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FEBRUARY 1966
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Editor

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de W2NSD/1

never say die

Africa?

Dxing is insidious. Back last spring, when I got on twenty meters, Europe was pouring through all day long. After a few weeks of this I was ready to go and I went. Now the band is open to Africa every afternoon right on into the evening. As I talk to more and more African stations I find that the old memories of Jungle movies are coming back. About thirty years ago they had a passel of them and I used to sneak downtown after high school to see them. And I read the Osa Johnson books avidly. I'd polished off the Tarzan books some five years earlier.

Now, as I find myself creaking well into middle-age, I get to thinking how much fun it would be to take a drive through Africa in a Land-Rover or to perhaps shoot a lion. If I'm going to do anything like this it has to be pretty soon . . . while I can still do things . . . and while Africa is still relatively unexplored.

Are there, perchance, among the readers, any who are thinking along similar lines? Would any of you be interested in driving around Africa this coming summer . . . August and September? We'd take along a ham station, of course, and operate from as many rare countries as possible. We'd work in a safari and shoot a lion or so, and perhaps even a leopard. It may not be long at all before a trip like this will be impossible . . . any takers? It'll cost quite a bit, but it will be something you'll never forget.

Too much hamming?

Impossible, you say? Well, I got to mulling over how much time I've been putting in on twenty meters recently and came to the conclusion that I was close to being hooked by the DX bug and that I'd better ease off before it was too late. I found myself turning on the rig when I got up in the morning, again during the 10 a.m. coffee break . . . then at lunch, mid-afternoon, late afternoon . . . evening . . . and then there was that marvelous DX on 80 meters from sundown until two or three.

With all that activity I haven't missed much that has been going on. Oh, I lost one or two while I was away for a few days on trips here and there, but that was about all.

Working 100 of what the League quaintly calls countries during a two week blast back in April got me started. It has been difficult to stop. I am still finding a new one every day or so. As this is written I am at 173 worked. Probably the best bet is for me to keep at it for 27 more and then "retire" at 200. Then I can devote my energies to getting up to 100 on 80 meters, which should be a little more difficult.

There are so many interesting and enjoyable things to do in amateur radio that I really shouldn't spend all my time on just one aspect of it like this.

No, you won't find me listed in QST in the DXCC lists. My fun is in working them, not in seeing my call is QST. It gets there all too much already.

Possibly others will join me in my retirement when QST stops printing the honor roll each month and cuts back to twice a year. I hope so. The DX ops would have a much better time of it is they weren't harassed by QSL hunters.

FCC pronouncements

The Commission has announced that henceforth it will conduct operator examinations semiannually in Las Vegas. Say . . . can we cut double or nothing for the fee?

Time to fight?

The intruders in our amateur bands are getting worse and worse. CW, RTTY, multiplex, broadcast and other unidentifiables are gradually pushing us right out of our bands. Our feeble attempts to complain about this have fallen on deaf ears and for every signal that is eventually removed from our bands there seems to be ten to take its place.

The worst offenses are on 40 meters, of

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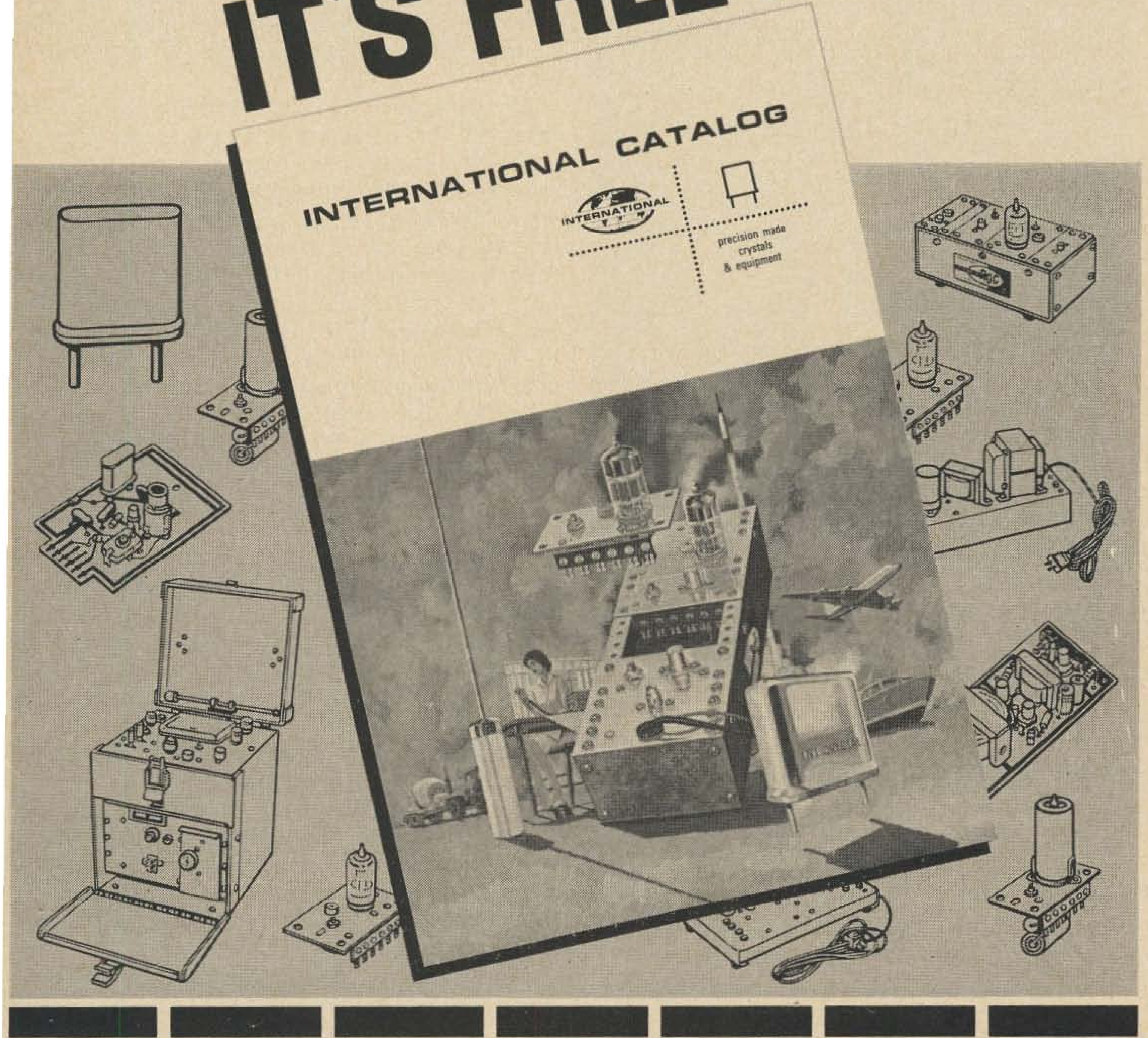

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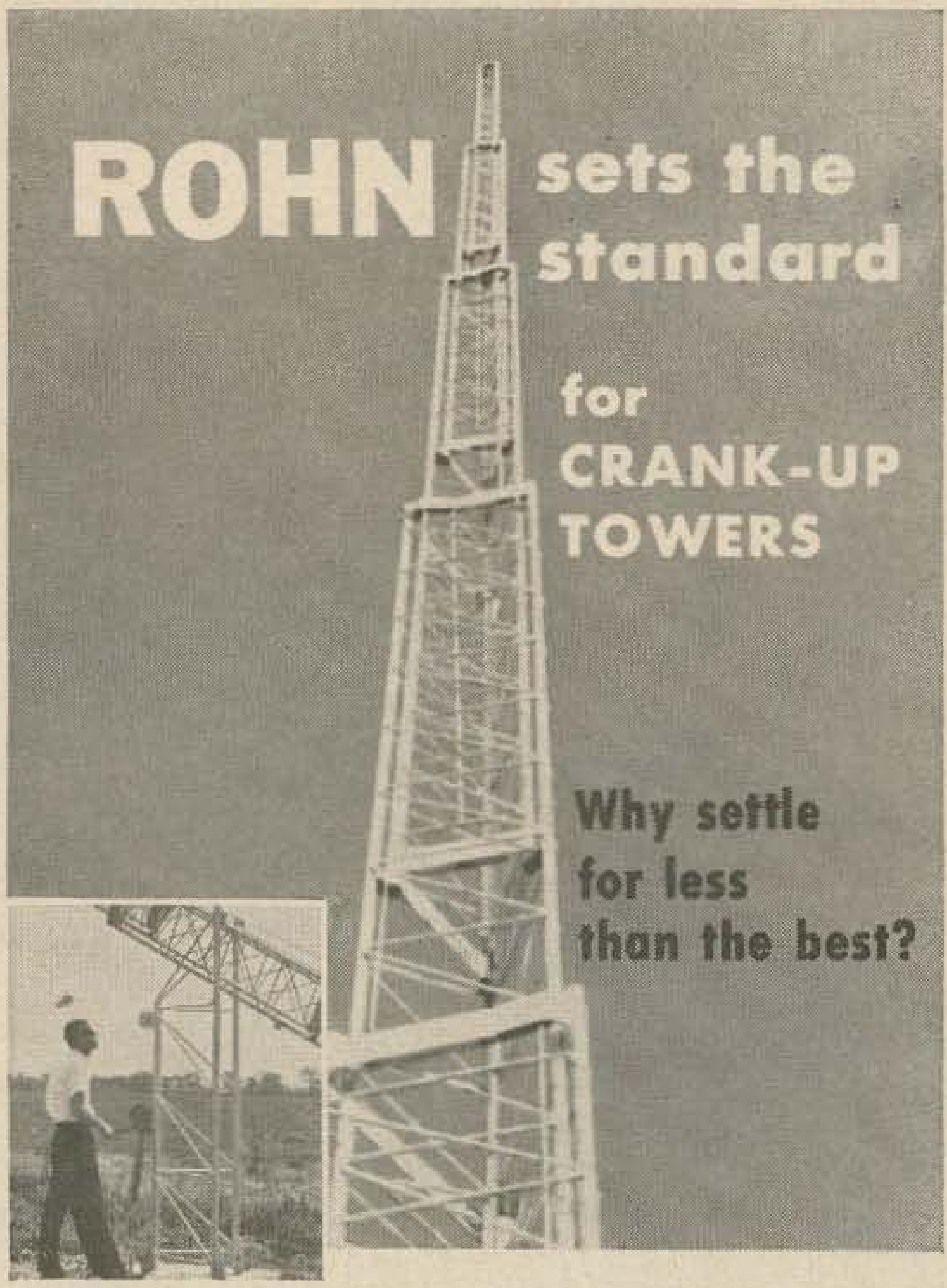


course. Here we not only have to contend with foreign broadcast stations, but our own umpteen kilowatted VOA are staked out every few kc through a good part of the band as I reported in detail a couple months ago. Add this to a few hundred 40-over nine RTTY stations and a few other services that have settled in our happy hunting ground and you have the bedlam that faces the 40 meter operator.

Or have you tried 80 recently. If you've been off the band for a couple years I guarantee you won't even recognize the band today. The 100 kc expansion of the phone band from 3900 to 3800 (thanks NARC) has largely been taken away from us again, this time by commercial RTTY. And you should hear the stuff the Canadian phones have to brave between 3750 and 3800!

So, what should we do? Shall we just move over and grumble about it? Should we send in an intruder report to the FCC? Or can we fight back with a little more backbone?

Vigilantes?

Obviously we are getting nowhere fast in our present unorganized state. I'd like to see a group on each of our ham bands which would meet as a net and pinpoint these intruders. Then I think that every means within our grasp should be used to force these stations out of our amateur bands. Just a handful of amateurs working together could, I believe, clean our bands up in short order.

Vigilante net members should have a direction finder at the very least. RTTY equipment will be needed to identify many of the stations. Some of the high speed CW can be taped and identified. The FCC and ITU will help locate the sources if we can get the call letters. Then we can get the FCC and ITU to pursue a complaint against the station with the government involved. We can also make it our business to use the intruder frequencies, thus showing them that these channels are indeed needed by the amateurs.

Wouldn't it be nice if some of the fellows who spend their amateur lives making things as miserable as possible for the rest of us could channel some of their energy toward making things unpleasant for intruders. Down on 80 it is almost impossible to work a real DX phone station without a very loud CW station calling a long halting CQ on the channel. That CW signal would raise hob with an RTTY station.

For that matter I am sure that some of our

(Continued on page 120)


SUPER
HUSTLER
RM-75-S


5726-A
"Another
NEW-TRONICS
Original"

Paul Zukin W6OVW

An 8163 Linear

For 2000 watts PEP on 80 through 10

In recent years many designs for single side band linear amplifiers have been offered the amateur interested in constructing his own equipment. This amplifier is neither original nor unique but does have several features which the author believes most desirable. A pair of modern relatively inexpensive 8163 high mu triodes are used. They have a combined plate dissipation of 800 watts and the ability to handle 2000 watts PEP with ease. The tubes are manufactured by Amperex and are specifically designed for grounded grid service. They need little cooling; a low velocity air flow provided by a small fan is plenty. This obviates the need for special sockets, chimneys, blowers or an air tight chassis. The elimination of these accessories permits a considerable saving in cost, and allows a physically smaller unit and one which is much quieter in operation.

This linear has been in service for the past six months and has proved extremely reliable and efficient. The total cost excluding high voltage power supply was under $150. It has replaced an amplifier using vacuum variable capacitors and relays and a 3-1000Z tube costing more than twice as much and nearly three times as large. The larger amplifier required considerable more drive but put out 5% less power with the same voltage and current input.

The circuit is standard. A band switching L network is used in the input to provide an optimum match for the exciter and to reduce intermodulation distortion. The filament choke is home made. A rotor coil was used as the inductor in the pi network but a band switching arrangement would serve as well. The counter dial is a readily obtained item on the surplus market. A surplus antenna relay operating on 110 volts dc was chosen since my 32S-1 provides 285 volts when the exciter is operative. This voltage is easily dropped to 100 volts with a 20 watt, 12,000 ohm series resistor. An alternative antenna relay system may be substituted for other exciters.

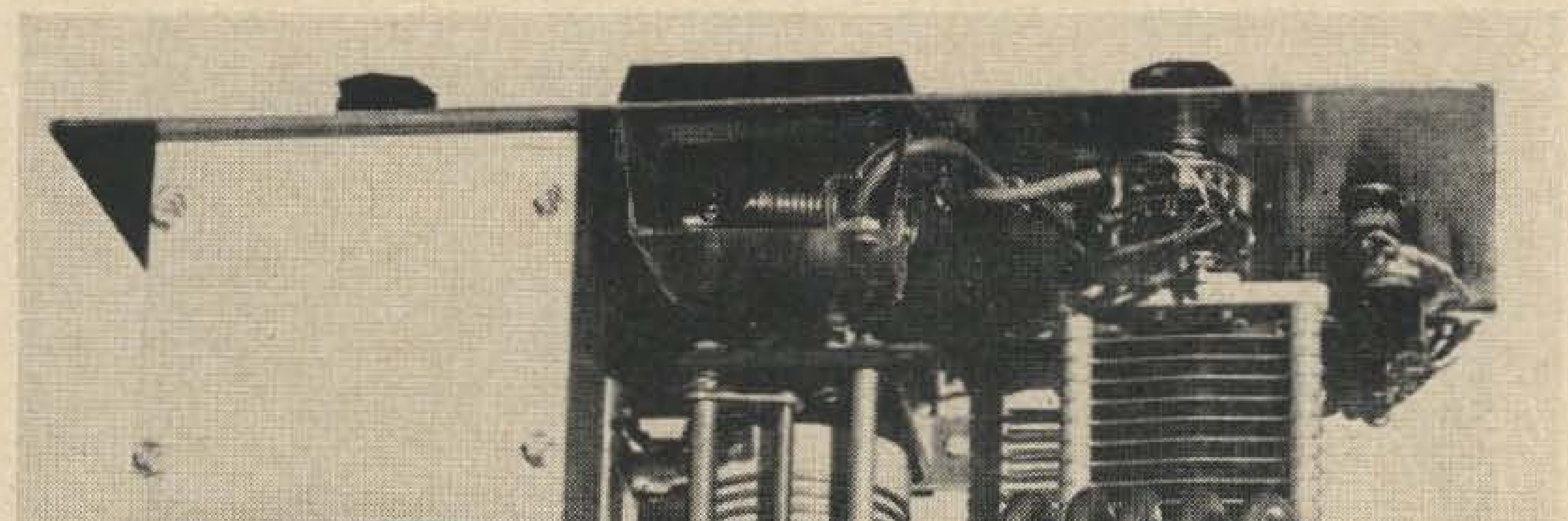
Since the high voltage supply is remote from the amplifier, interconnecting cables are required. A touch plate relay has been employed to switch the primary off and on. This bargain ($4) is a standard item used in low voltage house wiring circuitry. It features a built-in 24 volt dc source and will switch 20 amps ac without difficulty. The advantage in its use is that control of primary switching is by three small wires carrying only low current 24 volt dc rather than a large cable carrying the entire primary power. Information regarding these relays may be obtained from any wholesale electric supplier.

The meter circuit monitors grid current, plate current, relative output (by means of a rectified sample of the rf and plate voltage. A 1 ma meter movement forms the basic unit with the necessary shunts and series resistors switched to perform the desired functions. The meter is shielded from rf. The author's power supply uses a 60 second time delay relay in series with the relay activating the primary of the high voltage transformer and the meter illumination pilot turns on automatically when the time relay closes. The details of the high voltage supply have been omitted since the amateur radio handbooks describe several excellent circuits.

The small size of the amplifier actually permits its construction in many of the enclosures used for commercial exciters and transceivers. The amplifier described here is housed in a cabinet obtainer from Master Mobile, Inc. and measures 7 x 13 x 13 inches and harmonizes well with the S line.

A few notes regarding construction detail may be of value. All the coils in the input circuit are wound on ½ inch slug tuned National XR-50 forms. The capacitors are 1000 v silver micas and the input circuitry is housed in a 4 x 4 x 2 inch aluminum case with small coax connectors for leads in and out. The tube sockets are Johnson "Giant 5 Pin." In grounding pins 2, 3 and 4 it is advisable to use ¼ inch copper strap keeping the leads as short as possible. The components in the rf sampling circuit must be shielded and may be conveniently mounted in an old can with the sensitivity control coming through the top hole.

The relay circuit employed automatically bypasses the amplifier with S_3 in the off position. With S_3 in the on position output from the exciter feeds into the amplifier (instead of the antenna) and the output of the amplifier goes to the antenna. The extra set of con-



Top view of the 8163 linear amplifier. Note the small blower in the right corner. The massive anodes of the Amperex 8163 explain why more cooling isn't required.

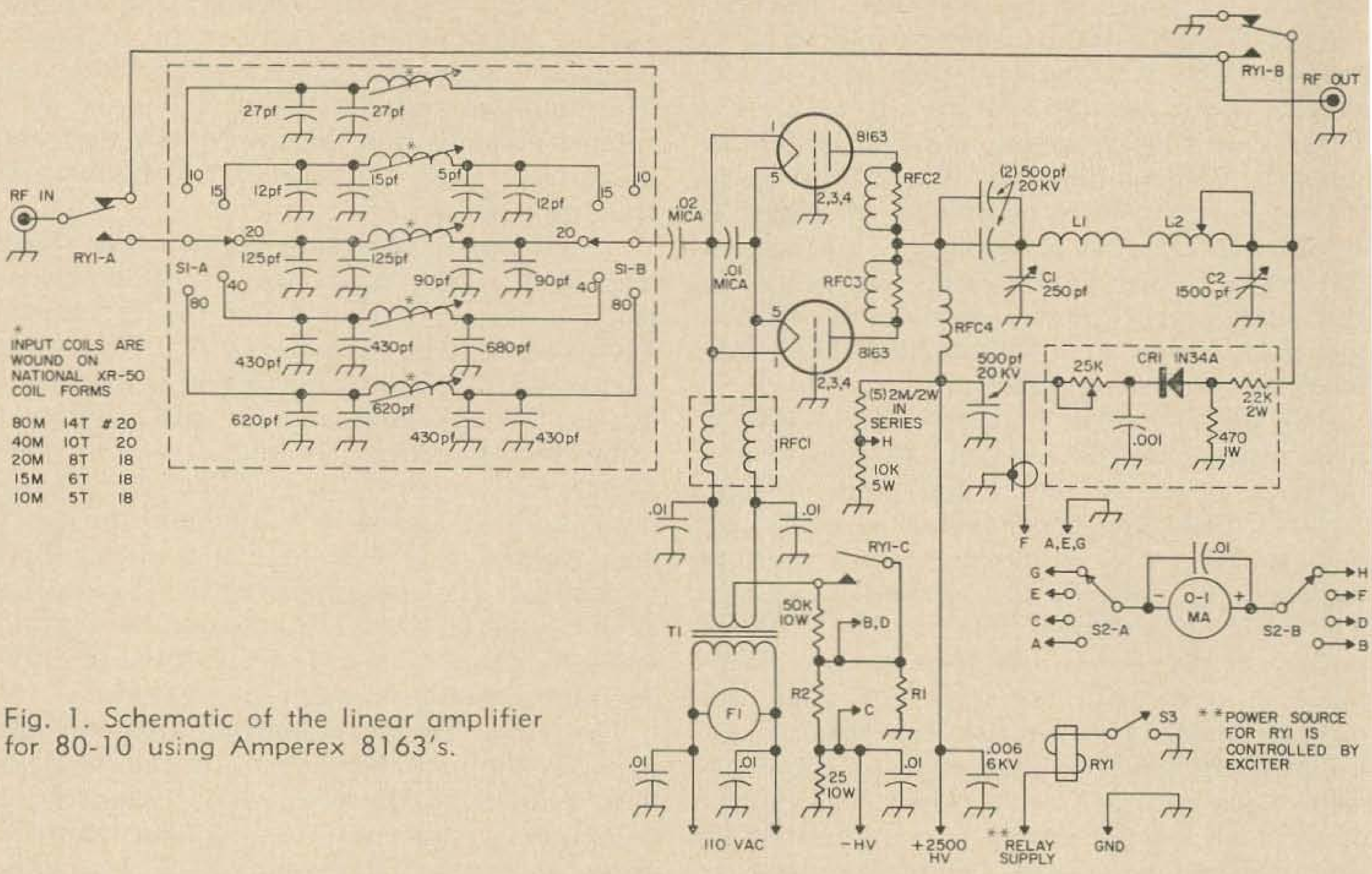


Fig. 1. Schematic of the linear amplifier for 80-10 using Amperex 8163's.

tracts on the relay are used to short out a 50,000 ohm resistor in series with the center tap of the filament transformer. In "receive" condition this resistor provides self bias for the tubes and they draw no current. In "transmit" shorting out this resistor permits the tubes to operate normally. A 25 ohm resistor is used between the chassis (ground) and the high voltage negative lead, keeping the meter essentially at ground potential. The meter shunts used will have to be chosen for the internal resistance of the meter movement. For the sake of simplicity both grid and plate current are measured on a 0 to 1 amp scale and the high voltage on a 0 to 10,000 volt scale. The meter used in the author's unit is particularly nice since all shunts are external and the translucent scales chosen simply slide behind a plastic compartment protecting the pointer.

The tune-up procedure should be well known to all amateurs and needs no explanation here. Adjusting the input network is simple. Feed a small amount of power from the exciter to the amplifier with the filament voltage on and the high voltage off, and with an swr bridge connected between the exciter and the amplifier. The slugs are tuned to provide a minimum of reflected power. In practice a 1 to 1 ratio is not difficult to obtain on bands. . . . W6OVW

A view of the amplifier out of its case.

Component List

C_1 Johnson, 154-9
F_1 Cooling Fan, Lafayette AYFA-403
L_1 5T ¼" copper tubing, 1½", 3" long
L_2 18 microhenry, Johnson 2291202
M_1 0-1 ma meter unit with 0-1 amp scale. (Phaostron Prestige II)
RFC_1 28 double turns, number 10 Formvar or Nyclad closewound on ½ inch diameter 7½ inch long ferrite rod (Lafayette Radio, NYC MS-333)
$R_{1,2}$ meter shunts for 0 to 1 amp full scale with 0 to 1 Ma movement.
$RFC_{2,3}$ ¼" copper strapping wound to form 3 turns, 1" diameter, 1½" long, around 3 220 ohm 2 watt carbon resistors in parallel.
RFC_4 B and W W800
RY_1 DPDT antenna changeover relay with extra set of contacts. (Hiway Electronics, 114 Venice Blvd., Los Angeles, California)
S_1 2 pole 6 position (5 used) ceramic rotary switch (Centralab, PA-2003).
S_2 2 pole 4 position rotary
S_3 SPST toggle
T_1 Thordarson 21F33

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And Then There's Phasing SSB

Home brew phasing type generation of SSB signals has numerous advantages over filtering. First, the frequency is determined by the builder, not the manufacturer of some filter. Second, it is cheaper to build. Third, sidebands are selectable without changing carrier oscillator frequency. The method seems limited by a combination of apparent complexity and inconvenience in using. This article will attempt to explain the complex in simple terms as this is all the writer understands about it.

It is inconvenient when the generator operates on the output frequency and must be retuned completely to QSY. Modern practice, however, is to generate the SSB signal on some fixed frequency and then mix with a VFO signal to get to the ham bands. 9 mc has grown to be an accepted frequency for this sideband generator to operate on. When mixed with a 5 mc VFO the difference frequency is on 75 meters and the sum is on 20. Two meters is available by mixing the 137 mc from a string of multipliers with the exciter output and so on.

This article is different from the many excellent articles in the literature in that the purpose is to explain those things about building and operating these phasing rigs that recent articles have left out. Nothing new is contained here, but some of the simple things have not appeared in print for years as they are "well known". A person without a good reference library is therefore left out.

Fig. 1 shows a more or less typical 9 mc phasing exciter built using a Barker and Williamson audio phase shift network (B & W 350-2Q4). In principle this and other phasing exciters have three parts: The audio processing section, the rf phasing section and the balanced modulator. In the sample schematic this takes three tubes and a regulator.

The basic idea is to get two audio signals that differ from one another by 90°, and to combine these signals in a pair of balanced modulators connected to a common rf output transformer tuned to the rf (carrier) frequency. The result is a single sideband suppressed carrier output which is then mixed to get to the desired frequency and amplified to obtain the desired output power.

Audio circuits

The circuit shown is that recommended by B & W. Others tried have not worked as well. The purpose here is to split a single audio

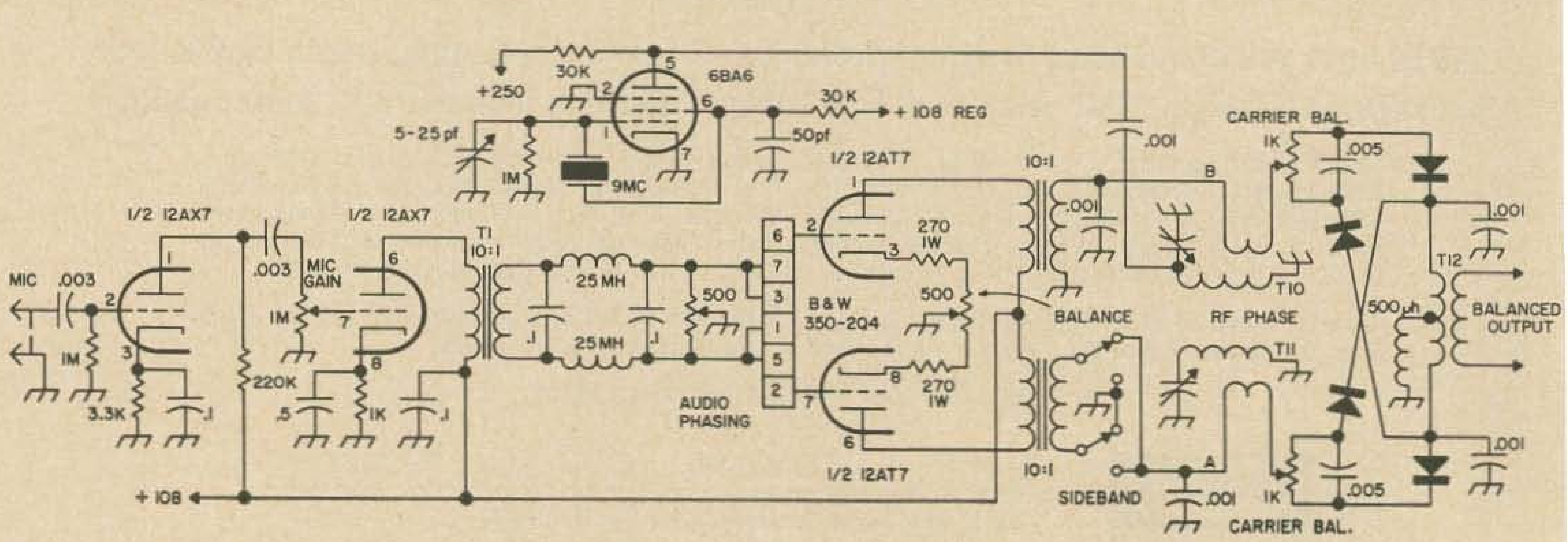


Fig. 1. Typical phasing transmitter. This is the schematic of the transmitter described in this article.

input into two separate outputs differing in phase by 90°. These two outputs are as individual as the two channels of a good stereo system. B & W rates their unit at 90° ±1.5° over the audio range of 300 to 3000 cycles per second. The 500 ohm AUDIO PHASING pot across the input to the network will end up adjusted off center by a ratio of 5 to 7. Don't worry, this is the way it is designed to operate. The two outputs must not only differ in phase by 90° but must be equal in amplitude for proper unwanted sideband cancellation. The 500 ohm BALANCE pot in the cathode circuits of the audio section output amplifiers is provided to set this, and need be touched up only occasionally as the components age.

Design of the preamp driving the phasing network must take into account the frequency range of the network. The high turns ratio of the transformer into the network is intentional and tends to shunt frequencies above the communications range. This turns ratio is 10:1 for an impedance ratio of 100:1. Smaller coupling capacitors and cathode bypasses tend to hold down the lows. The low pass filter network in the secondary of T1 insures that there is adequate rejection of the higher frequencies which will show up as chatter on the unwanted sideband if allowed into the phasing network.

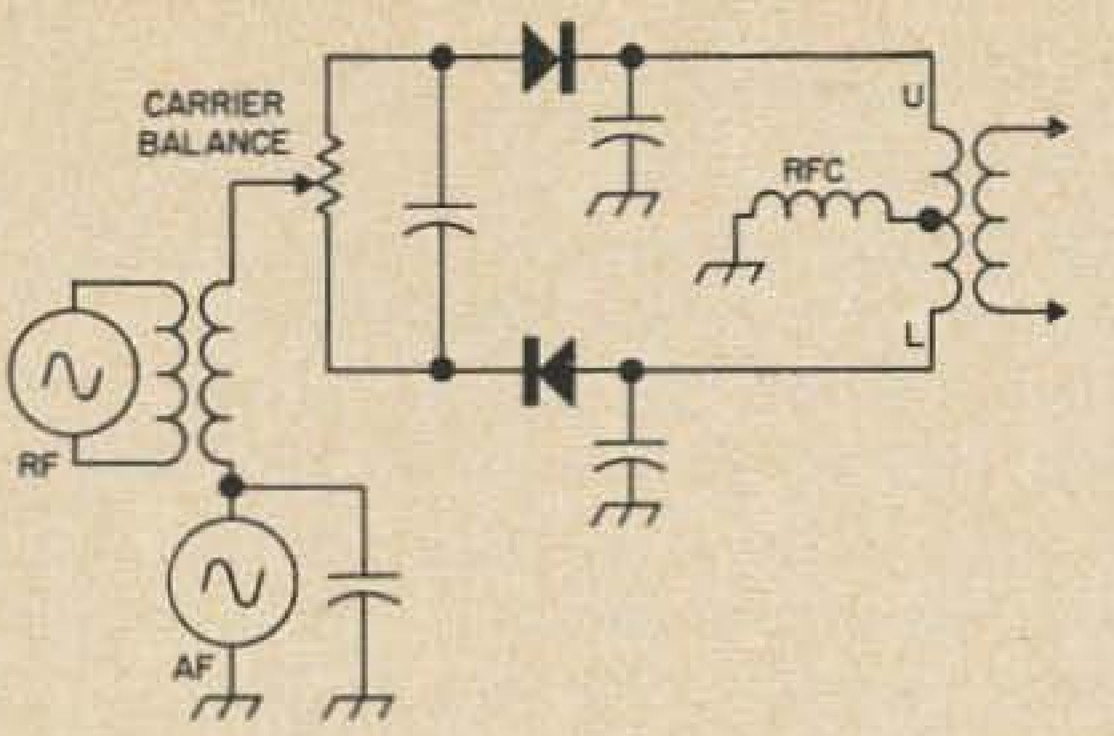
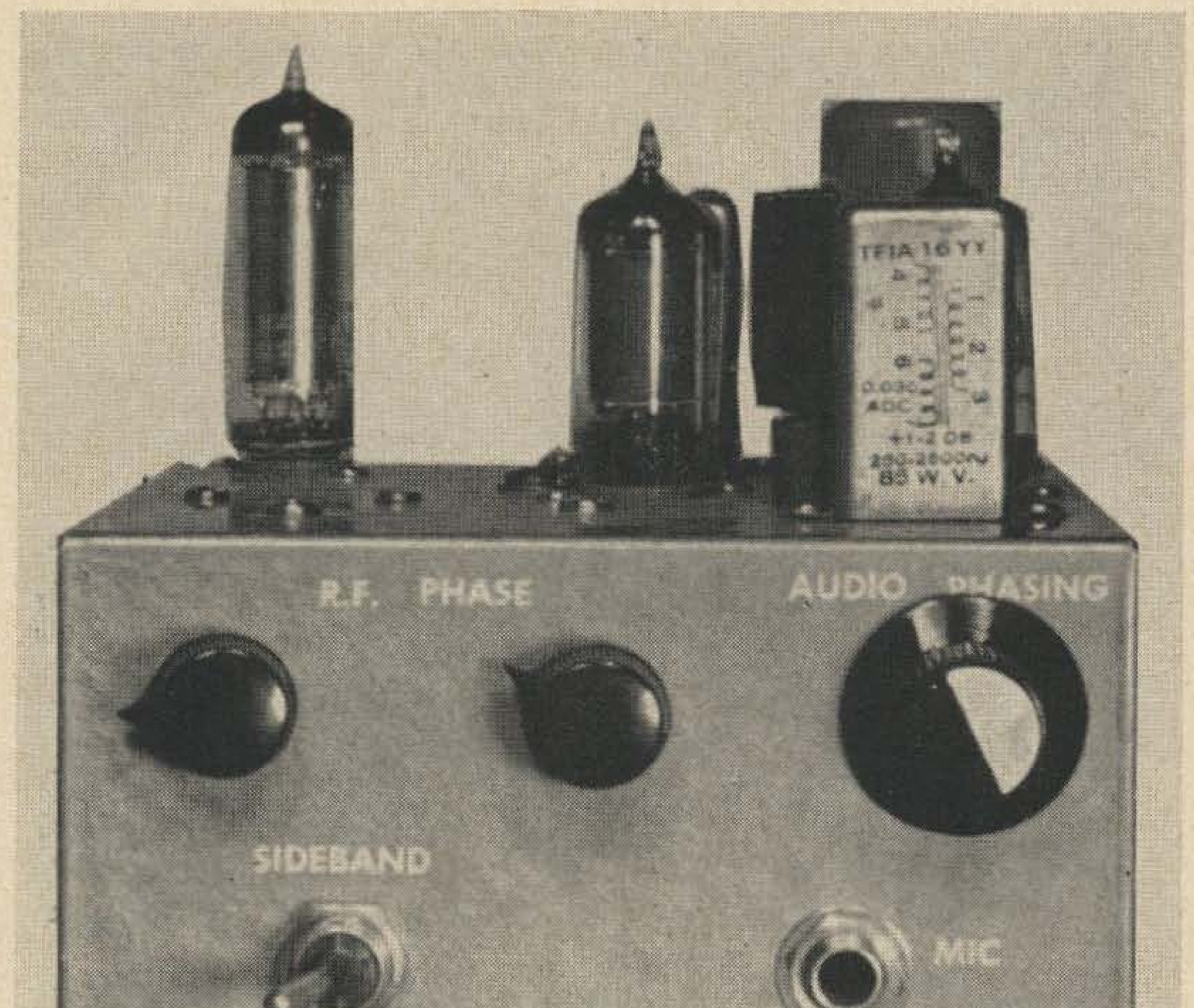


Fig. 2. Balanced modulator as used in this exciter.

The effect of excessive lows will be increased difficulty in tuning your signal at the receiving end, because most energy below 300 cps will appear in both sidebands. The



Front view of the phasing SSB exciter. The audio balance control is on the rear. Note that **mic gain** is a screwdriver adjusted control.

effect of excessive highs will be a chatter 3 kc and more away from your carrier frequency on the unwanted sideband side. These are design, not tuning problems.

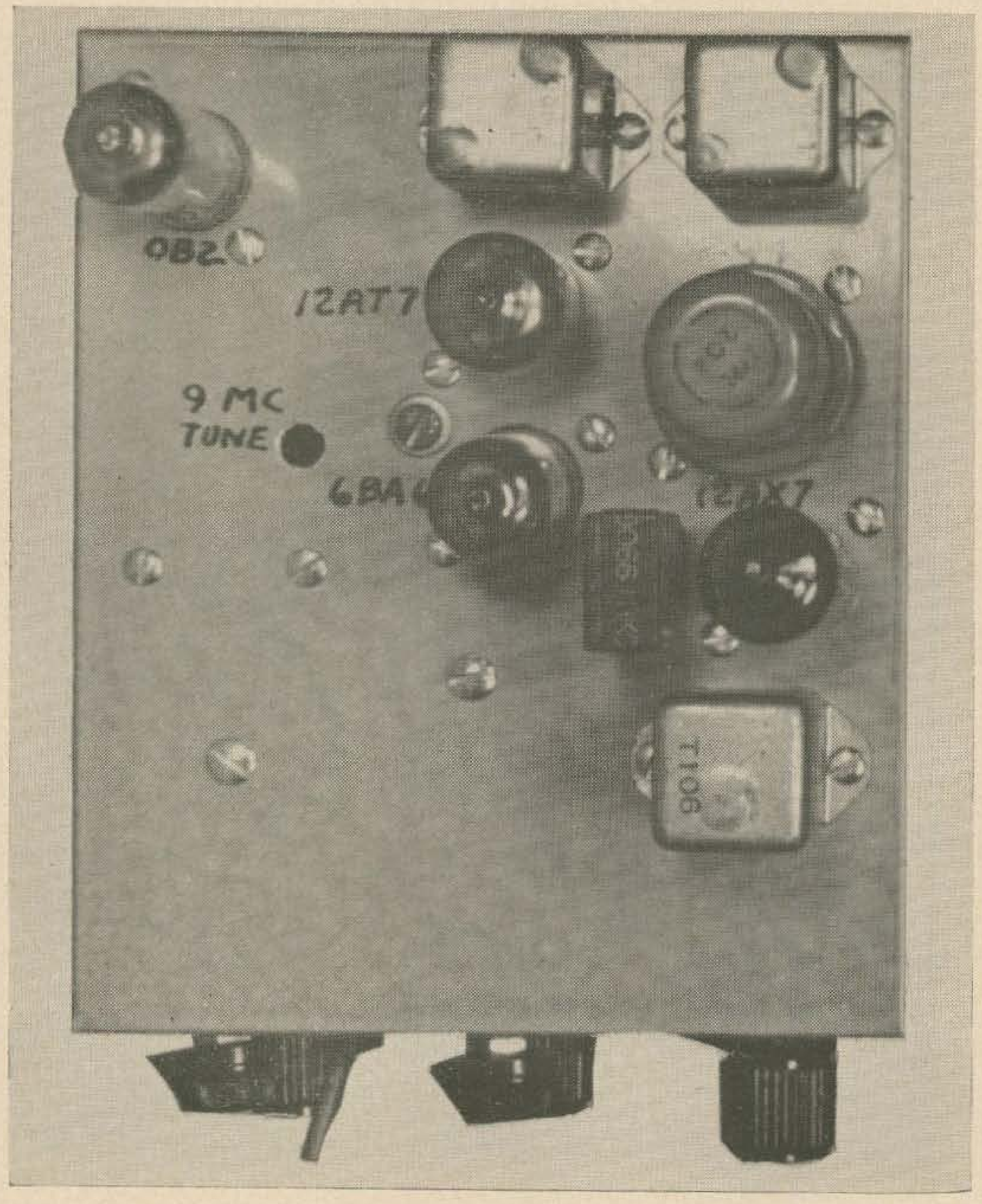
To sum it up, the output of the audio section consists of two individual audio outputs which are confined in range to the upper and lower limits of the phasing network and which are quite precisely 90° out of phase with each other and equal in amplitude. We can call them A and B and will pick them up later.

RF circuits

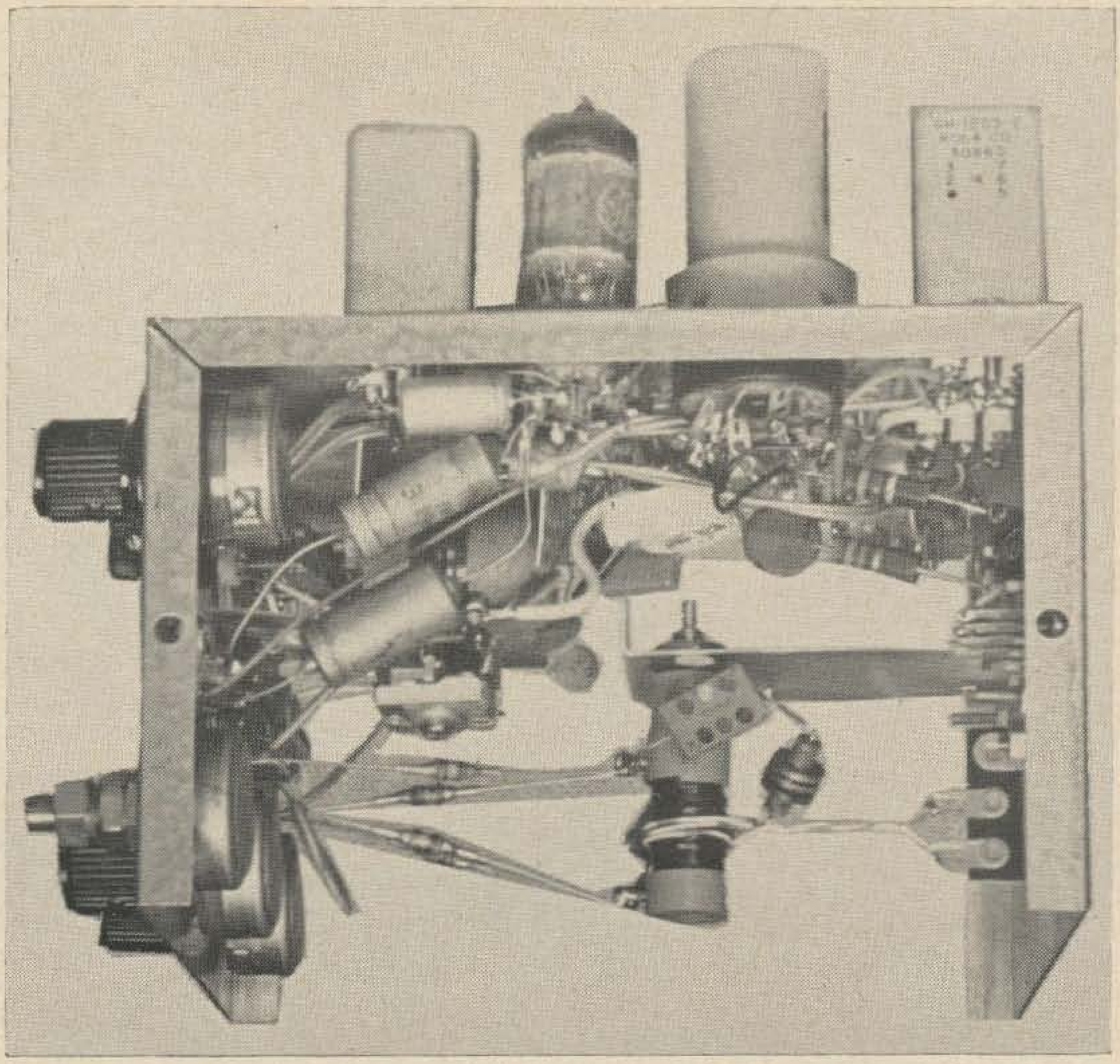
An electron-coupled, crystal controlled carrier oscillator at 9 mc is used as the rf source. T10 is tuned to the output frequency of this oscillator. T11 also tunes to the same frequency and is driven by T10. The oscillations in the two tuned circuits are 90° out of phase when properly tuned. The amplitudes of these oscillations should be fairly equal. Large inequality between these two outputs as measured at the swinger of the CARRIER BALANCE pots will show up in the form of less unwanted sideband cancellation (suppression). Adjustment of this amplitude may be accomplished by varying the distance between the two coils or by installing a small capacitance (gimmick) between the two.

Tuning adjustment for T11 (and incidentally T10) should be readily accessible to the operator (not a screwdriver adjust function) as T11 will have to be touched up if the unwanted sideband cancellation seems to be drifting up. The Q of these transformers should be about that obtained by using 70 pf to tune the inductors to the required 9 mc.

Wiring from the rf transformers thru the output should be symmetrical. Balance becomes more difficult when there is, for instance, more capacity from one set of diodes to ground than the other. The link output on T12 must be on the center of the coil, and it must present a balanced load. Otherwise, carrier balance will be impossible and, in



Top view showing parts layout. **9 mc tune** is the adjustment for the output control.



Side view of the exciter showing parts layout. The audio section is nearest. Note the output transformer on the right.

short, it won't work.

The two outputs from the rf phase transformers are obtained by winding a couple of turns of hookup wire around the cold or grounded end of the coils. The audio outputs A and B are connected to one end of these links while the other end goes to the swingers of the CARRIER BALANCE pots. The .001 bypass in each audio circuit should be installed right at the rf link if the wire run is long. The swinger of each pot ends up with pure audio and pure rf signals on it, unmixed. Mixing takes place in the balanced modulator.

Balanced modulator

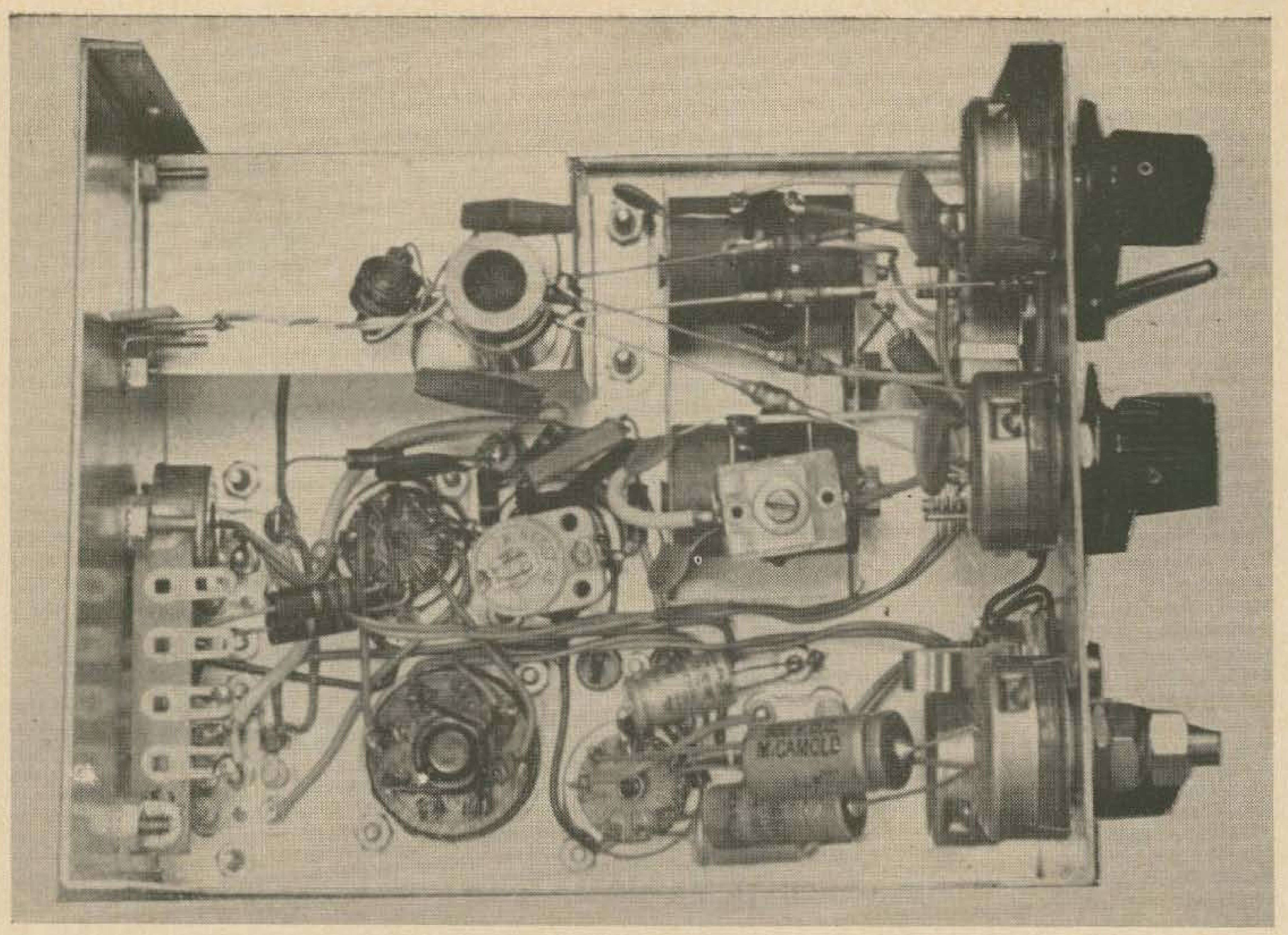
The two CARRIER BALANCE pots are carbon as they must pass rf. The amplitude of the rf signal should be at least three times the audio. This rf signal is used to switch the mixing diodes on and off while the audio signal determines the maximum value to which the mixed signal can go. The rf must therefore be much greater than the peak of the audio.

