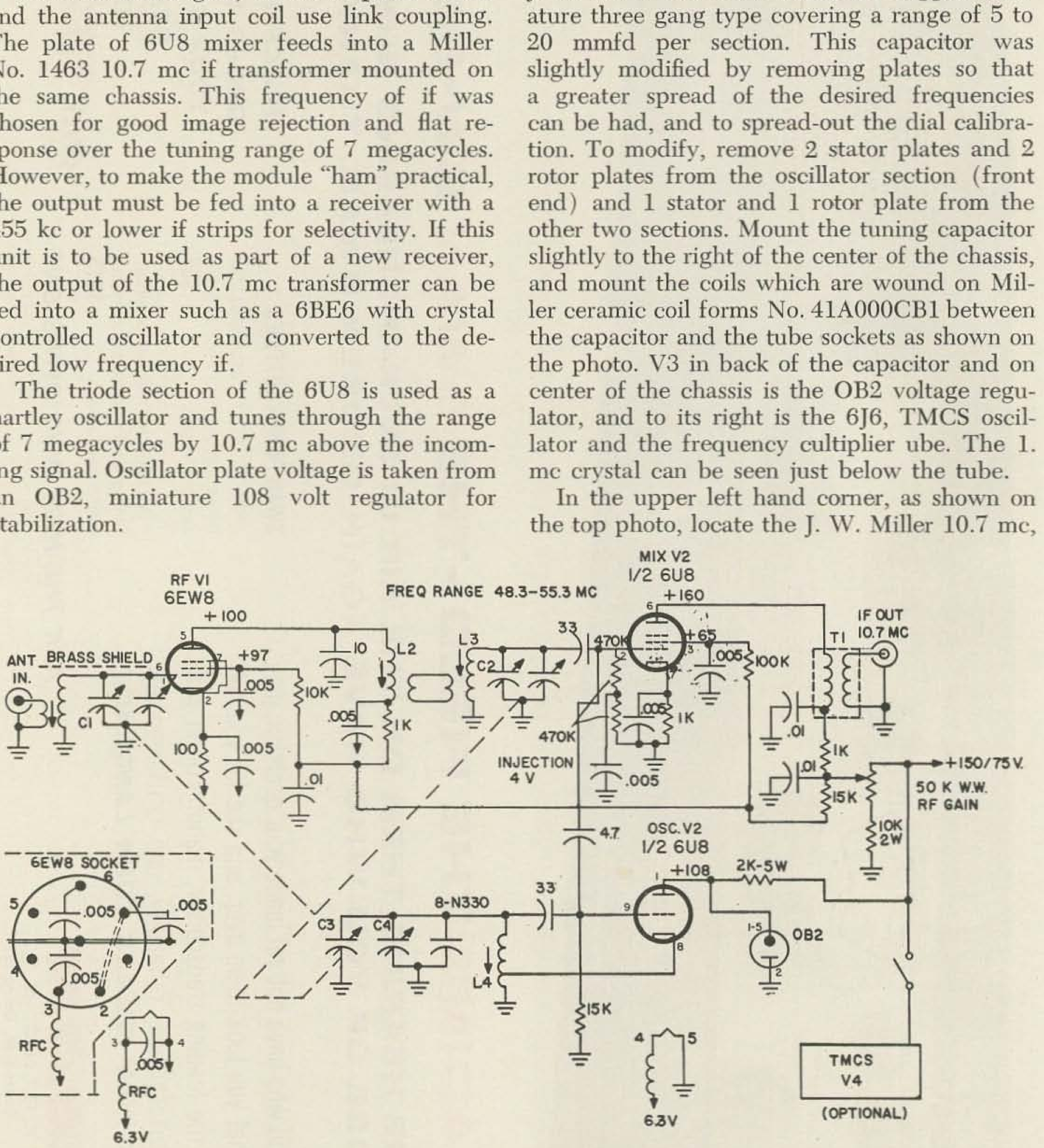
The 6U8 mixer grid, 6EW6 rf plate circuit and the antenna input coil use link coupling. The plate of 6U8 mixer feeds into a Miller No. 1463 10.7 mc if transformer mounted on the same chassis. This frequency of if was chosen for good image rejection and flat response over the tuning range of 7 megacycles. However, to make the module "ham" practical, the output must be fed into a receiver with a 455 kc or lower if strips for selectivity. If this unit is to be used as part of a new receiver, the output of the 10.7 mc transformer can be fed into a mixer such as a 6BE6 with crystal controlled oscillator and converted to the desired low frequency if.

The triode section of the 6U8 is used as a hartley oscillator and tunes through the range of 7 megacycles by 10.7 mc above the incoming signal. Oscillator plate voltage is taken from an OB2, miniature 108 volt regulator for stabilization.

Construction

The entire front-end module, including the TMCS, is built on a home-brew aluminum chassis measuring 4½ x 5½ and ½" deep. A plain plate can also be used, if desired, but to make the module rigid, the ends should be turned down. Variable tuning capacitor is a J. W. Miller No. 1460 which is a rugged miniature three gang type covering a range of 5 to 20 mmfd per section. This capacitor was slightly modified by removing plates so that a greater spread of the desired frequencies can be had, and to spread-out the dial calibration. To modify, remove 2 stator plates and 2 rotor plates from the oscillator section (front end) and 1 stator and 1 rotor plate from the other two sections. Mount the tuning capacitor slightly to the right of the center of the chassis, and mount the coils which are wound on Miller ceramic coil forms No. 41A000CB1 between the capacitor and the tube sockets as shown on the photo. V3 in back of the capacitor and on center of the chassis is the OB2 voltage regulator, and to its right is the 6J6, TMCS oscillator and the frequency cultiplier ube. The 1. mc crystal can be seen just below the tube.

In the upper left hand corner, as shown on the top photo, locate the J. W. Miller 10.7 mc,



C_1-C_2-C_3=J. W. Mll n. 1460
C_4=Johnson 15M11
L_1-L_2-L_3-L_4=J. W. Miller ceramic coil forms no. 41A000CB1 ¼" x 11/16" slug tuned.
L_1=6T #20 close wound 3T link
L_2=12T #20 close wound 3T link
L_3=6T #20 lse wund 3T link
L_4=7T #26 bare, space wound (dia. of wire) tap at 3¼ T. from cold end.
T_1=J. W. Miller no. 1463 10.7 mc if transformer
RFC=15T #26 enamel on ½ watt resistor.

Arrows indicate connections made to brass shield if transformer No. 1463 and the switchcraft 3501FP jacks for if take off, antenna input, and the TMCS output.

The bottom view of the photo shows a brass plate measuring 1½ x 3" which is cut out to fit over the center post of the 6EW6 socket and fastened to the aluminum chassis by 2-56 screws. This plate being the shield, is also used to solder the by-pass capacitors to it as the ground return. This is shown on the schematic and part detail of the circuit. The rf grid coil can be seen on one side of this shield and the other coils on the opposite side. The oscillator coil is to the right of the mixer coil and injection is transferred from the oscillator to the mixer by the 4.7 mmfd capacitor which is connected between pins 9 and 2 at the socket of the 6U8. A Johnson 15M11 oscillator trimmer can be seen below the coil; this trimmer is shunted with a 8 mmfd N-330 capacitor for temperature compensating, and connects to the main tuning capacitor by a bus, as shown on the bottom view.

The APC variable capacitor just below the oscillator trimmer is the frequency adjusting for the TMCS. Stray coupling between the harmonic coil of the TMCS and the rf coil of the converter is sufficient to pick up the signal when B+ is applied to the crystal standard.

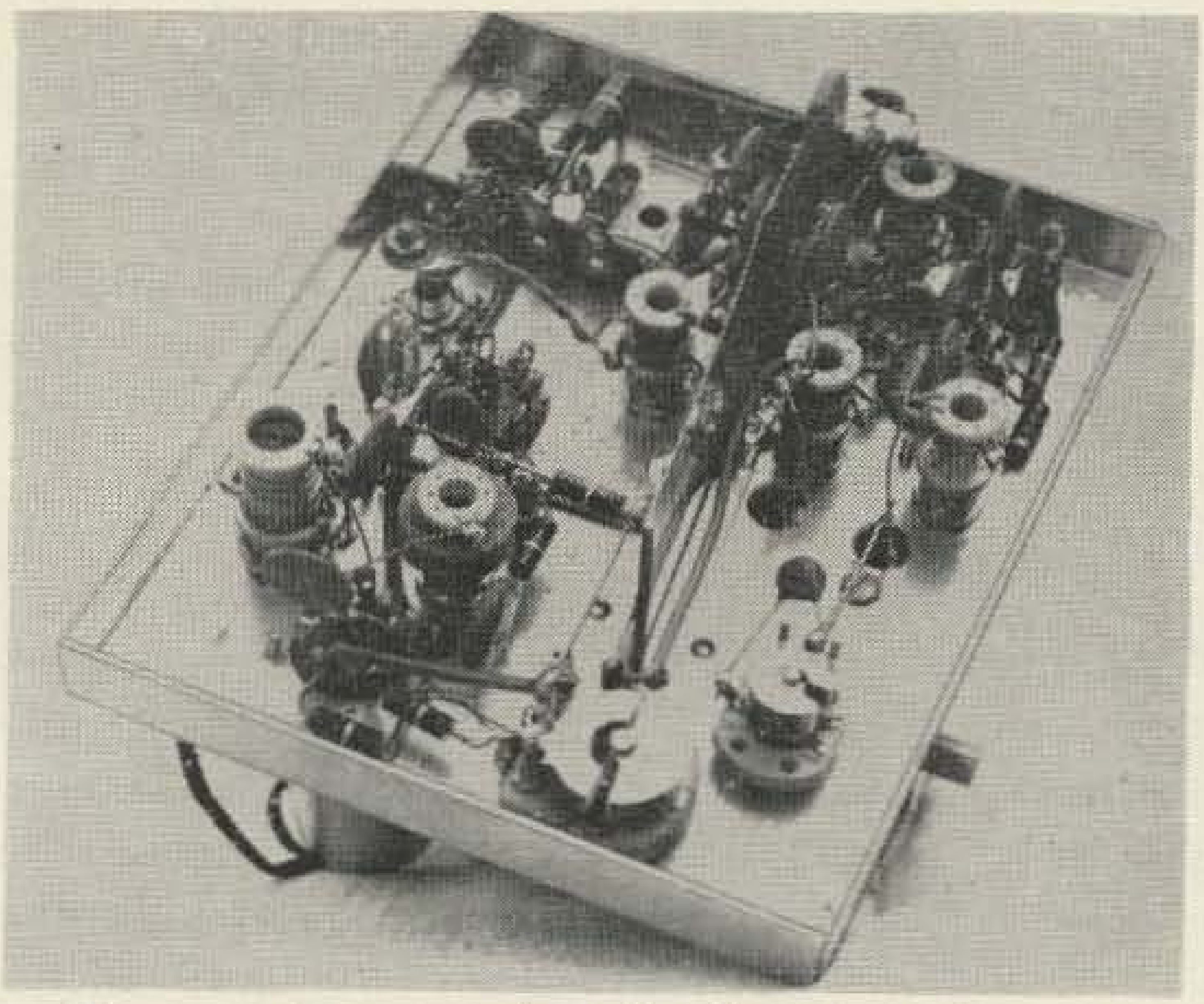
The coil shown at the top in the bottom view of the photo, is the plate tank of the rf amplifier which is linked coupled to the mixed as previously mentioned. Although the photo indicates that the components are crowded, there is sufficient room to work around them due to the narrow lip of the chassis.

Adjustments

After all coils are wound as per coil data and mounted together with other components, apply and check the voltages. Do not exceed the indicated voltages by more than 10% to keep the unit in the low noise catagory. If the voltages are satisfactory, turn power off and proceed with alignment and tracking.

Oscillator Range

To set the frequency range of the oscillator, with the aid of a grid dipper, first adjust the main tuning capacitor for max. capacity and the oscillator trimmer capacitor meshed about 1/3; adjust the powder iron slug in the oscillator coil so that it dips at 59 mc. Now tune the main tuning capacitor to minimum capacity and dip the coil again; it should read 66 mc. If the frequency is higher, add more capacity by rotating the trimmer to bring it down to the right frequency; then go back to



Bottom view showing the location of components. The three coils in the upper right hand corner are: rf plate coil on top, below is the mixer grid and to its right is the oscillater coil. The brass shield can be seen separatng these coils and the grid coil of the 6EW6. In the lower left hand corner are the 1 mc coil and the multiplier coil of the TMCS standard. The 6J6 socket is located just below these coils. The two variable trimmers in the right hand corner are the oscillator trimmer and the standard trimmer.

the low frequency end and check, adjusting the slug again to 59 mc. Repeat the process by adjusting the trimmer capacitor on the high frequency end and core on the low frequency end until the desired spread is obtained. With the oscillator coil adjusted, go to the mixer coil, but first short out all other coils, by soldering a wire from the hot end of the coil to ground, and proceed in the same manner as dipping the oscillator. In tracking the rf, mixer and the antenna coils the frequency should be 10.7 mc less than the oscillator frequency and should read 48.3 mc to 55.3 mc. It is impossible to be very accurate with the common grid dipper, so close approximation must suffice; but don't let that bother you because the final adjustments are generally made by peaking all coils (excepting the oscillator) on known incoming signals or with the aid of a signal generator.

Adaptability

The front-end can be used in connection with a standard communications receiver that will tune to 10.7 mc and can be done in the following manner. Use a short piece of RG-58U coax between the if output of this unit and the antenna input of your receiver. Tune the receiver to 10.7 mc and leave it set there. This is now your fixed if and all tuning is now made with the tuning capacitor on the module. Suggested way to do the tuning is to use a velvet vernier dial such as National ACA-1CN or MCN dial to reduce the tuning speed. These generally come as 5.1 reduction ratio and can be bought in most radio stores.

For two meter operation, the front end is used between the crystal converter and the receiver. This will make your set-up a triple conversion or better and will reduce spurious frequencies and images to a minimum. It will also give you that extra gain for those weak DX signals. Be sure that the if frequency of your converter is a 50 mc output; if not, adjustments must be made in your two meter converter mixer and the crystal oscillator.

The front-end can be mounted on a larger commercial chassis with its own power supply or can be mounted in a mini box for good over-all shielding and the power can be supplied by the receiver. Make certain that the receiver power supply is not overloaded; the power requirements are 1.3 amp at 6.3 volts and 40 ma at 150 to 175 volts for the complete unit including the TMCS.

. . . W9DUT

Parts Kit Available

The parts for this unit are available as a complete package from 73, Peterboro, N. H.
Order W9DUT-2 Kit $20.00

New Products

Byron Airpark?

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Sideband Linear

P & H Electronics has just announced a new linear amplifier. This job should work well with almost any of the sideband transceivers on the market to produce a 1000 watt PEP signal either at home or in the car. The small flat construction is designed for mobile use. The price is only $189.95 not including the high voltage supply. It uses six tubes in a grounded grid circuit. Drop a line to 424 Columbia Street, Lafayette, Indiana for more info.

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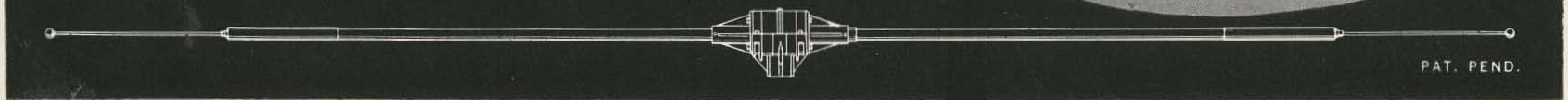

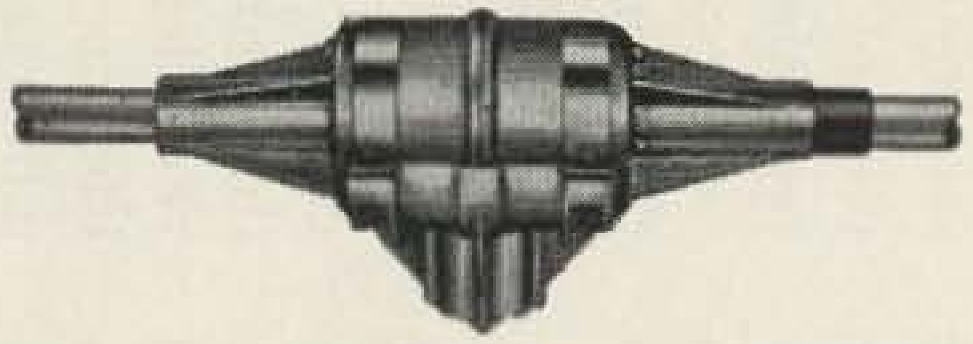

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Chemical City T.U.

Jim Kortge K8IQY
Jerry Kortge K8JAC
551 E. Wadsworth Hall
Houghton, Michigan
Photo credit: Don Roberts K8VXX

This article is an attempt to present a teletype terminal unit that is better than the majority of the T.U.s presently being used by amateurs on RTTY. This converter, called the "Chemical City T.U." after the chemical city of Midland, Michigan, features provisions for copying on either mark or space or both. It also permits copy of signals too low in the noise to be usable printable material except by the very best terminal units, which are usually not available to the average ham. The "Chemical City T.U." will out-perform both the W2JAV and W7CJB terminal units from which much of the circuitry for this converter was derived.

Our initial idea for this converter came after we had used a W2JAV, modified by W5ANW, T.U. on the air for a month. The only complaint against this converter was that it did not print signals that were down in the noise. Aside from that, it was a very good converter. However, it was thought that something could be done to improve the ability of the modified W2JAV when it came to copying noise covered signals. A partial answer to our problem came in an article by W7CJB in which he described a converter that utilized a balanced detector with a long time constant filter on the output which would eliminate a great deal of noise. With these two circuits at hand and several of our own ideas which we wished to try, we designed and built the terminal unit which you see in the pictures.

The first of our ideas appears at the secondary of the input transformer. As can be seen, we utilized a pair of 1N2071 silicon diodes for the first stage of limiting. These diodes, because they have the property of passing one fourth of a volt before they start to conduct, seemed ideal for limiting purposes without the use of bias voltage and the associated resistors necessary with the conventional diode limiter. The use of these diodes results in a total voltage of one half volt peak to peak on the grid of the 12AX7 second limiter amplifier. With this arrangement, the signal output from the 12AX7 is constant between the level where the signal is just audible to the ear to full output from the receiver.

The signal voltages then pass through a 12AU7 amplifying stage; one triode section for the mark channel and one triode section for the space channel. In the plate circuit one will note that the pair of transformers drive the 6AL5 balanced detector. The output of the balanced detector is used to feed three different tubes in the converter as can be seen in the schematic.

The first tube fed by the detector is another 12AU7 which is a dc amplifier and keyer for the mark and space coupling. Output from the detector also feeds the 12AU7 preceeding the detector. And finally, the detector voltage is fed to a 12AX7 inverter tube which begins the process of converting the trailing edges of mark pulses to space pulses and space pulses to mark pulses making it possible for one to copy on either mark or space when one of the two signals is not present for reception.

The second idea which we contributed to this converter is the feedback loop which is associated with the application of voltage, derived from the output of the 6AL5, on the grids of the first 12AU7 amplifier. This voltage causes three things to take place. First, the dc component from the output of the 6AL5 provides bias on the grid of the 12AU7 giving the converter a small amount of automatic gain control. This gain control begins operating when the signal into the limiter is of lower amplitude that the operating point of the limiter, at which time, the automatic gain control takes over to hold the signal through the converter at a more constant level than would normally be had if it were not present.

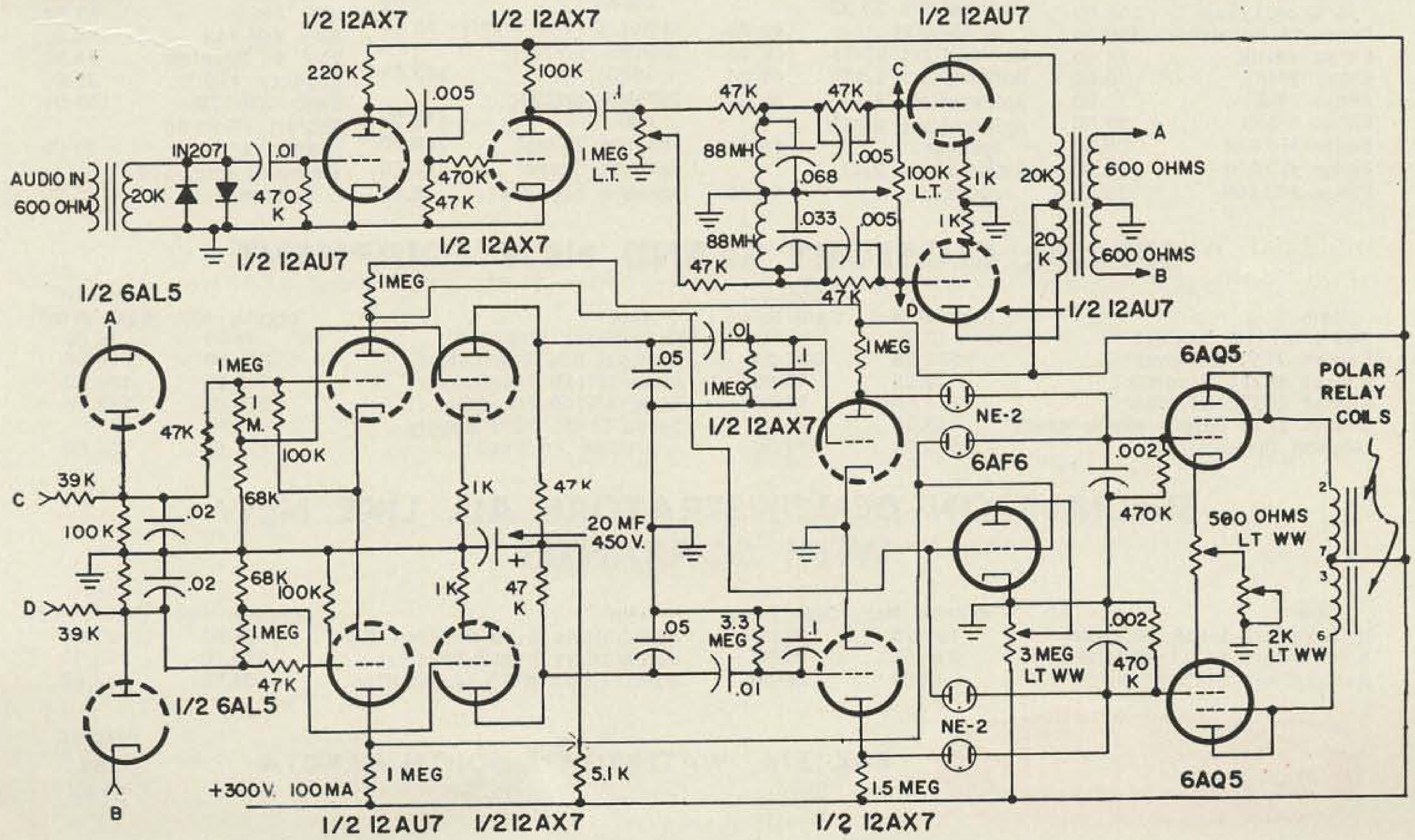
A second benefit derived from the voltage on the grid of the 12AU7 is that of giving pre-emphasis to the pulses as they pass through this stage before going on to the 6AL5 for detection. A close look at the operation of the detector will show that the voltage at the output of the detector is a function of the signal at any given time. When the signal changes from mark to space and back to mark again, the bias on the grid of the 12AU7 amplifying tube changes with respect to the incoming pulses. This action produces a more definite pulse at the grid of the 12AU7.

The dc output from the detector, which is actually negative half cycles of the audio going into the detector, is utilized in this converter, as in other converters, to operate the various keying stages. However, along with this pulsating dc voltage, there appear negative pulses of noise which will trigger the keying stages giving erratic operation on marginal signals. Feeding these negative pulses back into the grid of the first amplifying stage tends to cancel out the positive pulses of noise appearing at the grid, reducing the noise figure of the system.

A 6AF6 dual eye tube was incorporated in the T.U. to aid in tuning the signal in correctly. The grids of the 6AF6 are fed directly from the first 12AU7 keyer tube. The 3 megohm potentiometer is used as a voltage divider in the plate circuit of the 6AF6 to set the closure of the shadows to a hair line when the limiter is saturated.

The parts layout is not critical except the input of the T.U. should not be too close to the output of the 12AU7 amplifier as it may tend to oscillate. The only critical part needed in duplicating this converter would be the type of transformers used to feed the detector. On our model we utilized a pair of surplus transformers that we had on hand. They have a 20,000 ohm primary and a 600 ohm secondary. Almost any kind of transformer could be made to work. However, the 47K resistors at the output of the detector, which feed the 12AU7 keyer, would have to be changed and the voltage dividers feeding the 12AX7 inverter tube would also have to be changed. Other than the few suggestions that we have just given, one should have no trouble duplicating our results.

Finally, we might say that there are many more improvements that could be made on the mechanics of this circuit which would make the converter even better. The addition of a comb filter at the input would reduce even further the noise entering the T.U. Also, one could use band pass filters at the input for greater suppression of unwanted signals and for greater ease in tuning. The addition of an axis restorer to hold the machine in absence



We Goofed!

NOW HEAR THIS ! ! ! !

My dictionary defines "goofed" as meaning "made a mistake", acted foolishly", etc.

Guess that is right because we must have traded too high or done something wrong as we find ourselves loaded with fine used amateur gear that won't move. We aren't going to let this spoil our summer fun, however. In fact we are even going to make this summer fun better than you anticipated. This is just a 'sneaky' way of saying that we are really going to LOWER THE BOOM. I feel sorry for my poor competitors (like they feel for me). Anyhow OLD MAN here are some prices the likes of which you have never seen in print before. These are not mistakes (except ours). The units offered are all first class, fully reconditioned and fully guaranteed. Did I forget to mention that these are offered on a cash with order, no trade and no contract basis. Look 'em over REAL GOOD — they are TRUE VALUE and then ACT ! ! ! !

— 73 —
Stan Burghardt WØBJV

	Special Cash Price
Central Electronics 600L	$199.00
Central Electronics 20A	119.00
Central Electronics MM1	49.00
Central Electronics QT-1	5.00
Central Electronics Deluxe VFO	29.00
Cesco CM-52	19.00
Collins KWM-2	795.00
Collins 75S-1	329.00
Collins 75A4	425.00
Collins 30L-1	395.00
Collins 312-B4	129.00
Collins 325-1	429.00
Collins 32V-3	249.00
Collins 312-B2	69.00
Collins 270G3	10.00
Collins 270G1	8.00
Drake 2A with CALIB & Q MUL/Spkr	199.00
Drake 1A Receiver	139.00
Elmac PMR8	99.00
Elmac PMR7	79.00
Elmac AF-67	79.00
Elmac A-54H	39.00
Elmac M-1470	29.00
Elmac M-1070	29.00
Elmac PSA500	15.00

	Special Cash Price
Globe 755A VFO	$30.00
Globe King 500A & 755 VFO	249.00
Globe Champ 300A	199.00
Globe Scout Deluxe	$79.00
Globe Scout 680A	49.00
Globe VOX-10 & QT-10	5.00
Globe AT-3	5.00
Gonset G-66 & G-77 Mobile Pkg.	199.00
Gonset G66B & 3-way supply	99.00
Gonset GSB-101	199.00
Gonset Communicator 1 6mtr	69.00
Hallicrafters HT-37	375.00
Hallicrafters HT-41	235.00
Hallicrafters HT-40	69.00
Hallicrafters SX-100	149.00
Hallicrafters SX-99	84.00
Hallicrafters SX-99 & speaker	89.00
Hallicrafters SX-71	109.00
Hallicrafters S-53A	49.00
Hallicrafters S-40	49.00
Hallicrafters R-46B speaker	10.00
Hallicrafters R-42 speaker	10.00

	Special Cash Price
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Hammarlund HQ-110C	165.00
Hammarlund HQ-110	159.00
Hammarlund HQ-100C & cal.	125.00
Hammarlund HQ-129X & speaker	115.00
Hammarlund S-100 speaker	9.00
Harvey Wells AC Supply	12.00
Heath Mohawk & speaker	199.00
Heath DX40 Xmtr.	45.00
Heath Cheyenne Xmtr.	69.00
Heath HD-11	10.00
International 6 meter conv.	7.00
James C-1050 supply	15.00
Johnson Invader 2000	695.00
Johnson Invader 200	449.00
Johnson Valiant	249.00
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Jones 263 micromatch	24 00
Millen 90651 grid dip meter	39.00
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Mosley CM-1 & speaker	135.00
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Tecraft TR-20-50 6mtr xmitter	35.00
Vibroplex orig. STD & case	19.00

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Collins 75S1 Receiver	520.00	399.00
Gonset GR211 Receiver	76.98	49.00
Gonset GR212 Receiver	112.86	79.00
Gonset 3273 Deluxe phone patch	49.95	35.00
Johnson Invader 200	619.00	499.00

Item	Regular Net	Special Cash Price
Multi-Elmac M1070 Kit	49.95	29.00
National NC270 Receiver	279.95	199.00
Swan SW120 Transceiver	275.00	199.00
Swan SW140 Transceiver	275.00	199.00
Topaz C10XL 800V Supply (Collins or Swan)	119.00	84.00

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Item	Regular Net	Special Cash Price
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Hallicrafters SX111 Receiver	279.95	199.00
Hallicrafters S119 Receiver	49.95	36.00

Item	Regular Net	Special Cash Price
Hallicrafters S119 Receiver Kit	39.95	29.00
Hallicrafters SX117 Receiver	389.00	295.00
Hallicrafters HT40 Transmitter	109.95	88.00

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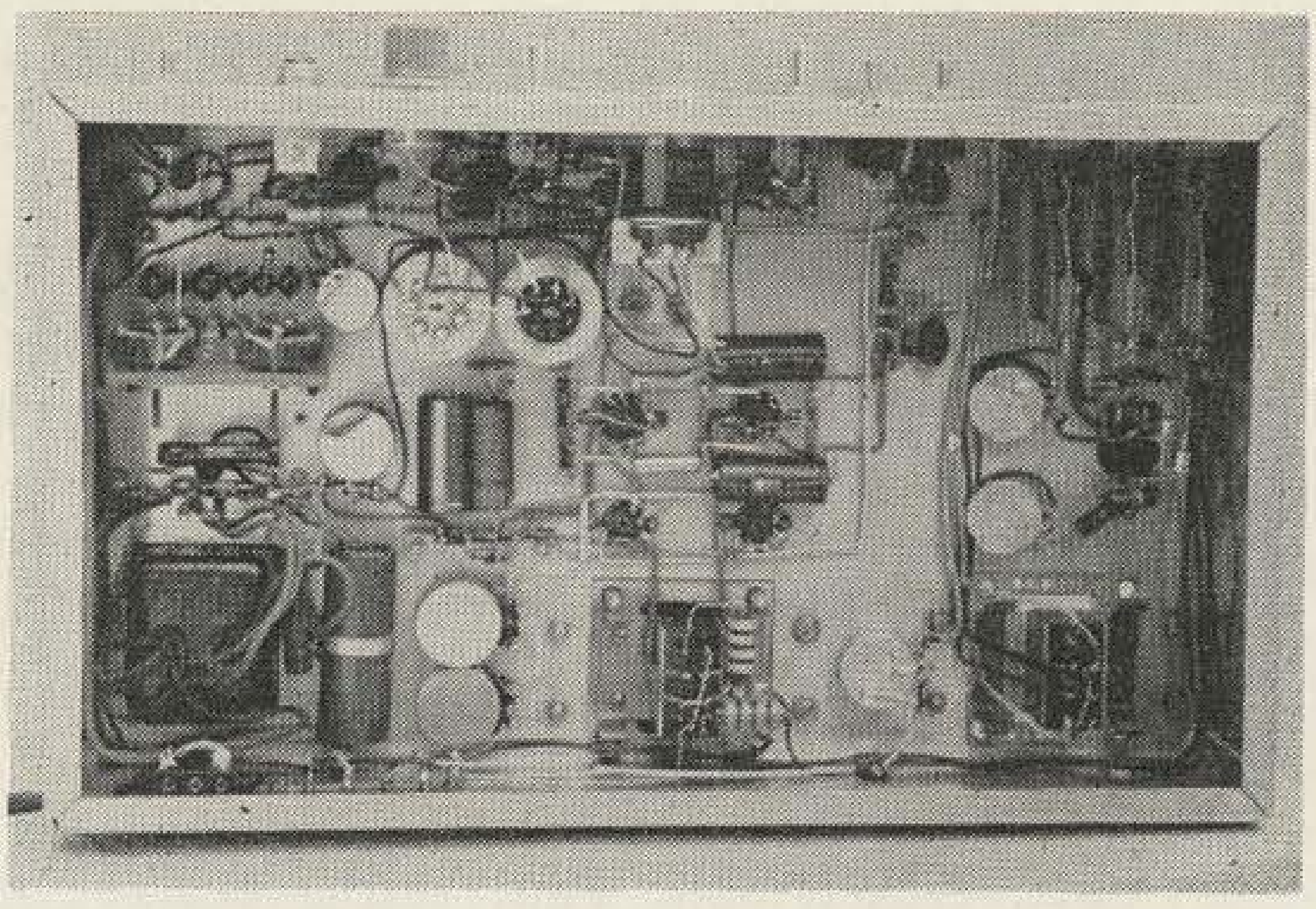
of any signal and the addition of a mark-space axis computer, to move the operating point of the detector half way between the mark to space peak amplitudes, would also improve performance.

As an aid to anyone who would like to construct a copy of our converter we have included pictures of the one we built. We might mention that this "Chemical City T.U." also contains an integrated loop supply on the same chassis which makes a very and useful piece of apparatus. One can see in the pictures that there is room available for future improvements and these will come with time.

The "Chemical City T.U." is by far a long ways from being the ultimate in RTTY converters. Our main purpose in designing it was to combine two good converters into a single unit which would out perform either by a wide margin. We feel we have suceeded in doing this. No originality for the basic circuits is claimed. Our ideas and improvements, however, have transformed a feasible idea into a working unit that performs ex-



cellently on the crowded ham bands and has been doing so for the three months we have been using it.

We are sure many RTTYers, whether old or new, will find this T.U. just the RTTY converter they have been looking for. To those who build this terminal unit, we would appreciate hearing your comments and any suggestions or other ideas which could be incorporated into a future "Modified Chemical City T.U." . . . K8IGY . . . K8JAC

Low Ebb in the Sunspot Cycle

Bill Ashby K2TKN
Box 97
Pluckemin, N. J.

It had been a particularly bad night on two meters; the guys that were far enough away to be interesting kept getting excited and increasing speed so that my Sync Detector wouldn't follow (see 73 Sept. 1962) and two locals persisted in rag-chewing on my reject channel. Even after all the publicity, a few die-hards couldn't get it thru their thick skulls how 1's, 2's and 3's were working 6's and 7's on TWO Meters every night. The idea of cranking the beam around toward Europe was not too inviting, the QRM from those Iron Curtain 220 mc club stations calling blind since they found out that we could hear them would be just too much. Before pulling the switch, decided to check 432 mc aurora to see if the same old gang was on tonight as usual—they were. You would think that after a year some DX would get interested—after all, this GI3, SVØ, RA1, and KKL7 gassing away couldn't read a signal more than 30 db under the auroral noise if they tried, some of them were even using superhets! Thirty minutes of copy of this crud just proved how bad things were, it must have been weeks since there had been a decent opening, so the only thing left to do before calling it quits was to re-calibrate the receiver. After shifting the cables around to get the high frequency front—end on the polar antenna and cranking in the usual deviation and hour angle settings —nothing! Banging the varactor multiplier string a few times with the ash tray, things began to sound normal—one of these days I'll get around to fixing that thing right. Then tuning around the right side of 1245 mc for a bit, there it was—eight ball in the corner pocket. Ever since we had started peaking up the receivers on the hydrogen line emission from the sun bouncing off the moon, things had been a little livelier on the VHF-UHF bands. There had only been two threats of suicide at the last club meeting when the letter from the FCC was read, thanking the US Amateurs for so generously giving up all rights to their historic bands below 144 mcs, as recommended by the ARRL to give more channels to the terribly overloaded citizens bands. Since most of these CB boys were running at least a KW peak of old-fashioned SSB they did need the room. One thing for sure, now the boys at HDQs would finally have to re-write the Handbook.

Might as well see if Sam or Tommy are on 1296 mcs—XZQ! #&$! That durn receiver is acting up again. Banging on it hasn't helped. Up - down, up - down, up - up - down - up, over and over again. Hey! That's CQ CQ CQ CQ! Some local must be overloading my front end—no, it peaks up on the moon. No coherence at all, just pure noise, half a mc wide, and almost -200 dbm strong! Some nut must be playing around with the world's biggest spark gap. I haven't heard anything like this racket in years. "CQ CQ CQ CQ CQ de 8X&DN ARK." What kind of a lid is this, 50 CQs and he signs once while I was diddling with the integration so I missed his call! Let me see—if I swipe some sync info from the TV generator to modulate the driver and short out the filter chokes on the final power supply, my note will be rough enough so that it could be copied with a tunnel diode, Ha. Boy, that used to clean the 6's out of the pile-ups on the low end of twenty. Now the final is up to full power with no more than the usual smoke —"QRZ QRZ QRZ DE K2TKN, etc." Nice and snappy, three by one calls just for style. Careful, don't let the speed drift up or he will never copy, even with these strong sigs. One second dots, three second dashes, that should raise Old Harry Himself. Lengthen out the dashes on the sign out—a Banana Boat Roll got me some choice contacts in the old days, why not now?

Where did he go? There he is—almost two megacycles lower—that xmtr must be an old Tuna Clipper Square-D! Listen to him roar! "S2 S2 S2 S2 de 8X&DN R R R R S2 S2 QRZ QRZ QRZ de K2TKN hv bn rcvg misc slow-wave sigs fr ovr 13 yr orbits abt yr star bt u frst 2 use planetary resonance 2 modulate yr star radiation giving zero delay—vy fb sigs ga.

S2 S2 S2 de 8X&DN QRZ QRZ QRZ de K2TKN S2 S2 S2 de 8X&DN ARK." Turn up the variac, there be no complaints about power on this one—"8X&DN de K2TKN." You know this isn't such a bad night for DX after all!

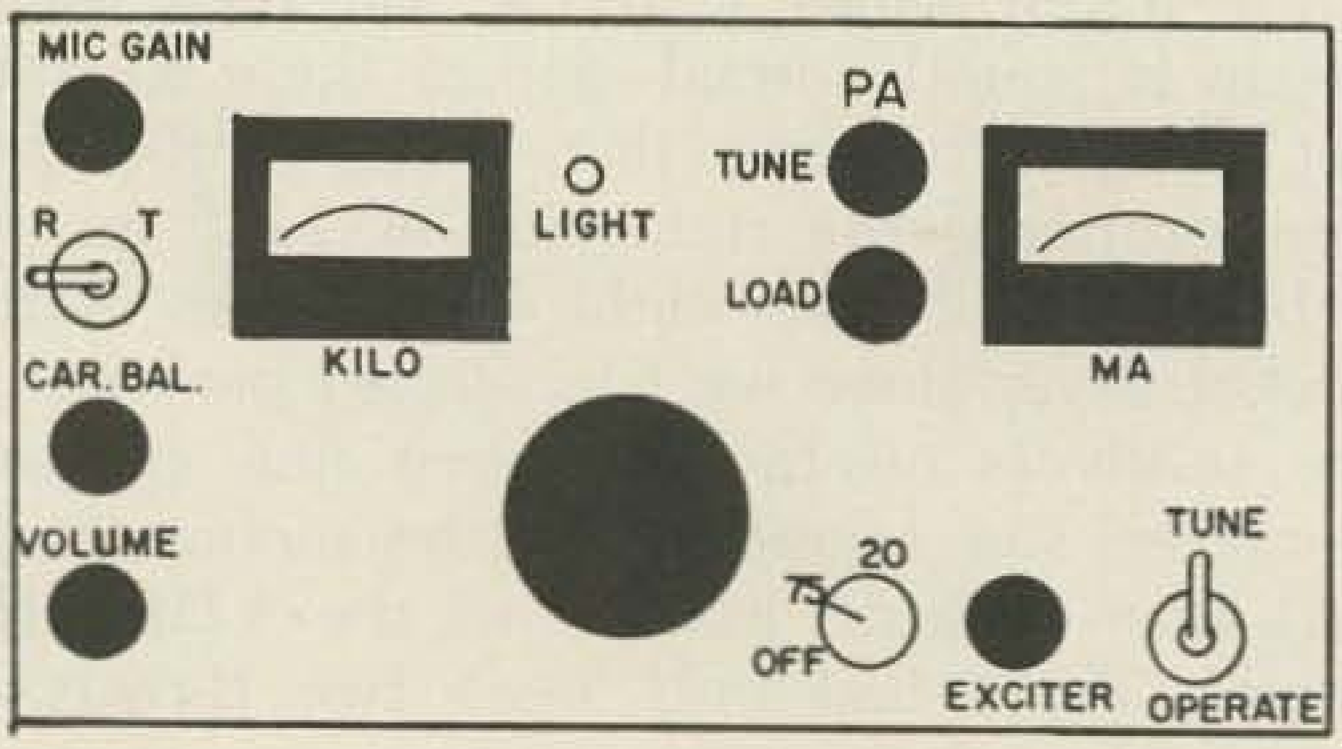
"8X&DN S2 S2 de K2TKN" "8X&DN de WIBU" "8X&DN de KH6UK" "8X&DN de DL3FM." Listen to that tail-ending pile-up!

. . . K2TKN

Two Banding The Swan One Bander

Dave Sherman W8DHZ
95 Dexter Drive
Hilliard, Ohio

After purchasing a Swan 175 I came to the conclusion that converting to 20 meters would be a simple matter since the sum of the VFO plus the 5775 mc SSB signal would be approximately 14 mc upper SB.

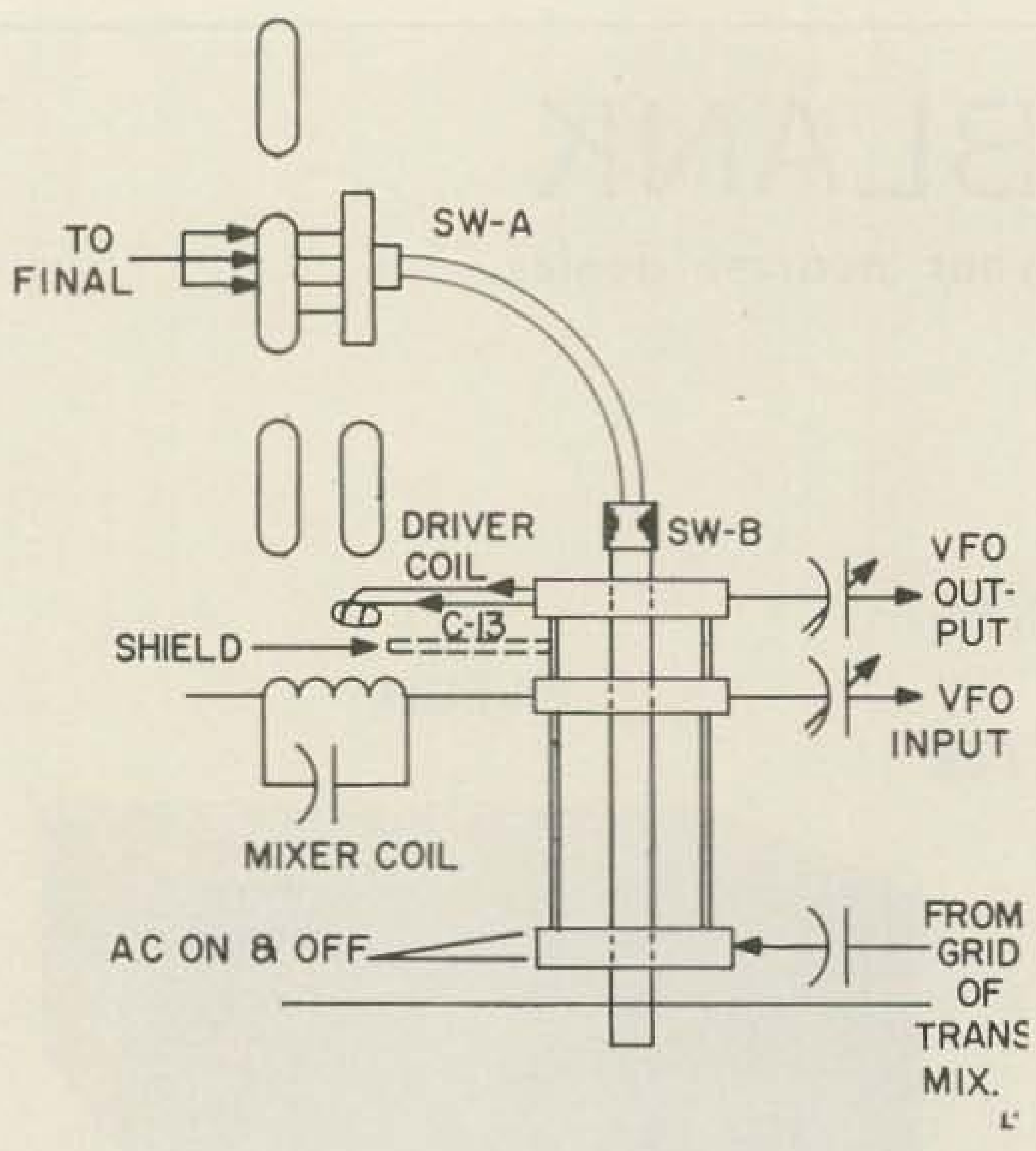


However I was determined to stick to the following rules:

(1) Do all band switching with 1 switch
(2) Use an existing control position on the front panel, therefore not alter the appearance of the Swan.

I decided to use the power on-off switch location for my band switch and include power on-off as a position on the band switch. To do this coil L4 must be moved over a slight amount to clear the band switch.

The band switch was a miniature Centralab PA 300 series 6" long with 3 ceramic decks 2 pole 6 position. The final switching is done with a single deck 2 pole 6 position coupled to



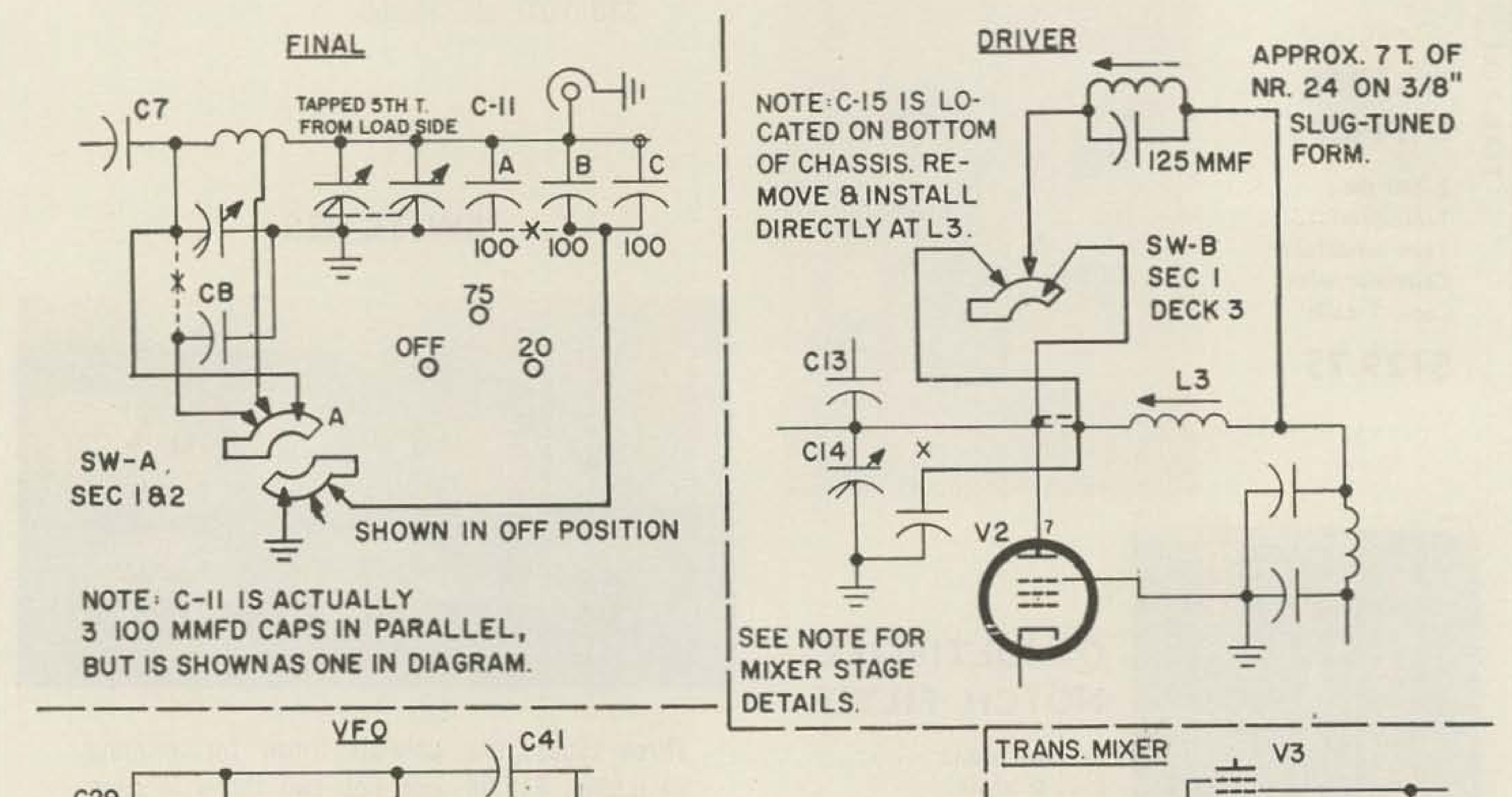
the band switch via a flexible shaft. A longer band switch could be used and include the final switch on it.

The 20 meter coils for L3-L4 are mounted beside the 75 meter L3-L4 coils. A hole must be drilled in the chassis to allow the 20 meter driver coil to be connected to the band switch and another hole drilled to bring the lead from capacitor C13 (which is located on the 6DQ5 socket) to the high side of C11.

To prevent the possibility of oscillation I added a small shield partition between the switch deck that switches the x-mitter mixer and the deck that switches the driver.

After making all modifications, switch to 20 meters and adjust the VFO padder which you added until you have 20 meters coming in. This can be done with a GDO. Then with the exciter tuning in the upper half of its range adjust the two 20 meter coils for max signal. Then switch to transmit and with an output meter coupled to the final, insert a little carrier and peak the coils to max output in the middle of the 20 meter band. Then adjust the VFO output capacitor, which we added, for max output as indicated by the output meter. If any trouble is encountered check all tuned circuits with a GDO.

The modification is very simple and for this reason the instructions are brief. No one with



any building experience should have any trouble with the modification.

The only disadvantage to this system is that with the long lead coupled to switch the VFO input capacitor the stray capacity is enough to throw the calibration off for the 75 meter band a small amount. This could be cured by coupling a switch deck over close to the VFO. Since I only work the upper half of 75 the error is very small upon adjusting C-34 after the capacitor is installed. This also requires going back and adjusting the 20 meter VFO capacitor again.

The dial can be calibrated by rotating the dial 180° and calibrating the blank dial for 20 meters with a good signal generator. The band spread is just right to cover 14.20 to 14.350.

I would like to thank John Collins and Miss Ruthellen Hutt whose assistance made this project and writeup possible. . . . W8DHZ

Letters

Dear Wayne:

As of October 1962 W4KXQ and K4GRY were the first in the State to have AFSK RTTY activity on 52.6 mc FM. Now we have WA4EQG and W4PZY in the local area plus others in Lynchburg, Roanoke, and Waynesboro, Va., now active. We hope to have a repeater going for AFSK FM on 52.6 mc soon and with added antenna height and preamplifiers ahead of the receiver to be ready for some good DX when the band opens up. We will sked anyone and help anyone interested in joining our fine group. K4GRY has a model 15, a model 14 REPFR and TD, a W2JAV converter—a SFO regenerator and a 50 watt LINK FM receiver and transmitter. W4KXQ has a model 15, a Western Union TD, a 14 REPFR and a model 14 strip printer with a Motorola 80 D for transmitter and receiver. KXQ's antenna is about 70 foot high. WA4EQG has simiilar equipment with a W2JAV TU similar to KXQ's. We are now active with autostart and will be ready to work anyone at just about any time conditions will permit.

George P. Oberto K4GRY
Richmond 26, Va.

Dear Wayne,

I am somewhat disturbed by the adverse comments that the double sideband suppressed carrier article by W3PHL (Feb. 73) has been drawing. Per se I am not against controversy, but to meet scientific argument with invective is childish. This is especially true as the author took considerable pains to supply a good bibliography for anyone wanting to pursue the validity of his argument further. Certainly none of the detractors have bothered to challenge the validity of the concepts involved, and perhaps their letters would make a good starting point for a case for demanding a greater breath of technical understanding from the fraternity. I suspect that a great deal of the references to "doubletalk" and "junk" arose from a basic misunderstanding of the principles of information in electromagnetic communication.

J.C.B., Ottawa.

The Buck-a-watt Six Meter Transmitter

Tuning indicator parts kit available

Robert Rose K6GKU
9332 Sage Avenue
Arlington, California

As fads come and go and interests change, this author has learned one very important fact. To run out and buy commercial equipment to meet each new demand can lead to the state of instant poverty. The answer—homebrew as cheaply as possible. A recent urge to try six meters produced the rig described herein. If you are a homebrewer who would like to get on six meters without spending a lot of money and still want to put out a signal to be proud of—this rig will do just that.

The transmitter is a plate modulated, 15-20 watt rig which is made up of reliable circuitry and low cost components. It also incorporates a novel (but not new) method of monitoring the oscillator/tripler output, the doubler output, the final tuning, and the modulation, all simultaneously. With any kind of junk box at all the transmitter can be built for about a dollar a watt.

Numerous articles on 6 meter transmitters were read with the same result—something was lacking. Either the modulation was not adequate, the power output was too low, the components were high priced, or the oscillator doubler stages used a triode-pentode combination. In general the authors junk box would have been of no help at all. It was finally decided to use circuits from several sources to get what we wanted. The final product is the 6 meter transmitter shown in Figure 1.

The 6AK5 oscillator/tripler is a modified Pierce circuit which makes use of economical 8 Mc. crystals. The 25 Mc. output drives the 6AK5 doubler stage. Both of these stages use a parallel resonant tank circuit. The use of variable capacitors in these tank circuits makes their tuning unique and smooth.

The output of the doubler stage is mutually coupled, through a series resonant circuit to the final 2E26 which is operated as a straight through amplifier. The mutual coupling between L2 and L3 is achieved by placing the axis of the coils in parallel. The spacing of the two coils is determined by the point of maximum drive to the 2E26 as the position of L3 is varied. Experimentation showed this spacing to be about ½ inch. The use of mutual coupling into the final and link coupling on the final output proved to substantially reduce the TVI problem.

The 10 watt modulator, shown in Figure 1, consists of a 12AX7 used as a two stage preamp and a 6L6 final modulator tube. The input was designed for use with a crystal microphone and the output provides plenty of punch for the 2E26. The modulation transformer used was a surplus modulation transformer taken from the ever faithful 522 and may be obtained from most surplus stores.

The power supply is strictly conventional in nature and any supply capable of 300 VDC at 150-200 ma and a 6.3VAC source will do the job nicely.

There is little to be said about the construction and layout of the transmitter unit. These may be determined by the builder to suit his needs. The coils L1, L2, and L4 are the air wound variety and were checked with a grid dip oscillator to ensure resonance in the proper frequency range.

The variable capacitors C1, C2, C3, and C4 were all the surplus APC type with shafts soldered on C3 and C4. Except for the observance of standard VHF construction practices, there is nothing critical in the building of this rig.

The novel method for tuning this transmit-

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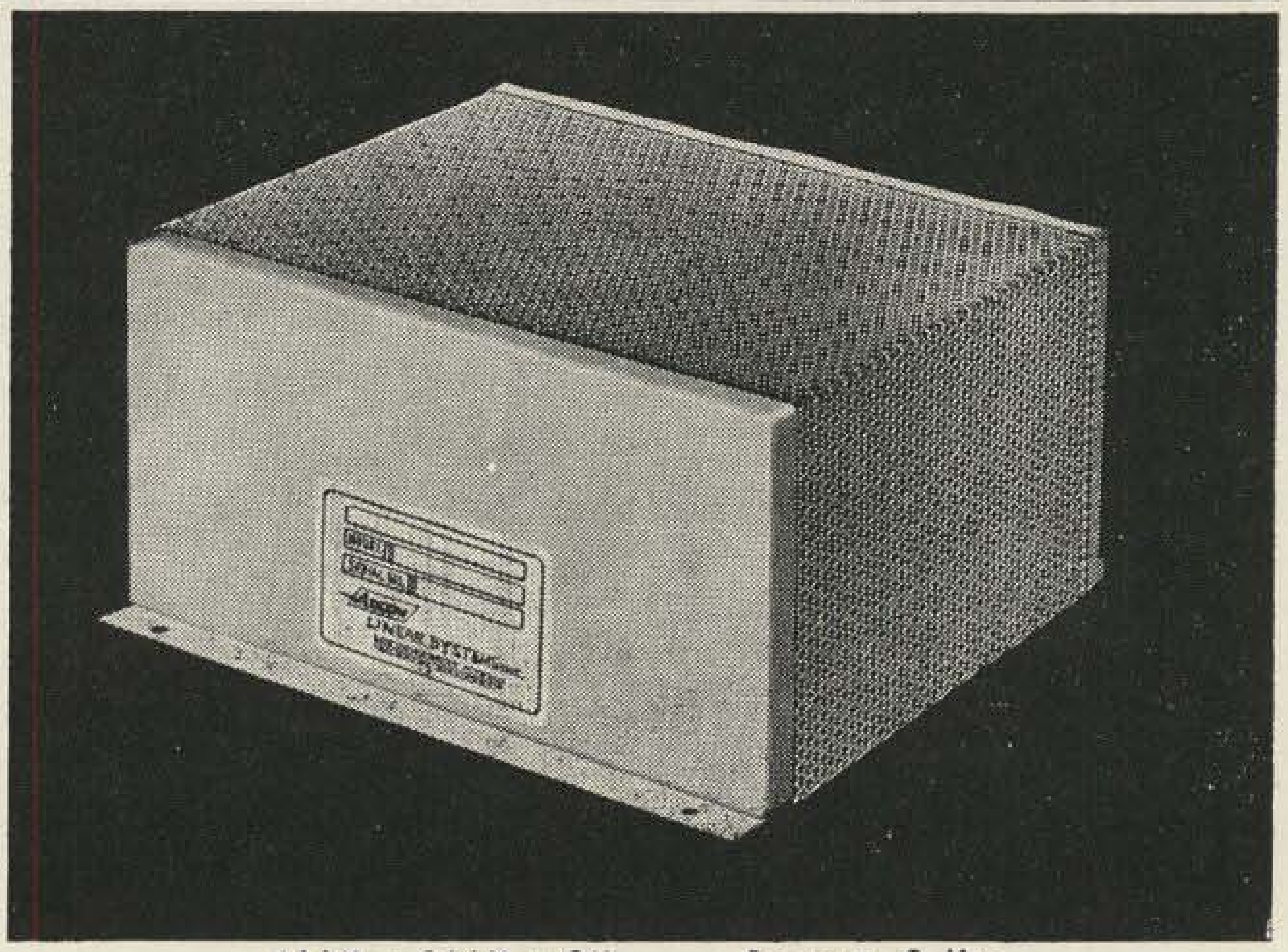

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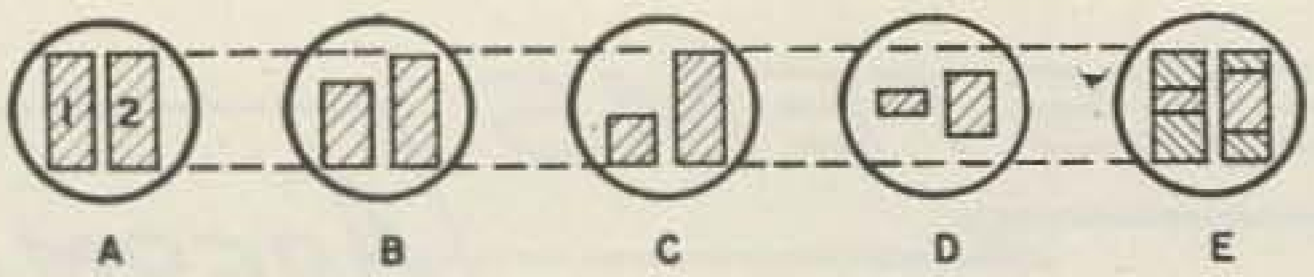


6AL7 Indicator Presentations

Figure 2a shows the 6AL7 display with no signal input. The output of the oscillator/tripler stage will move Bar 1 down from the top. Vary capacitor C1 for maximum depression of Bar 1. This indicates maximum tripler output as shown in Figure 2b. The output from the doubler stage will move Bar 2 down from the top. Varying C2 for maximum depression will indicate maximum doubler output as shown in Figure 2c.

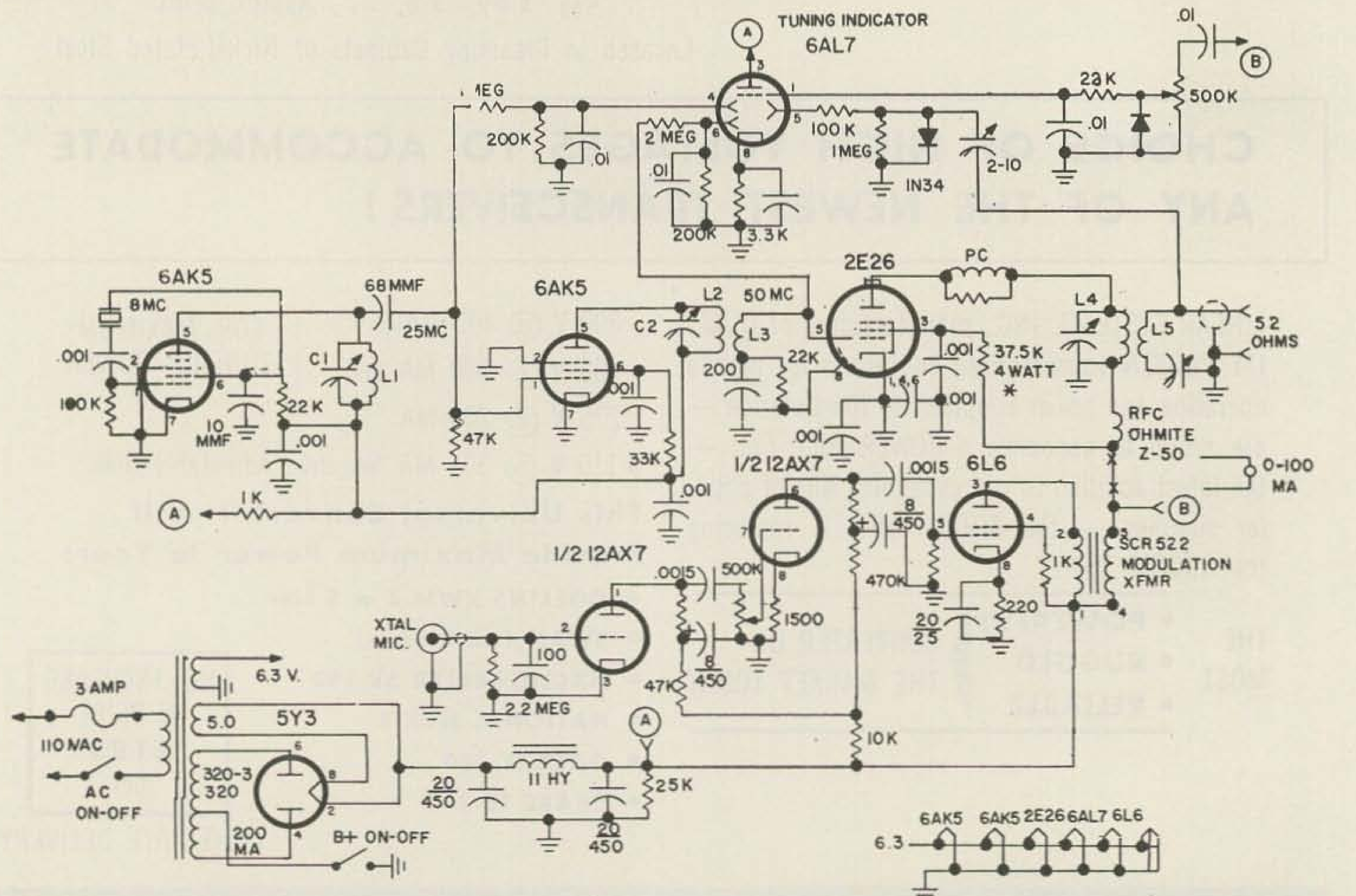
ter was taken from an article written by Don Stoner in the Nov. 1957 Brand X magazine. The tube, a 6AL7, is not the standard type of "eye" tube such as the 6E5. The 6AL7 presents two green bars, the height of which is determined by the signal produced by the output stages monitored. To save space the theory of this tube's operation will not be discussed here.

Learning to read the tuning indicator is a little tricky at first but once it is mastered, the feature of being able to see the output of the oscillator/tripler stage, the doubler stage, the final tuning, and the modulation simultaneously will make the 6AL7 a must item in future rigs. Figure 2 will help in tuning the transmitter.

Tuning the final for maximum output will move both Bars 1 and 2 up from the bottom. For those who worry, it has been found with a milliammeter inserted in the plate circuit, that the dip indicated on the 6AL7 will coincide with the dip of the plate current meter. Figure 2d shows the 6AL7 presentation with the tripler-doubler stages peaked and the final dipped.

All that is left is to apply the modulation. Advance the audio gain control and apply a signal into the microphone input. On the modulation peaks, the 6AL7 presentation will expand both Bars from the top and bottom. The amount of the expansion will depend on the amount of modulation. If you are lucky enough to have an oscilloscope, the face of the 6AL7 may be calibrated, by percentage, with a grease pencil. Figure 2e shows the presentation with the transmitter fully loaded and with modulation.

There is one point to be noted about the leads used to couple the tripler and doubler



L1—12T #20—½" dia ⅝" long
L2—7T #20—½" dia ½" long
L3—7T #20—½" dia ⅜" long
L4—3½T #14—¾" dia ½" long

L5—2T #14 cold end of L4
C1, C2, C3—25 μμfd variable
PC—5T #20 on 100 ohm resistor
*4—150,000 1 watt in parallel

signal to the 6AL7. The 1 megohm resistor to pin 4 of the 6AL7 should be connected directly to pin 1 of the 6AK5 doubler. The 2 megohm resistor from pin 6 of the 6AL7 should be connected directly to pin 5 of the 2E26. This will reduce any unwanted radiation through these leads.

This transmitter has been in operation about three months now and the signal reports received have been very gratifying. Reports on the audio indicate that it is clean and packs plenty of punch. Inasmuch as the author is living in a rented duplex, the choice and altitude of antennas is limited and little DX has been worked. It is felt, however, that with a beam, this rig will perform along with any in its class, either commercial or homebrew. So start digging in that junk box. You probably have most of the parts already.

. . . K6GKU

Bibliography

Simple Transmitters for 50 and 144 Mc.; Simple Transmitters for 220 and 420 Mc.—The Radio Amateur's Handbook, 38th Edition 1961. Pages 435-438; Pages 441-442.

Donald A. Smith W3UZN—8 Mc. Crystal Modification, 73, January 1961.

Donald L. Stoner W6TNS—The Glass Eye, CQ, November 1957.

Parts Kit Available

The parts for tuning indicator are available as a complete package from 73, Peterboro, N. H. Order K6GKU Kit $7.50

73 Tests The Hammarlund HX-50

When Hammarlund announced the HX-50 some months ago we at 73 anxiously read the literature to get an idea of what was in the works. The ads looked awfully good so you can imagine how excited we were when we finally got word from them that a unit could be spared for a quick editorial evaluation. It is pretty difficult to take a rig and lend it out for a few weeks when you have distributors all over the country phoning, sending telegrams, and trying in every way they can to get you to send more rigs.

Possibly due to the built up interest here resulting from the HX-50 ads and partly curiosity as to what kind of job Hammarlund had done on this sideband transmitter after all these years of sticking to receivers, the box was open before it hit the ground after being kicked off the Express truck and the HX-50 was being carefully scrutinized and exclaimed over.

As the Express truck turned out of our driveway the HX-50 was warming up for its first contact. During the next few hours it racked up many SSB contacts on 75-40-20 meters, including some garden variety DX, and got a good workout on 20 and 40 CW with W1MEL at the bug.

During the next few days we went over the rig carefully, feeding it into different antennas, checking it with a wattmeter, frequency standards, oscilloscope, and all that. We compared our tests with the advertised specs and could find no place where Hammarlund was not guilty of understatement.

It would be a shame if you read all the way through a test report on a piece of new gear without knowing just what it was you were reading about, so let's take a close look at the HX-50. The HX-50 is a combination SSB/CW transmitter which covers all of the regular ham bands, 80 through 10 meters. It will also cover 160 meters with an optional kit. It can also be used for the MARS or CAP channels with a crystal or external VFO. There is provision for three crystal controlled frequencies, external and internal VFO with one switch.

It is rated at 120 watts PEP, 90 watts dc input on sideband or CW and about 25 watts on AM. It has a built-in antenna relay, a great plus in a transmitter for it is something that you've got to have to operate and which is seldom found in rigs with the result that you usually have to buy a rather expensive relay and wire it in the circuit, giving you a lot more wires to drape around the shack.

Naturally the HX-50 has Vox and push-to-talk. The keying is time sequenced and adjustable. The VFO is not only quite stable but easy to read and very accurate due to the built-in crystal calibrator.

It would seem that the hams down at Hammarlund have thought of everything possible. If they've forgotten anything then it has escaped us too for this rig seems to work just fine and do everything you could ask, whether you be CW of SSB op. The $399.95 price is mighty low by today's equipment standards and makes it possible to have a pretty fancy ham station without a tremendous investment.

. . . Wayne

K6LSX San Jose, Calif.

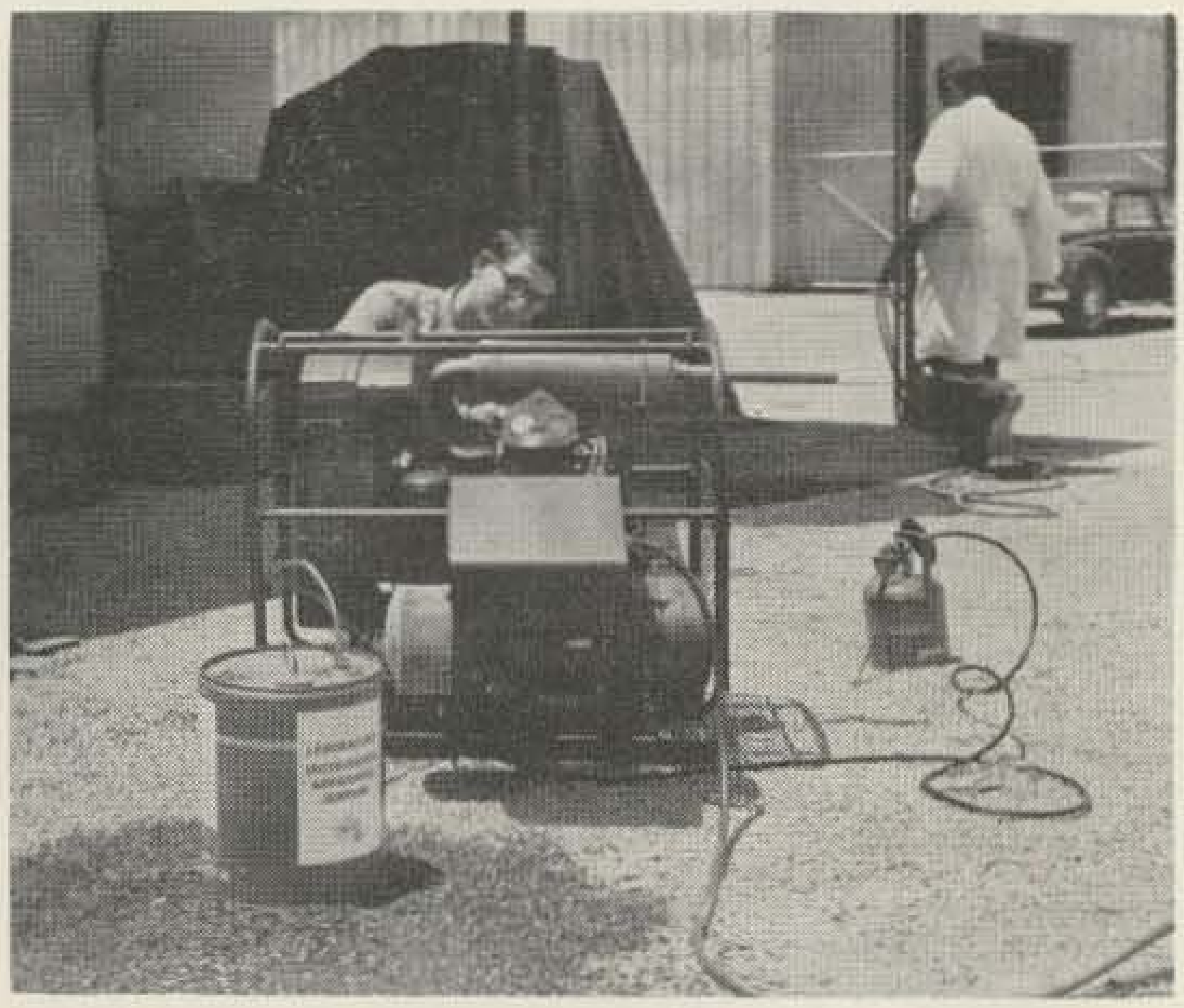
Field Day

The Sidewinder's Radio Club, K6LSZ, held it's annual field day exercise in a saddle between Mt. Loma Prieta, site of channel 11, and Mt. Umunhum, Almaden Air Force base radar site. There were 29 operators, 15 stations, and about 50 people, including many YLs and Jr ops.

Food was furnished from the club treasury —cold cuts and trimmings, hit chili beans and coffee the entire period, with a steak dinner Saturday evening and bacon and eggs, etc. Sunday morning. This cost about $2 per person.

Paul Barton W6JAT

"Tut" Tuttle WA6LUM confers with county fire captain Bob Olson on fire permits, in the rf lab at Jennings Radio.



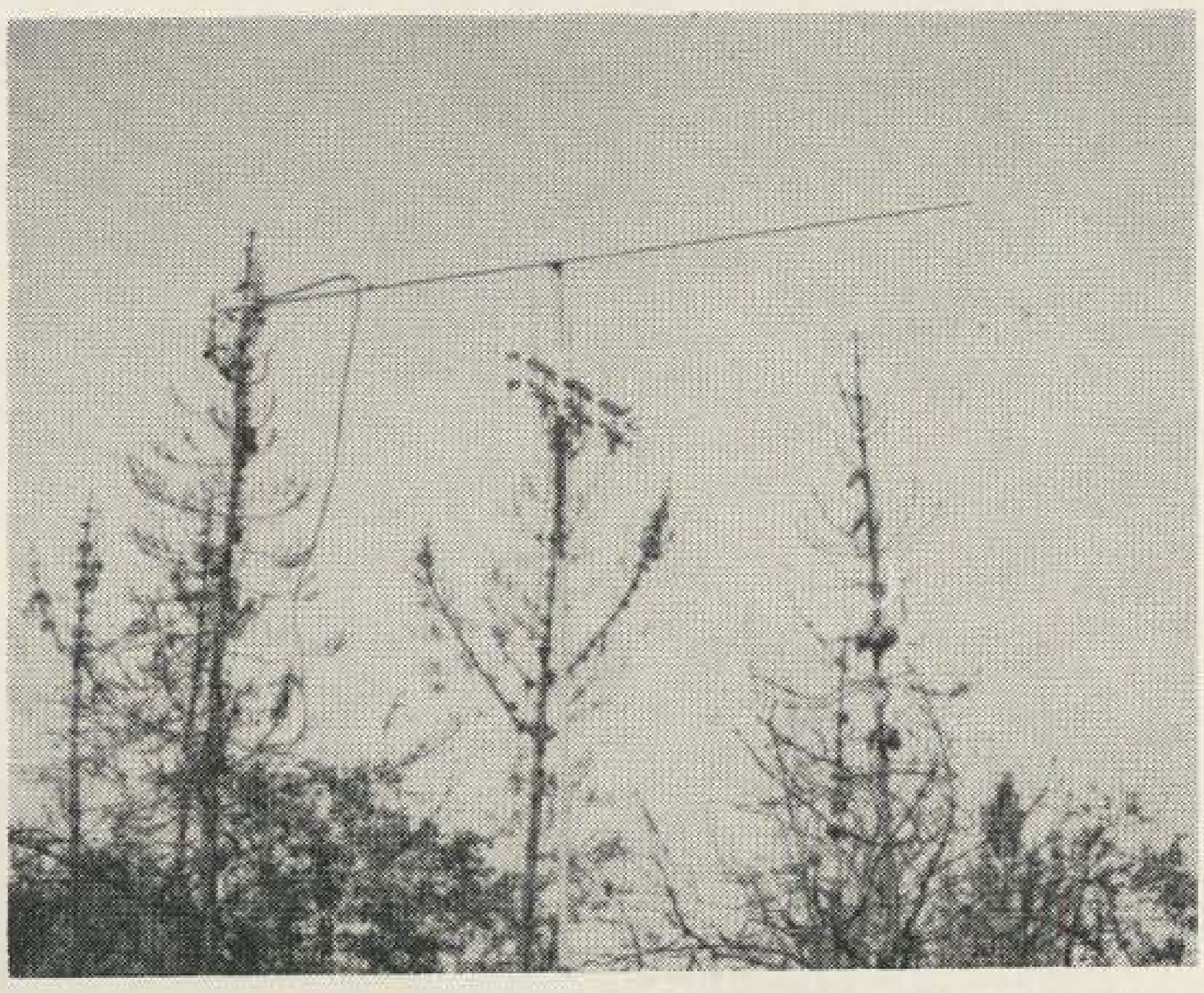
Dave Mauro W6LXK checking out a generator before field day. "Tut" WA6LUM in background.

"Buddy" Alvernaz at operating position of K6LSZ home station.

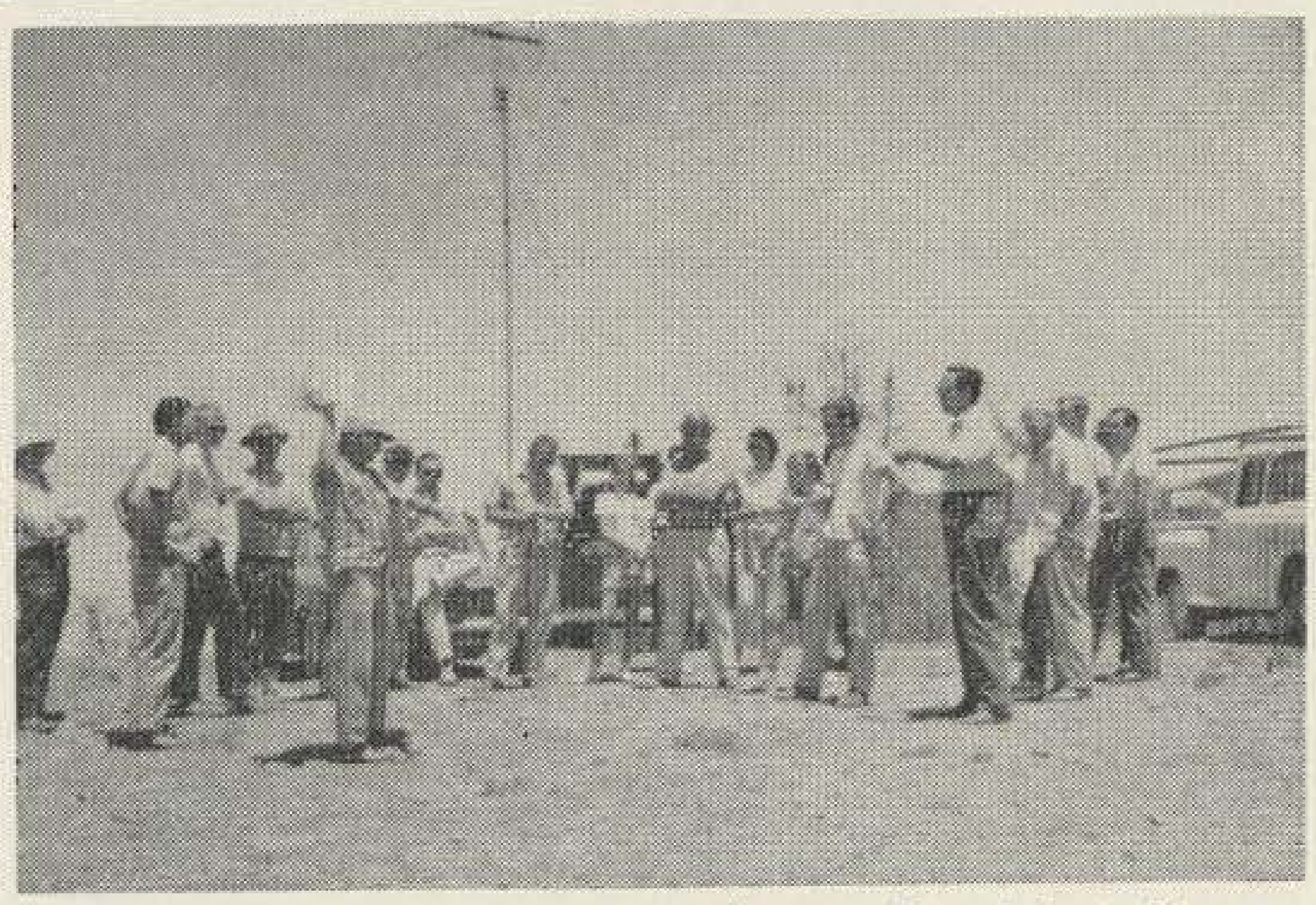
Bob Goddard K6EDU putting up eighty meter antenna.

Forty meter tent going up on field day site.

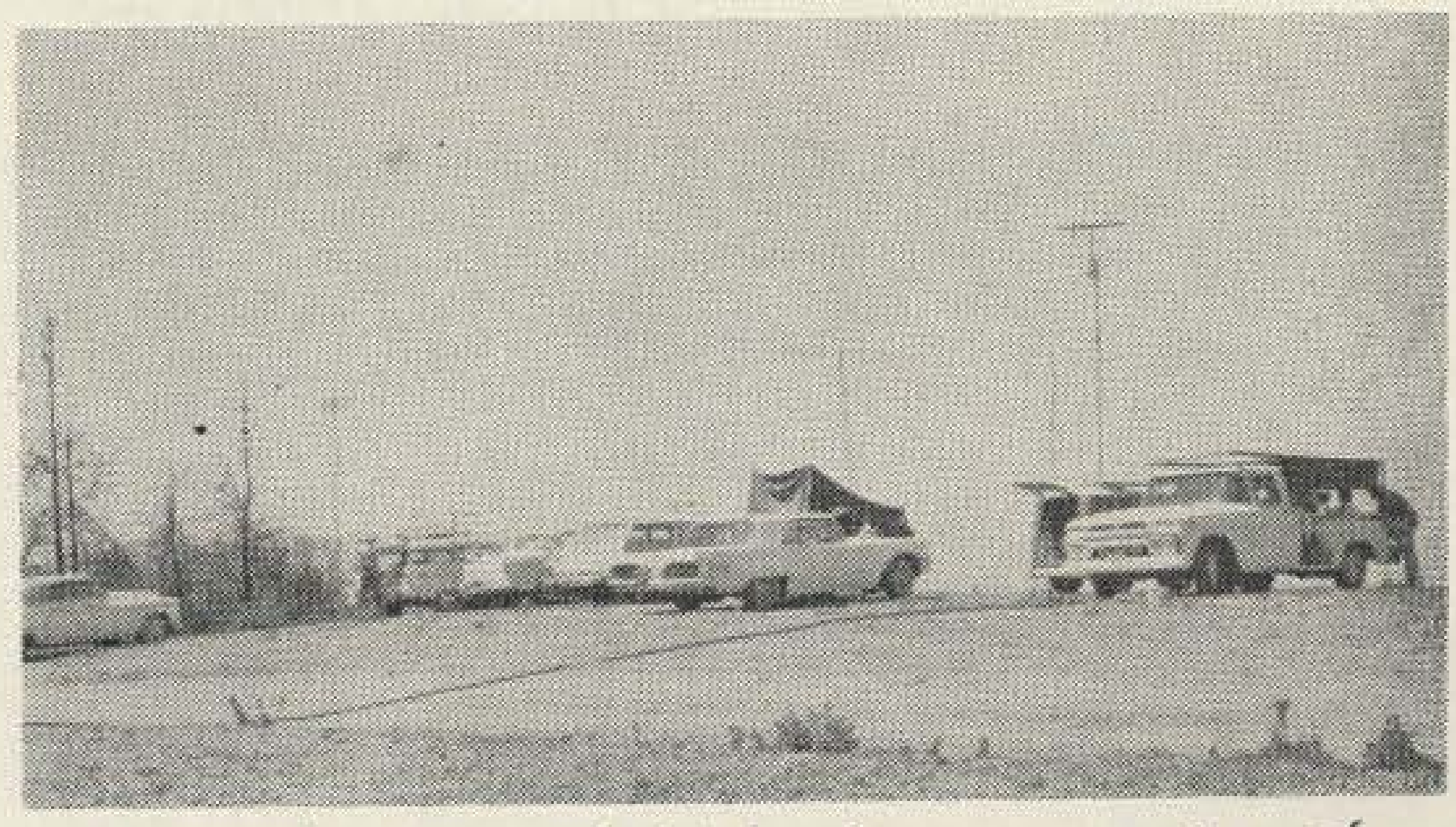
Tut WA6LUM inspects power cables from 7½ KW field day generator.



220 mc and 432 mc field day antennas.



All gear set up and working. Final briefing at 11:57 local time by WA6LUM. Count-down at 11:59 ¾ . . . 4 . . . 3 . . . 2 . . . 1 . . . go!



General view of high frequency site of K6LSZ field day operations.

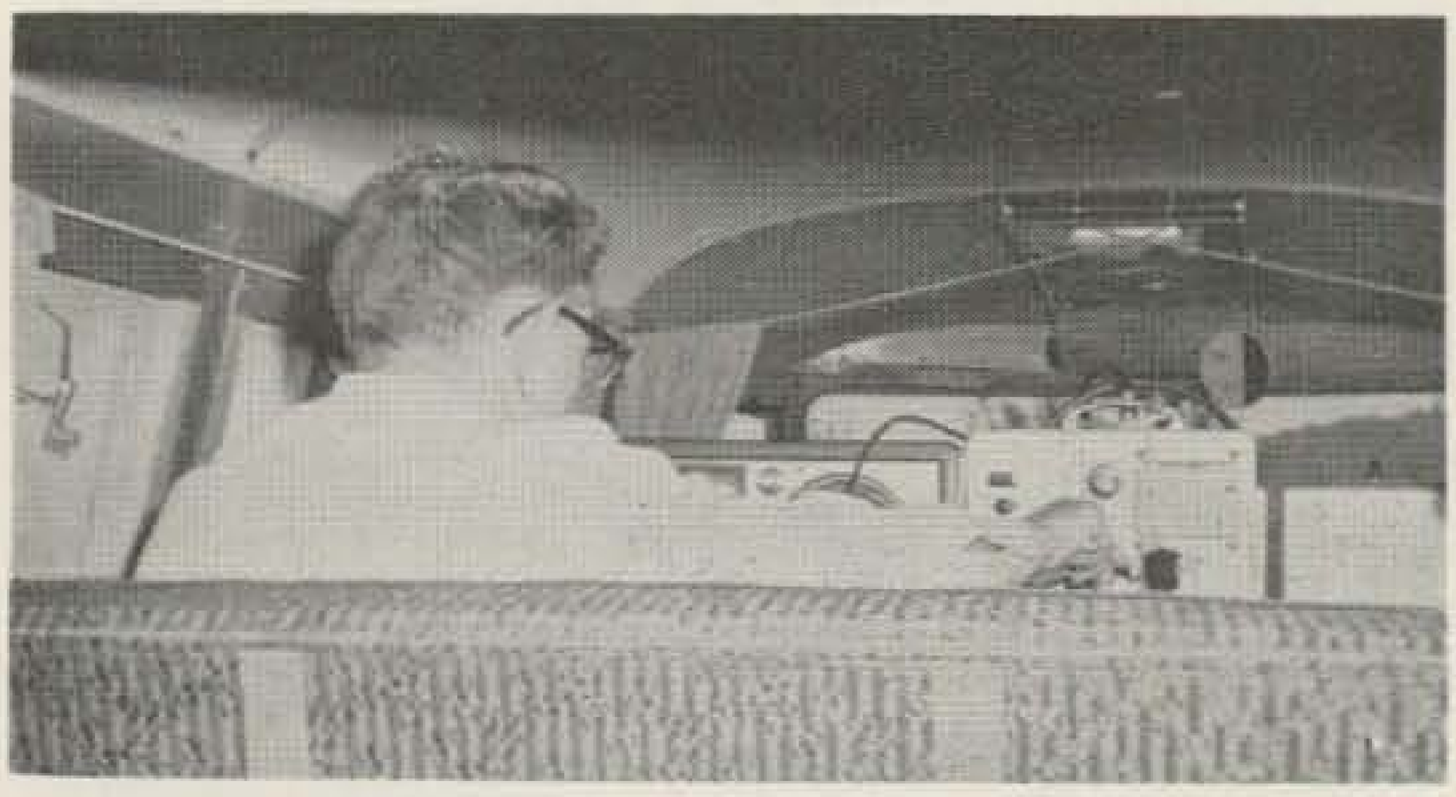
(K6LSX Field Day continued)

40 Meter operation. L to r: Bert Newkirk W6SIX, Dan Reid K6MZD, Bob Lile.

75 meter position.

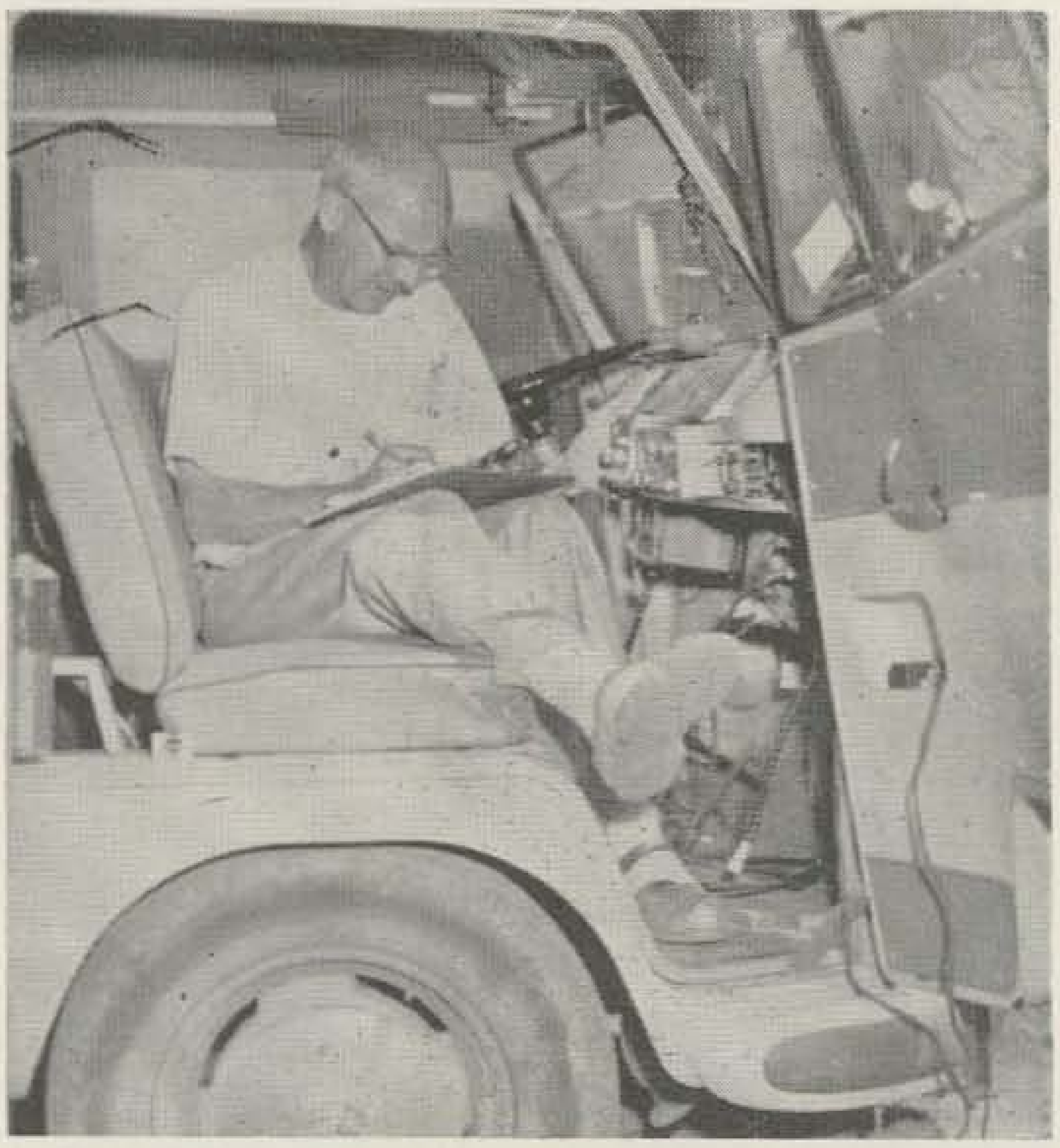
20 meter site. Bob and Dan Reid K6MZD

220 mc and 54 mc operation, Ken Holiday K6HCP and Roy Bortle WA6AVV.



2 meter operation, Lloyd Saxon W6EEX.

Emergency repairs by Bob Hiatt with Keith Nelson watching.



15 meter operation, Hank Plant W6DKZ
(more on page 32)

Linear

Amplifiers

80-2 Meters

Mono-band Units

Model 500 500 watts SSB and CW, 250 watts AM, 1 4X150 final, built-in silicon power supply and blower. **Price only $149.95**

Model 1000 1000 watts SSB and CW, 500 watts AM, 2 4X150 finals, built-in silicon power supply and blower. **Price only $199.95**

All units housed as above picture. Size 7" high x 15" wide x 9" deep. Please specify band when ordering.

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9000.000	10400.000	10666.67	11618.520	11717.41	15000.000	20.53333	22.15556	26.12083	26.16250
26.66667	27.120	27.78333	27.72500	28.620	35.55555	37.40741	37.77770	37.0000	38.53700
42.33333	42.59259	42.96296	46.10000	46.30000	47.90000	47.93750	54.8500	82.33333	83.33333

Same as above except in limited quantities of 20 or less in stock. Please give second choice when ordering.

10441.67	12000.000	12.3000	12600.000	15.7775	17.055	17.255	17.855	20.0060	26.235
28845.00	28.88889	29025.00	29475.00	29600.00	29.62500	30000.00	30.0000	30725.00	30875.00
30925.00	31.0000	32.22222	33.33333	33.90000	33.950	34.00000	34.050	34.10000	34.150
34.20000	32.250	34.3000	34.4000	35.0000	35.62963	35.66667	35.70370	35.74074	35.77778
35.81481	35.85185	35.88889	35.92593	35.96296	36.03704	36.07407	36.11111	36.14818	36.18519
36.22222	36.25926	36.29630	36.33333	36.37037	36.40741	36.44444	36.48148	36.51852	36.55556
36.59259	36.62963	36.66667	36.70370	36.74074	36.77778	36.81481	36.85185	36.88889	36.92593
36.96296	37.0000	37.03704	37.07407	37.11111	37.14815	37.18519	37.22222	37.25926	37.29630
37.33333	37.37037	37.44444	37.48148	37.51852	37.55556	37.59259	37.62963	37.66667	37.6958
37.70370	37.74074	37.77770	37.77778	37.81481	37.85185	37.8625	37.88889	37.92593	38.14815
38.537	39.51850	39.518519	39.55550	39.555556	39.592593	39.59620	39.629630	39.62960	39.66670
39.666667	39.70370	39.703704	39.74070	39.740741	39.77780	39.777778	39.81480	39.814815	39.851852
39.85190	39.88890	39.888889	39.92590	39.92526	39.96300	39.962963	40.03700	40.037037	40.07400
40.074074	40.1110	40.11111	40.1481	40.148148	40.185185	40.18520	40.22220	40.22222	40.259259
40.25930	40.296296	40.29630	40.33330	40.33333	40.370370	40.40740	40.44440	40.44444	40.481481
40.44583	40.48150	40.51850	40.55550	40.555556	40.59260	40.592593	40.62960	40.62963	40.666667
40.66670	40.70770	40.703704	40.74070	40.740741	40.77780	40.777778	40.81480	40.814815	40.851852
40.85190	40.88890	40.888889	40.92590	40.925926	40.962963	40.9630	41.0000	41.03700	41.037037
42.0000	42.62963	42.66667	42.7000	42.70370	42.74074	42.77778	42.81481	42.85185	42.8500
42.88889	42.92593	42.96296	43.03704	43.07407	43.11111	43.14815	43.18519	43.22222	43.25926
43.29630	43.33333	43.37037	43.40741	43.44444	43.48148	43.51852	43.55556	43.59259	43.62963
43.66667	43.70370	43.74074	43.77778	43.81481	43.85185	43.88889	43.92593	43.96296	44.00000
44.03704	44.07407	44.11111	44.14815	44.18519	44.22222	44.25926	44.29630	44.33333	44.37037
44.40741	44.44444	44.48148	44.51852	44.555556	44.59259	44.62963	44.66667	44.70370	44.74074
44.77778	44.81481	44.85185	44.88889	44.92593	45.1000	45.90000	47.00350	47.81250	47.92700
48.30000	48.312500	48.7000	49.9000	50.1000	57.27500	61.33300	67.5	69.000	69.5000

Watch future issues of 73 for complete listings of crystals in all categories. Be sure to include 2nd choice selections. Additional lists available for a stamp.

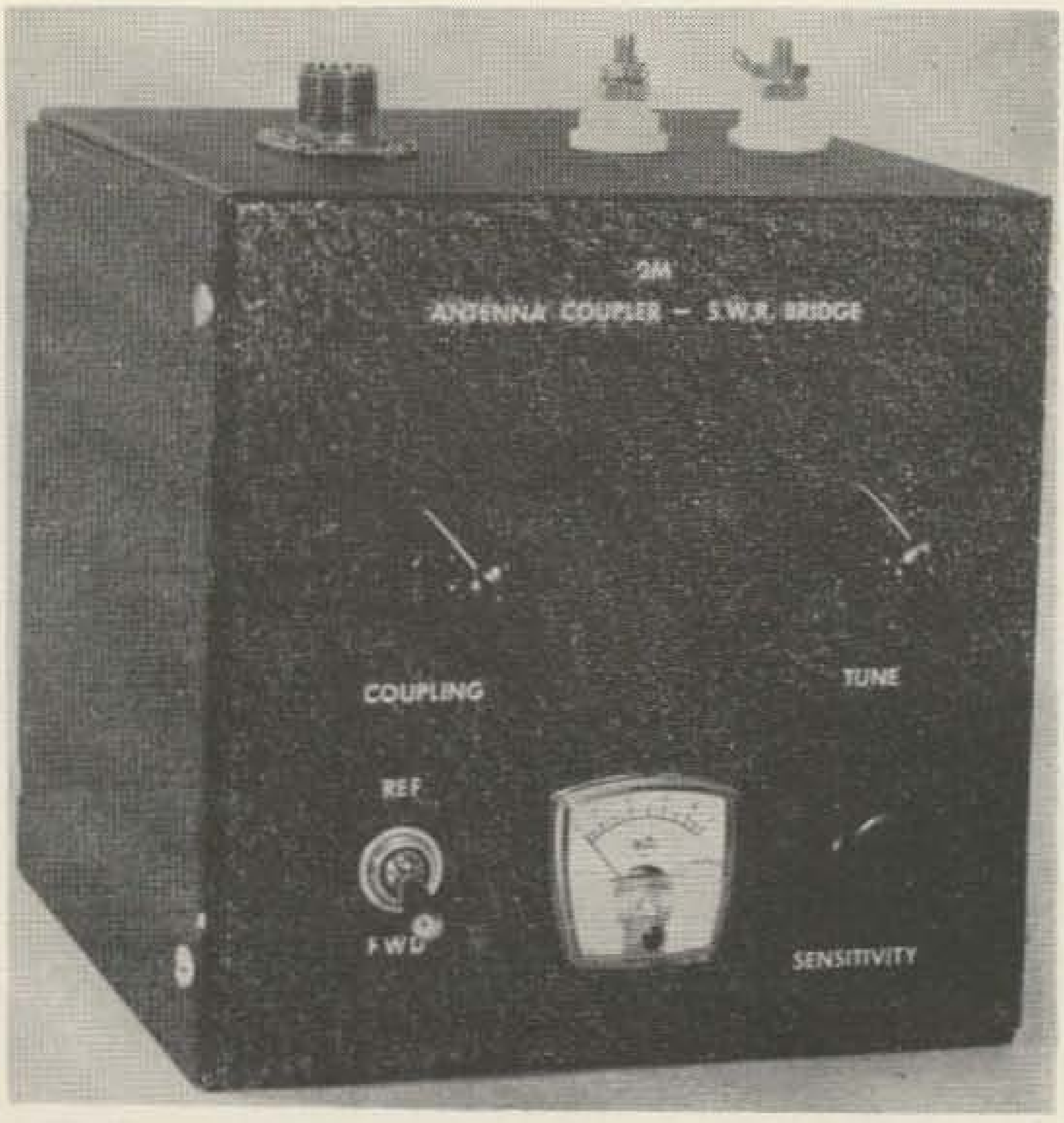
QUAKER ELECTRONICS PO BOX 215, HUNLOCK CREEK, PENNA.

(Field Day from page 30)

Russ Bentson K6KLY, 432 mc operation.

Steaks coming up. Bonnie Barton and Paul Barton W6JAT.

Chow down: Ray Mackaman K6PRH, Donna Tuttle, "Tut" Tuttle WA6LUM, Mae Barton K6YSR, Milt Hird K6KTQ, Ernie Vaugh W6SPS, Ernie Peterson W6NNS, Tom Mackaman, Paul Barton W6JAT.



Richard Van Wickle W6TKA
P.O. Box 4051
Santa Barbara, Calif.