Many types of signal diodes can be used, though all should be selected for compatability if practical. This consists of checking the forward resistance of a number of units and taking the four that are most alike.

Looking at **Fig. 2** now, let's imagine that the tuned circuit on the right is set at 9 mc. When a positive cycle is generated, it goes thru the upper diode and pulses the tuned circuit, driving point U positive. A half cycle later, point U is negative and point L has become positive. At this same time the source is applying a negative cycle thru the lower diode, also to point L. The positive and negative at point L cancel, and there is no output. This is true as long as the upper and lower diodes are conducting the same, any small variations being compensated for by the CARRIER BALANCE pot.

When audio appears, it tends to turn one of the modulator diodes on while turning the other one off. This allows unequal positive and negative cycles thru to the tuned circuit and they do not cancel, thus producing an output whose amplitude varies at an audio rate while superimposed on a radio frequency signal. This output is not distinguishable from a set of sidebands with no carrier. When two of these are properly phased in relation to one another and are connected to a common rf transformer, one sideband adds while the other neatly cancels out.

Note that each of the two balanced modulators produces both upper and lower sideband output while removing the carrier. The actual elimination of one of these sidebands is done



Bottom view. The terminal strip on the upper left is for all power connections to the rig.

by cancellation in the tuned circuit to which both are connected.

The 500 μh choke connected to the center of T12 is an absolute necessity. An attempt to build a simple SSB rig from a schematic where this choke was omitted resulted in a frustrating week spent seeking the answer. This choke is the return path for the audio signal fed into the balanced modulator, but must hold the whole tuned circuit away from RF ground or the very important 180° difference across the circuit will not be maintained.

Tuning up

Once the SSB exciter is tuned up and operating into a mixer stage there is no need to do more than touch it up occasionally. It will be desirable to null the CARRIER BALANCE pots as in any kind of SSB exciter, but the only other attention it will need is an occasional check of the unwanted sideband rejection. Start by injecting a 2 kc signal into the MIC input. Tune the tone in with a sharp receiver on the unselected sideband and null it out with the RF PHASE and AUDIO PHASING controls. Switch sidebands a couple of times, nulling the unwanted sideband each time, and the job is complete.

A little bonus here for those who are not too familiar with phasing rigs and have read this far: S1 is the sideband reversing switch. To go from one sideband to the other in a phasing rig it is necessary only to reverse one of the two audio outputs. This question is in practically every FCC Technician and General Class exam issued.

An oscilloscope is very handy when one of these rigs is being tuned up for the first time though with patience it can be done like the touch up in the next to last paragraph. For the complete tune up: put a 2 kc sine wave tone into the MIC input and advance the GAIN control a little. Referring to **Fig. 1**, connect the horizontal and vertical inputs of the scope on audio output A. Adjust the gain on both inputs for a perfectly diagonal line (same number of divisions across as up). Now put the horizontal on the other audio output B. Adjust AUDIO PHASE and BALANCE to get as good a circle as is possible. Advance the MIC GAIN until the circle is as large as practical before it distorts. Remove the tone. Talk into the rig with the microphone that will be used. Adjust the MIC GAIN so that the hash on the screen is not larger than the circle that was there. Do not operate with more MIC GAIN than this as all kinds of distortion can result. Instead, look for power gain elsewhere.

Now turn on the 9 mc oscillator. Put the antenna lead from a selective receiver near the output of the rig as a sensitive output meter. Tweak the capacitor in the oscillator grid for maximum out. Tune T10 and T12 for max out. Tune T11 to as close to resonance as is possible at this time. Go back and forth adjusting the CARRIER BALANCE pots for minimum output until a null is obtained. Unbalance one of the pots and make sure T10 and T12 are at maximum, then renull.

Introduce the 2 kc tone, being careful not to overdrive the audio system as mentioned before. Using the selective receiver, find the weakest sideband (if there is one). Flip it from upper to lower (using S1) to check. When the weakest is found, tune on it and adjust the AUDIO PHASING, BALANCE and RF PHASE (T11) to null it out. Be careful to go from upper to lower and back repeatedly, always nulling the unwanted sideband, until either is at full null when selected by the sideband selector switch S1. The rig is now on SSB, only one of the tones being present at any given time.

It is possible to null out one sideband, say the lower, without having the upper nulled out when sideband selector switch S1 is flipped. This is why it is necessary to go to the trouble of going from one sideband to the other to get a genuine switchable null. Both sidebands have the same carrier oscillator frequency and, once adjusted, are selectable at will using S1.

The exciter shown in the photos was built from the typical schematic (just to be sure) and works FB. The intention here has been to foster understanding of these rigs. Since many excellent construction articles exist there seems to be little need for more specific information of that type.

The following bibliography contains a few construction articles for those interested, plus the sources from which this article was lifted.

. . . WA6KLL

Photographs by Alan Pemberton WA6LEU

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2. Radio Amateur's Handbook, ARRL.
3. Orr W6SAI Radio Handbook, Sixteenth Ed.
4. "Cheap & Easy SSB," March 1956 QST or ARRL Mobile Manual 3rd Ed. 1962.
5. "Another Phasing Type Exciter," September 1962 QST.
6. "A Mobile Phasing Transmitter," CQ Mobile Manual 2nd Ed. 1956.
7. "A Simple SSB Exciter," October 1961 CQ (remember choke on T 12 !).
8. "Diode Modulators," May 1963 73 Magazine (recommended).
9. "Active SSB Modulators," July 1963 73 Magazine.
10. "Single Sideband For the Radio Amateur," ARRL 1954.

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Ralph Roanhaus
780 Forest Loop Drive
Port Hueneme, California

Better Selectivity for Your Transceiver

Use a crystal filter for better CW performance

The recent trend towards transceivers in amateur communication equipment has given the owner a very fine piece of equipment for either mobile or fixed SSB work. It has, however, also given him a very inadequate receiver when he desires to use the unit for fixed station CW work; the 3 kc selectivity characteristic being far to broad for good code communications. It would seem that a narrow passband for CW would be a very desirable feature to have built in, but, since it almost universally is not, some external unit to accomplish this is very much in order.

Over the past year numerous, and in some cases quite effective, devices have been designed to improve the overall selectivity of such receivers. Usually however they suffer from the common deficiency of insufficient skirt selectivity which leaves the receiver open to strong adjacent channel interference and, since "adjacent channel" usually means six or seven signals, this can and does wash out many contacts which would otherwise be completed. The device to be described here improves this skirt selectivity and when used with an outboard audio filter such as described in the July 1962 issue of 73 does just about all that is possible to do to insure good contacts under the present conditions.

A glance at the schematic (**Fig. 1**) shows the unit to be an outboard 455 kc, two section, half lattice crystal filter with a product detector and an audio amplifier. A small built-in power supply furnishes the unit with heater and plate voltages, however, it might be possible in some cases to extract these voltages from your receiver as the requirements are not large.

The selectivity curve for this amplifier (**Fig. 2**) is approximately 200 cycles wide at the −6 db point and fans out to approximately 700 cycles at the −30 db point. The overall width of the response curve for a filter such as this can be changed by the proper choice of crystal sets. Crystals spaced farther apart in frequency will broaden out the top of the curve and still leave the skirt characteristics substantially the same. Careful alignment of a filter of this type is necessary, especially so when you use wide spaced crystals, otherwise you will have a response something like that of **Fig. 3**—the chances are this is what you will get when you finish your first rough alignment anyway. You can however, by carefully setting the rf generator to the center frequency between the two crystals,

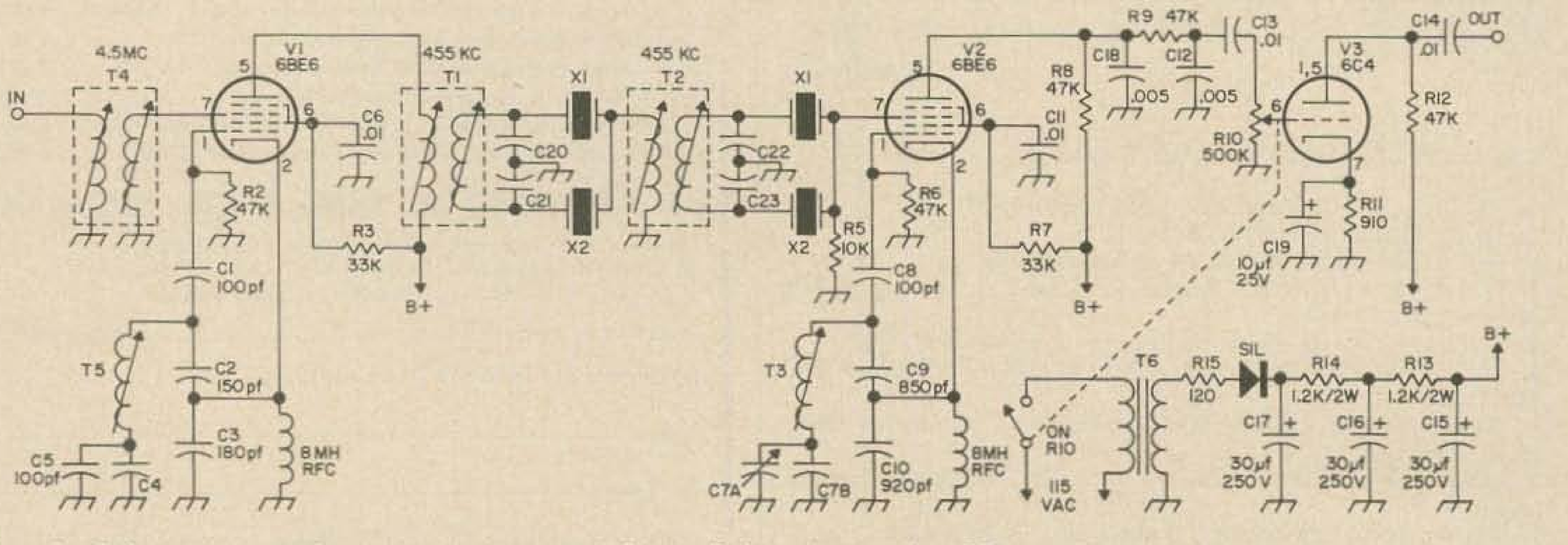


Fig. 1. Schematic of the outboard crystal filter CW adapter for SSB transceivers.

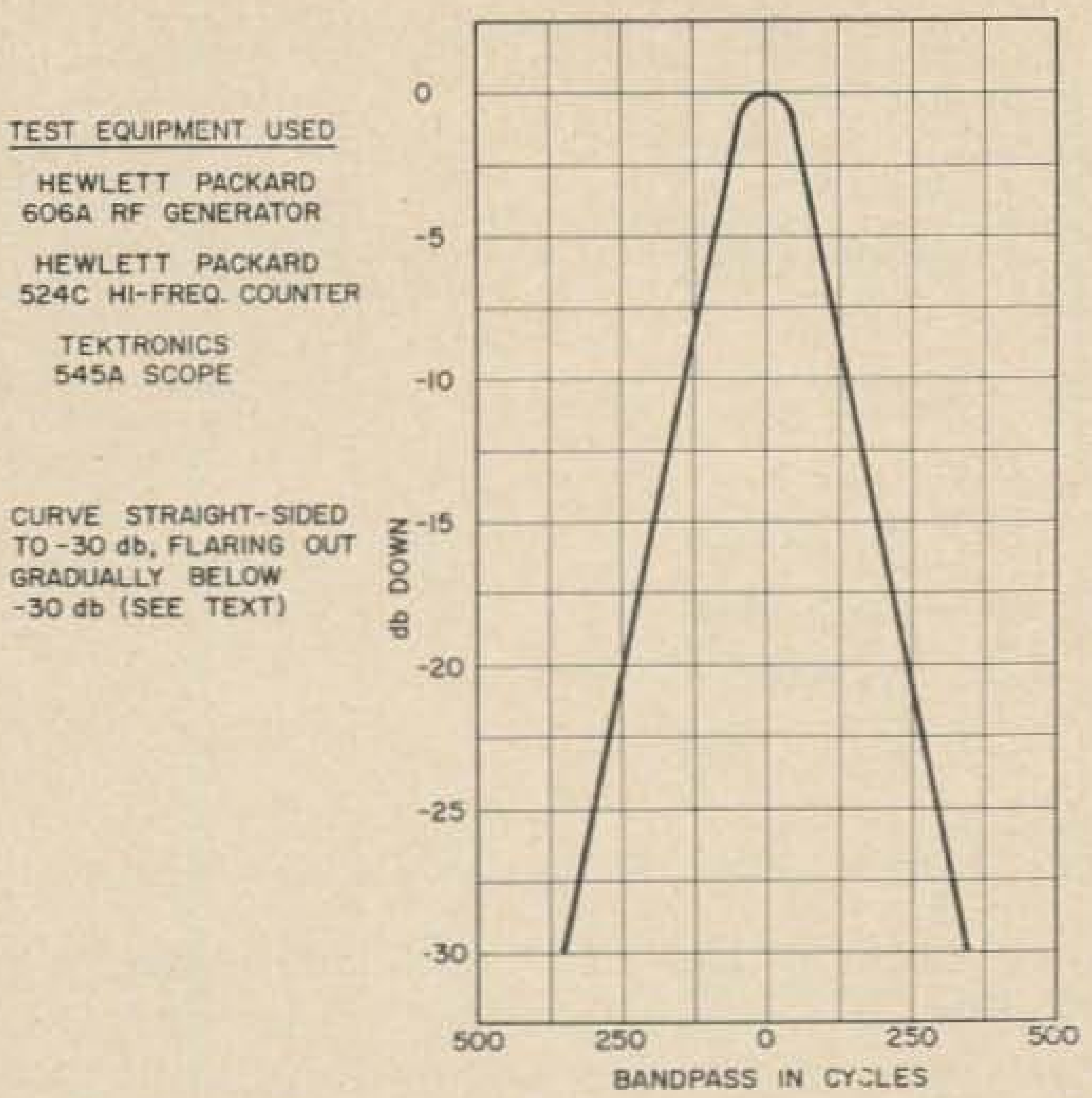


Fig. 2. Response curve for two section filter using crystals for channels 41 and 321.

fill in the center dip as you bring the *if* transformers into resonance, and increase the gain at that frequency. In case you do use wider spaced crystals you probably will need to stagger tune the *if* transformers to get a flat top to the response curve. This is no problem at all if you happen to have a sweep generator and not a very difficult one with only a rf generator and an output voltmeter.

Just in case you do have a sweep generator and happen to be a perfectionist you can also improve the skirt selectivity in the −30 to −50 db range by carefully balancing the capacity between the two halves of your lattice filter. The flaring out of the otherwise quite straight sided response characteristic is largely caused by capacity unbalance. An improvement in the skirt selectivity can also be obtained by the addition of more crystal sections. This complicates the alignment however, so is not particularly recommended unless a sweep generator is available.

The coupling from the receiver to the unit can be accomplished in several ways. The method shown in **Fig. 4** uses a small (10 pf) coupling condenser connected to the last *if* stage of the receiver, right at the point where it enters the detector stage. This will detune the last *if* transformer a little and will require a small adjustment of it's slug, but this can be left until last when it is easily accomplished by watching the S meter of your receiver. Just in case you do not wish to solder anything in your new receiver it is possible to get enough signal to operate the unit by simply making a few tight wraps of insulated wire around the lead coming from the last *if* can instead of installing the condenser. Five or six turns should be sufficient but put on more than that if possible. The *if* voltage from this coupling capacity is then brought out, preferably through a small BNC or an RCA jack on the rear of the chassis, to a short piece of co-ax going to the input of the outboard unit. Keep this co-ax lead as short as possible to avoid undue losses and the detuning of the *if* coils at each end.

The input *if* transformer used (**Fig. 1**) is one of the 4.5 mc type tuned, in this case, to the receiver's *if* of 3 mc. In case the receiver you have uses an *if* of a different frequency this transformer must match what you have of course. With the loading effect of the co-ax the input of this 4.5 mc transformer should resonate at the desired 3 mc with no trouble, if not it may then be necessary to shunt the input coil with a small condenser of 10 to 20 pf, a little cut and try may be necessary here as your co-ax lead length has a definite influence. The output coil of this transformer will require a small shunting condenser to bring it down to the 3 mc frequency also—again some cut and try may be necessary.

The first converter uses a 6BE6 tube in a standard mixer circuit with the oscillator operating on a frequency of 2545 kc, which, when beating with the incoming frequency of 3 mc, gives the proper *if* frequency for the unit. In case you have a different *if* frequency which will require a different oscillator frequency, care must be exercised to insure that the oscillator will not have harmonics which fall inside the ham bands. These can be picked up by the receiver and can be very annoying.

The output transformer for the 6BE6 is a standard 455 kc job with the secondary split by two 100 pf condensers. In the remote case that this secondary cannot be brought into resonance it will be necessary to change the

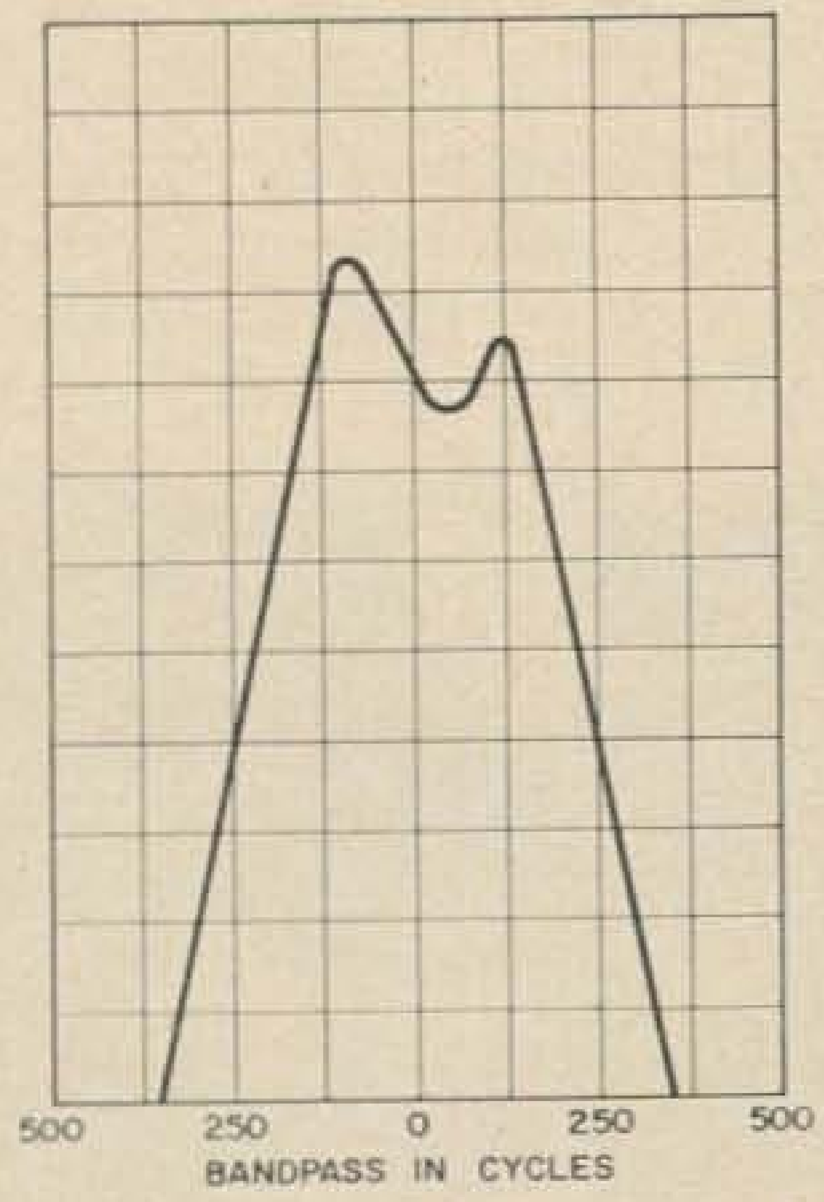


Fig. 3. Typical untuned response curve for two section filter.

value of these two condensers slightly. This probably will not be necessary however.

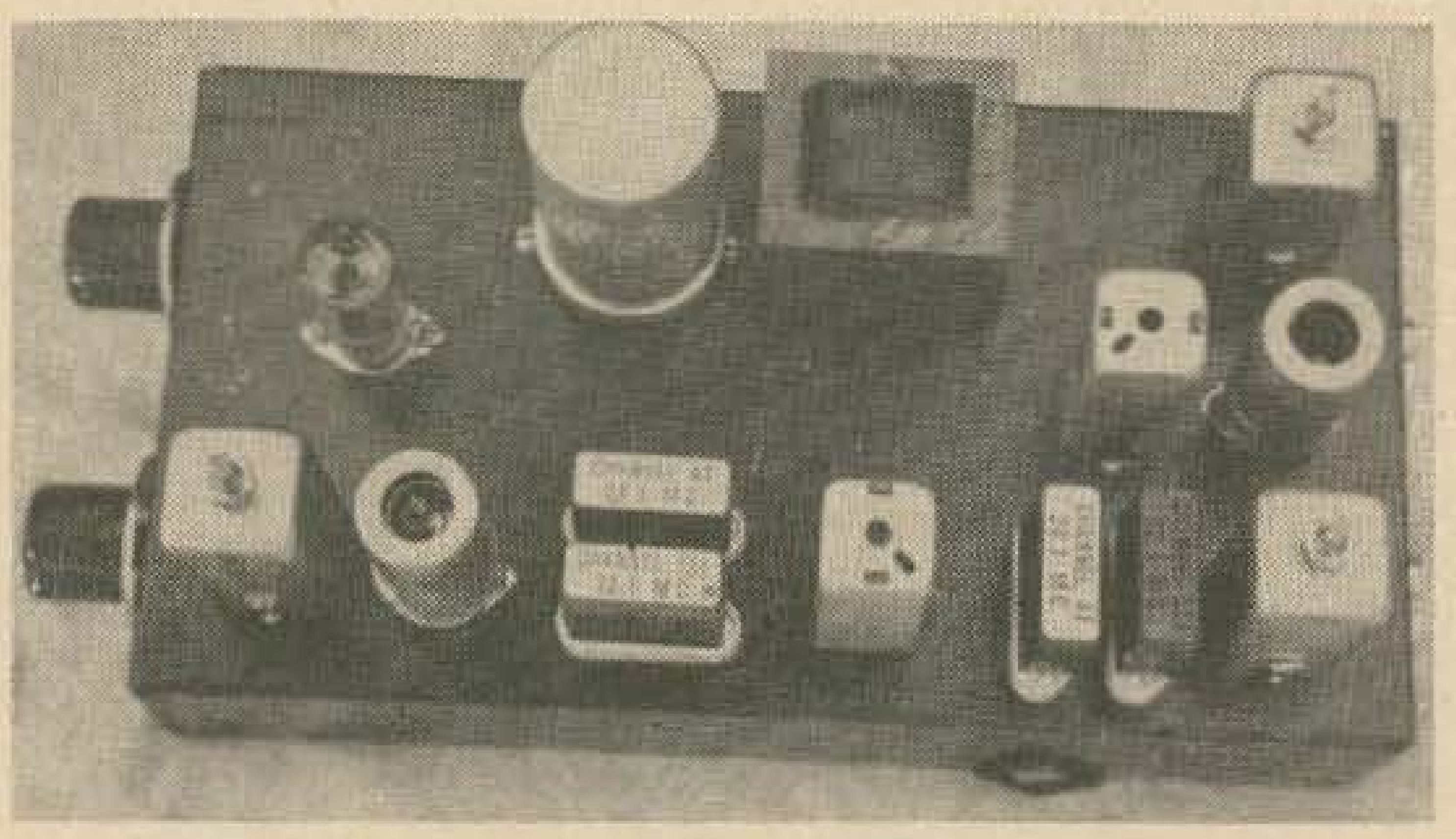
The four crystals are rather common on the surplus market and are obtainable for a very modest price. They come in FT241 type holders and are marked in channel numbers. The ones used for this filter are marked channel 41 and 321 (two each) which are for the narrow passband.

The second *if* transformer between the two crystal filters is identical with the first. Here again it may be necessary to pad the windings with a small condenser of 20 to 30 pf on the input and perhaps larger than the specified 100 pf on the output. This is not a difficult job as you can see as you tune up the coils that you can't quite reach resonance with the slug and you can also see with a trouble which way you must go to reach resonance.

The second 6BE6 is a product detector which is an excellent detector for CW as well as SSB. The oscillator section of this tube beats with the 455 kc signal to form the beat note for CW and the carrier insertion for SSB (it's understood that you must use a wider passband for SSB than the one described here of course). The tuning condenser is used to select either upper or lower sideband and can also be used for fine tuning of SSB. To adjust this oscillator simply set the condenser half way in and adjust the coil slug for zero beat with the 455 kc signal, the two sidebands, upper and lower, will then be on one side or the other of this zero beat.

The output of this stage then goes through a small filter to take out the rf and on through a gain control into the 6C4 amplifier stage. The output of this stage can be reinserted into the receiver's audio system or amplified by a power stage of af and used directly with it's own speaker. In the case of this unit it is amplified by the 6C4 and used only with headfones.

Probably the best way to "tune up" the unit is to set a rf signal generator to 455 kc and insert a fairly strong signal into the grid (G2) of the product detector (the second 6BE6), then tune up the BFO and check your audio circuits. If these operate properly, go back to the input of the second *if* transformer (T2) and, after inserting the two following crystals, tune up the *if* transformer. You can then set your oscillator to the exact center frequency between the two crystals and touch up your BFO coil slug. Now move the generator back to the input grid (G2) of the first 6BE6 and, after disabling the oscillator section by shorting the coil T5 and inserting the remaining two crystals, tune up the first *if* transformer. For the last adjustment retune the generator to the receiver's *if* and insert this into the input of the unit and adjust the conversion oscillator to the proper frequency to give the 455 kc beat. Don't forget to remove the short from T5.



Top view of the outboard CW adapter.

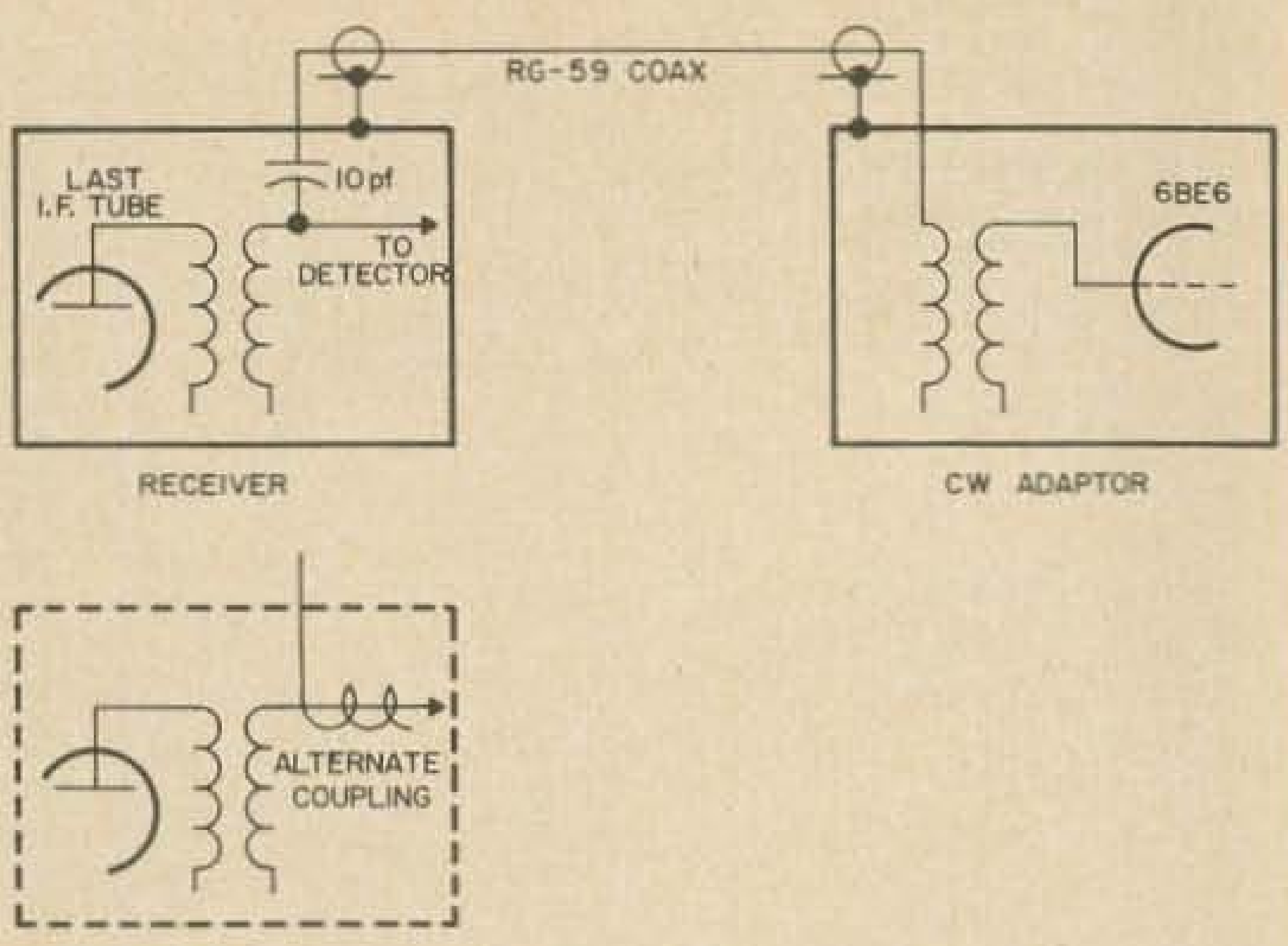


Fig. 4. Connecting the adapter to a transceiver.

Now if you have installed the input *if* transformer T4 tune it up and you are finished except that you probably will need to touch up the slug in T5 when you tune in a signal with your receiver in order to get it right on frequency. All these adjustments sound difficult but can be accomplished with a simple rf generator and a reasonable good ac voltmeter.

The unit is built in a 5 by 9½ inch aluminum chassis with the input and output jacks on the rear apron. The two controls on the front are the audio gain, which also has the power ON-OFF switch and the bfo oscillator condenser. This condenser, as called out on the parts list is a 35 pf job which might be a little larger than you will like—making the adjustment a little critical—so you may, if you wish, reduce its value a small amount and increase C7B by a like amount. No special care or skill is required to build or adjust this unit, anyone who has done any receiver work at all should encounter no difficulty—it is even possible to align the unit using nothing but a signal generator and your ear, optimum performance would be an accident in that case however.

One or two general comments—care must be taken with the first conversion oscillator construction. If this oscillator drifts, your converted frequency will drift right through the narrow filter passband. In this case when you first turn the unit on there will be no output, then as the drift builds up the output will increase to a maximum and then go back to zero as the oscillator drifts the frequency on by. It depends, of course, on just where in the drift time you originally set up the tuning, but in any event a drift can play hob with your results. The oscillator could well be crystal controlled but you probably will need to spot the crystal yourself so if you like to grind crystals to spot frequencies by all means try it.

The only reason for the first *if* transformer in the unit is to isolate the conversion oscillator from the receiver, as any oscillator voltage getting back into the receiver's avc circuits will give a constant S meter reading with no signal input. The isolation of the 6BE6 is quite good however, so if you wish to cut corners you probably could omit this transformer with small consequences. It might be well to leave a blank spot on the chassis and first try the unit with the input running directly into G2 of the first 6BE6 then, if it turns out to be necessary you can go ahead and mount the transformer.

The performance of an outboard *if* and detection unit such as this will make a world of difference when trying to use a transceiver with a 3 kc passband for CW communication or, for that matter, with any of the cheaper receivers which could use a little better selectivity.

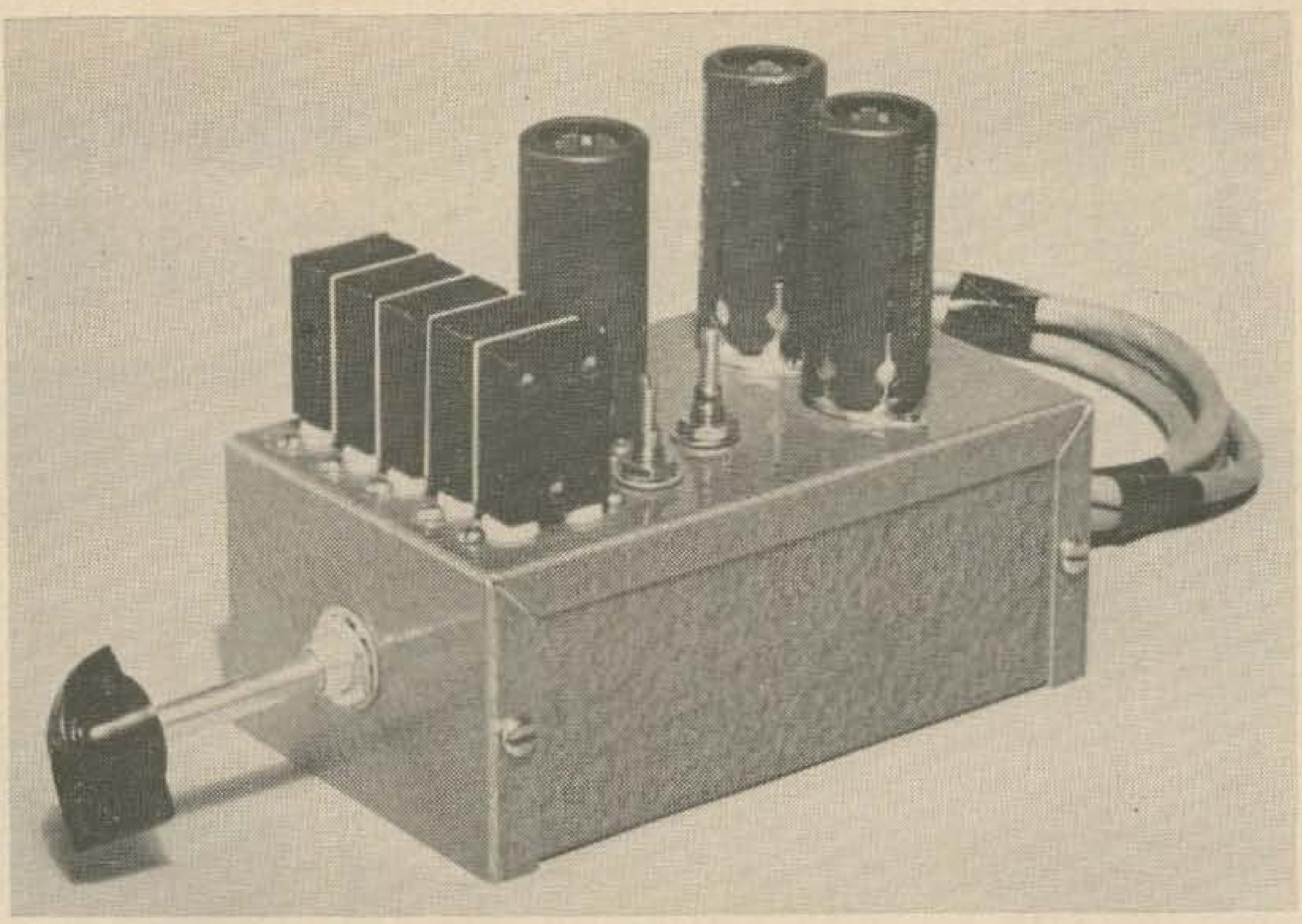
In case you are one who takes your ham work at all seriously it will certainly pay you to construct a unit such as this. You should have no serious problems getting it to operate and it really makes a lot of difference when you need that extra selectivity—and when don't you? As stated earlier, when you use this unit with an audio filter you have just about done all that the home builder can do to solve the interference problem. Besides that, building things like this is fun—try it.

. . . Roanhaus

Parts List

C4. 47 pf negative coefficient capacitor. Sprague 10TCU-N750-Q47.
C7A. 35 pf variable.
C7B. 120 pf silver mica.
C20-23. 100 pf mica.
T1, T2. 455 kc *if* transformers.
T3. 750-1400 μh rf coil. Miller 4413.
T4. 4.5 mc *if* transformer.
T5. 30-69 μh rf coil. Miller 4408.
T6. Power transformer with 130 volt secondary.

Norm Gignac K1QIM/2
Dick Stants WB2CEE
Navy Recruiting Station
P.O. Building
Albany, N.Y.



Put your old preselector to work again

A Crystal Controlled Front End

Have you taken a look lately at that 'once-prized' broadband pre-amplifier you had such high hopes for. . . . You had hoped it would make your receiver 'hottern'-a-firecracker,' but it turned out that you found your receiver was too 'broadband' to handle the added rf with the pre-selector hooked in . . . you had hoped that it would help you pull in the 'DX' on the higher frequencies, but it only makes the noise as well as the signals louder. How would you like to put it back in operation? . . . and without too much difficulty? . . . and with little expense?

This unit to be described here came into existence when it was realized that my own DB-22A, HF 10-20 and DB-23 pre-amplifiers were sitting under the bench . . . and that I had a sizeable investment in this equipment which was going to 'waste.' I'd like to add here that the Crystall-controlled front end described in this article will work equally well with the old-timer DB-22, the R-9er and the Ameco P-CL pre-selectors . . . (pre-selectors and pre-amplifiers meaning the same thing in the text of this article).

So, if you'd like to put into use some of those fine, but very little used pre-selectors, read on. If you're only interested in knowing how it's done . . . that in itself is worth the time to read the article. I'll say this much about the unit described here . . . it perks up the stability of the low-to-medium priced receivers . . . and it's a good way to start copying CW like you'd like to.

Circuit principle

The function for the crystal-controlled front-end (CCFE) rig is basically an rf oscillator, feeding a mixer (hetrodyning all signals down to the 3.5–4.0 mc range), then through a cathode-follower stage to the front end of the receiver.

What it does for the Receiver

It is a known fact, that the stability of the low-cost and medium-priced receivers is 'best' on 80 and 75 meters . . . and is usually 'pretty good' on 40 meters, but when you tune 20 m and especially 15 and 10 m, the stability and sensitivity of the receiver drops off in leaps and bounds. This little gem will make your receiver think all signals, be they on 20, 15 or 10, are really 3,500 kc to 4,000 kc signals . . . this is the principle of the 'tuned if' circuitry. Therefore, you could say the crystal-controlled front-end takes all signals and heterodynes them 'down' to the range of your 80-75 meter-band on the receiver dial. Why the pre-selector, you ask? You need the pre-selector to build up the rf signal coming from the antenna, to a level which would put the band-selected CCFE into action . . . and too, the pre-selector tends to keep the strength of the signal, although broadband through the pre-selector, at an even keel . . . the preselector acts as the 'tuning' element of the signal.

How do you do it?

Set the pre-selector for the strongest signal, by tuning in the normal fashion. Switch the proper crystal stage into play on the CCFE . . . and tune the signals on the receiver's 80-75 meter band. Therefore, if the preselector were tuned for 15 m CW, and the crystal-controlled front-end crystal was switched to the '15' meter position, the receiver would effectively be receiving 80-75 meter signals . . . e.g. Preselector at 21.100 m, CCFE switched to '15' (with the 17,500 kc crystal in place within the socket), the oscillator, (6AB4), mixer (6AH6), and amplifier (6AB4) would introduce a '3.600 mc' signal to the rf amplifier (or if there is no such stage, to the mixer of the receiver).

The signals entering the receiver's rf amplifier stage (at the antenna input) are stable, selective, and strengthened rf notes which have been through pre-selection, heterodyning and slightly re-amplified. You will find the receiver is operating with greater effectiveness as you "bandspread" your signals across the band. There are no further adjustments to make to the CCFE; there *may* need minor re-tuning of the pre-selector tuning knob should you swing from, say the low end to the top end of the band. In most cases, the RME Pre-Selectors are fairly broadband, and depending on the 'built-in' selectivity of your receiver, may or may not require much attention, other than to make initial band selection and placing the tuning knob in the general portion of the band which you desire to operate.

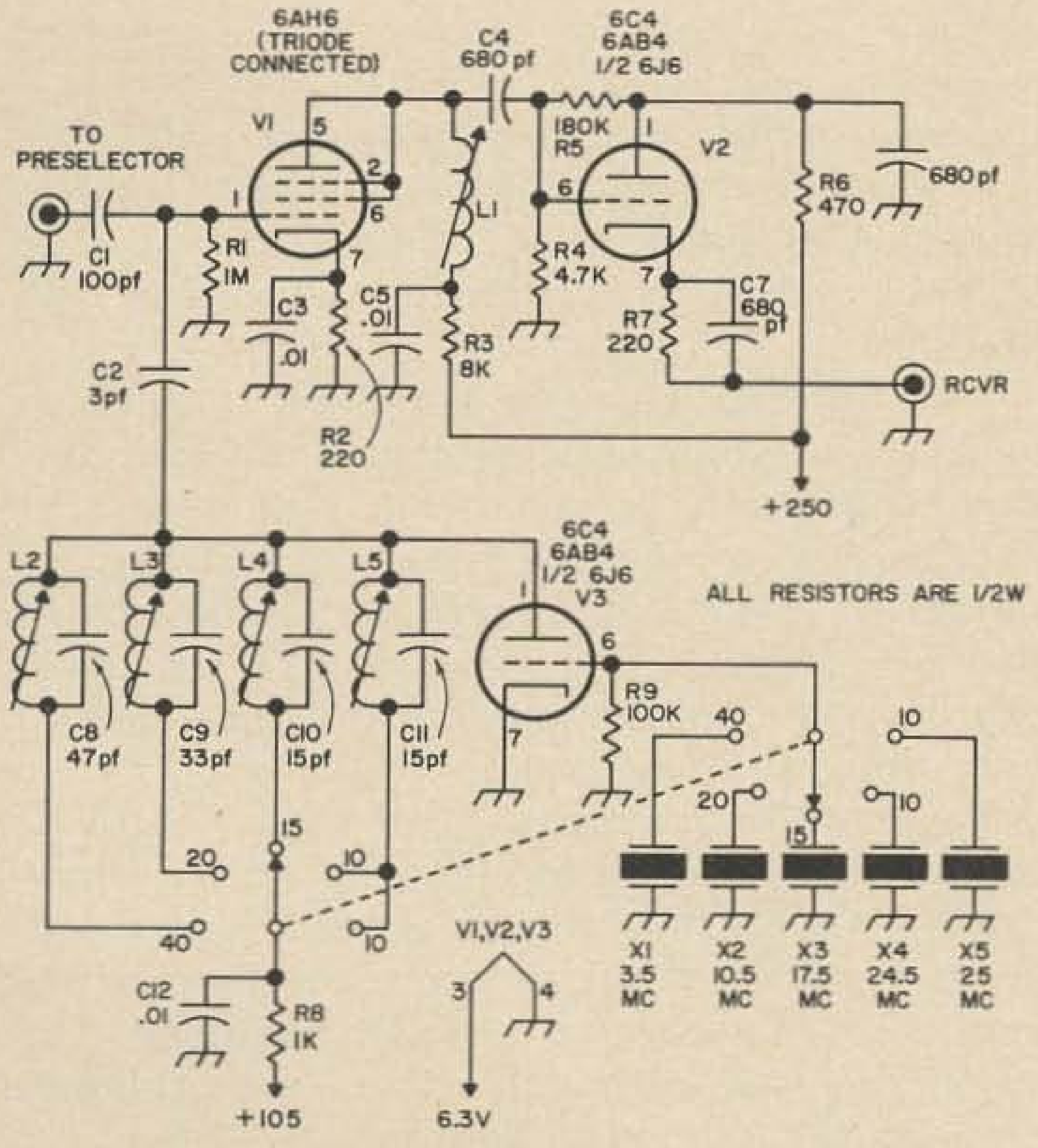


Fig. 1. Schematic of the CCFE.

Construction hints

As the schematic, **Fig. 1** depicts, the layout is fairly simple and normal construction precautions should be observed. Leads are not critical, but as with any component connected with rf oscillations and amplification, as well as mixing, the tradition of keeping the leads short is recommended . . . especially those leads from the crystal sockets to the bandswitch. Current carrying leads should be lead along the chassis and the signal carrying wiring should be traced about ½" above chassis.

Coil L1 is a CTC 1 mc coil with 180 turns removed. Any other coil that will tune to 3.75 mc (the center of the band) will do very well.

The photo shows a general scheme for component layout. The cable uses an octal plug which leads to the receiver's power source feeding the filaments, B+ and common ground and the rf source from the pre-selector. The shaft and crystal-selection switch are left extremely long in this case, because it allows the constructor to place the unit inside the receiver in an appropriately suited location and with either an extension shaft, or as is (depending on location within the receiver) the shaft affords the extension needed to come through the front panel of the receiver (after drilling or punching the appropriate size hole and placing a dial plate behind the knob to indicate the band/crystal selected. If it is desired to leave the unit outside the receiver, the shaft may be hacksawed down to size and would work equally as well . . . this arrangement is a matter of personal choice.

Adjustment is simple. Apply power and tune coils L2 through L5 in sequence for maximum output consistent with reliable starting. A diode detector or dip meter may be used for this. Then peak L1 and you're in business. Nothing more to do, you're receiving.

. . . WB2CEE, K1QIM/2

COIL TABLE

L1. Tunes to 3.75 mc. CTC 1 mc coil with 180 turns removed.

L2. Tunes to 10.5 mc. Miller 4407, 15 to 31 µh.

L3. Tunes to 17.5 mc. Miller 4405, 3 to 7 µh.

L4. Tunes to 24.5 mc. Miller 4404, 1.5 to 3.2 µh.

L5. Tunes to 25 mc. Miller 4404.

All coils have variable iron cores

Ken Sessions K6MVH
4861 Ramona Place
Ontario, California
Drawing by K3SUK

The Key to Peaceful Coexistence

Between 6 meters and channel 2

Probably the most important task a 6-meter man will encounter is that of convincing irate neighbors that channel 2 interference is due to inadequacies in his TV set.

When faced with a TVI problem, the amateur must convey a considerable amount of information to his neighbor in a fairly short time. For this communication to be effective (and understood), the facts must be presented in an orderly, logical sequence. The usual setting for ham-neighbor TVI conferences is not an ideal one for cooperative oral exchange. The relationship between the two individuals is strained at best. The neighbor is bothered by the fact that his program has *already* been disrupted to the point where he finds it necessary to make an appeal (or a demand) to the ham to knock it off. And the amateur knows that within minutes the band may be closing and his DX for the evening will be over.

I have noticed a certain clumsiness in my own oral explanations to neighbors. I skip over important details and neglect thorough explanations of the TV receiver's problems. Consequently, disturbed televiewers have departed without satisfaction, only partially understanding the situation.

It was such a lack of effective communication that prompted me to write a letter explaining my side of the story. The results have been so successful that I feel others might benefit from adopting the same practice.

After writing the letter, I distributed copies to all my close neighbors. Two days later, four high-pass filters were installed in the area, eliminating four TVI problems. When others in adjacent neighborhoods came to complain, I simply gave them a copy of the letter, allowing them to read it on the spot if they desired.

It's nice to be an accepted part of the neighborhood again. We actually get friendly visits from even those 'hard' cases now. And I don't get that queasy feeling in my stomach anymore when I crank up the kw on 50.5 in the evening.

Here is the letter, for those who might want to copy it for their own use:

To my neighbor:

The purpose of this letter is to assist me in determining the extent of television interference occurring in this neighborhood from my amateur radio transmitting equipment. With your cooperation, *all such interference* can be removed and your television viewing need never be disturbed.

If you are experiencing serious television interference (TVI), you can help me to determine the best method of eliminating the problem.

The radio frequency spectrum has been allocated to commercial broadcasters, private industry, special institutions, and amateur operators. Although this spectrum is crowded, there is room for all. The Federal Communications Commission has assigned me an amateur operator license (K6MVH) and a selected range of frequencies in which to operate. To obtain my license, I was required to pass a very rigid examination to prove my technical ability and knowledge of radio theory. *I am not authorized to transmit on frequencies assigned to television stations.* The FCC has taken great pains to assure that I do not.

The fact that I can be heard on a television receiver does *not* indicate that I am transmitting illegally. It is usually an indication that a television receiver lacks the selectivity required to reject signals near the frequency of the TV channel. The type of TVI you have can help me to determine the cause and to help you effect a cure.

I operate on frequencies between 50 and 51 megacycles, as directed by the FCC. Channel 2 covers a 6-megacycle spread from 54 to 60 megacycles. Thus, interference in your reception of channel 2 is a definite indication of an inadequacy—although by no means incurable—in the television receiver.

Channel 2 interference is the most common

type of TVI a 50-megacycle amateur experiences. No amount of filtering or regulation at the amateur transmitter can reduce this type of interference because it is a receiver problem and the cure can only be effected at the TV set. The degree of interference will determine the prevention measures.