Parts Kit Available

Once upon a time there was a ham who could not get the SWR of his feedline low enough to suit him. Blaming his Monimatch, and other SWR-measuring equipment, he threw it all in the fireplace and stalked away. Hence, the expression "He burned his bridges behind him."

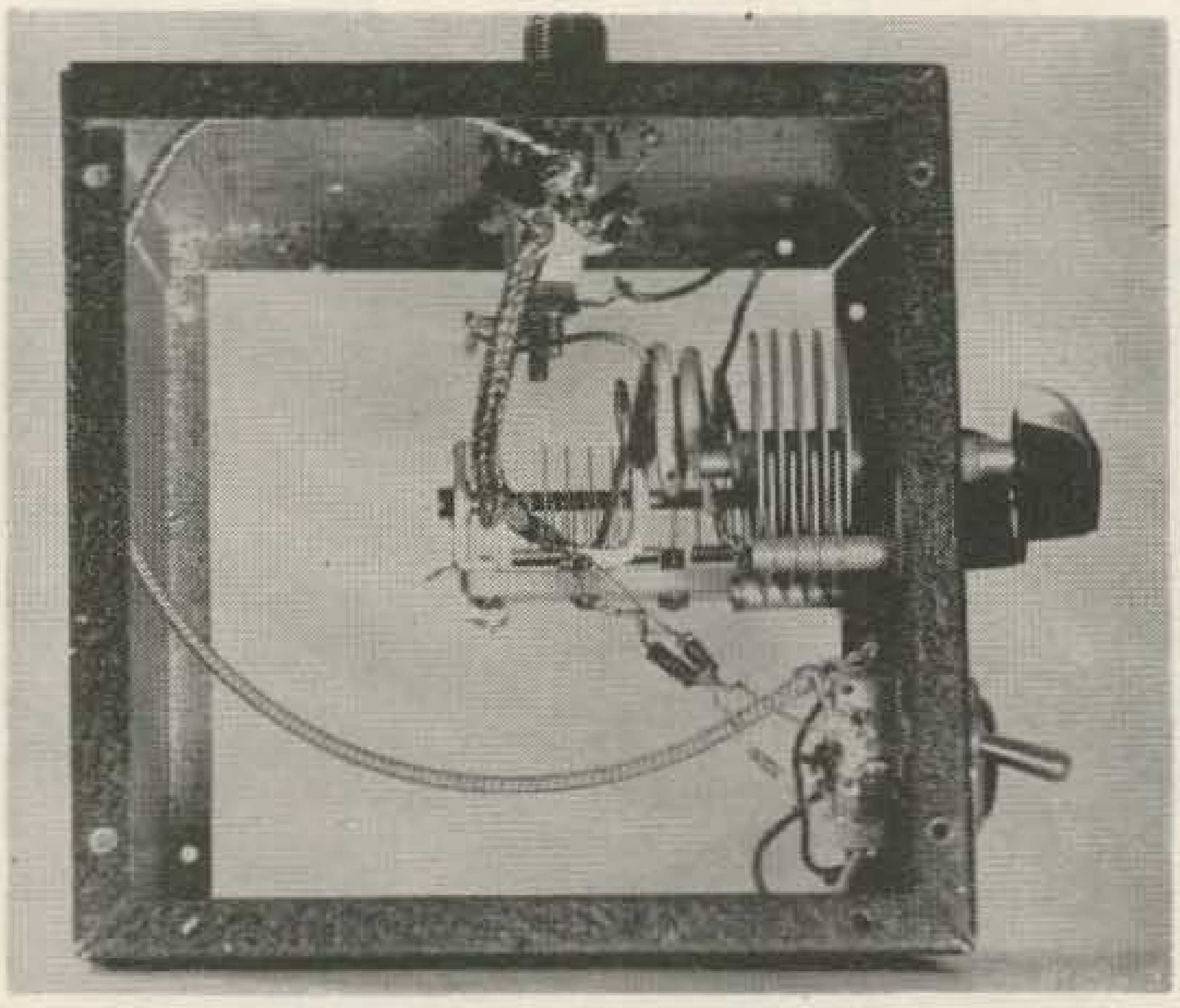
We hope that you will not want to throw this antenna coupler–SWR bridge into the fire. It was developed especially for the two-meter operator who does not like to use coaxial cable as an antenna feedline because of the high attenuation of coax at VHF and who hence prefers open-wire or TV-type balanced feedlines. The antenna coupler will match 52 or 72 ohm unbalanced lines to balanced lines of between 200 and 600 ohms. The SWR bridge is designed to be used with 72-ohm coaxial cable, but can be used with 52-ohm coax, with a simple modification, which will be described.

The manner in which the rf is obtained to operate both the reflected power and forward power bridges is rather unique. Coils are

Two Meter Antenna Coupler and SWR Bridge

wrapped around the insulation of the center conductor of the coax, to provide both inductive and capacitive coupling. The standard arrangement for obtaining rf in reflected power meters is either by running a fine wire between the coax center conductor and the shield, or by running two conductors parallel to the center conductor, and using one of the conductors for the forward power pickup, and the other for reflected power. Both such arrangements are quite good up to about six meters, but at higher frequencies the picture changes. After much experimentation I concluded that the capacitive/inductive/coil coupling arrangement was the most satisfactory for two meters—at least in my own application. This system does not appear to cause an appreciable impedance "bump," and the measured power loss resulting from use of the two bridges is less than one-half watt.

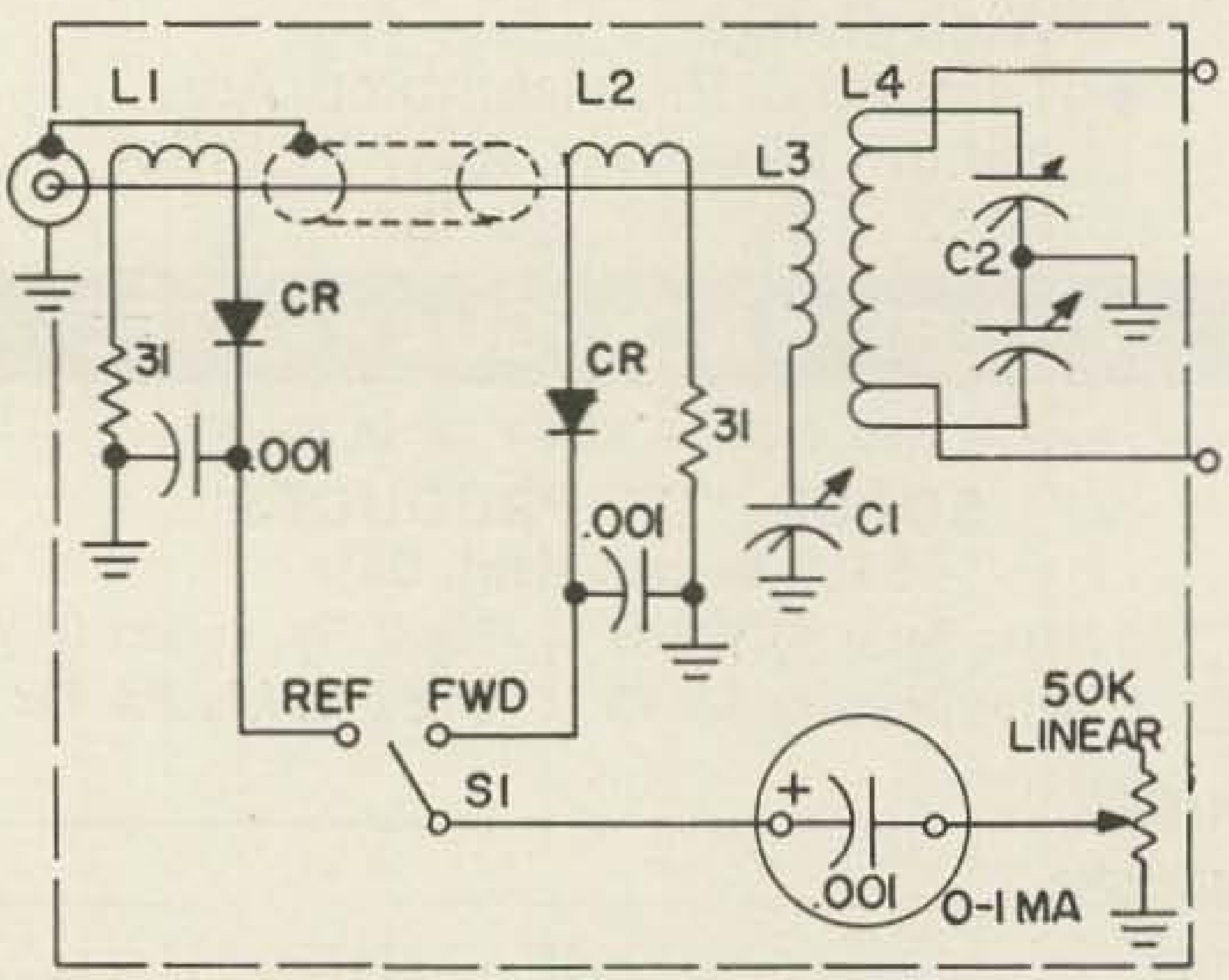
The accompanying photographs show the manner of front panel layout and actual construction of the coupler and bridges. The reflected power pickup coil is wound on the center conductor insulation close to the point



Interior of the two-meter antenna coupler—SWR bridge. The forward power pickup coil can be seen at the center of the unit. The two resistors shown make up the required 31 ohms. The forward power bridge is connected directly to the SPDT switch, while the reflected power bridge (top center, directly below the input connector) is connected to the switch through a length of shielded wire.

where the coax enters the cabinet; it consists of six turns of #26 enameled copper wire, wound clockwise. The shield braid of the coax does not cover the pickup coils. Rather, a heavy, low-inductance length of shield braid, approximately ⅝ in. long, connects the coax braid, leaving most of the pickup coil exposed. Completely shielding the pickup coil will decrease the rf pickup.

It should be pointed out that if the coils are not wound in the proper direction, and the resistors and diodes not connected to the proper ends of the coils, the bridges will not provide the desired indications—i.e., the reflected power bridge will read forward power, and vice-versa. The forward power pickup coil also consists of six turns of #26 enameled copper wire, but it is would counter-clockwise



around the center conductor insulation. In the case of the reflected power bridge pickup coil, the resistor is connected to the starting end of the coil (with reference to the input end of the coax), and the diode is connected to the opposite end, while with the forward power bridge pickup coil the resistor is at the finish end and the diode at the starting end (again with reference to the input end of the coax).

Let me make it clear that the reflected power bridge will provide relative indications of standing wave ratio—but will not indicate specific levels of SWR. When the coaxial cable between the transmitter and the antenna coupler is properly matched, with the antenna coupler, to the antenna feedline, the SWR will be 1:1 and the meter reading will be zero. The forward power bridge reads, obviously, rf going into the antenna coupler link, and is a valuable aid in tuning the transmitter for maximum power output. It is not in direct relation to the reflected power, as in the conventional Monimatch. My chief concern was to develop a device which would provide a relative indication of SWR, indicate rf output for transmitter tuning purposes, and act as a matching device; this unit does all three nicely.

My two-meter transmitter has a power output of approximately 15 watts, and this device was designed for that power level. If the unit is to be used with higher-powered transmitters, the rf pickup, of both bridges, can easily be decreased by reducing the number of turns in the pickup coils.

The meter is a 0-1 ma. unit, which is made in Japan and stocked by Henry Radio Co. (Butler, Mo. and West Los Angeles, Calif.), selling for only $2.95. It is entirely adequate for this application. The cabinet is a 6 in. by 6 in. by 6 in. aluminum utility box, black-wrinkle finished.

Much tinkering lead to the conclusion that 31 ohms is the optimum value for the bridge resistors, for a 72-ohm line, in this particular unit. It is quite possible that you will find that a value of resistance somewhat different will be required in your own bridge for use with 72-ohm line. For 52-ohm line, cut-and-try will also be required to determine the value of resistance at which the best null is achieved when the coax is removed from the antenna coupler link (within the cabinet, of course) and attached to a 52-ohm dummy load—the same way I determined the optimum resistance for the 72-ohm coax, using a 72-ohm dummy load.

The resistors shown in the photograph are 39 and 150 ohm units (one each in both the reflected power and forward power bridges) connected in parallel to achieve the 31 ohms. Naturally, if you happen to have a pair of 31 ohm ½-watt carbon resistors (for heaven's sake, don't use wire-wound resistors!) on hand, use them. I happen to have a large supply of 39 ohm and 150 ohm resistors, hence this combination to achieve 31 ohms.

The ratio of reflected power to forward power can best be adjusted by adding or subtracting turns on the pickup coils until a full-scale meter reading can be obtained in the forward position when the transmitter is tuned for maximum power output, and in the reflected power position when both the tuning and coupling controls of the antenna coupler are greatly detuned, with the antenna feedline connected to the antenna coupler output.

Maximum usefulness of the SWR bridge occurs when building or installing a new antenna. A dummy load of the same impedance as the antenna is connected to the output terminals of the antenna coupler, and then antenna coupler tuned for minimum SWR and the transmitter tuned for maximum power output, using the forward power bridge. The feedline from the new antenna is then connected to the coupler, and, without changing any antenna coupler or transmitter controls, the antenna is adjusted for the same minimum reflected power reading achieved with the dummy load.

If you are feeding your antenna with coax, the antenna coupler portion of the unit could be eliminated, with the bridges constructed as indicated. The coax shield braid would simply be stripped back for about ½ inch, in two locations, separated by three or four inches, and the pickup coils wound on the center conductor insulation. The broken shield braid would then be re-connected with a length of heavy braid or wire.

. . . W6TKA

C1—Hammarlund 50 mmf variable, MC-50
C2—E. F. Johnson Dual Section variable, 27 mmf. per section; 167-51
CR1, CR2—1N34A germanium diodes
L1, L2—6-turn pickup coil; #26 enameled; see text
L3—2 turns, #12 insulated, 1 in. dia. ⅛ in. spacing
L4—5 turns #12 tinned, ½ in. dia., ⅞ in. lg; tap 1½ turns from each end
S1—SPDT toggle switch

Parts Kit Available

The parts for this unit are available as a package from 73, Peterboro, N. H. Order W6TKA Kit $10.00

Replacement Power Transformer

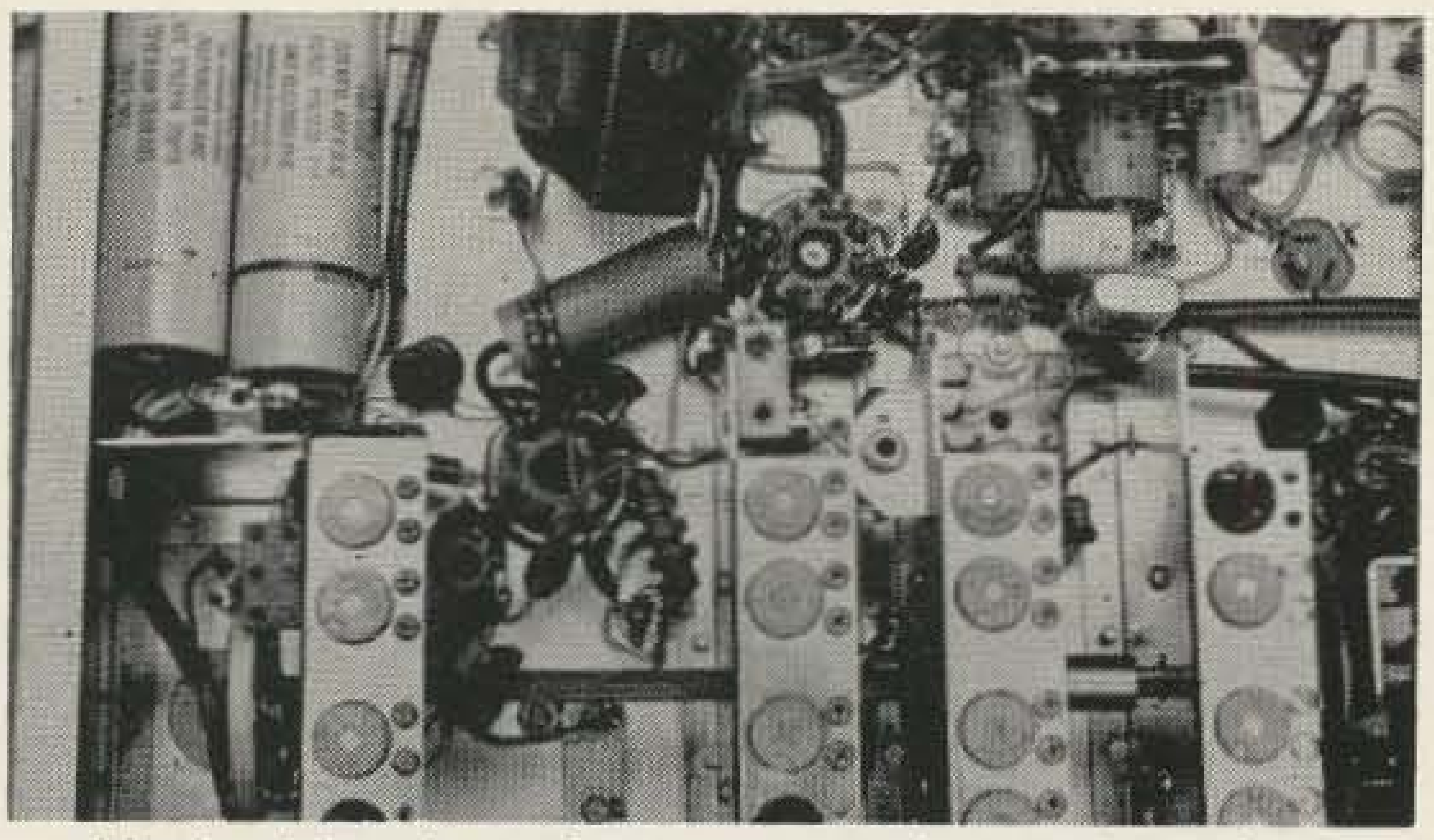
James Speck W5PPE
1609 Glenbrook Terrace
Oklahoma City 16, Oklahoma

Photos by K5EVI

View of modified power section showing more or less unmodified appearance. The 6DE4s are in the top center of the photo.

One Thursday evening, waiting on a schedule, the power transformer in my Gonset GSB-100 suddenly shorted, putting the station off the air. A telegram to Gonset brought prompt word that they could not ship for four weeks! A look at the circuit showed that the transformer was a special job with a 600-0-600 secondary tapped at 300-0-300 with a 150 volt bias tap. Several calls quickly confirmed that nothing remotely resembling these ratings was available locally. Drastic measures were called for if Saturday's sked was to be met.

Since this same circuit is common to many of the present crop of transmitters, AM as well as SSB, this solution may come in handy to you. A TV replacement power transformer was bridged for the high B voltage, and low B



Underside view of power supply section after modification. The 6DE4 sockets are top center. The bias transformer is dismounted from its right standoff to show the silicon rectifier strings.

voltage (one half the high) was taken from the secondary center tap. This is a common trick in transistor dc to dc converters, and took care of the high voltages. A separate half-wave 150 volt transformer was used for the bias.

The TV replacement unit used was the Merit P-2884, rated at 324-0-324 volts at 270 ma, with 5 volts and 12.6 volts center tapped at 5.6 amp windings. The mounting shell was not exactly suited for this mounting, but the new unit was the same size as the original, so the shells were swapped, which incidently

(Turn to page 88)

The Visitor

John Costas W2CRR

It was a normal weekday evening; the wife was busy with kitchen chores and the children were concerning themselves with homework or television, depending upon age. I had only given the evening paper a passing glance in preference to the February, 1963, issue of QST which had arrived that day. The W2AOE article on communications practice in the HF bands was especially interesting. In brief, W2AOE argued that a.m. should be made illegal starting January, 1964, the c.w. bands should be reduced by a sizeable factor and the phone bands should be increased with only s.s.b. operation being permitted. The QRM problem was becoming intolerable, argued W2AOE, and the only way to solve this problem was to conserve our precious spectrum space by reducing transmission bandwidths. Bandwidth-wasting schemes such as a.m. simply had to go and legal action would have to be used for the good of the majority. I had gone over this article for the second time and was rechecking the QRM arguments under the "Band Loading Capacities" and "Channel Loading" sections when it happened.

I don't quite know how to tell the rest of this story. I would like to forget the whole affair, but I can't because it has forced me to make a decision. What happened, you ask? I had a visitor. Not just a normal-type visitor but, as it turned out, this man who came to see me was none other than Larson E. Rapp! Worse yet, Rapp was not his normal, witty, amusing self. The Larson E. Rapp I had to contend with that night was a very angry and revenge-seeking Larson E. Rapp. As soon as we were alone in my study, Rapp wasted little time in telling me his troubles.

"The League has betrayed me," said Rapp with rising anger. "They have dumped me and are letting just anybody write my type of material."

"Come on now, Larson," I stammered, "Najork's 'Templeton Case' piece was pretty good, wasn't it?"

This turned out to be a poor job of mind-reading on my part as evidenced by Rapp's screaming response.

"Costas, don't try and humor me at a time like this! How stupid do you think I am? The 'Templeton Case' is not my type of stuff. You and I both know that there is nothing impossible about the general situation Najork described, even though the average amateur might consider this type of material as pure science fiction."

By this time Rapp was standing and had just begun to pace the floor when he whirled in my direction and shouted:

"It's the W2AOE article in the February issue I'm talking about. Haven't you read it?"

"Yes, I just finished it," I said, and added with some reproach, "and I don't see where this article has the slightest resemblance to your material. If this article is the cause of your complaint, then you're being very unfair to the League staff."

This apparently stunned Rapp, for he sat down, looked at me with some pity in his eyes and let me continue:

"W2AOE is pointing out that QRM levels are getting bad and the only way to meet the problem is by reducing transmission bandwidths. If this requires drastic action such as making a.m. illegal, then we should petition for such action. What's wrong with that?"

I was prepared to continue, but tears started to form in Larson's eyes. His whole attitude was changing from that of violent aggression to frustration and defeat. It took a few minutes for Rapp to compose himself, after which he spoke in a calm, even manner.

"John," he began, "what you just said only proves my point because, obviously, you too have been taken in. That shows how cleverly written the article is. Not only are other people writing my stuff, but they are even doing a better job than I did. For example, who is complaining about a.m. operation on the phone bands?"

I took a minute to think this one over but before I could answer, Rapp continued:

"It's not the c.w. men because allocations prevent conflicts there, and the a.m. boys can hardly complain about a mode they are using themselves, right?"

"Sure," I answered, "it's probably the s.s.b. boys."

"How can it be?" countered Rapp, "We all know that s.s.b. has a 9db advantage over a.m., right? Now with this much power advantage it's the a.m. boys who should be screaming for help, not the other way around."

"Wait a minute, Larson, what about the spectrum waste due to the a.m. carriers? W2AOE makes a good case against that."

"How much spectrum space does a carrier occupy?" he asked with a trace of sarcasm.

"Anywhere from practically zero to a few cycles depending on the oscillator, the condition of the ionosphere, and the number of hops."

"Right!" Rapp hit back, "So we can easily notch carriers out at the receiver. Now if we ban a.m. and force all these guys to use s.s.b., the power they were putting into a few cycles which could be rejected at the receiver will now be spread over several kilocycles with no chance for getting rid of it. This will make the QRM problem worse, right?"

I must admit that Rapp now had me in a corner, but rather than show my temporary confusion I went on the offensive.

"Come on, Larson, what point are you trying to make?"

"Simply this," he shot back, "the true facts are that no one has any reason to complain about a.m. and, furthermore, conversion from s.s.b. back to a.m. would do much to reduce QRM. On top of all this, it turns out that it's the a.m. boys who have a case to present before the FCC because of the unfair 9db advantage of s.s.b. W2AOE makes everything come out backwards with a very logical presentation. If this isn't my type of material, what is?"

Rapp was now becoming more angry and I couldn't think of a good counterargument, so I tried changing the subject slightly.

"Look, Larson, maybe W2AOE did slip in a bit of sophisticated humor, but the rest of his presentation is certainly quite serious, especially those tables and the calculations showing the average number of signals in each channel for different operating modes."

That did it, Rapp really went on the attack now.

"John, I'm really beginning to wonder about you; didn't you catch the gimmick there?"

"No," I said with some confidence, "that part looked pretty sound to me. Furthermore, I went over this portion of the article with extra attention."

"OK," said Rapp (he was laughing now which made me feel a bit foolish), "you go over that material with me and I'll show you how you were taken."

"Well," I started, "W2AOE points out that the jumble of noises and chatter out of a receiver, tuned to a particular frequency, is due to a large number of signals falling in the passband of the receiver. Also, he points out that this random addition of many signals represents a QRM power level which can be measured by the receiver S-meter. OK so far, Larson?"

"Sure, sure that's fine, keep going."

"Then an estimate of the average QRM level is made by dividing the total number of stations on the air in the band by the number of channels in that band. In this way W2AOE obtains a number Q which represents the average number of signals per channel. The lower the Q number the higher the probability of a successful QSO because a better 'hole' in the QRM is likely to result. So the object is to use modulation techniques which give the largest number of channels and consequently the lowest Q values which seems___"

"Wait a minute," Rapp broke in, "you don't need to go any farther, you've already been hooked."

"How?"

"I'll tell you how," he barked, "W2AOE first discusses QRM as being caused by a level of interference *power* on the desired channel, then he neatly switches from power considerations to Q, the average number of signals per channel. The two are not the same. What he should do is multiply the average number of signals Q by the average power per received signal P to obtain an estimate of the QRM level. It is not Q, but the product Q times P that should be considered. Am I right?"

"Sure, that would be more nearly correct, but will it make any difference in the final conclusions?"

"It makes all the difference in the world." Rapp countered, "Just take W2AOE's example of all-s.s.b. operation on 20 meter phone. Estimate the average QRM power level to be expected in a given channel by using Q times P. Then work the whole problem over, but this time assume that all the s.s.b. exciters in use had a simultaneous malfunction so that, say, 10 s.s.b. signals were being generated and fed to the linears instead of the normal one."

"That's a screwy example, Larson," I said, "Do I assume that all these spurious s.s.b. signals fall randomly within the band? If so, the answer seems obvious. This will have the same effect as a ten-to-one increase in the number of stations on the band and the QRM per channel will be ten times as bad on the average."

"OK, wise guy, you go ahead and work it out while I go down and talk your wife into some coffee and dessert. Call me when you've got an answer."

As Rapp left the study, he smiled. It was not a pleasant smile, which bothered me but I was glad to be alone so I could collect my thoughts. I opened QST to page 54 and started to work.

Following W2AOE's channel loading arguments we may define:

Number of s.s.b. signals on the band=N

Number of s.s.b. channels available=C

Average number of signals on each channel=Q

Average power per signal as received=P

Average QRM power level per channel=I

Now the average QRM power level per channel will simply be equal to the average number of signals per channel times the average power per signal as received. Thus,

$$1 = Q \times P = \frac{N}{C} \times P$$

which is the same result obtained by W2AOE except for the multiplying factor P.

As I looked at the above equation it began to dawn on me that Rapp had hit upon something which is rather obvious after a little logical reasoning. If straight s.s.b. operation is first considered, certain values may be assigned to N, C and P and I may be calculated. The actual number values really aren't important. Now if all the s.s.b. exciters in use are assumed to have a simultaneous malfunction so that, say, K s.s.b. signals are generated instead of the normal one, then there will be K times as many signals on the band. However, the average power of *each* of these signals will be divided by this same factor K since each linear must now split the available power between the K signals now being amplified. This means that the average power per signal as received will be divided by the factor K. Thus, for Rapp's rather wild example we have

$$I = \frac{(KN)}{C} \times \frac{(P)}{K} = \frac{N}{C} \times P$$

which leaves the average QRM power level per channel unchanged!

Stunned at the result, I quickly called Rapp, showed him my calculations, and was answered with,

"Sure, that's exactly what I came up with. You've done it right."

"But, Larson, look what this means." I pleaded, "If every station uses, say, ten times the normal s.s.b. bandwidth and the QRM power level on the average in each channel is left unchanged, what is the point to bandwidth conservation? In fact, the results seem to show that in the heavily-congested ham bands the average QRM power level in any given channel is determined, not by the bandwidth of each signal, but by the total power being poured into the band. The form of each signal or the type of modulation makes no difference, it's the total power being put into the band that is important. If this is so, then we've been spending a lot of money____"

A look of fear came over Rapp's face. He silenced me with a quick motion and got up to close the door. Sitting down, he pulled his chair close to mine and began talking in a near whisper.

"Look, John, you had better watch that kind of talk. What you say about the futility of bandwidth conservation for ham operation may be quite true. I've tried not to think about that aspect of my results because it's just too dangerous. I've stuck my neck out on a lot of subjects as my April QST efforts in years past prove, but I'm not about to get mixed up with this particular issue."

"But, Larson, we may have something here that is vital to the future of amateur radio. We may be wrong but at least we can study this and present our results to the ham fraternity for discussion and ____"

The fright in Rapp's face became more evident so I stopped. He continued, still whispering,

"You don't understand the situation, John. We're playing with dynamite on this one. Look, everyone agrees that the way to beat interference in the ham bands is to make more efficient usage of the available spectrum.

Everyone also agrees that the obvious way to do this is to convert to narrower-bandwidth transmissions. So we've had a big drive on to get everyone to shift over to s.s.b. Now this has cost the rank-and-file boys a lot of money; just look at the prices of s.s.b. gear these days. Do we dare even hint that this is not the answer? Furthermore, the whole thing has spread beyond ham radio. A lot of awards and honors have been given out by professional societies and a lot of big names have been built on the 'narrow-the-bandwidth-and-save-the-world' kick. No, John, pushing against this sort of thing is out of the question. Take my advice and just forget the whole thing."

Now I began to realize that Rapp was more than a good technical man and a clever writer. He was obviously an astute judge of people and political situations.

"Look," he continued, "we could be drawing the wrong conclusions from our work. The 'narrow-the-bandwidth' approach has never been challenged by anyone of any consequence. The boys at M.I.T., Stanford and other such respected places have gone right along, haven't they?"

"Yes," I said in resignation, "we could be wrong."

"No, we *are* wrong. Is that settled now, once and for all?"

I nodded in agreement and asked, "If narrower bandwidth is the answer, the W2AOE article in this regard is serious and then the League isn't exactly pushing you out of a job."

Rapp's mood now changed from fright back to anger as he said, "No, they are dumping me for sure. Don't you see, W2AOE gets the right answer by using the wrong approach. Remember that QRM argument where he switched from power considerations to average number of stations per channel? That was very clever. My gimmick was to use the right approach and arrive at a wrong answer. He does this too in the arguments against a.m., but he goes me one better in the QRM portion by getting the right answer in the wrong way. I don't mind so much being dropped by QST, maybe my stuff was wearing a little thin. But you would think that the boys at West Hartford would at least have given me a chance when they decided to start running my type of material again. But don't worry, I'll get even."

His last sentence was said coldly, without emotion. This man was surely bent on revenge and I wanted no part of any plot he might have cooked up against the League. So I tried changing the subject again.

"Larson," I started, "we have now agreed that going narrow-band on transmissions is obviously correct, but I hear a lot of grumbling these days on the phone bands. The boys are complaining that things are getting hopeless even with s.s.b. I heard one guy the other night making fun of those ads that show a ham pleasantly working the world from his fireside using a cute little 100 watt p.e.p. job, barefoot with a compact antenna."

"That's exactly it!" said Rapp excitedly, "After a guy goes into debt for two or three years to convert from a.m. to s.s.b., he expects results, not more of the same frustration. Sure this is becoming a problem and it's obvious that someone had better come up with a solution in a hurry. Now—and get this—I, Larson E. Rapp, ex-writer for QST, have the answer. I, not the League, will come to the rescue of ham radio."

I had put my foot right in it. It was no use trying to stop him, he was too excited.

"Look, our ham population is growing and we've got to reduce signal bandwidths to make more room for the newcomers, right? So what does the League push? They push s.s.b., that's what. All that cost and complexity compared to a.m. for a lousy two-to-one reduction in bandwidth. Peanuts! Too much investment for too little gain in spectrum usage. What I propose will offer a twenty—do you hear—a twenty-to-one reduction in phone signal bandwidth relative to a.m. The answer, my puzzled friend, is v.s.t., VOCODER SPEECH TRANSMISSION!"

Up to a point I thought Rapp was kidding, but his last sentence was certainly no joke. The Vocoder is a device developed by the Bell Telephone Laboratories. It takes the speech signal, analyzes it and puts out narrow-band control signals. These control signals, *not the speech signal itself*, are transmitted to another Vocoder unit at the receiving end which *recreates* the speech signal from the control signals. The bandwidth needed for transmission of the control signals is only about 300 cycles per second or one-twentieth of the bandwidth required for a.m. voice. Furthermore, the Vocoder is no new laboratory-type gadget; it really works. I've heard Vocoder speech which required only a 300 cycle channel and it is very good; you can hardly tell the difference between the Vocoder output and the original speech. So Rapp had done his homework and had come up with something that had to be taken seriously.

"Yes, John," Rapp went on with a no-nonsense tone in his voice, "s.s.b. has got to go and

give way to v.s.t. We can no longer tolerate the waste of our precious spectrum space by using a system that requires ten times the bandwidth of v.s.t. All right-thinking amateurs will convert voluntarily from s.s.b. to v.s.t. As for the rest, well, we will give them a reasonable time to make the change and after that we will petition the FCC to make s.s.b. phone illegal. One of these days we'll have to get on the ball and ask the FCC to give the s.s.b. boys one year to go v.s.t. or follow 'spark.' "

"How about the cost of v.s.t., Larson?" I asked as I pulled some paper out of my desk drawer and began to take notes. This was getting interesting.

"The cost will be more than for s.s.b., but consider what you are getting for your money. A ten-to-one reduction in bandwidth, and remember, bandwidth is the key. We can't buy bandwidth but we can buy the equipment which conserves the precious amount of spectrum space we do have. Besides, the cost to amateurs will be reduced because I'm forming a company to develop v.s.t. equipment for the military, but the same techniques will be applicable for the ham and commercial markets. In fact, I'll probably sell the ham v.s.t. line at a loss, at least at the start. So you see, with what amounts to a government subsidy, I can materially reduce the cost of v.s.t. for the amateurs."

"But, why sell to the amateurs at a loss? Is this an act of philanthropy on your part?"

"Hardly, it's really a two-pronged marketing attack. You convince the amateurs that v.s.t. is good because you can show them that the military is spending millions on the system. At the same time you can point out to the military that the amateurs are using the system so that not only is v.s.t. effective, but it can be operated and maintained in the field without trouble."

"How effective will v.s.t. be in operation as compared to s.s.b.?"

"All I can say here is that v.s.t. receivers need only one-tenth the bandwidth of s.s.b. receivers so that the input noise or interference power is reduced by a factor of ten."

"Are you saying that v.s.t. has a ten db power gain over s.s.b.?"

"It sure looks that way, but I'm not going to make any flat statement in that regard. However, once the bandwagon starts rolling there will be plenty of people who will show that this is the case."

"Larson, I go along with amateur promotion of v.s.t. because we just might profit from the tremendous bandwidth saving being offered. However, shouldn't you go a little easy on the military end?"

"What do you mean by that?" asked Rapp with obvious annoyance.

"Well," I said, "what would happen in combat if an enemy s.s.b. station were working on top of one of our v.s.t. channels?"

"The v.s.t. channel would probably be in real trouble, but the s.s.b. circuit could go right on by simply notching out the much narrower v.s.t band of frequencies."

"Wait a minute, Larson, you're now killing yourself in the military market. How can any branch of the service dare use v.s.t. if it won't stand up to s.s.b. under combat conditions?"

"John, I'm not going to make any claims as to the combat-worthiness of v.s.t., it may perform poorly under such conditions."

"Then how do you crack the military market?" I asked.

"By simply telling them the simple truth. With v.s.t. they get ten voice channels where they now have one with s.s.b. That will sell it, don't worry."

"But what if they test v.s.t. under simulated combat conditions against s.s.b. interference and your system falls on its face. Then what?"

"That's easy; this just proves that s.s.b. causes unnecessary interference and gives added emphasis to the need for eliminating such interference by accelerating the conversion from s.s.b. to v.s.t. Don't forget, by this time the more progressive hams who have converted to v.s.t. will also be yelling for the removal of s.s.b. signals from the amateur bands. So my job will just require sitting back and letting nature take its course. Remember, I wasn't being sentimental when I planned on selling the v.s.t. ham line below cost. You've just got to think ahead to stay ahead in business, my boy."

"Look, Larson, these military people for the most part are dedicated and public-spirited individuals. National defense has gotten pretty scientific these days and specialists like you and me can easily put one over on a guy who has so many other things to worry about that he rarely finds time to keep up to date technically. Remember, we work at our specialty 8 to 12 hours per day. Don't we have an obligation to our country and the military to try and steer them in what we think is the right direction? I know it sounds corny, but doesn't patriotism enter into the picture at all?"

This brought on an embarrassing silence, so I had no choice but to pick up the conversation again.

"Larson, the research centers and universities will look into v.s.t., how will you make out there?"

"Great, John, just great. The scientific community will eat this v.s.t. stuff right up. They liked s.s.b. because it was fairly complicated, but about the only high-powered math you could apply to s.s.b. was Hilbert Transform Theory and, of course, the usual Theory of Stochastic Processes. But with v.s.t., it's a whole new world! Just think of the way a Vocoder works! You've got Man-machine Relationships, Dynamic Programming, Bionics, Self-Optimising System Theory, and probably a few new ones when government-sponsored v.s.t. research really gets rolling. Yes, the scientific community will be one of the biggest boosters of v.s.t., that's for sure."

By now I was convinced that Rapp and his v.s.t. scheme were going places.

"Larson, I'm sold. When do you plan to start active promotion of v.s.t.?"

"Just as soon as the sunspot cycle goes on the rise again, naturally."

I didn't quite understand this answer but rather than reveal my ignorance, I nodded in agreement.

At this point Rapp cut off any further questions and made me a business proposition. I won't go into the details because this would violate business ethics. I can tell you that Rapp has lined up some impressive financial backing on Wall Street and he has a Madison Avenue advertising firm already at work on the promotional aspects. He offered me a chance to go in with him and left me a contract to sign. My share appears to be relatively small but there are some stock-option and trust fund provisions that have definite capital gains and other tax advantages. He told me that the contract had to be signed within 60 days and then left.

By now it was well past midnight and the family had long since gone to bed. I couldn't sleep; Rapp had given me far too much to think about. I went downstairs, poured a drink and sat at the kitchen table to try and clear things up in my mind.

How much of what Rapp had said was correct and how much was wrong? Also, if some of his statements were in error, was this accidental or was he purposely trying to mislead me? Many of the arguments advanced by Rapp appear to contradict points of view that most of us have long accepted as being obviously correct. Yet when one gives some of Rapp's arguments some thought, it becomes difficult to reject what he says. Especially bothersome is this whole question of whether bandwidth conservation is really important or even helpful when heavy congestion is encountered. Rapp knew more than he was telling here, that was obvious. Our calculations seemed to indicate that the QRM power level per unit bandwidth, on the average, is not affected by the bandwidth of the transmissions. Yet narrow bandwidths are desirable as c.w. has proven for years. But then there may be something wrong with comparing phone and c.w. since the information or word-per-minute rates are drastically different. *Could it be that the information rate is the fundamental quantity and not the bandwidth?* If we got phone bandwidths down to a few hundred cycles, this should reduce QRM because of the very narrow passband needed for reception. But would the phone system now be so much more sensitive to interference that we would still be back where we started? No, Rapp is right, it is best not to pursue this line of reasoning. After all, if there were something fundamentally wrong with bandwidth conservation for amateur and military usage, the boys at Rand or M.I.T. or someplace like that would have caught it by now.

So now I'm convinced bandwidth conservation is important and has a bright future. What about Rapp's v.s.t. scheme? I know enough about the Vocoder to realize that the system really works. Furthermore, it was developed at Bell Laboratories and that's also where s.s.b. originated. But if we push v.s.t. and it goes over big, this could result in the outlawing of s.s.b. on the ham bands. This might be hard on some of the boys, but after all, one has to be willing to pay a price for progress________ I guess.

All of this still leaves me with a decision _____the contract Rapp left expires in 60 days. What do I do?

. . . W2CRR

73 Reviews

The Paco Model G-15W Grid Dip Meter

Jim Tonne W5SUC
% KBIM, Box 910
Roswell, New Mexico

The grid-dip meter is a most useful accessory around the ham shack. Instrument manufacturers have obviously recognized this to be a fact, for the latest issue of Electronics Buyers' Guide shows 15 companies fabricating the little gems.

This is not the place to explain what a dipper can do. For the curious we seriously recommend a quick check with your favorite handbook. For the better informed we here present data on the PACO Grid-Dip Meter.

Condensed Specifications

Frequency range: 400 kc to 250 mc.
Functions: Grid dip meter, absorption wavemeter, modulation indicator, and other uses related to these three basic functions.
Size: 7½ inches long, 2¾ inches wide, 2½ inches deep. One-handed operation.
Power: 115 volts, 60 cycles, approximately 10 watts.
Shipping weight: 3 pounds.

Grossly . . . .

Condensed specifications are shown in the accompanying table. This will show the unit to be more or less typical of units in this price range. How does the device differ from the competition?

Removing the little gem from its packing (very well packed, by the way), I immediately found myself holding it just like the pictures shown. The size is such that it fits into one's hand very naturally and easily. It has a heavy feel—I was under a first impression of a steel case. It's actually of fairly heavy aluminum, with a pretty hefty coat of grey paint.

For clarity, the various scales are printed in alternate bands of black and red. These are clearly indicated by alphabetical letter. The corresponding coils are color-coded in a manner similar to the resistor code: the first coil is brown, the second red, third is orange, etc. So, going on the assumption that you know the color code, grabbing for the proper coil is child simple.

Functions

The device works well. The well-written instruction manual shows 15 different things that this little machine will do. One of them is to give an indication of modulation percentage. This is unique with PACO, and is obtained simply by altering the grid circuit configuration. It is particularly suited for telling the ham exactly what he wants to know: if he is at or near 100% modulation.

A phone jack is included so that the unit can be used as either an oscillating detector or for audibly monitoring phone transmissions.

The usual diode/dipper switch is included. This unit seems to have higher than average sensitivity in the diode position. Specifically, a two meter rig with a pair of 2E26s in the final gave a quarter-scale deflection of the meter at a distance of about 6 inches. I suspect this is due to the half-mil movement and the lower than average value of grid resistor, 10K ohms.

Another unique thing, or at the very least unusual, is the inclusion of a serial number on the unit. Especially among the smaller kits this is probably a worthy innovation.

On the subject of physical examination, it might be worthwhile to point out that the internal appearance is neat. But one must remember that the oscillator section of any grid-dip meter is invariably set up for *very* short leads in order that the thing will function well on the higher bands.

The instruction book seems to cover every conceivable point. Uses, trouble shooting, maintenance, guarantee (very reasonable terms, 90 days) and parts list are included. 13 pages cover 15 suggested uses, with the understatement that "other uses will become apparent." A chart included so that unknown capacities from 50 mmfd to .007 mfd can be measured.

Comments

There is a minor set of small false dips on the highest range, but these are, first, insignificant, and second, typical of every dipper I have seen.

The meter zero adjustment is a bit sensitive, but this is a result of designing the unit so that in effect the scale is expanded. As a result, the dips are quite pronounced and obvious. The byproduct is a seemingly overly-sensitive zero adjustment.

One-handed operation is not only feasible, but practical.

Frequency accuracy is within a few percent on each of the 4 ranges checked.

We had the gadget about a month or so and finally managed to drop it. As luck would have it, it landed on the coil—on a cement floor. Now the PACO might be rugged, but not *that* rugged! A new coil was ordered, and less than a week later we had it. Quite a change compared to some manufacturers, and most comforting to know that the company stands behind you. . . . W5SUC *a technical discussion*

The Cubical Quad

L. W. Van Slyck W4YM
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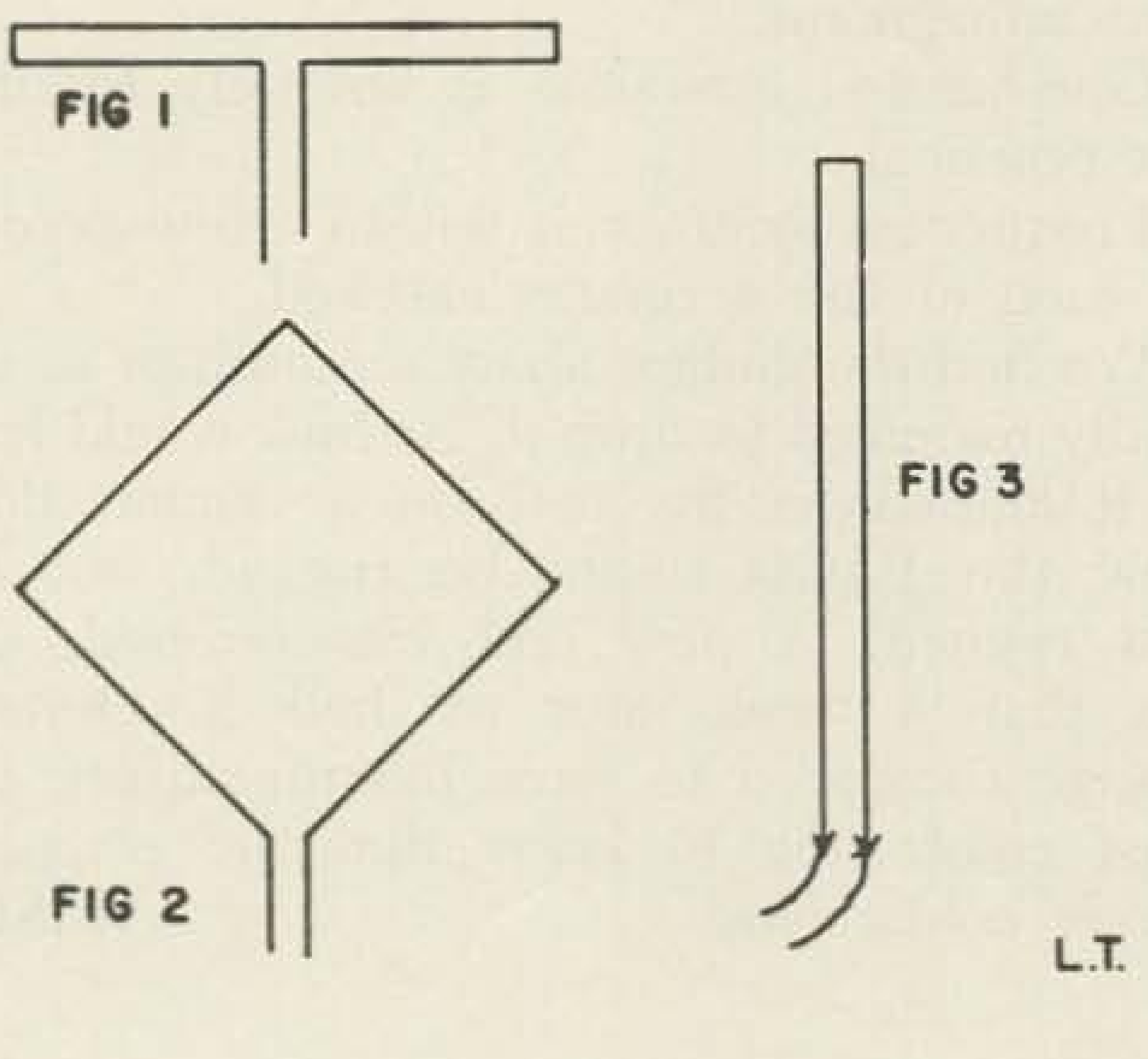
Temple Terrace, Florida

The cubical quad is a natural development of the folded dipole. Observe Fig. 1. This is a folded dipole. The input impedance is approximately 300 ohms. Now stretch the sides of the folded dipole out so the included angles formed are 90 degrees. Fig. 2. This is now a quad, and the input impedance is approximately 125 ohms. Continue to stretch the sides out and we finally have a shorted half wave line, with an input impedance of approximately zero ohms at resonance. Fig. 3.

We are interested in the quad wire, stretched only half way out, so that a square is formed. As noted above, the input impedance of this configuration is approximately 125 ohms. Now add a reflector ⅛ wavelength (about 8 feet) behind the radiator portion, and the input impedance drops to approximately 75 ohms, a good match for RG11U co-ax.

The power gain of the radiator portion of the quad only approximates 1 db over a dipole. The power gain of a quad with a reflector approximates 7-8 db over a simple dipole. With a properly adjusted reflector stub, or coil, the F/B ratio approximates 25 db. The F/S ratio is even higher.



The Q of a cubical quad is low. The Q is the ratio of the reactance of an antenna to it's radiation resistance. The advantage of a low Q antenna is that it is less frequency selective, and therefore easier to feed. If the SWR of a quad is, or approaches 1:1 at resonance in the middle of an amateur band, then the SWR rises very slowly as the transmitter is tuned towards the ends of a band. This is a distinct advantage.

It must be understood that the figures mentioned above concerning F/B ratios and gain figures, may vary considerably from those mentioned, due to local conditions. They may be greater or less. The height above an effective ground, the presence of nearby objects, etc., all affect these figures, either for better or for worse.

The half power point of a quad is approximately 75 degrees. It is truly a broad band beam. Of course, the F/B ratio will vary as the quad is tuned away from resonance, but it varies rather slowly, and may be considered as good at any place in the amateur band, if the quad is resonated at the center of the band.

The total length of wire for a 20 meter quad should be 844" for the 15 meter quad 575 inches, and for the ten meter quad 414 inches.

These figures change somewhat when a quad is built for three bands on a single framework, as shown in the diagram, Fig. 4. In general, the sides of the quad for 20 and 10 should be modified somewhat, and made somewhat less, due to the fact that the 10 and 20 quad wires are pulled in to the feed point of the 15 quad. This reduction, in the case of the 20 meter quad is about 4 inches per side less and in the case of the 10 meter quad, the reduction in length is approximately 2 inches. If this is not done, the bands in question will resonate somewhat lower in frequency. This will not materially effect the operation, however, and may be ignored in the practical case.

14.0-40 ohms	14.2 -70	14.4 -80
21.0-50 ohms	21.22-50	21.35-50
28.0-50 ohms	29.0 -50	30.0 -80

Fig. 5

The quad is particularly suited to multiband construction, as shown in Fig. 4. A single framework will hold all three quads very nicely. In fact, the three band model is more rigid than a single quad. There is no noticeable reaction between quads when the multiband quad is used.

A single feed line may be used to feed all three quads, and no switchover system is needed or desired. The input impedance, as measured on a three band single feed line system, is as shown in Fig. 5. This indicated that the feed line may be either RG8U or RG11U. Use 8U if xmtr output x req. The SWR on the three bands has been measured as indicated in Fig. 6.

A quad may also be constructed for 40 meters, but the size is such that it first must be determined whether or not there is room for erection. The length of a side would be approximately 35 feet and the boom length would be 16 feet.

The reflector portion of a quad must resonate at approximately 5% lower than the radiator. This may be accomplished by the use of either a tuning stub, or a reflector coil. The reflector coil is compact, and needs no arrangement for holding the ends. A stub is somewhat easier to tune correctly, but is more cumbersome, and needs an arrangement for holding the stub in place. A stub arrangement is a likely arrangement for a single quad, but the coils are much superior for a three band quad, due to the complicated lash up necessary where three stubs are used. A reflector coil may consist of several turns of wire wound on a one inch diameter, non-hygroscopic tube. The same wire as used for the quad elements may be used for the coils. No. 14, enamelled copper wire is recommended, as it will carry a full kilowatt with ease.