If the picture is affected seriously, or replaced by a series of horizontal bars that vary with the sound of the amateur station's signal, the problem is serious enough to warrant installation of a simple high-pass filter in the television antenna line. This will remove all channel 2 interference in 95% of the cases. (A high-pass filter costs a minimum of 75¢ and not more than $4.00. The price depends upon the degree of filtering required.) High-pass filters are easily installed in minutes. While the FCC has cautioned me against installing filters for neighbors, I will gladly guide you in such installation.

A letter to the FCC will quickly bring you assurance that the installation of filters in TV sets experiencing channel 2 interference is *not* the responsibility of the amateur but a joint responsibility of the set owner and the TV manufacturer. (TV manufacturers are now required to furnish such filters on request for sets manufactured after 1961. This is in recognition of the cause of the fault: the lack of rejection selectivity in TV receivers.) To install a filter, the 300-ohm antenna wire must be cut between the TV tuner and the TV set's antenna terminals. The "antenna terminal" side of the cut wire connects to one side of the filter; the "tuner" side connects to the other. This finishes the operation.

I can furnish soldering equipment, wire cutters, screwdrivers, and technical advice. I will also recommend the type of filter you need and the place where the filters may be obtained.

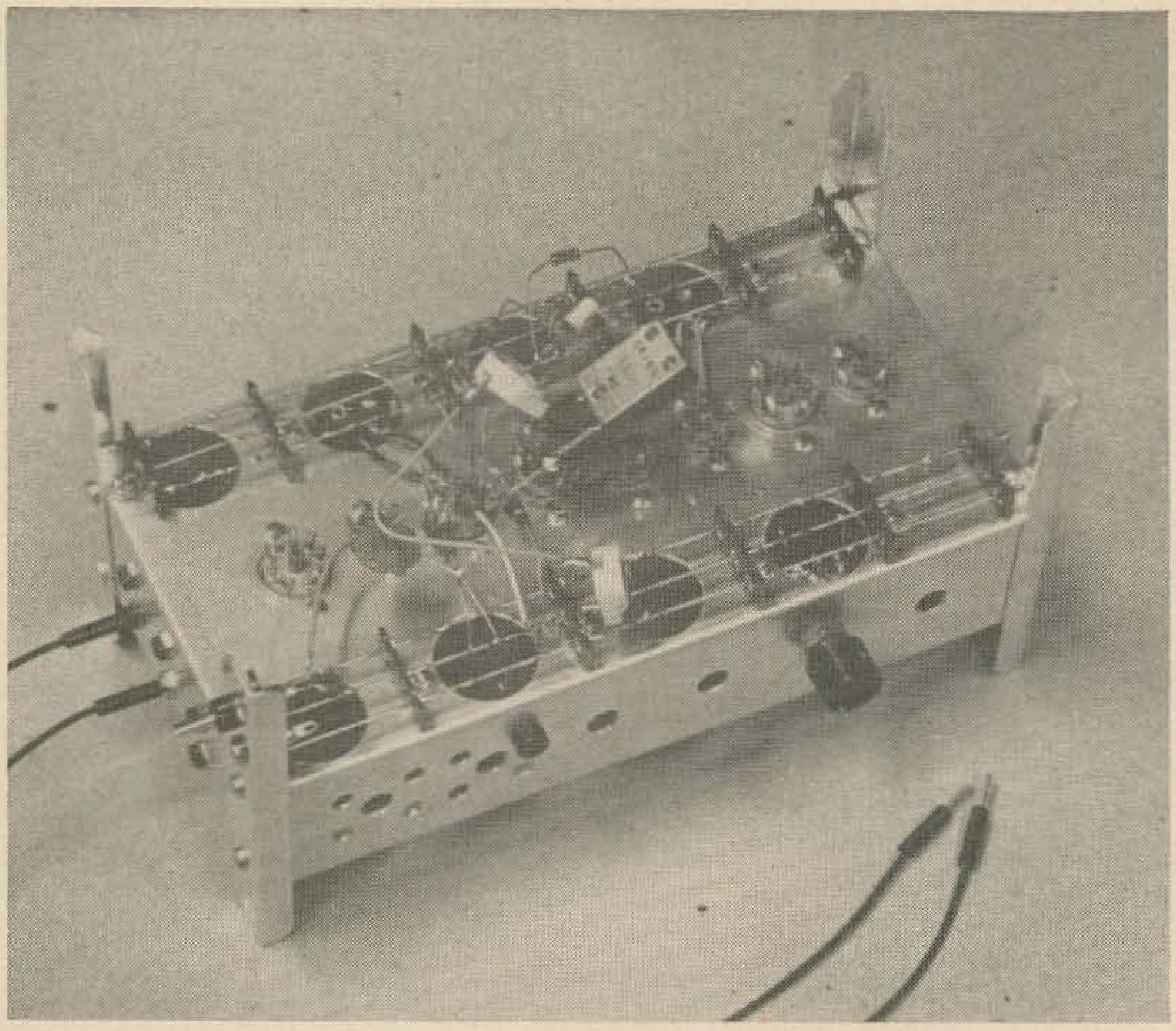
Another type of TVI attributable to the television receiver's inadequacies is the pickup of an amateur's audio signal although the picture may be undisturbed. This type of interference is not restricted to a particular channel, and frequently occurs in hi-fi and stereo systems, radios, and fm receivers. Generally, the cure is very simple—but again, it can only be accomplished at the place where the interference occurs. The principal sources of signal pickup are the ac line and speaker wires. First, make sure your amplifier is well grounded to a good earth ground (such as a cold water pipe). If this doesn't do it, the ac line must be bypassed to the amplifier chassis. This is merely a matter of soldering a .01-microfarad capacitor from each of the 110-volt wires to the chassis at the ac input to the amplifier.

If the interference is on channel 11 or 13, the problem may be attributable to harmonic radiation. If this occurs, I can help it at my transmitter by installing a low-pass filter in my own transmitting antenna line or by taking more extreme measures in shielding. This will not affect channel 2 interference.

Whatever the interference or cause, I want to cooperate with you. There is no reason why you can't enjoy your evening hours with television while I indulge my chosen hobby. Ham radio and TV reception *are* compatible, but only through reasonable interference precautions cooperatively administered. My wife is probably more critical than any neighbor, and she enjoys color TV nightly, watching any channel without interference. I eliminated problems at my own set by installation of a 75¢ filter.

My name is Ken Sessions. I operate a 6-meter amateur radio station at 4861 Ramona Place. Please feel free to stop by at any time for any reason. We can just get acquainted, discuss TVI, or talk about the world crisis. The coffee pot is always on.

. . . K6MVH



Breadboard of the **if** amplifier in Fig. 2.

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

Breadboarding

Do you breadboard everything you build? Maybe I should have asked, do you breadboard anything you build? I suppose breadboarding each circuit would be too much, but it seems to me that in general most amateur electronics builders do not do as much breadboarding as they should.

I think I ought to mention for the beginners that the term "breadboard" stems from the days when real, actual breadboards, obtained sometimes from the kitchen, were used for building circuits. In a way that seems like a long time ago, but as recently as the late thirties people were still writing up projects built on breadboards. In fact, I remember seeing such projects in the now defunct electronics sections of *Popular Mechanics* and *Popular Science* after WW2!

But enough of that. Why do you breadboard? What is breadboarding, if circuits are no longer built on pieces of wood? And how about stray capacitances, and having the circuits right out in the open? What about shock hazards? These are some of the questions you might ask about breadboarding.

I might begin answering them by giving an example. **Fig. 1** is a schematic of a crystal-coupled *if* circuit, copied out of an amateur publication. This isn't the entire *if* section. It is a single basic circuit unit.

Now let's look at this in a hardheaded, skeptical sort of way, like the farmer who saw a purple cow. The first thing to do is to decide on a plausible explanation of how it works. I'll skip over that point since it will do you good to work it out for yourself and I'm aiming for a different target anyway. The next thing to do is to decide on reasonable values of voltage and current. This is a very good exercise because these operating values are rarely given, and are useful in dealing with a circuit that doesn't work. Besides, it helps clear up some residual doubts about how the circuit works. Now when we look at this schematic we see some interesting things.

Namely, if the supply voltage is 150 volts and the rated class A (from tube handbook) circuit is going down through the tube, then the drop across the load resistor puts the anode voltage at minus 700 volts. We must conclude that the tube is carrying far less than its rated current. Is the resistor ten times too big? This could happen as a result of a misplaced decimal point. If it were 4700 instead of 47,000 ohms, at ten ma, there might be about 50 volts across the resistor and 100 volts across the tube. This certainly seems better.

Secondly, how about those 2200 ohm resistors at cathode and anode of the phase splitter? This triode has the same ratings as the other one. Again, 10 ma thru 2200 ohms gives 22 volts. This drop in each resistor leaves 100 volts for the tube. But wait! How about the grid voltage? If the grid is at ground and the cathode at plus 22 volts, this particular tube is cut off, carrying no current at all. Obviously this triode, also, is carrying a current far different from the handbook listing, unless we can find another possible error. What might it be? Well, anode and cathode resistors have to be equal, and they can't be too large, and the grid-cathode voltage has to suit the anode voltage and current. There's only one way to do it. We have to bring the grid voltage above ground.

If the 10 ma is flowing, and the cathode is at plus 22 volts, the grid has to be at a little lower voltage than that. About one volt should do it. Current to a positive grid? No, not when the grid is negative with respect to the cathode. We want the grid to be at about 20 or 21 volts—the cathode will follow it by the required amount positive because of the fairly large cathode resistor. If we add a resistor—it might have been left out of the drawing—just large enough to pass enough current through the grid-to-ground resistor to bring the grid to the required voltage, it should work.

That would account for it—one incorrect parts value, and a copying error. We might want to change a 47k to a 4.7k resistor and add a 560k resistor.

Now before we go off and celebrate, there is another possibility to consider. Somebody built this circuit and if worked. But we have just decided it can't work, or at least that it can't work very well. How are we going to resolve this? But a good idea to have an answer before going to the time and expense of building the finished product, wouldn't it?

This is where the breadboard comes in. The old practice of building things on breadboards was gradually transmitted to the process of trying things out on breadboards. But what with the natural shapes of components, the convenience of working on a metal sheet, and the fact that chassis seemed to be more available than breadboards, the metal type breadboard came into use. It is still called breadboarding, but I have seen and adopted the term "universal chassis."

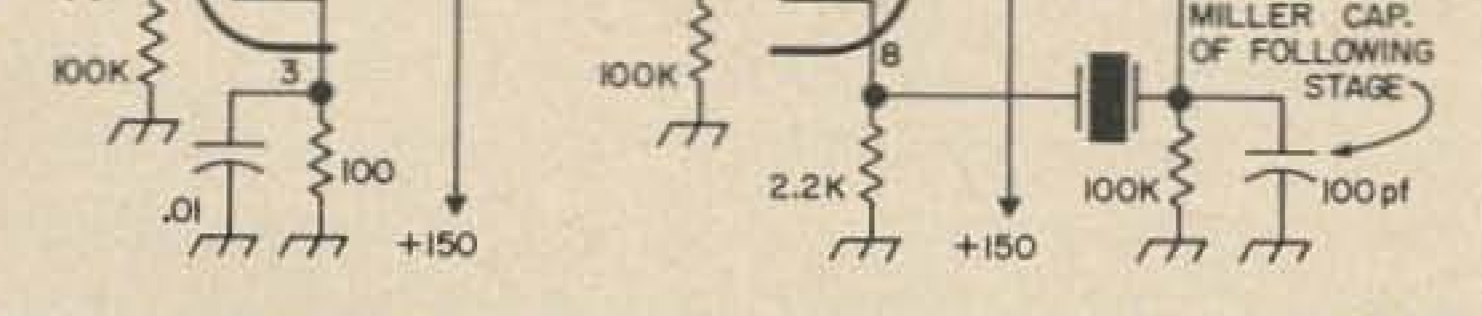


Fig. 1. Original schematic of a crystal-coupled **if** amplifier. This circuit has a number of problems as discussed in the text.

So let's suppose you have a universal chassis handy (I'll come back to this later, meanwhile see the photograph). You have a heater voltage transformer and a power supply providing a few reasonable voltages such as 75, 90, 108, 150, and 258, stabilized by voltage regulator tubes, also some instruments and a clear place to work.

So. Those voltage regulator tubes I mentioned. If you use a series dropping resistor, or a tapped resistor, to get the correct voltage, every time the current changes the voltage will change too. Also, while these regulator tubes are not very accurate, they may be better than your meter. And the current the simple breadboard circuits use will rarely exceed the capabilities of a single tube to regulate—20 ma or so.

Now we can start breadboarding the circuit. Look at the universal chassis again. This is the circuit I am writing about, after breadboarding. There are a lot of parts aren't there? This is what the permanent ones do: The posts at the corners enable you to set the chassis with any surface down and expect it to stay that way while you work on it. Supply voltages are brought in through the tip jacks in the chassis, left hand end. Signal voltages go in where required, sometimes through a jack in the front of the chassis, often to a wire projecting out of the circuit, or through a jack in one of the posts. There are some clearly identifiable ground jacks for circuit and particularly and most emphatically for safety reasons. When making connections the ground is made first; when removing wires the ground goes, definitely, last.

The holes across the front of the chassis are for controls. Additional holes are drilled if and where needed. Transformers are mounted by one end or corner, and we try to get along without meters and such in the chassis. In normal usage the tubes or transistors project downwards, out of the way of the work.

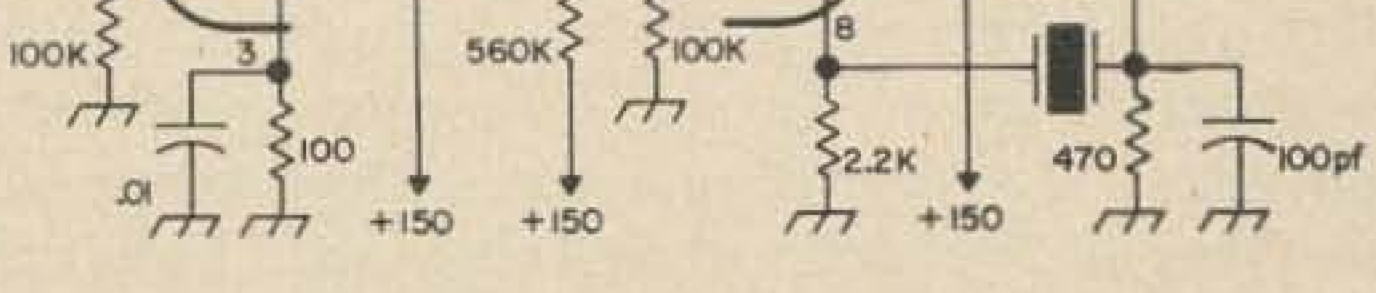


Fig. 2. Revised schematic of the **if** amplifier.

We work mostly on the upper, flat surface. You can see the tube sockets projecting upwards, some miscellaneous wiring, and two sets of three wires each across the chassis. These wires are the supply lines, permanently connected to labeled jacks at the end of the chassis. I labeled the jacks plus-plus, plus, chassis, minus, heater, and heater. The plus-plus and plus lines go across the side of the chassis away from you, with the center one being well connected to the chassis. One of the three on the side toward you is also connected to the chassis, the other two being a minus and a no-connection. Two lug strips mounted inside the chassis carry the heater voltage, and I run wires for this as needed. When stripping the chassis, I leave the heater wiring in because it rarely needs to be changed.

Now we have things pretty well explained and are ready to start. Having collected the parts we start putting them in. There are two extremes here which you would like to get fairly in between. You aren't trying to build an electronic masterpiece, but on the other hand if things don't go well you might be working on it for quite a while. I try to put parts in neatly with enough room around each one for another and without putting too many into networks floating in the sky (ha!). But I don't let this interfere with getting the circuit finished so I can answer my questions.

So now the thing is put together. I connect it to the power supply—ground lead first! And I turn on the heater voltage only. One minute later I turn on the high voltage and if I have any idea that a particular component might be expected to sizzle, I'm watching it. (smoke test) Usually everything goes well and we are ready to make measurements.

This brings us to a Major Problem. That is, how can you get the most from your time? Which measurement will supply the best answers? If the measurement doesn't tell you anything, you are wasting your time. And the only way to avoid this is to have some idea a) what you should find and b) why you might not find it.

With this in mind we approach the breadboard—which has passed its smoke test—with a good voltmeter. Measurements verify our conclusions about the tube currents being small. But what is the circuit gain? It seems to be about unity! At this point we need to stop and think very clearly because rf measurements tend to be hard to make with simple gear. Now the bigger the signal we put in, the bigger the output will be, and both will be easier to measure than very small signals. But if we put in too large a signal, we will upset the tube biasing, spoiling our results.

Back to the tube manual. The 6BK7 entry doesn't show any plate characteristics but it does say 18 ma per section thru 56 ohms cathode resistor, which will yield a grid to cathode bias of slightly over 1 volt. That means the absolute maximum rf signal on the grid ought not to exceed 2 volts peak to peak. At best we would like to have a signal a tenth of this amplitude, peak to peak. Let's settle for about half. The frequency of the signal is determined by the crystal we are using—let's say we have a 6.9 mc crystal in the socket.

You must make these measurements with something that won't disturb the circuit too much, and a proper rf probe attached to a vacuum tube voltmeter is one way to do it. Another good tool is a Tektronix scope and probe—then you can compare input and output to check for non-linearity. Or go to a lower frequency and use a Heathkit oscilloscope. The important thing is to have an instrument —something that will at least suggest to you what's happening in the circuit.

Well. Now the circuit is assembled—I won't say built because we want to have it around the least possible amount of time. It has passed its smoke test, a gain check shows that something is getting through. We start to measure voltages. The grid of the first triode is negative! The cathode voltage indicates a current of 2.2 ma is flowing, and the anode voltage is about 36 volts. Now why is the grid negative. . . . Having reasoned that out, we see about the gain. With a transconductance of 9300 micromhos we would expect a fairly high gain—we get a result something like 4! Seems we could use more current. So in goes a smaller anode resistor and we see the gain increase, but as we continue in this line we find that the gain does not get up to the figures we might think possible. Well, we won't worry about that—come back to it later.

After disconnecting the signal source we go on to see what the second stage bias voltages are. Well, here's the cathode at 3.4 volts and the anode at 139 volts. That is 135 out of 150 volts across the tube. Seems like there should be more across the resistors. Also the grid voltage is going to tend to overshoot the cathode voltage if the signal is large enough. That's another thing to keep in mind.

Taking a signal voltage measurement at the grid of the second triode, we reduce the generator voltage until we have the same voltage out that we formerly had in—a volt or less, depending on our instruments. This is to avoid overloading the second stage.

Reconnecting the signal generator we make a gain measurement. The gain, expected to be near unity, turns out much poorer than that. Since the tube current is small, it seems that a good move is to increase it. Adding a 560k resistor from plus 150 to the grid brings up the current—now the output signal is better.

Why didn't we start at the second stage and work backwards? In an audio amplifier this would be a good idea, since we could use the finished part to operate a loudspeaker, and we could listen to the results. But this circuit is an rf circuit containing a quite active tube and a crystal whose properties near resonance are very, very abrupt. This way we can put the signal into the relatively tame first stage and if there is any reaction from the second stage back to the first(there is), the circuit will be seeing this in the way most similar to normal operation when finished.

A measurement now shows that there is a much larger signal at the second stage anode than at the cathode. How can this be? The same current is passing through both 2200 ohm resistors, there simply has to be the same signal voltage at both points. But these measurements show otherwise. . . . Ha! This is a reactive circuit. We have different reactances at anode and cathode though the resistances are the same. The reactance is probably capacitive, and there is more of it at the cathode than at the anode—we should probably add a trimmer, anode to ground. We'll come back to that—we go on to the output and think about the 100 pf capacitor which is taking the place of the next triode's input characteristics. What's the reactance of that capacitor at 6.9 mc? About 200 ohms. Then why use a great big grid resistor of 100k? The phase splitter should be able to drive a heavy load. Let's put in a smaller one and see what happens. 47k . . . 15k . . . 8.2k . . . 2.2k . . . how long can this go on? Finally we stop at 470 but this obviously is not the end of the line. The output is down a little, just enough to detect the change. Having gotten some results in this line, we put it off till later.

The sharp tuning is beginning to be a pain . . . well, let's solder in the anode to ground capacitor and see what happens to the gain. Why, it appears that the gain increases as the anode capacitance is increased! The more capacitance from anode to ground, the higher the gain! An the anode and cathode signal voltages are nearly aqual. Now that's an interesting result, and a useful one too. The schematic now looks like Fig. 2.

At this point the apparent circuit gain has increased from about one to around five, the tuning seems to be sharper, and we feel like stopping. I did some things that aren't listed here, mostly checks to get the clearer idea of what was happening. The greatest problem is the signal generator which tunes too fast. Let's see, if I had another universal chassis, I could put together a simple circuit with a cathode follower into a gain control, with good bandspread, about a mil of plate current . . . let's see now. . . . And I leave the subject at this point. It isn't finished. That bandspread signal generator will be needed, and we ought to look into the actual characteristics of that diode pump probe at these frequencies (mine is off to half at 200 mv PP input, reads 0.8 times input at 4 volts PP, etc.) and we should read up on some vacuum tube and rf measurements theory before trying again.

So that's an example of the application of the universal chassis to breadboarding a single circuit. Can you see how much better this is than wrestling with a semifinished product? A good hard look at any circuit can pay big dividends. But human nature and other problems being what they are, the hard look is likely to be deferred if you can't do it fairly easily and efficiently—hence the universal chassis and its associated power supplies.

That seems to introduce the idea quite thoroughly. I think that only one or two points remain. The first is circuit capacitances, to chassis, and to other wiring. Now how large are those capacitances, really? Are they very large compared to the other capacitances you put in yourself? In general, they are not. And in cases where they are you can try to minimize them, or at least allow for their effect.

The other point is safety. Those high voltages, out in the open. Anybody who works with high voltages is going to get bitten. But the frequency with which this happens can be made very close to zero. The first thing you do about this is decide on a sequence for turning things on and off—high voltages last and first, respectively. Then you learn to follow this sequence, invariably—or at least almost invariably. Then you keep in mind that though you remember turning the thing off just now, you are going to act as if it were still hot. And finally, you try not to have such a cluttered and crowded bench that you lose control of what you are doing. I think that to the extent that these precautions are fudged —and they will be fudged—accidents are more likely. But you will learn very quickly, probably have already, that the greater the voltage the more religiously you will follow the safety procedures you have decided upon.

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Noise Considerations in a Preamplifier

Many pages of text have been devoted to the classic subject of noise, but few hams involve themselves with this information. Unfortunately, most noise concepts are explained at an engineering level that is difficult for the amateur to comprehend. Noise in an amplifier is the primary criterion of merit at frequencies above 100 mc. The basics covered by this article should be known by all VHF-UHF enthusiasts and will be useful to every ham.

Tube Noise

The predominant sources of noise in tubes are described briefly as follows:[1]

Shot Noise is caused by random emission of electrons. It is found throughout the useful range of operation and is somewhat greater at high current levels.

Induced grid noise is due to fluctuations in the space charge which induce voltage in the grid circuit. This is a predominant source of noise above 30 megacycles.

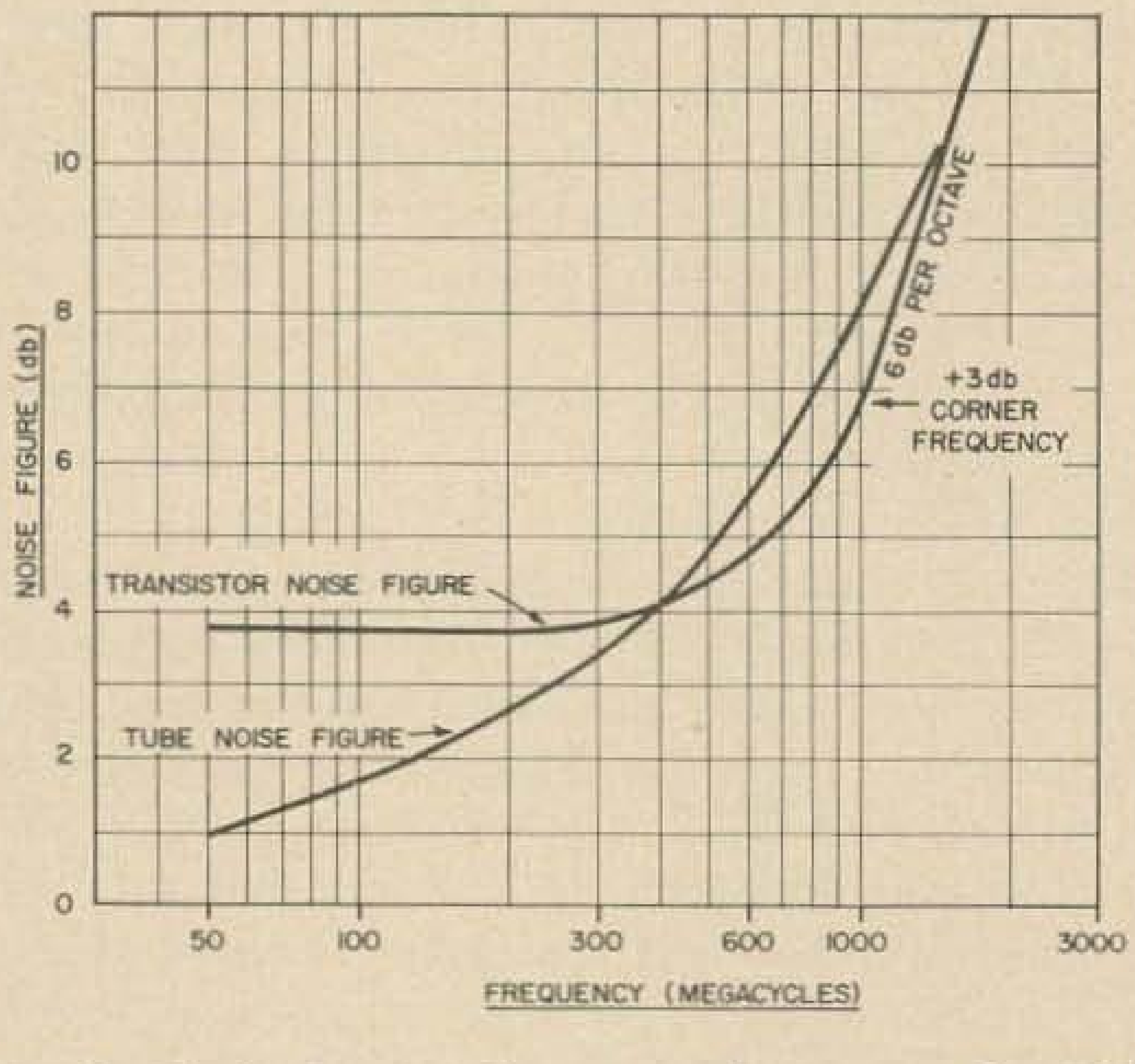

Fig. 1. Typical noise figure vs. frequency for UHF tubes and transistors. Note that curves are intended to show shape and only represent typical transistors and tubes. Modern transistors may have very low noise figures and much higher corner frequencies so that they are superior to tubes for all practical purposes.

Partition noise is caused by the division of current to several positive electrodes. It is this noise which makes tetrodes and pentodes more noisy than triodes.

Gas noise occurs when gas particles in the tube become ionized. Gas noise is not usually a problem above 10 Mc.

Flicker noise is another low frequency effect caused by variations in cathode emission.

The total noise output of a tube increases proportionally to the square root of temperature (°K), the tube resistance, and band width. Mathematically, this is expressed as

$$\text{Enoise} = \sqrt{4k\ T\ R\ \Delta f}$$

where Enoise is noise voltage output
K is Boltzmann's Constant = 1.372 x 10^{-23} joule/°K
T is the absolute temperature (°K)
R is resistance (ohms)
Δf is the bandwidth

Usually a triode amplifier will have lower noise if it has a high transconductance (Gm). (From the formula, Gm may be considered as $\frac{1}{R}$.) Because several other factors, such as construction, enter into the picture, this generality is not used to show the merit of a tube in the VHF-UHF frequency band. A new term, *noise figure*, is introduced to cover the situation in a more practical manner.

$$NF_1 = \frac{S_i/N_i}{S_o/N_o}$$

In this formula, it is seen that Noise Figure (NF) is a ratio of the *input signal-to-noise ratio* (S_i/N_i) and the *output signal-to-noise ratio* (S_o/N_o). Pretty confusing? Not really, if one considers that a high signal-to-noise ratio is what is most wanted. In an ideal amplifier with no noise, the input signal and noise would be amplified the same amount, and the signal-to-noise ratios would be the same. ($S_i/N_i = S_o/N_o$).

The noise figure would be 1 (0 db not 1 db). Because the amplifier is not noiseless,

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[1] Ryder, J. D., *Electronic Fundamentals and Applications*, Prentice-Hall Inc., Englewood Cliffs, N.J., 1959, PP 211-213

the output signal-to-noise ratio is always lower than that of the input. Noise figures of amplifiers are therefore always greater than 1. It is convenient to speak of noise figures in terms of decibels (db) because of certain mathematical relationships. The noise figure in decibels is a power relationship equalling 10 $\log_{10}$ NF. A perfect noise figure of 1 is equal to 0 db. Let us now consider adding a preamplifier to a receiving system. Using the information from the last paragraph, we know that the noise will be greater, but the factor of gain also enters the relationship.

$$\text{NF overall} = \text{NF}_2 + \frac{\text{NF}_1 - 1}{\text{G}_2}$$

NF_1 = Noise figure of the original system in db.

NF_2 = Noise figure of the preamplifier in db.

G_2 = Power gain of the preamplifier in db.

If $\text{NF}_1 = 11$ db

$\text{NF}_2 = 5$ db

$\text{G}_2 = 10$ db

$$\text{NF overall} = 5 + \frac{11-1}{10} = 6 \text{ db}$$

The preamplifier has thus improved the system noise figure by 5 db. It can be seen that the preamplifier will generally improve the system if its noise figure is lower than that of the system and the preamplifier has reasonable gain.

Semiconductor noise

Transistors and semiconductor diodes have noise generated in the junction (S). Random electrons, whether excited by temperature or the flow current, are the sources of this noise. Semiconductor noise depends greatly on the type of junction and the various geometries (shapes) of junction.

Excess noise is the term used for the *low frequency noise* in semiconductors which is inversely proportional to frequency. The graphs showing transistor noise do not include excess noise because low frequencies are not considered.

Shot noise in transistors is approximately the same as that for tubes.

Thermal noise is generated by temperature changes and relates directly to the resistance of the element. The same mathematical relationships hold for semiconductors as for tubes.

Tubes vs. transistors

If curves are available for noise figure and power gain of various tubes and transistors, the amateur would be wise to compare before selecting a specific device. Noise figure curves have been sketched in **Fig. 1** for a comparison of shape. Note that the transistor has a minimum noise plateau which extends from below VHF to the transistor's upper frequency limit. This plateau is in the 2 db to 5 db NF region. From the upper limit of the plateau, the noise figure increases rapidly to a maximum slope of 6 db/octave. (An octave is the range in which the frequency doubles.)

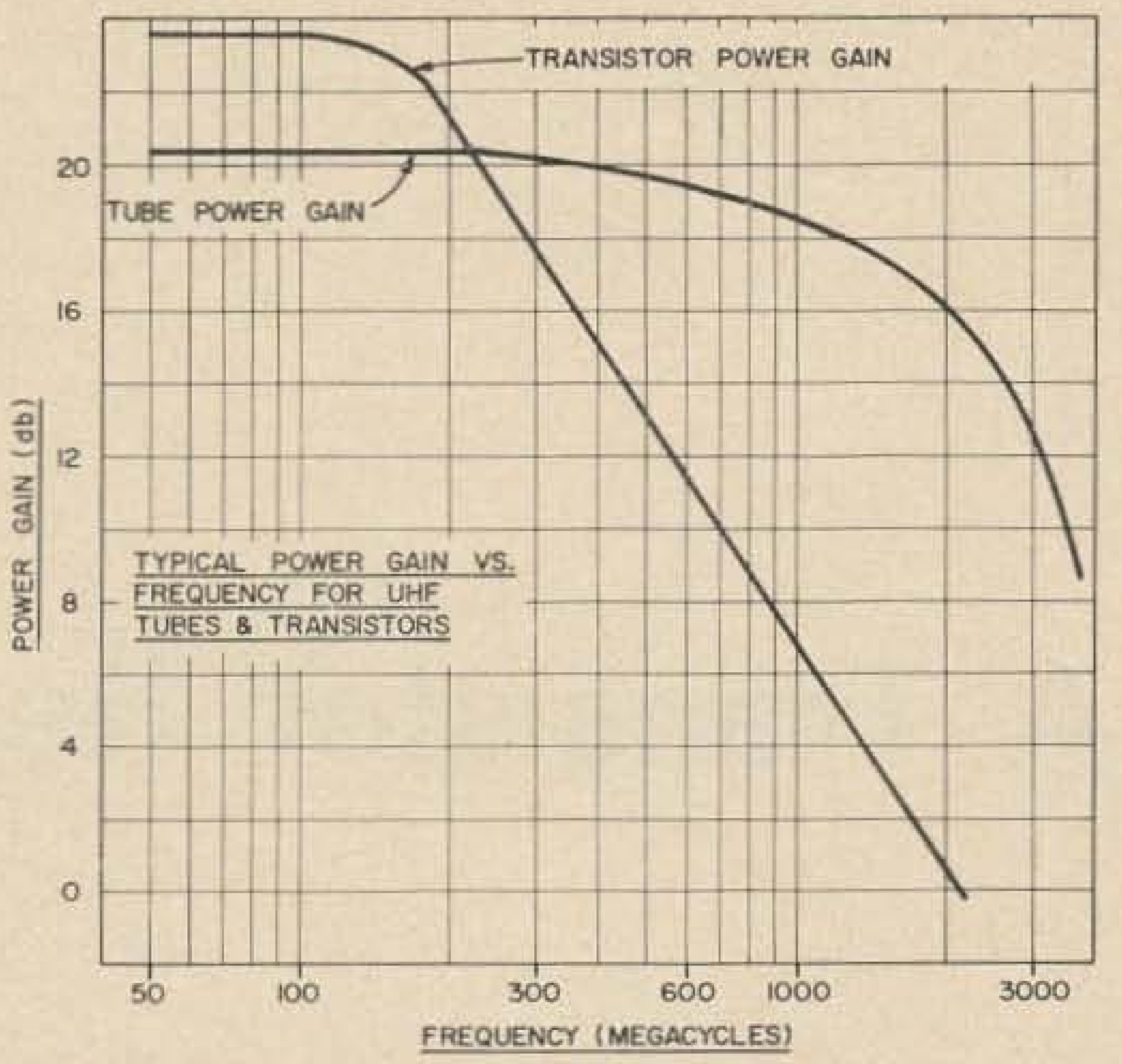

Fig. 2. Typical power gain vs. frequency for UHF tubes and transistors. The same considerations applying to the tubes and transistors in Fig. 1 apply here.

Tube noise figure is seen to have a somewhat different curve which *may* cross that of transistor noise figure. Assuming the curves shown were accurate for a particular tube and transistor, it may be seen that this transistor takes preference on the 432 mc band while the tube would be better on 220 mc and 1296.

The gain curve of a transistor (**Fig. 2**) is the inverse of the noise figure curve, dropping sharply from the maximum gain level to zero. Tube power gain declines more gradually which makes the tube useful at frequencies where the transistor is not. A distinct advantage of tubes which is not obvious from these curves or calculations is their comparative ruggedness and resistance to transients.

The question of whether or not to add a preamplifier is best answered by determining just how much performance is gained for the expenditure of time and money. The author feels that nothing is accomplished if the noise figure is compromised. A few simple calculations can tell you if the preamplifier project is worthwhile. Assuming the calculations recommend the project, it should be emphasized that optimum noise figures are achieved only with careful construction. Good Luck!

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A Transistor Receiver — VU Style

We, in India, have no manufactured amateur equipment in the market of the quality required for SSB operation. Our Government does not allow import of non-productive machinery, which covers most of our ham gear. Besides most of us do not have necessary finances to buy it off the market either.

Yet our ambitions are high. We want to keep up with guys in the other parts of the world. The only way to do it, is the hard way. We home-brew our equipment. Since economy and performance are the basic considerations, our designs eliminate sophisticated gadgets; we do not bother about good appearance either.

I started thinking about building a receiver when I got a packet of transistors from DL3IR. I was a novice in transistors, as I had hardly seen one before. Being in proud possession of these tiny gadgets I sought simple literature on transistors and their applications. Soon I acquired enough information to kick off.

A review of my ham gear collection revealed a lot of possibilities in the use of components of command receiver BC 455. I stripped one of all the components except the ganged condenser, antenna trimmer, rf coil pack assembly. Relocating the *if* transformers, octal bases, and terminal strips, I kept on tinkering till I built for myself a 12 transistor, plug in coil, ham-band receiver, which is described below.

Circuit description

First is a grounded base rf amplifier using a AF114(T_1). The grounded base application is expected to provide greater stability and a better noise figure, similar to the grounded grid electron tube application. The original coil pack assembly and the plug-in system is adopted for use in this receiver but the coils are rewound and connections suitably altered. The receiver is protected against damage due to reception of strong signals by a reverse biased diode OA72 across the antenna coil. The output is coupled to the base of the mixer stage transistor AF114(T_2). The heterodyne oscillations are fed to the emitter of the same. The components of this stage are particularly chosen for best mixing efficiency. The mixer collector is connected to the *if* transformer where a low impedance tap is provided on the coil to match the crystal filter that follows it.

The oscillator is a colpitts type with a grounded base transistor AF114(T_3). The capacitive tap is provided by 50 pf and 170 pf condensers for connection to the emitter of T_3. Since the band required to be covered is only 350 kc in the 14 mc band, no difficulty is experienced in tracking.

The stability of the oscillator is excellent, but the frequency is very sensitive to supply voltage variations. A 1.5 volt change in the supply voltage varies the oscillator frequency by 10 Kc. This might be a very good feature for use in FM, but presents a great problem in SSB work. I could not lay my hands on a stable supply source hence I decided to run the oscillator exclusively from a string of five 1.5 v torch light cells. Since the drain on the supply is only 1.2 ma, the cells may last their shelf life. I run the receiver off a supply which by no means is stable.

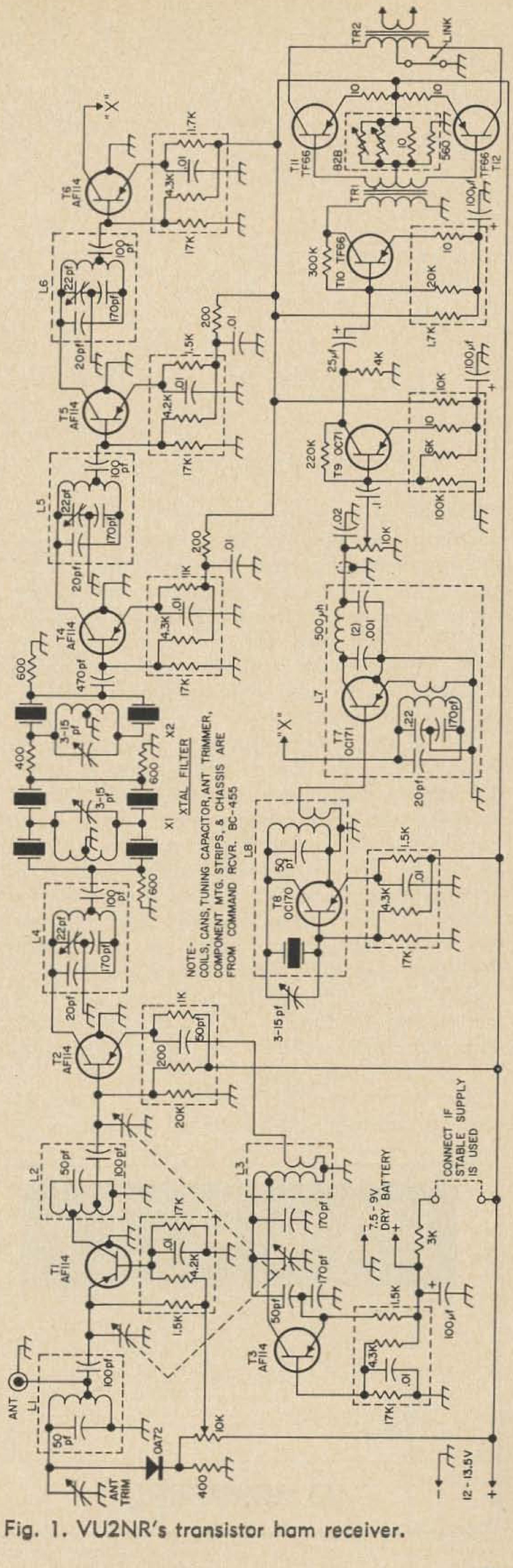
The selection of the intermediate frequency of my receiver was determined by the frequency of the FT 243 type crystals available to me. The intermediate frequency in this case is 7540 kc. Since the *if* is high, there is hardly any chance of image frequency appearing in the *if* section.

The filter is similar to that described by W3HEA (in *QST* Oct. 1960). X_1 and X_2 are toroid coils, the formers of which have an interesting origin. Commercial transistorized portable receivers come with miniature *if* transformers of the size ½ inch cube. They have ferrite cups which surround the coils. Such cups are salvaged from these transformers. When the base of the cup is carefully sawn off it leaves a ring with a flat wall about ¼ inch diameter. It takes about 25 turns of 36SWG bifilar winding to resonate around 5.5 mc with a parallel condenser of 15 pf. In actual circuit these toroid coils are shunted by trimmers 3-15 pf and tuned to maximum and the best *if* response. The first full section filter is independently terminated by 600 ohm resistance and coupled to the following half section by a 400 ohm resistance. I found that the independent termination of the first section is necessary to get a flat *if* response.

The second section is also terminated by 600 ohm resistance and coupled to the base of the 1st *if* stage. There are a couple of spurious response points in the filter. Since they are around 25 and 50 kc away on the high frequency side, they were allowed to pass on to audio section where they are filtered out.

The *if* strip consists of a 3 stage amplifier using AF114($T_4T_5T_6$) in grounded emitter configuration. The coils are wound on the original *if* forms of BC 455. The coils are grounded in the middle and opposite ends brought to the terminals. This was done, anticipating the requirement of neutralisation. In fact the stages proved to be so stable neutraling was not called for. Each coil is coupled to the next stage base by a 3 turn tap located adjacent to the ground point. The final *if* transformer has an eight turn link which feeds into the emitter of a product detector which is housed in the can itself.

The normal practice is to use a diode detector in the transistor receivers, and I did the same. But this was unsatisfactory as it caused distortion on strong signals. After a lot of worry and tinkering, I hit upon the idea of using a transistor OC170(T_7) without DC potentials as a product detector. It worked surprisingly well. The signal is given to the emitter. The bfo voltage is given to the base. The rf in the collector filtered out and terminated on af volume control. A condenser of high value of .02 μf was used across the potmeter to eliminate high frequency audio signals in the af strip that crept in due to the spurious response of the crystal filter.



NOTE-
COILS, CANS, TUNING CAPACITOR, ANT TRIMMER, COMPONENT MTG. STRIPS, & CHASSIS ARE FROM COMMAND RCVR. BC-455

Fig. 1. VU2NR's transistor ham receiver.

Coil Table

Coil	Form dia	Turns No	Gauge of wire	Tap point	Purpose
L_1	Original forms in the coil pack of BC455	10	22	1	Antenna and emitter of T_1
L_2		10	22	8 1	Collector of T_1 Base of T_2
L_3		10	22	8 1	Collector of T_2 Link to emitter of T_2
L_4, L_5 and L_6	Original if cans of BC455	42	36	18 15	For ground For coupling to next stage.
L_7	—do—	42	36	18 8	For ground turn link to emitter of T_7
L_8	bfo can of BC 455	35	38	3	Link to base of T_7
TR_1 & TR_2	—	Input and output transformers for OC128			

Note: Terminal blocks, coil assemble and several components come out of BC455.

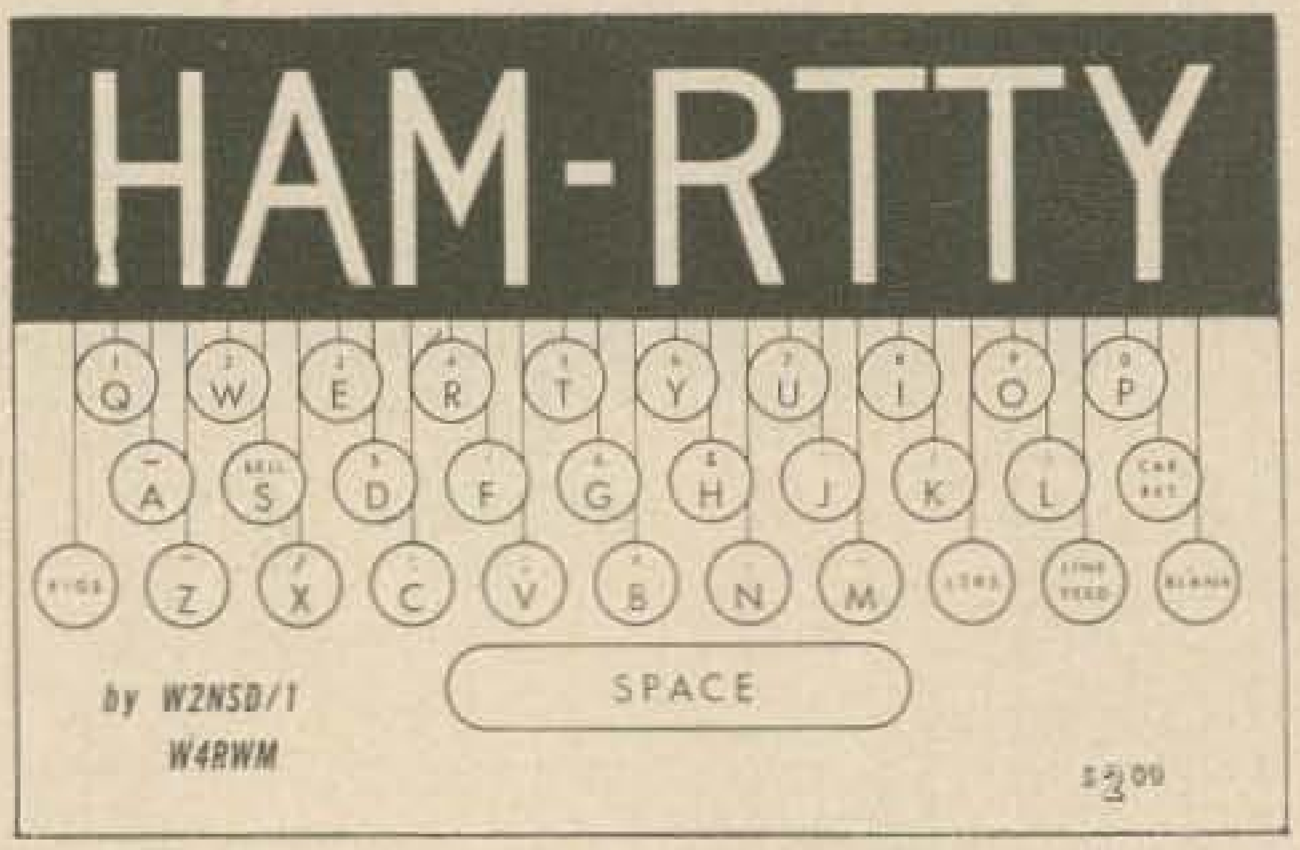
The bfo is crystal controlled. The frequency can be moved slightly by varying the capacitance across the crystal. The coil, the transistor T_8(OC170) and the crystal are all housed inside the original bfo can of the BC455. The crystal holder pins are shortened to allow tight packing in the can. The output is taken through a three turn link to the base of T_7, the product detector.