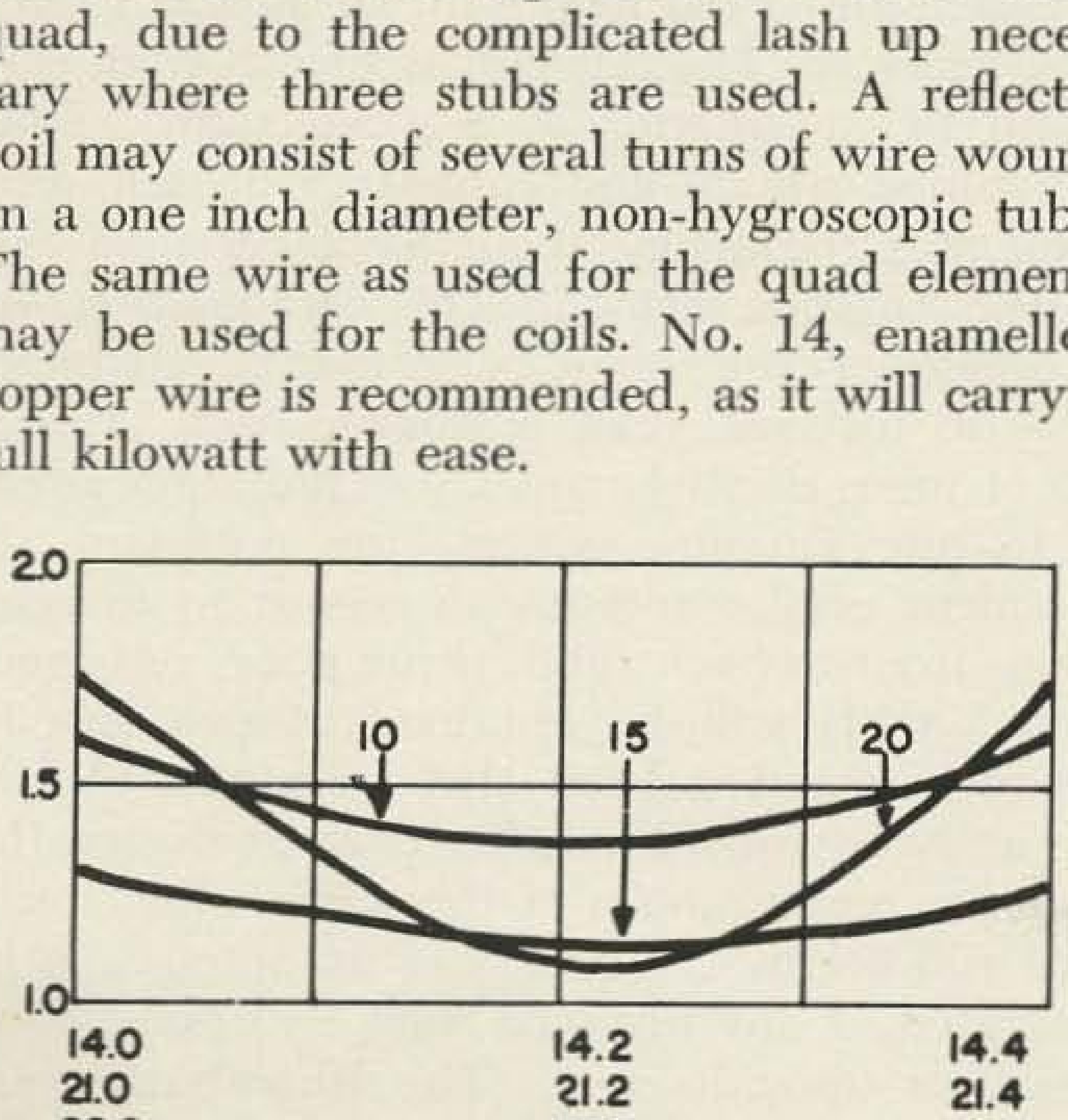


FIGURE 6 L.T.

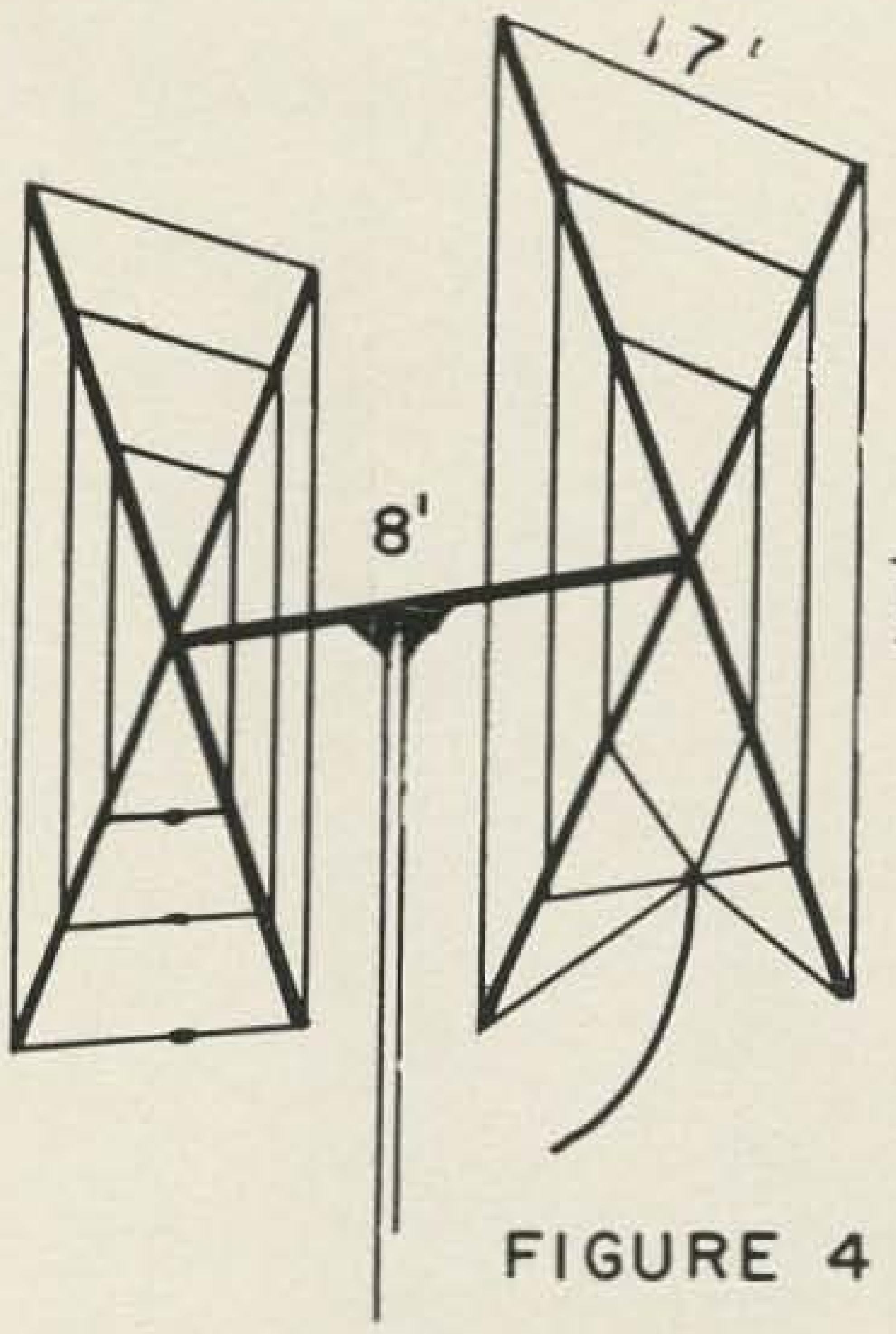
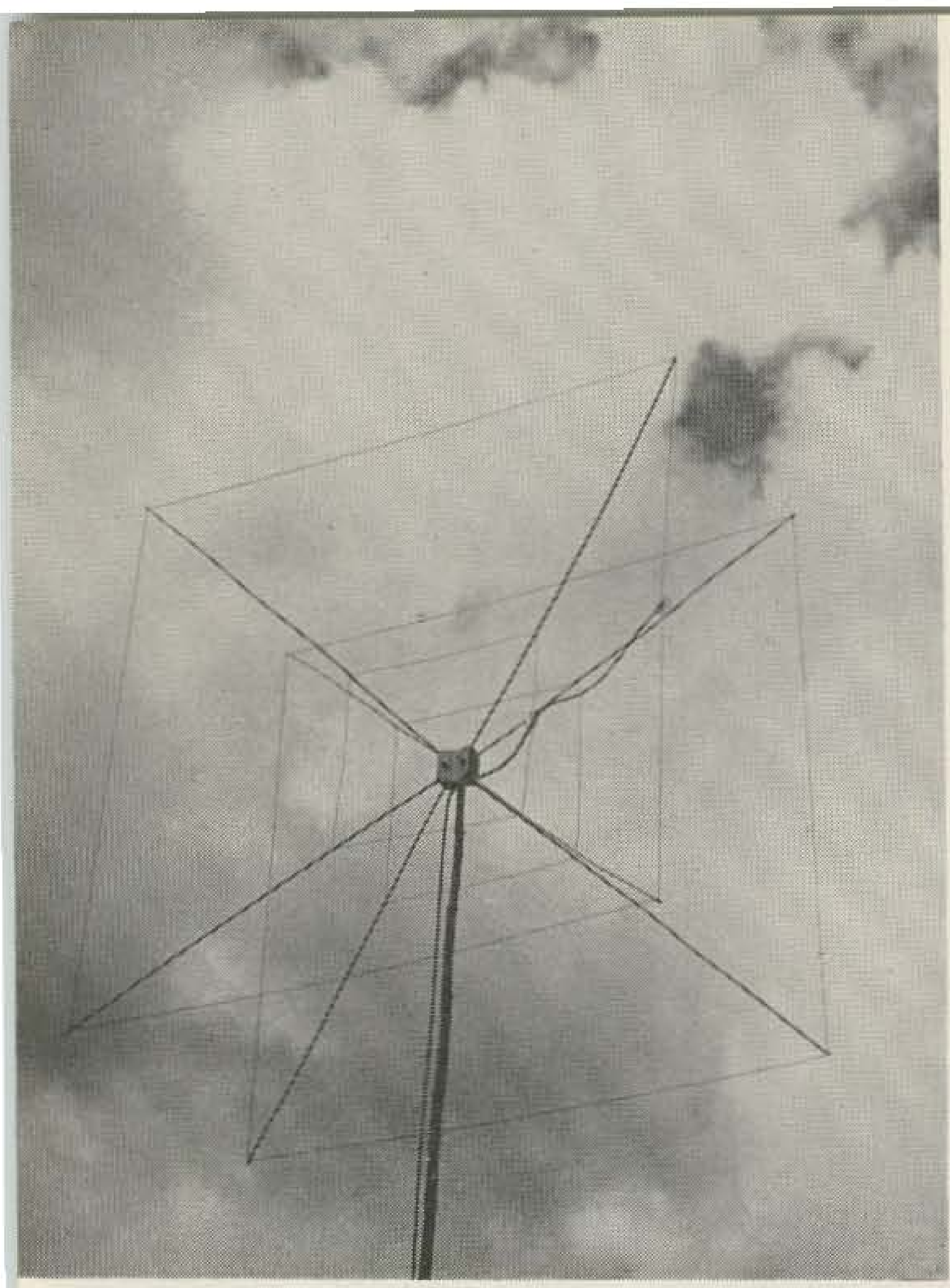


FIGURE 4 L.T.

Quad spreaders may be either of bamboo or fiberglass. The bamboo spreader will last for several years if properly treated with several coats of alkyd resin enamel. Another way to treat bamboo is to spiral wrap it with plastic tape, wrapping from the small end. It is well to dab the bolts which hold the quad wires with a bit of roofing cement to prevent entry of water in this case.

Fiberglass spreaders are of course, ideal for spreader arms. They deteriorate but little from the weather. They are even lighter than the bamboo, and are extremely resistant to lateral stresses, although they can be crushed by dropping a heavy weight on them. Of course, they are absolutely straight, while bamboo is not. They are more expensive, of course. They need no treatment against the weather whatsoever. Bamboo should be bought in 20 foot lengths, and cut to the 12½ feet necessary for the spreader arms, in order to have a reasonably large tip at the outer end. Curved washers should be used to fasten the bamboo or fiberglass to the end spider, and they should also be used in either the bamboo or fiberglass where the quad wires cross. This distributes the pressure of the bolts over a greater area than if flat washers were used.

A quad is truly an outstanding performer on the amateur bands. It possesses all the desirable qualities of a good beam, namely, reasonably low cost, good gain, good F/B ratio, and low Q tuning characteristics. It is an easy beam to feed, and seldom, if properly made and adjusted, exhibits appreciable reactance at the load. Check the signals, on the air, of amateurs using cubical quads. They are almost invariably outstanding. . . . W4YM



A Two Band VHF Quad

Joe Williams W6SFM
4150 Beck Avenue
North Hollywood, Calif.

Photo credit: Bob Jensen W6VGO

The Quad is no longer a "new" antenna but it is showing every sign of never becoming an old antenna. The unique structure and performance of these beams has made them a subject and the objects of continuing interest to radio amateurs. In short, the quad seems to be here to stay. The first cubical quad was devised by W9LZX while he was associated with missionary radio station HCJB near Quito, Equador. That first quad was cut for an International Short Wave band and was beamed on the United States; later W9LZX, using the call HC1JB, used a quad on the 20 Meter ham band. The rest is a part of amateur radio history. The quad caught on and has snowballed to become one of the most popular DX antennas in the world.[1] The simplicity and efficiency of this antenna type makes it an excellent array for the high frequencies and it is finding increased favor as a VHF radiator and collector.[2]

A most casual survey of antennas for HF and VHF will reveal those qualities that are sought by the amateur who intends to build his own beam. An antenna that is attractive is one that will render reasonably consistent results and which can be constructed and used with a minimum of folderol. The Quad is such an array. In its simplest form, a quad is a one wavelength driven loop with an adjacent parasitic reflector. The reflector is spaced from one-tenth to one-quarter of a wavelength behind the tuned square and caused to be self resonant at a frequency about 5% lower than that of the Antenna element. This combination will produce a two element beam that is capable of a 5 db forward gain, a front-to-back ratio of 15 or more decibels and a low radiation angle.

In any antenna system, the optimum adjustment of the antenna in regard to forward gain, front-to-back ratio, drive point resistance and VSWR will be obtained at one specific frequency and only at that frequency. When an array is worked at other than its design frequency, compromises of the above characteristics will occur. The ability of an antenna to be operated at any distance from its design point depends upon its type. The Rhombic is perhaps the most tolerant of antennas since it can be operated over a 2 to 1 frequency range. A quad will perform very well from 3% below its design frequency to 5% above that frequency and it is for this reason that quad frequency placement is often toward the low end of the amateur band for which it is cut.

The light weight VHF quad shown in the photographs and diagrams was designed to provide a simple two band beam that would offer a reasonable measure of gain, an effective degree of directivity and economy of construction. The true "cubical" quad has a spacing between the driven element and the reflector of one-quarter wavelength; this gives the array a cuboid outline. As a practical matter, the cubical quad is more difficult to build and will render less forward gain than some other quad forms. Field tests have indicated that the element spacing that will give the highest gain—5.7 db—is one-eighth wavelength.[1] $\lambda/8$ pacing can be developed without a boom and is the spacing used in this VHF quad. The plywood spreader support used in its construction causes the relative spacing of each antenna in this array to be the same. In a free-space situation where a quad's environment is perfect and its reflector is properly tuned, the amount of space between the driven element and its reflector is the principal drive point resistance determinant. This means that under certain conditions one transmission line can be caused to match, or nearly match, either of several driven elements.[3] This is possible just as it is possible to work more than one dipole from a single feedline when the dipoles are suspended at a proper height above the ground.[4] Ordinarily, we could expect the $\lambda/8$ spacing between the elements of this VHF quad to create a radiation resistance of about 60 ohms. This impedance figure presupposes that the ground is moderately conductive and that foreign objects such as trees, power lines, the mast, guy lines and other quad elements exert no influence over the behavior of the quad. Such a model situation seldom, if ever, exists and for that reason the feed point impedance of each driven element is considered to be in the neighborhood of 52 ohms.

Construction

The construction of this quad begins with the spreader support block. Two identical plywood plates (Fig. 1) are glued together with Weldwood cement to make one strong unit. The dimensions of each plate can be drawn on the ¾" plywood stock to facilitate the sawing. Any kind of fine toothed saw can be used to make these cuts but a tilt-head sabre saw or a table saw will make this work fast and easy. The tongue of wood that remains after the slot cuts have been made can be removed by scoring and delaminating with a wood chisel or a sharp screwdriver. Square blocks are not used to make the spreader support because they will not produce the desired aspect ratio when the plates are assembled. The corners are trimmed to make flat surfaces for the drilling of the spreader socket holes. These holes, which should be made after the spreader diameters are known, should be piloted with a small drill prior to the final boring. Slight drilling errors at this stage of the construction will be magnified into larger errors when the spreaders are mounted—so much care and enough time should be spent here. In the building of the prototype of this quad, the holes were made with an electric hand drill and a small liquid level was used to make sure that the drill was perpendicular to the work. After the plywood block is completed and the cement has set, the holes for the U-bolt mast clamp can be drilled. The U-bolt can have a throat size of 1¼ to 1⅜ inches and must be at least 3¼ inches long. The "V" saddle formed by the joined plywood plates serves as the other half of the mast clamp as shown in Fig. 2.

The spreaders used in this quad are made of bamboo. These particular bamboos are 4 foot plant stakes which are standard nursery items

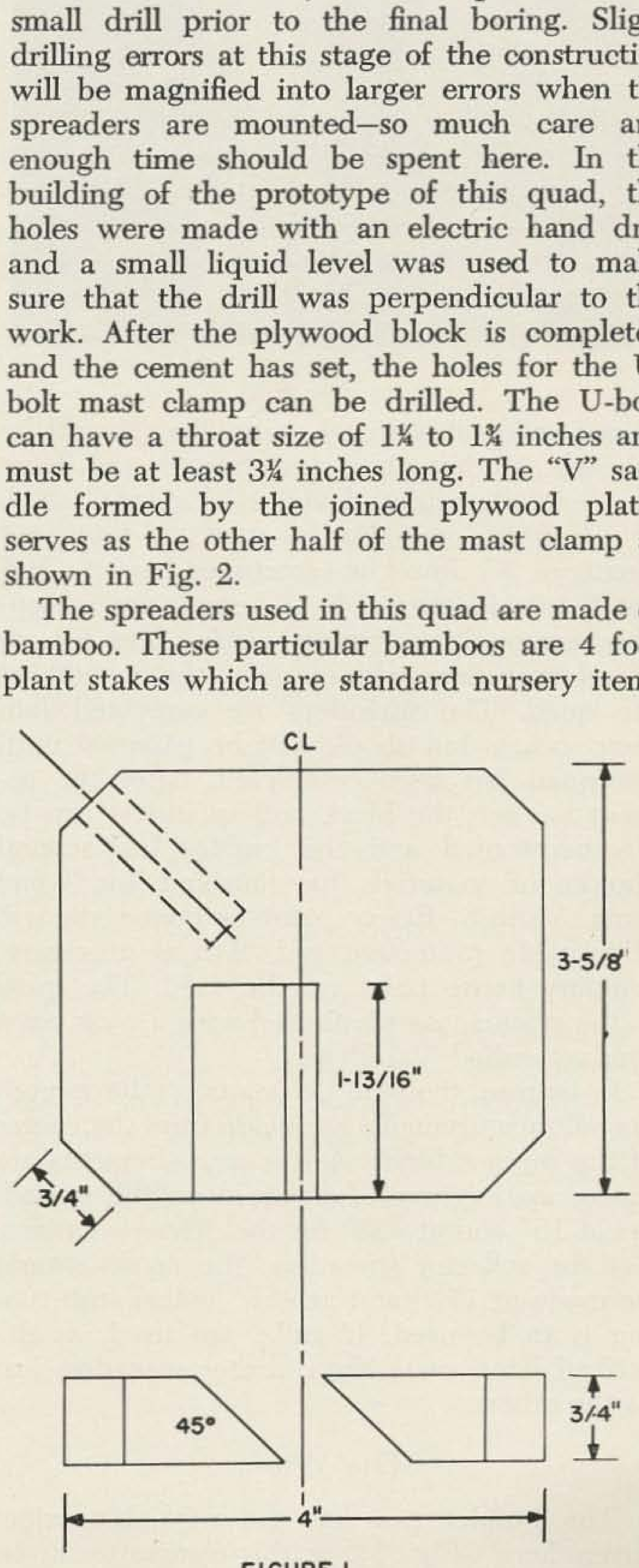


FIGURE 1

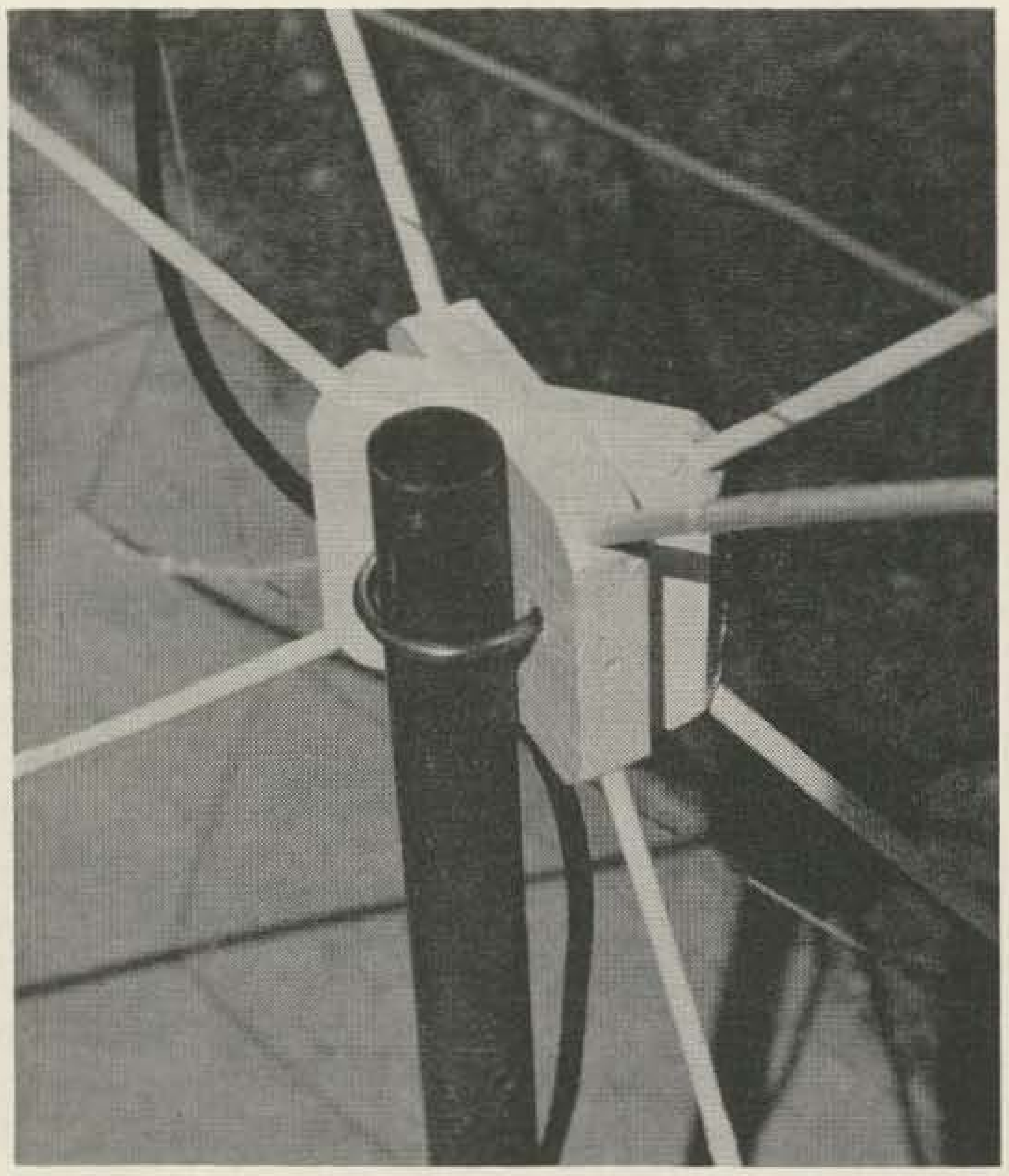


Fig. 2

priced at about a nickel each. They should be selected so that they are straight and have base end diameters of about ⅜". Dowel stock of ¼" to ½" can also be used. A four foot length of ⅜" dowel is sometimes hard to find but 8 foot lengths of 7/16" stock are reasonably common at lumber yards. The use of dowel spreaders will increase the weight of the quad. The spreaders are cemented into their sockets but should not be trimmed until the quad has been completed. After the cement has set, the block and spreaders can be weatherproofed and the builder has several choices of materials for finishing the wood parts. Varnish, Epoxy paint or boat resin will all provide protection and, if it is necessary, ordinary house paint can be used. The quad in the photos was plasticized with a west coast product called Varathane.

In figuring the wire tie points on the spreaders, all measurements are made from the center of the support block. As the measurements are made, marks should be placed on the spreaders at 15" and at 43½" for the driven elements. For the reflector spreaders, the marks should be made at 15¾" and at 45½" unless stub tuning is to be used. If stubs are used, as described later, mark the reflector spreaders just as the others.

The Wires

The builder can use the wire dimensions given here (Fig. 3) or the elements can be cut to favor local net or repeater frequencies. The inch is handy for VHF use and will lead to less annoyance than will the use of feet and decimal fractions of the foot; to compute the length, in inches, of each side of a driven element: the design frequency, in megacycles, is divided into the constant 2976. The reflectors of this beam are stubless and their dimensions are based upon dead reckoning. That is, each reflector is made 5% longer than its associated antenna element. This method of reflector construction was chosen for the following reasons. An oversized reflector can be made up, installed and used with no instrumentation; the absence of a stub will avoid any distortion of the radiation and collection patterns that sometimes occurs with stub use; the oversized reflector will increase the *effective aperture* of each quad section and will enlarge the capture area of each of the antennas. Stubs can, of course, be used to artificially lengthen the reflectors and their use in quad construction is common. When stubs are used they should be in the form of 3" open wire ladders which are closed at their bottom ends. The stubs can be insulated and separated with three-inch plastic spreaders or the old stand-by: dowels which have been boiled in wax or paraffin. The stubs are inserted into the centers of the bottoms of the reflector wires.

Using solid or stranded wire of #16 to #20 gauge, the antenna and reflector squares should be carefully planned. After being freed of kinks and having been stretched slightly, the wires can be measured and marked off with nail polish. The wire marks should be made at those points that will become corners when the loops are attached to the spreaders. Each

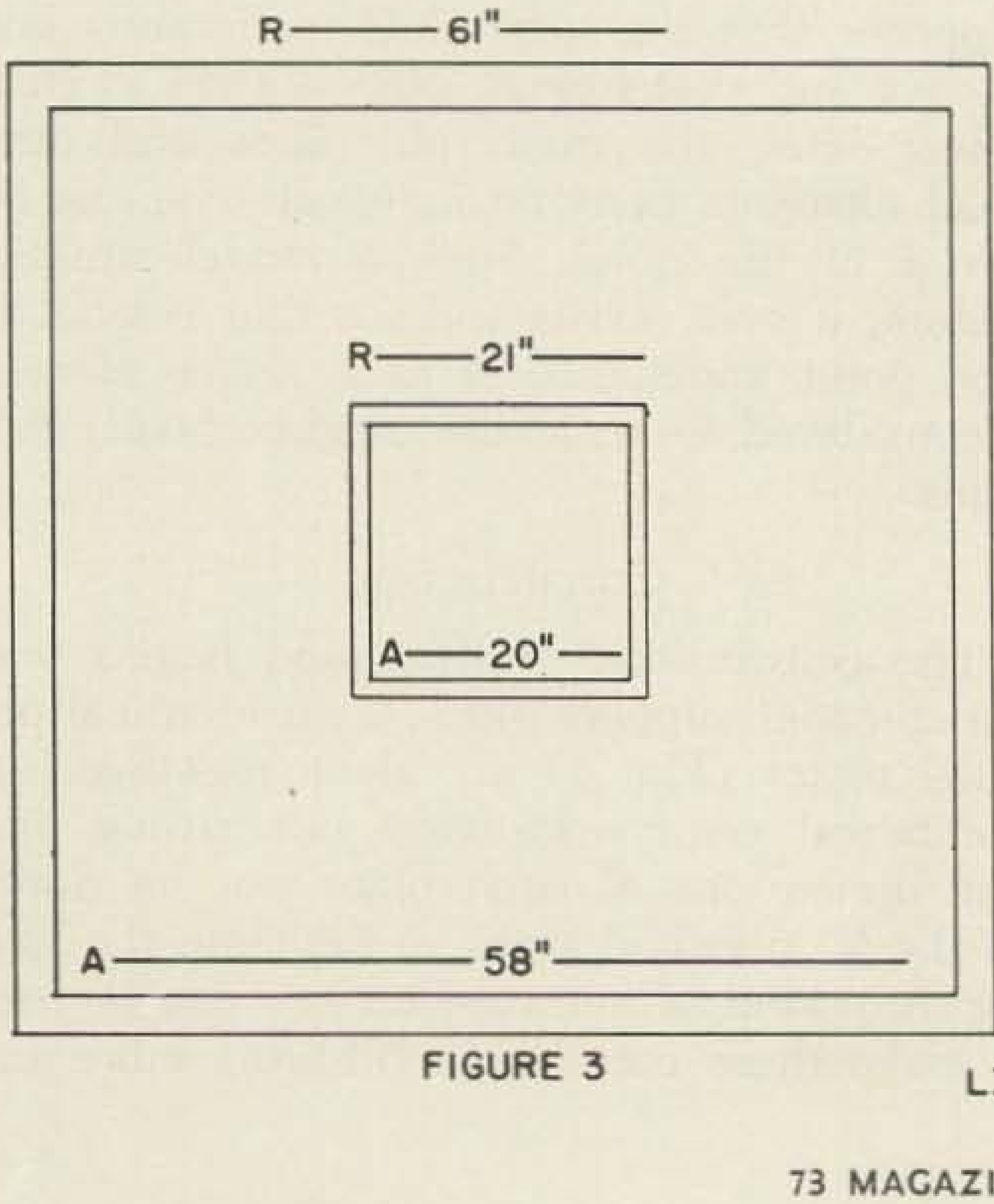


FIGURE 3

wire element is attached to the spreaders with 15 pound test soft monofilament fishing line. A series of clove hitches and square knots can be used to secure each wire corner to its proper spot on the spreader. It's easier and neater when the monofil is tied to the spreader first. After the monofil is trimmed, the ends can be burred with a hot cigarette to prevent unraveling. The insulators used at the feed points of the driven elements should be small and light. 1" slugs of plastic, drilled to accept the wires, will work fine and a toothbrush handle will furnish enough insulators for the whole project. The drive points can be waterproofed by enclosing them in small plastic boxes as shown in Fig. 4; the boxes can be sealed with model cement.

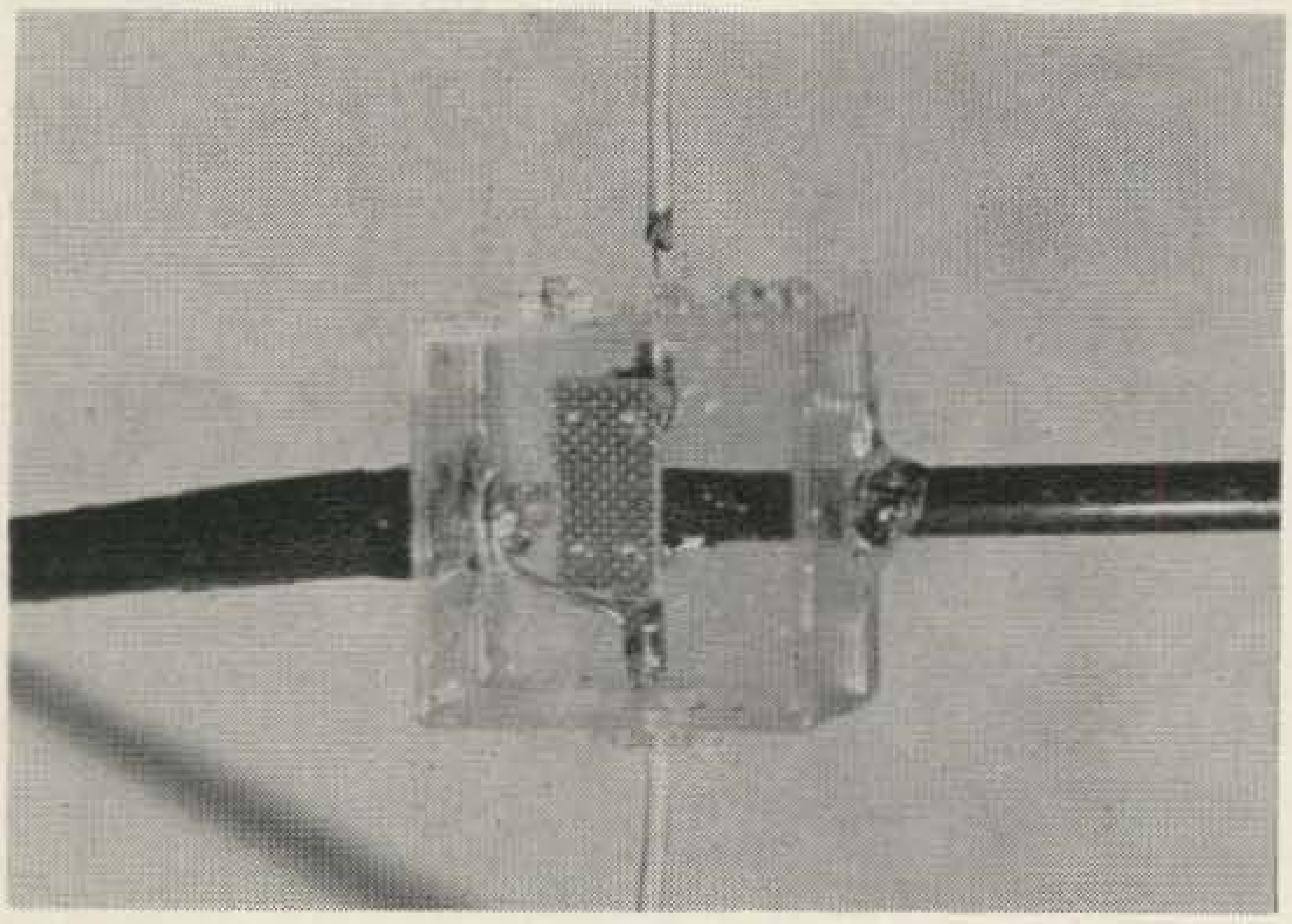


Fig. 4

This quad is light and is not very big but it will be found that element attachment goes easier if the block and spreaders are supported while this work is being done. If the block is clamped to a section of mast and the mast is held horizontally in a bench vise, it will be possible to walk around the spreaders to make the wire ties without too much difficulty. The 2 Meter elements should be attached first. Another way is to position the quad frame on the seat of a kitchen chair so that the ends of the spreaders will be free for work. When the 6 Meter wires are tied to the spreaders, it is possible that the marks on the wires will miss the marks on the spreaders by as much as an inch. This can happen due to small sawing or drilling errors or because one or more of the spreaders is slightly crooked. Such small errors won't affect the performance of the array. After all of the wire elements have been attached, a 30" monofil stay should be tied between the spreaders—from the front to the back—at each 6 Meter corner. The monofil stays will add no appreciable weight and will true up the quad frame geometry and stabilize

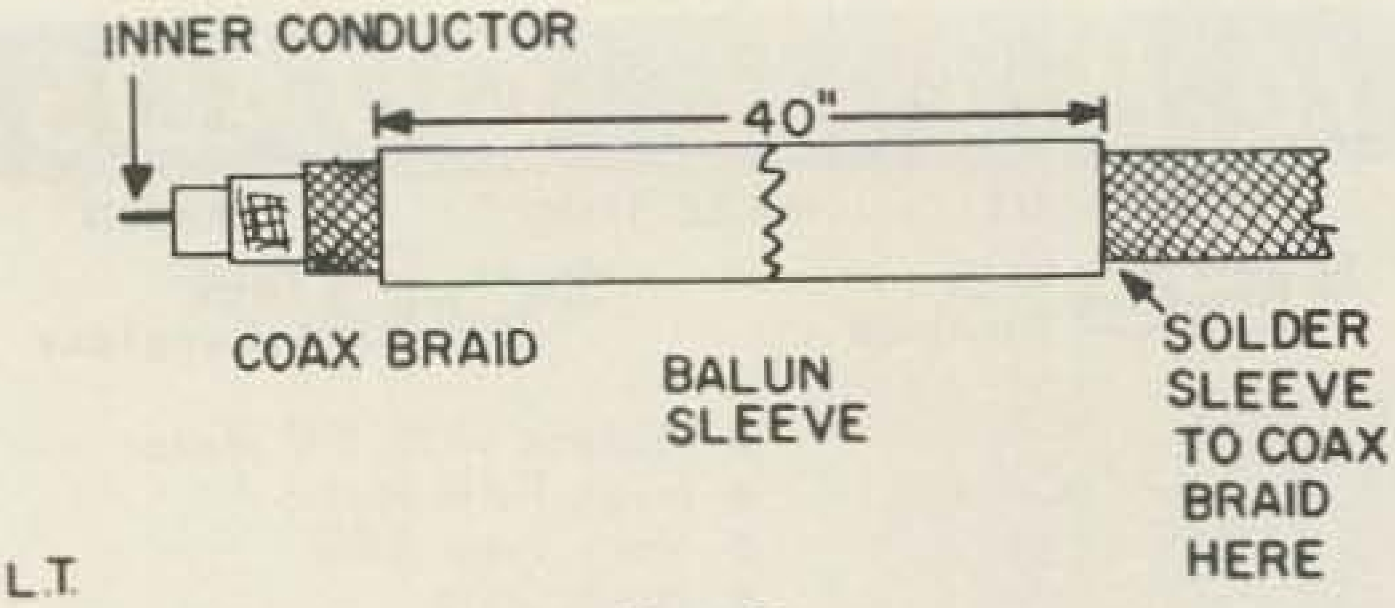


Fig. 5

the antenna mechanically.

The Feedline

We are all familiar with the classic transductance equation in which the generator, the line and the load all possess the same characteristic impedance and in which there are no balanced-to-unbalanced problems. Under such an arrangement, the only losses that are incurred are the natural losses imposed by the rf resistance of the feedline. Unfortunately, this ideal situation is rarely enjoyed by the radio amateur. Feeding quads is like feeding other antennas in that it is sometimes necessary that we use devices or tricks in order to get the rf energy to and from the quad's feed points with a minimum of loss. The quad is a balanced antenna and should be treated as such; this means that the most elementary form of transmission line that may be used with the antenna is a two conductor balanced affair such as open wire or twin-lead. For the sake of convenience, however, coaxial cable is more often used. The use of coax at the transmitter end is simplicity itself since it is usual but necessary that the cable be connected to the pi-net matching circuit, or the output link, of the rig. But when coax is used, two bugbears present themselves: it becomes necessary that some form of balun be employed to satisfy the balanced quad; and coaxial line losses are high—particularly at VHF.[5] Practical solutions to these problems exist and they will be partially catalogued here. The builder has the choice of several functional feed methods and it will be assumed that the quad will be used with an unbalanced shack termination in both the transmitter and the receiver.

The simplest and roughest way to feed a quad with coax is to cause the antenna to display a radiation resistance at each of its driven elements that will approximately match the impedance of the coax and then just solder the braid and inner conductor to the driven wires where they are brought together at a common insulator. This drive method ignores the fact that the quad is a balanced array—but it works. In fact, it works better than it has a right to. Many quads are fed this way at the High Frequencies and they turn in creditable performances. The drawbacks to this arrangement include: feedline radiation, deceptive SWR readings and a directive skew in the radiation pattern. Where such a feed method is used, feedline radiation can be reduced by the use of a coaxial "balun." This is an electrical quarter wave of coax formed into a king sized doughnut and bound with tape. This type of "balun," which is really more of an rf choke, is situated near the driven element feed point. The extra loss introduced by this device is not attractive at VHF and it is not particularly recommended.

The Gamma match is an excellent system for meeting both the impedance matching and the unbalanced-to-balanced problems that go with quad feeding. This tuned transformer is described in detail in the ARRL *Handbooks* and in the W6SAI book, *All About Cubical Quads*. The most satisfactory single-line feed method for the multiband quad revolves about the use of the Gamma match and it will produce the lowest true voltage standing wave ratio that can be obtained. The Gamma matching procedure is, however, lengthy and complex and requires some things not found at every hamshack; a crank-up tower, good instrumentation, waterproof variable capacitors and much time and patience.

The Sleeve Balum,[1, 6] which is recommended for this 6 and 2 quad, is handy as a transmission line modifying device. (Fig. 5). Sometimes called the "Bazooka," this type of balun will change a coax from an unbalanced cable into a balanced line without transforming the impedance greatly as does the "Trombone" balun. To feed a quad with a sleeve baluned single coax is possible if the quad is for one band or if it is built for two bands having a 3 to 1 wavelength relationship. 40 and 15 meters for example. This is feasible because $\lambda/4$ on 40 is ¾ of a wavelength on 15; thus sustaining the "odd number of $\lambda/4$" requirement of the sleeve balun's electrical dimensions. The same concept allows the practical, if not exact, use of a 6 meter sleeve at both 6 and 2 meters. The balum sleeve is the same length, 40", whether it is made with RG 8 U or RG 58 A/U because each cable has a velocity factor

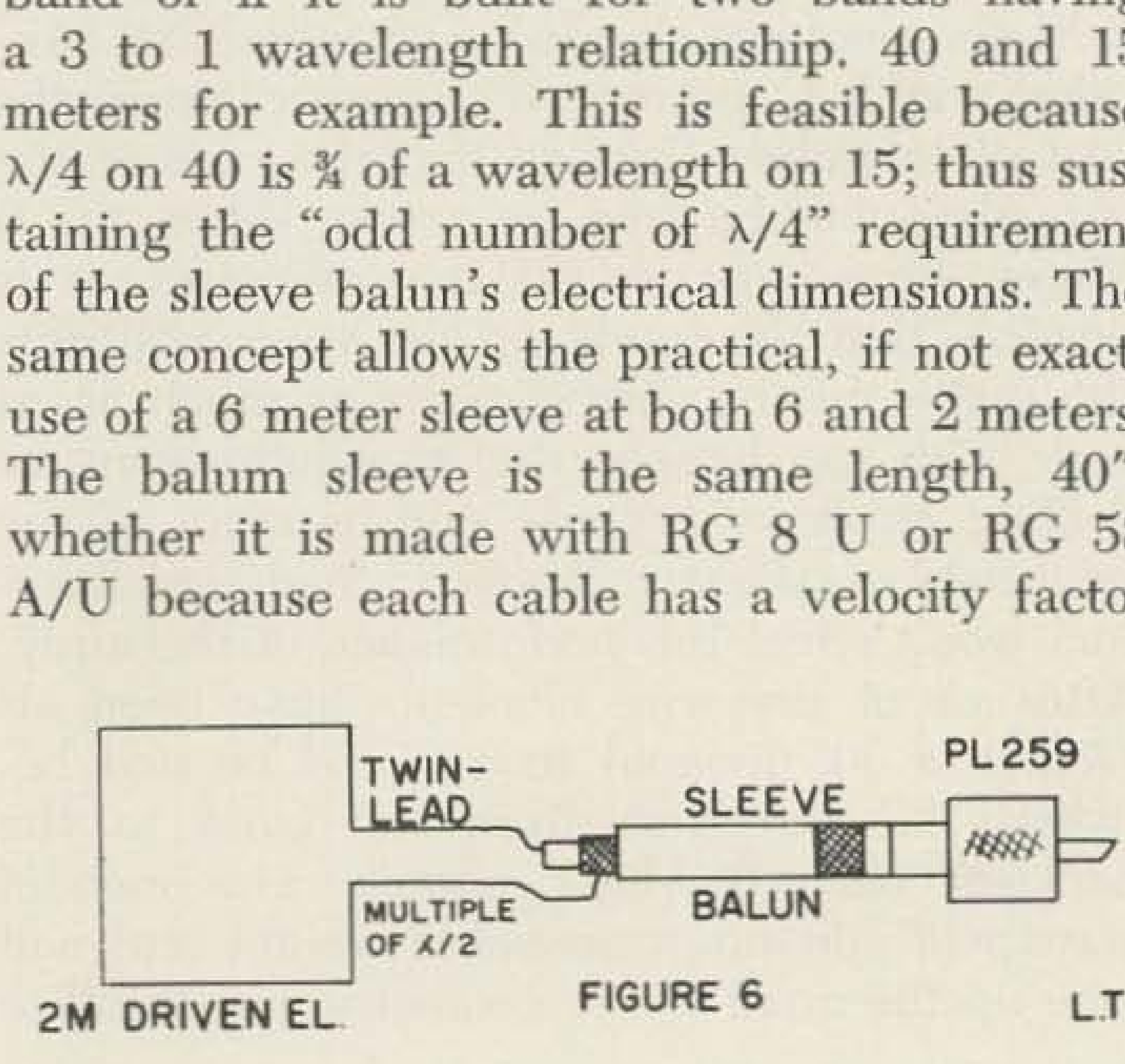


FIGURE 6

of dot sixty-seven (.67) and an electrical quarter-wave is 67% of a yardstick quarter-wave. The sleeve can be made of woven braid of the type often used for flexible bonding straps. Getting a Meter of braid to slip on a coaxial cable can be quite a tussle and it's easier if the braid is put on in several short lengths and joined with solder after the sleeve is completed. At the builder's option, the sleeve can be made by winding bare copper wire upon the coax in the manner of a long coil. The sleeve bottom is soldered to the coax braid and should then be waterproofed with pre-warmed plastic insulating tape. If the quad is built for 2 Meters only, make the balun sleeve 13½" long. When coax is used entirely, the sleeve is installed at the load end of the line; but if the line run exceeds 60 or 70 feet the coaxial losses will become high, especially at 144 mc.

An inexpensive and more efficient line can be made of open wire or twin-lead. In this arrangement, the balun is made up and used at the shack end of the system as indicated in Fig. 6. The balanced output of the coax is connected to the open wire as shown. The common types of twin-lead or open wire obviously will not impedance-match either the quad or the balun; so the line must be cut to a multiple of an electrical half-wave.[7] The velocity factor of household twin-lead is .82 and a 300 ohm line can be any multiple of 95". Typical lengths might be 47′ 6″ or 63′ 4″. Clearly, the tuned line will not be right on the nose for each band, so the following procedure is suggested: make the twin-lead line 8 inches longer than its computed length and check the SWR on each band as the balun connection point is tapped back toward the computed "mark." This way, the feedline can be trimmed to a spot that will be compatible with each of the driven elements. Open wire lines are affected by environment and should be transposed—by twisting—to cancel the effects of nearby conductive objects. Twin-lead can be treated with silicone compound so that moisture will not cling to upset the qualities of the line.

It is also possible to feed the antennas by using open wire and a pair of "Trombone" baluns.[8] This method requires a balun at both the sending and the load ends of the line. The use of a multiple λ/2 wire line and balun combination can cause the drive point impedance to be mirrored to the transmitter and good transconductance will be obtained.

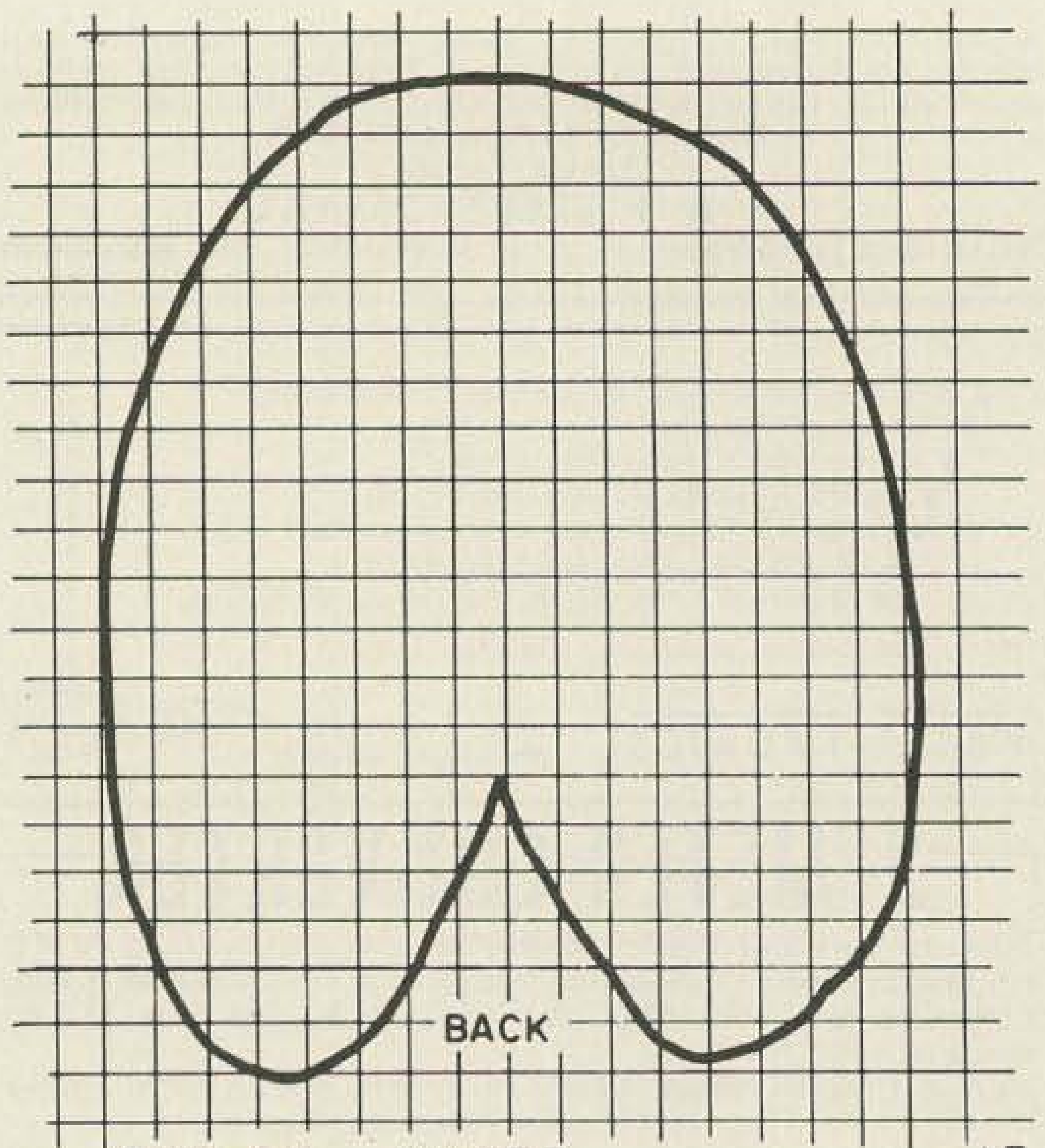


FIGURE 7

L.T.