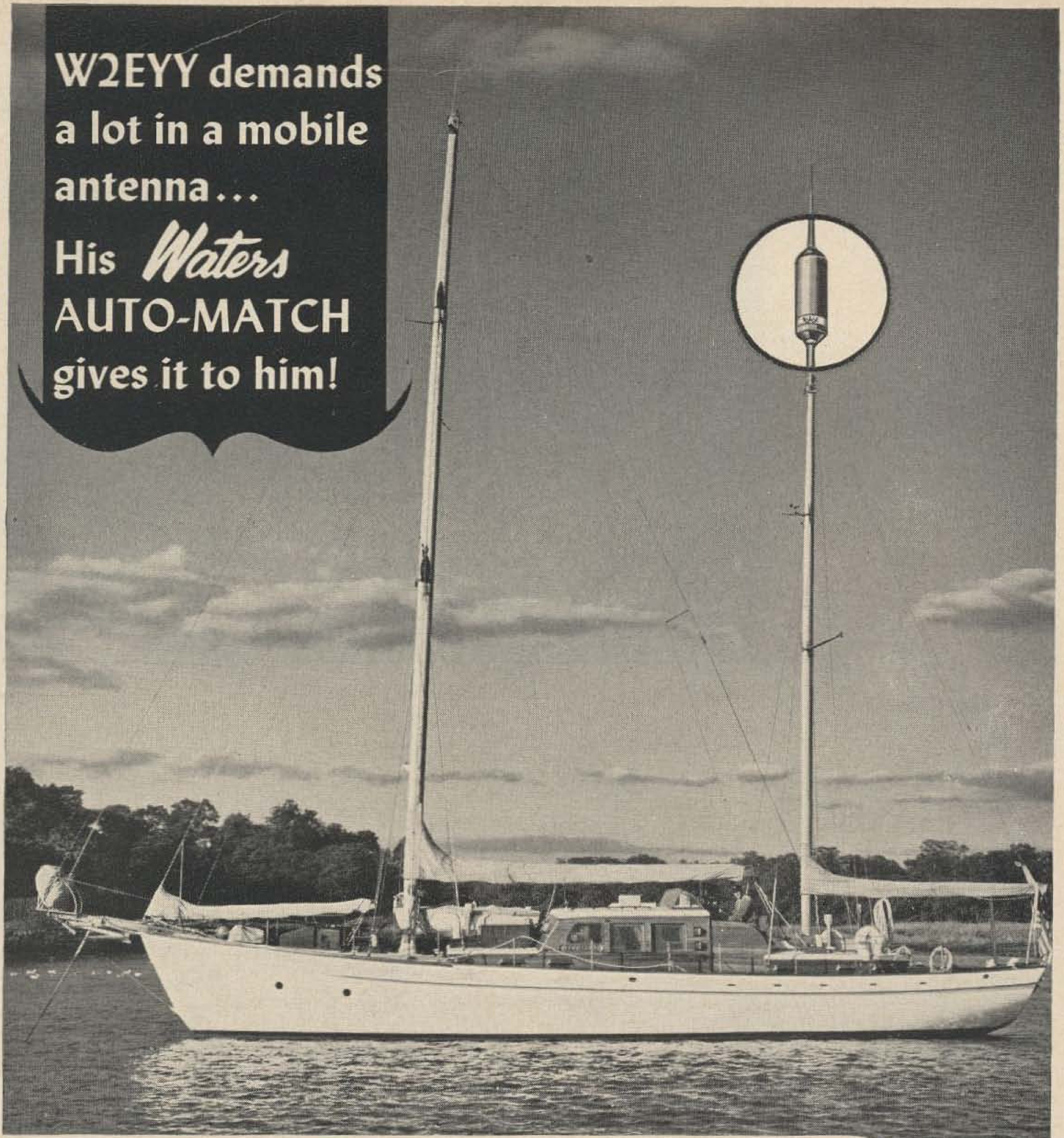
The af section consists of a stage of audio amplification, the driver and a class B push/pull output. Slight negative feed back is used in the early audio stages. The output stage can deliver an output of 500 mw on a signal of 10 μv. The output stage is protected by deriving its base bias through a low resistance network across supply voltage. Two thermisters type B2B are provided for stabilisation during hot weather. The output transistors T_{11} and T_{12} (TF 66) are housed in a heat sink and clamped to the side of the receiver chassis. This stage idles at 2 ma and goes up to 150-200 ma on signal peaks.

Avc is not provided as it was not considered an essential requirement of a ham receiver. Provision is made for band hopping by changing the coil packs. At the moment a coil pack for 20 meter band is made as there is no activity on other bands around this part of the world.

The receiver is put into operation on the 20 meter band and minor adjustments, as found desirable, are made. Later it is given a check to satisfy a ham in any part of the world. The sensitivity is .7 microvolts for a signal to noise ratio 10 db and gives 50 mw output for 2.5 microvolts of signal input approximately. This level is good enough for a comfortable copy. The selectivity check indicates a 2.1 kc filter response. The response is flat except for a 2 db pop up adjacent to sheer drop on the high frequency side and, with bfo adjusted to 400 cps at 6 db point on filter characteristic, the fidelity is good for SSB operation. The stability can be considered excellent as SSB copy is not lost by knocking the receiver on the table. The appearance, however, is poor, but the owner has no reason to grumble about it.

. . . VU2NR




W2EYY demands a lot in a mobile antenna...
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The Astro Ten

Allan Schechner W3YZC
Ellis Hersh W3IXL
2466 77th Avenue
Philadelphia, Pa.

Here's a ten meter mobile transceiver that is small, efficient, inexpensive and rather easy to build. Spare evenings over a three week period were all it took to get it going. Its one watt power level has been sufficient to enable the authors to hold QSO's around the Philadelphia area. The design approach was to make the rig as simple as possible so that the average ham could get involved with RF transistor circuitry. Let's face it—equipment is all going transistorized and not everything you might want will be available commercially. There's always that certain type of rig you wish you had but nobody's selling, so back to the workbench.

Theory of operation

The transmitter portion (see **Fig. 1**) consists of crystal controlled oscillator Q_1 (a 2N697) driving an amplifier Q_2/Q_3. Either third overtone crystals on ten meters or fundamental crystals from 9500 kc to 9900 kc may be used in the oscillator. The final amplifier approximately matches 50 ohms, so no additional matching network was included. Inexpensive transistors were used in the final and no heat sinks are needed.

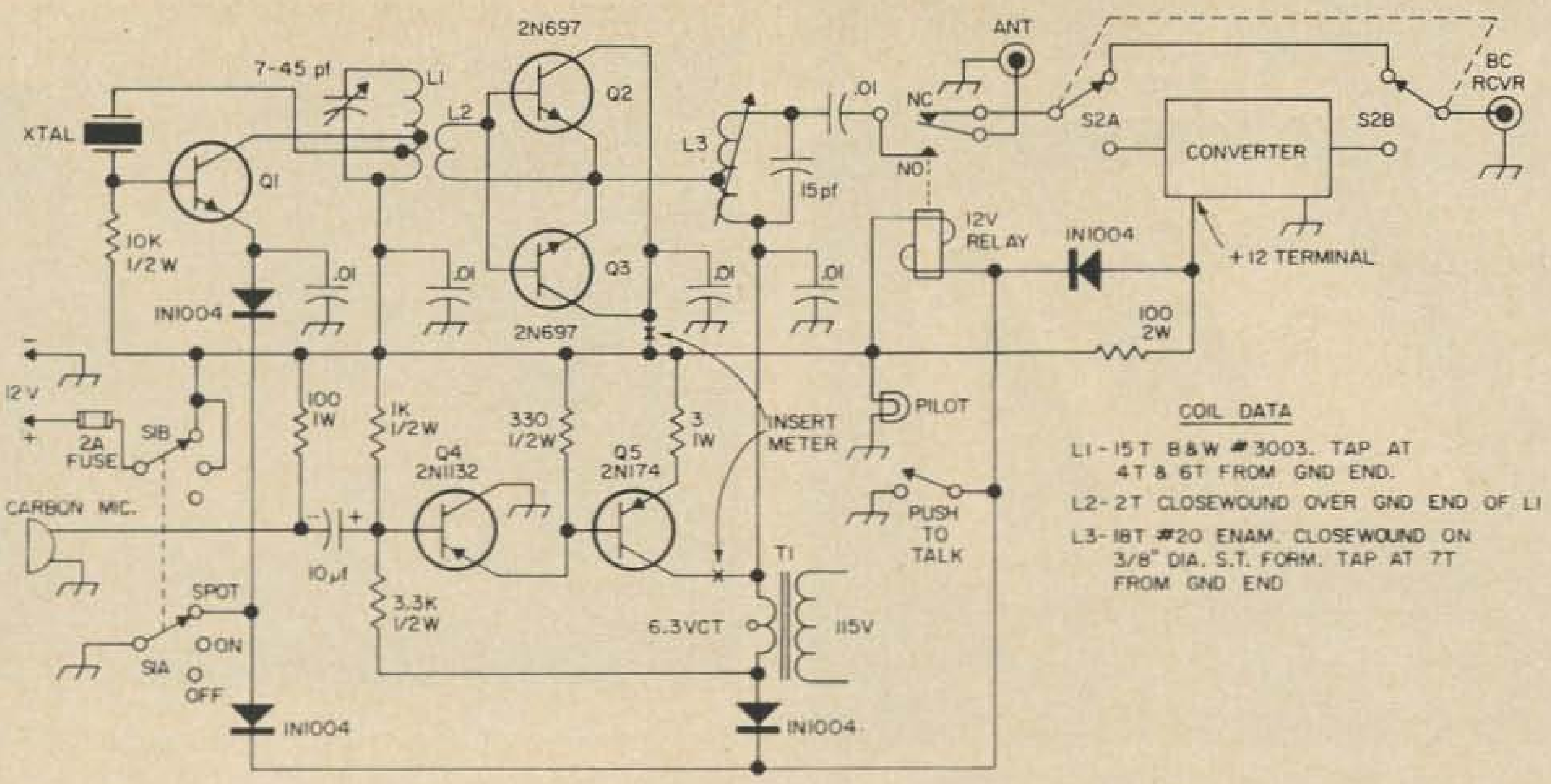
The modulator Q_5 is a straightforward class A "Heising" type using a filament transformer as a modulation transformer. Stage Q_4 serves as a microphone preamp. Emitter negative feedback was included both to improve bias stability and linearity and to prevent accidental burnout of the modulator.

Reception is accomplished by the tried and true method of using a commercial frequency converter with its output on the broadcast band, which then goes to the existing car radio. Power switching for the converter and transmitter circuits is all solid state, a feature found in only the most modern equipment and providing simplicity and reliability at low cost.

Construction

The transmitter is built on a printed circuit board for ease of cutting and drilling and to be able to make soldered ground connections. The preamp is also built on a printed circuit type board but the modulator transistor is mounted on the case for good heat dissipation. Laminated copper printed circuit boards are commonly available from large electronic parts dealers.

The completed circuit boards, modulation

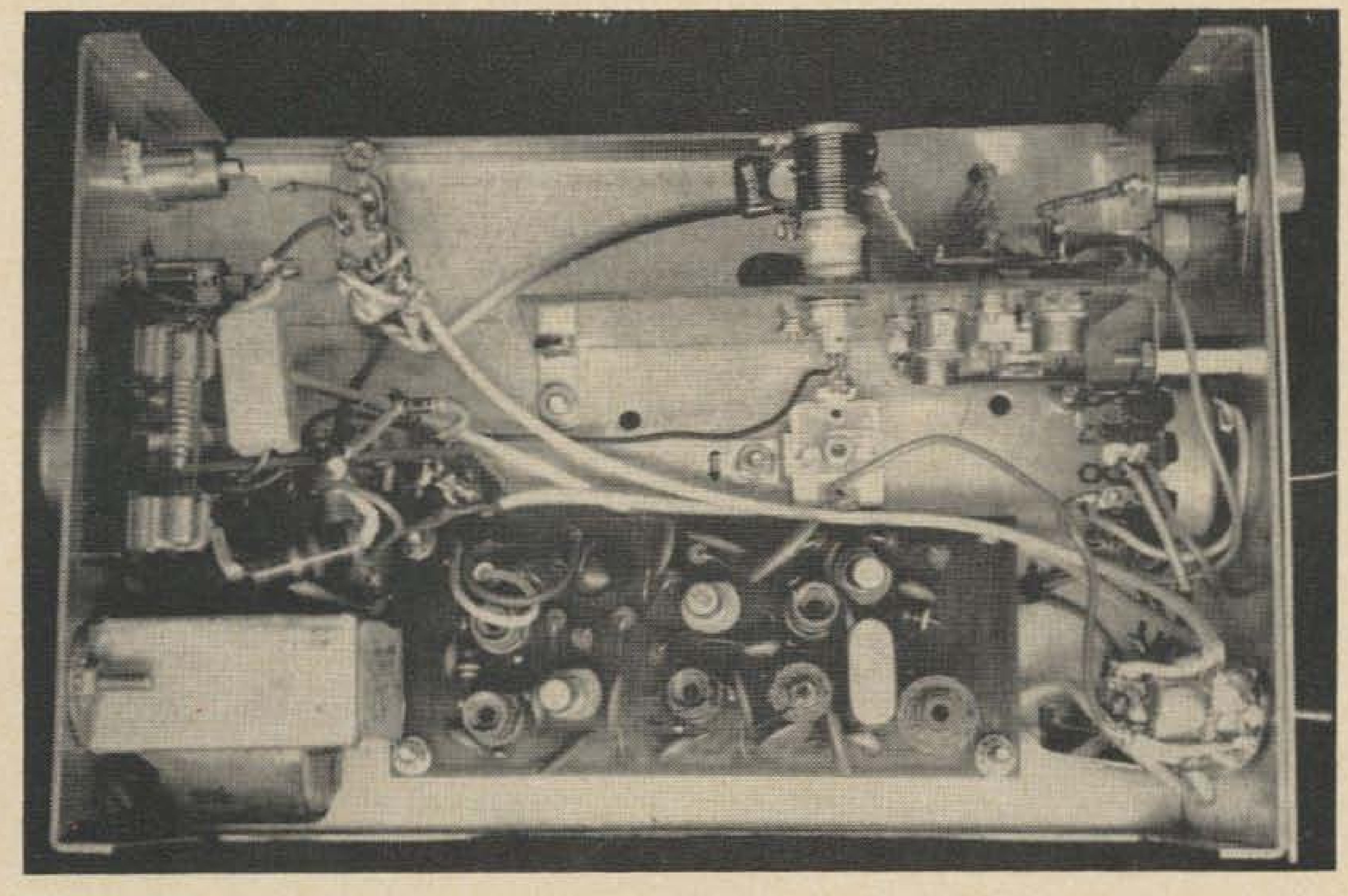


Schematic of the Astro Ten. Q1 is a 2N697. Refer to text for details on construction and circuits.

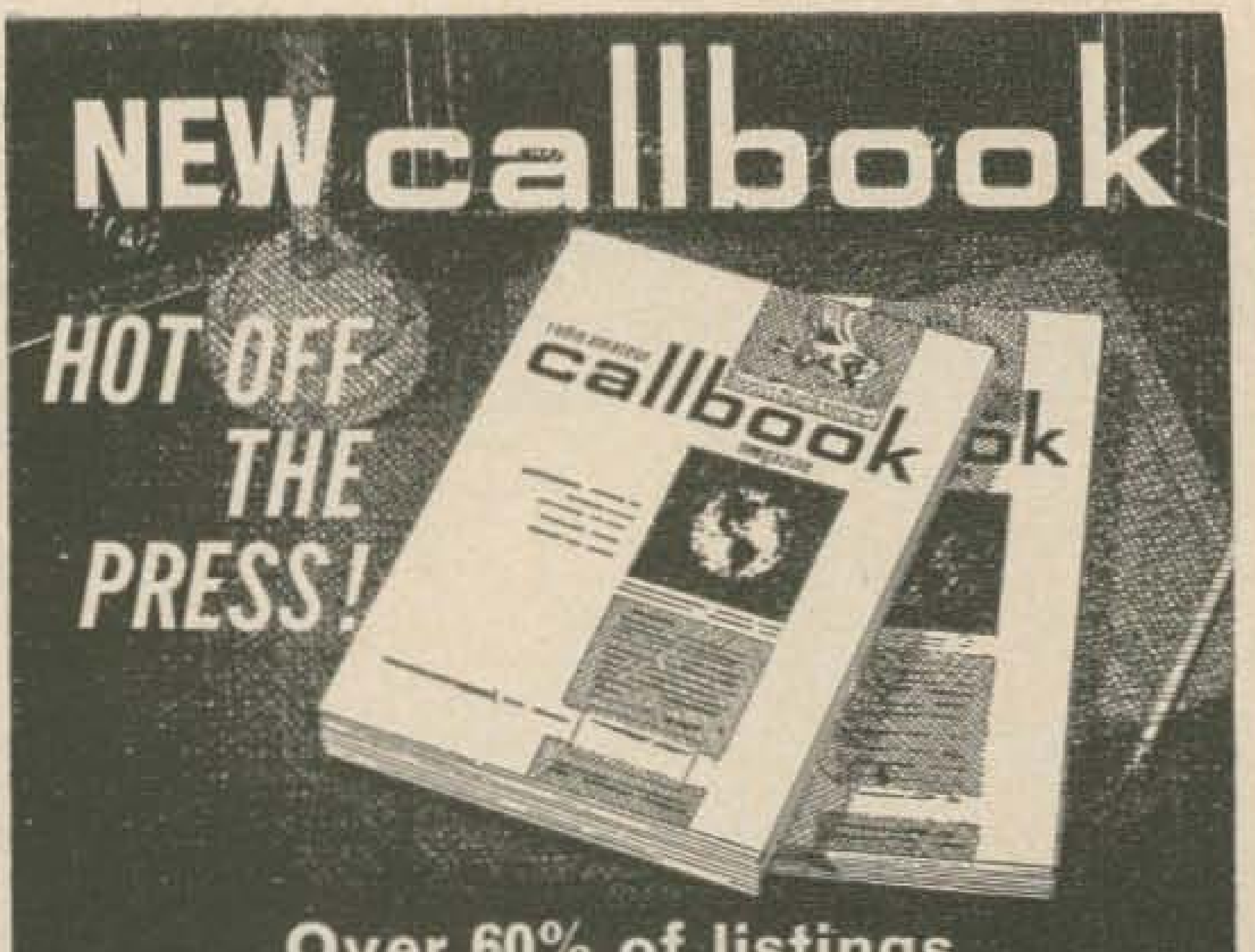
transformer, antenna relay and converter are mounted by means of standoffs and homemade brackets in a 3x5x7 aluminum Minibox. Layout and parts placement may be judged from the photographs. The only critical wiring is on the transmitter board and the guideline here is to keep the leads short. The board is mounted so that Q_1 is close to the crystal socket, which is mounted on the front panel. The oscillator is coupled to the final by a link which feeds through a hole in the copper shield, which is soldered to the printed board. Use solid insulated hookup wire, about #22 for this link.

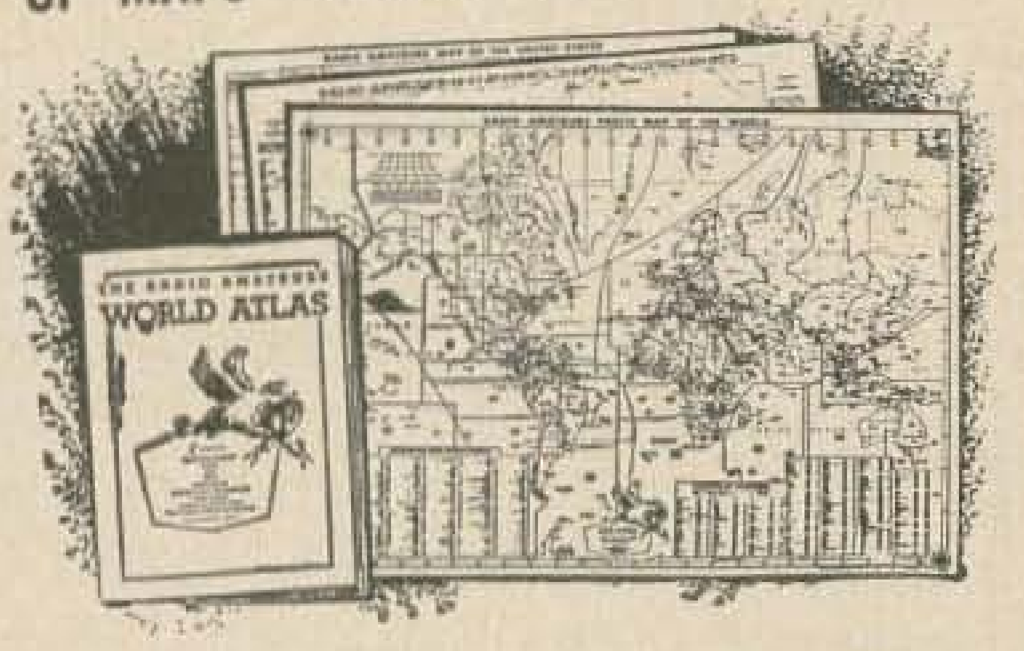
A word about the modulator transistor: the case is isolated from chassis ground by the mica washer and bushing supplied with the transistor. De-burr the mounting hole and base and emitter lead holes. Make sure there is clearance for these leads. Check continuity from the transistor case to chassis before wiring the modulator to be sure there isn't a short circuit.

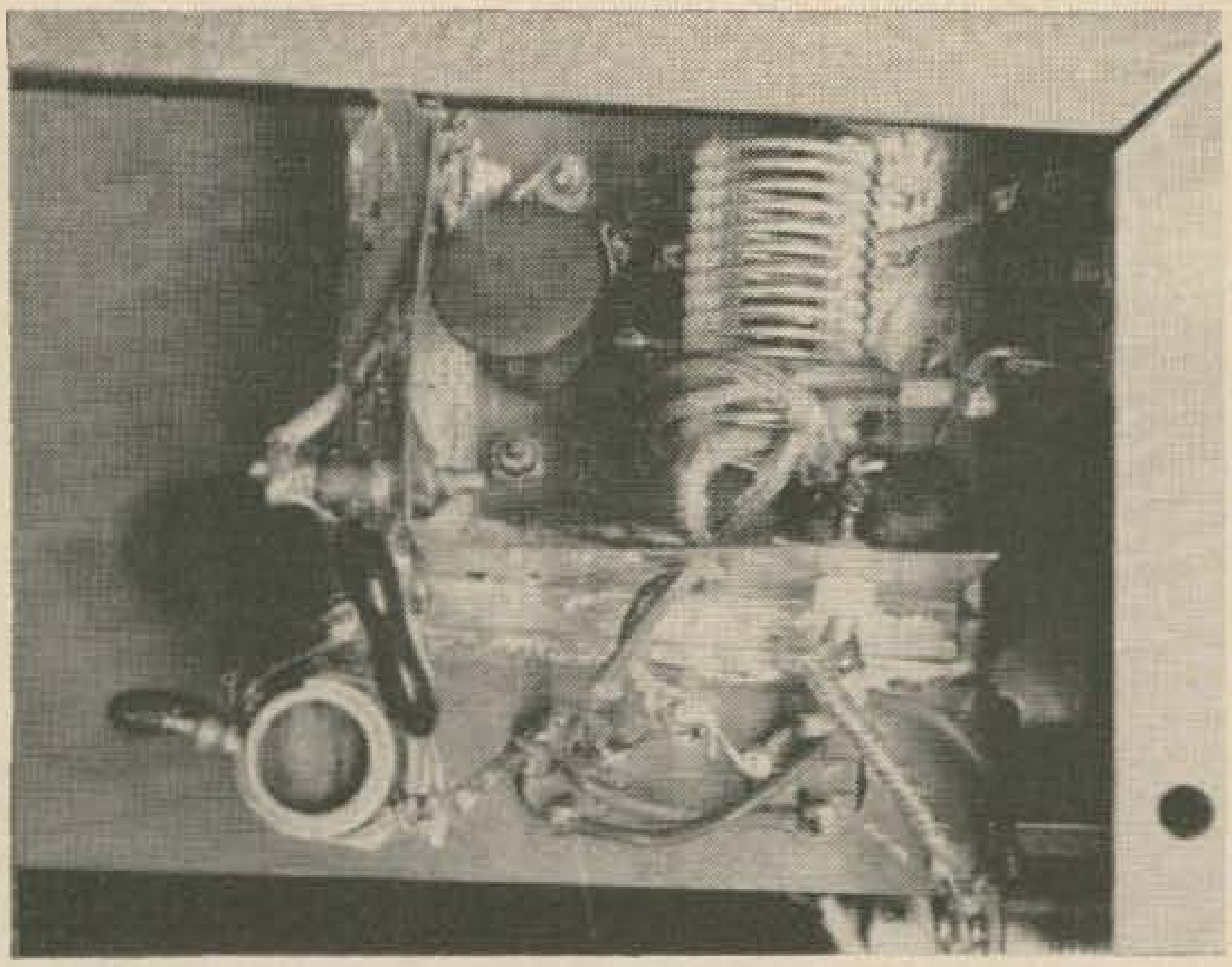
The remaining parts were drawn from the junkbox. These include the antenna relay, Motorola antenna connectors, fuse holder, rotary ceramic function selector switch, converter in-out switch and pilot light. Hole sizes and spacings shown are for the author's components and should be revised by the builder if substitutions are made. These are non-critical items and will not affect performance of this rig. Wiring between circuit boards and controls was done with solid insulated hookup wire except for some RF lines. These are shielded, stranded hookup wire, shields grounded at each end. Subminiature coax will also do.



Top view of the Astro Ten. In the lower center is the commercially made converter with the modulator (hard to see) just above it to the left and the transmitter at the upper right.







Bottom view of the transmitter section of the Astro Ten.

Tuneup

With Q_1, Q_2 and Q_3 removed, and a milliammeter in series with the collector of Q_5 (see schematic) apply power and press the transmit button. Q_5 should draw between 200 ma and 350 ma. If it is far outside this range check Q_4 and Q_5. Now interrupt power (go back to receive), replace Q_1, Q_2 and Q_3, apply the milliameter as shown to monitor final collector current and reapply power. Tune the oscillator for maximum final current. The final will not draw current if the oscillator is not working. A receiver serves as a good monitor to check the oscillator. Final current, when the final tank is dipped, and a dummy antenna (50 ohm one watt carbon resistor) is connected should be about 100 ma. Do not let the final current exceed 150 ma for any length of time, or the transistor's dissipation will be exceeded.

Now check operation of the rig across the band by substituting different crystals (obtained from surplus stores). The oscillator tank might have to be returned to cover the full range properly. Once tuned up, the milliameter may be removed and the rig will continue to run reliably without any retuning. The authors monitor output from time to time with a field strength meter (73, April '62, p.9) but have noted no changes. The transmitter board, by the way, is obviously larger than needed. When higher power RF transistors become much cheaper, a higher powered final will fill up the empty space. The modulator, by design, has sufficient reserve power to handle a more powerful final.

Instructions come with the converter, so nothing more need be added. If trouble is experienced here, recheck your wiring. Then there's nothing to do but put it in the car and enjoy it. . . . W3YZC, W3IXL

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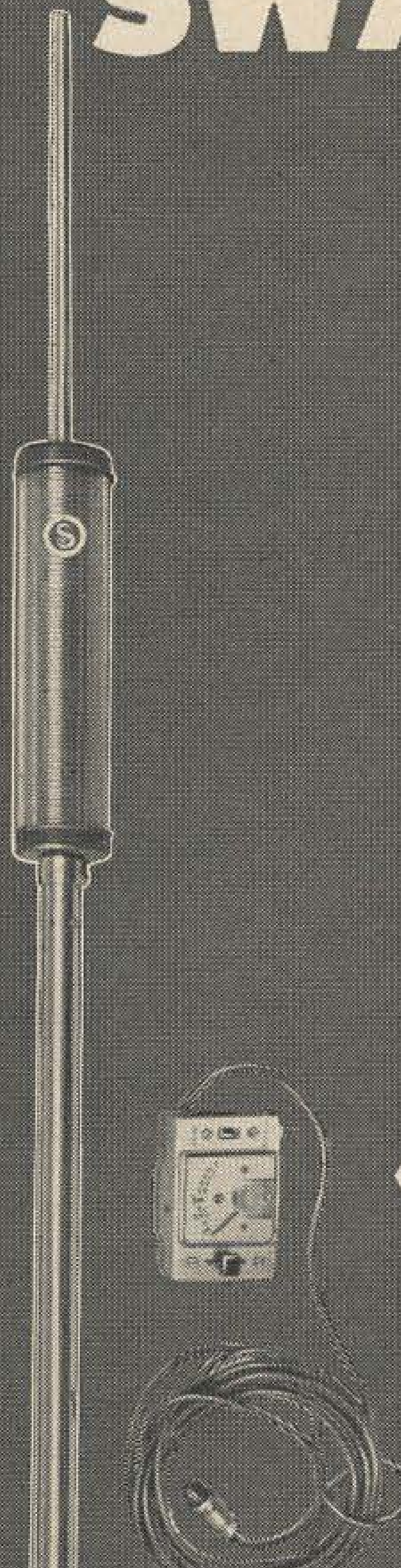

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Improving RTTY Reception

It's a big thrill to watch your printer pounding out perfect copy from a distant RTTY station—but it is far from thrilling when bursts of interference suddenly cause the copy to look like a cartoonist's idea of profanity! But don't give up. . . . There are several things we can do to improve this situation.

Most RTTY receiving converters convert the incoming FSK to audio tones. These audio tones are then passed through a limiter and then to tuned filters with associated tone detectors. This method of FSK detection is fundamentally the same as FM and exhibits much the same characteristics as FM. Whenever the signal we are trying to copy is stronger than interfering signals, the "capture effect" occurs. The desired signal passes through the limiter and the interference is attenuated. So—to obtain a big reduction in the effects of interference on our RTTY copy, it is only necessary to reduce the interference amplitude to less than that of the signals we want.

There are three points in the average receiving system which can usually be improved significantly. These are:

(1) The *if* amplifier

(2) The second detector

(3) The audio ahead of the RTTY converter.

This article will discuss each area. Your particular receiver may be ideal in one or more of these areas. You should be able to judge from the following discussion whether you will benefit from some modifications in your receiving set-up.

IF amplifier considerations

As in any communications system, the bandwidth of the *if* amplifier should be no greater than necessary to pass the spectrum of the signal you want to copy. **Fig. 1** illustrates the spectrum of an FSK signal using 850 cycles shift. Notice that practically all of its energy is contained in a 1200 cps bandwidth. So, we see that 1.2 kc is the optimum *if* bandwidth for amateur RTTY reception.

Many old receivers have *if* bandwidths de-

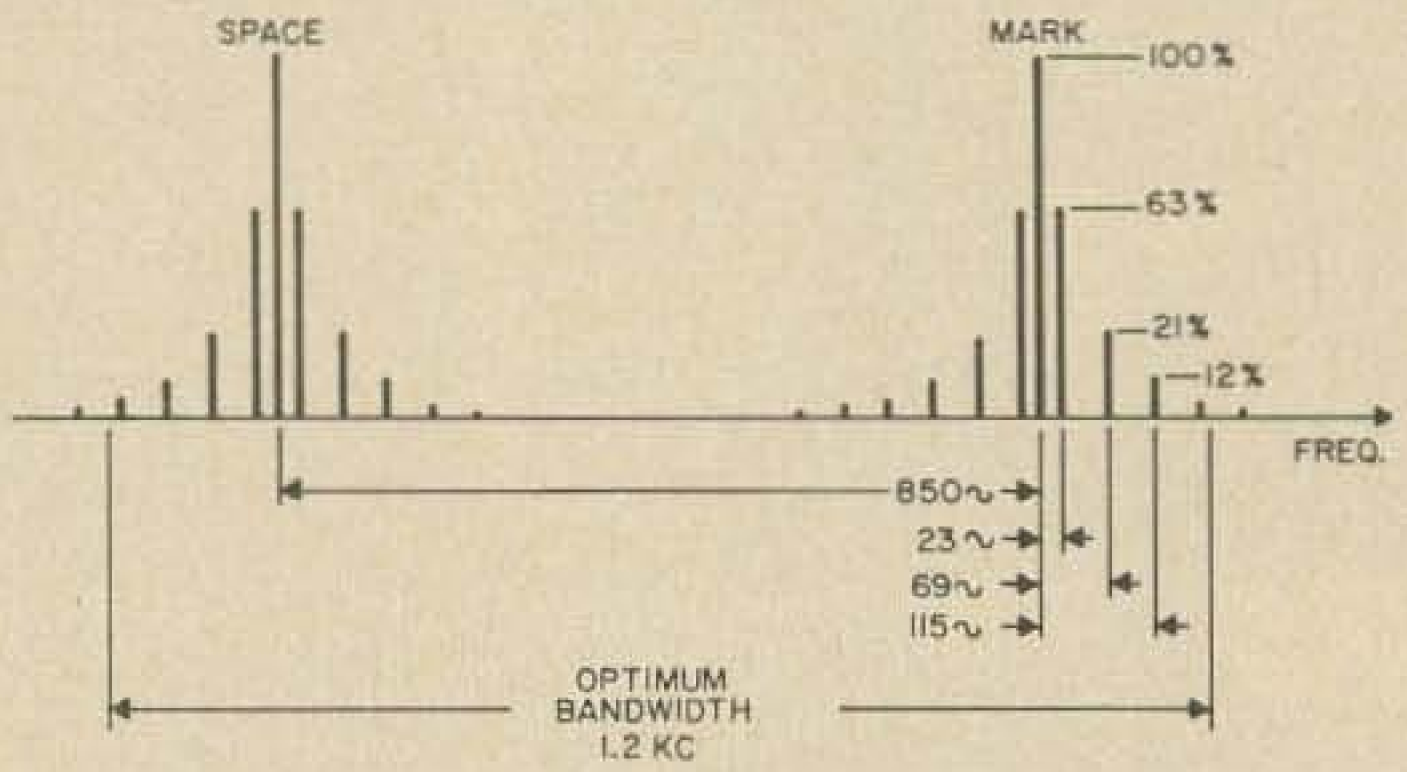


Fig. 1. Spectrum of 850 cps shift FSK signal.

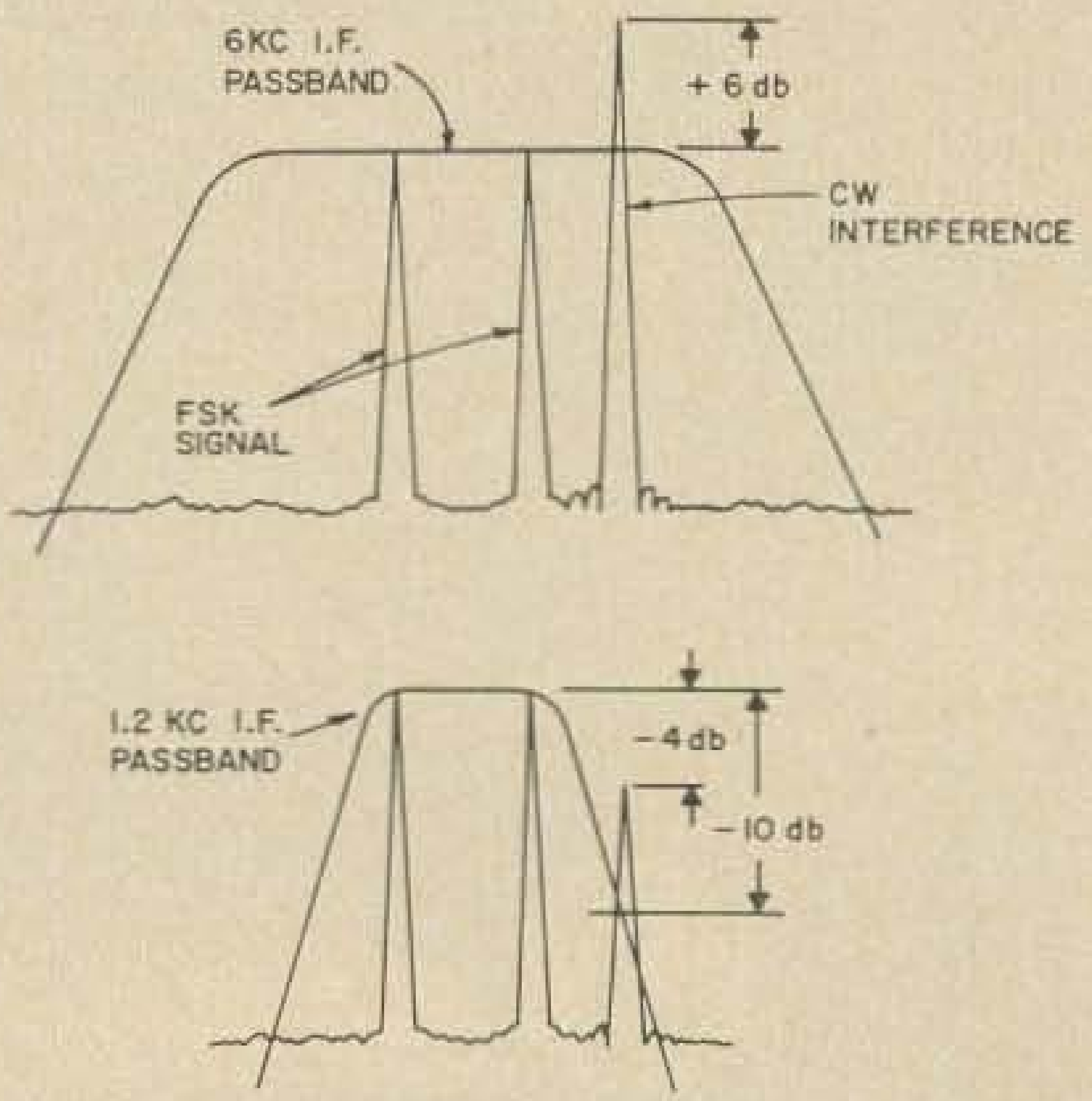
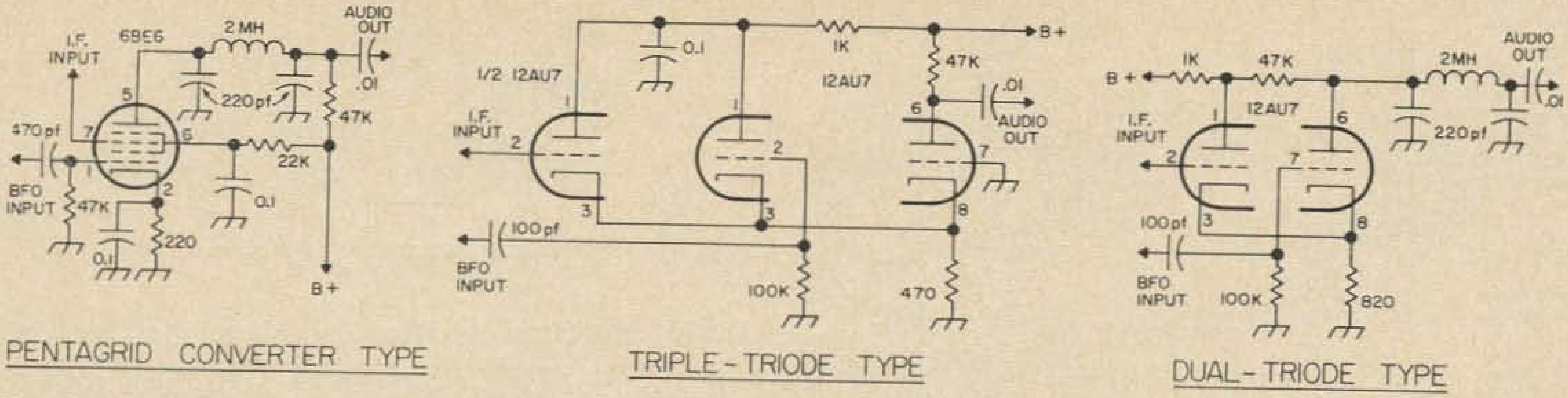


Fig. 2. Improvement in interference by increasing if selectivity.



PENTAGRID CONVERTER TYPE

TRIPLE-TRIODE TYPE

DUAL-TRIODE TYPE

Fig. 3. Product detector circuits that can easily be adapted to most communications receivers.

signed for AM signals 6-10 kc wide. If you are using one of these for RTTY you should definitely take steps to improve the situation. To illustrate how effective using the correct *if* bandwidth is, take a look at **Fig. 2.** Here a receiver designed for AM reception is shown having an *if* bandwidth of about 6 kc at the half power points (−3 db). A CW signal which is 6 db (one S-unit) stronger than our FSK signal comes on about a kilocycle away. Since it is passed on to the RTTY converter, it will capture the limiter and we start printing "Greek"! Now, suppose we can narrow the *if* down to 1.2 kc as shown. The skirts of the filter attenuate the CW signal by 10 db so it is now 4 db weaker at the converter than our FSK signal and our FSK signal has the upper hand. Perfect copy again!

Many modern receivers designed for SSB use have good mechanical or crystal lattice filters with nice, steep skirts and bandwidths of 2 kc or slightly higher. These are excellent for RTTY, and optimum audio filtering (to be described later) is all that is required to put the finishing touches on the receiving system. If you have one of the older receivers which has an excessive *if* bandwidth, there are several possible ways of improving the situation. Obviously, a mechanical or lattice filter of the desired bandwidth can be installed or added by means of an adapter. Many articles have appeared in various magazines describing such modifications for popular receivers.

If your receiver has a conventional crystal filter, some improvement can be obtained if care is taken in adjusting the filter. The selectivity setting and phasing control should be experimented with to find the best settings and these settings marked on the panel for easy resetting. You can easily get the filter adjusted too sharply which chops off part of the FSK spectrum. This will cause the mark and space tones to have unequal amplitudes.

The ubiquitous Q-fiver is also a good solution to the broad receiver problem. The old-standby BC-453 has an ideal pass band for RTTY when the *if* coupling rods are pulled all the way out.

Second detector

At first glance, it would seem that the second detector would not be a fruitful point for improvement. However, if your receiver has a conventional diode detector, a worthwhile gain in RTTY performance can be obtained by changing to a product detector. The reasons are much the same as for using a product detector for SSB. A diode detector produces beat-notes between all signals. Thus, if there are interfering signals coming in with the FSK, the diode detector will generate new frequencies from all of those signals beating together. The result is an increase in noise added to the "honest" noise. This just gives the RTTY converter that much of a harder job. When a product detector is used, it is linear with respect to the signal input and only beats between incoming signals and the BFO appear at its output. So, we give our RTTY converter the cleanest possible signal. If your receiver doesn't have a product detector, you should certainly install one. It will help your SSB and CW reception also. **Fig. 3** shows simple circuits which can be adapted to most receivers. Again, many articles have appeared describing this modification for popular receivers.

Audio filtering

One of the easiest and most effective ways of improving RTTY reception is by the construction of a double band-pass filter to be used ahead of the RTTY converter. If you include a switch to cut the filter in and out, you

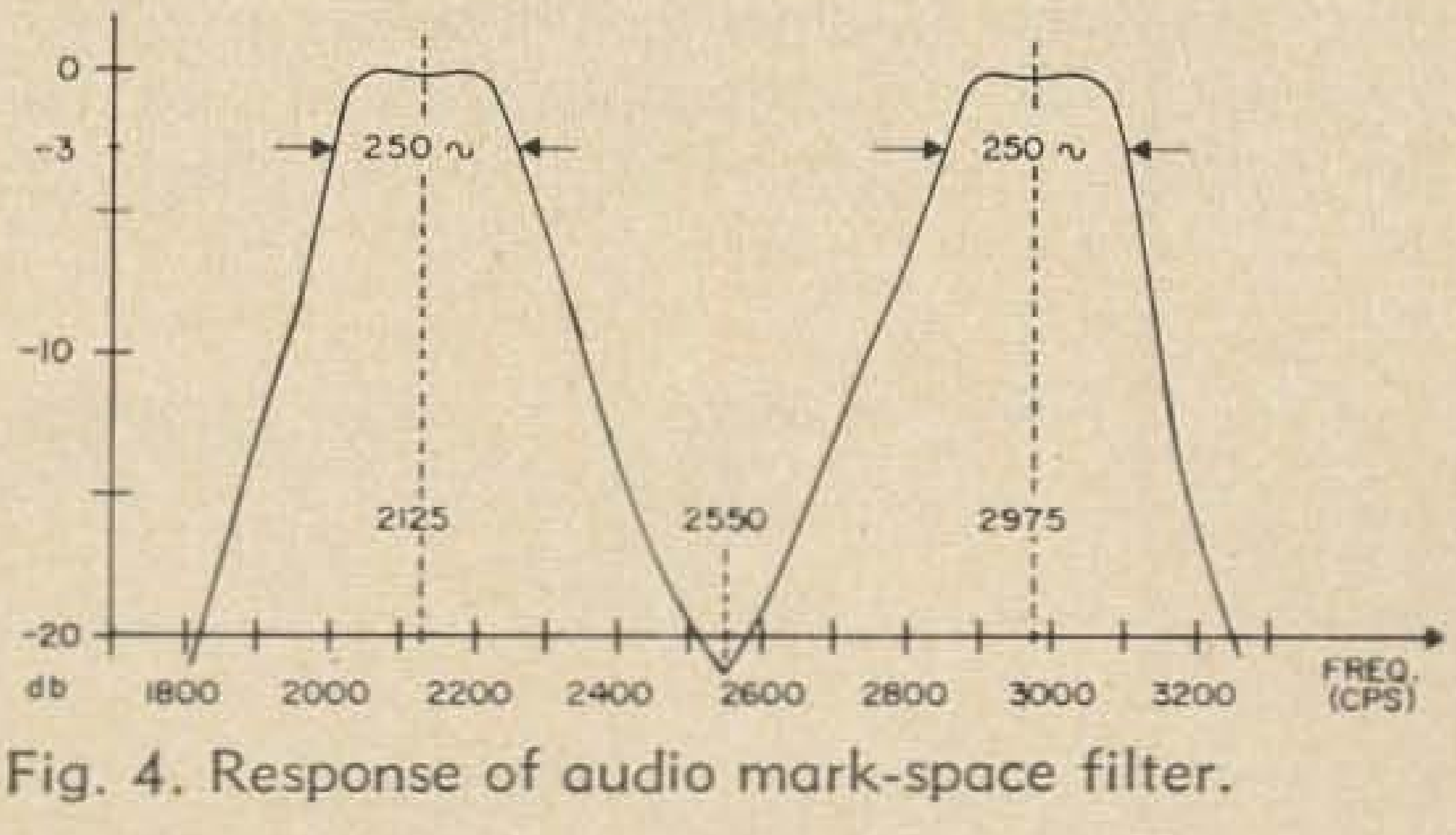


Fig. 4. Response of audio mark-space filter.

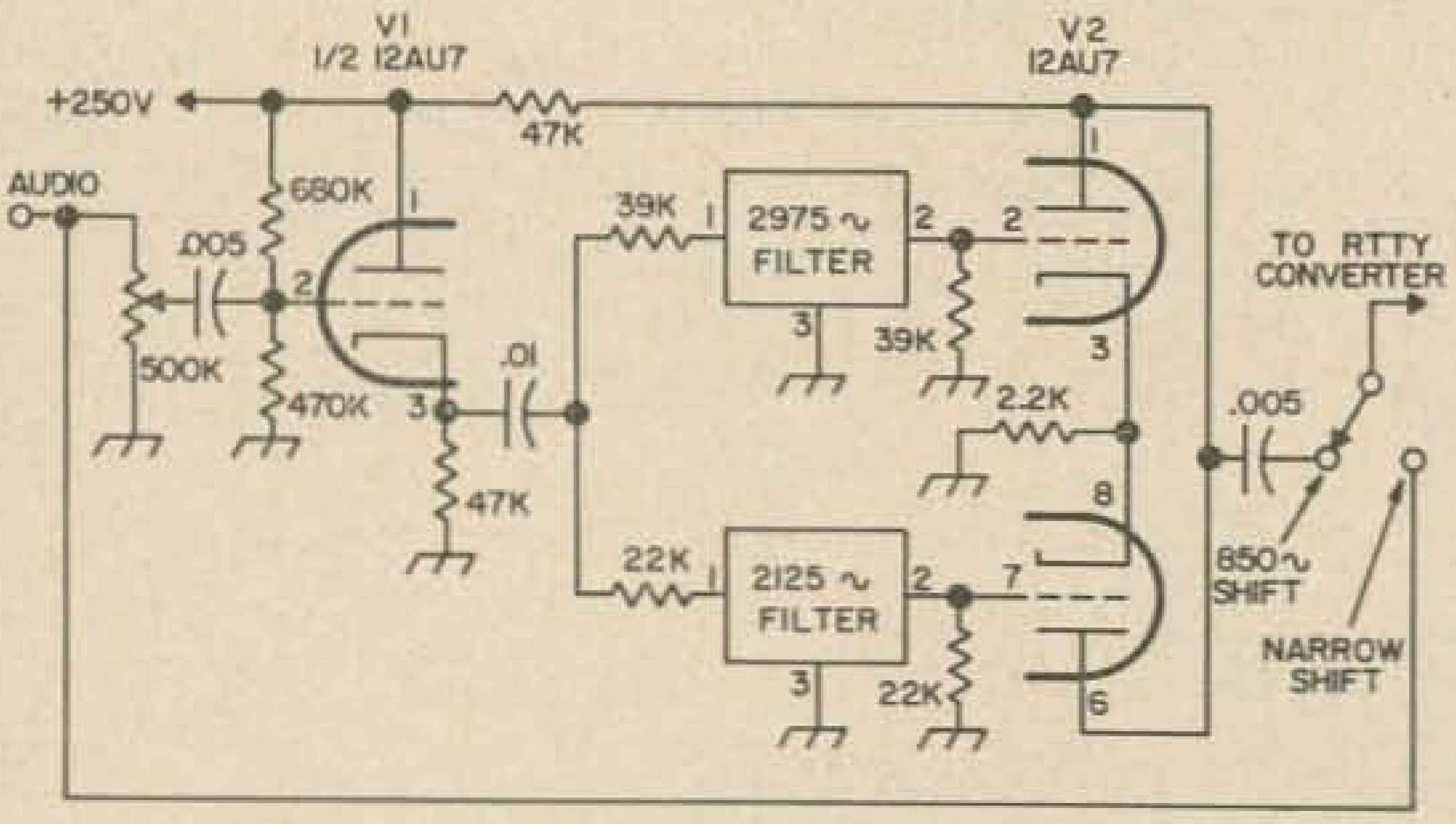


Fig. 5. Schematic for audio mark-space filter.

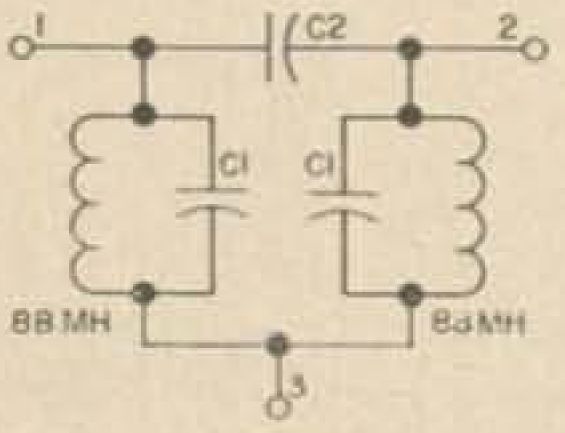
can demonstrate very dramatically how the filter can allow perfect copy even with heavy interference.

Looking back at **Fig. 1** we can see that the FSK energy is concentrated about the mark and space frequencies. The filter to be described has a response curve as shown in **Fig. 4.** Note that the response is down over 20 db halfway between mark and space. Thus, we can have a CW signal at 2500 cps nearly 100 times as strong as our RTTY signal and still get good copy. The half-power bandwidth of each bandpass section is about 250 cps which allows some margin for misadjusted shifts and for a small amount of drift before retuning of the receiver is necessary.

The circuit of the complete filter amplifier is shown in **Fig. 5.** A cathode follower V_1 is used to drive the two bandpass filters in parallel. The two series resistors are essential to provide the correct driving impedance since the filters are modified m-derived types requiring a match at input and output.

They are also terminated with the proper load impedance as shown. V_2 is used as a simple combiner and to provide some gain to overcome the insertion loss of the filter sections. A switch is included to be able to bypass the filter when narrow shift is being copied (and to impress visitors with the gadget!). The input gain control can be permanently set to give unity gain through the filter-amplifier if extra gain is not needed.

Details on building the filters are given in **Figs. 6** and **7.** The inductors are 88 mh surplus telephone loading coils which are widely available. The capacitors used should be paper, mylar, or mica. The ceramic types are often voltage-sensitive so are not recommended. Notice in **Fig. 6** that each toroid must be peaked at a frequency slightly higher than the filter center frequency. **Fig. 7** shows a test set-up for tuning. A calibrated audio oscillator and a VTVM or scope is needed. If you don't have an audio oscillator, an LM or BC 221 frequency meter can be used. Set the meter up on 2000 kc with the crystal calibrator on. You can then obtain accurate audio tones from the headphone jack by detuning the meter dial. For example, if you want 2125 cps, just look in the calibration book for 2002.125 kc and reset the main dial to that reading. The beat note with the crystal will then be 2125 cps.



CENTER FREQ.	C_1	C_2	TUNE EACH L-C CIRCUIT TO:	LOAD "R"
2975 ~	.03*	.0022	3075 ~	39K
2125 ~	.06*	.005	2225 ~	22K

Fig. 6. Circuit and values for sharp filters.

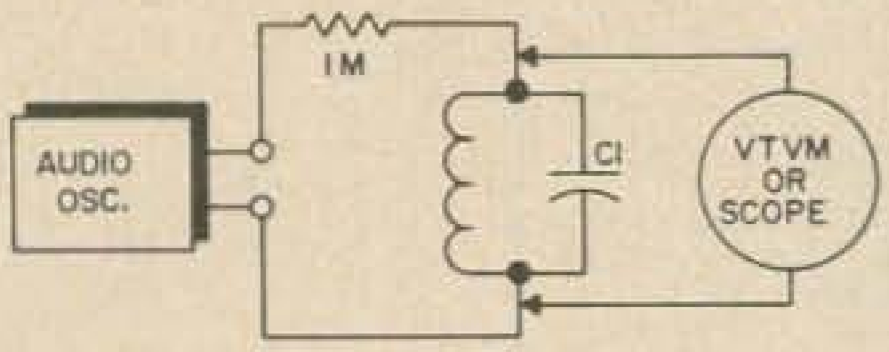


Fig. 7. Test set-up for tuning toroids.

With the circuit as shown in **Fig. 7,** select a capacitor for C_1, and tune the audio oscillator until you get a peak on the meter or scope. If the audio frequency is not the value desired, you can adjust the circuit by either changing the capacity or removing turns from the toroid. If you wish to remove turns, then use a capacitor that gives a resonant frequency slightly *lower* than shown in **Fig. 6.** Then unwind turns until you hit the specified frequency. If you don't want to fool with unwinding the toroid, then select a capacitor which gives a slightly higher reading. Then shunt it with small capacitors until the right frequency is obtained. Of course, if you're lucky, you may find one capacitor which hits the right frenquency on the nose! Incidentally, small ceramics in the .001 to .003 range are OK for trimming since small variations in these would have negligible effect.

When all four toroids are properly tuned the filter can be assembled. Small pieces of perforated board with "flea clips" are very handy for mounting the components. When installing the filters in the amplifier be sure to provide isolation between input and output to keep down leakage around the filters.

Conclusion

The suggestions in this article should help even the most mediocre RTTY converter to do a top-notch job. They also will help the most sophisticated units to live up to their expectations. Happy printing!

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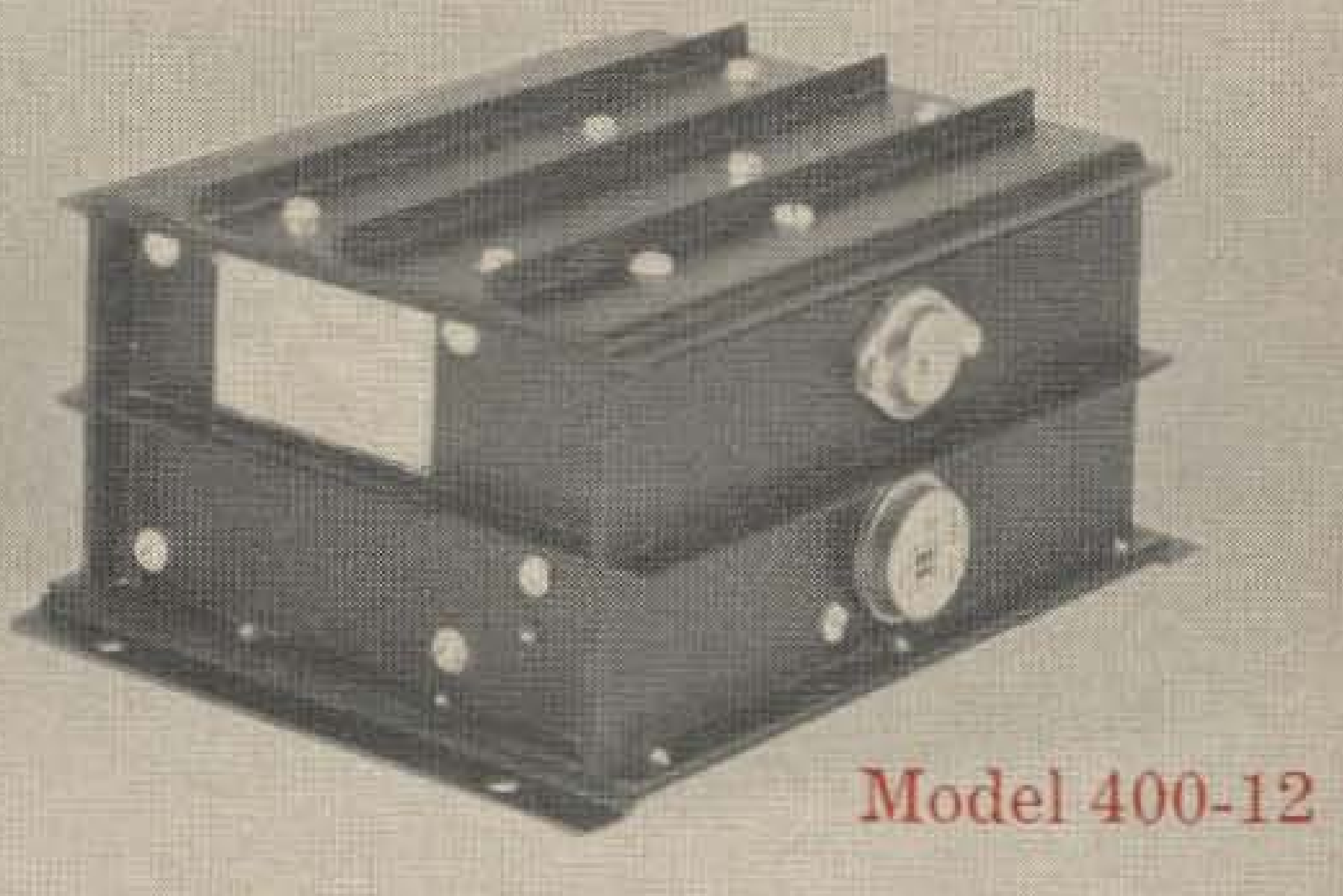

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Now of course there are dozens of ways to get that negative voltage, ranging from a complete separate power supply with reversed polarity to the popular back-to-back filament-transformer hookup—but hidden in the antiquity of ideas bypassed many years ago are a few which are simpler than any of the methods currently popular.

One, for instance, can give you up to 500 volts negative (from a supply nominally rated at 400 volts positive) at the current drains usually needed for bias (1 to 8 ma), with the addition of only *four* components over those normally used. The largest and most expensive of these components is a small filter choke; the other three are a 400 volt diode and two capacitors!

If you're in need of lower voltages, the same trick can give you up to 9 volts from the filament lines. For tube-and-transistor work, this proves an excellent way of obtaining transistor operating potentials.

The secret of this trick lies in the use of *shunt* rectification rather than the more popular *series* type. **Fig. 1** shows the difference. In A is the normal series rectifier hookup (half wave); the diode passes current to the load on one half-cycle and blocks it on the other. The shunt hookup is shown at B; the diode now shorts the supply to ground on one half-cycle, and looks like an open circuit on the other. When the diode is "open", the current is shunted to the parallel load.

Obviously, shunt rectification cannot be used when the ac generator has low impedance, since on conducting half-cycles the diode is a short to ground and would burn out in short order. Addition of a resistance as shown at C becomes necessary to limit current flow through the diode when it is conducting.

However, since we're dealing with ac rather than dc, there's no need to burn up power in a resistor. An impedance will limit the current flow equally well, and has the advantage that it consumes no power while doing so. The reduction in current flow is accomplished by shifting the phase of the current in relation to the voltage.

This brings us around to the practical shunt-diode rectifier shown in **Fig. 1-D,** consisting of a capacitor in series with a diode, the whole works connected across the ac source, and the dc taken off across the diode. If the end of the diode which goes back to the ac source is grounded, the dc will appear from the hot side to ground.

As in all half-wave rectifiers, the output consists of pulsating dc with a high ripple content. To be useful, it must be filtered.

However, if we try to filter it by connecting a filter capacitor across the diode we find that all of a sudden we have merely a capacitive voltage divider across the ac source, and no usable output. The filter, then, must be of either the choke-input or resistor-input variety.

For relatively low-voltage output, up to about half that available from the ac source, we can use resistor input. The resistor's value should not be less than 100,000 ohms according to the literature, but tests conducted by W5PPE showed 200 volts at 5 ma were available at the output with resistor values as low as 10K. With the same resistor, 10 ma could be drawn at 105 volts. Incidentally, the value

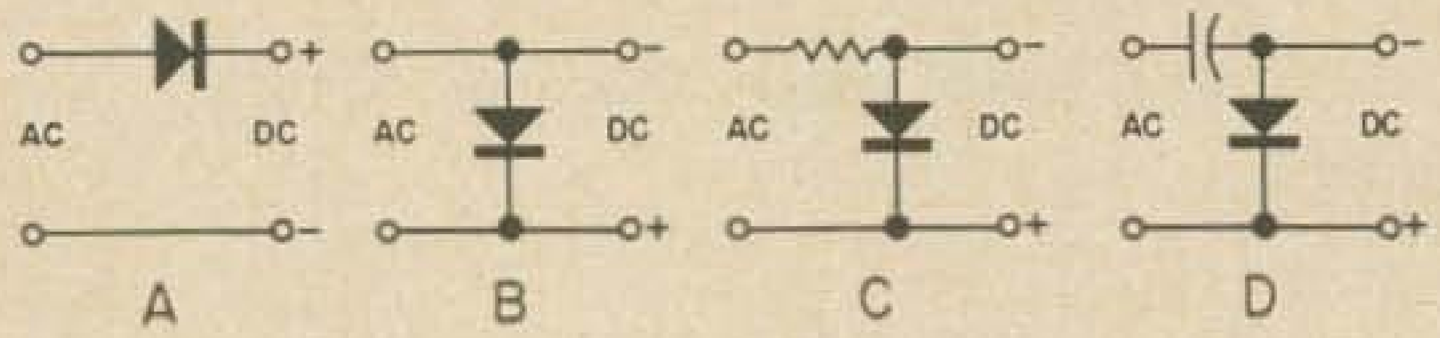
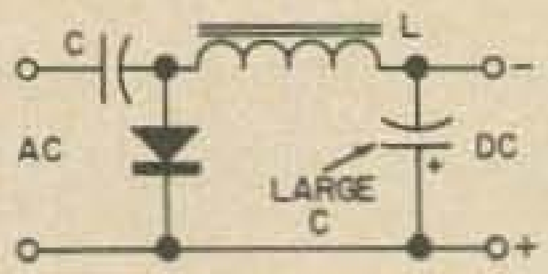
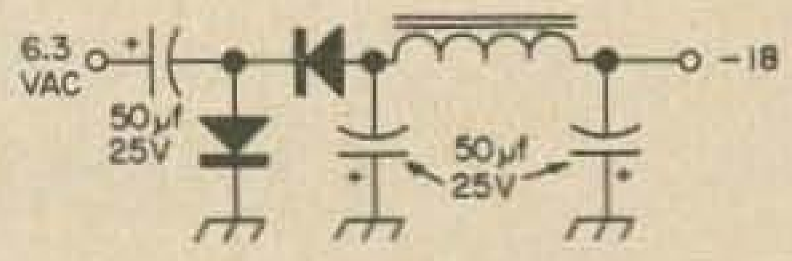


Fig. 1. Series and shunt rectification.





Left. Fig. 2. Step-up by LC resonance. Right. Fig. 4. Voltage doubler bias supply.

of the resistor in these tests appeared to be somewhat critical, voltage dropping as the resistance was either increased or decreased in value.

For higher voltages, a choke should be used. **Fig. 2** shows how this works. The choke and the input capacitor form a series-resonant circuit so far as the ac source is concerned, if their values bear the proper relation to each other, while they are a parallel-resonant circuit for the diode and the output. With this hookup, 500 volts could be developed from a 400-0-400 volt transformer with load current running as high as 50 ma!

Speaking of the values for capacitors and chokes in this circuit brings us to another interesting point. The output voltage will be dependent to some degree upon the value of input capacitor C1, even aside from any possible resonance effects. A larger capacitor with its lower impedance will allow more current to flow, resulting in more output voltage. Practical values for C1 range from 0.1 to 1.0 uf, with 0.22 being about as large as will ever be needed for bias supplies not over 150 volts negative.

The filter capacitor should be at least 8 uf, and larger values won't hurt anything. The W5PPE setup used .22 uf at C1 and 40 uf in the filter.

Should a trace of hum or ripple remain, another stage of RC filtering can be added. However, this should seldom if ever be necessary, especially if the output is regulated with a VR tube after the filter.

All of which brings us around to the complete practical circuit, **Fig. 3**. The bias-supply additions are shown enclosed in a dotted box; they can be added to any existing power supply in the 250 to 500 volt output range.

"All this sounds fine," you may be saying about now, "but what about the extra load on one side of my power-supply transformer? Won't that foul things up?"

Strangely enough, according to tests run years ago and written up in "Radiotron Designer's Handbook" (in the power-supply chapter), the extra current drawn from the power transformer is only in the neighborhood of some 100 microamps even when supplying a much higher load current. Diode current is similarly low. The only explanation we can offer for this is that the current is "phased out" by the complex reactance network made up of the transformer secondary, the input capacitor, and the choke.

For the 9-volt supply, the circuit is identical except that the input capacitor C1 goes to the filament line rather than to the high side of the HV winding. Values of C1 will remain about the same, but the output capacitor can be made much larger since it now must have only a 25 volt or so working rating. The diode, similarly, can be something like a 1N34 as the maximum voltage it will see will be in the neighborhood of 9 volts.

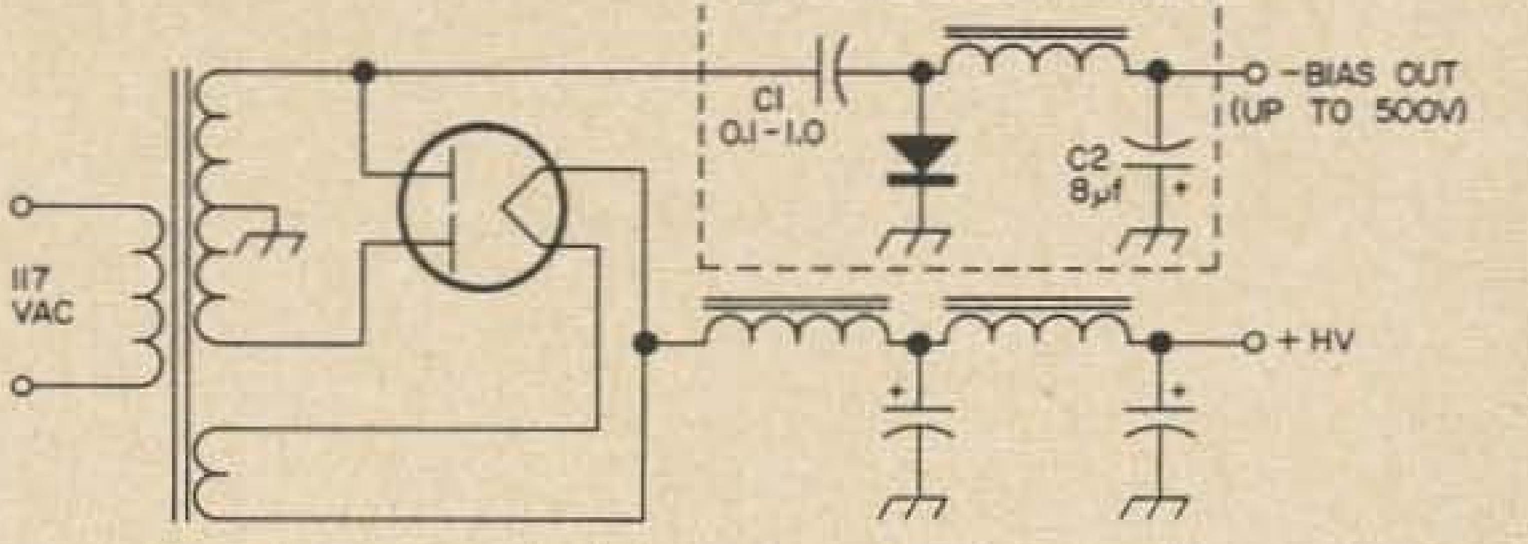


Fig. 3. Bias-supply schematic.

Should 9 volts not be quite enough and 100 volts be too high, the circuit of **Fig. 4** may come in handy. This is a voltage-doubler operating from the filament line, and delivers 18 volts without load. Loading resistors can be put across the output to drop this down to anything desired; at K5JKX the −12 volts for a 6V6 modulator is obtained this way.

The same trick can be used for other purposes than bias supplies. For instance, by reversing polarity of all diodes and capacitors the output becomes positive rather than negative. Now, by putting the circuit of **Fig. 4** on the high-voltage transformer as shown in **Fig. 3** (C1 is now the same value as C2) and using diodes with high enough piv ratings (three 400 volt diodes in series are adequate to handle the normal 350 volt TV special transformer) you have an additional positive power supply which delivers about 1,000 volts no-load. It won't supply much current, so don't expect this to handle a 250 watt final, but it's an ideal way to put together a scope in a hurry.

Some years ago, we rebuilt a surplus ARB-5 loran indicator into a general-purpose scope, using this type of power supply with 0.1 µf, 1600 volt auto-radio buffer capacitors for C1 and C2, and virtually no output filtering. Since our transformer had a separate winding usable for the 5BP1, we left the output negative rather than positive and ran the scope tube's cathode 1,000 volts negative to ground, so that the accelerator could be at a less jolting level. Deflection plates ran about 150 volts positive (direct-coupled to the plates of the deflection amplifiers) and the intensity was much more than adequate.

But for any purpose, the shunt recitifier circuit deserves more attention than it's had in recent years. Keep it in mind next time you need an extra output from an existing supply!

. . . K5JKX

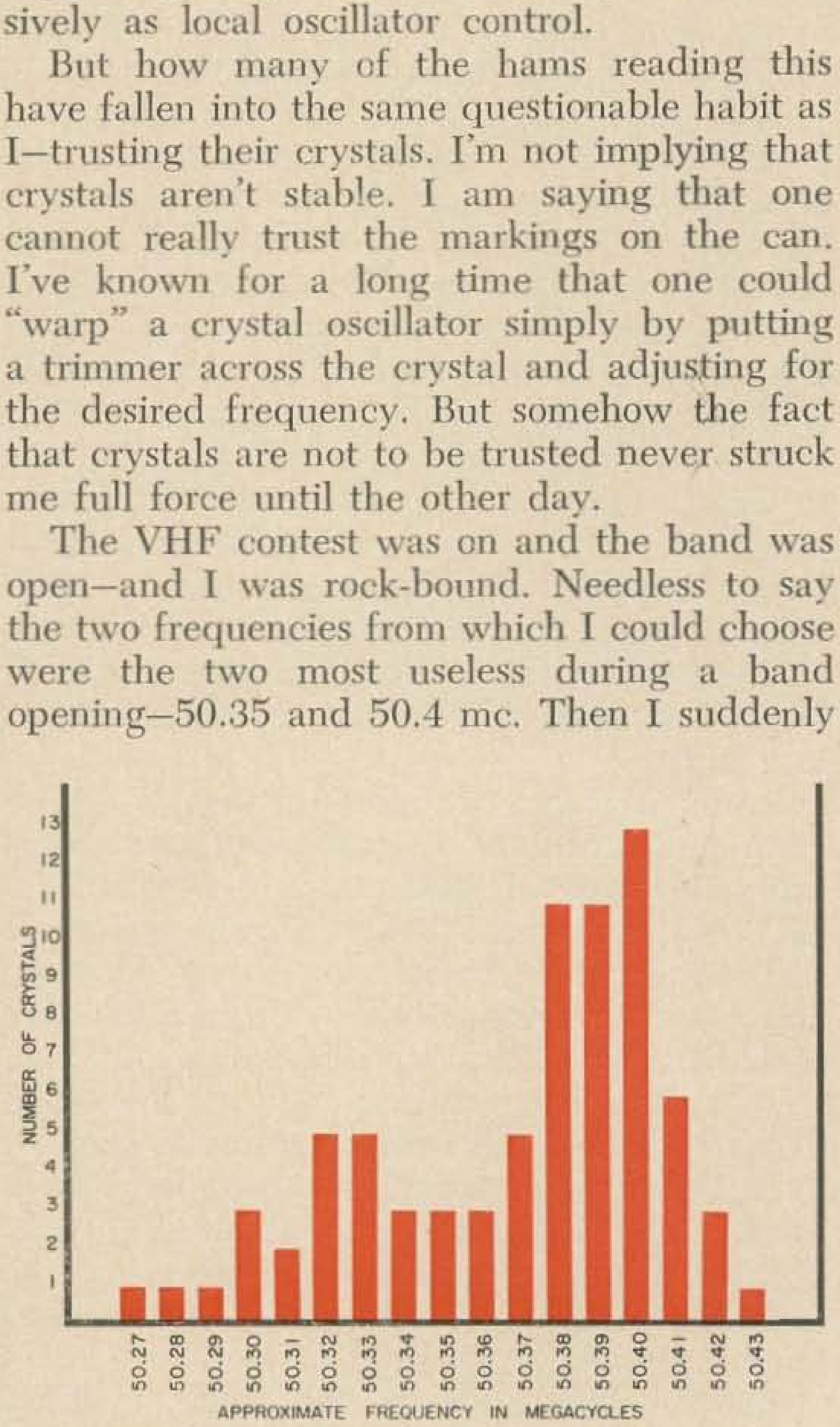
Ken Kokjer K0JXO
902 N. Gregory
Urbana, Ill.

A Word about Crystals

It's well known that crystals supply probably the cheapest and easiest method of fairly accurate (and stable) oscillator control. Most of us have used them as transmitter control at one time or another. And most of the better high frequency receivers use crystals extensively as local oscillator control.

But how many of the hams reading this have fallen into the same questionable habit as I—trusting their crystals. I'm not implying that crystals aren't stable. I am saying that one cannot really trust the markings on the can. I've known for a long time that one could "warp" a crystal oscillator simply by putting a trimmer across the crystal and adjusting for the desired frequency. But somehow the fact that crystals are not to be trusted never struck me full force until the other day.

The VHF contest was on and the band was open—and I was rock-bound. Needless to say the two frequencies from which I could choose were the two most useless during a band opening—50.35 and 50.4 mc. Then I suddenly realized that both crystals had been picked from a batch and were marked with the same frequency, 8408.182 kc. Now a quick multiplication by six yields 50.449092 mc. Obviously neither of the two crystals I had picked were very accurate. Of course the capacitance in the feedback network of the transmitter could be warping them, but both should be warped about equally.



Frequency distribution (note to statisticians: a very rare bird, this frequency distribution of frequencies) of a number of crystals marked 8408.12 mc by the time they got to 6 meters.

I had a box of these crystals and decided to check each one. My frequency determining setup leaves a lot to be desired, but the relative frequency of each crystal was important for this determination, not the absolute frequency. I used my 6 meter receiver setup (International converter into a BC-455) to monitor the 6 meter signal from the oscillator-multiplier chain of my transmitter.

These crystals are military surplus units in the HC-6/U package, and with a string of numbers like 8408.182 I figured that all would fall within a kilocycle or so after multiplication. But let me show you the figures.

After testing the lot I was able to set myself up with a series of crystals which I marked in 10 kc increments continuously from 50.27 mc to 50.43 mc. In all I checked 77 crystals over that range. The total results are presented as an histogram.

If you, like I, hadn't been convinced before, perhaps these figures will help you. Perhaps the lot of crystals which I happened to have are typical, but had they been near the band edge, and had I put them on without checking I would have been outside the band. Just take a second thought before you blithely slip that crystal in the socket and call CQ.

. . . K0JXO

Ed. note: The distribution of the curve hints that the oscillator circuit K0JXO used presented an excessive capacitance to the crystal. However, another circuit would likely produce similar results except that the values would cluster around a different frequency.

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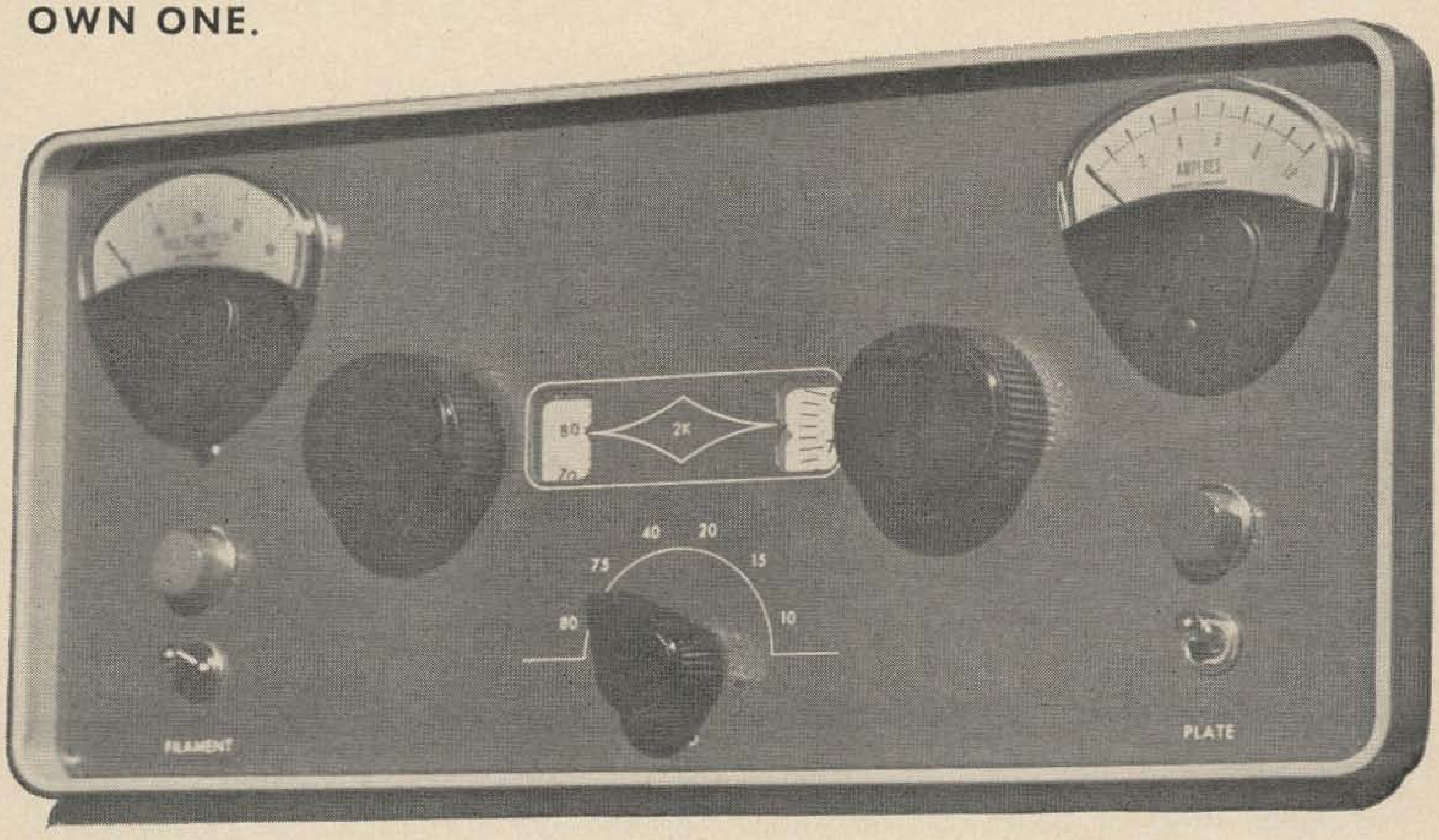

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The Design of Parabolic Reflectors

For serious amateur moonbounce experimental work, one must have an antenna that provides a very narrow beamwidth plus adequate gain. The ultimate array for the EME circuit on frequencies of 70 cm or above is the parabolic. With an aperture of just 10-15 wavelengths at the operating frequency, a beamwidth of 4° or better can be readily achieved. Below 70 cm the size of the parabolic required to allow its capabilities to be fully employed is the limiting factor for the average amateur.

Unless you're fortunate enough to come across a "dish" that has been scrapped by a radar station in the junkyard, you'll more than likely have to roll your own. The following will provide you with the info that you need to do just that—design and construct your own parabolic reflector.

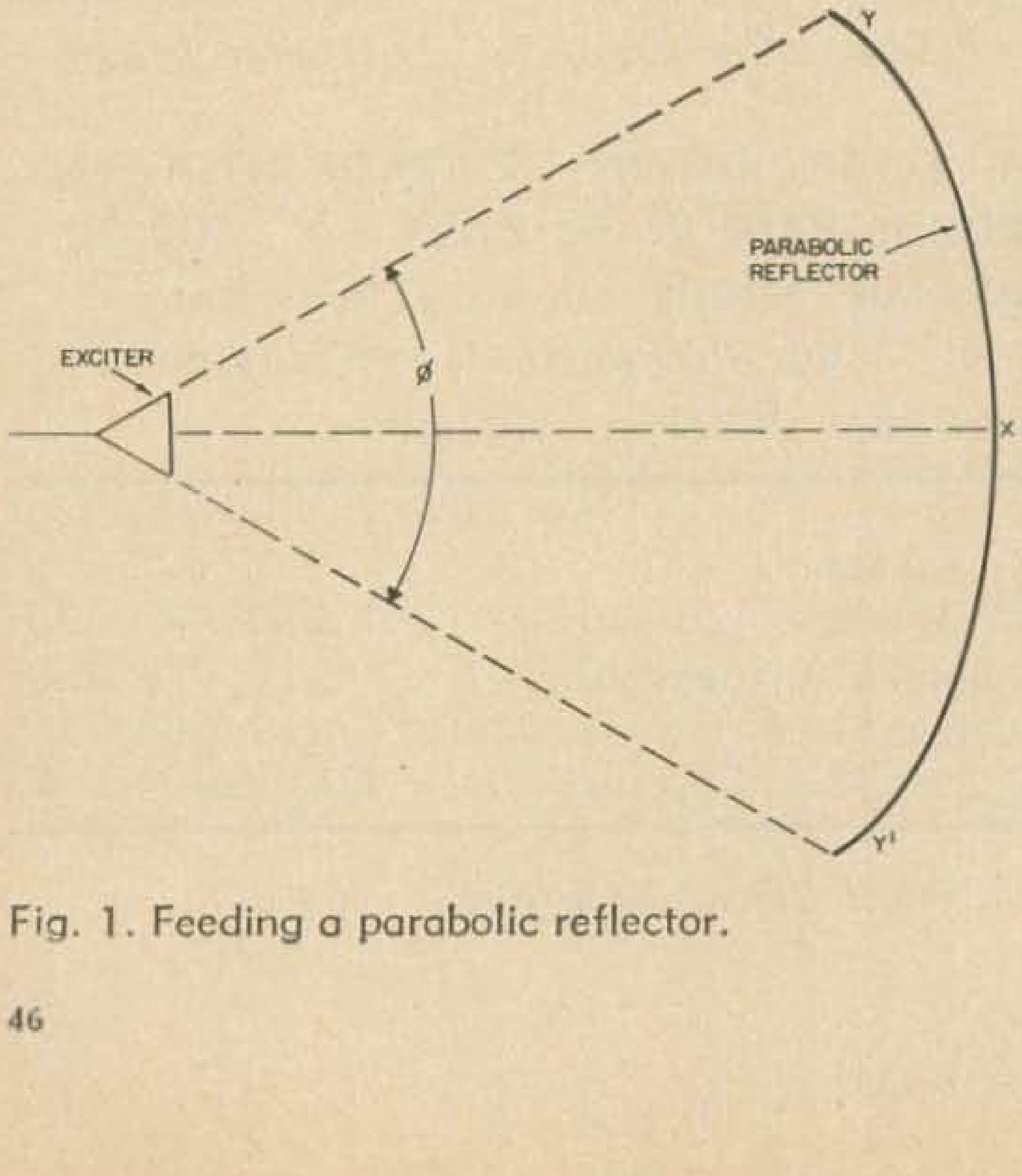

Fig. 1. Feeding a parabolic reflector.

First of all, let's get some facts straight about the parabolic. The parabolic does *not* follow the curve of a circle as so many believe. We can easily confirm this by comparing the equation for a circle to that of a parabolic curve. The equation for the former is $F^2=Z^2+Y^2$ while the parabolic follows the equation $Y^2=4FZ$ (where Y and Z are rectangular coordinates and F is the focal distance). Granted, when viewing the cross-section of a small parabolic one could not detect much difference, if any, between it and the curve of a circle with the human eye. It is only on larger parabolics that the difference is readily apparent.

The focal length for a given parabolic is a constant; it does *not* vary with frequency. Concerning the actual parabolic contour when designing the array, the focal length should be selected to fit the primary feed pattern. Short focal lengths are used with the less directive feed systems while the longer focal lengths are employed with the more directive feed systems to obtain the most efficient aperture illumination.

Depending on how directive the feed system is, the focal length will generally be in the area of .3 to .6 the diameter of the dish D^2. The formula for finding the focal length and a given parabolic is: $\text{F.L.} = \frac{D^2\ (\text{ft.})}{16d\ (\text{ft.})}$ where D is the diameter of the dish and d is its depth. This formula will be most useful as a check on calculations after the parabolic curve has been calculated.

The parabolic reflector can be excited in various manners. The most commonly used feed systems in amateur circles is the dipole; either the asymmetrical or slot-disc version (the reader is referred to "Pulse: A Practical Technique for Amateur Microwave Work," April, 1963, *QST* for details on a typical slot-disc dipole feed system). Of course, waveguide can also be used to excite the parabolic but it has the disadvantage of being bulky and difficult to work with. If you are interested in a waveguide system, you might refer to K5JKX's article in April, 1964 73 Magazine entitled "Waveguide Simplified." It should supply you with a lot of useful and interesting info on the topic.

The antenna feed must be placed at a point from which all reflected waves from the parabolic will be parallel. The center of the feed is placed in the reflector so that it is an integral number of half-wavelengths from the vertex and as near as possible to the focal length to obtain maximum gain. The antenna pattern of the feed is such that at the edges of the dish, the feed radiation is 10 db (10 times) down from the radiation at the center of the dish. (See **Fig. 1**).

The energy at points Y and Y should be 10 db lower than at point X. Thus, the feed antenna should have a radiation pattern which would ideally look as in **Fig. 2.**

Therefore, a "shallower" dish will have a longer focus and the feed will be farther from the parabolic reflector.

The parabolic reflector can be constructed of solid or perforated material but the latter has some distinct advantages. Perforated material is much easier to work with and it also reduces the over-all wind resistance of the array. For instance, a 10 foot dish would exhibit the following wind force characteristics:

Wind Force (lbs.)		Wind Velocity
(Solid)	(Mesh)	(MPH)
32	24	10
130	95	20
300	220	30
510	380	40
700	600	50

Of course, a solid plate would make a better reflector but if the perforations are kept small the mesh will not have any noticeable effect on performance. As a rule of thumb, keep the perforations less than 1/20 wavelength in size at the operating frequency.

The reflector material should be constructed from shiny copper or aluminum which has been protected in some way from corrosion. Metals other than these are not recommended for moonbounce because of their heavy losses. Copper would be the best bet for the reflector material since it can be soldered to. This would make construction less difficult and it would also improve the mechanical stability of the array. Mechanical strength is one of the most important factors to consider when designing and constructing an array of this type; it can not be over-emphasized.

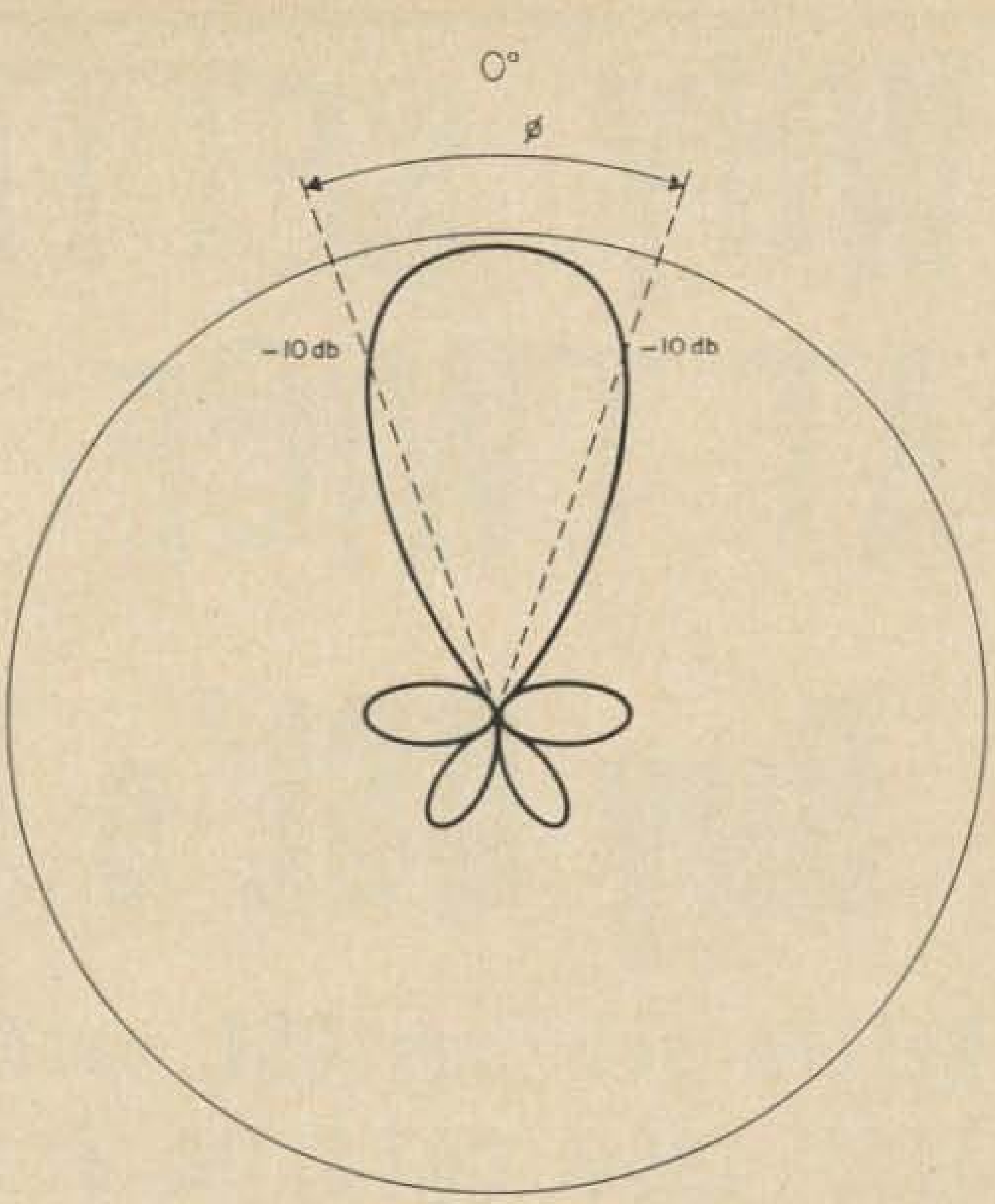

Fig. 2. Radiation pattern of a parabolic dish (paraboloid).

Now, for an illustration of how the formulas are used let's calculate some values for a 10 foot dish. The surface of the parabolic will naturally follow the equation $Y^2=4FZ$. The origin of the coordinates is at the vertex of the parabola, and Z lies along the axis (see **Fig. 3**). The primary feed is of course placed at the focal point.

Suppose we select a focal length of 4 feet for this particular dish. Y is equal to one-half the diameter of the parabolic (5 feet in this case). Z_r, corresponding to the points on the outside of the parabolic curve, is derived by substitution from the equation. Therefore, we have: $Y^2=4FZ_r{}'\ 5^2=4.4Z_r$; $Z_r=\frac{25}{16}$ or 1.56 feet. This is the depth of the parabolic reflector. The other corresponding points along the reflector are found employing the same procedure.

Now, for a check on our calculations, let's see if our Depth (Z_r) corresponds with the formula focal length $=\frac{D^2}{16d}$. Substituting the known values, we have: $4= 100 \div 24.96$ or $4=4.007$ (close enough!).

By plotting several Z values on a large sheet of graph paper, one can obtain an accurate parabolic curve. These values can then be scaled to full size on heavy paper or cardboard. This can then serve as a plan for constructing plywood formers which are used to shape the actual parabolic by securing the reflector material to it. It is best to make one-half of the parabolic at a time and then join the two sections at the hub after they are covered.

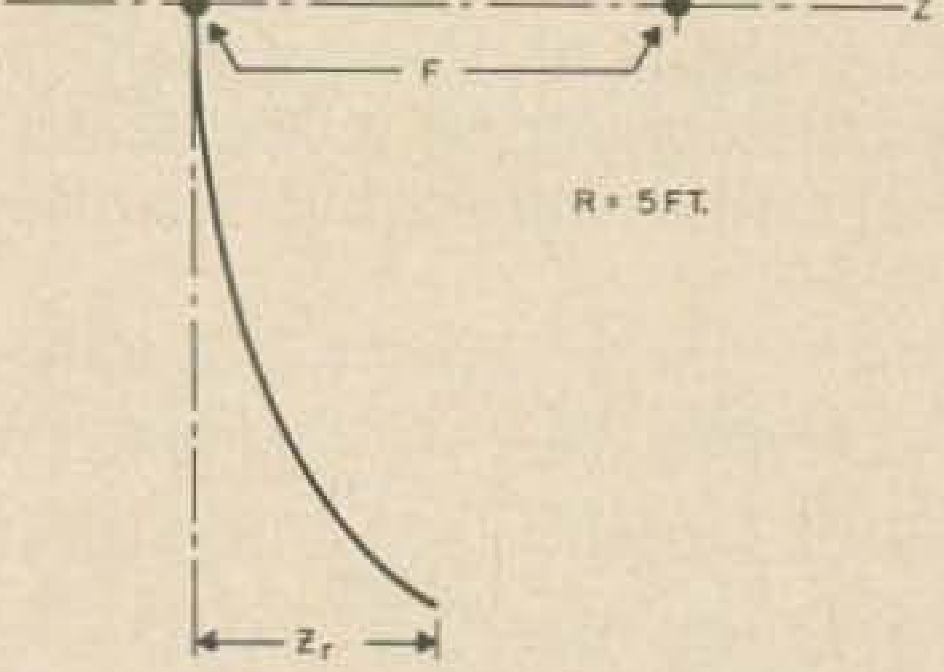

Fig. 3. Focal point of the parabolic reflector.

The gain of a parabolic can be computed from formula but it is complex and will not be discussed here. But the following chart should give you a good idea of what to expect gain wise from a parabolic.

Dish Diameter (Feet)	Gain in db over dipole Frequency (Mcs.) 144	432	1296	2300	10,000
5	5	14	23	28	42
10	11	21	29	34	48
20	18	27	36	40	54
30	21	31	39	44	58
50	25	35	43	48	62

Values given are approximate and will vary some depending on design considerations and mechanical imperfections. In regards to the latter, the error should not exceed 1/16 of a wavelength at the operating frequency.