Feedline Connection

The balance corrected load end of the feedline is soldered to the 2 Meter driven element. A 20" length of coax is connected from the 2 Meter drive point to the 6 Meter driven wire. It may seem strange to use an unbalanced coax for this link but if open wire were used here, the 6 Meter driven element would see the open wire link as an extension of itself. This would cause the antenna to be self resonant considerably below its design frequency. The coax link is less than $\lambda/4$ at six meters and thus does not assert its character and becomes two pieces of wire—one inside the other.

SWR

The most familiar indicator of the feedline to antenna impedance match is the old boomerang factor—SWR. If a quad is operated with an SWR in excess of 2:1, two things will occur; the directivity will get soft and line losses will be higher. A high SWR will create an rf loss factor that increases as the line is lengthened. In a very long line, the standing wave ratio can be deceptively low because of the line loss presented to the returning reflected signal by the long line.[9] The design frequency SWR's of this quad were checked as the quad was being fed with a line and balun made of 30 feet of RG58 A/U. The signal sources were a modified Collins MBF and a Gonset Communicator II. Readings of 1.25:1 and 1.65:1 were obtained at 6 and 2 meters, respectively, on a Heath Kit AM 2 reflectometer which was strapped for 50 ohms.

Adjustment

This quad has been built for vertical polarization because it is very popular in the Los Angeles area. If horizontal polarization is desired, feed the driven elements in the centers of their bottoms instead of their sides. If the antennas are fed at a corner, oblique polarization will result.

If the quad is built with the pre-cut oversized reflectors, adjustment is not intended. It should be realized, though, that the optimum front-to-back ratio and forward gain relationships may not occur precisely at the design frequencies. When 3" wide stubs are used, they should have initial lengths of 9" for Six and 3" for Two Meters. The stubs can be experimentally shortened, if F/B improvement is sought, by shortening the stub with a shorting bar made with a crocodile clip at each of its ends. Such tests are more easily conducted with the receiver tuned to a properly polarized carrier which is several miles away and which is free of reflections from mountains or other objects that can obscure the polarity and the directivity of the sent signal. It will be found that the directivity patterns of this antenna will be different from those charts which have been published for horizontally polarized quads. One of the most noticeable characteris-

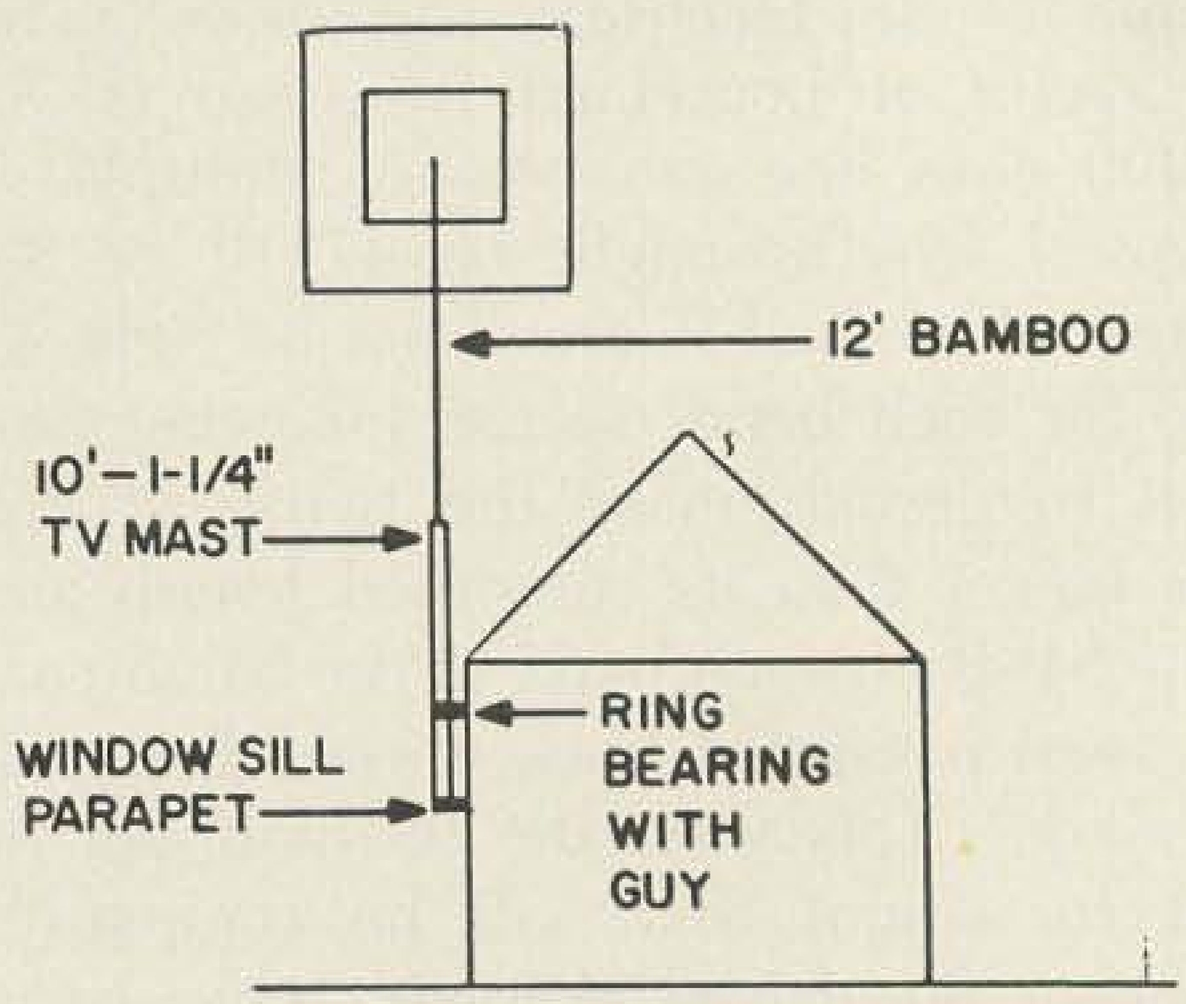


FIGURE 8

L.T.

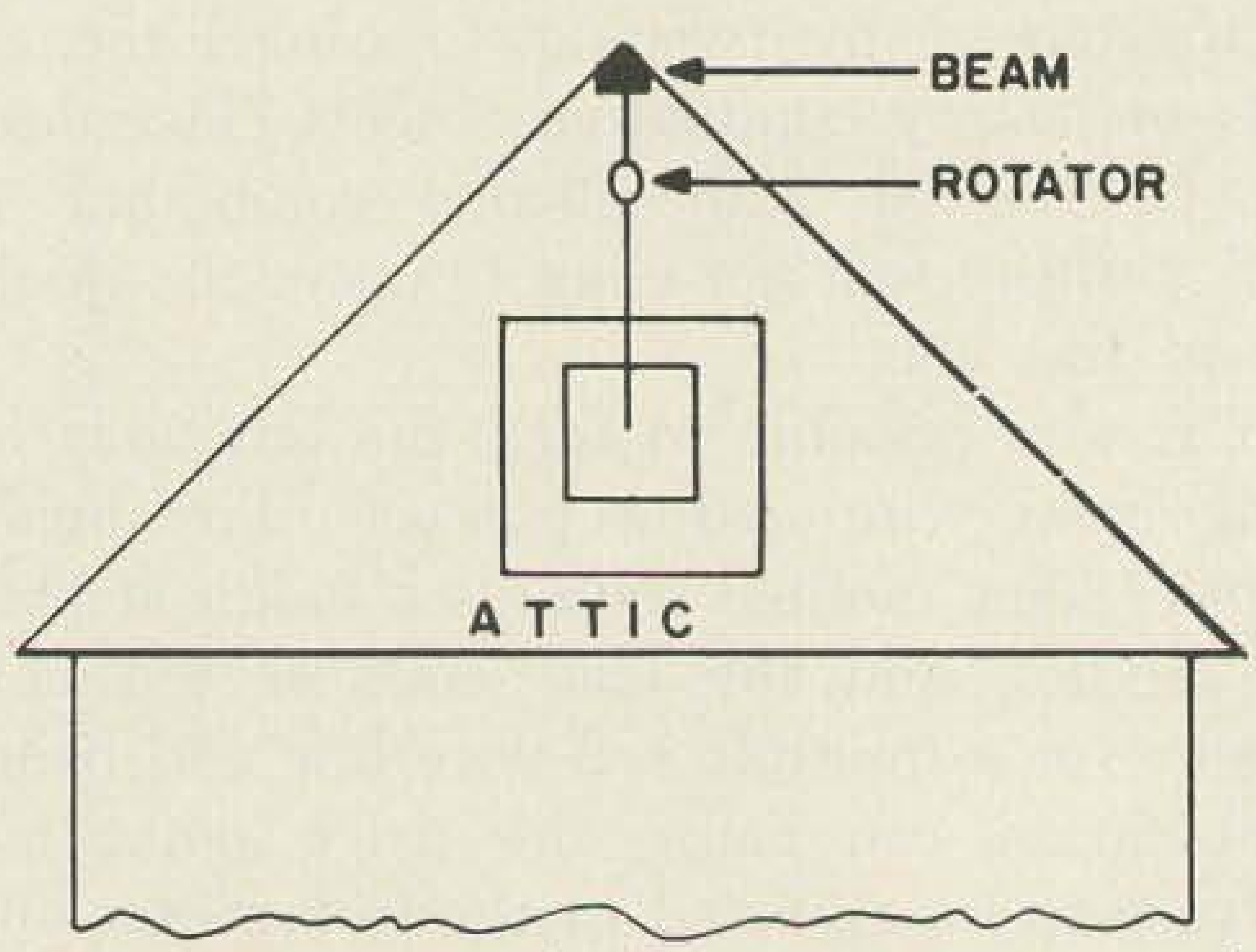


FIGURE 9

L.T.

tics of any horizontally polarized array is its dramatic front-to-side ratio; but this effect is not as pronounced in the vertically polarized quad. This 6 and 2 meter antenna has a cardiode pattern as shown in the graph of Fig. 7. This collection pattern was plotted on six meters over a clear optical path between Mount Wilson and the San Fernando Valley. In this case, the receiving equipment used was a Hallicrafters SX 110 and a Vanguard converter. The reflectors were not adjusted in any way and Fig. 7 shows the kind of directivity that can be expected by the builder. As compared with the front, signals fall off 15 to 20 db on the sides and back; the slot in the center of the back may be as much as 42 db deep. This rejection slot is handy for excluding unwanted signals and can be used to prevent receiver overload when strong locals are being worked. When making tests for front-to-back and front-to-side ratios, the checks should be made under several path conditions before any major correction is applied to the antenna. Misleading readings can be obtained due to the many factors which may disguise the true performance of the array. If your station receiver has no "S" meter for making these comparisons, the antenna can be checked by sending to a station having such an indicator. A field strength meter can be used for checking the quad but it should be at least 500 feet away from the transmitting site.

Masts

The light weight and small size of this array permits a variety of support systems to be used to get it up to a useful height. The operating parameters of this quad require that it be at least one half-wave above the ground, or a metal roof. This works out to be only ten feet at six meters and presents no real problem. The quad in the photos is worked on a 12 foot bamboo pole which has a 10 foot length of TV mast ferreled onto its bottom end. This combination is manually rotated in a pipe socket which was driven into the ground just outside the shack window. This arrangement requires no guys and is easily dismantled for Mountain Topping and other field work. Another support and rotation method which suggests itself is the use of an upstairs window sill parapet as the mast support. (Fig. 8). With this arrangement, the mast should be bearing guyed as it passes the eave of the roof. The short turning radius of this 6 and 2 beam allows it to be used within an attic as seen in Fig. 9. The builder can attach this quad to a previously erected fixed or rotating mast as the antenna is being assembled. Construction of the array is carried out as described earlier except that the reflectors are left off. They are added after the quad has been clamped to the mast. A motorized or lanyard operated flip-flop arrangement can be employed if frequent polarity changes are desired.

. . . W6SFM

Reference Literature

[1] All About Cubical Quads, W6SAI, Radio Publications, Inc.
[2] An Interlaced Quad Array for 50 and 144 Mc., K8WYU, QST Feb 1963
[3] The Delta Quad, W6SFM, CQ Sept 1961
[4] The Radio Amateur's Handbook, ARRL, West Hartford, Conn.
[5] Coax vs Open Line, W9HOV, 73 Nov 1962
[6] S 9 Signals!, W6SAI, Radio Publications, Inc., Wilton, Conn.
[7] Half Wave Transmission Line, W2KPE, 73 Mar 1962
[8] Coaxial Baluns, WA2INM, 73 Dec 1962
[9] Are You Being Lied To, OM?, KZ5SW, 73 Oct 1962

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PAQUHOWWAMOMAM*

**(Putting a Quad Up Half One Wave With A Minimum Of Money And Manpower)*

Jack Archibald, Jr. K2AAC/PJ5MA
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East Aurora, New York

If you have just made the final payment on that umpteen-foot-high status symbol or whatever, supporting a rotary in your backyard—all you can possibly get out of this article is the urge to laugh derisively. Maybe that will help your subconscious. If you haven't yet spent your money and want to stimulate your own thinking a bit on the subject of getting a 14 mc or triband quad high enough off the ground to do some good, read on.

Much has been written [1] concerning the design and construction of cubical quad antennas, but aside from occasional references to the fact that tilt-over towers were an effective method of getting them to altitude and back alive to adjust stubs, etc., past authors have been strangely silent on the subject of getting them UP. There have been frank admissions regarding the difficulty involved—"The thing has no handle," etc.—but generally the actual job of plugging all that bamboo and wire into a rotator on top of a tower has been left to the reader's imagination.

The Scheme

As we said before, if you already have a suitable tower or the ready where-withall to obtain one you probably won't be interested in a method that costs only twenty bucks—that takes up not one square inch of real estate—that keeps you and others from stumbling over guywires—and that puts the stubs within easy reach required.

All you need besides a ten-foot tripod, a ten-foot and a five-foot TV mast, something under a hundred feet of guy wire, and assorted screweyes, turn-buckles, thimbles and cable clamps for three guys. . . is a garage. Or maybe even a carport. Even a house will do. Seriously, to make this scheme work as easily for you as it has for me, you should have a building with a ridge pole some ten to fifteen feet above ground level. Any less than these limits, and you will have to settle for less than thirty three feet to the quad's midpoint. Any more and you will have a helluva time getting the thing on top of the roof. You may not have a spare unattached garage lying around as I did, but if you have a one-story garage attached to anything from a ranch to a two-story house you're still in business provided that the second ridge is no more than ten feet or so above the first.

By now you're probably wondering about the arithmetic involved and maybe even why we want to put this thing a half wave above ground. Various authorities [2] have commented on the fact that a quad will do a better job relative to a Yagi when both are handicapped by low elevation. In fact 601ND gave me a 579 during an SWR check while the quad reposed at half mast so to speak, awaiting an antenna party to get it up the final twelve feet. Incidently, the SWR was 1.5/1. But I digress. Anyway, if you just joined the class, we want our antenna a minimum of one half wave above ground to attain 1) useful radiation pattern, and this means low angle of radiation for DX work 2) actual impedance approaching characteristic feedpoint impedance and thus low SWR. This may be a good point to mention that using Orr's dimensions for a single band 14 mc quad and feeding same with RG-11/U resulted in a standing wave ratio of less than 1.1/1 after arriving at thirty three feet. But again I digress. Back to the arithmetic.

I have a one car garage twelve feet by twenty feet with a ridge pole twelve feet in the air. Add ten feet for the tripod (actually you lose a few inches mounting the tripod astraddle the ridge, but you get this back in the space taken up by the AR-22 or equal); add another seven to eight feet for the push-up mast, and another four to five feet for the stub mast from top of rotator to boom—and your home free, or at least thirty three feet in the air even if you started from a point only ten feet off the ground.

Mobilizing for Action

Now that you know what is involved, perhaps you would like to hear how I went about it. Please note that what follows is *not* a set of instructions. It's nothing more than an account of how one low-budget ham beat the high cost of skyhooks. So if you fall off the roof and disfigure the XYL's prize rhododendrons, or maybe wind up in the hospital, don't bother to write me threatening letters. I promise they will go unanswered.

The first thing I did after acquiring all the hardware was to mount the tripod on the garage roof and install the screweyes for the guys. Since you, or whoever you might con into the job, will have to climb the tripod later, I would suggest you do a workmanlike job of it. I used scrap lumber backing up the plywood roofdeck between joists, and thru-bolts—plus a little roofing compound to forestall leaks.

This much accomplished, I began work on the quad. I used U-bolts to secure the spreaders to foot-square pieces of five-eighths inch plywood and attached pipe flanges to the plywood bored to accept a one-and-one half inch dia. aluminum boom. I then assembled the respective elements flat on the ground, one atop the other. The elements completed, I lashed the ten-foot mast vertically alongside a clothes pole. If you don't have a clothes pole handy, you might try sinking the end of the mast into the ground and temporarily guying it in place. With the aid of a stepladder the boom was then attached normally to the mast at a point approximately nine feet above ground using a one-quarter inch aluminum plate and U-bolts. After this it was a simple matter to pick up the elements one by one and slip the pipe flanges over the ends of the boom. The first flange was drilled and bolted to the boom at random and the process was repeated on the other element after alignment with the first. The quad itself was

[1] We won't bore you with the usual bibliography. The past five years of QST and CQ contain some two dozen articles on quad dimensions and construction techniques. Just check your year-end indicies. Or get a copy of **All About Cubical Quad Antennas**, Orr W6SAI, 3A2AF

[2] Take my word for it.

thus completely assembled as a one man operation.

For what follows the services of two additional helpful types were required for perhaps half an hour. Before arranging for their time however, I a) secured the guys to the rotator b) taped U-shaped pieces of strap iron to the tops of two twelve foot bamboo poles, heavy ones which came inside of rugs, and c) opened up the bottom wire of both driven element and reflector at the insulators, and taped the wires to adjacent spreaders. Those of you with good perception will note that this takes a healthy ninety degree segment out of the bottom half of our nearly cubical gadget. To facilitate disassembly of the wires and to make later attachment of the feedline easy, I ran 10-32 plated brass machine screws thru holes in the ends of the insulators and secured elements, stub and eventually feedline with nuts. You will shortly discover that step c) above is the clue to getting this rather unwieldy object in place on top of the tower.

Up With It

After the reinforcements arrived, I had one of them climb the ladder to the garage roof. The other one stabilized the quad while I untied the mast from the clothes pole. Next I picked up the mast, quad and all, and walked it across the backyard approaching the garage with the boom in line with the ridge pole. When the lower end of the mast was at waist height the boom was a foot or so above the ridge. If your ridge is over twelve feet, you can climb a stepladder placed half the boom length away from the end of the building to get the boom above the ridge. The lower spreaders were then eased forward against the edge of the roof somewhat below, and astraddle the ridge. By raising up still further on the mast the boom was thus tilted toward the man on the roof. He simply reached thru the spreaders, grabbed the boom, and then picked up the entire assembly. With the end of the boom against his thigh, and the boom tilted up at about forty five degrees, he walked backward down the ridge toward the tripod tower.

At this point we joined him on the roof, brought the mast to the vertical, raised it enough to enable the boom to clear, and then centered the boom on the tripod. Next we taped the feedline to the boom, leaving enough coax to reach the feedpoint once the lower wires were rejoined at the insulators. This accomplished, we tied the boom to the top of the tower thus raising the tips of the spreaders above the roof line and connected the bottom wires and feedline. At this point we were forced to vacate the roof owing to an approaching thunderstorm—hence the opportunity to check SWR at twenty one feet and get a report from 601ND.

When the antenna party reconvened, I roped myself to the tripod so as to have both hands free; loosened the U-bolts holding the ten-foot mast to the boom, removed the mast and inserted it down thru the top of the tower. I then clamped the rotator, guys trailing, to the top of the mast left projecting above the tripod. The upper end of the five-foot mast was then clamped to the boom. Finally, using the hook-equipped twelve-foot poles, my fellow roof dwellers raised opposite ends of the boom an additional five feet (I untied it first), and reaching up I guided the lower end of the stub mast into the top of the rotator. After cinching up bolts, further taping of feedline, etc., yours truly came down off the upper rungs of the tripod.

Now the quad's centerline reposed about twenty-six feet above the garage floor; the lower element wires about six feet or so above the roof, which put the stub shorting bar within easy reach. After tuning the reflector, it was a simple one-man job to raise the pushup mast a final seven feet, slip a board across the tripod rungs beneath the end of the mast for temporary support, and snug up the bolts holding the mast in place. The last step was attachment of the guys to the screweyes via turnbuckles, which were then adjusted, and the job was considered finished.

More on Construction

Those of you who succeeded in overcoming the urge to laugh at my antics might be interested to know that the cash outlay for the entire antenna system; tower, rotator, and quad material came to less than the cost of a new AR-22. I'll admit this does not include the coax, multiconductor rotator cable, or the six cans of beer consumed by members of the antenna party. Nor does it include the carton of cigarettes gratefully presented to a local greenskeeper after he supplied us with eight selected bamboo poles (the poles are used to swish dew off the greens in the morning, I'm told). But it does include tripod at fifteen dollars; masts, guy wire and assorted hardware at five dollars; one hundred and fifty feet of #14 copper wire, eight-foot do-it-yourself aluminum boom, vinyl tape and other sundries for five dollars; and a used CDR rotator at ten dollars. The plywood was obtained from lumber yard scrap for two-bits, and the U-bolts were made up by running a die over opposite ends of five-inch lengths of three-sixteenths brass rod I had on hand, bending about a piece of pipe and covering with spilt sections of old windshield wiper hose.

Addendum

By any standards, I feel that this was money well spent. Within two weeks after climbing off the roof 20 CW yielded VR2DK, VP8GQ, KR6MO, ZK1BY, VQ5IU, and 9U5BH—plus assorted JA's, VK's, UA's, etc., with reports ranging from S5 to S8. Rig used was a venerable DX-35 panting into a homebrew 811A linear.

I can't kid myself about the value of antenna comparison info coming from a neophyte who has yet to wear out his first General ticket, and who for that matter has never had a commercial antenna tied to his rig—but for what it is worth I will say that this quad definitely outperforms a previous homebrew, interlaced, two element 15-20 Meter beam. Besides superior ability in the face of pileups (remember the mob on Gus during his 9U5 stint?), its performance during reception is perhaps even more significant. I find I'm listening to and working a whole new layer, particularly far Pacific, that I never knew existed at this QTH.

Finally, to forestall queries from some of you astute types, I will say that preliminary investigation indicated no appreciable change in SWR with the car in or out of the garage. I had early visions of combating QSB with visual signals to the XYL behind the wheel, shuttling in and out of the garage. For a variety of reasons, perhaps needless to say, this has not come to pass. . . . K2AAC

Three Elements on Three Bands

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"Darn. Beat out again! Gotta do better. Can't waste my life away calling DX. Time to *work* some. Quads have appeal. But not another *ordinary* quad. RSGB Bulletin (March 1959 pg 432) and VE3IT have the idea—a three element quad. His quad is built with a 14 foot steel 1¼" boom. It only covers 28 mc but I could put it on 14 and 21 mc also."

There has been considerable controversy about the gain of a quad. Many people have claimed a 3 element quad was no better than a 2 element. Let's look at the quad in the following way. Consider an ordinary 2 element parasitic beam at optimum spacing. Its theoretical gain is on the order of 6 db while 5.5 db may be realized in practice. Even if the element ends are drooped as in the case of the Weeping Willow Antenna of ZL2AFZ approximately the actual gain of the non drooped beam may be realized. ZL2AFZ has built a 3 el 14 mc parasitic beam with the usual element length but has made it into a Weeping Willow. This is done by inserting 90° bends in the elements one quarter of the particular element's length from each of its tips. A 2 element version of the Weeping Willow is drawn in Fig. I.

If a second Weeping Willow antenna is now stacked below the first one, and fed simultaneously with the first one, approximately 3 db stacking gain can be obtained or a total of 9 db. Suppose that instead of connecting the feedpoints of the two Weeping Willows together that the bottom or second one is inverted. It is fed by connecting its element tips to those of the first Weeping Willow. Then the feet point of the first will be sufficient to feed the entire array. See Fig. 2.

The resulting antenna is called a cubical quad. If two 3 element Weeping Willows (as used by ZL2AFZ) are combined in this way to form a quad a stacking improvement of 3

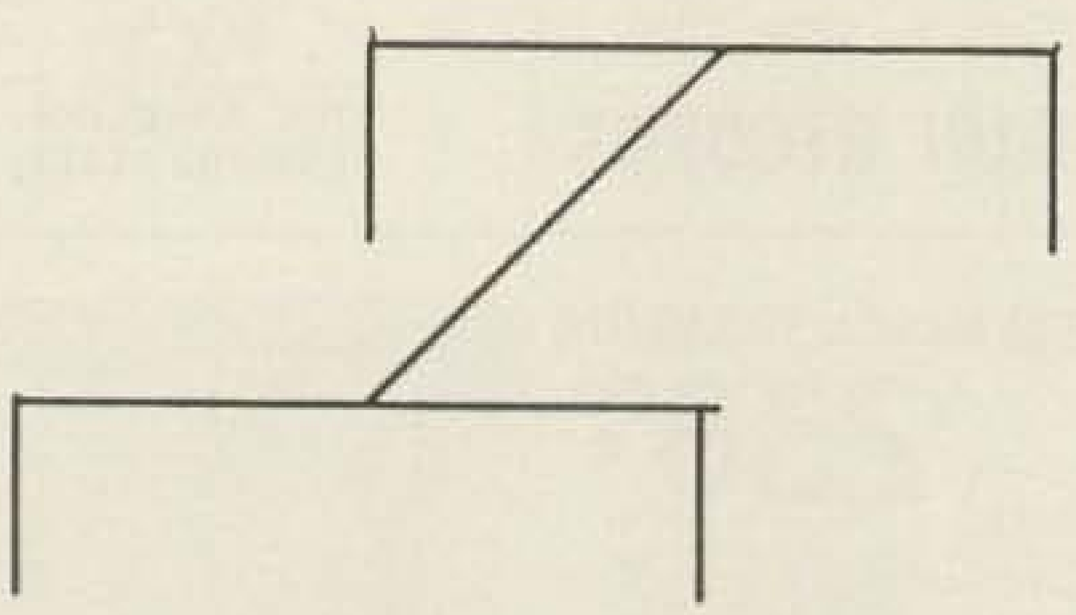


FIG I

The Weeping Willow 2 element parasitic beam of ZL2AFZ's design.

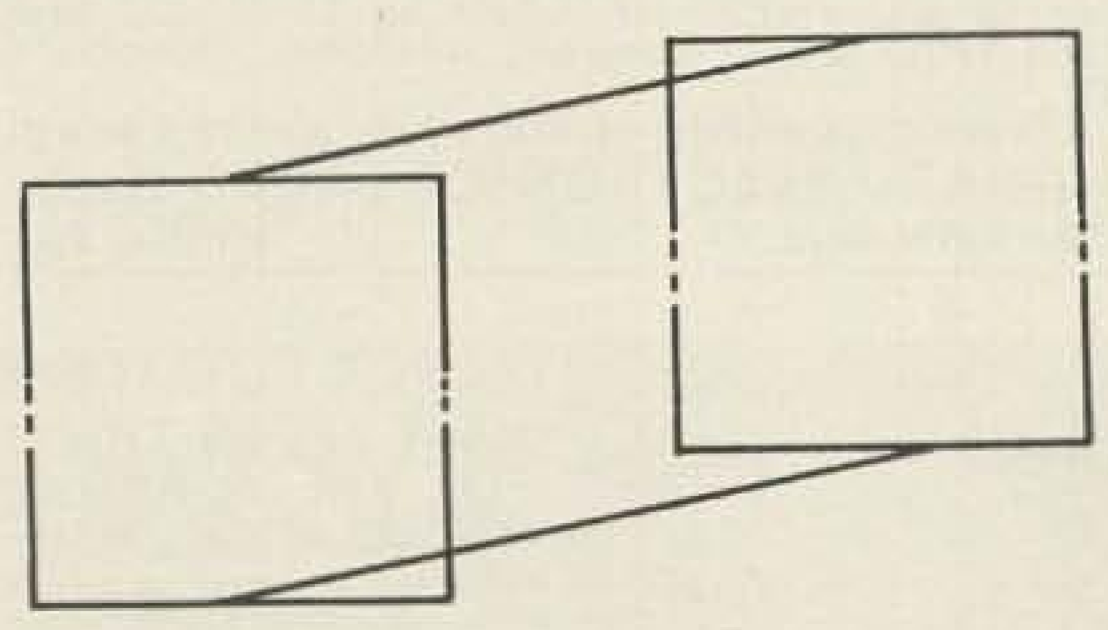


FIG 2

Stacking the two Weeping Willows to get some 9 db. gain.

Designer	Design Frequency mc., F	Director feet	Driven el. feet, D	Reflector feet	Constant FD
VE3IT	28.25	31.9 plus stubs	33.5	33.5 plus stubs	948
KR6CG	28.6 (estimated)	32	34	36	972

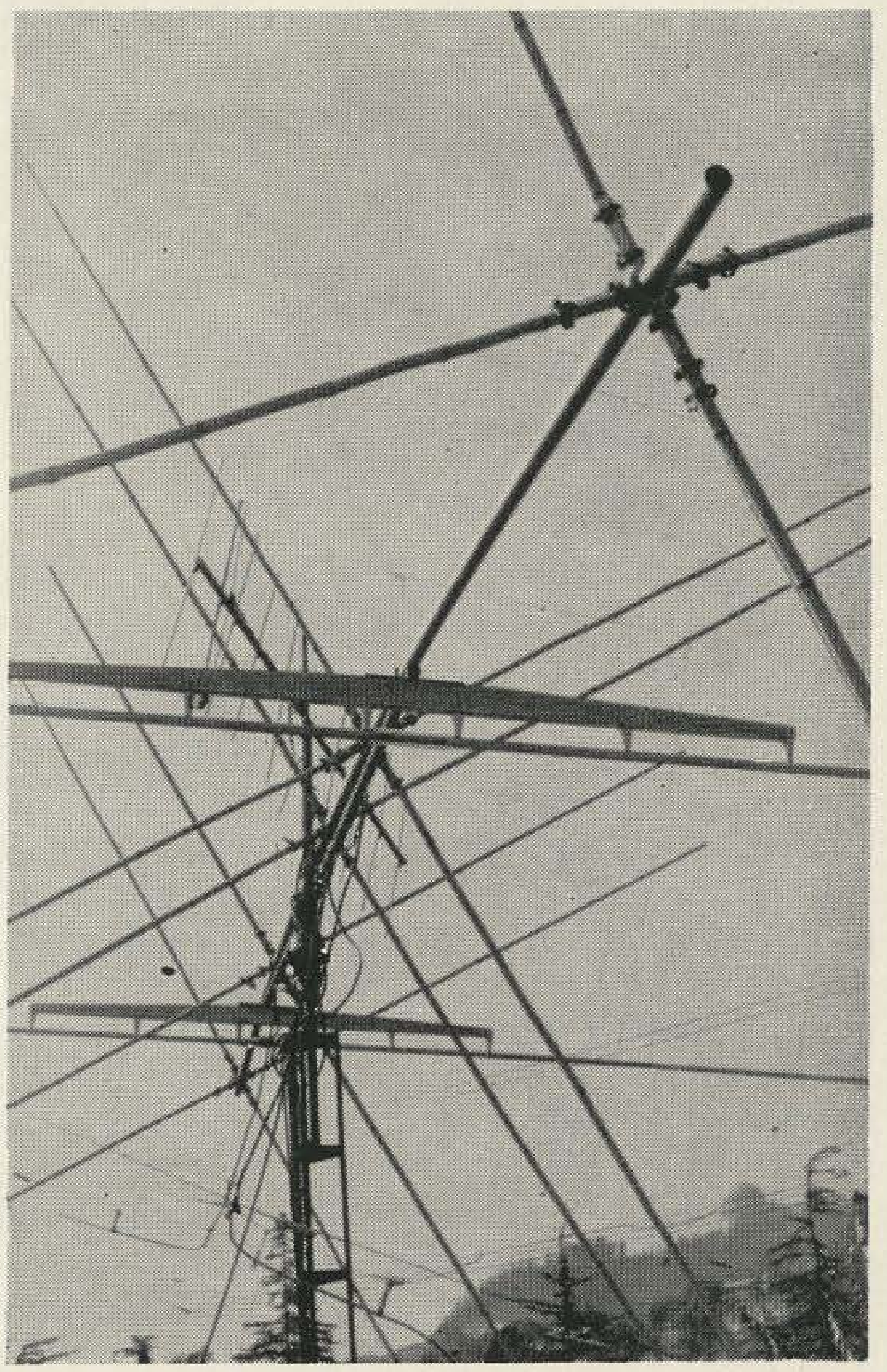
Table 1

db will be expected. The actual gain of a 3 element parasitic beam of optimum design is 9 db thus this 3 element quad should have forward gain of 12 db over a reference dipole standard. This figure of 12 db seems quite reasonable since measurements of the Cubex Co. made at a commercial antenna range on 2 element quads at 21 mc and at 28 mc with spacings of 0.19 to 0.25 wavelengths gave forward gain figures of 9.8 to 10.0 db.

VE3IT was one of the first to publish an article on the construction of a 3 element quad. KR6CG also built a 10 meter 3 element quad. The dimensions of these quads are in Table I.

With the success of VE3IT in mind I thought that I might do even better by building a tri-band system of 3 element quads. Rather than complicate things by changing his dimensions and spacings it was built using exactly the same dimensions on 28 mc. On 14 and 21 mc the element lengths were directly proportionately longer. The element spacings were 0.20 between director and driven element and also between driven element and reflector. In order to maintain this equal spacing on each band a total of 5 spiders on a 30 foot long 2 inch diameter aluminum boom were used. The boom was attached to a two inch OD waterpipe mast about 2 feet above the rotor by means of a boom to mast fitting supplied by Cubex. The AR22 rotor (adequate for rotating but not for holding this antenna is one direction on a windy day) was mounted on a 55′ crank up tower. For additional support of this boom 18′ of 1½″ OD water pipe was run parallel to it beneath it and clamped to the boom with large TV antenna—vent pipe aluminum clamps. (This piece of pipe also served as a boom for a loaded two element 7 mc parasitic beam.)

The standard 2″ bore aluminum castings supplied by Cubex were used with 13′ pieces of bambo clamped in them as spiders. Hose clamps were used. See Fig. 3. The bamboo was well covered with spar varnish before use. (It is difficult to obtain bamboo in many areas of the country. Consult the yellow pages of your telephone book. The Sea and Jungle Shop, Glendale, Calif. has a large permanent stock and will ship quality bamboo.)



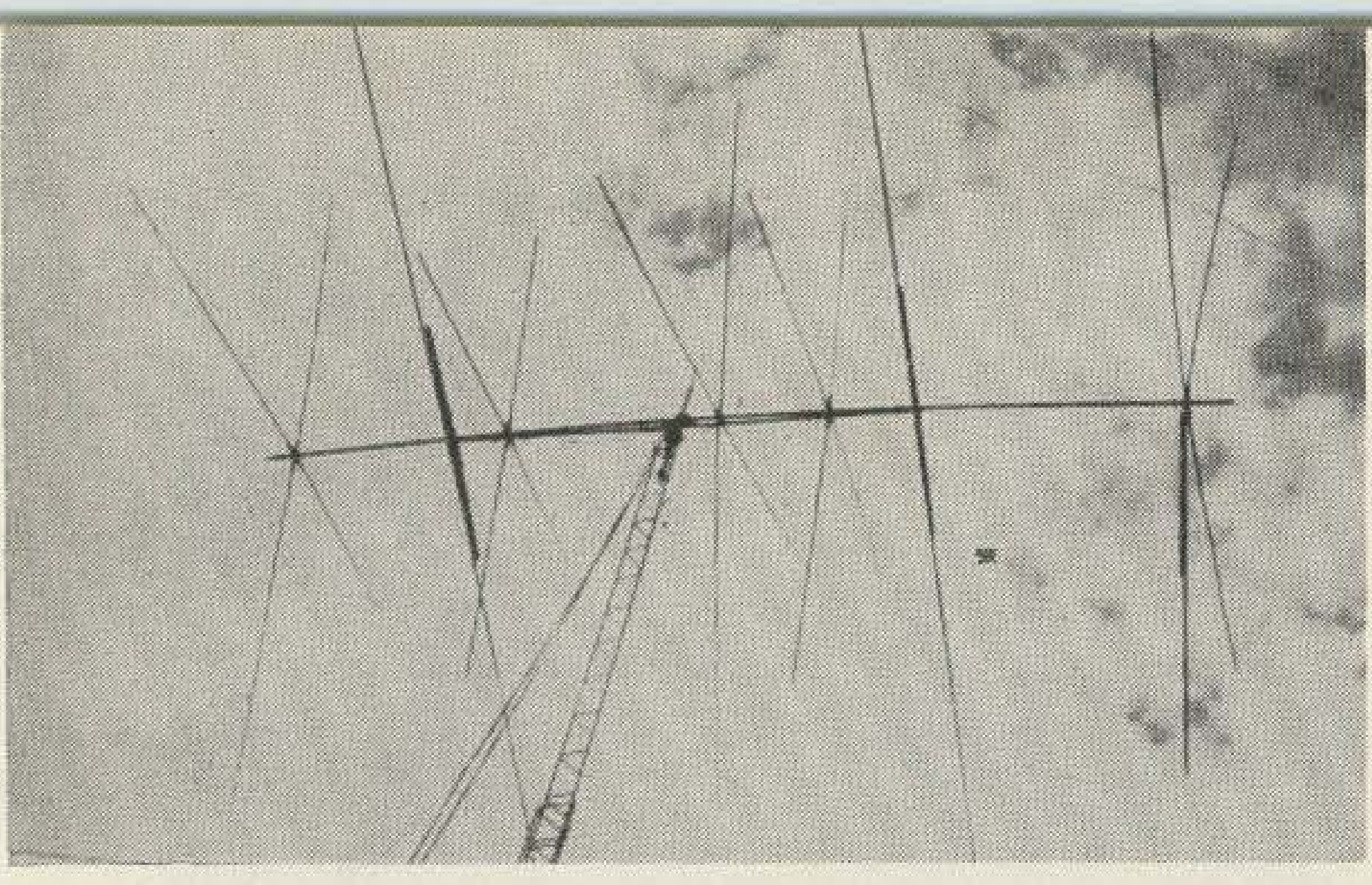
Quad closeup. A 10 element 2 meter beam in center.

The arrangement of the elements is shown in Figs. 4 & 5.

Elements were made from soft #14 copper wire. The corner of each element was attached to the bamboo support arm with another loop of wire. This loop ran through a hole drilled in the very tip of the arm and thus the element could be loosened or tightened as required by varying the length of the loop.

Electrical Construction

As I have mentioned the original element lengths were calculated by the use of the 948 FD constant of VE3IT. The resulting resonant frequencies (estimated from SWR measurements) were 15025, over 22500, and over 29600 kc. The corresponding driven element lengths were 69.4 46.3 and 34.5 feet. By the addition of tuning stubs to each element it is possible, altho not too practical, to resonate the quads. The stubs were several feet long. Large coils made from loops of wire one to three feet long as required were added in pairs, three feet from the center of each element to increase its length. The elements were thus extended to employ the more recently



View of complete quad.

published constants described in letters to QST by W1WTF, W2GJD, and W5GGV (as reproduced in the Malayan Radio Amateur, March/April 1959 pages 15-17). W1WTF reports the constant FD as 1004 from 10, 15, and 20 meter measurements by W1ALK, W1HTR and himself. W2GJD reports FD as 1004 on 10 and 15 meters and as 1042 on 20 meters in a 3 band quad, as 1022 in a one band quad, and as 1012 in a two band (10/15 meter) quad. W5GGV obtained FD of 1004 on a 14 mc quad in the air (QST, April 1957). From my own experiments the values derived for this quad are in Table II. The F of Table II is the point of minimum SWR for the quad measured 56′ above the ground after tune up. Note that the geometry of the coils used may vary these dimensions slightly.

The quads were all fed with 52 ohm RG8/U coaxial cable through gamma matches. The gamma matches were constructed by removing the copper braid from RG8/U coax and slipping the portion remaining through a length of ¼″ aluminum tubing to form a condenser. Shorting bars were made of aluminum strips ½″ wide, ⅛″ thick. Gamma match rods were spaced about three inches from the wire of

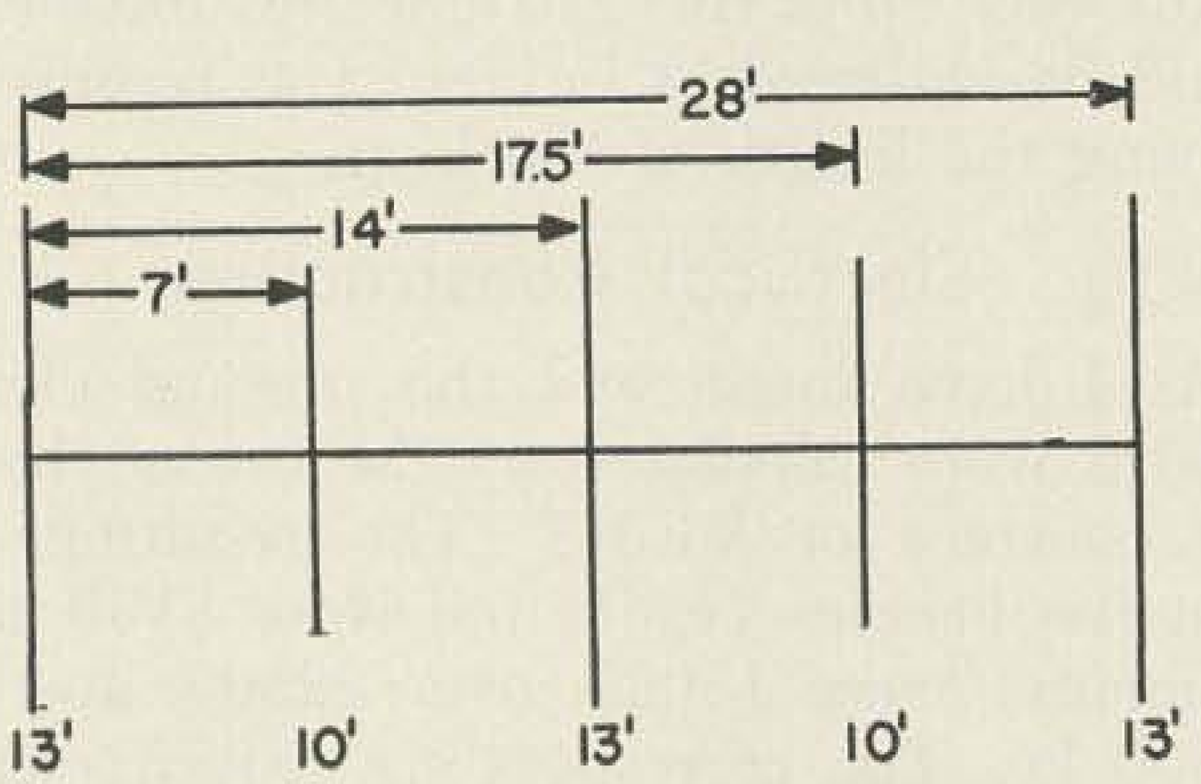


FIG 4

Bambo Length feet	13′	10′	13′	10′	13′
Band					
14	Director	—	Driven	—	Reflector
21	—	Director	—	Driven	Reflector
28	Director	Driven	Reflector	—	—

Element spacings for the three element quads for three bands on one boom.

Designer	Design Freq. mc., F	Director feet	Driven el. feet, D	Reflector feet	Constant FD
K6DDO	14.050	68.2	71.6	75.2	992
K6DDO	21.100	45.45	47.75	50.2	1002
K6DDO	28.200	34.1	35.8	37.6	1010

Table II. Element lengths

the driven elements. The following measurements of SWR from the quads in the air were obtained: 14000, 1.35; 14050, 1.30; 14350, 1.85; 21000, 1.25; 21100, 1.05; 21450, 1.40; 28000, 1.30; 28200, 1.07; 28800, 1.90; 29600, 3.20. The adjustment of the gamma capacitors was not too critical and the distance of the shorting bar from the center of the driven element was 2′ on 10 meters, 3′ on 15 meters, and 4′ on 20 meters.

Front to back ratios were on the order of 30 db on each band in local tests. Front to side ratios ran as high as 50 db for locals but these ratios were variable in the case of skip signals.

Results

In two months of routine CW and Phone operation during poor summer conditions from the middle of July to the middle of September I worked my second WAZ and my second DXCC and had good success in pile ups. The quad readily beat out any sort of loaded or trap beam and was somewhat better than 2 element quads and 3 element beams. It had a signal comparable to a well designed 6 element Yagi. About 1000 DX QSOs were made in these two months.

The quad rode through the second highest winds ever recorded in Los Angeles, 48 MPH (49 MPH is the record), in fine style only to have the tower knocked from under it by a falling 2 X 4 mast the next day. It survived a windstorm in which some 150 trees in Hollywood and vicinity were blown down.

The most enjoyable feature of this antenna was that we could call CQ once during a band opening to Europe and usually be assured of plenty of DX calling in reply. It was possible to raise one station on the CQ and have DX stations then call for a couple of hours afterward as contacts were completed. Since then many 3 element quads have been built. Some of the big quads can be found at VK3AHO, W4AZK, W5SVP, K6BPY, K6CT, WA6HUM, K6PRU, and K7HXB.

In conclusion I wish to thank my family, K6CEO, K6IDA, W6RW, the Cubex Co., VK3AHO and the others who helped with the project.

. . . K6DDO

Propagation

EASTERN 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	7	14	14	14
Argentina	14	14	14	7	7	7	14	14	14	21	21	21
Australia	14	14	14	7	7	7	7	7	7	7	14	14
Canal Zone	21	14	14	7	7	7	14	14	14	14	21	21
England	14	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	14	14	14	14	14	14	14
Japan	14	14	7	7	7	7	7	7	7	7	14	14
Mexico	14	14	14	7	7	7	14	14	14	14	14	14
Philippines	14	14	14	7	7	7	7	14	14	7	14	14
Puerto Rico	14	14	7	7	7	7	14	14	14	14	14	14
South Africa	7	7	7	7	7	14	14	14	14	14	14	7
U.S.S.R.	14	7	7	7	7	14	14	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	14	7	7	7	7	7	7	14	14
Argentina	21	14	14	7	7	3	14	14	14	14	21	21
Australia	21	21	21	14	14	7	7	7	7	7	14	14
Canal Zone	21	14	14	14	7	7	7	14	14	14	21	21
England	14	7	7	7	7	7	7	14	14	14	14	14
Hawaii	14	14	14	14	7	7	7	7	14	14	14	14
India	14	14	7	7	7	7	14	14	14	14	14	14
Japan	14	14	14	7	7	7	7	7	7	7	14	14
Mexico	14	14	14	7	7	7	7	14	14	14	14	14
Philippines	14	14	14	7	7	7	7	7	14	14	14	14
Puerto Rico	21	14	14	7	7	7	14	14	14	14	21	21
South Africa	7	7	7	7	7	7	14	14	14	14	14	14
U.S.S.R.	14	7	7	7	7	7	14	14	14	14	14	14

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	7	7	7	7
Argentina	21	14	14	7	7	3	7	14	14	14	21	21
Australia	21	21	21	14	7	7	7	7	7	7	14	14
Canal Zone	21	21	14	14	7	7	7	14	14	14	21	21
England	14	7	7	7	7	7	7	7	14	14	14	14
Hawaii	14	14	21	14	14	7	7	7	14	14	14	14
India	14	14	14	14	7	7	7	7	14	14	14	14
Japan	14	14	14	14	14	7	7	7	7	7	14	14
Mexico	14	14	14	7	7	7	7	14	14	14	14	14
Philippines	14	14	14	14	14	7	7	7	7	14	14	14
Puerto Rico	14	14	14	7	7	7	7	14	14	14	14	14
South Africa	7	7	7	7	7	7	7	14	14	14	14	14
U.S.S.R.	14	7	7	7	7	7	7	14	14	14	14	14

July Forecast

Good: 1-2, 9-10, 12-13, 16-19, 22-23, 26-31

Fair: 3-5, 8, 14-15, 21, 25

Bad: 6-7, 11, 20, 24

Es: 8-9, 12-13, 29

Es means the possibility of a high MUF and/or freak conditions.

Items of Interest

1. We are presently about one year from the minimum portion of the 11 year sunspot cycle. Monthly average sunspot numbers this year have been January 19, February 23, March 17, April 30. May is also showing an increase over March but this is temporary and the numbers should fall again. The last year comparable to the present was 1953 preceding the low of 1954. In 1954 the sun was nearly bare of spots for the first six months.

2. The useful frequencies of 1963 are almost identical to what they were in 1953 and signal qualities also show the same pattern. At this portion of the 11 year cycle, the Winters are bad and the Summers are quite good.

3. During the 22 orbits of Cooper's wonderful mission the Sun carried three sunspot groups one of which was as large as any sunspot the sun has produced in the past two years. This large sunspot, however, was quiet and actually improved radio conditions by raising the MUF; and on May 16th radio conditions for the astronaut's flight were perfect on both Atlantic and Pacific paths. The early part of the 15th, however, was slightly below normal on Pacific paths due to absorption.

J. H. Nelson

Active SSB Modulators

Staff

An earlier portion of this series of articles on sideband might have led you to believe that *only* diode modulators are used in modern sideband circuitry.

Tain't so. "Active" modulators—those involving tubes or transistors, and thus capable of providing some amplification of the signal instead of mere loss—are also widely used.

It's common knowledge, of course, among active sidebanders, that active modulators are used. But many active sidebanders seem to believe that only a few such circuits exist.

This ain't so either. A search of the literature going back to the earliest days of the current sideband boom (early 1948) revealed a minimum of 15 circuits. Each of these, of course, is subject to an infinite number of minor variations as well.

Before we dive into the intricacies of these 15 circuits, though, let's make some comparisons between active modulators and those of the diode variety. You just might not want to wade through all the active-modulator circuits —and then again you might.