The paraboloid is the most efficient antenna that the amateur can use for serious moonbounce work in the microwaves. It is an extremely narrow-band and high gain array when designed and constructed carefully. Mechanical strength is of utmost importance because of the parabolic's high wind resistance. With the present state of art in the micro wave region, it can make the difficult EME circuit much more feasible for today's advanced amateur. . . . K3PBY

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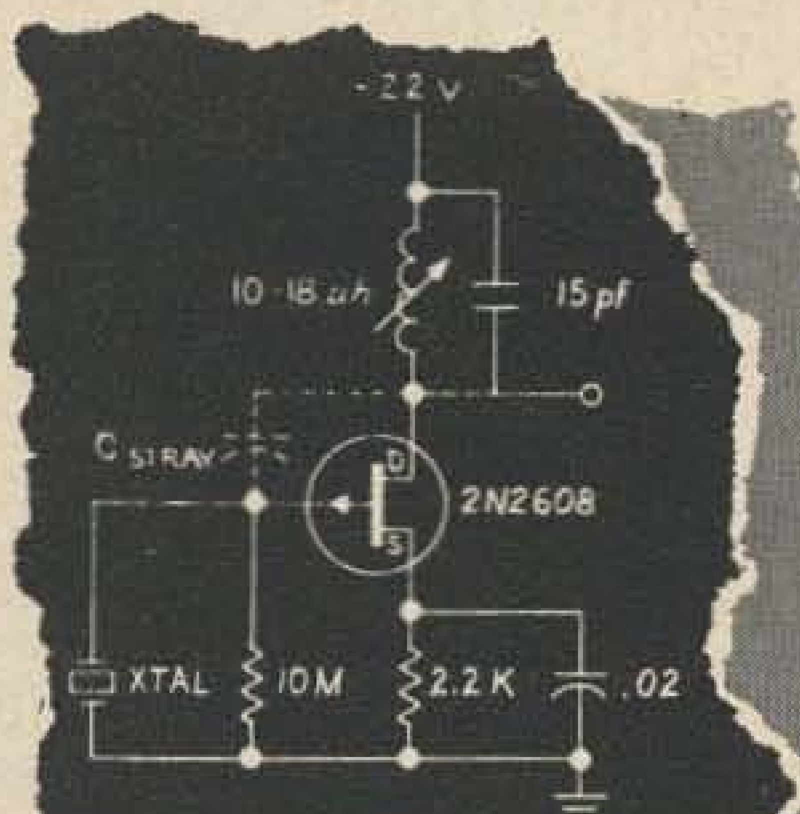

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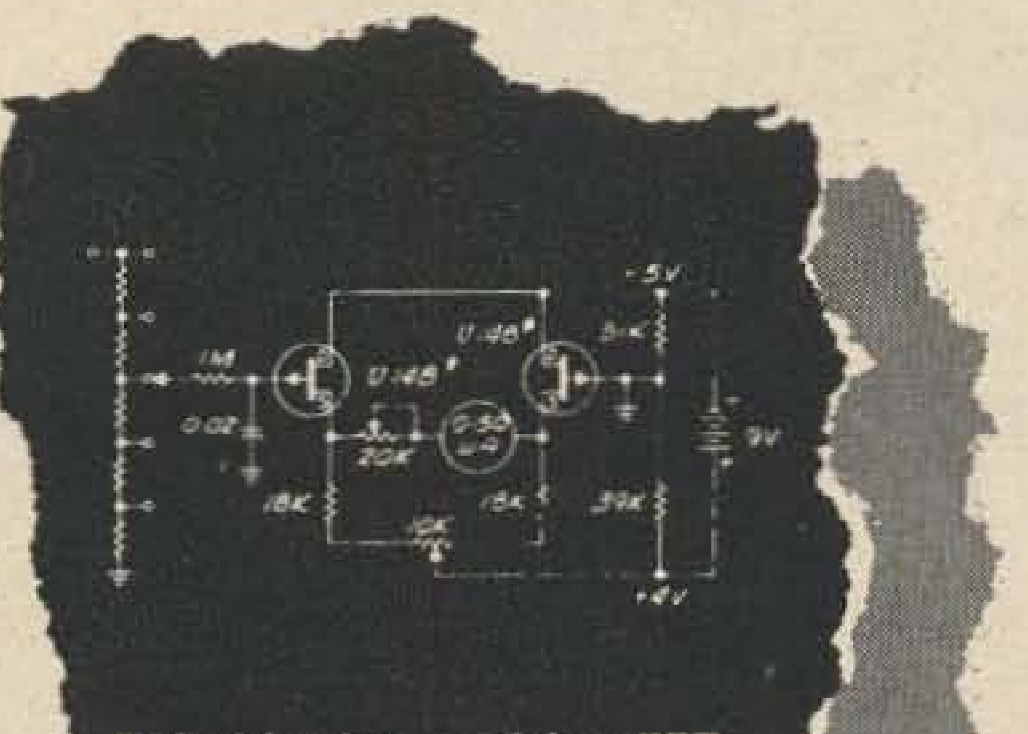

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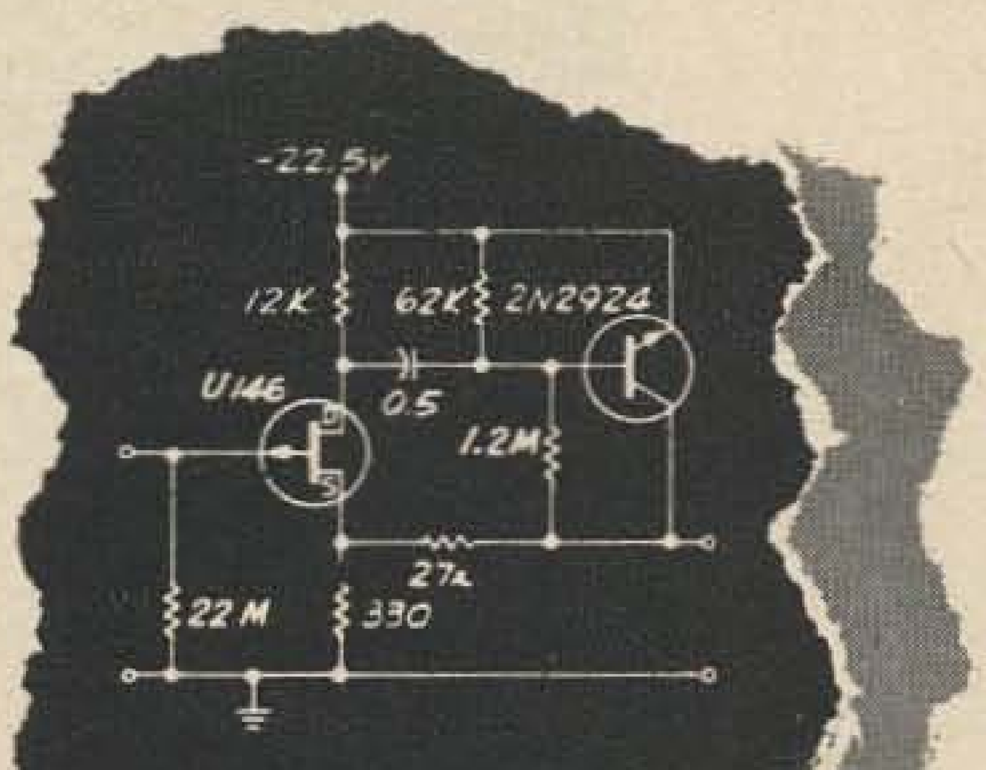

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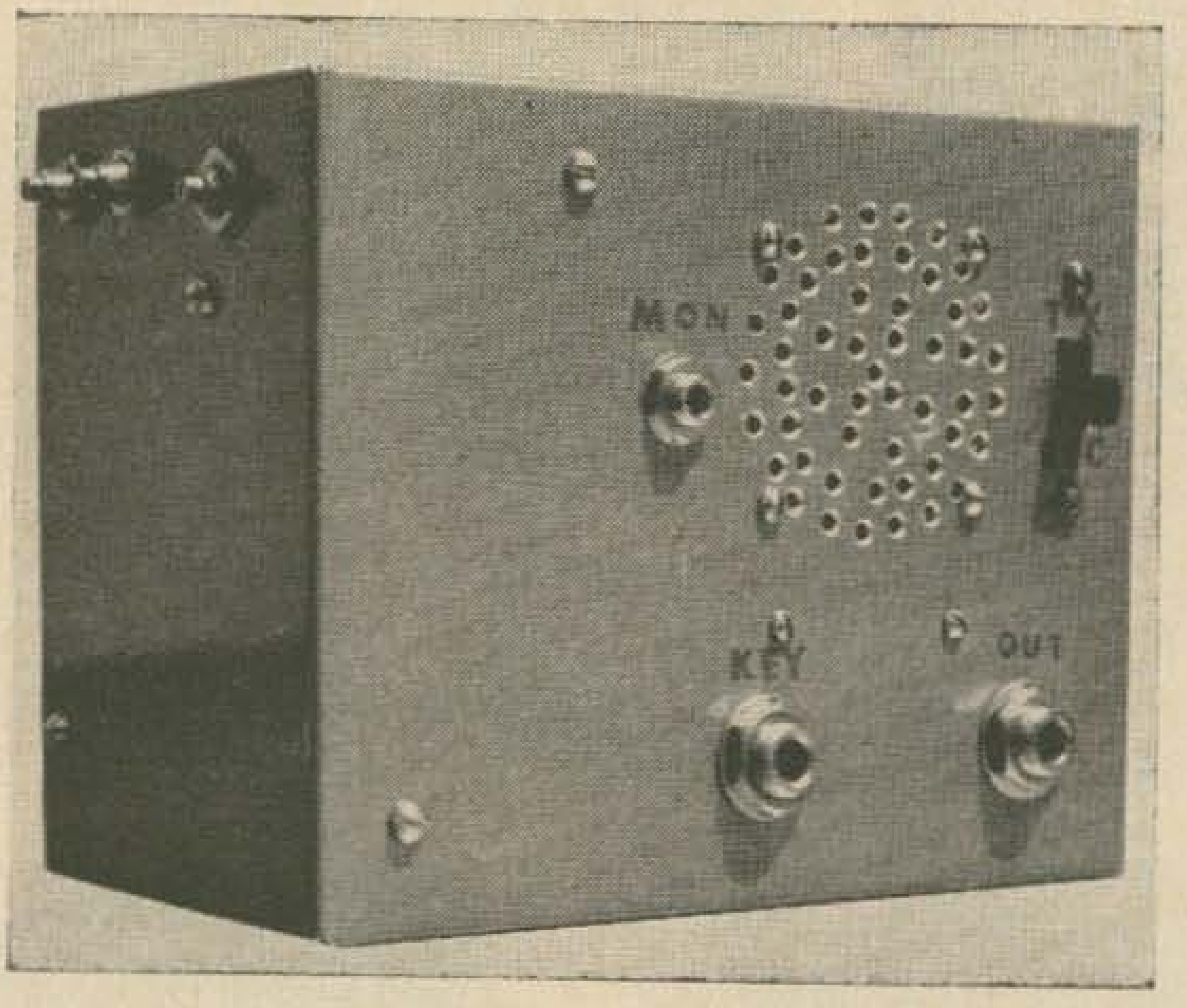


John Sury W5JSN
3013 Valerie Court
Arlington, Texas 76010

Transistorized CW Adapter

Use your SB-33 or 34 on code

Do you want to get on CW with your SBE-33's or 34's or some of the other types of SSB transceivers? Try this easy way with a built in monitor which should not cost over $10.00. Some amateurs with a well stocked junk box will get off with less. This could be a way to improve your proficiency on CW if you have a keyless rig like the author's. By using the adapter with a good suppressed carrier rig like the SBE's, the end result is A-1. On the air checks were made with Dick Scott WA5HPZ. His remarks were, "It is clean and sure sounds good." He has an SBE-33.

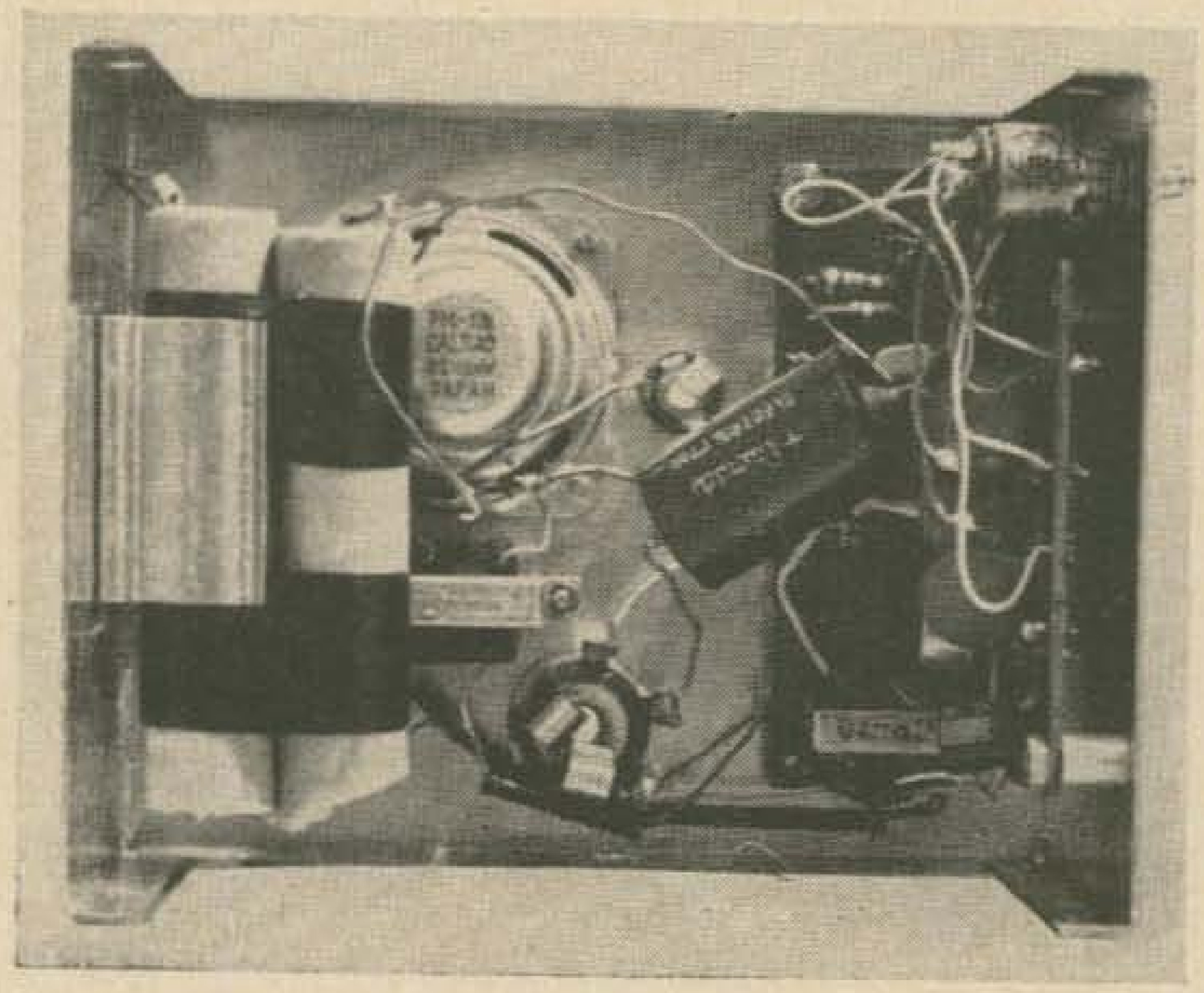
Oscillator

The heart of the adapter is a phase-shift oscillator that produces a pure sine wave with very low harmonic content. The oscillator is keyed at the emitter of the transistor. Resistors R4 and R5 or capacitors C1, C2, and C3 can be varied to change the frequency. Since it is a simpler task, less expensive and space saving to vary the resistors, this is the way the author chose to vary the frequency. It would be very nice to have dual pots of 5K each, but since one was not available separate 5K pots were used. This type of oscillator circuit is more difficult to oscillate. To obtain a good clean sine wave and good sustained oscillation a high gain transistor such as the 2N527 must be used. The reason for using a high gain transistor is because the losses incurred in the network are high. A 2N107 was tried without success.

Amplifier

The amplifier is a straight forward medium gain two stage RC coupled amplifier. Here two 2N107's will do very nicely, although a lower noise type is more desirable. The collector of the last stage is coupled to two transformers, one for coupling to the mic input of the transceiver and the other to the speaker and/or headphone output for the monitor.

Power requirements for both the oscillator and amplifier is 12 volts at 4 ma. A 12 volt battery is used in the unit so it can be used also for CW practice. Power may be obtained from the transceiver if desired.



Inside view of the CW adapter.

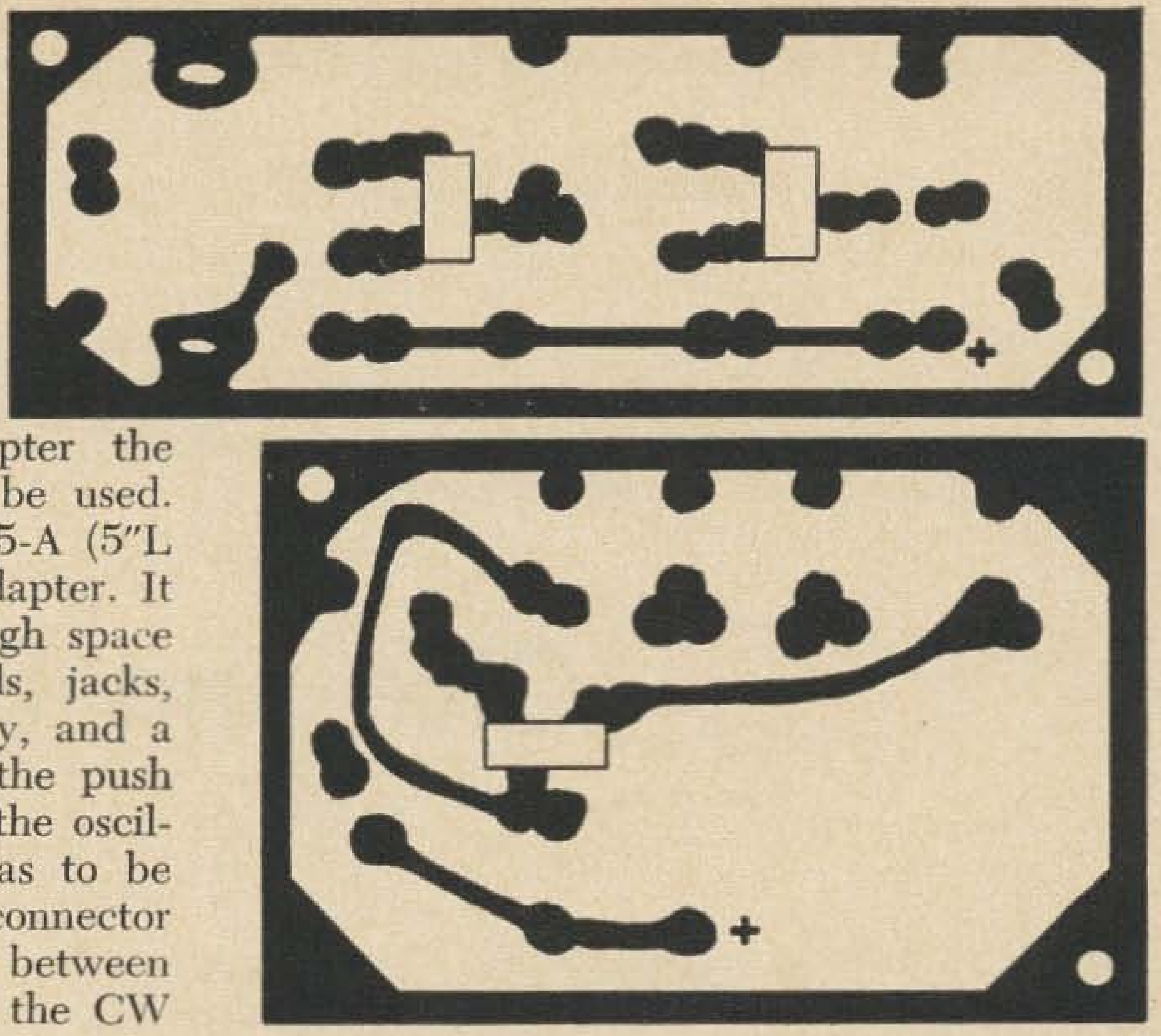


Fig. 2. Right: Layout of the printed circuit board for the amplifier. Below right: Layout for the oscillator board.

In the construction of the adapter the printed circuit board patterns may be used. These are full size. A BUD CU-2105-A (5"L 4"W 3"H) was used to house the adapter. It is not too large and it allowed enough space to install the printed circuit boards, jacks, speakers, speaker transformer, battery, and a DPST switch. The switch operates the push to talk as well as applying power to the oscillator and amplifier. The key jack has to be insulated from the mini-box, or a 3 connector type must be used. The key break is between R1 4.7K resistor and B plus. When the CW key is open there is no B plus applied to the emitter of Q1.

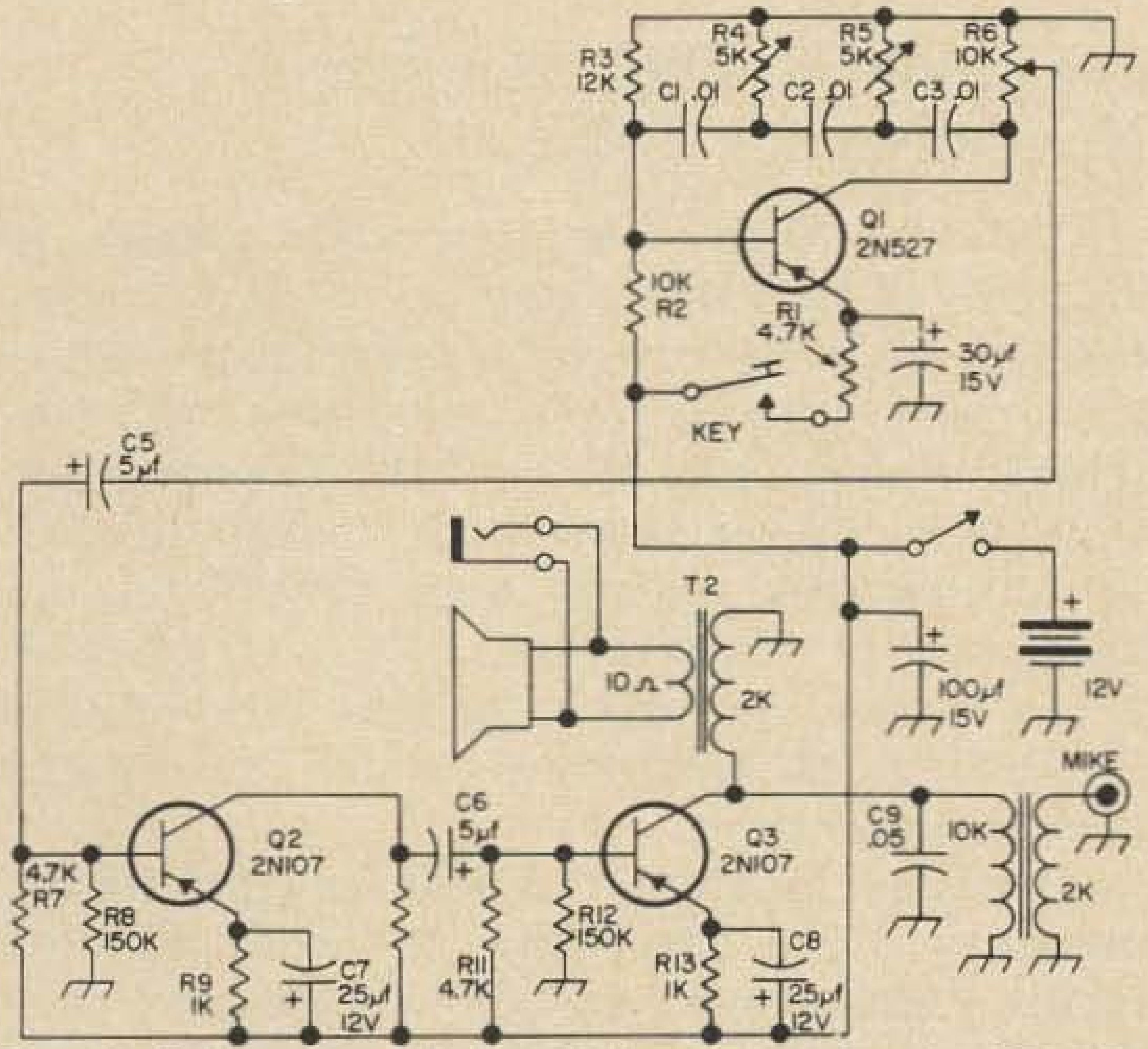
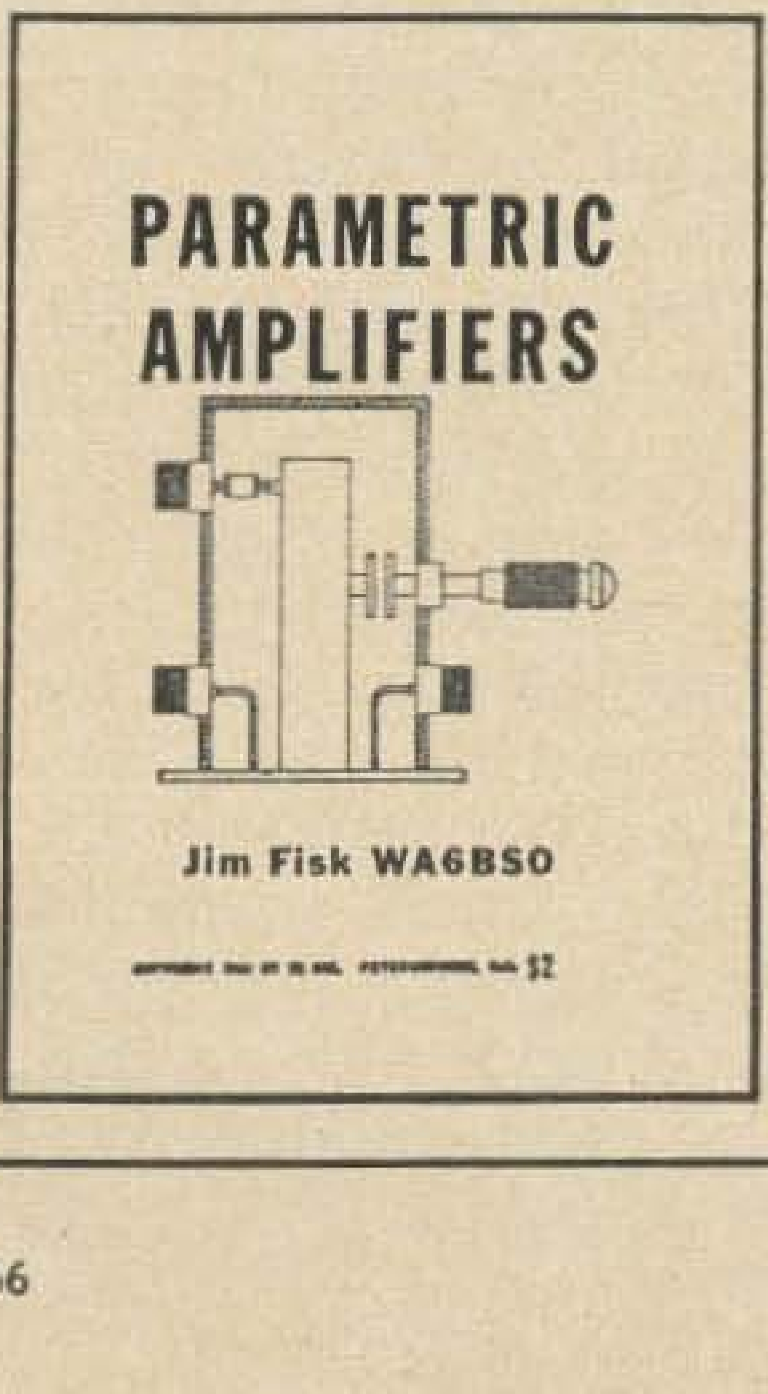


Fig. 1. Schematic of the CW adapter for the SB-33.

Adjusting the adapter is fairly simple. Adjust R4 and R5 for the best tone, or use 3.3K resistors to obtain approximately 1800 cps. Feed your SBE into a dummy load and load up on your favorite band. Set the mic gain in the same position that is used with the microphone. Turn R6 to the lowest output. Turn on the adapter, and key the oscillator; adjust R6 to a level no higher than that obtained with the microphone. The monitor output level on the earphone should be comfortable. The speaker output will be low if a speaker is used. If it is preferable to use the speaker, adjust R6 for desirable level and reduce the gain of the mic input on the transceiver.

Try the "See Dubya" adapter and listen for dah dit dah dit, dah dah dit dah, dit dah dah, dit dit dit dit dit, dit dah dah dah, dit dit dit, dah dit. . . . W5JSN



F. D. Whitmore W2AAA
223 W. Holly Ave.
Pitman, N.J.

Give and Take

International radio conferences introduced amateurs to a new interpretation of the old axiom "you must give and take to get along in this world." From the first to the last, the pattern appears the same: amateur radio can do the giving; foreign nations will do the taking.

The famous Franco-American QSO of November 1923 won for American hamdom the harmonically related bands. Things looked great: 500 kcs on 80 meters, 1000 on 40, and 2000 on 20. But they didn't last. Four and a half years later the power of the first international conference struck. Suffering radical changes, the bands then became worldwide.

Along with the band changes went the right of each nation to control amateur radio within its bounds. Granting of this control really hurt. Many a scar lies unhealed today due to a local change that affected hamdom all over the world. Will conditions get better? Will conditions get worse? Look at the results of each of the five conferences held to date. Can you find any encouragement that amateur radio will fare better at the sixth now hovering somewhere in the near future?

Meters	Remarks
150-200	Spark, CW, and Modulation
75- 80	
40- 43	
20- 22	
4- 5	

The original harmonically related bands assigned by the U.S. Government to American amateurs July 24, 1924.

Washington, D.C. October 4-November 25, 1927.

With shortwaves carrying radio signals to all parts of the world, nations needed to allocate the radio spectrum to prevent one country's radio services from interfering with another's. Regulations of the 1912 London Convention no longer sufficed. To tackle this job, several hundred people from fifty-two countries met in Washington, D.C., October 4, 1927. Within the power of this International Radiotelegraph Conference rested the fate of the amateur bands.

American amateurs looked forward to the meeting. Tired of trying to work DX on bands slightly above or below their own, they hoped for international segments that would put ham activity the world over in the same spots. The United States backed the amateurs 100%. At the conference the American delegates suggested agreement to the current American harmonically-related bands, and cited the value of amateur radio to win the countries over. *It didn't work!* Except for Australia, Canada and New Zealand, amateur radio found few friends. Most countries knew little about it and cared even less.

Shocked that the many important radio contributions by amateurs meant so little in foreign lands, hamdom watched the battle lines form. The fight lasted several weeks. Right from the start England agreed to harmonically-related wavelengths but wanted the bandwidths limited to around 100 kc. France held

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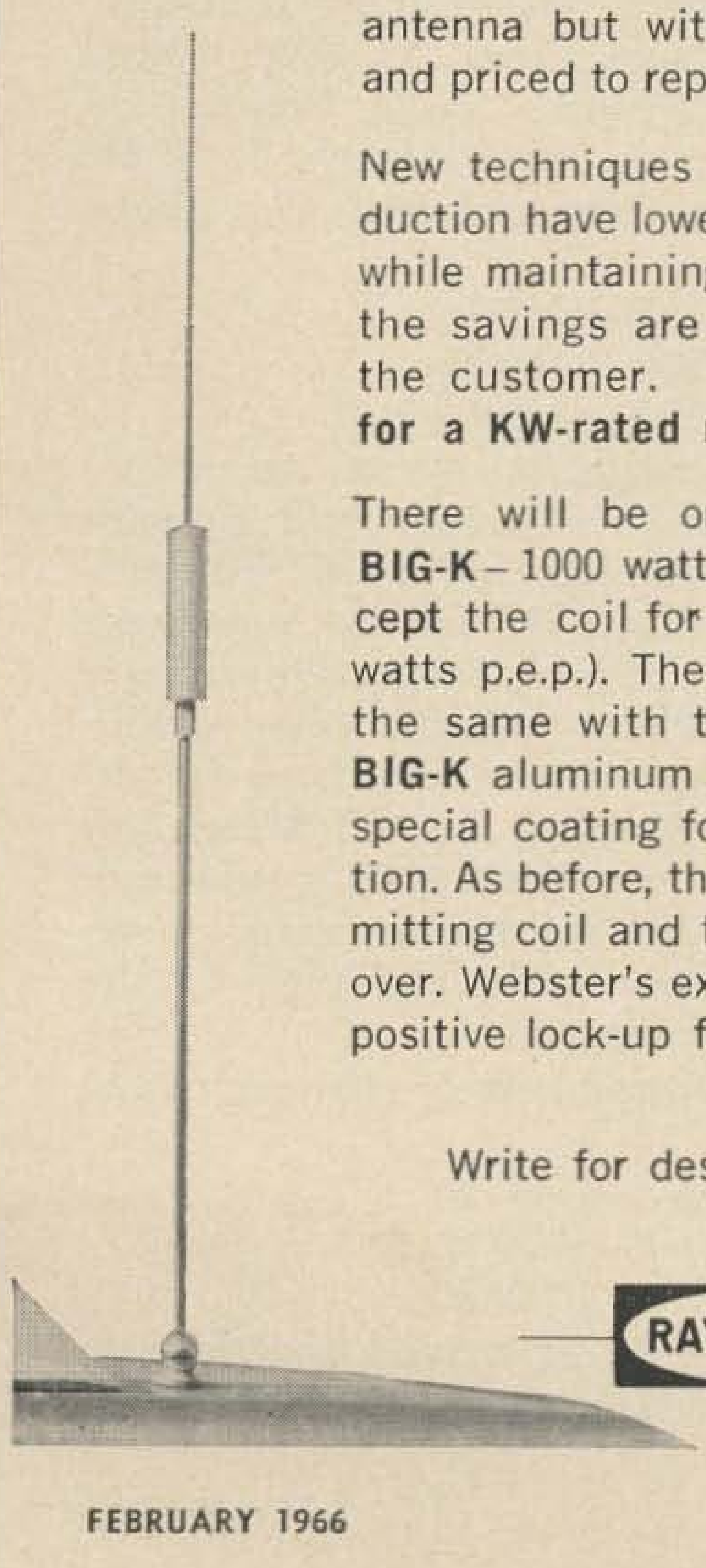

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KW-20	1 kilowatt, **20 meter coil**	**6.95**
KW-15	1 kilowatt, **15 meter coil**	**6.25**
KW-10	1 kilowatt, **10 meter coil**	**4.45**
TW-160	300 watt, **160 meter coil**	**5.80**

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Table I.

(a) The American amateur bands in effect when the international Radiotelegraph conference met in Washington in 1927.

(b) The international amateur bands set by the Washington international conference and made effective worldwide on January 1, 1929.

(a) Kilocycles	(b) Kilocycles
1500–2000	1715–2000
3500–4000	3500–4000
7000–8000	7000–7300
14,000–16,000	14,000–14,400
28,000–30,000	28,000–30,000
56,000–64,000	56,000–60,000
400,000–401,000	

out for no message handling; she wanted amateur radio limited to experiments only. Back and forth the battle raged. One moment hope; the next, despair. Only thirty days before the Federal Radio Commission issued hamdom their latest bands; now American hams stood to lose nearly everything practically overnight.

Slowly out of the turmoil 150 to 175 meters emerged for the top band. But the biggest battle lay ahead—shortwaves. Under the American plan the whole bandwidth of a higher frequency band lay in harmonic relationship to the next lower one: 3500-4000 kc doubled all the way from 7000-8000, and quadrupled throughout from 14,000-16,000. Canada, England and Germany balked. Such wide bandwidths interfered with point-to-point assignments in their countries and all refused to move a station.

At this point Italy swung to the side of the amateurs and suggested *variable* bandwidths for the bands. Opposition showed no interest. Recognizing a ray of hope in Italy's recommendation, the United States bought the Italian plan and at the same time suggested consideration of each band separately. It worked! With little difficulty the countries established 3500-4000 kc for the 80 meter band. Now the representatives girded for the real trouble spot—forty meters.

Starting at 7000 kc, the delegates worked upward. At 7200 the first road block cropped up: a German station operated there and the delegates refused to move it. Discussions stymied. To keep things moving, the United States suggested dropping 40 meters for awhile and moving on to 20. The others agreed. When it became evident that 400 kc represented the full spread possible for the 20-meter band, the countries finalized on 14,000 to 14,400 kc. Only forty meters remained. Now a change of heart by Germany removed their station and the 40-meter band moved up to 7225 kc. At this point England consented to move a few and Canada followed suit. Their moves released another 75 kilocycles letting the 40-meter band spread from 7000 to 7300 kc. Beyond that no one would budge.

The Conference adjourned November 25, 1927, after setting January 1, 1929 for the effective date of the agreements and designating Madrid, Spain, as the host city for a second international radio-telegraph conference. As a result of the eight-week struggle: amateur radio obtained international recognition, hams got worldwide frequencies including the 10-meter band, and our present "Q" signals emerged. Each nation reserved the right to fix the power of amateur stations, and to permit or prohibit hams as it desired. *All countries could withhold any or all bands from the hams.* International amateur message traffic could not occur unless special arrangements existed between the nations involved. And, amateurs received identifying prefixes for their calls. Table I compares the international bands with the then current American bands.

Madrid Spain. September 5-December 9, 1932.

Recovering from the shock over loss of big chunks of their favorite DX bands at the Washington conference—1600 kilocycles on 20 meters and 700 on 40—hams naturally cast wary eyes on the Madrid conference scheduled five years away. What, they wondered, would they lose next time? As they waited and fretted, the Federal Radio Commission opened the 10-meter band March 7, 1928, and at the same time changed the phone bands:

1715–2000 kc
3500–3550 kc
56,000–64,000 kc

August 3, 1928, brought television and picture transmission to the 160-meter and 5-meter bands. Two months later (October 1st) prefixes joined our calls: "W" for the mainland; "K" for territories and possessions. On January 1, 1929, America along with the other nations swung over to the international ham bands. However, in addition, the United States still retained the ¾-meter experimental wavelength (400,000-401,000 kc) for the amateurs—a region not considered by the delegates at the Washington conference.

April 1, 1932 brought more changes to the phone bands:

1875–2000 kc
3900–4000 kc
14,150–14,250 kc

Then December 9, 1932, arrived and the amateurs breathed a sigh of relief. The foreign try to juggle amateur frequencies again failed. Five years of fretting for nothing. The Madrid verdict: No change to the ham bands; and, increased amateur stature by designating amateur radio a service thereby removing it from the "private experimental station" category. But with the good news came some bad: *Another international conference scheduled for Cairo, Egypt, in 1938.*

Cairo, Egypt. February 1-April 8, 1938.

Amateur luck ran out after the Madrid conference. From then on, hams not only fretted, *they sweat!* The Cairo conference dropped the first bombshell: *foreign shortwave broadcasting allowed in the forty-meter band!*

A year before the conference, participating nations received from the Berne Bureau in Switzerland their copy of a book containing the changes each country intended to bring up. The Berne Bureau compiled these from information supplied by the nations approximately six months before. Getting wind through the agendas of pending disaster, seventeen countries in the Americas met in Havana in the Winter of 1937 to consolidate amateur policy in the Western Hemisphere.

By unanimous vote, this Inter-American conference voted to keep all the bands from 1.75 to 60 mc exclusively amateur in their countries and recommended 7-, 14-, 28-, and 56-mc for exclusive amateur use throughout the world. The conference also agreed to change the 160-meter band to 1750-2000 to eliminate non-harmonic overlap, to allow a forty-meter phone band at 7050-7150 for Latin America because terrific static in those countries made phone operation impossible on the lower bands, and to permit 14,000-14,300 mc phone for Latin America, Canada and Newfoundland though the United States elected to continue 14,150-14,250 for American hams. Before adjourning, the Inter-American conference agreed to meet regularly midway between the international conferences, and designated Santiago, Chile, for their next meeting. Two months later the United States entered the Cairo conference armed with the Western Hemisphere decisions and designated spokesman for the Americas.

European and Orient nations lay in wait with heavy artillery, all pointed at amateur frequencies. Organized into combines of like interest, these countries with their government radio monopoly demanded large chunks of the ham bands for broadcast and aviation. Japan even wanted to cut American power. The United States stood pat. "No!" Unable to achieve their aims through debate, the European nations pulled rank according to their rights under the Washington agreement and took sizeable segments from the ham bands. When the smoke lifted from the battlefield, amateur casualties lay exposed: 7200-7300 kc lost to foreign broadcasting; 3635-3685 gone too; and part of 5 meters set aside for other interests. In the Western Hemisphere the bands stayed intact. But, actually, the Americas lost too. Strong foreign broadcasts render much of forty meters unuseable at night.

Before the Conference closed, the delegates adopted America's QSA 1-5 and QRK 1-5 signal strength and readability scales, and changed the International Morse code. (Because telegraph printers of some companies rendered a period as three I's, the Telegraph Conference meeting jointly in Cairo asked the Radio Conference to concur with a change making the symbol for a comma a period, and the exclamation-point symbol a comma). The effective date: September 1, 1939.

Atlantic City, New Jersey. May 15-October 2, 1947.

Between the Cairo and Atlantic conferences, amateurs received numerous band changes from the FCC. See **Table II.** Then the fourth international conference convened. World War II caused the Conference to meet at Atlantic City in 1947 instead of at Rome as planned in 1942. Hams rejoiced. With it once more on home territory, they expected to recoup all their losses. Five months of wrangling followed. At the end, instead of expanded ham bands or foreign commercials knocked out of forty, amateurs lost 50 kc at the high end of twenty and 300 more at the top of ten. Fortunately gains came with the losses. Amateurs

Table II.

Highlights among the pleasantries the FCC allocated to American amateurs during the years between the Cairo and Atlantic City International Conferences.

Frequency		Date
58.5–60 mc	Opened to FM voice	April 13, 1940
28,100–30,000 kc	Designated A-3	July 9, 1941
29,250–30,000 kc	Opened to FM	July 9, 1941
7250–7300 kc	Opened to unrestricted A-3 (U.S. entered World War II following day)	Dec. 20, 1941
114–148 mc 2300–2450 mc 5250–5650 mc 10,000–10,500 mc 21,000–22,000 mc	New Bands opened	Nov. 9, 1945
420–450 mc	1st 10 mc only opened	Jan. 16, 1946
1215–1295 mc	Opened	Jan. 16, 1946
235–240 mc	Opened	March 13, 1946

received as a pacifier the 21 mc band 450 kc wide for their use alone, and picked up internationally the bands above 225 mc. American hams retained 80 and 40 meters intact; foreign hams lost a little more in each. The 21 mc band and the cut in 20 meters became effective in mid 1952.

Geneva, Switzerland. August 17-December 21, 1959.

Following World War II, hams slowly got their bands back. From time to time changes came too. The special license requirement to operate 80 and 20 meter phone disappeared February 18, 1953; forty meter phone opened without restrictions two days later; and the following month the FCC allocated 21,250-21,450 mc for phone. In April 1958 the 3300-3500 mc band shifted to 3500-3700. Four months later, the August calamity hit: hams lost 11 meters to the Citizens!

As the Geneva convention approached, the proposals of participating nations arrived. Hamdom shuddered. One glance showed the magnanimity of the task ahead. Faced with such an attack, how could the United States delegates save hamdom at home let alone help the international hams? The proposals:

1800-2000 kc. India, Poland and Russia wanted to delete amateurs from this shared band.

3500-4000 kc. Argentina proposed splitting the band in our hemisphere giving lower half only to hams. In region III, Australia proposed only 3500-3700 for amateurs. India proposed a maximum of 10 kc for hams somewhere in the lower portion of band. The USSR thought 3500-3650 still shared with government and commercial fixed and mobile stations would be adequate for the hams.

7000-7300 kc. Australia, Poland and USSR proposed 7000-7100 for the hams. (i.e. deletion of present amateur sharing of 7100-7150 outside our hemisphere). India wanted only 7000-7075 for hams. Austria, Belgium, France, Italy, Morocco and Netherlands proposed that Western Hemisphere nations conform to the agreement in the rest of the world and take the top half of the band away from our amateurs with 7100-7150 also available to broadcasting but shared with the hams. Ceylon, Ethiopia, Ghana, Libya, Malaya, Morocco, Pakistan and Tunisia joined in proposing 7000-7100 amateur; 7100-7300 broadcasting worldwide.

When the Geneva Conference convened, the United States delegation consisting of about 100 persons—30 official government delegates, around fifty industry consultants or advisors, and an office staff of twenty—stood their ground for amateur radio, a voice weak in the din of international opposition. Unable to sway their opponents, the American delegation could only watch as foreign nations robbed their amateurs once again. On eighty, our representatives saved the full 500 kc for the United States hams. Elsewhere, each country shared the band to suit themselves with other services. Forty meters stayed put for us too. But not for foreign hams. They lost another 50 kc to the "other interests". Now only 7000-7100 kc remained amateur. Twenty and 15 meters escaped unscathed internationally as also did 10. And, while 50-54 mc stayed exclusively amateur here and in Region III, it received no general allocation in Europe and the Mediterranean countries of Region I.

Where do we go from here?

Any day now announcement of the next international telecommunications conference may come. Probably soon. New nations need frequencies and the satellite era requires communication control. Will amateur radio lose again?

Before the date set for a conference, nations taking part submit suggestions for revising or expanding the present treaty. A short time later, each receives a copy of the submitted recommendations. From then until conference time, countries analyze each others' aims and decide which to support or oppose. To reach such conclusions, the United States government draws from government services, industry and the amateurs.

Knowing that international conference number six lies ahead, let's make sure the United States delegation knows our wishes. If you don't care to contact your Senator or Congressman, remember, the Institute of Amateur Radio (IoAR) exists and will try to do it for you. Apathy will get us nowhere; concerted action will.

Sometimes our delegates must veer from amateur wishes concerning one band to secure better results in some others. Horse trading. That happened at Cairo on forty. Though it spoiled one DX band, it saved the others. Naturally we must live and let live amidst a spectrum that apparently won't stretch. However, let's not make it easy to be robbed. Foreign countries need strong amateur organizations to develop strong electronic industries. Until the International Amateur Radio Unions get this across, our DX bands await a fate similar to the article by an auctioneer's side: Going . . . Going . . . GONE!

. . . W2AAA

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	300-Q	144-148	14-18	$12.95 ppd.
6M	300-B	50-51	.6-1.6	$12.95 ppd.
	300-C	50-54	14-18	$12.95 ppd.
	300-J	50-52	28-30	$12.95 ppd.
20M	300-G	14.0-14.35	1.0-1.35	$11.95 ppd.
CB	300-A	26.965-27.255	1.0-1.29	$11.95 ppd.
WWV	300-H	5.0	1.0	$11.95 ppd.
Int'l.	300-I	9.0-10.0	.6-1.6	$11.95 ppd.
CHU	300-K	7.3	1.0	$11.95 ppd.
CHU	300-L	3.35	1.0	$11.95 ppd.
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Aircraft	300-N4	121-122	.6-1.6	$13.95 ppd.
	300-N5	122-123	.6-1.6	$13.95 ppd.
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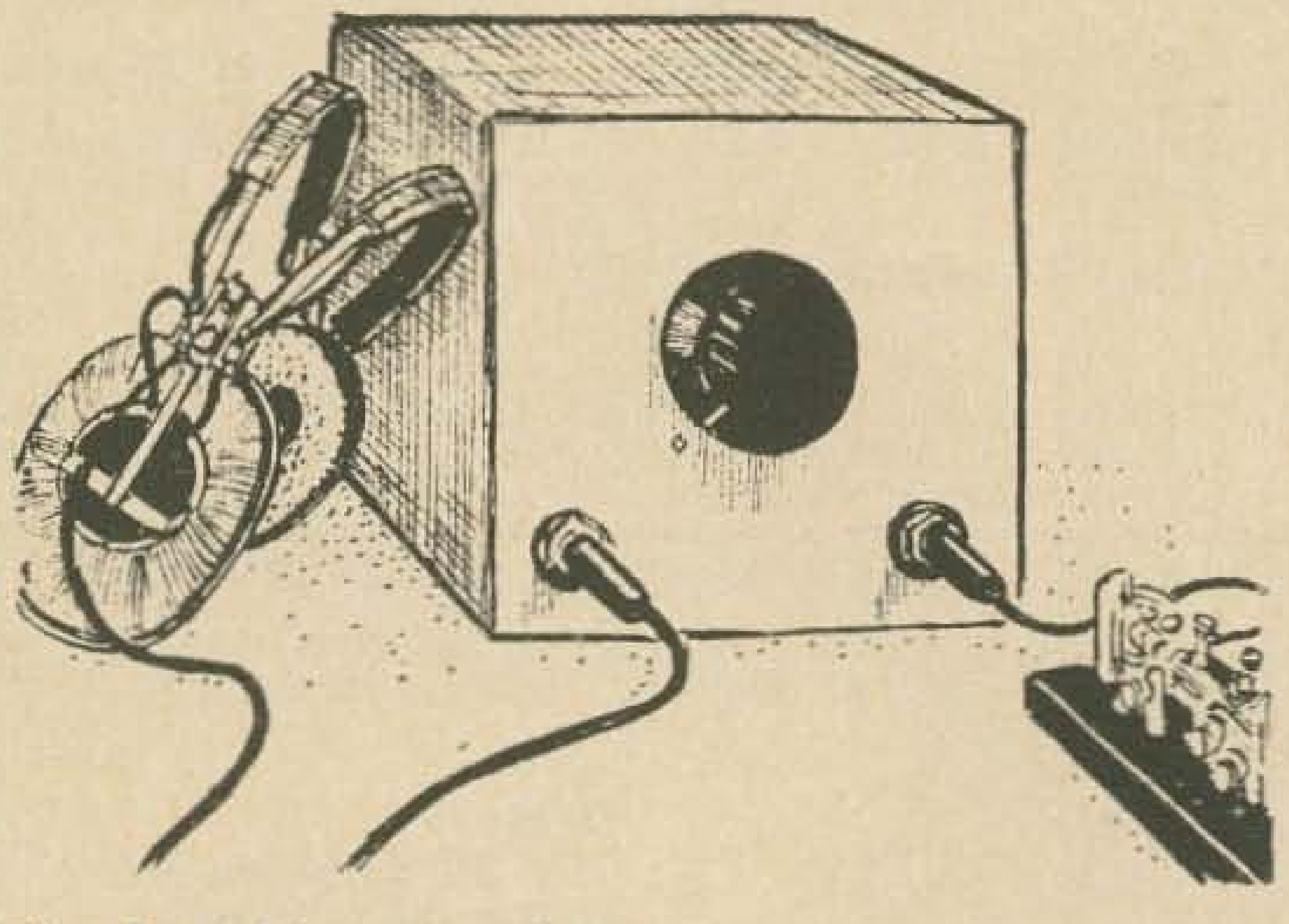
Drawings by Wayne Pierce K3SUK

The Zero Meter Band

Back in the October 1964 issue of 73 Magazine, you may have noticed a small ad inserted on page 86, announcing the attempted unloading of mountainside premises somewhere in New Hampshire, complete with a considerable selection of antennas. Within that tempting array, your eye may just have skipped over the fact that it included, and I quote, "Hy-Gain Tri-Bander for O-15-10M." Even if you did happen to notice the peculiar specs on that antenna, almost certainly your eye slid over it, thinking it no more than another of the many typographic atrocities perpetrated by the perenially sloshed typesetters up there on that N.H. hillock, what with it being cider season and all. Only a few insiders were aware of the fact that it was quiet notification by the editor that the old Zero Meter Band was open again.

It was many years since I'd been on Zero the last time, with my original call, and the idea that the band was opening up again naturally brought back many nostalgic memories of old-time operating before the government not only closed it down early in 1942, but confiscated every bit of equipment known to be in private hands.



The Zero Meter band rig.

I never did hear after the war that Zero was open again. The regulations said anything above 40K megs was okay, but I was sure that didn't mean Zero. Mainly because I'd heard stories during the war about the experimental work the government was doing with Zero Meter Radar, and I figured that in the slather of stuff that was ultra top secret afterward they'd included Zero. I didn't want to ask, you know how it is, not making waves and all that. Nobody wants any 3 a.m. visits from conservatively dressed types wearing snap-brim hats wanting to know just how much I knew about Zero Meters, and where I'd learned it, and exactly what was it I talked about to the foreigners on my private radio station. That sort of thing.

Now I figure they must have given up the experimental work because of troubles like the ones I did hear about. There was a fairly well substantiated story that they did work out the antenna problems and get just one Zero Meter radar station working somewhere in England. Up to then they'd been working with stuff as long as ten meters, and were slowly finding out that the shorter the wave, the greater the definition. Naturally, with the zero wavelength on Zero, the definition would have to be pretty good. According to the story, when they fired up the rig and pointed it at a wave of bombers coming in, it was so good they could read the dogtags on the German aircrews. Used to scare the hell out of the Luftwaffe high command by broadcasting back to Germany not only the names, ranks and serial numbers of everybody on a mission, but even their blood types.

Either that last touch finally tipped off German intelligence, or their agents in Eng-

Zero Meter radar was set up in England.