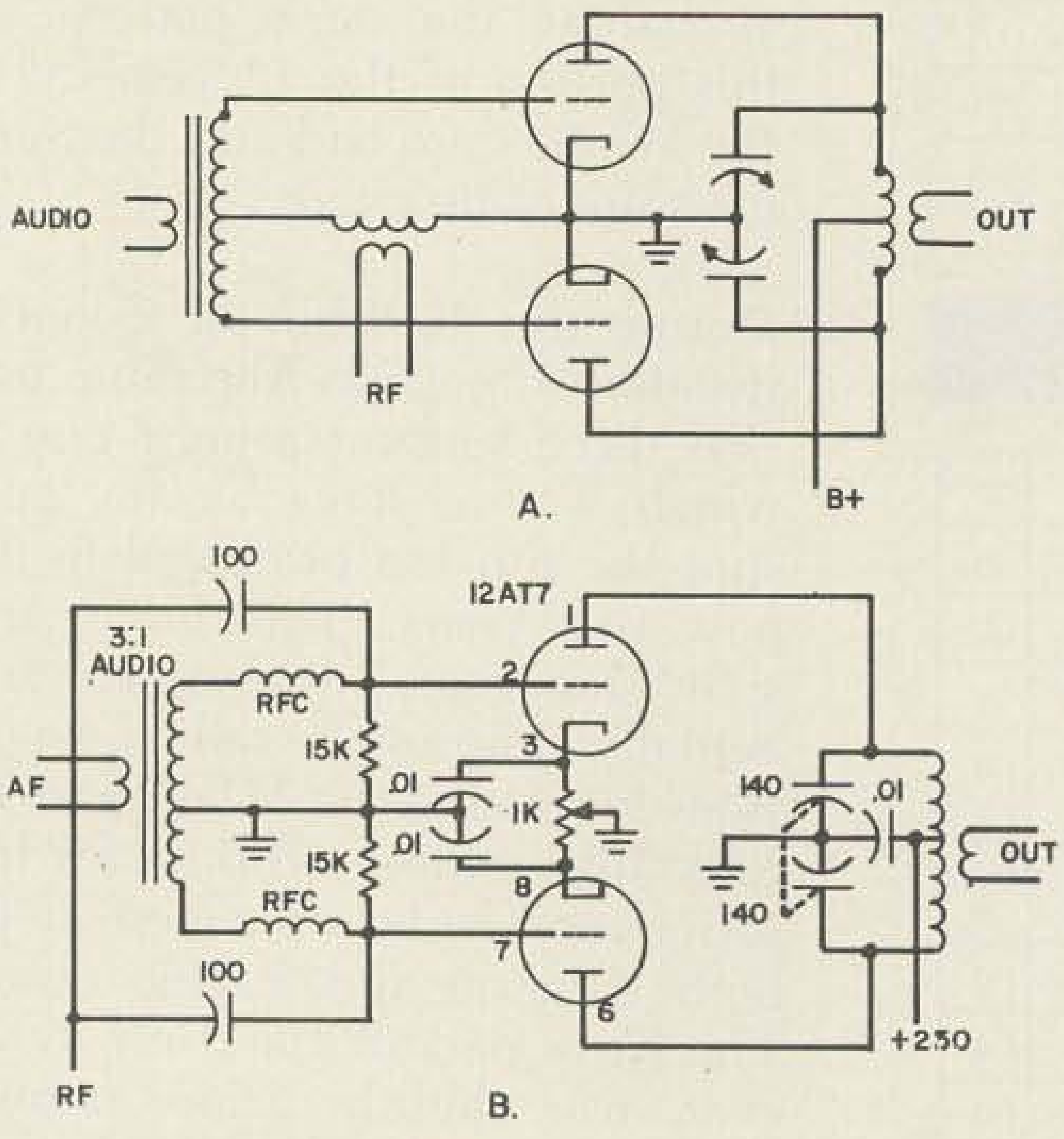


FIG. 1

A. Basic Circuit
B. Practical Circuit
Push Pull Balanced Modulator

The major characteristics of the diode modulator are its simplicity, low number of components, absence of power-supply requirements, and relative freedom from aging.

The active modulator, on the other hand, has (in addition to the opposite of all the characteristics just mentioned) the capability of amplifying the signal instead of just producing losses.

For a given amount of rf output power, you're going to have to use about the same number of active devices. The real choice, then, becomes one between a diode modulator plus an extra linear amplifier, or an active modulator without the amplifier.

And viewed in this light, it becomes one of those things about which there is much difference of opinion. Some people prefer to battle it out with the amplifier, while others prefer to fight their problems with the modulator.

If you're interested in going *double* sideband instead of single, then the active modulator is recommended. You can build one of these to operate at a kw if you like, and avoid *all* amplifiers (such a circuit, although for a more practical power level, is included in our list).

Ready to look at circuits? Let's get with it.

One of the most basic of the active modulator circuits is that shown in Fig. 1, the push-pull balanced modulator. Fig. 1B shows the practical version of the circuit, including balance control and means for routing rf and audio to their proper places.

This circuit works something like an electronic switch, turning the carrier off and on under the control of the audio (or other modulating signal—wherever "audio" is mentioned in this article, rf of a different frequency than the carrier can be substituted equally well and then the circuit becomes a "mixer").

Thus, when the grid of the upper half of the tube (in Fig. 1) becomes less negative, more of the carrier flows through this tube. At the same time, the lower grid becomes more negative, cutting off carrier flow through this half of the tube.

The carrier is eliminated because it affects both grids equally and plate current in both halves of the tube goes in the same direction at the same time. This current flow cancels itself out in the push-pull tank circuit.

However, incoming audio drives one grid positive while the other goes negative, allowing current to flow more through one half than the other as mentioned earlier. This flow, being different in the two halves of the tank circuit, does *not* cancel out—it shows up instead in the output as the sidebands, less the carrier.

The *modified* push-pull balanced modulator of Fig. 2 works the same way. Carrier is injected into the cathodes of both tubes, in phase. Audio is injected into only one; it affects the other because, for audio, the two tubes form a "long-tailed-pair" phase inverter circuit.

This phase inverter is worthy of special mention. The secret of its success is the 33K resistor in the common cathode circuit. In addition, the resistive loads in the plate circuits are necessary.

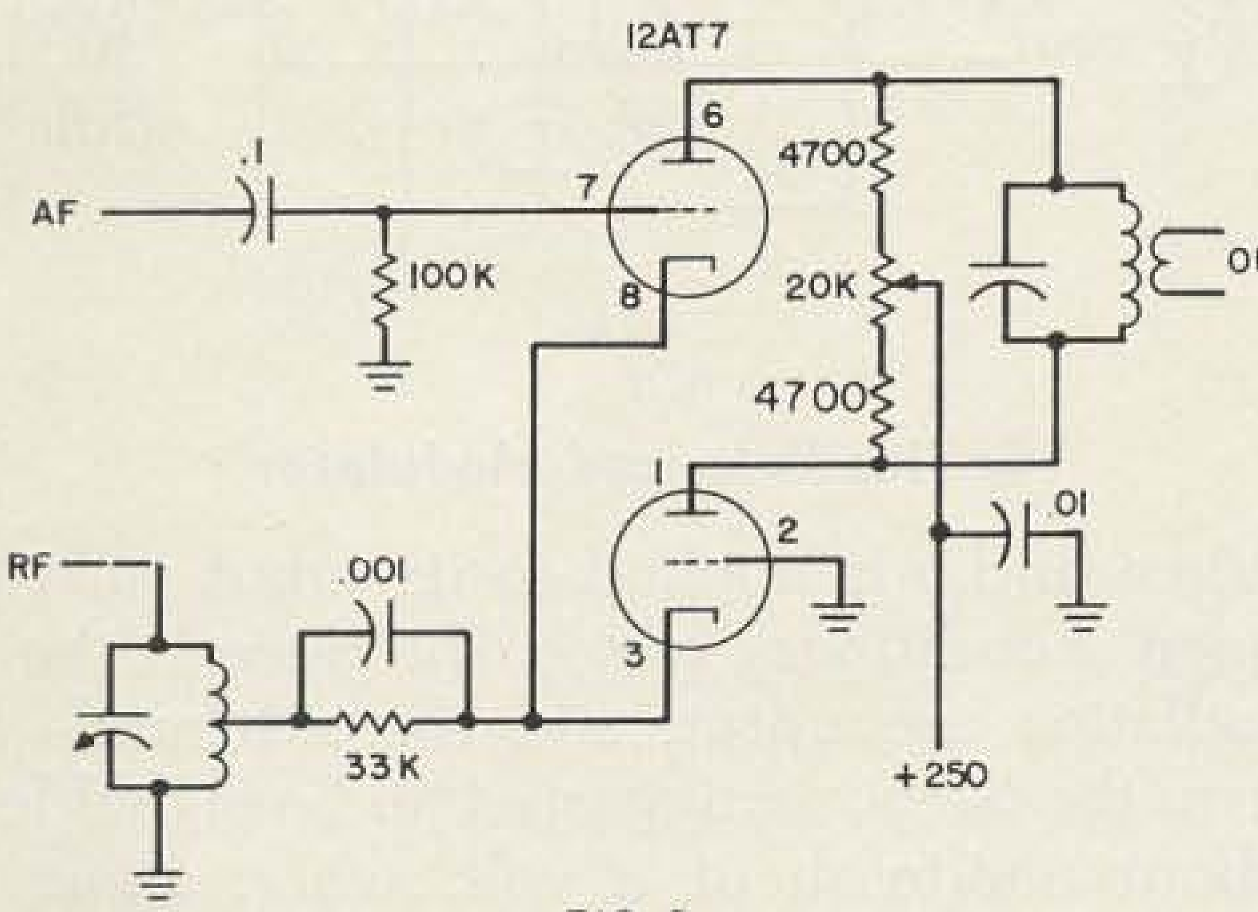


FIG. 2

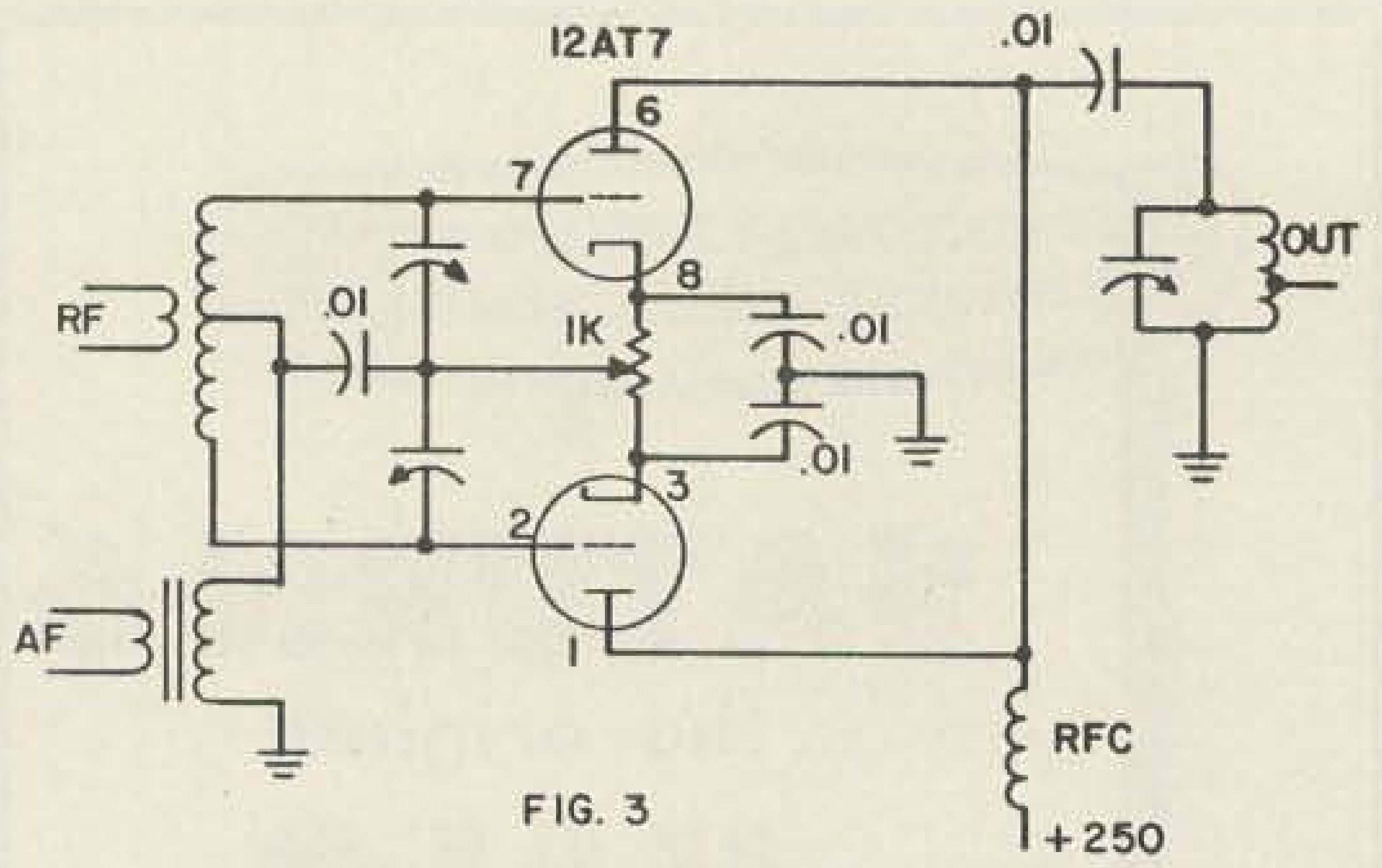
Modified Push Pull Modulator

Under these conditions, the upper tube acts a little like a cathode follower for the audio coming into its grid. The audio appears across the cathode resistor, which is much larger than the plate resistors. The lower tube, then, functions as a grounded-grid amplifier. However, the upper tube in addition to being a cathode follower acts a little like a conventional amplifier too.

A conventional amplifier shifts the phase of incoming signals 180 degrees; cathode followers and g-g amplifiers do not shift phase at all. Thus the audio signals at the two plates must differ by 180 degrees—and this implies that the audio at the two grids also differs by the same amount, thus satisfying the requirement for push-pull input!

Both the circuits we've seen so far use push-pull input and push-pull output, with the modulating signal applied in parallel. Now let's look at one which uses single-ended output.

This is the push-push balanced modulator



Push Push Balanced Modulator

of Fig. 3. So far as the rf circuit is concerned, this circuit is identical to the push-push frequency doubler with one exception. The output circuit is tuned to the same frequency as the input.

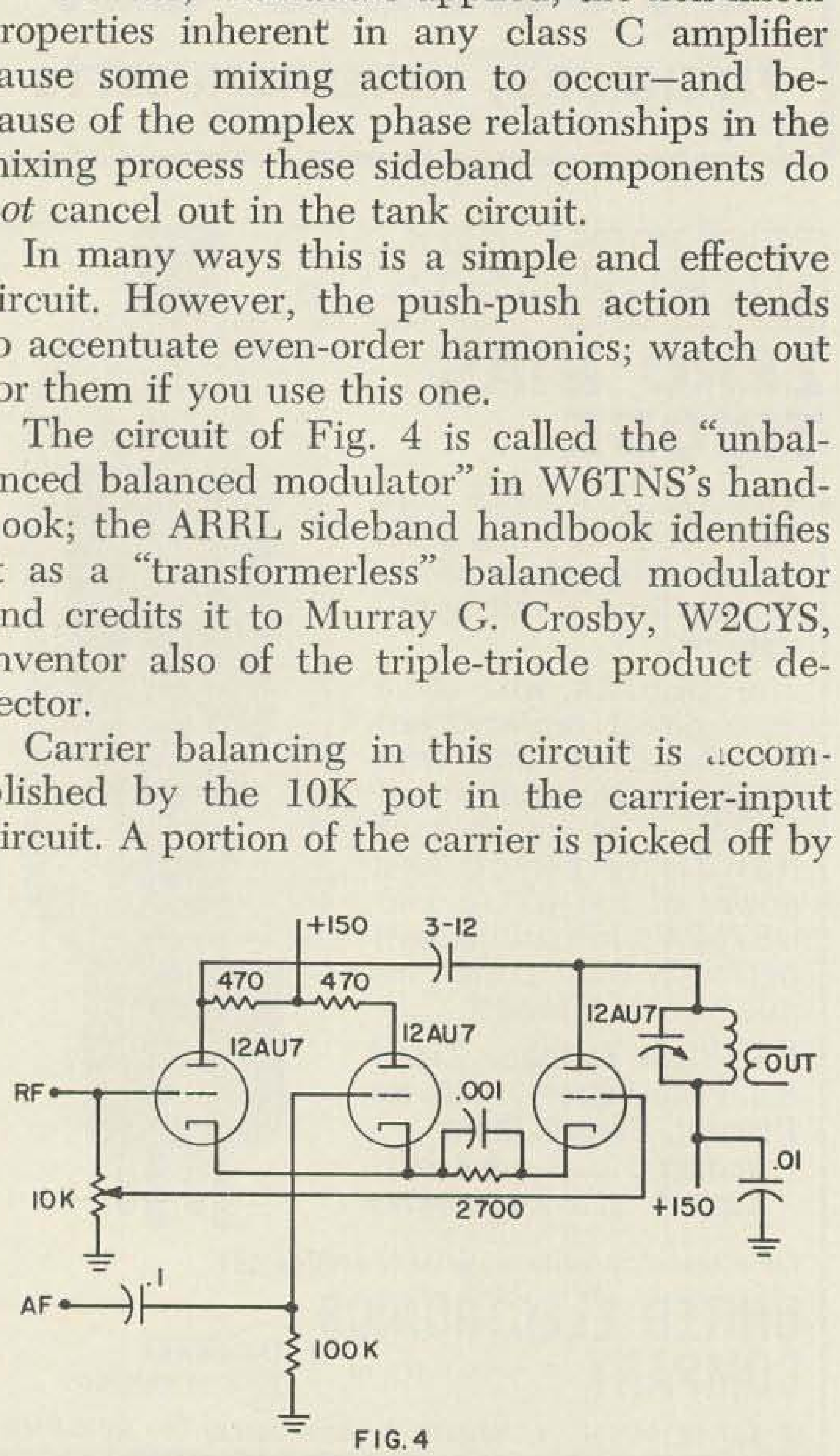
Carrier is balanced out because one of the two tubes is always conducting (in the absence of audio) and the plate-current pulses fill each other in. You might say they beat each other's brains out at the tank circuit.

However, with audio applied, the non-linear properties inherent in any class C amplifier cause some mixing action to occur—and because of the complex phase relationships in the mixing process these sideband components do *not* cancel out in the tank circuit.

In many ways this is a simple and effective circuit. However, the push-push action tends to accentuate even-order harmonics; watch out for them if you use this one.

The circuit of Fig. 4 is called the "unbalanced balanced modulator" in W6TNS's handbook; the ARRL sideband handbook identifies it as a "transformerless" balanced modulator and credits it to Murray G. Crosby, W2CYS, inventor also of the triple-triode product detector.

Carrier balancing in this circuit is accomplished by the 10K pot in the carrier-input circuit. A portion of the carrier is picked off by



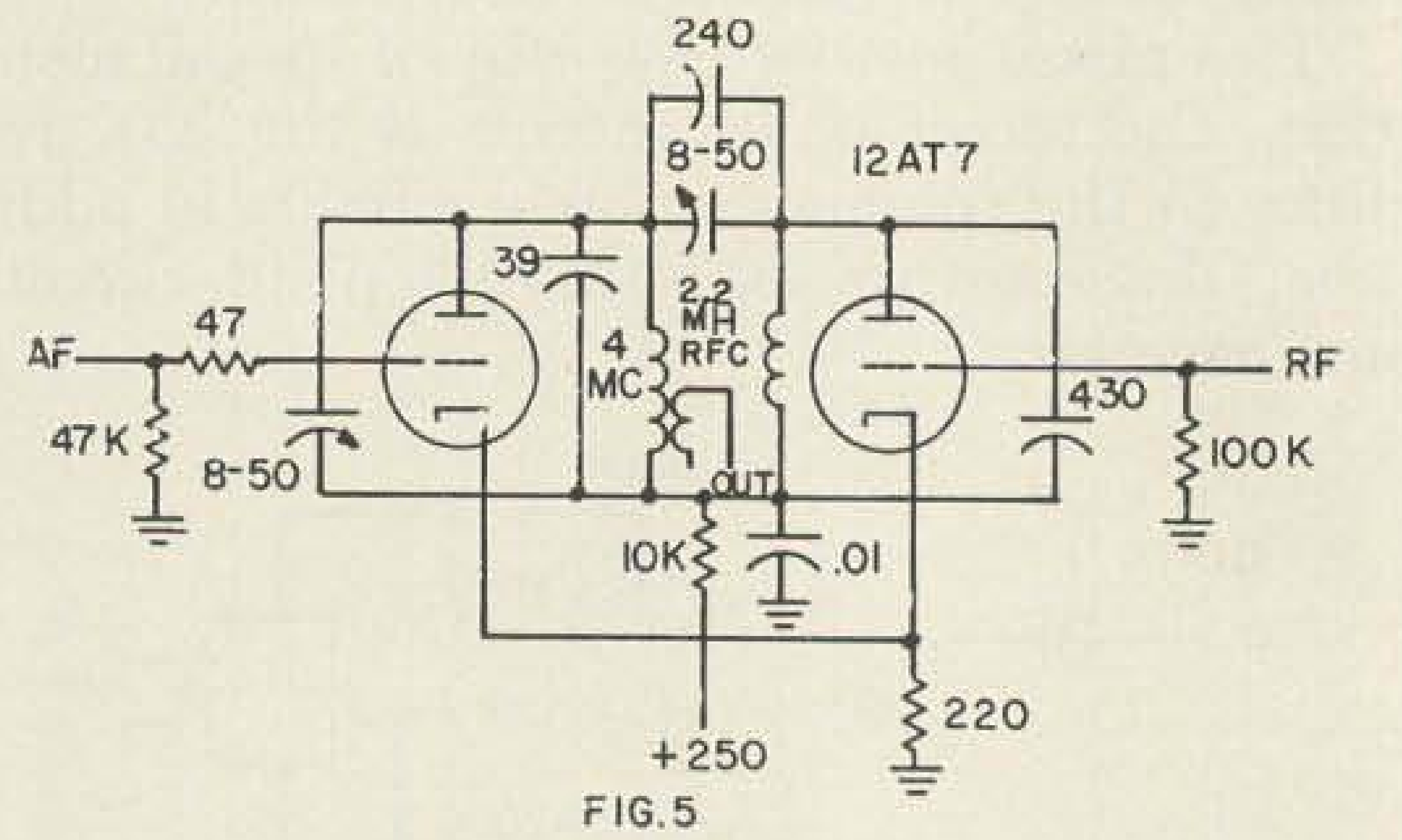
Crosby "Unbalanced" Balanced Modulator

this pot and fed, out-of-phase, to the output circuit. The adjustable capacitor is used to neutralize capacative feedthrough in the tubes.

The major advantage of this circuit, aside from novelty, appears to be the exceptionally low distortion created. Crosby reports distortion less than ½ of 1 percent, using this design.

Another active modulator which does not require push-pull circuitry is shown in Fig. 5. This one is used in the KWS-1 for frequency conversion, but can also be used for audio modulation.

In the absence of audio input, the circuit acts as a long-tailed phase splitter for rf, and the out-of-phase rf is then cancelled out in the plate circuit.



Collins Balanced Modulator

When audio is applied to its input jack, the balance conditions which produced the rf cancellation are upset, and the sidebands appear in the output. Suggested audio signal level is about one-tenth of a volt, while about 1½ volts of the rf are required.

All the active-modulator circuits looked at so far require plate-supply power. The circuit of Fig. 6, though, known as the "plate-modulated" balanced modulator when By Goodman, W1DX, first described it in the November, 1949, QST, requires no power except for the filaments.

The principles of operation here are very similar to the circuit of Fig. 1, except that the audio is fed to the cathodes rather than to the grids. Plate power is supplied by the audio input only, however. In the absence of audio, no

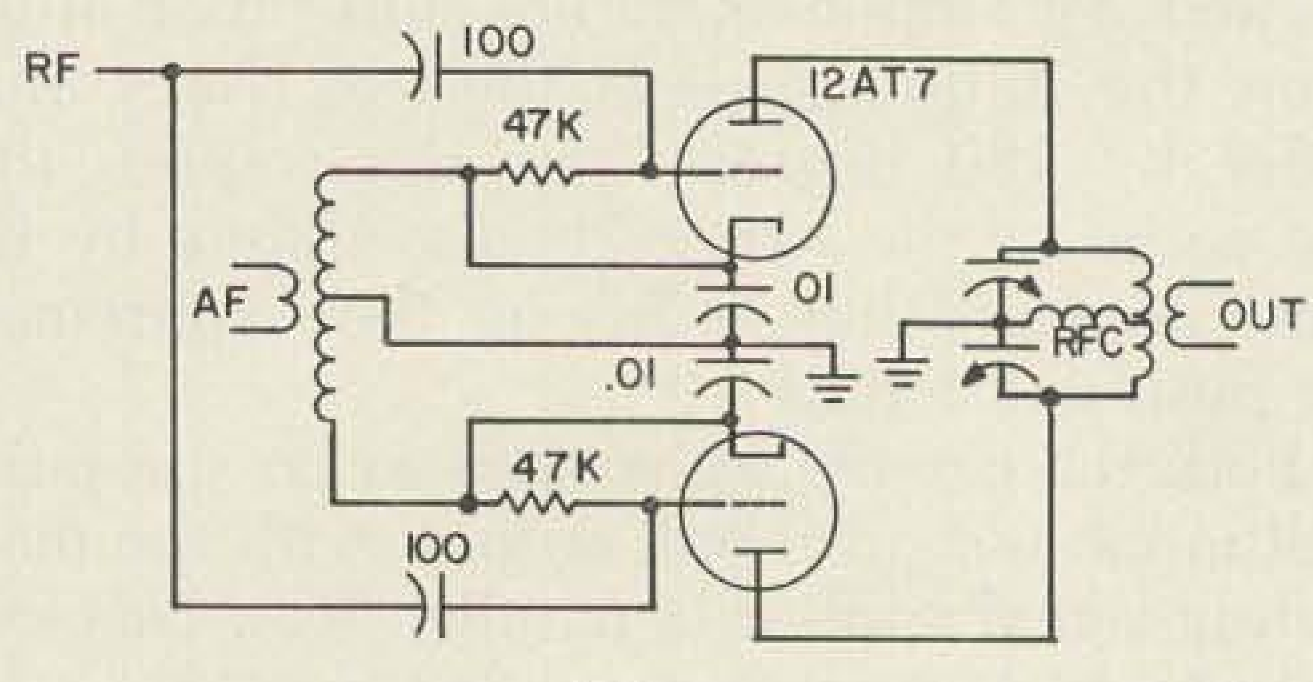


FIG.6

Plate-modulated Balanced Modulator

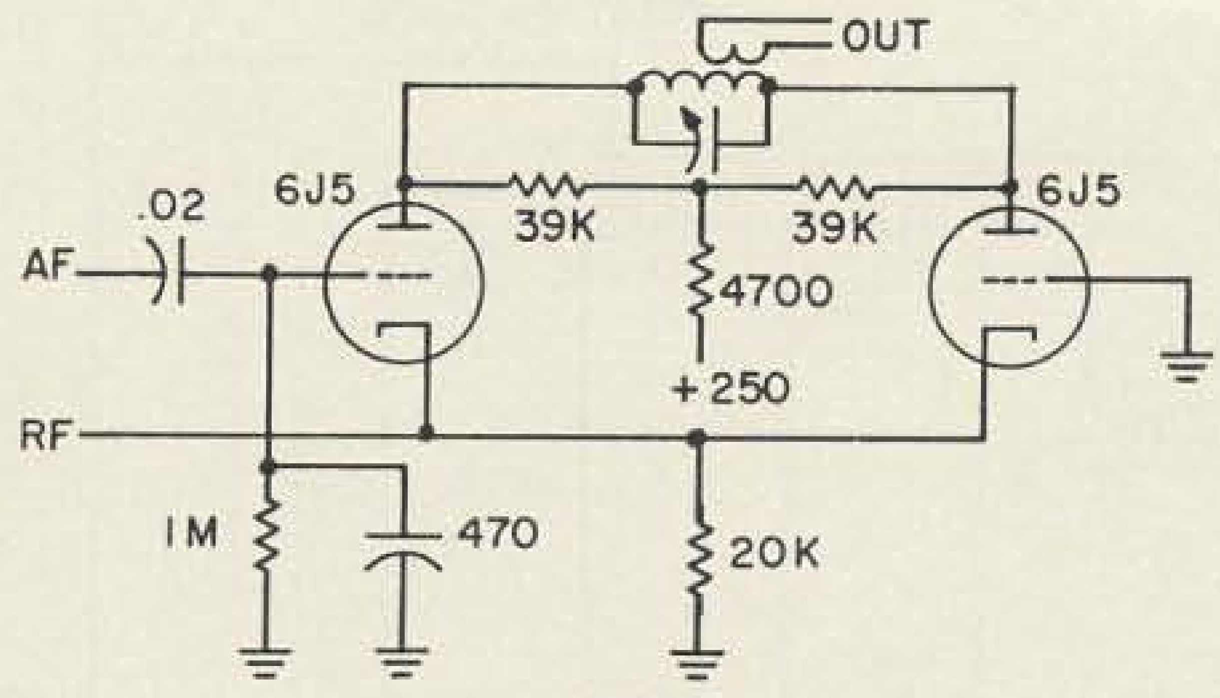


FIG 7
W7BMF/Motorola Balanced Modulator

power is applied to the stage and nothing naturally, gets through. When audio is applied, one cathode goes positive while the other goes negative. The tube whose cathode is positive does nothing—but the one whose cathode goes negative can then amplify so long as the audio half-cycle lasts, and routes carrier and sidebands through to the output. The carrier balances out in the push-pull tank, leaving the sidebands.

The circuit shown in Fig. 7 is credited to W7BF in its first published appearance, with the note that it is "swiped from Motorola." Its major feature is that it does not require push-pull input for either the audio or rf signal; rf input is to a 20K cathode resistor common to both tubes, while the audio signal is phase-split by the pair acting as a long-tailed splitter.

In many ways, this circuit is similar to the one shown in Fig. 2. The major differences are the high-impedance untuned rf feed to the cathodes, and the RF filter included in the audio input circuit.

All of the active modulator circuits discussed so far give only DSB output; the circuit in Fig. 8, first described several years ago in QST by VE6CN, allows a choice of DSB or phase-modulated output.

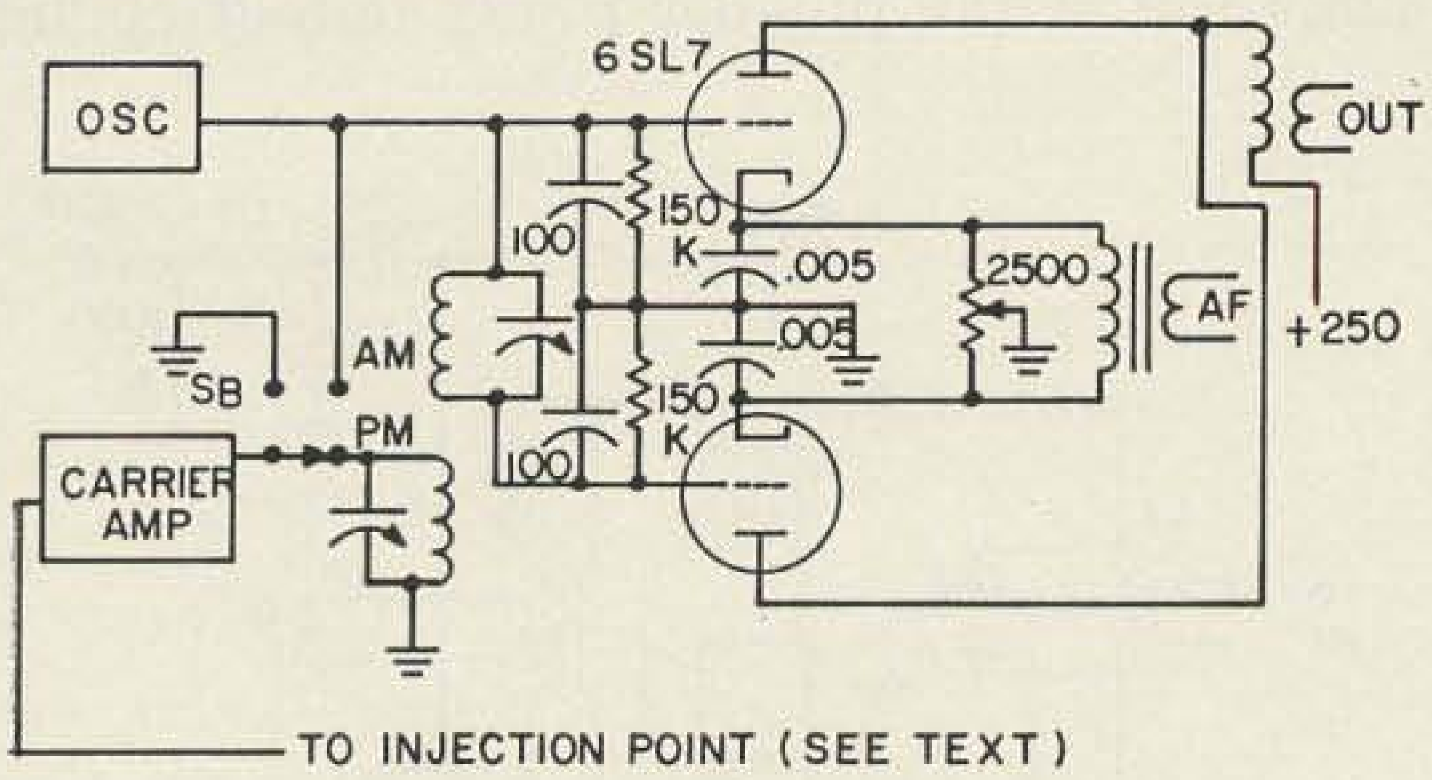


FIG. 8
VE6CN Phase-or-sideband Modulator

This circuit is very similar to the push-push modulator of Fig. 3, with the changes all being in the circuitry between the oscillator and the rf input to the modulator.

With the switch in the sideband position, rf input to the two grids of the modulator tubes

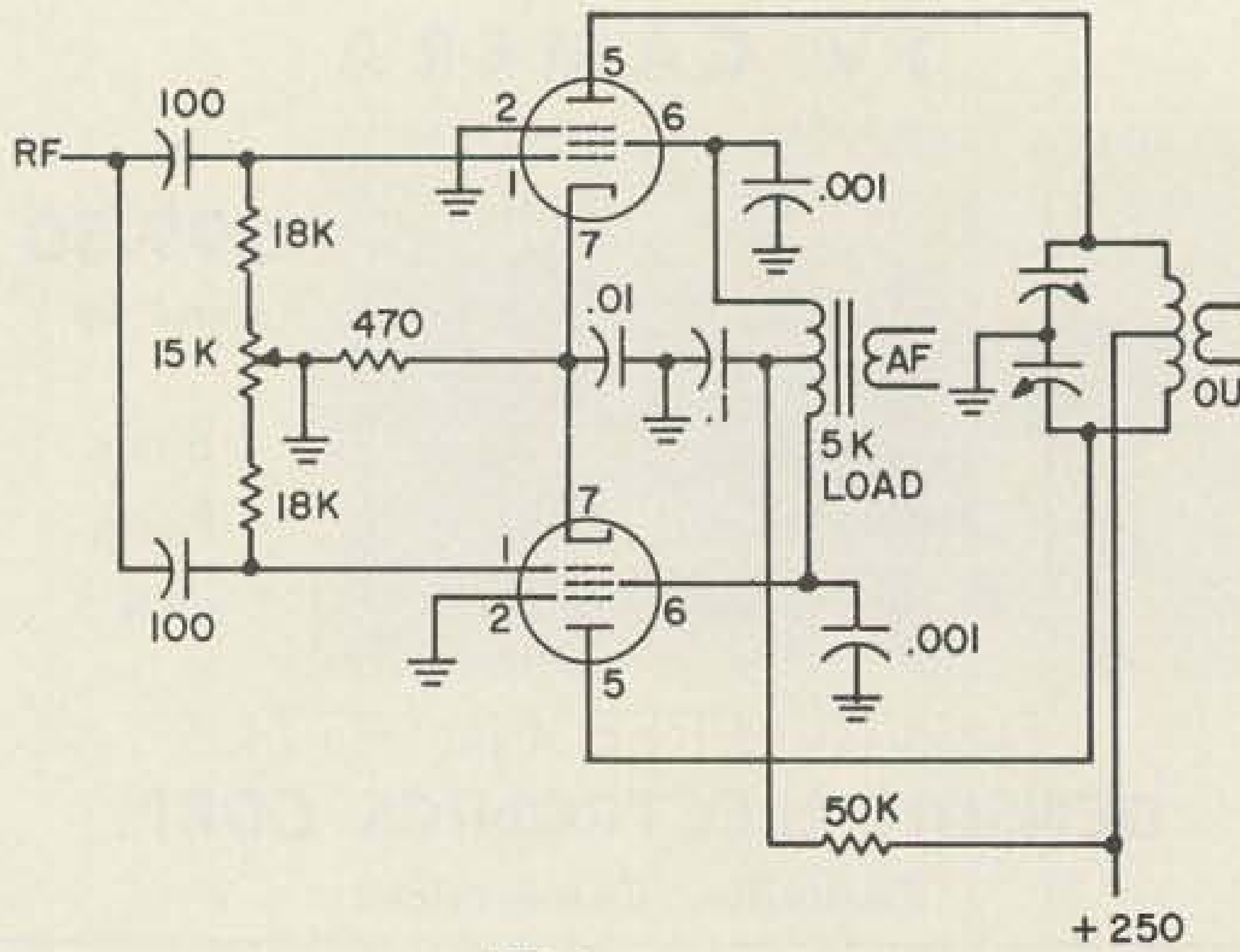


FIG. 9

Pentode Balanced Modulator

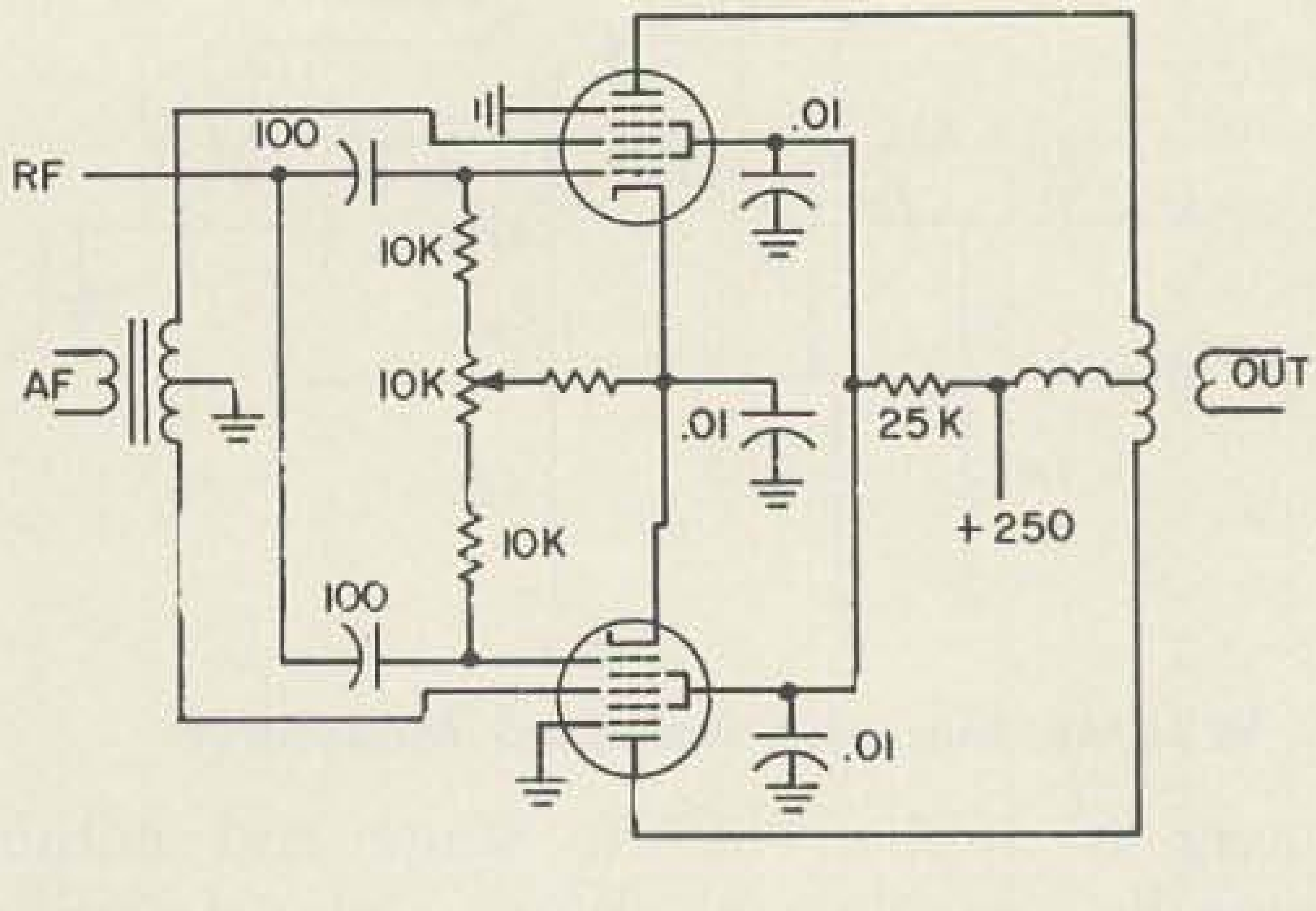


FIG. 10

Pentagrid Balanced Modulator

is applied in push-pull. Filtered sideband output goes on through the transmitter. In the AM position, the same action takes place except that a portion of the rf input is also applied to the "carrier amplifier" and is re-inserted in a stage following the filter. And in the PM position, carrier voltage 90 degrees out of phase with that applied to the modulator is applied to the carrier amplifier.

The 90-degree phase shift between re-inserted carrier and the sidebands produced by the modulator result in phase modulation. This circuit allows good deviation to be obtained without multipliers.

Up until now, we've been looking only at those circuits which use triode tubes. However, pentode and beam-power tubes can also be employed, as can transistors and one type of tube specially made for balanced-modulator service. We'll look at these circuits now.

Fig. 9 shows a balanced modulator using type 6BA6 pentodes. Rf input is applied to the grids in parallel while the output is taken from the plates in push-pull fashion. Audio is applied to the screens push-pull, and in the absence of audio input all the rf carrier balances out. The pot in the grid circuit allows complete balancing of the circuit.

When audio is applied, the tube whose screen goes positive at any instant draws more current than the other, unbalancing the circuit and allowing the sidebands to appear in the output tank.

As shown, this circuit uses positive voltage on the screens. With a bit of juggling, the screens can be returned to ground and then current drain in the absence of audio will be almost nothing at all.

The pentagrid balanced modulator of Fig. 10 derives from a circuit originally described by Villard, W6QYT, in the April, 1948, issue of QST. This was less than 6 months after W6QYT triggered off the current boom in sideband by putting W6YX on the air SSB. It is seldom used any more because of cost of components, but still retains all its advantages of low distortion and easy adjustment!

This circuit operates in the same manner as the pentode circuit of Fig. 9, except that the audio signal is applied to grid-3 instead of to the screen in each tube. Interaction between audio and rf signals is minimized by the screening action of grids 2 and 4.

Though most balanced modulators operate at low signal levels, they need not necessarily do so. The circuit of Fig. 11 is widely used to produce a double-sideband output signal directly in the final stage, and depending on the tube type chosen can produce power ranging from watts to kilowatts!

This circuit operates in exactly the same manner as that shown in Fig. 9 except that the tubes are heftier. Grid input at carrier frequency is fed push-pull fashion simply to allow use of the popular pi-net output circuit.

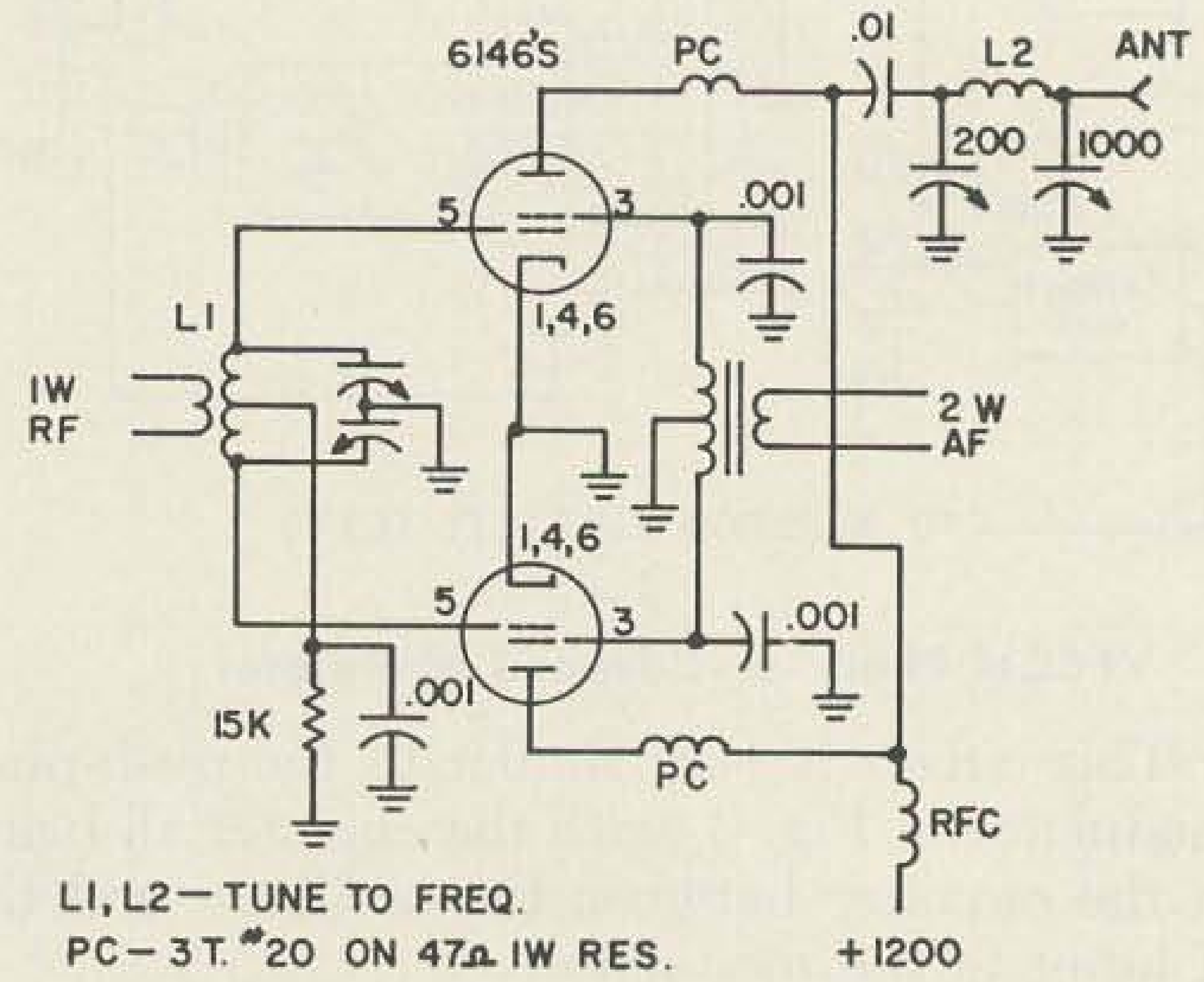


FIG. 11

400-watt PEP DSB Modulator

Modulation is applied to the screens in push-pull.

With the 6146 tubes shown, plate voltage can be as high as 1200 volts. This is twice normal rating, but is no higher than the voltage applied during modulation peaks in AM service! To estimate allowable ratings for other tubes, double the voltage rating for AM service and use anything up to that figure. Current on peaks, though, should not exceed that rated for AM use.

Output power of this circuit, as shown, will be in the neighborhood of 400 watts peak. Maximum indicated input power will be only about 240 watts, however. No-signal plate current should not exceed 25 mils.

And while balanced modulators may operate at either high or low signal levels, they need not always use tubes or diodes. The circuit of Fig. 12 employs a pair of rf transistors.

This circuit operates identically to the triode push-pull modulator of Fig. 1; the differences are entirely due to the differences between tubes and transistors.

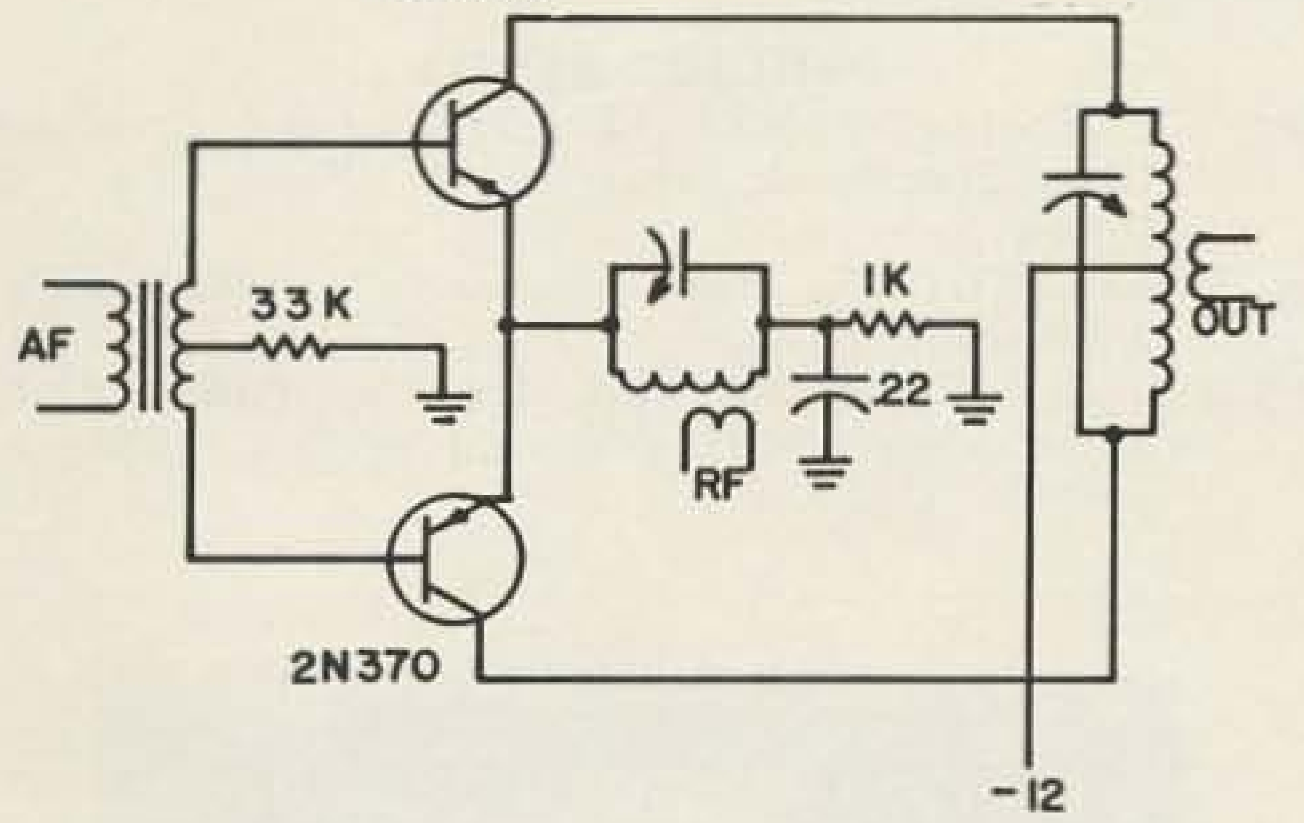


FIG. 12

Transistorized Balance Modulator

RF input is applied to the emitters in parallel, while the radio signal is applied to the bases in push-pull. Note that no base bias is present. Thus, in the absence of audio input the transistors and cutoff and cannot conduct; therefore, balance is not particularly critical.

When audio is applied, only that transistor whose base goes negative can conduct. Carrier balances out in the push-pull tank circuit, leaving only the sidebands to be amplified.

RCA type 2N370 transistors were specified in the original description of this circuit; the newer Amperex 2N2084 "universal" rf transistors should work equally well if not better, due to higher frequency ratings and greater power-handling capability. With 2N370's, power should be kept in the 10-20 *milli*watt region for reliable results.

The final active-modulator circuits we'll ex-

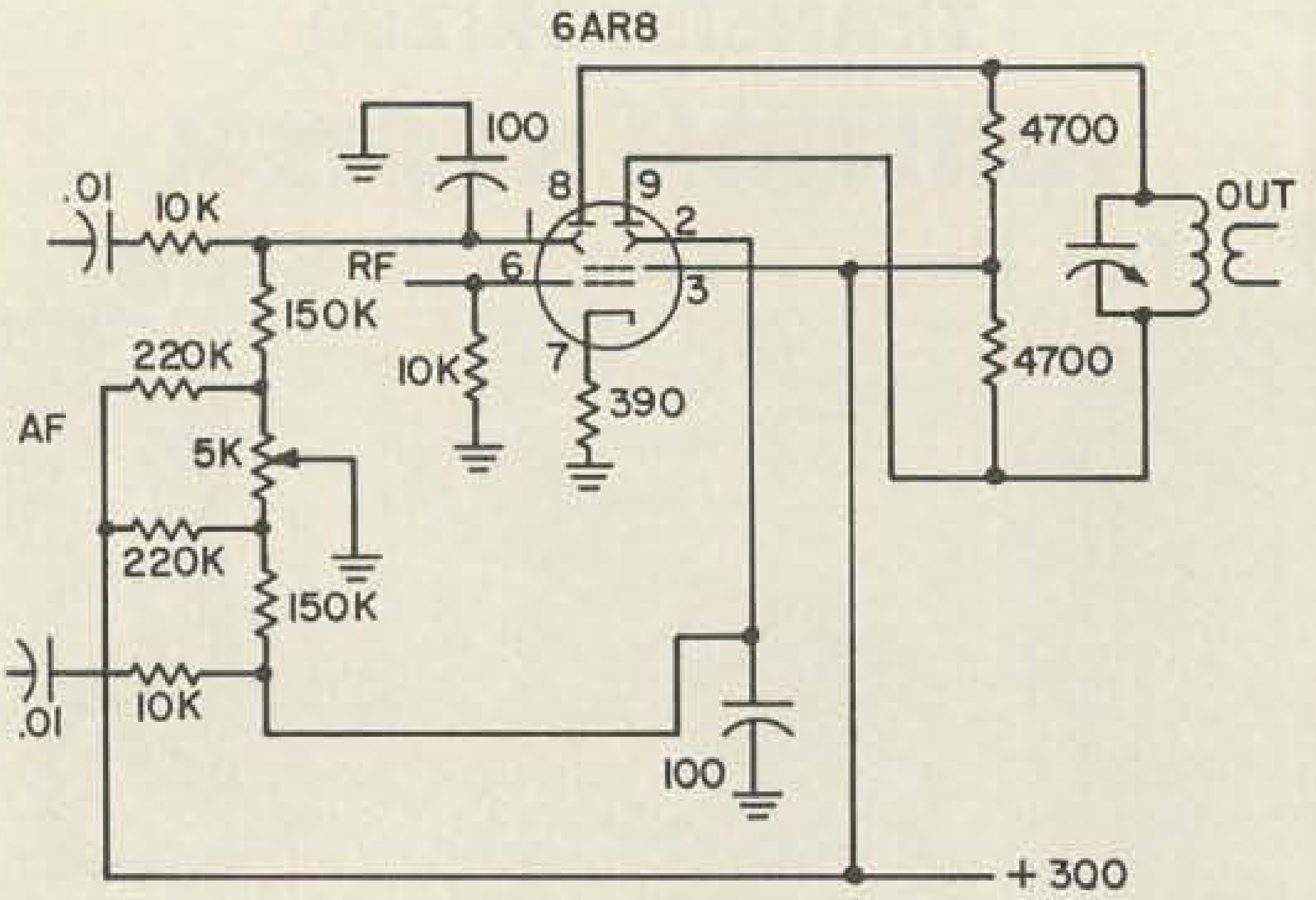


FIG. 13
Orr-Stoner 6AR8 Balanced Modulator

amine are those built around the sheet-beam tube.

This tube was originally developed for color television, and the first one to reach the market in any quantity was the type 6AR8. Bill Orr W6SAI, described a modulator built around this tube in the July, 1956, issue of CQ. The circuit of Fig. 13 is an adaptation of the Orr design.

Unfortunately, the 6AR8 is almost extinct now. However, RCA came out with a special tube designated the 7360 which performs the same function, and which in addition was especially designed for balanced-modulator use. With this tube, 50 db of carrier suppression is easily achieved and even greater suppression can be obtained with a little care.

The circuit shown in Fig. 14 is one recommended for use with the 7360. Note that it is quite a bit more complex than that of Fig. 13. Either should perform well with either tube.

Unlike all the other balanced-modulator circuits, the circuits of Figs. 13 and 14 operate by actual deflection of the electron beam within the tube.

The special tube contains a cathode and control grid, just like ordinary tubes, but then comes a pair of deflection plates (like in a scope tube) and two plates rather than one.

If carrier is applied to the control grid and push-pull audio is applied to the deflection plates, then the carrier signal will determine the amount of current flowing in each plate circuit while the audio signal will determine which plate circuit the current flows into.

The mechanics are actually very similar to those of the pentode modulator, in which the rf current available for each plate was the same but the audio signals applied to the screens determined which plate got the current at any given instant.

If the plates of the sheet-beam tube are connected in push-pull, then the in-phase rf from the control grid will cancel out in the absence of audio. Application of audio to the beam plates will unbalance the circuit, letting the sidebands show up in the output.

Undoubtedly, the circuits described here do *not* include all the possible active-modulator circuits. They do include most of them, though, and all those in wide use are discussed. For additional data on any one circuit, check the references below.

BIBLIOGRAPHY

Harry D. Hooton W6YTH, **Single-Sideband Communications Handbook**, Howard W. Sams, Inc., Publisher.

Don Stoner W6TNS, **New Sideband Handbook**, Cowan Publishing Corp.

ARRL Staff, **Single Sideband for the Radio Amateur** (first edition, 1954; second edition, 1958; third edition, 1962).

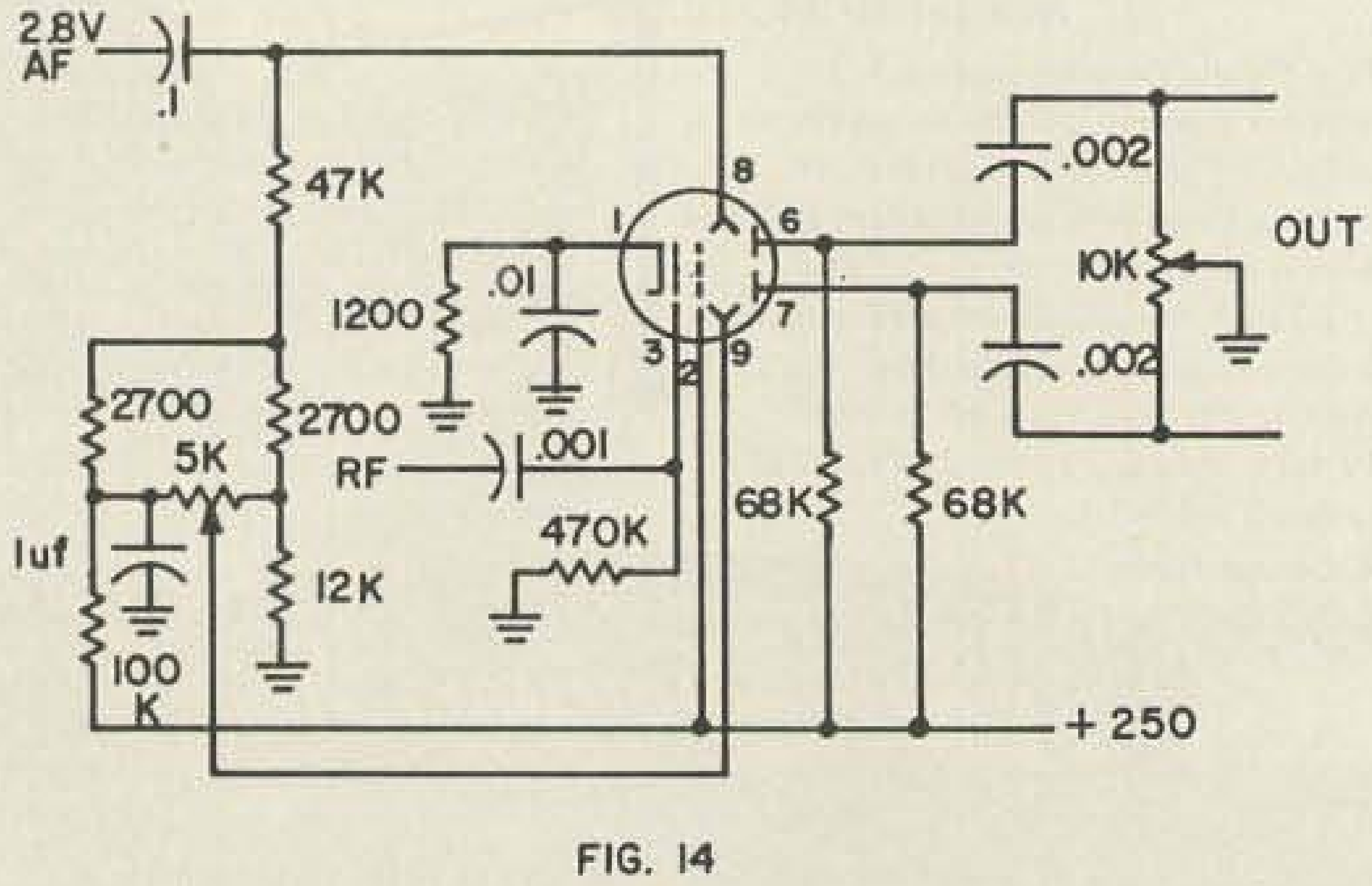
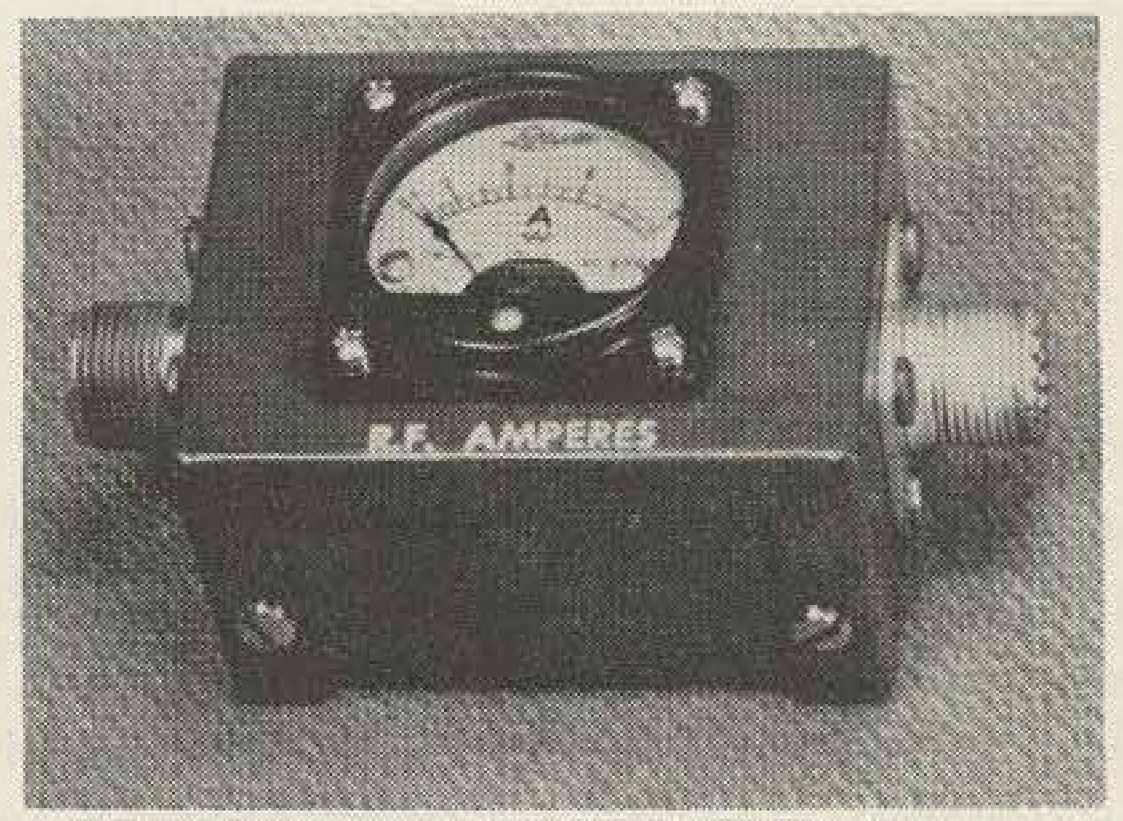
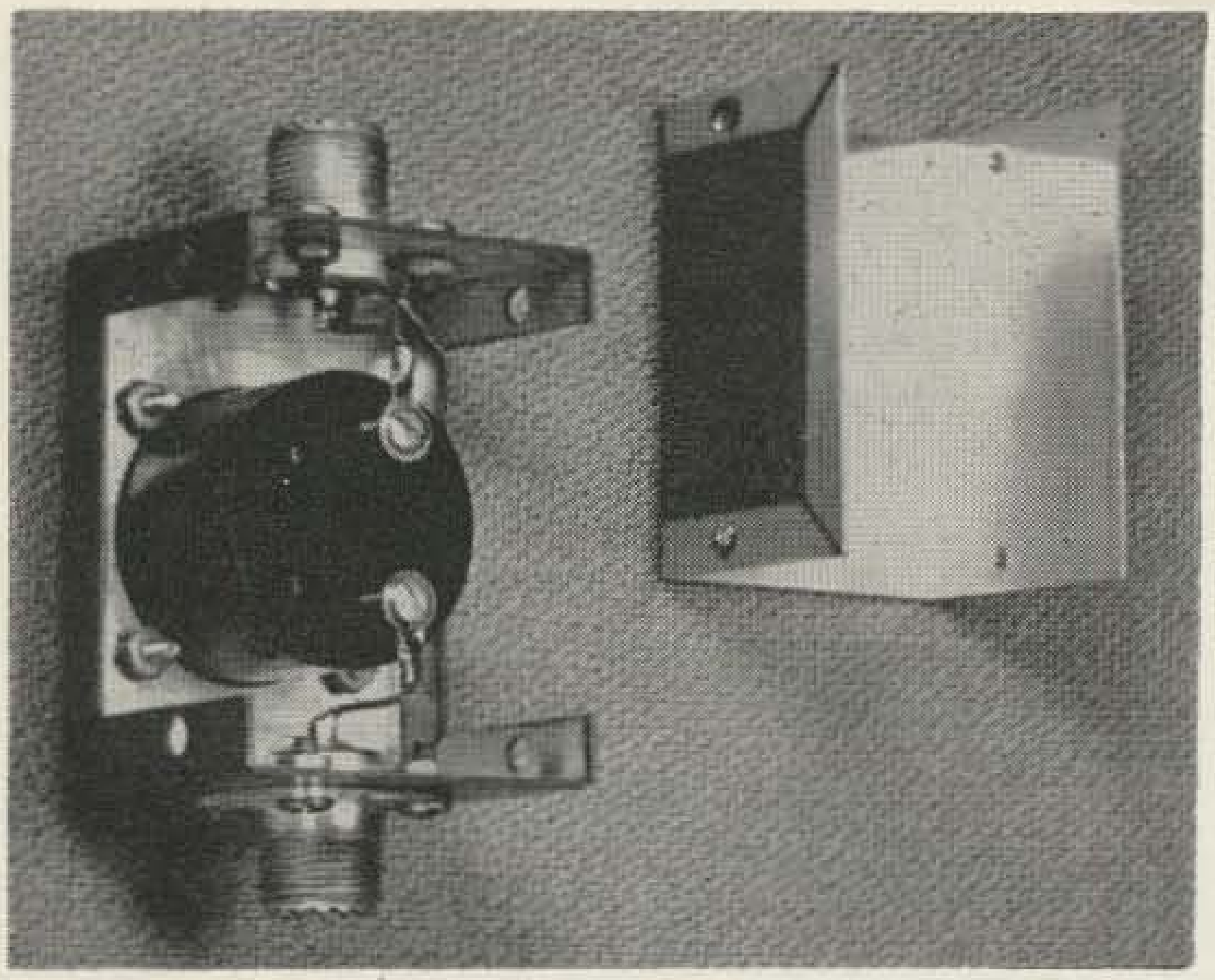


FIG. 14
Sheet-beam Modulator using type 7360



New Look in RF Ammeters

The amateur today can pick and choose from a wide variety of commercially available SWR bridges, impedance bridges, relative power indicators, absolute power indicators and other rf transmission system instruments. Although most of the factory assembled instruments are moderately priced, further savings may be realized by constructing one of the excellent kits



that are available. If you want to build from scratch, excellent designs are published in the handbooks and in the amateur magazines.

The very availability of this more sophisticated instrumentation has obscured the value and utility of some of the more primitive rf metering methods. An example of this is the old reliable thermocouple rf ammeter. Although more or less in general disfavor, the ARRL Handbook has described a packaged rf ammeter unit for several years. And well they should, since for sheer, un-ambiguous utility, the instrument is difficult to beat.

The photograph shows one version of the packaged rf ammeter, in this instance an imported, miniature 0-5 ampere unit. This meter is marketed by Lafayette Radio under their catalog number TM-500 and sells for $3.95. The meter mounts in a 1½" round hole and fits easily into the smallest available Minibox. The case shown in the photograph is a Premier PMC-1000 which measures 2¾" x 2⅛" x 1⅝". A pair of SO-239 coaxial fittings mounted on either end of the aluminum box completes the parts list. Wiring simply consists of an inch of #16 bare copper wire between the center contact of each receptacle and one of the meter terminals. The small size of the case and the short direct leads minimize the discontinuity introduced in the coaxial line by this instrument.

Use of the ammeter is simple and straightforward. Connect the rf ammeter in the 50 or 70 ohm transmitting transmission line, apply transmitter power and read rf current directly. Average power in the transmission line is easily computed by the formula, $P=I^2R$ where R is the characteristic impedance of the transmission line. With a reasonably low standing wave ratio in the transmission line, power output can be read quite accurately.

For those who have difficulty with mental computations and can't find a pencil, the following chart gives the computed power levels present in nominal 50 and 70 ohm coaxial lines for various values of rf current:

RF CURRENT AMPERES	POWER OUTPUT IN WATTS 50 OHM LINE	70 OHM LINE
0.5	12.5	17.5
1.0	50	70
2.0	200	280
3.0	450	630
4.0	800	1120
5.0	1250	1750

All opinion to the contrary, the rf ammeter is not ready for retirement. Used alone or to confirm or supplement the power readings obtained by more refined techniques, the packaged rf ammeter is a valuable, low cost instrument for both shack and shop. . . . **W4WKM**

Photo by: Morgan S. Gassman, Jr.

(W2NSD from page 6)

There have been many suggestions that the reason behind this move for incentive licensing is to cut down the number of phone stations and thus cut down on the QRM on "Class A" bands. If this is a factor in the mind of the ARRL directors then they should come out and state it. I seriously doubt that this can be so for this would be an unspeakable arrogance and manifestly unfair to the General Class licensees.

The June issue of QST reported on the meeting of the Board of Directors. Fascinating. Sandwiched in among many obvious platitudes we again find incentive licensing, this time invoked in the name of more efficient use of amateur frequencies, increased technical proficiency and more effective performance in the public interest, convenience and necessity. It is virtually impossible to be critical (even for me) of many of the points made by the directors. Some of them I have suggested in my past editorials, such as #7, the publication of League history, #4, a more effective Official Observer program, and #8, to encourage the amateur to make the best use of the presently allocated bands.

Frankly I was rather disappointed to see CQ taking a me-too stand on this subject, though I was not overly surprised, for after several serious cases of foot-in-mouth disease they seem to have turned extremely cautious.

What would be the effect if all of the General and Conditional Class licensees were suddenly demoted? I hate to think what this might do to the used ham equipment market! With tens of thousands of amateurs thrown off the bands that they have been using for many years and no longer able to keep in touch with their many friends, I suspect that we might well lose up to 50,000 amateurs. Maybe a lot more. Complicating the problem would be the anger that the deposed amateurs would feel over this inequity which might go a long way towards stopping them from just resigning themselves to fate and getting out their books for some more memorizing and studying. If only 10,000 amateurs dumped their equipment on the market it would have a catastrophic effect. It would take years before dealers could recover from this disaster . . . and we might well lose many of our present ham manufacturers. As one prominent manufacturer told me: "The ARRL is trying to put me out of business and I am casting my vote the only way I can; you'll see a lot more of my advertising dollars in 73." And this is from one of the most level-headed men in the industry.

It is not possible to roll back the clock to the Class A days for conditions are entirely different now. The old Class B license was primarily for fellows interested in CW operation, and in the old days the great percentage of the active amateurs were CW men . . . many didn't even have a mike in the shack. Today there are few amateur stations that are not equipped for phone and phone operation now dwarfs CW. In the old days the Class B amateur had the 160 meter band, 250 kc of phone frequencies which served about the same purpose as the present 75 meter band. Today we have a little skeleton of the 160M band left which would sink almost instantly out of sight with even a fraction of the old activity we used to see on the band. Where would the Generals have to go? To 40 meters? Ho ho. To 15 meters? 15, 10, 6 and 2 meters will all be pretty much the same for the next few years. These bands are fine for volunteer work, but just imagine being forced to operate there! This would make the General Class license about equal to the Tech license.

The ARRL has decided that amateurs should spend more time learning electronics and since the amateurs haven't done this by themselves they should be forced by government regulation to so learn. What has happened to the American way? Are we to follow the Soviet Union into complete government regulation of everything, even our hobby? Has the American way of doing things failed us completely? Is it possible that only government regulation is left as a method of getting fellows to learn more theory? Balderdash. Our readers survey polls show that the 73 staff technical series has a very high percentage of readership and interest. 73 readers *are* learning. In the 25 years that I have been reading QST I have never seen anything like our simplified technical series in the magazine . . . nor in the Handbook. Perhaps government regulation can substitute for good writing.

Another point. The ARRL makes a big point about how valuable incentive licensing was in the past. I might remind the Directors that in those days virtually every amateur built his own transmitter and as a result technical proficiency was strongly correlated with signal quality. It *was* a lot more complicated to put out a good phone signal than a CW signal and there was an advantage to requiring the phone men to pass an additional test on phone theory. Today, with the great bulk of the transmitters being commercially manufactured, it does not take any additional knowledge to operate phone (or even SSB). You just follow the instruction book and away you go. The signals on our phone bands will be exactly the same whether we require an additional exam for it or not.

Perhaps I'd better take this opportunity to speak up in behalf of commercial equipment. Strange thing for me to do since I am one of the leading proponents of home construction, eh? Let us hark back to the beginnings of commercial ham gear, the receiver. By the time I became seriously involved in ham radio almost every amateur was using a commercially made receiver. The transmitters were home made, but not the receivers. How come? Simple . . . receivers were too complicated for the average home builder to tackle, but transmitters were very easy to build. Doesn't the same rationalization hold today? Transmitters are now even more complicated than receivers used to be. How many stalwart constructors would tackle a 32S1 or any of the other sideband rigs today? Darned few. When I look into my 200V I see the virtual impossibility of my ever building such a device. Given a year of free time and unlimited machine shop facilities I suppose I could come up with something relay rack size that would do the same job.

Does this mean that home building should stop? Not a bit of it. There are still thousands of things that can be much better made at home . . . and a lot of things that will never be available any other way. The VHF men have to do a lot of their own work because there isn't enough demand for the commercial manufacturer to spend the thousands of dollars necessary to produce something for this limited market. Ditto RTTY, amateur television . . . etc.

(Turn to page 82)

Don Wherry W6EUM

A Ham Looks at the Knight Kit R-100A

and likes it

A recent survey of the stations being contacted here at W6EUM revealed that well over 50% were using some form of a kit transmitter. The same stations, meanwhile, indicated that less than 1% of them were using kit receivers. A little investigation into this situation uncovered a rather widespread belief that the assembly of such a receiver would leave something to be desired in the way of results.

Now if you are one of the more fortunate ones who can tap the family budget for $500 for a new super-delux job the validity of this belief is of little concern, however if you're like most of us where even $100 bends the monthly balance, perhaps you should examine the situation a little more closely. With this in mind, and since I am one who believes that a receiver kit costing less than $100 would be inadequate (some will argue that), a search was made into available units costing around that figure. The results of this search was the purchase of a Knight Receiver Kit Model R-100A and the following article is a review of this kit as a ham sees it, and not necessarily as the Knight Company might.

If you have not assembled, or seen, a modern ham kit in recent years you're in for a surprise when you unpack your R-100A. In contrast to what you may have heard or to what you may have remembered of early kits you will find the components of this unit to be of first class quality throughout—the chassis is heavy gauge steel, the tubes RCA, all resistors and condensers top quality and, in fact, no indication at all that Knight cut cost corners on components or hardware. Everything is furnished, even the solder.

Now for the assembly—the mechanical portion proved easy, being straight forward with no tricky adjustments or hard to get at parts or screws. The wiring itself is almost all printed circuit boards—only three of the fifty resistors used are not on these boards. This simplifies the wiring to an enormous degree and allows anyone, regardless of radio experience, to do the job. The resistors themselves are even mounted on cardboard with their "R" identification number alongside so you can even be color blind and still get the correct value.

The circuit itself is a nine tube (performing the function of 13) single conversion general coverage superhetrodyne. It's a fairly standard circuit starting with a 6BZ6 rf stage using four rf coils—the 14, 21 and 28 mc bands are all on one rf coil. There is an rf trimmer condenser controlled from the front panel which is used to trim the rf coil in use. This allows peak performance from the stage for any antenna loading, which is especially desirable from the ham operators standpoint.

The mixer stage uses a 6HB6, the pentode section of which is used for the mixer and the triode section for the conversion oscillator. There is nothing special about this circuit except, possibly, for the use of an OB2 regulator tube for the oscillator plate supply—nothing else is on this regulator tube.

One thing about the circuit so far which does deserve mention is the band switch. This switch is a printed circuit board type and is the greatest thing invented since suspenders. It simply plugs into the main board and is soldered in place—36 connections made in approximately two minutes with no possibility of a mistake. The two *if* stages use the pentode section of two 6AZ8 tubes and are nothing unusual. The demodulator (detector) uses one section of a triple diode 6BC7 in a typical diode detector circuit. The second diode of this tube is a AVC rectifier which has a built in delay to remove all AVC action on weak signals. The third section is a series noise limiter which automatically adjusts itself for the average level of the received signal. This works real well for ham use. The two stage audio section is entirely normal and needs no comment. The BFO uses the triode section of a 6AW8 and is unusual in that the BFO output signal is fed into the circuit at the input to the second *if* stage, and there at a very low level. This seems to allow better operation on SSB and, when this feature is combined with the real smooth vernier action of the BFO frequency control, it allows excellent SSB reception. This from what is normally considered an AM detector—SSB is AM by the way. A product detector would probably operate a little better but this circuit does do a good job.

The Q multiplier is really something. Some multipliers of this type seem to be unstable and hard to operate when used in the "peak" mode, but this receiver seems to have licked the problems and its use makes a world of difference when you are trying to beat some bad QRM—and who isn't? Fact is if you have never operated one of these little jobs you will be amazed at the way you can pull a signal out from a big pileup of QRM. It's also valuable as a null device but, in my opinion, it is not as fine a performer there as a notch filter. Nothing else about the circuit is unusual enough to mention except that the power supply filter uses an LC combination instead of the more common RC, with the result that there is no discernible hum at all in the output.

A check on the sensitivity indicated that the specifications were reasonably close. However you must expect to do an alignment job to get real good results. Knight has complete alignment instructions and even suggests a way to do the job without a signal generator. However I would strongly recommend the use of a good rf signal generator. The coils are all pre-aligned but, that is not good enough if you want top results. The AVC does not operate on CW or SSB. This, in my opinion, is not especially important and only means that you must use the rf gain control for a volume control when in those modes.

The overall construction of this kit was so straight-forward and easy that no special instructions to you, as the builder, seem necessary. Just the usual caution to "do it their way." Use the manual and follow directions and you can't go wrong. The only trouble you might experience is in the identification of some things such as switches, controls, etc., and even there you will find, somewhere on the pictorials, the information you want.

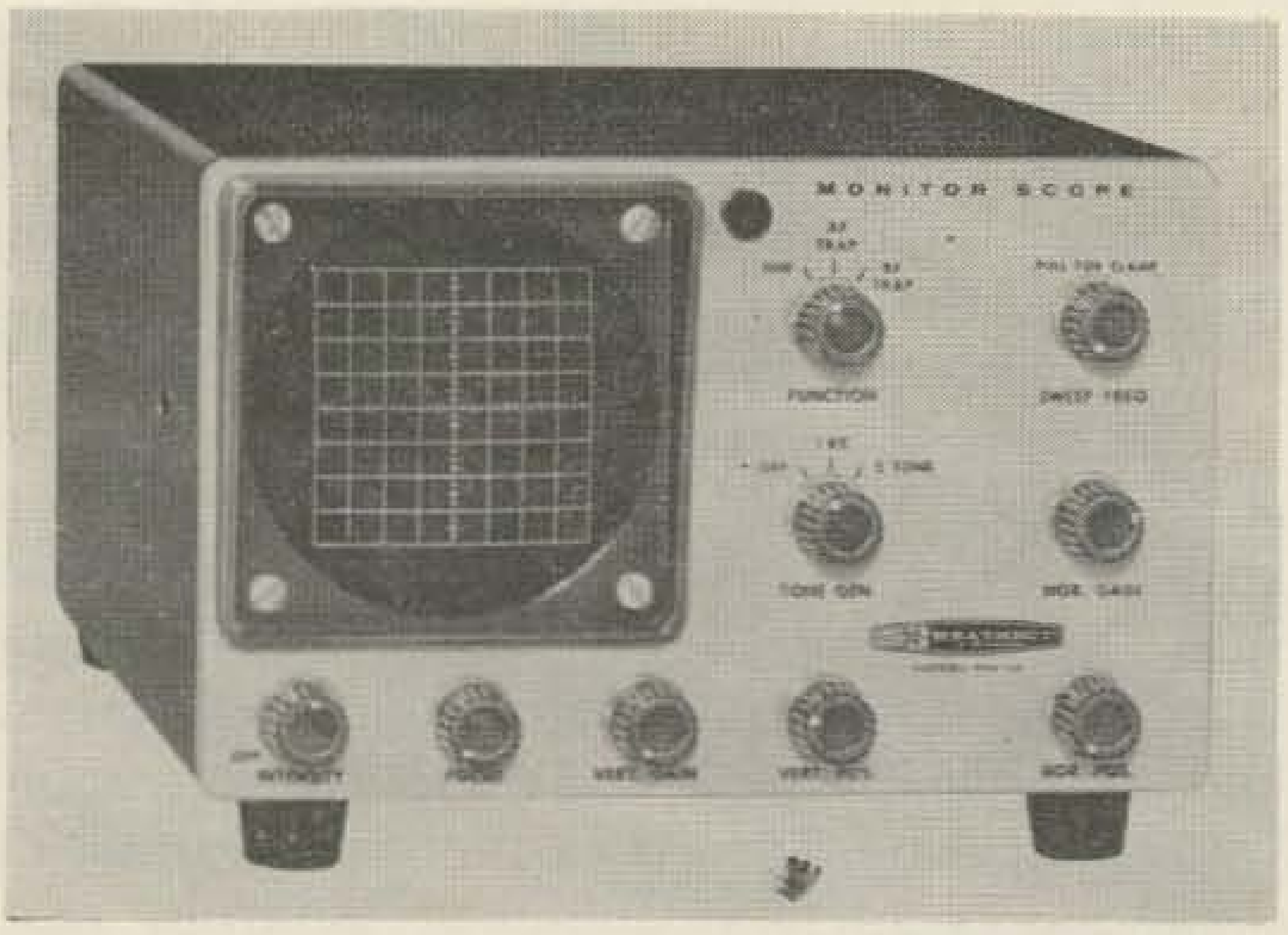
Now for a few general comments on this little job. The rig is much better looking than the pictures would indicate, the combination of jet black, silver and gray is real nice. When used with its matching transmitter it makes a very nice looking station. I do think, however, that the average ham will deplore the fact that it is not a "hambands only" receiver. While the bandspread feature spreads the bands over approximately 165 degrees of the bandspread dial, the markings are not especially easy to read. They look a little crowded. Also the bandspread dial has a ratio of about six to one in reduction and that also would be better if it were 12 or 15 to one. It's not hard to tune as is, but any help along that line is desirable. Maybe if enough of you would write Knight they would put out a ham band only model of this same receiver where a better dial and tuning ratio could be used.

Since this is a general coverage type receiver you should purchase the 100 kc calibration accessory, which is available quite reasonably. This I feel is important and just might save you a pink ticket. The S meter accessory makes the outfit look much nicer but adds nothing to the actual operation.

There is no more than the normal amount of drift in the conversion oscillator as it warms up, and after a few minutes this settles down well. No drift in the BFO was noticeable. A remote connection is brought out on the rear of the chassis to silence the receiver while you are on transmit and it works well.

To summarize—I think that the only conclusion that can be drawn is—if you have several hundred dollars to spend, go ahead and buy a SX115 or the S-line, but if not, take a good look at this kit receiver. If you want a general coverage job I doubt if you can touch a better receiver for the $100 asked.

. . . W6EUM



Roy Pafenberg W4WKM
John Bowden W4SYJ

73 Tests The Heath HO-10

The Heath HO-10 Monitor Scope is a welcome addition to the ever-expanding variety of amateur equipment available in kit form. This compact little handful of instrument contains a full 3" tube and is packed with all the features required for adequate monitoring and detailed analysis of both transmitted and received signals. The price of this unit, $59.95 in kit form, is remarkably low for the features provided. Ready availability of this instrument, at a price most amateurs can afford, should do much toward cleaning up some of the signals that infest our crowded bands.

While the value of a scope in adjusting AM and SSB transmitters is well known to most amateurs, the instrument is not as widely used as it should be. There are several reasons for this. It is often difficult to justify the purchase of the relatively complex and expensive general purpose scope to perform the relatively simple functions required of a monitor scope. An outboard audio oscillator, or oscillators, is required for thorough testing. The resulting test lash-up is usually so complex that it is only used for initial testing and adjustment. The HO-10 Monitor Scope combines these specialized functions in a compact instrument that may be left permanently connected in the station wiring.

While the specifications show all the details, several features, some of which are not included in competitive products, are worthy of special mention. Two audio oscillators are provided for both single frequency and 2-tone test of the transmitter. A full-fledged, adjustable frequency, horizontal sweep generator is provided along with both horizontal and vertical deflection amplifiers. Provision of a demodulator for rf trapezoid measurements, an rf attenuator and a beam clamp circuit are other design highlights. While these features are impressive, the true utility of the instrument is achieved by a switching system that functionally integrates them to best meet the specialized requirements of amateur station monitor service.

All inputs appear on the rear of the instrument and it may be permanently connected for the type of display desired in normal oper-

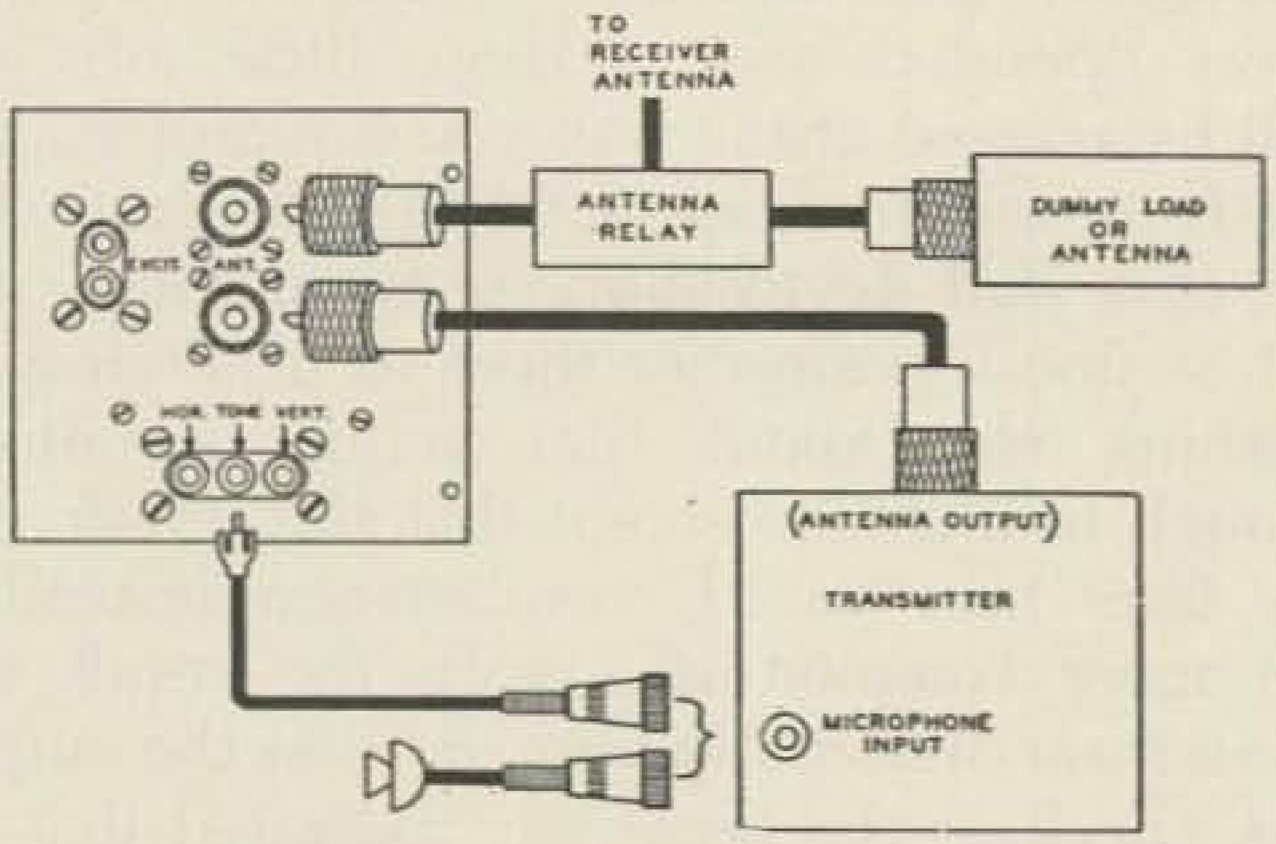


Figure 2

This drawing shows the proper connections for obtaining transmit envelope patterns. Typical patterns for various transmitter conditions are shown in patterns 1 through 21.

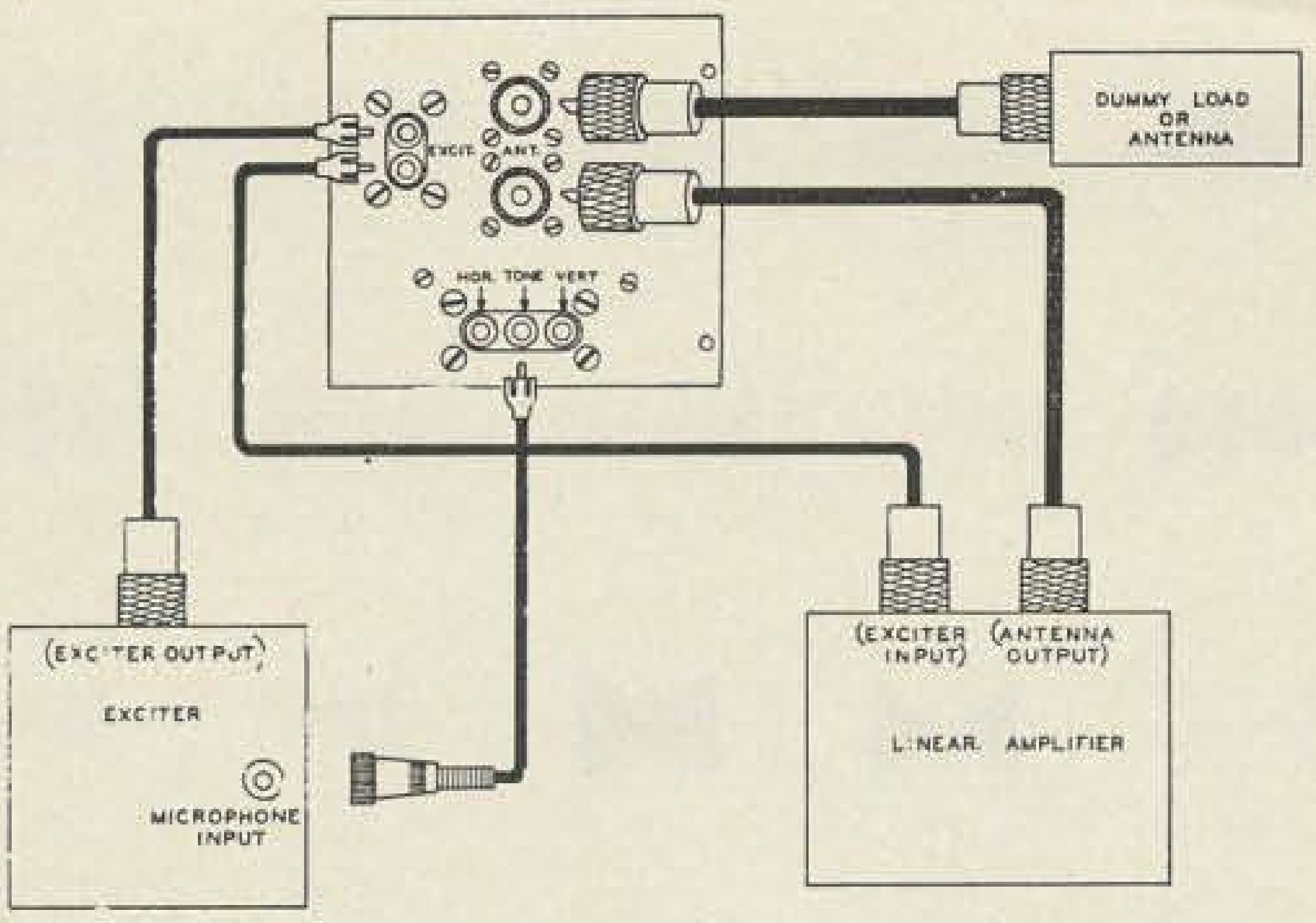


Figure 3

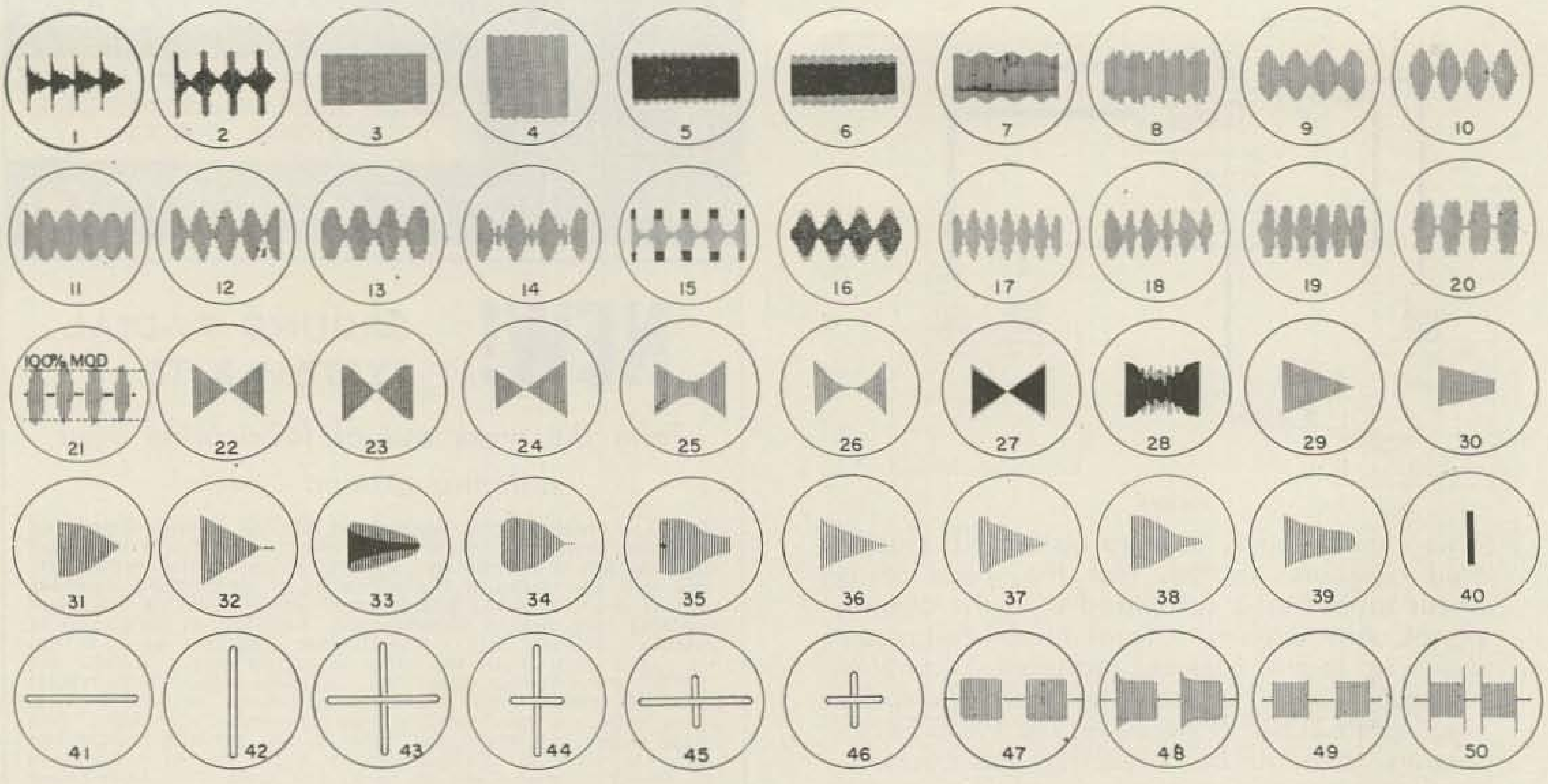
This connection is used to obtain RF trapezoid patterns. In this test the input of a linear amplifier is compared with the output signal. Any departure from linear operation shows up in the patterns obtained. Examples of various amplifier conditions are shown in the TRAPEZOID AND BOW TIE PATTERNS section. It should be noted that this connection indicates the operating conditions of the amplifier only.

ation of the station. Optional displays include rf enevlope, rf trapezoid and the more or less conventional trapezoid and bow tie patterns. Single frequency or 2-tone audio output is available for connection to the transmitter speech amplifier *during dummy load tests.* Switching between the transmitter and receiver displays is automatic. The transmitter is fed to one vertical deflection plate of the CRT and the receiver *if* to the other; normal transmit-receive switching disables one of the two inputs.

In use, the transmitter output coaxial line is routed through the HO-10 by means of two SO-239 connectors. A portion of the rf is coupled to the vertical deflection circuit of the CRT through a step attenuator which permits use with transmitter powers ranging from five watts to well above the legal limit. The input circuit is untuned and substantially independent of frequency to over 100 mc and is usable at higher frequencies.

In addition to use as a transmitter and receiver monitor, the HO-10, within the limitations of sweep frequency, makes a perfectly acceptable utility oscilloscope. While the instrument has many circuit features that would be of interest to the technically inclined reader, the specifications will have to tell the story. We are providing a special bonus feature in this article and space does not permit a lengthy discussion of circuit details or presentation of the HO-10 schematic diagram. Sufficient to say that the circuitry is more than adequate to meet all claims in the specifications.

Parts used in the HO-10 Monitor Scope were found to be of high quality. The mechanical



1) SSB signal, voice input, correctly adjusted. **2)** SSB signal, voice input, slightly excessive speech gain, or insufficient amplifier loading. **3)** Pure CW carrier or perfect single tone input on SSB. May also occur on single tone SSB with excessive drive which results in amplifier "flat topping." Note absence of fine ripple. **4)** SSB signal, single tone input, sideband suppression down approximately 40 db or CW signal with spurious radiation down approximately 40 db. **5)** Same as 4 except down approximately 20 db. In SSB, the poor suppression may be due to audio unbalance or improper RF phase shift. **6)** Same as 4 down approximately 10 db. **7)** SSB signal, single tone input with carrier leakage. This pattern will have half the number of ripples due to poor sideband suppression. (See waveform 5.) **8)** SSB signal, single tone input. Distortion in audio oscillator or audio system, balanced modulator detuned, or insufficient RF in balanced modulator. **9)** SSB signal, single tone input. Very little sideband suppression. Caused by defective modulator tube; audio phase shift network; 90 degrees RF phase shift component; partially shorted modulation transformer; secondary of transformer that feeds audio phase shift network shorted to ground; crystal oscillating on two adjacent frequencies simultaneously or both heterodyne oscillators on together. **10)** Normal double sideband, single tone input. SSB signal, single tone input with no sideband suppression. May be due to one modulator tube dead, modulation transformer open or shorted, defective bandpass filter. Normal SSB signal, two tone input, tones properly adjusted for equal amplitude. **11)** SSB with carrier, single tone input. Incorrect value of carrier or modulation. Excessively rounded tops would indicate too much carrier. **12)** Plate modulated AM, or double sideband with carrier inserted, single tone input. Nearly 100% modulated. Excellent waveform. **13)** Double sideband with carrier inserted (low level AM), single tone input. Too much carrier inserted. Note that the positive peaks flatten before a fine base line is obtained. Peak flattening may also be caused by insufficient antenna loading, insufficient interstage loading, an overdriven linear amplifier, poor dynamic power supply regulation, etc. **14)** Double sideband with carrier inserted (low level AM), single tone input. Insufficient carrier insertion or excessive audio, resulting in high distortion (overmodulated). Also called Double Sideband Reduced Carrier (DSRC). **15 & 16)** Low or high level AM with strong parasitics appearing on modulation peaks. Very fine, "Grassy" appearance on peaks would indicate parasitic in the UHF range. **17)** SSB, two tone input, or double sideband, single tone input; carrier leakage in either causes uneven height of successive half cycles of modulation envelope. **18)** Low or high level AM, single tone input. Severe distortion in modulator system or AF tone generator, RF feedback to audio system, or RF feedback to previous low level stage. **19)** Nonlinearity in modulated RF stage, single tone input, due to insufficient excitation of a plate modulated stage, overdrive to a grid modulated stage, or insufficient antenna loading of a grid modulated stage. **20)** Plate modulated AM, single tone input. Overdriven modulator incapable of 100% modulation. May also result from deliberately "clipped" audio not properly filtered. **21)** Plate modulated AM, single tone input. Modulator output more than ample. Modulation in excess of 100% in both directions. **22)** Good linearity. Desired pattern. **23)** Peaks slightly flattened. Caused by overdrive (grid current curvature), insufficient antenna loading, or regeneration. **24)** Carrier leakage through working modulator. **25)** Carrier leakage through disabled modulator. **26)** Grid bias curvature. Caused by excessive bias, or by operating some types of tubes with high plate voltage and high bias. May also be due to regeneration, or imperfect neutralization. **27)** Spurious radiation about 20 db down or insufficient selectivity in RF circuits, allowing undesirable beat products to pass through. **28)** Parasitic oscillation. **29)** Plate modulation, single or double sideband with carrier, or RF trapezoid. Good linearity. Desirable pattern. **30)** Plate, grid or cathode modulation; double sideband or SSB with carrier. Modulation less than 100%. No distortion. **31)** Nonlinear. With plate modulation, indicates lack of grid drive or insufficient grid bias. With grid modulation, SSB or DSB with carrier, or RF trapezoid through linear amplifier, indicates overdrive, insufficient antenna loading, grid current curvature or regeneration. **32)** Plate modulation in excess of 100% in downward direction. Both modulator and final show good modulation capability. **33)** Plate modulation. Audio phase shift due to improper audio connection. Modulated approximately 80%. **34)** Plate modulation. Overmodulation in downward direction, with insufficient modulator capability. **35)** Plate modulation. Inadequate or mismatched modulator. **36)** Nonlinear. With plate modulation this indicates regeneration due to improper neutralization. In linear operaton this also indicates regeneration, or excessive grid bias. **37)** Parasitics occurring on modulation peaks. **38)** Screen grid or suppressor grid modulation, maximum modulation capability. **39)** Grid modulation with improper neutralization and reactive load. **40)** Unmodulated carrier. Can be caused by: No signal at horizontal deflection plates. Tone test oscillator inoperative. Gain control turned off on transmitter or oscilloscope. Audio failure in transmitter. **41)** Mark only. The relative narrowness of the elipse provides good indication of the channel separation capability in the terminal unit. **42)** Space only. The relative narrowness of the elipse provides good indication of the channel separation capability in the terminal unit. **43)** RTTY signal, proper shift, correctly tuned in. **44)** Incorrect shift, space tuned in. **45)** Incorrect shift, mark tuned in. **46)** "Straddle" tuning of incorrect shift. **47)** Good CW pattern, properly shaped keying, string of dots. Pattern can be approximately "locked" using automatic keyer or bug. **48)** CW pattern showing effect of receiver AVC action or poor power supply regulation in the transmitter. **49)** CW pattern, mild key clicks. **50)** CW pattern, severe key clicks.

assembly of the kit consists of a wrap-around frame with a chassis plate monuted vertically in the frame. This assembly is then secured to the formed aluminum panel. The chassis material is fairly light guage aluminum with a gold anodized finish. Despite the lightness of the material used, a very sturdy assembly results when it is all screwed together. As shown in the photograph, the substantial CRT bezel, attractive (and functional) CRT grid scale and the two-tone finish all combine to make a very attractive package.