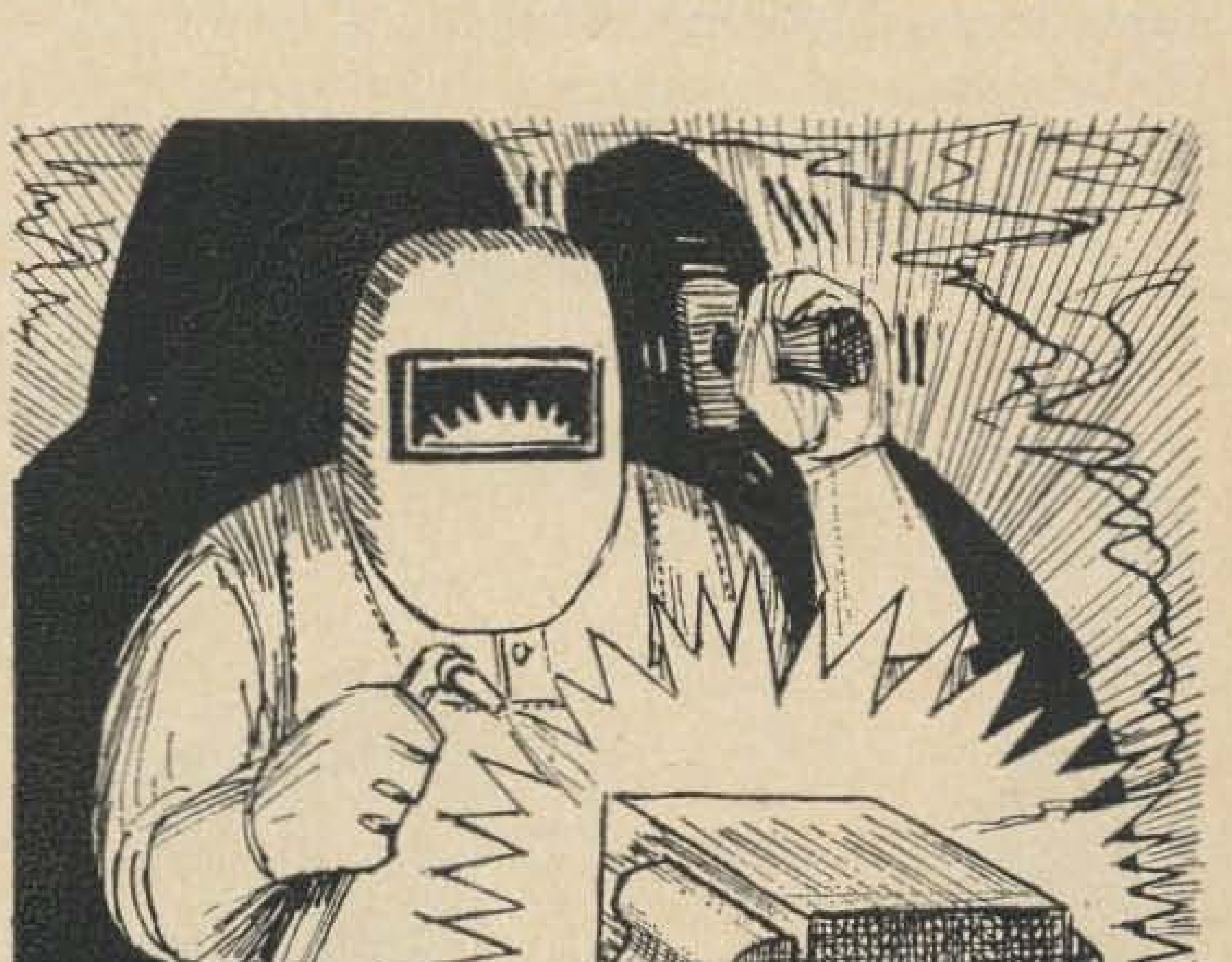
land got wind of what the installation could do, and they pulled a real cutie. Late in '43, I think it was, they sent over a special flight on a bombing run. Had to search all through the Luftwaffe and Wehrmacht for them, I think, but every man Jack of the two thousand crewmen on that flight was named Schultz, rank Feldwebel, blood type AB. Naturally when that list went up to G2 from the Zero Meter Radar crew, some brass-brain upstairs decided the thing must be on the fritz and ordered the techs to take apart the Blue Box. They protested, of course, but orders are orders, so they cut it open with a welding torch. As any of the old civilian Zero Meter ops could have told them, that was the end of that. Whatever was inside was melted into a few droplets of slag by the time they could make a big enough hole to shine a light in, and that was the end of Zero Meter Radar. At least that's the story I got from guys who were near the project.

That was one of the most frustrating things about Zero—those Blue Boxes. You read a lot these days about how sad it is that everybody is an appliance operator and that there's hardly any homebrewing any more like in the old days. There wasn't any homebrew equipment on Zero at all. Everybody I ever contacted on the band was working with the same old Blue Box. As far as anybody knew, they were all World War I surplus rigs; at least we all found ours the same way, knocking around in the junk piles at the backs of the WWI surplus stores. They never did get in the catalogs, because the store operators fortunately didn't know what they were.

It wasn't surprising either, because a Blue Box didn't look like much. It was a small box about six by six by ten, with a dull blue-black crackle finish. There was only one knob on the front, a jack for a key, another for phones, and an antenna terminal on the back. No label, no brand name, nothing. Just a plain Blue Box, except for the peculiar business about there being no sheet metal screws or rivets, or any way at all to open it up.

Some of us tried, of course. Any ham would be curious about the circuit and components that could handle that kind of frequency. But drill bits got blunt and hacksaws didn't seem to have any effect, so we gave up on that angle and just operated. We all heard about the guy who couldn't take not knowing and went at his with the blowtorch. He never showed up on the band again. Just like with the radar unit, when he got it open he found everything inside melted down. One of us—I don't remember now exactly who—got a postcard telling what happened, and about how he was looking all over the country for another Box, but he apparently never did find one.

We had to admit that the theory of it was beyond us, which is why we never got very far in homebrewing, or even in drawing up tentative circuits. After all, how do you design a tank circuit that is resonant at infinity megacycles? That, unfortunately, is the way it goes on Zero. If the wavelength is zero, you can't fight the fact that the frequency has got to be infinite. Some of us had a few bright ideas about designs, but search as we would through the old catalogs, we never could find specs for components that would come close to what we'd need. Maybe soon, with some of the new microminiature stuff that's coming out, but back then there wasn't



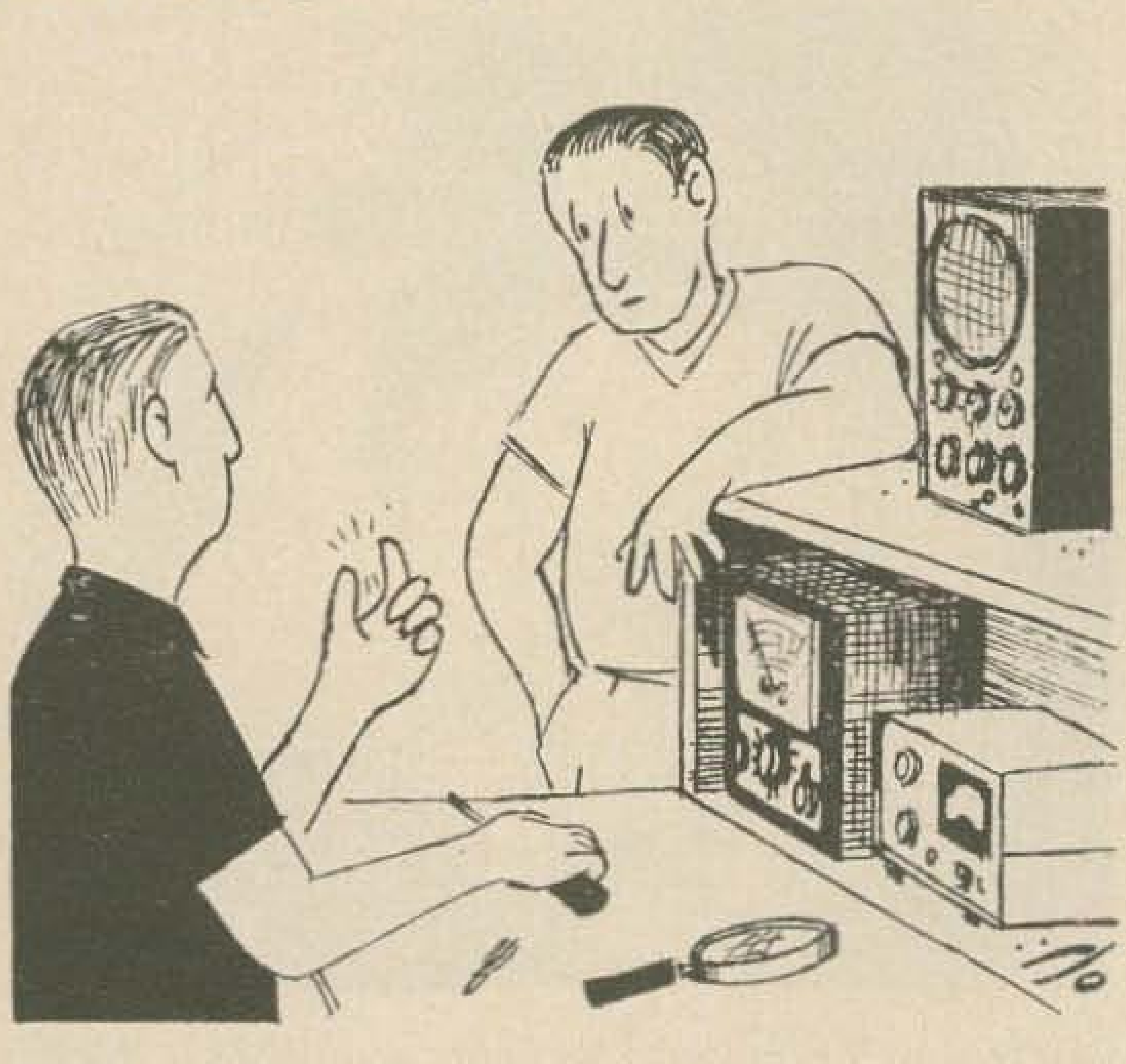
Of course, it was hard to open up the Zero Meter rig.

a tube on the market that could handle infinite frequency. At least not with enough gain to make it worthwhile wiring into a breadboard circuit.

The frequency, of course, was why everything on the band was CW. If you think about it a little, you'll see that modulating a wave means you are adding to it and subtracting from it. And if you've had the math, you know that no matter what you add to or subtract from an infinite frequency, you still have the same frequency at the output. Maybe phase or pulse modulation might be the answer, but we didn't know enough about that sort of thing then.

That was the reason the old Blue Box was so simple, too. If you're rock-bound on a single frequency, you don't have to worry about tuning and loading and such. There was only that one knob, which was on-off and receive volume. No VFO or frequency read-out, of course, because you can't QSY on Zero, for the same reasons you can't modulate it. And when I say rock-bound, incidentally, I say it because I imagine that was the way it was done in whatever circuit was inside the Box. We did a lot of speculation about it on the band in the old days, laboriously tapping out our theories to each other. About the only thing we came up with was the fact that it had to be that way—seeing as a crystal gets higher in frequency as you grind it down, then if you keep grinding and get it down to zero thickness, then it has to oscillate at an infinite frequency. Makes sense.

I tried once, figuring if I was ever going to build up a circuit on my own I might as well start with the crystal. I ground and ground away, and after ruining a lot of stock finally managed to get one down to zero, but as soon as I tried to pick it up the damned thing shattered. That was the last time I tried working on zero-thickness crystals. I'd worked so hard mastering the technique of getting them down to zero thickness—and that's precision work, believe me, with no tolerances at all—that I didn't want to spend another year or so figuring out how to handle anything that thin without breaking it.



Building a Zero Meter beam.

My crystal fiasco naturally brings to mind the story of poor Joe, who was experimenting with the antenna end of things. That was one of the real pleasures of working on Zero, the fact that you could work up a really fancy antenna and not have to worry about space or big hunks of metal hanging up there in the sky to worry the neighbors. On Zero, you can obviously have all the elements you want, on a zero length boom, and with zero length elements. You have to be pretty careful about spacing, though. If you're off by even the littlest bit your directors start acting like reflectors, and you end up with a pretty confusing polar plot.

I never bothered with more than 42 elements on my own beam, but Joe decided he was going to go for broke and really put out the rockcrusher signal of the band. You know how some guys are if they don't get forty-over reports every transmission. Joe'd worked on his beam for over 12 years and managed to fit something over four thousand elements onto the boom—he'd lost track once, and wasn't sure exactly how many he had, because of the difficulty of counting zero-length elements on a zero-length boom with zero spacing—but he did know he'd put on more than four thousand. Then one day he had the beam taken down and in his shack to add still some more elements, and while he was out getting some more zero-diameter aluminum element stock his wife came into the shack and opened the window. I need say no more than that there was a strong breeze that day, and poor Joe never found his beam again.

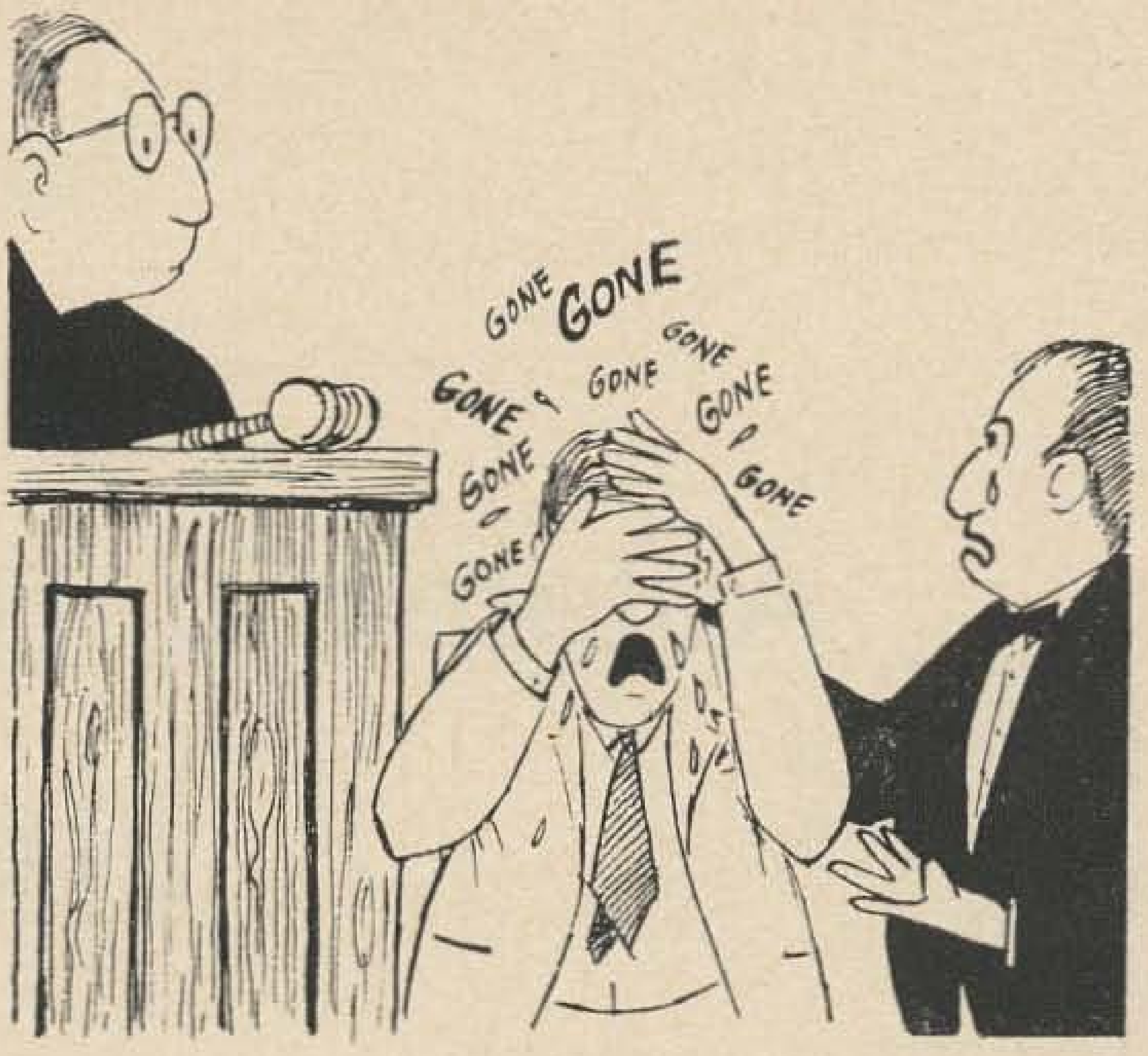
At the trial, Joe kept sobbing so piteously and mumbling over and over, "Gone, gone, gone" that the jury couldn't believe anybody that grief-stricken could possibly be responsible for his wife's mysterious disappearance. It took the spirit out of Joe, though, all those years of work lost, and the last I heard from him he was working low frequency, down on the 20-Micron band.

I think Wayne was a little reluctant to let the news about Zero get around too much, which is why he gave us OOT Zero ops the word in such a coded fashion. But I've managed to convince him that somebody has to get out a warning about Zero antennas just in case one of you stumbles across a Blue Box up in the attic, or finds one in a surplus store. We're both convinced that there aren't any left, but still, just in case.

The warning is this: whatever you do, never use a long-wire antenna on Zero. All of us on the band back then knew enough about antenna theory to know what was likely to happen if we put even a one-inch wire on that antenna terminal and operated it as a wire antenna instead of running a feed-line to a properly designed, resonant Zero Meter antenna. If you look at the charts in the manuals, you'll see why yourself. The gain of a long-wire goes straight up as the antenna lengthens in terms of wavelengths, and there doesn't seem to be any fall-off.

Consider the wavelength of Zero, and you see right away that any length of wire at all contains an infinite number of wavelengths. That means, of course, infinite gain in the antenna, which means that the minute you hit the key you'd put out an infinitely strong signal. It would slop over onto every other frequency in the spectrum, still with infinite strength, and blow out the front end of every other receiver in the world. And eventually in the universe. It would only be a split microsecond pulse, but enough. Or maybe that strong a signal would instantaneously melt your longwire, and thus no signal would get out at all. I'm not really that strong on theory, but that's the way we used to figure it—that it would last long enough to get that infinite-gain signal out—and so we never dared try to see if it was right. If you should find a Blue Box, take heed!

The reason I'm back on Zero is that when the big confiscation came, I turned in the Box I was operating with, and completely forgot that I'd picked up a spare, and that it was lying behind a lot of other old radio junk in the cellar. But when I read Wayne's ad I suddenly remembered it, after all these years, and went down and found it. I dusted it off, plugged it in, and put out a tentative CQ. Much to my surprise there were some answers, so pretty much the same must have happened to some other guys.



Joe kept sobbing pitifully at his trial.

I recognized a few of the calls, and it was a real pleasure to meet old friends on the band. There were a few pretty strange prefixes coming in, though, and when I asked one of my contacts about his exact QTH—but that's another story.

Dig into the backs of those WWI surplus stores. There may still be a few of them around. Maybe you'll be lucky enough to find a Blue Box. Just be extra careful about not putting on a long-wire, and I'll see you on Zero.

. . . WA2TDH

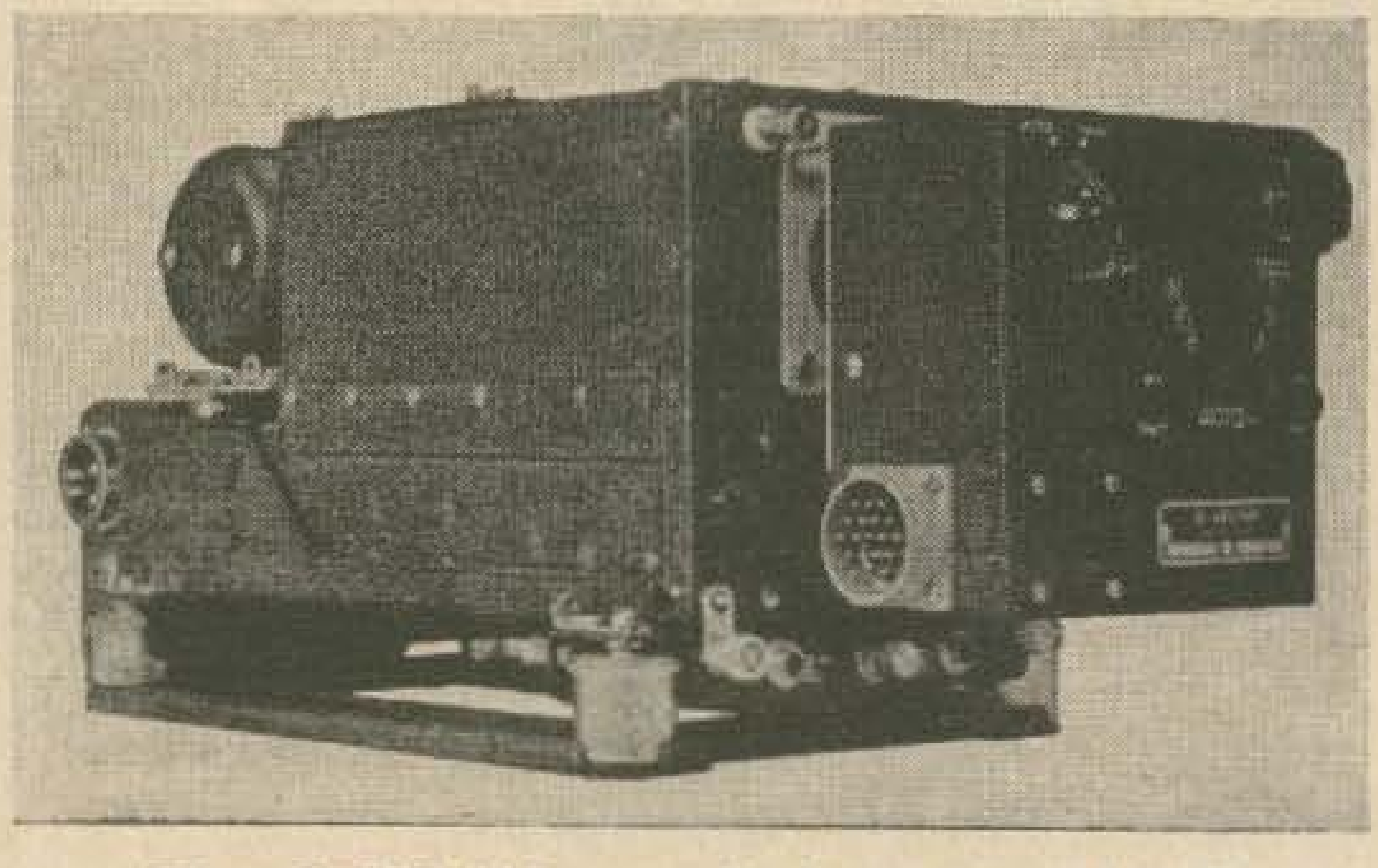
Roy Pafenberg W4WKM
316 Stratford Avenue
Fairfax, Virginia

Automatic Tuning for the ARC-5 Receiver

The typical aircraft Command Set installation used a remote control station located for convenient operation by the pilot or, in some cases, another crew member. The receiver and transmitter were fitted into whatever space was available and tied together by cables. Flexible shafting was used for remote tuning of the equipment.

Some Navy aircraft installations precluded the use of flexible shafting and a motor driven remote tuning unit, the C-131/AR Automatic Selector Mechanism was developed for use with AN/ARC-5 and Navy ARA Command set receivers. This automatic tuning has been spottily available on the surplus market. More plentiful have been the ARA and AN/ARC-5 receivers with the C-131/AR installed. The photograph shows a Command Set receiver with the motor driven control unit in place.

It is not feasible to remove the automatic tuning system from the receivers since the original dial and drive were discarded when the control unit was installed. Manual operation of the receivers is not changed from the original and the direct drive tuning knob is a bonus not found with the run of the mill Command Set receivers. A further advantage is that the modified receivers may be used for mobile operation and located in the trunk of the car. While the remote assembly was designed to operate from a 20 to 30 volt dc source, they will work from a 12 volt dc system.



The C-131/AR installed on an ARC-5.

The schematic diagrams of the drive assembly and the remote selector switch are shown in Fig. 1. Circuit elements referred to in the following discussion are keyed in the diagram by circled letters. The unit contains six selector disks with contact segments (A) separated by gaps (E). The angular position of the gaps controls the setting of the receiver tuning capacitor, and the position of each disk may be set by a front panel screwdriver adjustment. Contact arms (B) are mounted on a common shaft (D) which is geared to the motor drive. Direction of motor rotation is determined by the motor winding (C) selected by the relays (R). The two contacts of the remote control switch associated with each of the six positions are wired to corresponding segments (A) of the six selector disks.

When the remote control switch is set to a given position, the circuit is closed through a disk segment (A) and one of the two relays (R) is energized through the contact arm (B). This relay closes the circuit through one of the motor windings (C) and the motor turns in the corresponding direction. The mo-

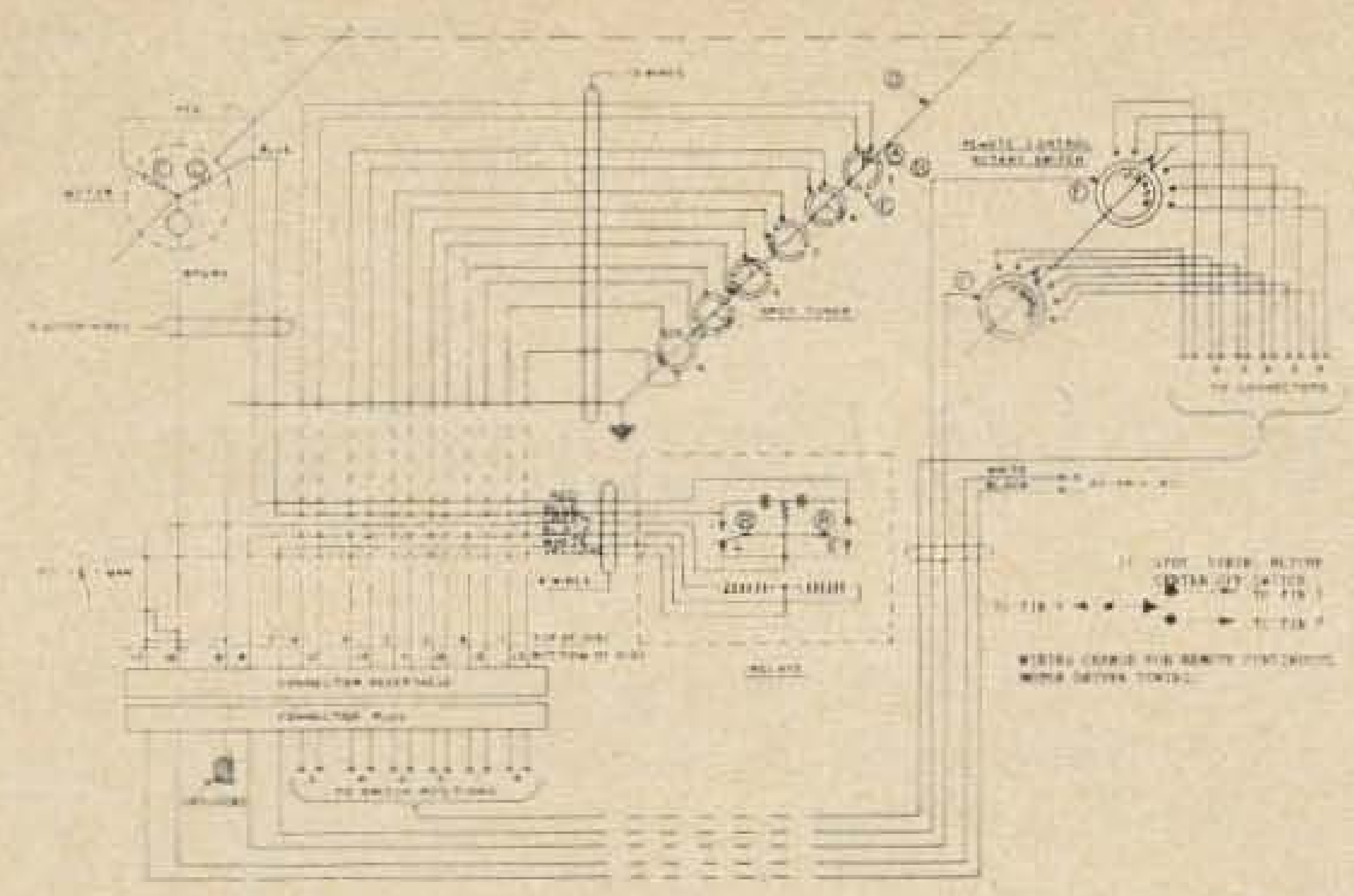


Fig. 1. Schematic diagram of the C-131/AR automatic selector mechanism.

tor turns the receiver tuning drive and the contact arms until the contact arm bridges the gap (E) between the disk segments. Both relays are then closed, removing voltage from the motor and the drive stops at the preset position. Turning the remote switch to another position will start the tuning cycle again.

For operation from a 12 volt dc source, the relays in the C-131/AR unit must be adjusted. Remove the cover and decrease the armature spring tension of the relays until they operate reliably on 12 volts. If spot frequency reception is desired, wire a six position, two gang switch to the unit as shown in Fig. 1. Connect the auto battery "hot" lead to Pin 17 of the receptacle and the ground return to Pin 16. Make no connection to Pin 9. Polarity is not important; while direction of rotation will change, the system will still work.

To set up the spot frequencies, turn the front panel switch to the "Auto" position and slide back the covers from the front panel channel adjustment screws. Set the remote switch to the desired channel and turn the corresponding channel adjustment screw until the receiver tunes itself to the desired frequency. Set up the balance of the channels in the same fashion.

If continuous remote tuning is desired, delete the remote selector switch and associated wiring. Connect battery to Pins 16 and 17 of the connector and wire a spdt, center off, spring return switch as shown in the Fig. 1 inset.

The motor driven tuning feature of the C-131/AR control unit does have practical amateur application. Even if the receiver is installed under the instrument panel, the motor driven tuning saves a lot of inconvenient, and often dangerous, knob twisting. In any event, this article answers the question of what the "little black box" was used for.

. . . W4WKM

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Boosting Talk Power in ALC Transmitters

One of the big premises on which the advantages of SSB over conventional AM phone is based is, of course, the high peak power level—sometimes exceeding CW ratings—to which most transmitting tubes can be driven. However, much of the advantage dissipates when it is recalled that the "average" voice drives the usual SSB rig to but 30 to 60 percent of PEP ratings, hitting top peaks only occasionally.

Regular audio speech clipping, which has been applied successfully to AM phone for many years to increase the average modulation level, does little to improve matters in SSB. Well-designed audio compressors (or even better, compressors applied to the SSB RF waveform *itself* in some intermediate stage in the transmitter) represent the ultimate in attaining *average* power near the PEP ratings for which the transmitter was designed. Unfortunately, such units—especially the RF compressors, which require an additional SSB crystal filter—are costly and can not be easily installed in the cabinets of most rigs to make a completely self-contained unit.

A poor-man's approximation to the compression and limiting action of these accessories can be had very easily for only a couple of dollars and a few minutes' time if your rig employs automatic load control (ALC).

Most of the circuits work like this: When no final amplifier grid current is drawn, a normal bias exists at the grid of an earlier intermediate amplifier or driver stage, providing maximum gain. When final amplifier grid current begins to be drawn, the circuit generates a rectified voltage (which follows audio peaks), applying this voltage as an additional bias to the intermediate amplifier. This effectively decreases the gain of the stage, and consequently, the driving voltage that is applied to the grid of the final amplifier. The whole process is remarkably similar to the standard AVC action in communications receivers.

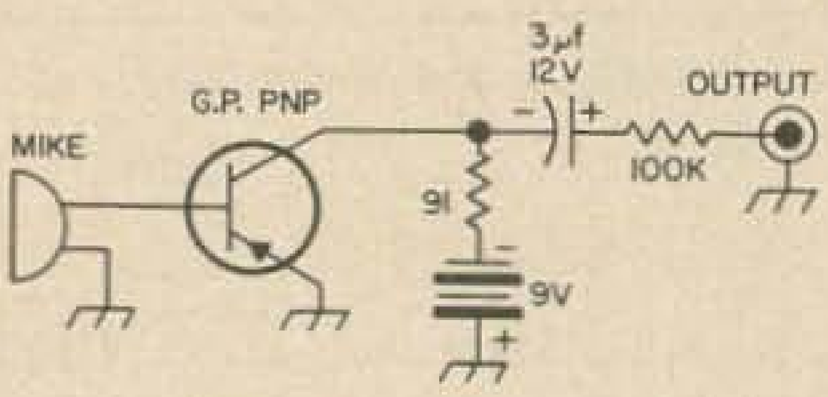

Fig. 1. The transistor preamplifier described in the text.

ALC in the SSB transmitter improves performance by making it difficult to seriously overdrive the final amplifier with its resultant "flat-topping" and distortion, and by indirectly providing a measure of speech compression. But because the ALC is asked to work over too-wide a range of levels, corresponding to the complexities of human speech, it cannot markedly increase the average-to-peak power ratio.

An improvement can be had by adding a simple microphone pre-amplifier ahead of the first speech amplifier stage in the transmitter. By driving the speech amplifier very heavily —but below the point of serious distortion—a measure of speech compression can be obtained in conjunction with the ALC circuit.

Fig. 1 shows the schematic diagram of a miniature one-stage transistorized preamp which can be built into most crystal or dynamic mike cases.

The preamp was built into the case of an Astatic D-104 crystal mike, and a miniature 9-volt battery was mounted within the mike stand. Most communications mikes have ample room within the case for the entire preamp. While good results were obtained with the D-104, even better performance could be expected from one of the newer, specifically-designed SSB mikes.

In practice, the rig's audio gain control is operated at a much lower level; the rig is talked-up by advancing the gain control to just below the point where flat-topping begins to appear. On-the-air comments with the preamp, using a Heath Marauder, brought universally favorable comments on the audio "punch" and quality, with no noticeable distortion. The mike should be held several inches from the lips or held sideways, however, to prevent "blasting" from breath noises.

Although not tried in a non-ALC transmitter, the little preamp should give some limiting action, though undoubtedly not as much as it would produce in an ALC-type rig.

. . . K2IKZ

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Seeing Your SWR

During the past decade, literally scores of devices for checking out SWR, antenna impedance, and related items have been described in the amateur press. They include bridges, directional couplers, and other exotic hardware.

But one of the simplest and most useful devices has apparently been overlooked during all this time!

The device (a technique, really) we're talking about will (1) give you a direct visual picture of your SWR curve, (2) give you a direct measurement of impedance vs. frequency over any desired passband, (3) tell you how much loss exists in your feedline, and (4) do all of these things at the same time with a single hookup and test. Interested? Read on.

We'll start by saying that this is nothing new, as such. Some manufacturers of antenna feedline have used the technique for years; if you've ever seen an advertisement for "frequency-swept" coax, you've been exposed to the results of this technique. But so far as we know, hams just aren't applying it.

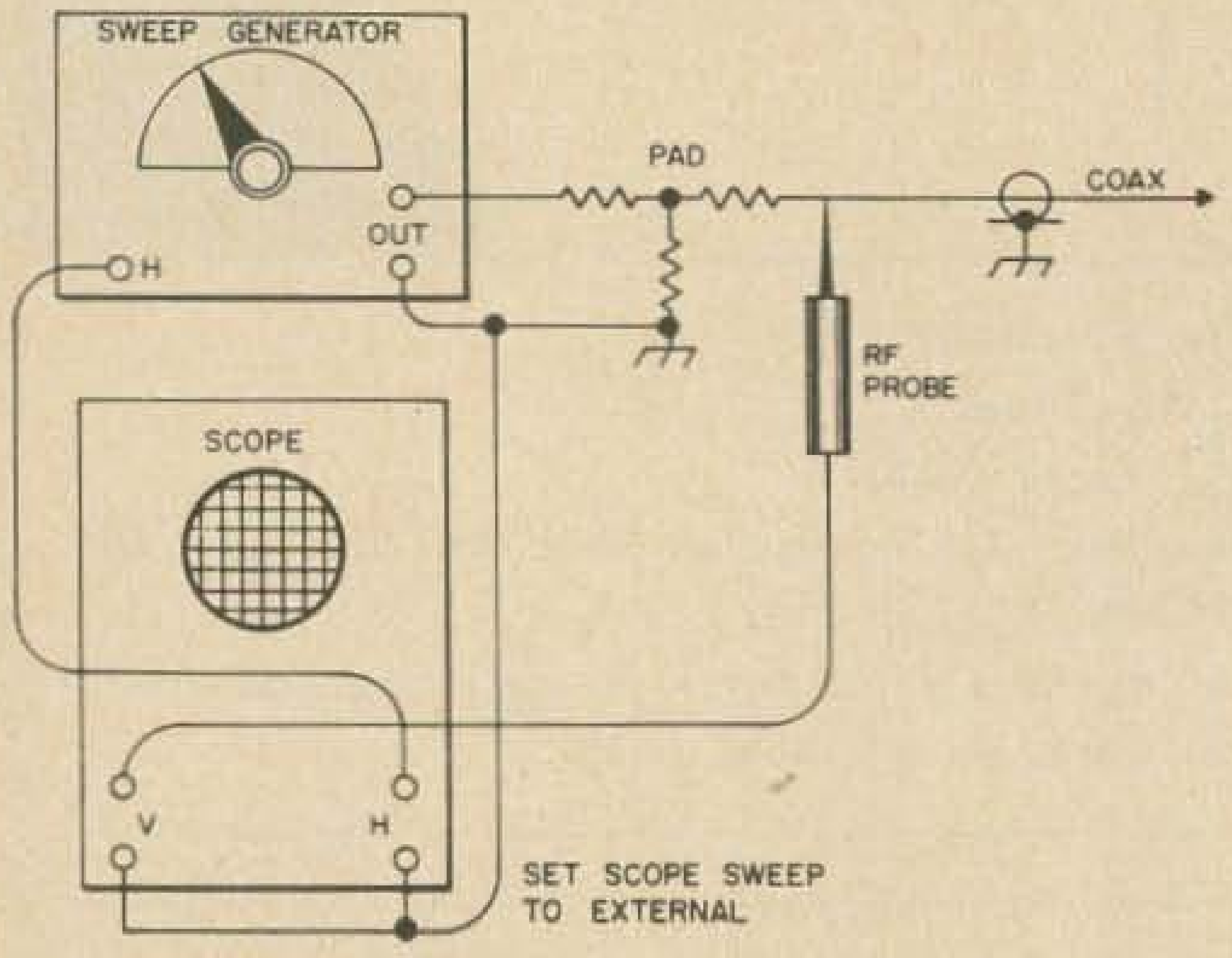

Fig. 1. Basic set up for seeing your SWR.

A large part of the reason for this may be that it required two items of test equipment, neither of which could be considered common in a ham shack until the past few years. One is an oscilloscope, and the other is a "sweep generator." The scope is seen in more and more shacks these days, though the sweep generator still can't be called common.

However, a sweep generator adequate for the purpose can be easily built, and a number of them have been described recently. So we'll assume that you have, or can get hold of, both the sweep generator and the scope, and start from there.

The technique is extremely simple; merely hook up the sweep generator to the feedline or other device to be tested for impedance (through a terminating pad), and use the scope with an RF probe to measure RF voltage across the impedance at the same point to which the sweep generator is connected. **Fig. 1** shows the scheme.

You don't need a fancy scope to do this, either. With the RF probe, the RF voltage is transformed to DC. Since the sweep generator *does* sweep across its band at a regular rate, any variations in RF voltage (and consequently in DC output of the probe) occur at the same rate as the sweep. In most gear, this is 60 cycles per second, and virtually all scopes will handle a 60 cycle signal adequately.

When the load is "flat," though, there are no variations in RF voltage and as a result the output of the probe is pure DC. If your scope happens to be of the DC variety, you

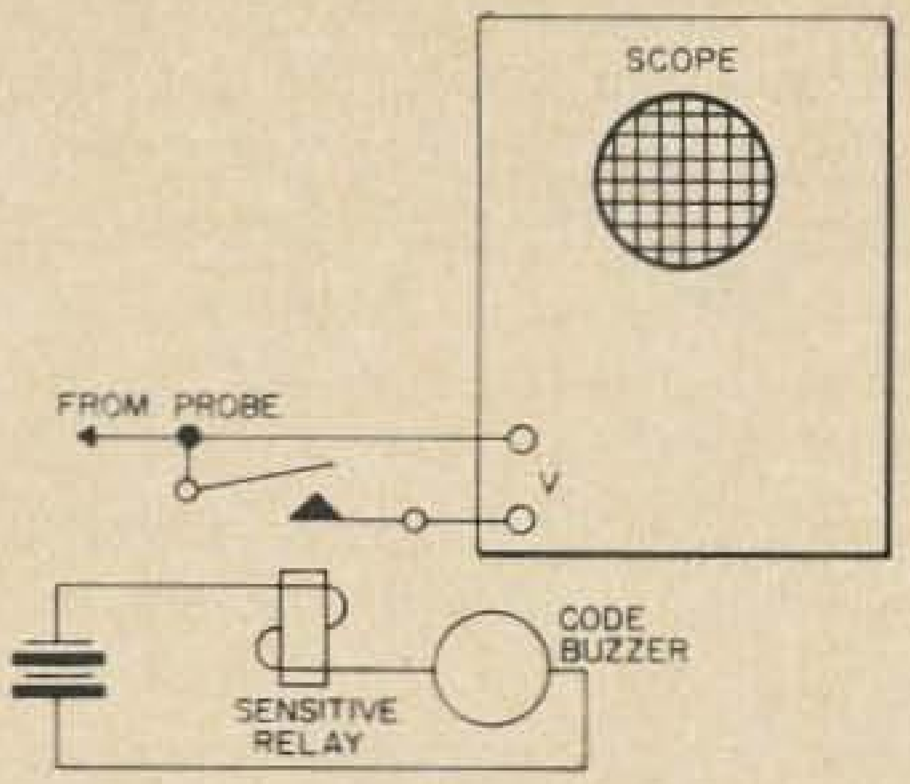

Fig. 2. Chopper circuit necessary for AC coupled scopes.

have no problems at all here. If not, hook up a "chopper" as shown in **Fig. 2** to give you a zero-reference line. Now any DC output from the probe will appear (to the scope) to be AC square-waves, at the frequency at which the chopper operates. If a code buzzer is used, this frequency will be around 1 kc, and since the sweep rate is so much lower, the scope trace will approximate a pair of straight lines for a flat load.

To calibrate everything, provide a dummy load of the same impedance as the coax cable you're using and hook things up as shown in **Fig. 3A.** Most commercial sweep generators are designed for 75 ohm output, which is why we show 75 ohms rather than the more common 52 ohm coax. Make sure that the dummy load really is flat at the frequency you're interested in, then turn things on.

If everything is working right, you should get the "perfect trace" pattern of **Fig. 3B.** The upper line is the "load" trace, while the lower one is the zero reference. The distance between them is proportional to the DC voltage developed in the probe by the RF across the 75 ohm load.

It may happen, though, that the sweep generator doesn't give you a constant output over its sweep band. In addition, sometimes probes have resonances which tend to foul things up. If either of these happens, your trace will look something like the "non-linear trace" picture in **Fig. 3B.** The bumps and dips may be at different places, but at any rate you won't have a nice smooth straight line.

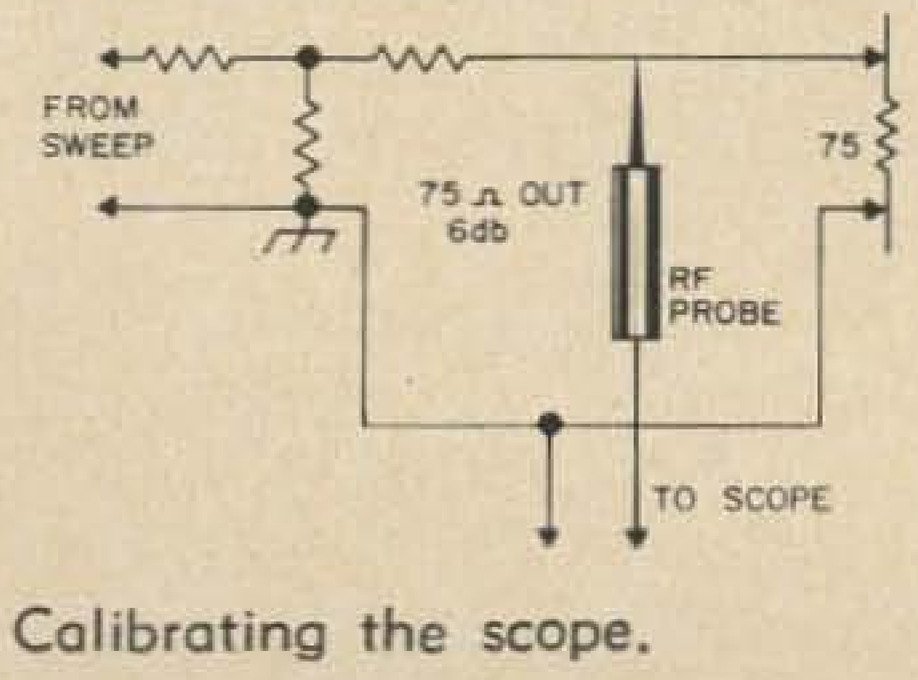

Fig. 3A. Calibrating the scope.

Don't let it bother you too badly. It will complicate things a bit, but not excessively. Simply take a grease pencil and trace over the line, no matter how jagged it is. The grease-pencil tracing then becomes your standard of a "flat" line, and SWR is figured by noting departures from the tracing rather than from absolute flatness in the later stages of the measurement.

This is the point, incidentally, to start wondering how this idea works. **Fig. 3A** is almost obvious; as the sweep generator sweeps its frequency band, the RF voltage across the resistor stays the same and so probe output also stays constant. The chopper lets the AC scope display the result, and you get **Fig. 3B.**

But what if, instead of a 75 ohm resistor, we have a length of coax which terminates in an antenna? This, after all, is what we want to measure.

Before getting into that, let's see what happens if we use just a length of coax terminated in a resistor. Let's make the coax a full wavelength long at 400 mc, which is a shade under 20 inches (after allowing for velocity factor) and is a nice convenient desktop size. Let's also assume that our resistors are still pure resistance at 400 mc, though of course we know that's not quite true.

Now let's hook a 75 ohm resistor across the far end of the coax from the probe and start sweeping around 200 mc. Since the load is an exact match to the line (under the assumptions we made) all the power from the sweep generator goes on up the line and is dissipated in the load resistor. It makes no difference just what the exact frequency is; the load is not frequency-sensitive under our assumptions.

But if we hook a 150 ohm resistor on the far end instead of the 75 ohm unit, we have introduced a 2-to-1 SWR on the line. What this amounts to is that not all the power going up the line to the load can be absorbed by the load; some is reflected back down the line. In **Fig. 4** the block marked X represents the measurement point, and this is where we measure the reflected voltage. With a perfectly matched load, E_{refl} is zero, but with

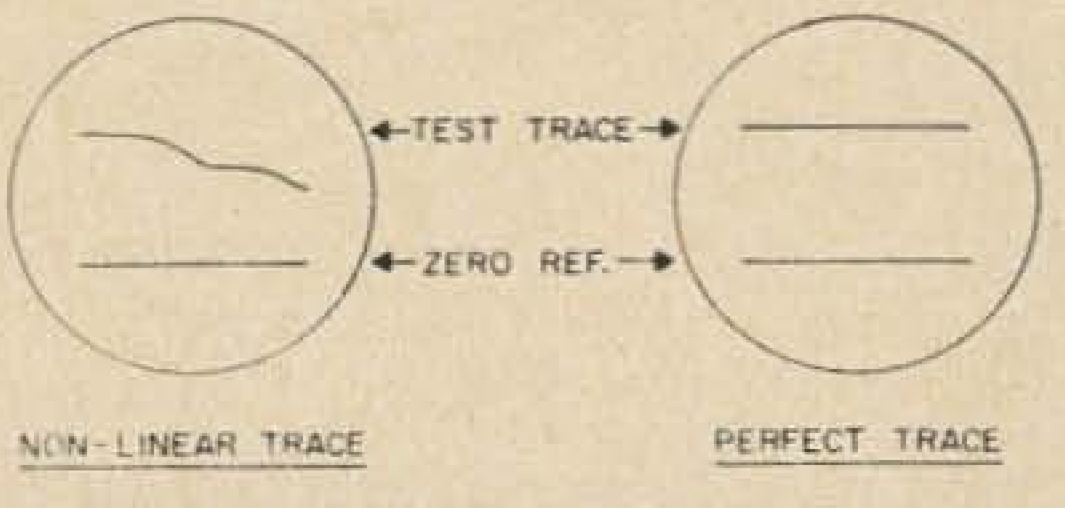

Fig. 3B. Typical traces from the circuit of Fig. 3A.