The instruction manual is very comprehensive, consisting of 60 pages, 8½"x11", with 19 major assembly drawings and countless other drawings showing components, assembly details, equipment interconnection and typical scope patterns. The detailed, step-by-step assembly instructions were followed to the letter. No errors of any kind were found in the manual and no problems encountered in the construction. After construction, the scope was tested, following the instructions, and everything checked out perfectly. Assembly time, from start through final test, was just under 12 hours.

The design concepts and performance objectives for the HO-10 Monitor Scope were quite

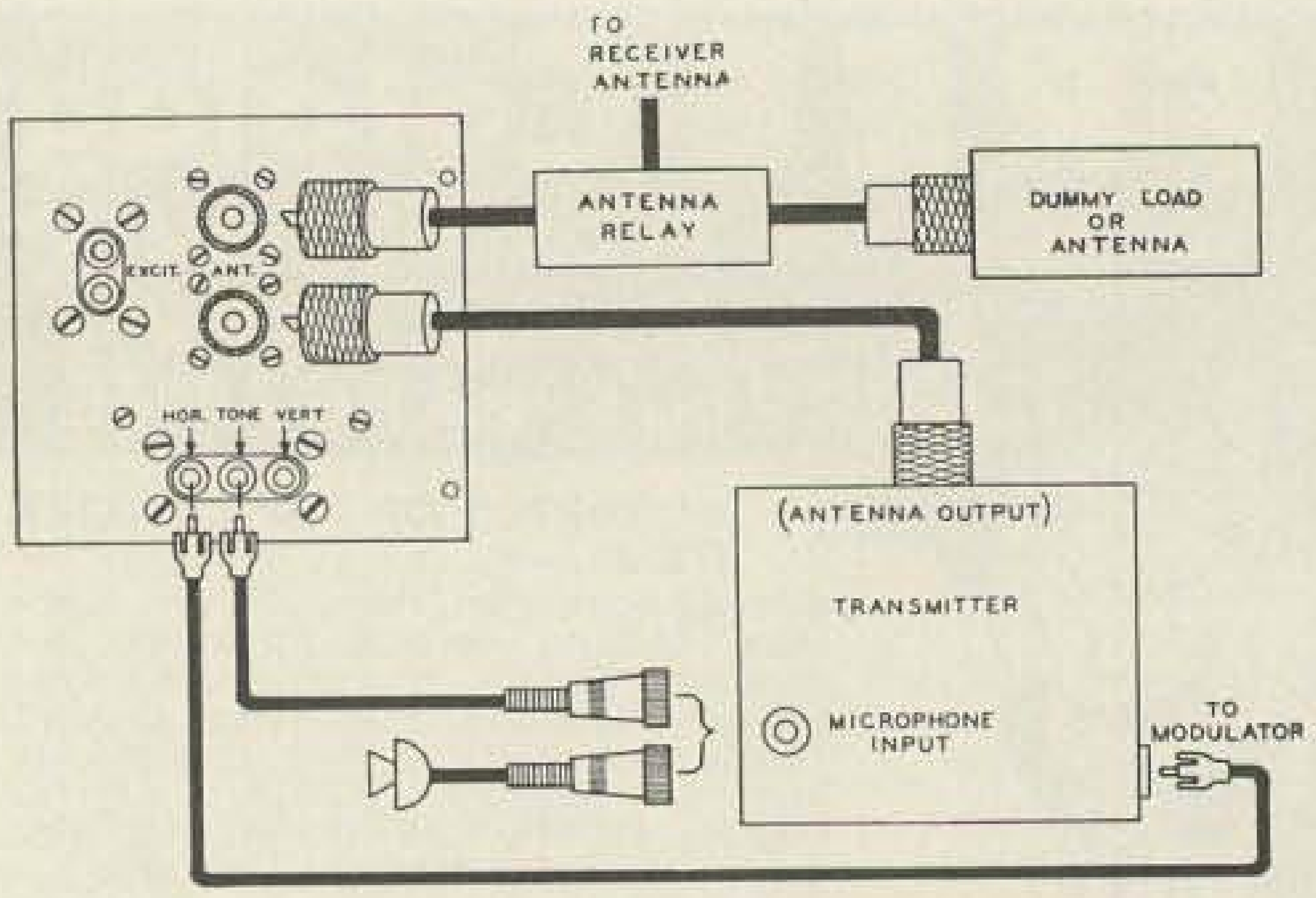


Figure 4

Test connections for obtaining the classic trapezoid and bow tie patterns. Typical patterns for various transmitter conditions are shown in patterns 22 through 40.

ambitious for a moderately priced kit. Heath is to be commended for the manner in which the production instrument achieves these objectives. Three amateurs have participated in this test and we all have nothing but praise for the scope. Heath is also to be commended on the instruction manual which should enable even the inexperienced amateur to construct the scope and, more important, use it to the best advantage of all who use our bands.

A full 19 pages of the manual are devoted to operation, interconnection of the instrument with station equipment and typical scope patterns. This is the most comprehensive collection of diagnosed scope pattern drawings the writers have found in any single reference. These drawings are of such obvious value and general interest that our immediate reaction was to call the Editor to see if he would agree to devoting the space for their reproduction as a part of a review article. Wayne's reaction was enthusiastic. The next step was to obtain Heath's permission for reproduction and here they are. Figures 2 through 5 show typical installations of the monitor scope. The captions indicate the type of displays that will be obtained. The actual waveforms depict operating conditions ranging from wonderful to horrible and, where appropriate, suggested corrective action is indicated. W4WKM

SPECIFICATIONS

VERTICAL AMPLIFIER—Frequency Response: ±3 db from 10 cps to 500 kc. Sensitivity: 500 mv per inch deflection. Input Resistance: 50 KΩ.

HORIZONTAL AMPLIFIER—Frequency Response: ±3 db from 3 cps to 30 kc. Sensitivity: 800 mv per inch deflection. Input Resistance: 1 megohm.

SWEEP GENERATOR—Recurrent Type: Linear sawtooth produced by internal sweep generator. Frequency: 15 to 200 cps (variable).

TONE OSCILLATORS—Frequencies: Approximately 1000 cps and 1700 cps. Output Voltage: 15 mv (nominal).

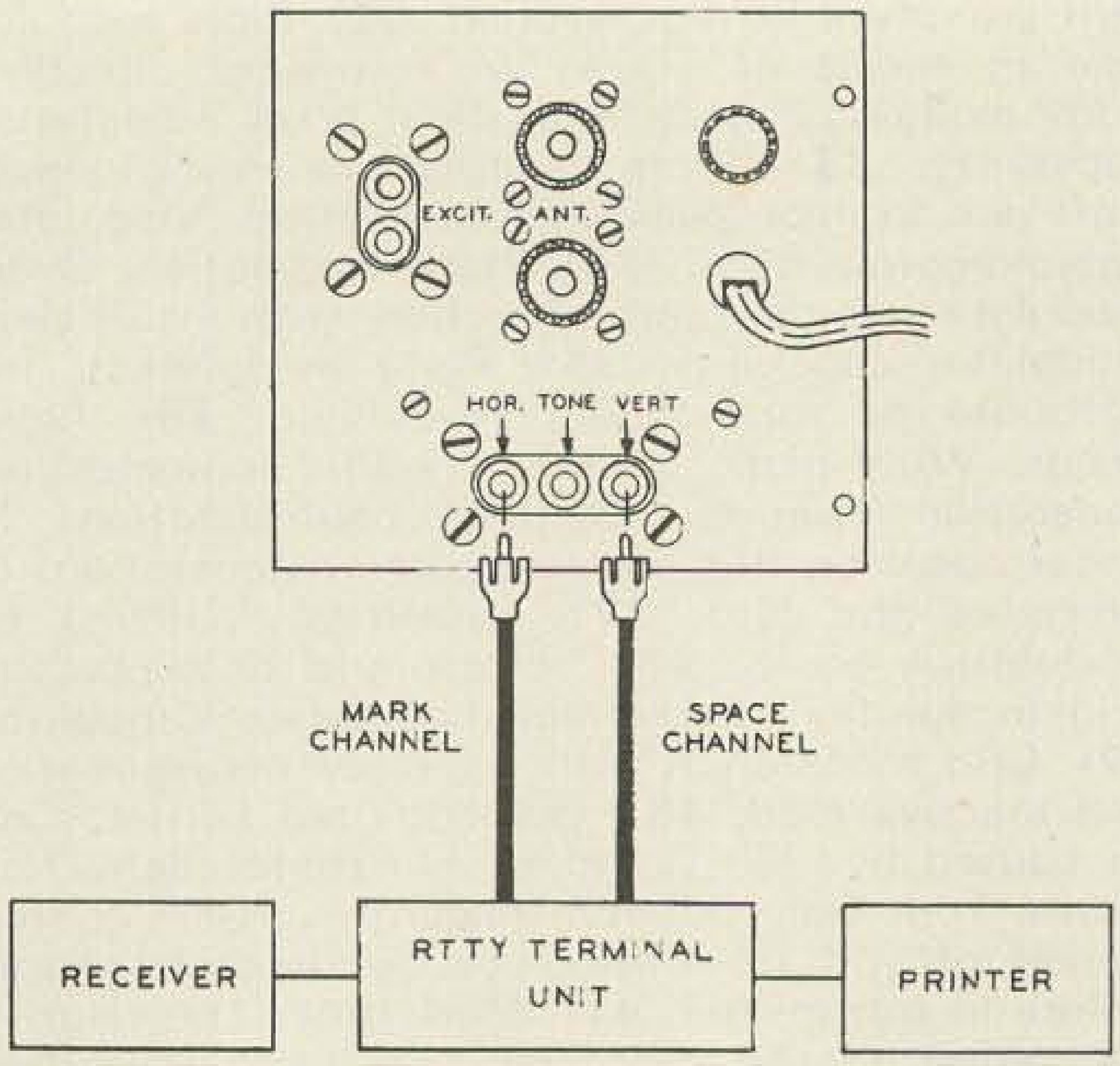


Figure 5

Test connections for obtaining RTTY cross patterns. This connection is useful in evaluating both converter performance and received signal characteristics. Typical displays are shown in patterns 41 through 46.

GENERAL—Frequency Coverage: 160 through 6 meters (50-75 Ω coaxial input). Power Limits (At rear coaxial connector): 5 watts to 1 kilowatt output. Tube And Diode Complement: 1—3RP1 CRT, medium persistence, green trace. 1—6BN8 Clamper, low level RF detector. 1—6C10 Sweep generator, horizontal amplier. 1—6J11 Twin phase shift tone generator. 1—12AU7 Vertical amplifier. 1—1V2 High voltage rectifier. 4—Silicon diodes, B+ rectifiers. Front Panel Controls: FUNCTION Selector. SWEEP FREQ. TONE GEN. HOR. GAIN. HOR. POS. VERT. POS. VERT. GAIN. FOCUS. INTENSITY/OFF. Rear Control: XMTR ATTEN. Attenuates 0 to 24 db at approximately 6 db per step. Power Supply: Transformer operated, fused at ½ ampere. Power Requirements: 105-125 VAC, 50/60 cps, 35 watts. Dimensions: 5¼" high 7⅜" wide x 11" deep (including knobs). Net Weight: 8¼ lbs. Shipping Weight: 10 lbs.

(W2NSD from page 75)

To sum it up. I cannot see that the ARRL has proved that there are any advantages to their proposed incentive licensing plan, nor have I yet seen any indication that they are speaking for their members in this move.

Club News Bulletin

Now that we have bulletin printing facilities at the 73 Hq we can renew the publication of the Club News Bulletin which was so popular.

This bulletin comes out monthly and is designed to be of help to the editors of club bulletins and to provide news of interest to club officers. The editor, Marvin Lipton VE3-DQX, scans all of the club bulletins each month and exerpts the news of interest for other editors to use. He also passes along lots of information of great value to club officers who are anxious to keep their clubs in top shape.

The subscription to the Club News is only one dollar per year. Send your dollar to VE3DQX, 311 Rosemary Road, Toronto 10, Ontario, Canada and be sure to put Marvin on the mailing list for your clubs bulletin.

If your club officers might have missed this announcement we would appreciate it if you would read this at your next club meeting and get the club to allocate the dollar.

NEW VHF MAGAZINE
$2.00 a year!

One of the big problems with VHF news is that it is usually old before you can get it. The publishing schedules of all ham magazines prohibit anything current ever being rushed into print. About the fastest news you can manage under normal publishing conditions is 30 days, with 45 to 60 days being the rule. This is one of the big reasons why we have never considered running a VHF column in 73.

The obvious solution to the problem is to publish an offset magazine which only takes a day or two to be printed and mailed. This is what DX Magazine is doing and they are doing it well. In the DX field you know about DXpeditions and new stations while they are still on the air instead of after it is too late to do anything about it.

In order to cope with this difficult problem we have wangled our naive bank into enough of a loan to buy a small offset press. We've also installed one of those six foot copy cameras for making our own negatives, a dark room for processing them and all of the graphic arts facilities necessary to prepare material for printing as fast as possible. Never has a VHF magazine had such facilities for quick publications.

The Post Office is a stumbling block. If we send the magazine out by the usual second or third class mail it will be a week or so old before you receive it. We'll try using first class mail. The first one thousand subscribers to VHF (original name, wot?) will get first class mail delivery of the VHF magazine at no extra charge. If we find that we actually can break even doing this we will continue it, otherwise we will have to use third class mail for later subscribers and increase the subscription rate just a bit for those who are anxious for immediate delivery.

We have been very fortunate in getting a highly experienced editor for VHF magazine:

(next page, of course)

Jim Kyle K5JKX, who is both an avid VHF'er and a marvelous writer. Jim is looking for volunteers to help him with this project. He'd like to have fellows who are active in different areas keep him up to date on activities, openings, new developments, and anything else that will be of interest to the VHF'er.

Send $2.00 to VHF Magazine, Peterborough, New Hampshire. Include name, call, and address.

Certificates

Now that we have complete printing facilities here at 73 for making things like subscription blanks, etc., we find we are all set up to turn out certificates. If your club has a certificate in mind and you have any problem getting it made up by a local printer we can do a nice job for you at a very reasonable price. Just send in a sketch of the layout you want, typewritten copy of the wording, good inked drawings for any artwork, and we will be able to take it from there. Our art department can make up the finished layout, make the negative of it, and from that we will make up a printing plate and print your certificates. The price for this is $25 for 500, $20 for 250, and $15 for 100.

Manufacturers Please Note

By way of doing something special in our October issue we will run a special section devoted to covering, as completely as possible, the equipment in current manufacture this fall. I would appreciate getting as complete specifications as possible, including a good glossy photograph, at an early date. We will be devoting special sections to transmitters, receivers, transceivers, linears, and VHF equipment.

And Readers

The October issue, celebrating the start of our fourth year of publishing, will be our first with a four color cover. One of the major difficulties in running a full color cover is in getting photographs that are worthy of the enormous printing expense involved. If you have any ham radio pictures in full color which are technically excellent why not submit them for possible cover use. We'll pay well for them.

License Fees

An awful lot of fellows are probably hoping to open 73 this month and find me blasting the FCC for being so rotten as to set up license fees for ham radio. Unfortunately, as I have written before, the fee seems entirely reasonable to me.

Though I am not completely immune to the something-for-nothing virus, I have a better than average ability to fight off its ravages. Things just don't seem worth much unless I have to work for them.

While I realize that my skills as a ham are of value to the country, I cannot accept that they should pay for them unless they set up a system to evaluate the extent of my skills and pay me what I am worth . . . and everyone else what they are worth. This is obviously impossible, so why not strike that flimsy rationalization for getting our ham license for free. And how about all the public service I accomplish with my license, like the time a group of people were trapped on top of Mount Washington and the only communication was through my Gonset Communicator. Same argument . . . I was happy to do it and enjoyed it, and that is the basic reason for a hobby, isn't it? Why should I get paid for having fun?

We have, it seems to me, been getting something for nothing for a long time now and I'm greatly encouraged to see it stop. The FCC gives me quite a lot: a license exam, all the paperwork necessary to issue me a license, allocated frequencies (and you wouldn't even believe all of the work that goes into this), monitoring to clear up some of the inconsiderateness of other amateurs, plus an interest in changing the rules to keep up with progress. I'm getting a very good deal.

If I, personally, am getting all this benefit, is it fair that I shouldn't pay for it? Why should public tax money be taken for my personal benefit? I know how I feel about the government draining off my dollars with taxes at every turn in order to support things like foreign aid (give them the money, but don't let us go over and visit and spend money for something in return, thereby developing their economy instead of riddling it with graft brought on by our handouts), social security (take 46c dollars from me now and give me 10c dollarettes when I am 65), federal price supports (I have to pay more for things), etc.

Perhaps when fellows have to pay a bit for their licenses they will take a little more interest in their hobby. One of the greatest things that could ever happen to amateur radio would be for a few hundred fellows to care enough about it to improve it.

The fee, by the way, is only $4 for a five year license for new and renewals. Modifications are $2.

Silver Lining

As if the CB'ers didn't have enough problems with the proposed amendments to their regulations which promise to practically put the ham-type CB operation out of business, now they have a little extra worry: a license fee of $8.00! What the revised regulations don't do it is probable that that fee will. It is entirely possible that we may see the eleven meter band eventually in use as was originally proposed by the FCC.

The CB magazines have reacted interestingly to this challenge. CB Horizons seems to be out to make the FCC back down by fighting the proposed changes in every way possible. I suspect that they realize that a great percentage of their readership is made up of ham-type CB'ers and that the existence of the magazine depends upon saving this type of operation. S-9, which seems to have met with considerably less success than CBH from what I can see, may have given up the ghost already for I've heard reports that they are planning consolidation with CQ, which would probably be for the purpose of making good the few subscriptions that had been sold. No doubt this would mean that S-9 would follow VHF Amateur into the oblivion of the back pages of CQ, getting smaller and smaller each month. Good riddance S-9.

"I Already Subscribe to so many Magazines I Can't Read 'em All"

This is the story I hear at conventions over and over again. Somehow this plea falls on deaf ears, not because I am so intensely involved with the magazine that I can't appreciate other peoples problems, but because I know what a lie that is. Or perhaps I should be kind and use the word "rationalization," which is a more polite way of saying lie because it is a lie that you really believe.

Virginia and I got to talking about this the other day as we were driving up to the printer in Hanover (N.H.) to give the final OK's for the June issue. Virginia made a list of the magazines that I read and counted 94 magazines that I subscribe to and read each month. This is in addition to about 100 club bulletins, three or four books, The Wall Street Journal (I just skim that), and an unbelievable number of ad catalogs which come in each month. On top of that I put in about twelve hours a day on the magazine, I help cook (I like to cook) the meals, and even help wash the dishes now and then. I watch a few favorite TV shows (three or four a week in

(Turn page)

(W2NSD continued)

addition to Bullwinkle daily), devote some time to marvelling over the kid (named her Tully; after my Grandfather; family name), and greet an almost constant stream of salesmen interspersed with visiting hams.

If I can get all that reading done on my schedule I don't see why fellows begin to panic when they have three magazine subscriptions. There is always a pile of magazines that I have to wade through to get to bed . . . and Virginia has a pile on her side.

Of course I have to admit that a good number of these magazines are in the radio field: QST, VHFH, WRA, Electronics World, Poptronics, DX, Electronics Illustrated, Science & Mechanics, Short Wave, RSGB Bulletin, Broadcasting, Electronics Design News, Instrument & Apparatus News, Product Design, Japan Electrical Industry, Electronic News, CQ, S9, CBH, Radio Constructor, Autocall, Monitor and probably more that escape me at the moment. I have to keep up with the printing field too: Printers Ink, Graphic Arts, Printing News Weekly, In-Plant Offiset, and Printing Production.

Newsweek does well for me in the general news department, saving me from much reading of the daily papers. Life gets a cursory reading, as does the Post. In the car field I read Sports Car, Pit Talk, Porsche Panorama, Christophorus, Road & Track, International Autoist, Car & Driver, Motor Sports and bulletins from the various clubs I have joined.

Humor: Mad, Help, New Yorker, Monocle. Then there are miscellaneous magazines such as Skin Diver, Readers' Digest, Analog, Family Handyman, All Pets, Aquarium, Holiday, Fortune, National Review (weekly), National Review Bulletin (weekly), National Geographic, U.S. Camera, Modern Photography, Industrial Photography, Scientific American, Mensa Correspondent, Popular Mechanics, Changing Times, Consumer Reports, and the Village Voice (weekly).

Yes, I read them all . . . weekly or monthly. Now, about all those magazines which don't leave you time to read 73 . . . . . ?

Progress Report

One of the most often asked questions is, "How do you like it up in New Hampshire?" My answer is, "I wouldn't move back to New York for anything."

This 37 room old house that we are using for living and offices is ideal from almost every standpoint. It is beautiful and impresses visitors, which is nice. Though we are gradually filling it up, we haven't yet exhausted the accomodations. If I keep buying surplus gear we will run out of barn space one of these days.

The one drawback to the house is its location right on Route 101. This furnishes us with a miserable noise level on the VHF bands much of the time. We looked around for something similar to this house, but with a better location. We found a nice one up on top of a hill not far away . . . several hundred feet higher than we are now. This really looked good from a VHF viewpoint and we even began to consider the possibility of putting in a regular broadcast FM station up there too. But the house, as large as it was, didn't have a barn and this meant that we would have to build storage facilities and probably even some extra office space. It was wonderfully isolated, being more than a half mile from the nearest house.

There was a little additional problem . . . we still didn't have any money. Fortunately the bank was willing to overlook this and they worked out an interesting arrangement which provided us with the house 100% financed!

Every time I went up and looked over the new place I got a little more discouraged about all of the building that we would have to do. Finally I decided that, even with a half dozen eager beaver hams to help us this summer, we wouldn't be able to get all the extra space built that we needed by fall. I dropped a hint to our Porsche-pushing real estate broker that I might be induced to sell and a few days later the place had new owners and we had a nice little bundle to help out the magazine.

Virginia began to get all excited, thinking of trips for 2½ around the world, until she realized that what looked like a fortune was in fact about equal to about one week's expenses of the magazine. Instead of being nip and tuck, usually on the nip side, we were suddenly a week ahead. Big deal.

I'm Not Complaining

There is nothing like living in the country to give a girl a chance to make up for an underprivileged (animalwise) city childhood. While I have been pursuing bigger and better two meter antennas (making up for *my* underpriviledged city childhood) Virginia has been quietly adding to the animal population around here. New Hampshire puts out the devil's own invention: the Weekly Market Bulletin. From this miserable little sheet we have so far picked up two goats ("aren't they cute"), two geese ("aren't they cute"), four ducks ("aren't they cute"), and two Dutch Rabbits ("aren't they cute").

That isn't all. One of the 95 magazines we subscribe to a month happens to be All Pets. From the ads in this insidious source come all sorts of Express packages. There were the tropical fish, complete with tanks, heaters, filters, and all that. You should see how easy it is for salt water tropicals to drop dead . . . unbelievable. Then came some white mice ("aren't they cute"), which were ordered as food for the Indigo snake (no mention of cuteness). I must admit that the snake is intriguing . . . and reasonably friendly . . . for a six footer. An article on what marvelous pets skunks make put us on the waiting list for one of those as soon as it is weaned. Another article on Burmese cats got one of those on the way.

Perhaps I'd better say something so things don't get out of hand.

. . . Wayne

Correction

Lazy Man's Coil Evaluator, June 1963

In Fig. 6 on P. 22 of June 73 the two resistors marked 100 should be marked 100K.

(Transformer from page 37)

preserved the original appearance of the rig. The 5U4GB rectifiers were removed and added to the junk box, and 6DE4 half wave TV damper rectifiers were plugged in.

The bridge rectifier could be 100 per cent silicon diodes, but the 6DE4's have the advantage, again, of preserving the (almost) original appearance, and secondly are slow-warm-up types which allow the rest of the tubes to come to operating temperature before the low B and final screen voltages are applied. The high B voltage will come up immediately to about 400 volts, and, as the 6DE4's warm up, to 800 volts (no load). Sarkes-Tarzain F-6 diodes were used to complete the bridge, with .0015 mfd ceramic disc capacitors across each one to divide up the inverse peak and ac transient voltages. Fig. 1 shows the original circuit, and Fig. 2 the modification. Note also that the 5 henry high voltage filter choke has been eliminated. This choke shorted causing the failure of the power transformer. A little pencil pushing showed that the ripple percentage without it was 4%. This was reduced below 1% (full load value) and the dynamic regulation improved by the addition of two 100 mfd 450 volt filter capacitors in series as

Why Subscribe?

The very foundation of a magazine is its subscribers. When you subscribe to a magazine you are giving a vote of confidence and telling them that you like their publication. We like to be told. Then too, when you buy from the newsstand you not only have to pay more for each issue (40c a copy vs from 29 down to 25c per cppy), but we actually lose about 5c on each copy you buy, which has to be made up by the advertisers. 73 is on the newsstands in order to get more circulation and have more hams discover it and we pay dearly for this service. You help us tremendously when you subscribe . . . and you save yourself money.

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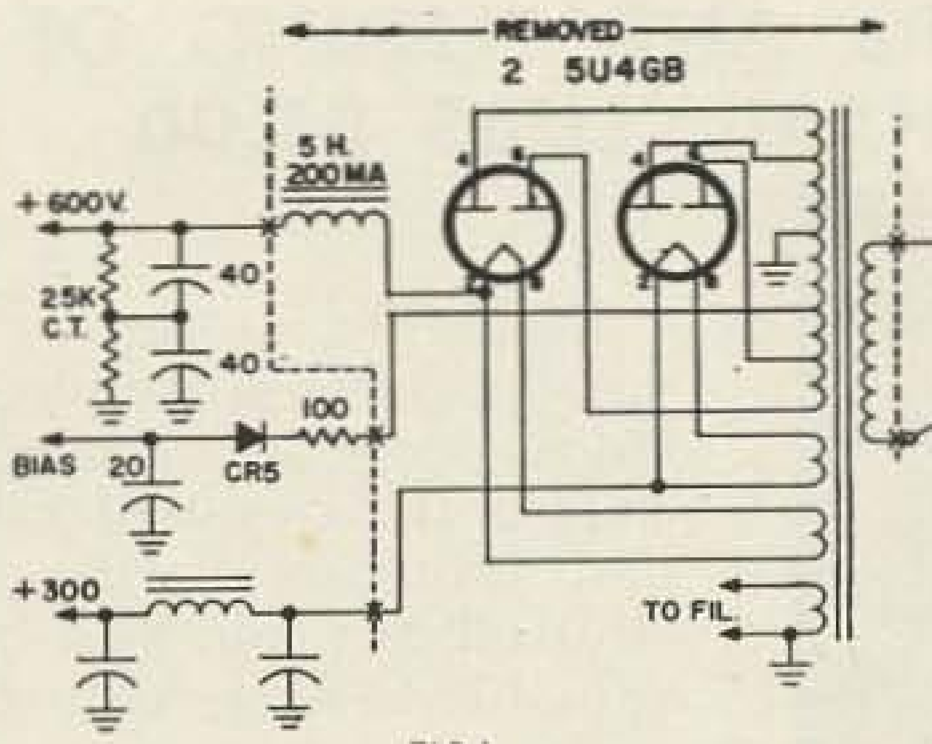


FIG. 1

All components between dotted lines were removed. Showing the modified supply. D1 thru D6 are 750 ma 600 piv C1-C6 are .0015 mfd 1000v disc, C7 and C8 are 100 mfd 450v (Sprague TVA-1718). T1 is Merit P-2884 or equal, T2 Merit P-3046 or equal.

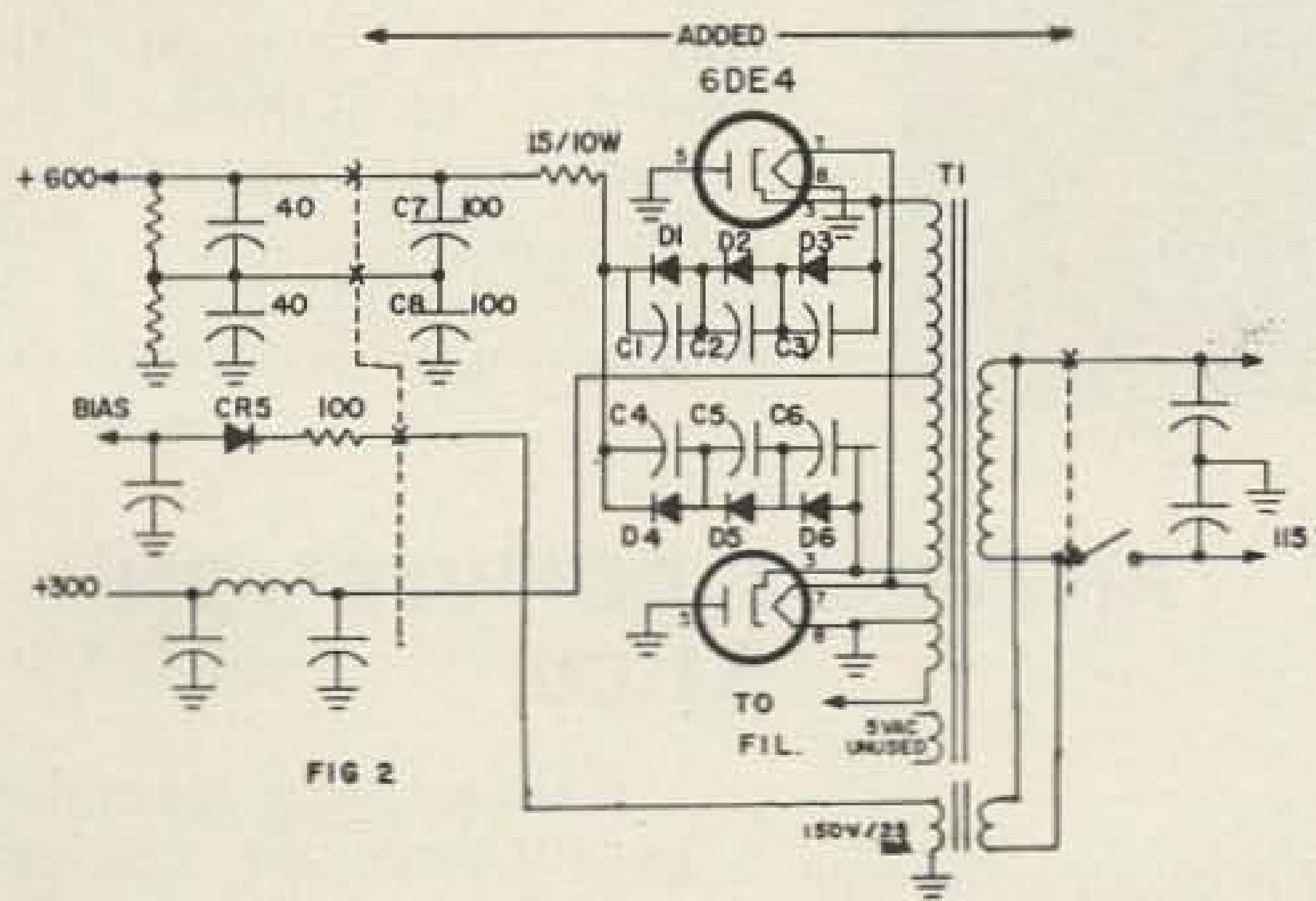


FIG 2

shown in Fig. 2. These capacitors were mounted in the space formerly occupied by the choke.

The center tap of the 12.6 volt winding was grounded, the 6.3 volt filaments of the transmitter were supplied from one end, and the other end supplied the 6.3 volts for the 6DE4's. The hardest part of the modification was moving all the filament leads from pin 5 of one of the rectifier sockets, formerly used as a tie point, and now the plate of the 6DE4, to pin 6 of the same socket. The photos tell the rest of the story. . . . W5PPE

I'd like to see . . . answer

Dear Wayne,

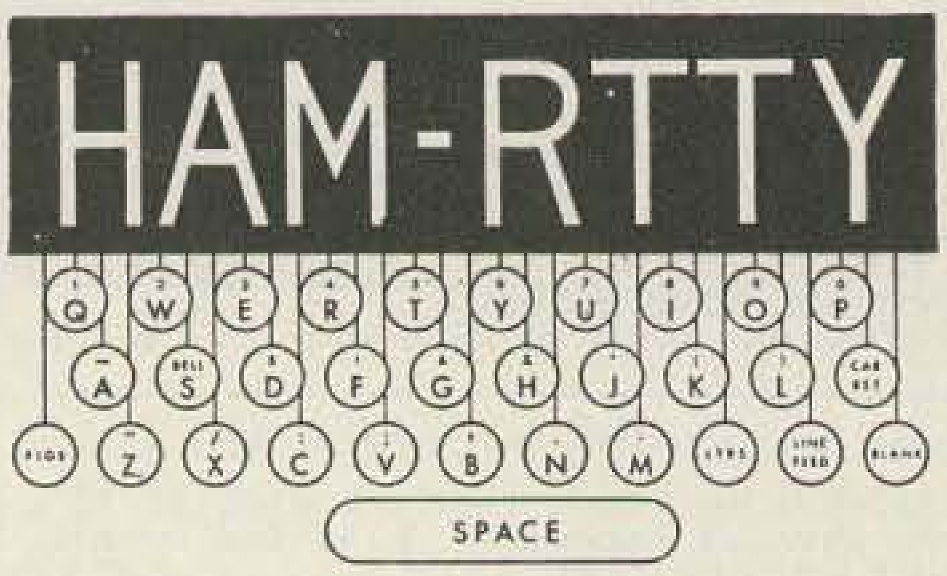
In reference to W2WLR's note (May page 55), the following are some of the coaxial cables that are available with silver plating of the inner conductor: RG's 5A, 9, 55, 87A, 94, 115, 141, 142, 143, 144, 159, 165, 166, 209, 210, 214, 223, 225, 226, 227 . . ./U. All have 50 ohms. RG5A/U and RG9/U are probably best suited for use by the ham fraternity, and I have seen them on the surplus market at relatively low cost.

Jim Fisk WA6BSO

73 Products

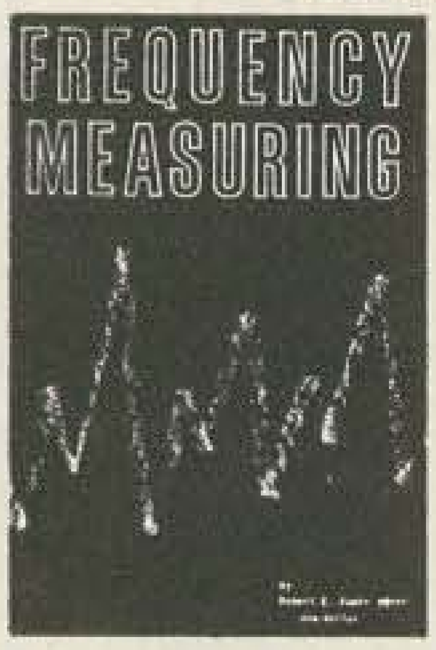
Peterborough, N. H.

NEW RTTY BOOK $2.00



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

FREQUENCY MEASURING HANDBOOK $1.00



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

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

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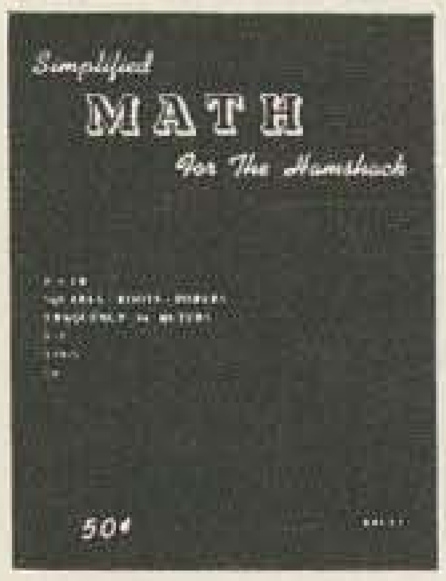
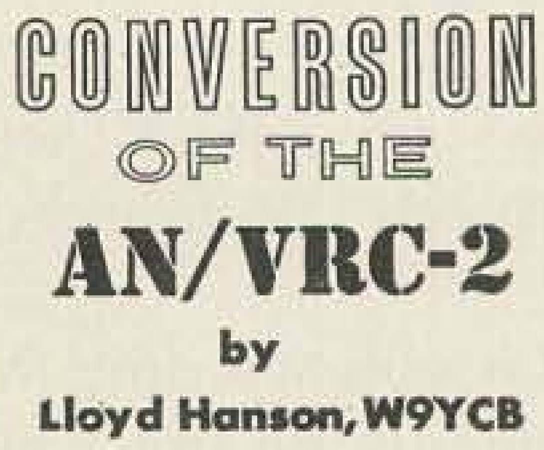
K9AMD's interesting book on all aspects of forming and holding together a ham club. This is the result of exhaustive interviews with many club officers and will be invaluable to every club going.

SIMPLIFIED MATH 50c



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

AN/VRC-2 CONVERSION $1.00



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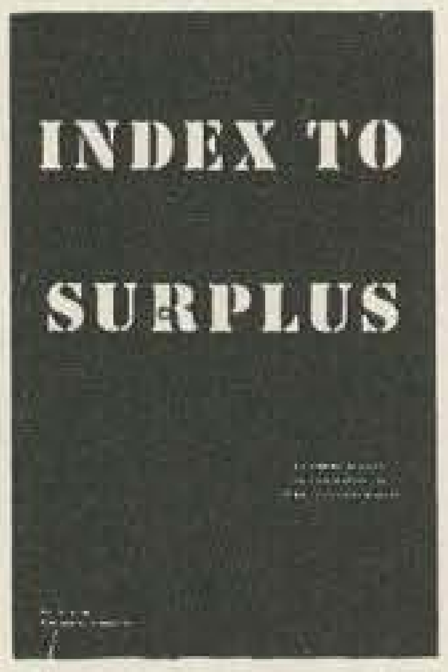

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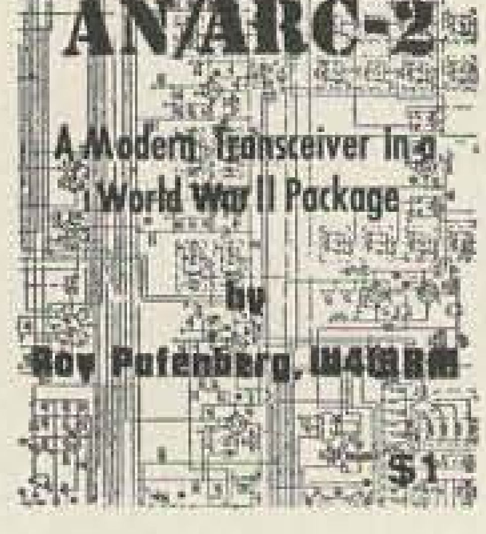

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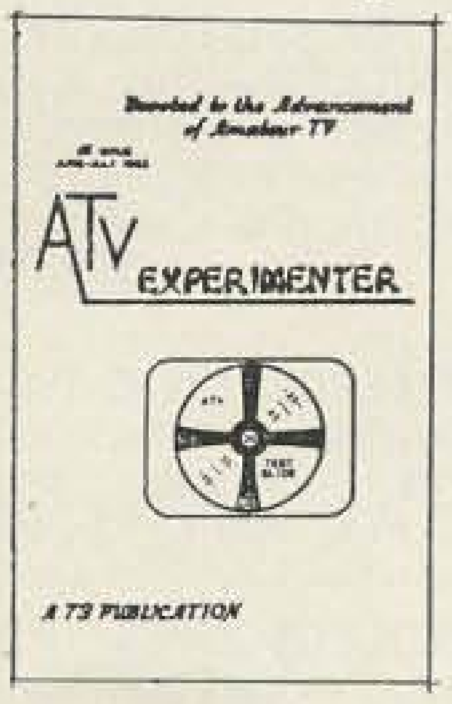

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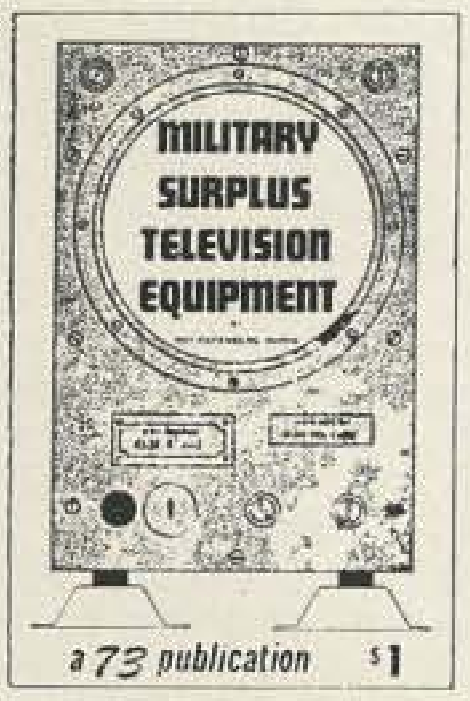

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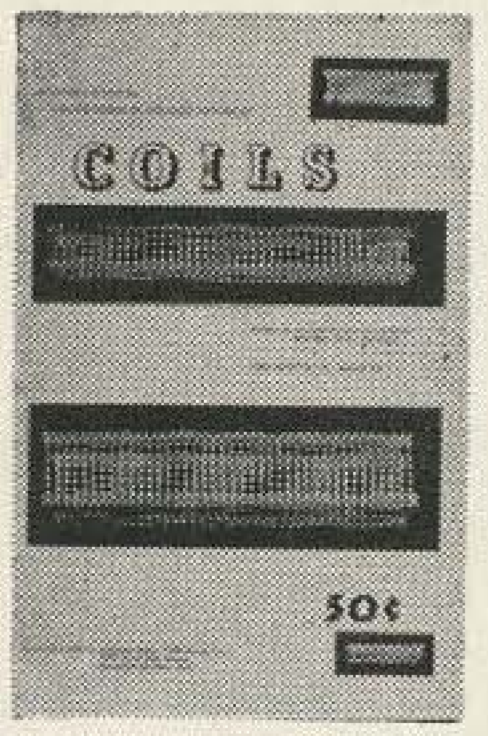

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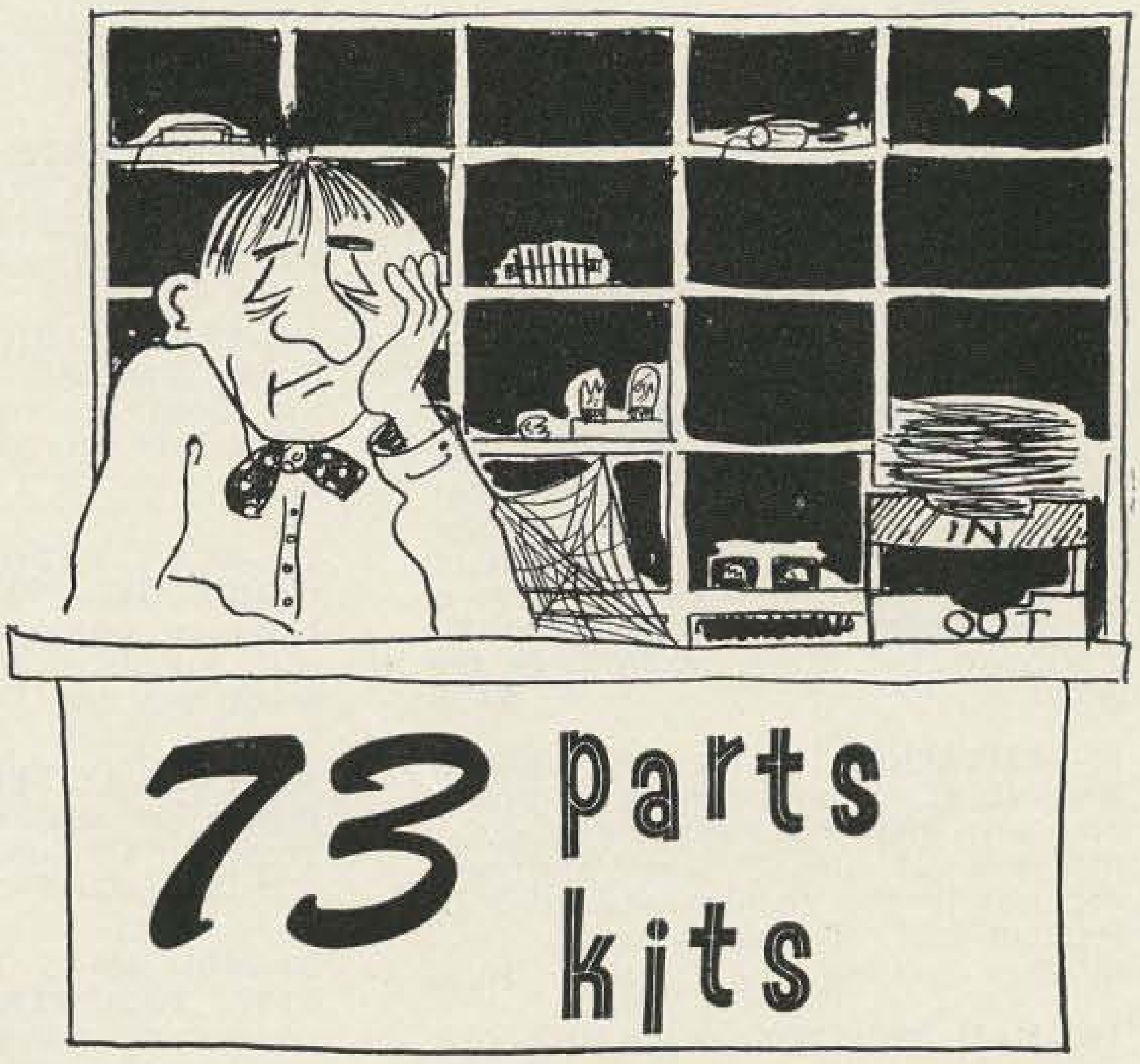

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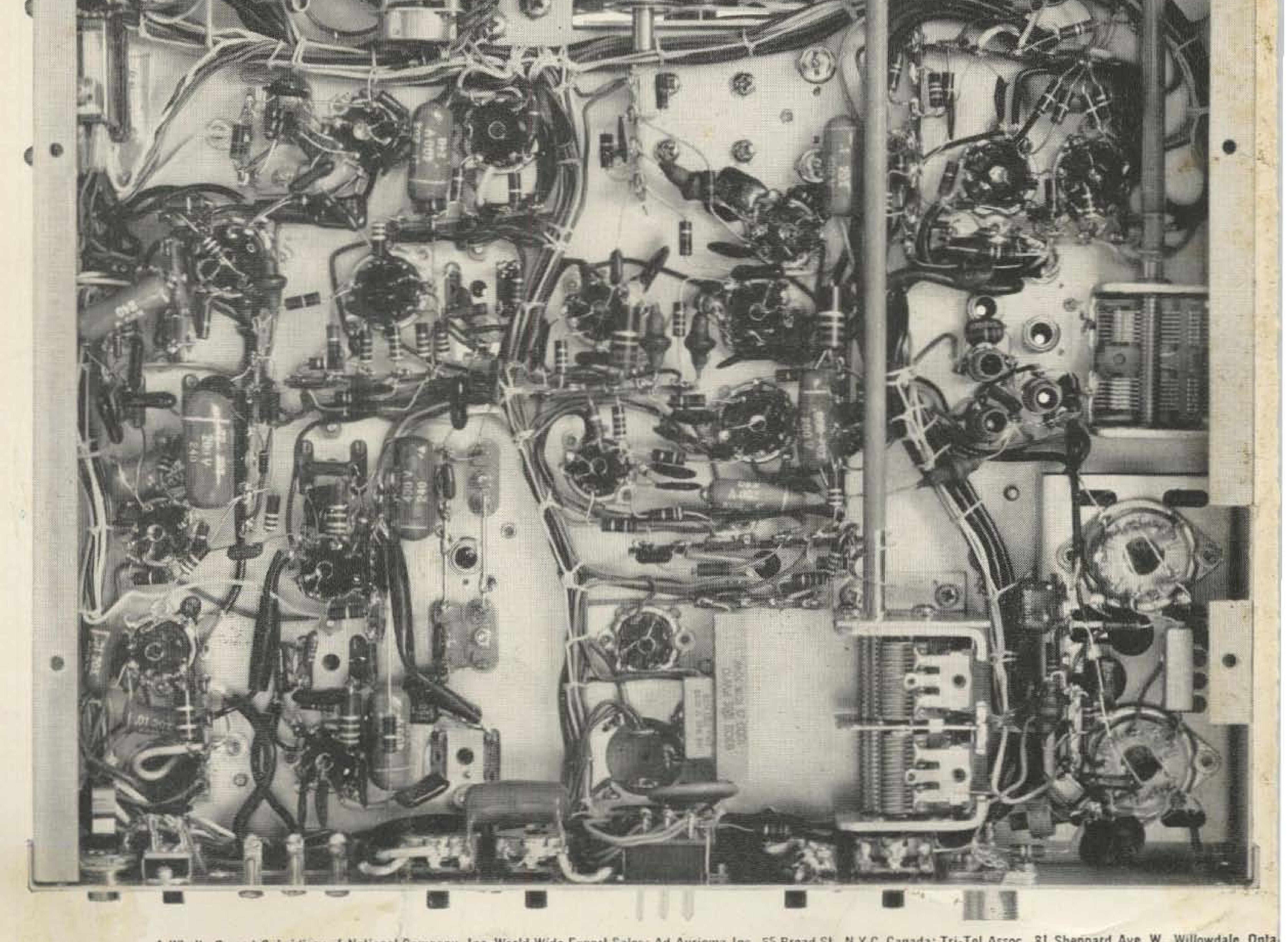

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