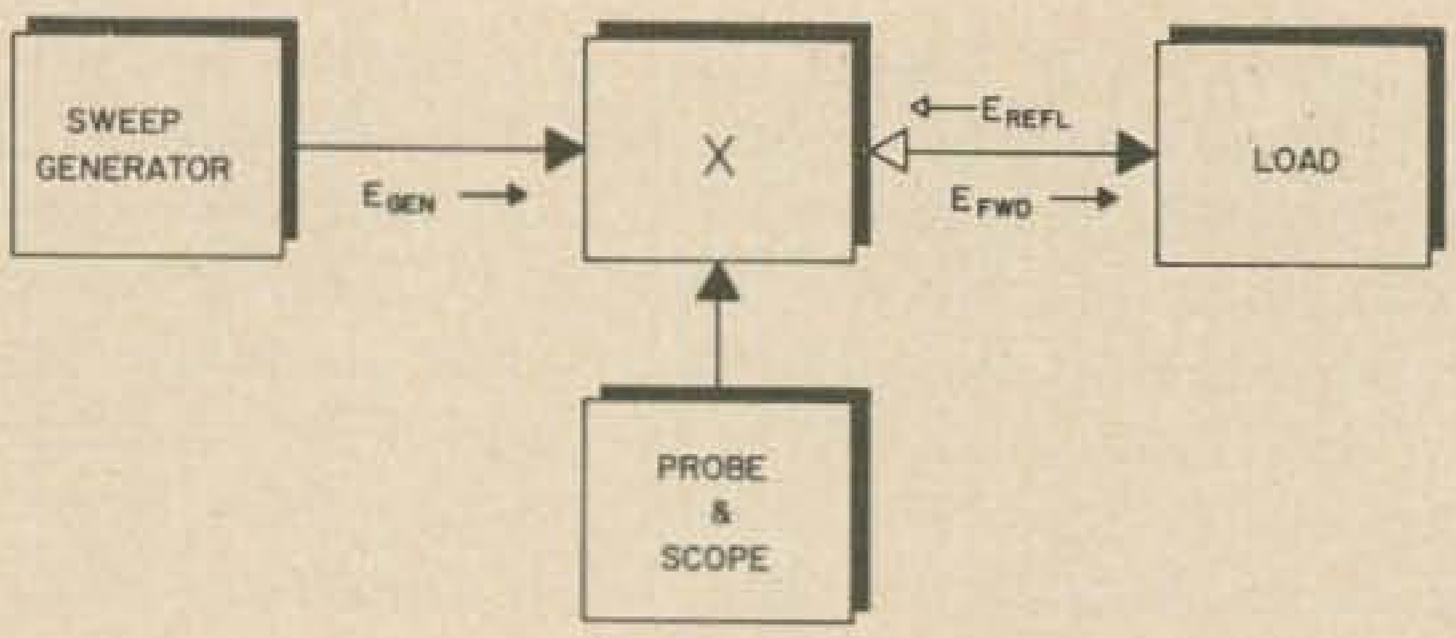

Fig. 4. Explanation of the scheme to see your SWR.

a mismatch at the far end, E_{refl} exists. It may be nearly equal to E_{gen} if SWR is extremely high and line losses are low.

At point X, the voltage we will read with our probe consists of the *sum* of E_{gen} and E_{refl}. If they both happen to be in the same phase, the voltage at point X will be higher than that of the generator alone, while if they are out of phase with each other, the voltage will be less. Phase at point X depends on both frequency and line length.

The phase of E_{refl} is determined by the time it takes for the outgoing signal to get to the end of the line and come back to point X, and thus depends on the frequency of the outgoing signal if line length is fixed. What this means is that, at some frequencies the voltage at point X will be greater than that of the generator alone, while at other frequencies it will be less. In between, it will vary from positive to negative peak values.

Now let's go to **Fig. 5**, which shows four typical scope traces. **Fig. 5A** is simply our perfect reference trace all over again; this is what we get with a flat line. The two traces are exactly parallel.

Fig. 5B shows what happens if we use the example just cited and sweep from 100 to 400 mc. At 100 mc, the total line length from point X to load and back to point X is ½ wavelength. When the signal reflects at the load, its phase is shifted 180 degrees, and the half wavelength out-and-back which it must travel adds another half wavelength or 180 degrees to its phase delay. The result is that E_{refl} and E_{gen} are in phase, and the voltage at point X is at its peak.

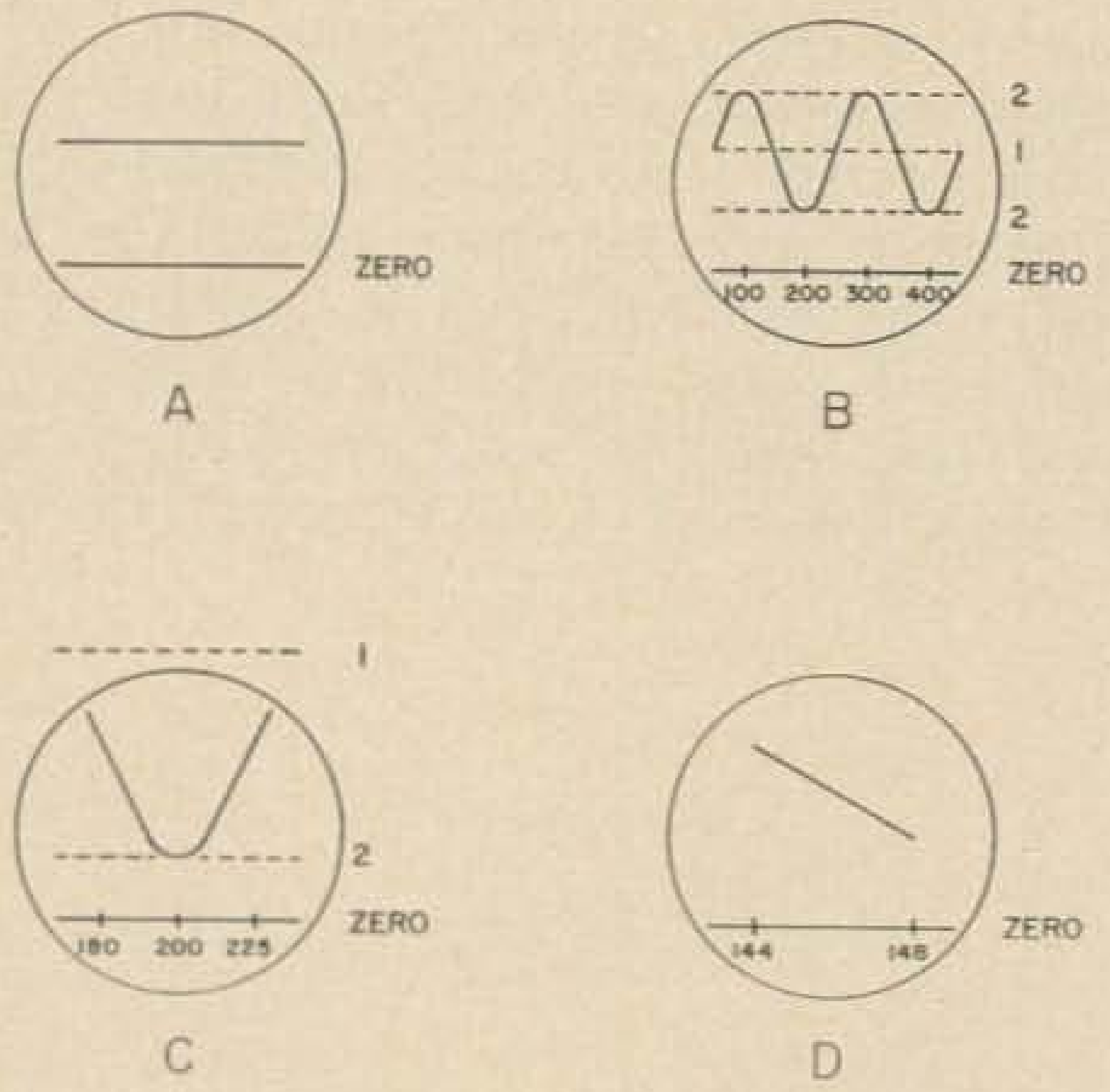

Fig. 5. Typical scope traces. See text for explanation.

When the sweep generator reaches 200 mc, the round trip from X to load and back is a full wavelength, which leaves the phase of the reflected voltage unaffected. Since it was already shifted 180 degrees by reflection, it is exactly out of phase with the generator voltage, and the total at point is at a minimum.

At 300 mc, round trip distance is 1½ wavelengths and the situation is the same as at 100 mc; at 400 mc, the distance becomes 2 wavelengths and the 200 mc argument applies.

The frequency markings on the zero reference, by the way, are there just for the example. Don't expect to find them on your scope.

In between the peaks and valleys, the total voltage at point X is somewhat between the extremes we've discussed. If you were to duplicate this example with such an extreme sweep range, you'd find that the trace would be a perfect sine wave. At this point, what you have on your scope screen is an actual picture of a standing wave on the line!

The peak value of the reflected voltage depends, naturally, on how much voltage is reflected, and this in turn depends on the amount of mismatch at the far end. Since SWR is just a more convenient way of saying "amount of mismatch," the lines shown dotted in **Fig. 5B** could be drawn on the scope face and marked "SWR=2." Similarly, all other values of SWR could be calculated and the scope face calibrated for them.

Normally, we would never use such a wide sweep range. Let's narrow the sweep width down to cover just the area between 180 and 225 mc and see what we get. It's shown in **Fig. 5C**, and as you can tell is simply a horizontally-expanded version of that portion of the curve around 200 mc in **Fig. 5B**. We also changed the vertical gain setting for this

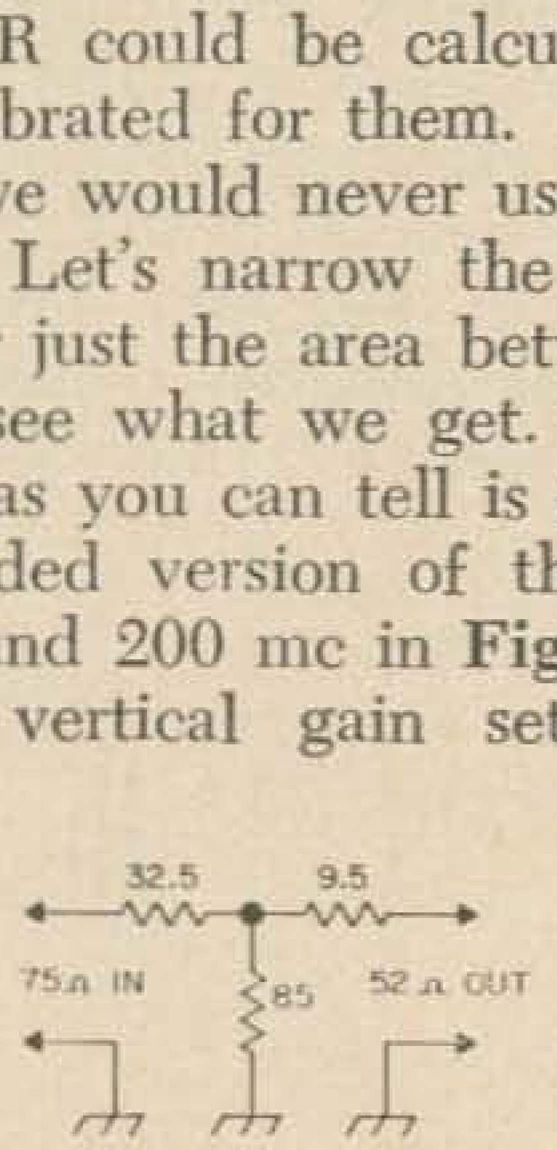

Fig. 6. 6 db pad for matching 75 ohms to 52 ohms.

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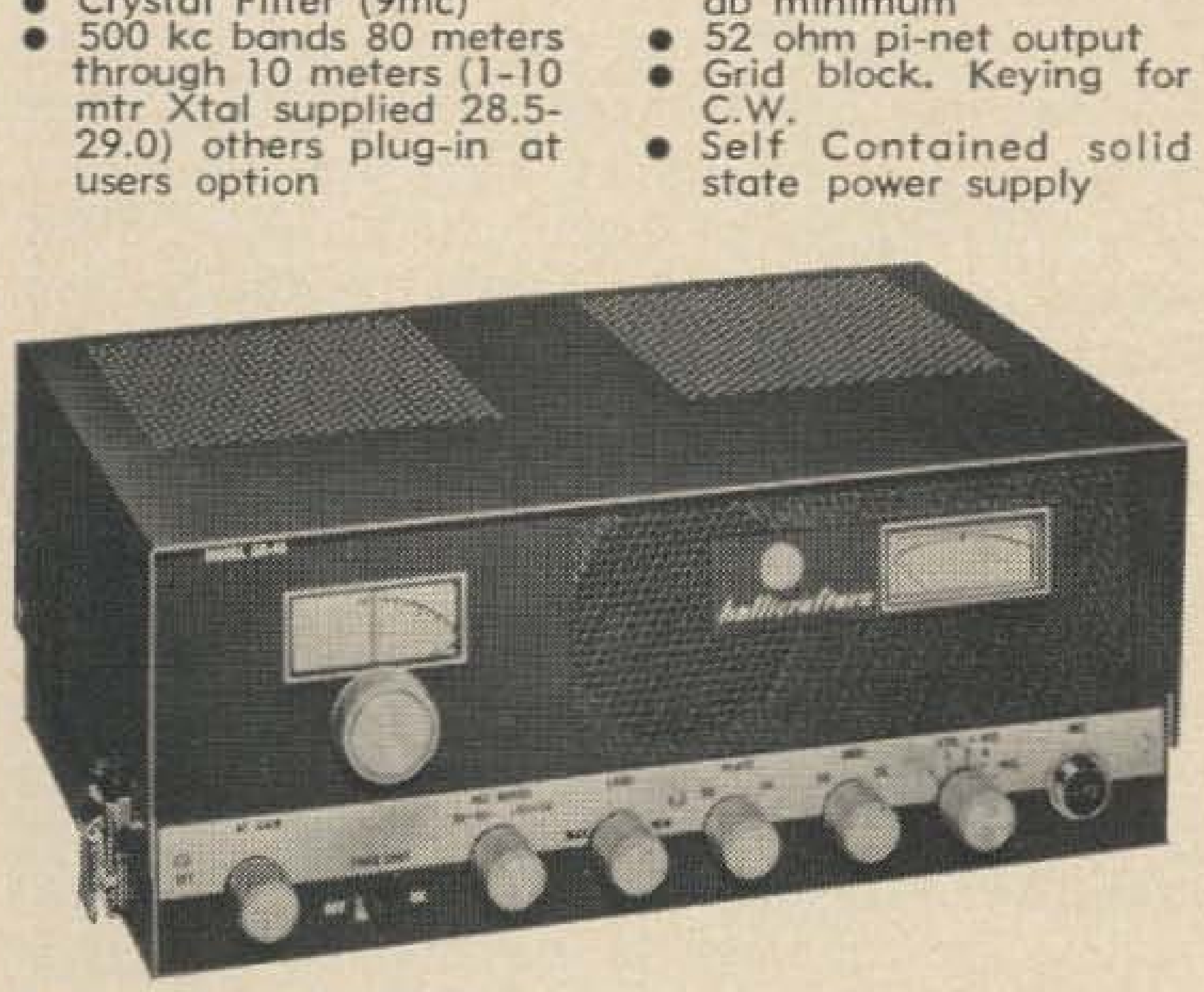

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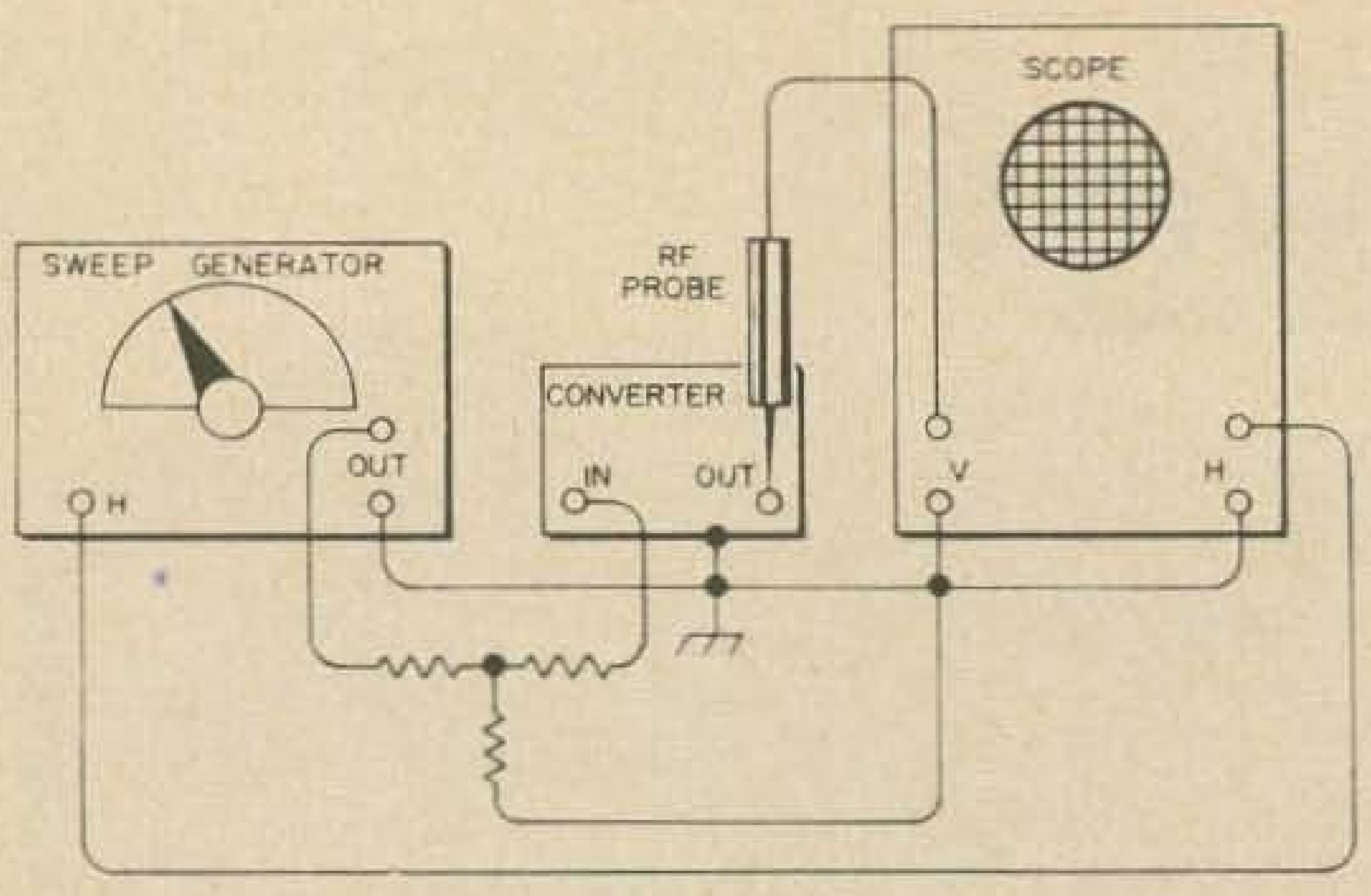

Fig. 7. Aligning your VHF converter.

drawing, as indicated by the different positions of the SWR-calibration lines, to make more clear what happens. In practice, this is the kind of curve to expect. If your sweep range includes the frequency of lowest SWR, the trace will resemble **Fig. 5C** or its image (upside down).

Should you get a trace which looks like **Fig. 5D**, you are sweeping a band far removed from the frequency of lowest SWR. Retune the sweep generator until you get something like **Fig. 5C**, and you'll be in the right ballpark.

Keep in mind that so far, we've been talking simply about a mismatched transmission line, with a resistor at the far end. The position of minimum SWR is determined by line length in this case. But if the line terminates in an antenna instead of in a resistor, which is the case we really want to check, then the picture changes.

For instance, let's assume a dipole antenna cut to resonate at 7.1 mc, and sweep from 7 to 7.2 mc.

Right at resonance, the antenna will be a pure resistance, and to keep things simple let's assume that it matches the line perfectly. At this stage, SWR is 1 to 1, and at the resonant frequency the trace would be flat; it would be just as far from the zero as if a resistor were on the end of the line.

As we go below resonance, to 7 mc, the antenna begins to look like a capacitor, and the SWR rises. Some voltage is now reflected back down the line, and our scope trace will depart from flatness.

Above resonance, around 7.2 mc, the same thing happens again. This time the antenna appears inductive, but the effect is similar. Voltage is reflected back down the line, and the scope trace changes again.

The important thing is that, on either side of resonance, the voltage at point X changes. It will change in the same direction regardless of being above or below resonance; the direction will be determined by line length, but no other characteristic will be affected.

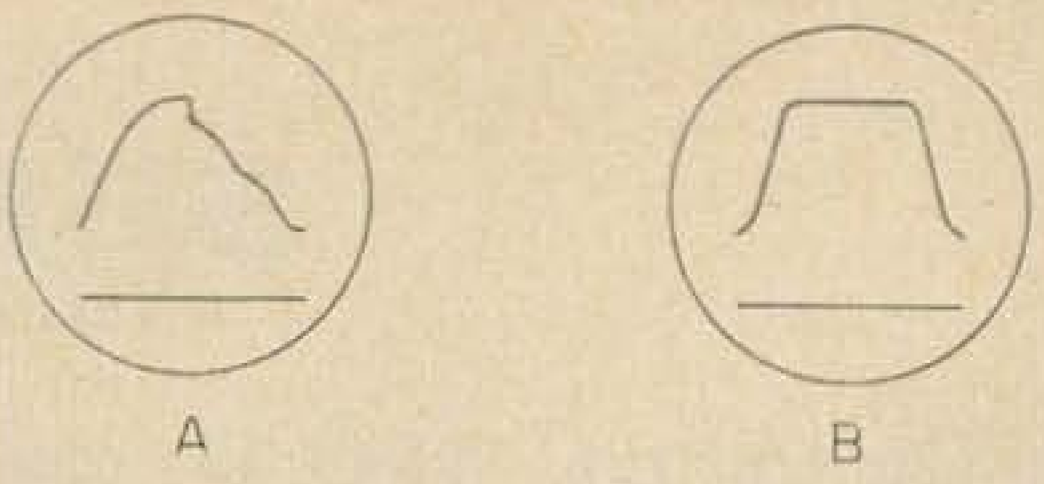

Fig. 8. Typical traces when aligning a converter.

What you come out with is a trace that looks like **Fig. 5C**, except that the trace now touches the 1-to-1 SWR calibration line instead of passing through it to touch the "2" line. If the antenna isn't matched to the line at resonance, the trace will be either above or below the "1" line because of SWR. In either case, if you have some idea of vertical-scale calibration you can get a direct reading of your VSWR.

To get this idea of the vertical-scale calibration, you could measure the SWR of your antenna at several points over the band (say at 7, 7.1, 7.2, and 7.3 mc) with a good SWR meter. Next, sweep the band with the hookup described here, and read the vertical grid in arbitrary units. Using a frequency spotter, find the points on the trace which correspond to the frequencies at which you took SWR measurements, and make up a chart relating "vertical units" to "measured SWR" at these points. You will find that they fall into a simple relationship, and from that point on you can tell the SWR at any spot on the trace by reference to your chart relationship.

The disadvantage of this idea is that it is good for only one setting of the sweep generator, and sometimes for only one line length! A more general technique for calibration involves a little bit of arithmetic, but can be applied anywhere. Here it is:

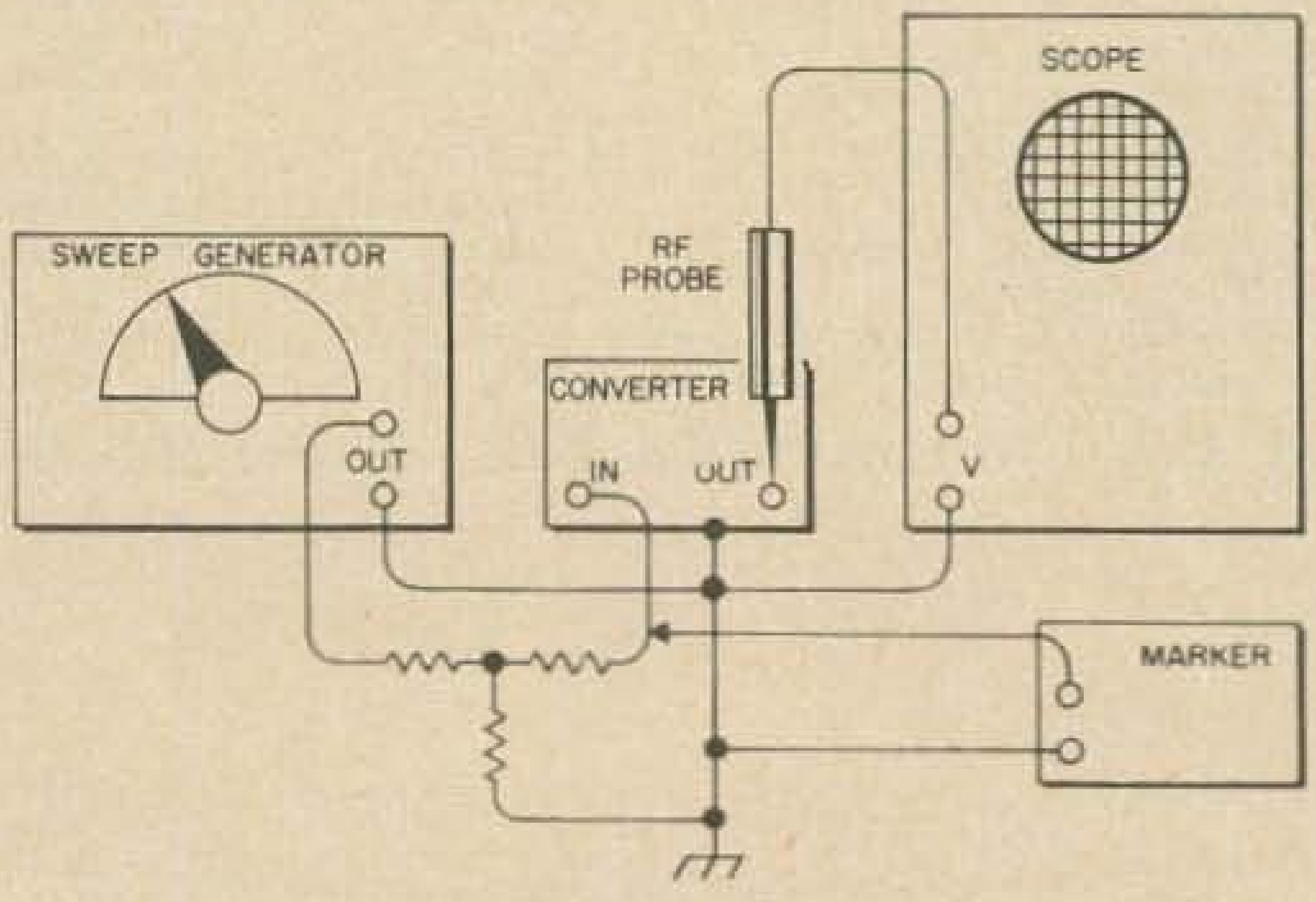

Fig. 9. Adding a marker generator.

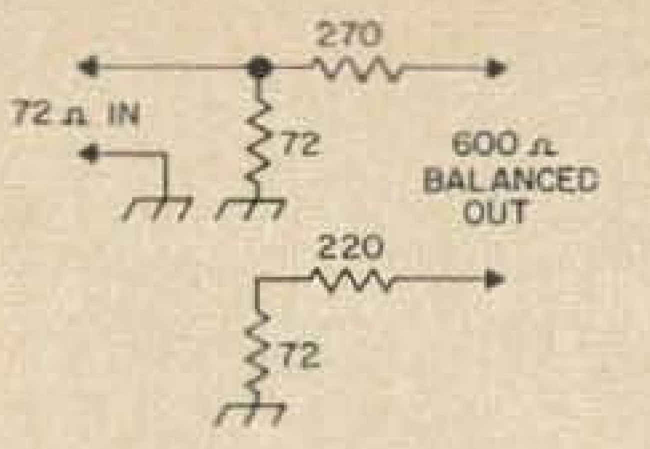

Fig. 10. 75 ohm to 600 ohm balancing pad.

By removing the coax and hooking up the calibration circuit of **Fig. 3A**, you can determine how many vertical units of voltage you would have on a completely flat line. When you reconnect the coax, you can tell from the screen how many units of voltage are actually present at point X, for any specific frequency. By counting vertical units from the "flat" voltage to the final trace, you can tell how much reflected voltage is present.

Once you have values, in the same "vertical units" for both the "flat voltage" and the reflected voltage, you can proceed to the VSWR formula. It requires that you first divide the reflected voltage by the forward voltage to obtain a ratio which we'll call "A," then solve the equation: $VSWR = (1 + A)/(1 - A)$.

All you really have to do is to obtain ratio A in a decimal-fraction form, then look in the ARRL Handbook's "RF Measurements" section for their calibration curve on the "Monimatch" type of SWR meter. This is the curve of the VSWR equation, and it can be read directly.

And if you don't have a Handbook handy, we've put together a table of VSWR vs. "ratio A" which can give you a quick idea of your VSWR.

VSWR Table

Ratio A	VSWR
0.0	1.00
0.1	1.22
0.2	1.50
0.3	1.86
0.4	2.33
0.5	3.00
0.6	4.00
0.7	5.67
0.8	9.00
0.9	19.00
1.0	infinite

All this time we've been talking about the use of the sweep technique for a specific application with a specific value of impedance, 75 ohms. What about other impedance values?

If they're fairly close to 75, you can use an impedance-matching pad for terminating the sweep generator. This is a T-pad designed to see 75-ohm impedance on one side, and whatever impedance you desire on the other. To perform its job properly, such a pad must have a certain minimum loss, and the greater the separation between the two impedance values, the more loss necessary. To match 75 to 52 requires 6 db, which isn't prohibitive. **Fig. 6** shows a suggested matching pad for this purpose. For best results, resistance values should be as accurate as you can get them, even though they're not standard. And the resistors *must* be non-inductive.

But what if you want to see the trace of a high-impedance grid circuit, for instance?

One way to do this is to wind a link on the resonant tank, coupling and tuning the link so that it looks like a perfect match to either 52 or 75 ohm coax when the grid circuit is at its proper impedance level. Then sweep the input circuit, coupling in through the link. Any impedance variation in the high-Z circuit will be reflected back as a change in impedance of the link, which will in turn show up as increased SWR on the scope trace. By this technique, bandpass circuits can often be adjusted to have just the characteristics you desire.

To determine the loss of your feedline, climb the tower and put a good short across the feedline right at the antenna. Then come back down and sweep the feedline in the neighborhood of your frequency, changing sweep generator center frequently as necessary until you get a trace looking something like either **Fig. 5B** or **5C.**

If the line had no losses, the negative peak of the trace would come right down to touch the zero-reference line, because all the voltage would be reflected back down and you would get perfect cancellation.

But in practice, the loss in the line will keep the negative peak from quite touching the zero reference. The amount by which it misses indicates how much loss you have; the less separation, the lower the loss.

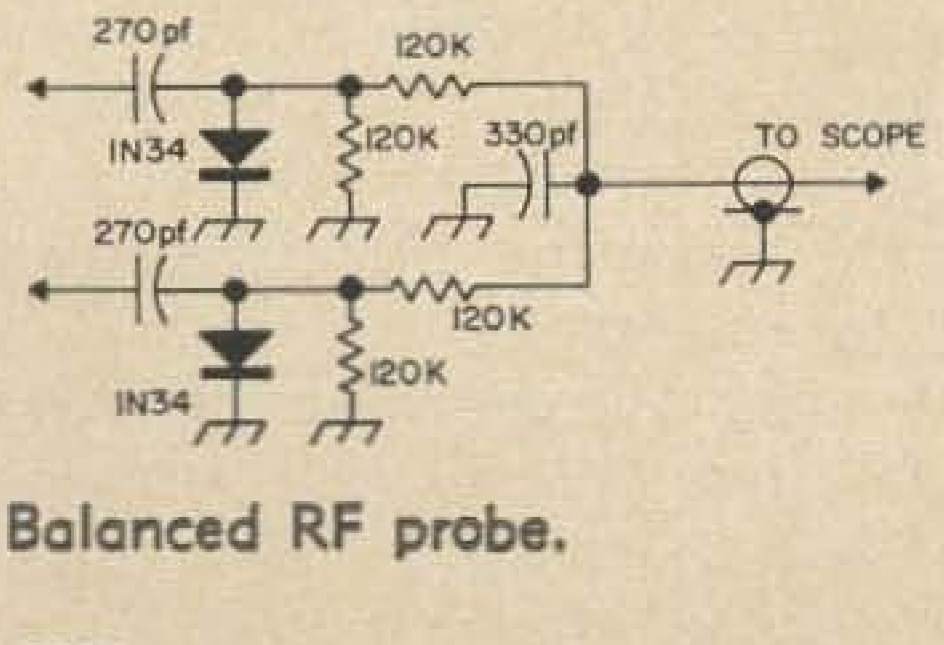

Fig. 11. Balanced RF probe.

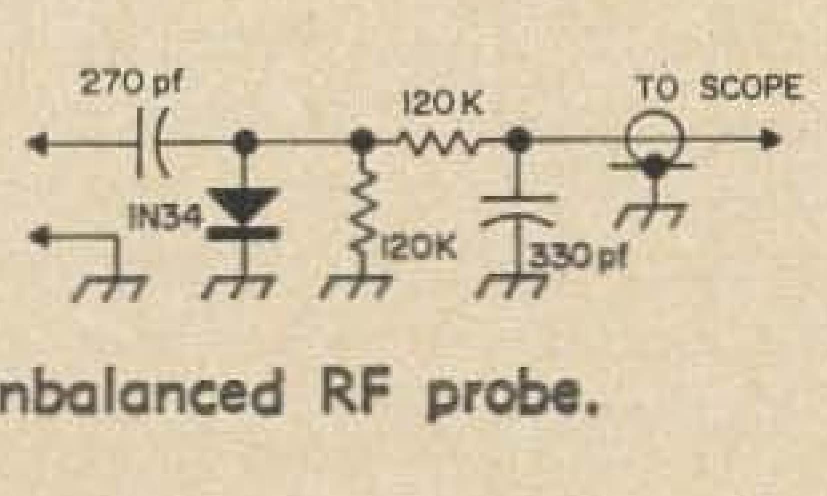

Fig. 12. Unbalanced RF probe.

To measure loss exactly, determine the amount by which the peak misses zero, and also the "flat voltage" just as in measuring SWR. Then calculate the corresponding "ratio A." This is the *square* of the fraction of voltage lost in a one-way trip up the line, since your measurements were made on a round-trip basis. But since power varies as the square of voltage, it is also *directly* the fraction of power lost in the line on a one-way trip, and can give you the loss in db.

To convert this power fraction into a decibel figure, simply look in a power-to-db chart. The result will be the db loss in your feedline.

Oh yes; don't forget to go back up and remove the short before turning on the rig!

While you have everything hooked up you might want to take some readings on any VHF converters lying around the shack. A few connections would have to be changed to do this, but not many. The equipment arrangement is shown in **Fig. 7**; the major difference is that the RF probe is moved to the converter output.

The sweep generator should be covering the band for which the converter is designed, with at least half again the bandwidth of the converter on either side. For instance, if you're checking a 6 meter converter the sweep should be from 48 to 56 mc. As always, calibrate the setup first by hooking a dummy-load resistor across the sweep-generator's terminating-pad output and tracing the resulting display with a grease pencil on the scope face.

Then move the probe to the converter output as shown in **Fig. 7** and sweep away. Most likely, the first display you'll see will be a lopsided curve like that of **Fig. 8A.** With a bit of care and patient tweaking of all tuning adjustments, you should be able to get it looking like **Fig. 8B.**

To tell just where you are in frequency, a "marker generator" may be added to the hookup as shown in **Fig. 9.** The marker output, hitting the RF probe along with the sweep output, causes an audio beat. The resulting audio signal at the probe output causes a pip to appear on the trace whenever the sweep and marker generators zero-beat with each other.

The marker may be your regular station VFO, with as much of the transmitter as necessary to get output of about the same strength as that of the sweep, or it may be a 1 mc crystal oscillator as used in frequency standards. With a 1 mc oscillator having high harmonic output, pips will appear every megacycle across the trace, giving a convenient calibration of frequency.

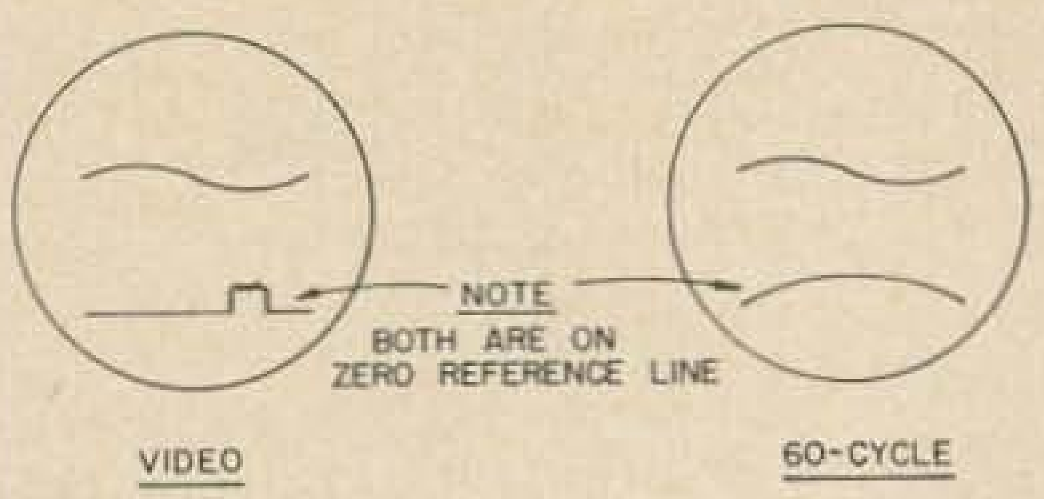

Fig. 13. Improper signals resulting from spurious pick up.

All this way, we've been talking about coax and other unbalanced systems. What about the balanced variety?

It works just the same way except that the sweep generator's output must be made balanced by using either a set of balun coils or a balancing pad, and a balanced probe must be used.

Fig. 10 shows a 75-to-600-ohm balancing pad, while **Fig. 11** is the schematic of a balanced probe suitable for any impedance level. If you want to build an unbalanced probe instead of buying one, use the schematic of **Fig. 12.**

In either case, use normal caution in wiring the probe. The balanced probe, especially, requires as perfect balance as you can get between its two sides. Unbalance will result in inaccurate readings. The best way to get the balance in the first place is to make everything physically symmetrical, and the way to check it is to measure a resistor or other known flat load.

When measuring out an antenna system, you may run into trouble from TV stations or strong locals riding through and showing up on your scope trace. Also, 60-cycle hum may be picked up from house wiring. The pattern contributions from these sources are shown in **Fig. 13.** There's little you can do to avoid them, but when you know what they are they can be ignored.

For additional data on these subjects, a wide range of books is available. The subject of probes themselves and some more applications of this technique are covered in *Probes,* by Bruno Zucconi and Martin Clifford, published by Gernsback Publications Inc. The subject of SWR is taken up in detail in a paper-bound book titled *Microwave Transmission Design Data* by Theodore Moreno and published by Dover Publications Inc. Don't let the imposing title frighten you; the data can be understood by anyone who has waded his way through the Handbook, and there's far more detail and explanation as well. . . . K5JKX

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The 1215 Transistor Superhet

Part II: if, af and assembly

This article is the third part of the UHF transistor superhet receiver series that started in the December 73. The first article described the mixer and the second the oscillator. This one takes care of the *if* strip, audio amplifier, final assembly and a simple antenna.

Basic *if* amplifier

Fig. 1 shows the basic 28 mc *if* amplifier. It has good gain so three stages are all you need for the complete *if* strip. The Sprague 2N1726 costs under $1.25 and does a good job. You can use the 2N1745 for a little more gain if you wish.

It will pay you to go through this circuit carefully as there are certain principles which, if followed, will give you a good understanding and confidence in stable HF transistor amplifiers.

The DC bias for the base is inserted through RFC1. C1 isolates that DC from any other DC voltages or ground that might be present on the input cable or connections. If the input is another of these stages (shown at L3), RFC1 and C1 are not needed. A low impedance cable or link should be connected to A and B while testing or the stage may oscillate. It won't take off in the final *if* strip.

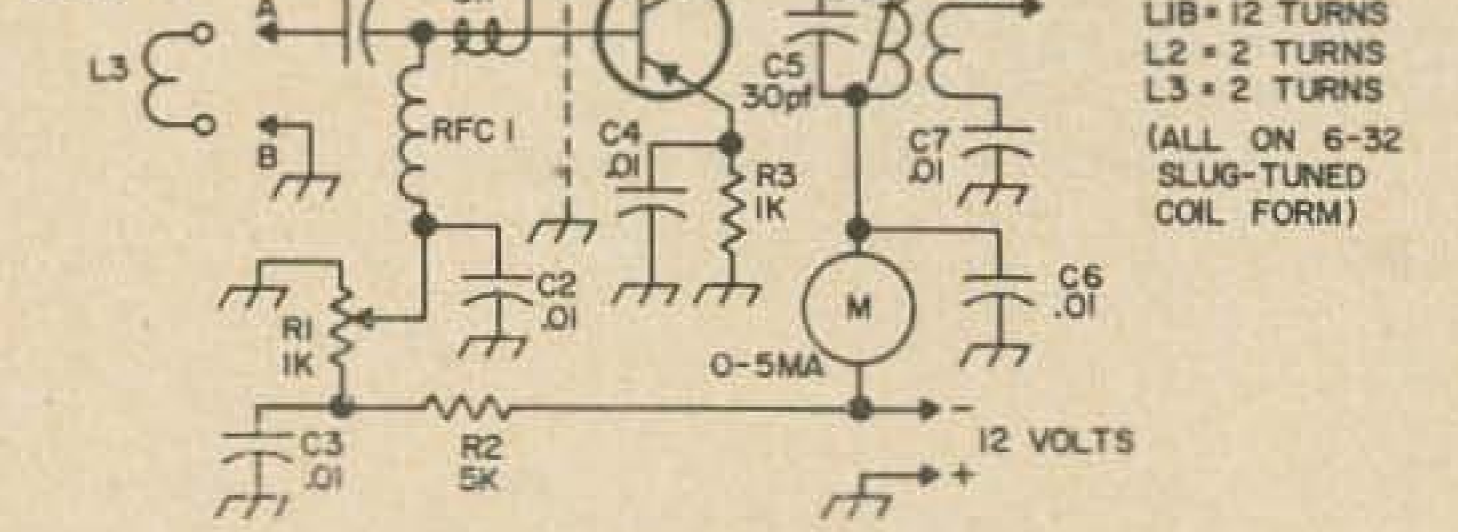


Fig. 1. Basic 28 mc if amplifier.

The base bias is shown as adjustable. This is to set the gain and current at the correct point, but fixed resistors are used in the final circuit. As a general rule, you can use 5 k from base to ground and about 33 k from base to the minus 12 volts.

A good place for an *if* gain control is in the the emitter circuit. Add a 5 or 10 k potentiometer (actually rheostat) to R3-but be sure to keep R3 in the circuit.

Some shielding is advised. A much smaller model makes this even more important. Put the transistor base connection close to a hole in the shield and run the base lead through it with a short wire. A word on *if* feedback and regeneration is due here. Feedback from the collector to the base circuits will produce oscillation of course, but much less feedback will produce much greater regeneration between the three stage amplifier input and its output. Watch out for this when completing and cabling the whole package.

Now coming to the collector circuit and L1.

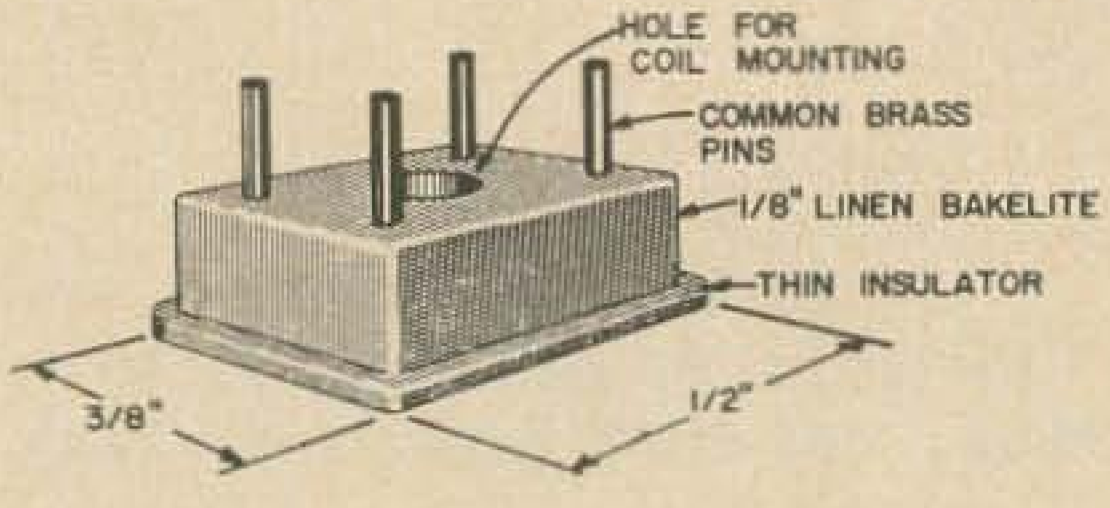
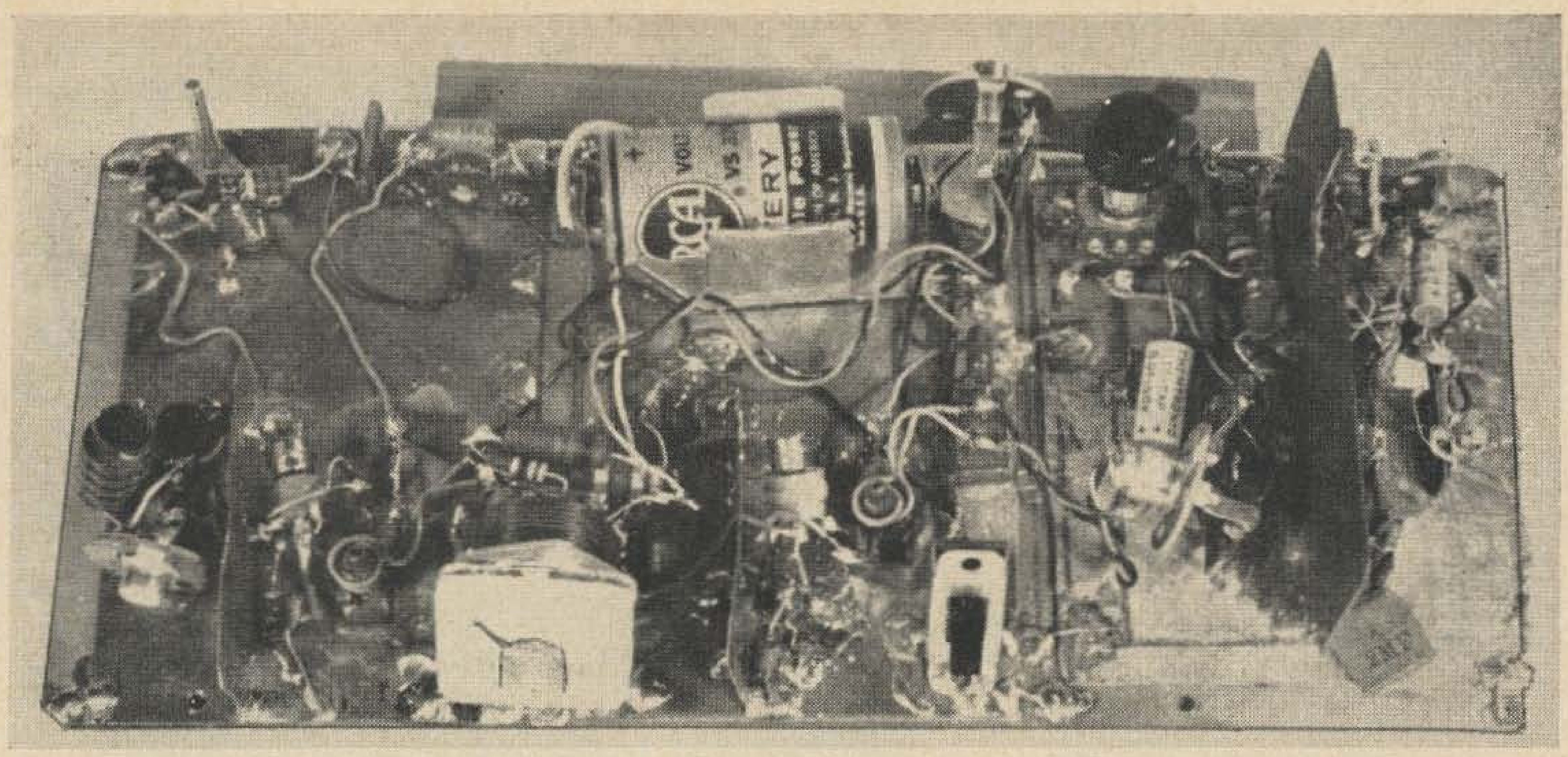


Fig. 2. Subminiature terminal strip.



The 28 mc if amplifier strip. It's built on a piece of copper clad bakelite with shields between each of the three stages.

This is the heart of the amplifier. I like the 6/32 internal threaded paper coil forms because they are small and only cost a few cents apiece. There must of course be some method of tuning the stages, whether by making C1 a trimmer or by adjusting the powered iron core in L1. The latter takes up less room and costs less. A drop of wax will keep the core from turning after the alignment of the amplifier on 28 mc.

A little trick was pulled with the neutralization circuit. I found that the amplifier had more gain and was less critical when I used fewer turns in the neutralization portion of L1 than when I used a center tap. See the diagram for number of turns. Cn may be one or two turns of plastic hookup wire around the base lead. This wire has to go through a hole in the shielding to get from L1 over to the base circuit. With the stage running you will quickly find the part played by Cn. Using all three stages, there will as a rule be oscillation without the neutralization. If you use too large a value for Cn you will only cut the gain a little.

Fig. 2 shows a simple subminiature terminal strip that is especially useful for mounting the *if* coils. Cut small pieces of linen base bakelite as per the drawing and drill .02 holes in it. Use a Variac on your quarter inch drill to slow it down when you do this. You may also have to get a jeweler's chuck to hold those small drills. Then hammer .021 common brass pins into the holes with a light hammer, cement a thin piece of bakelite underneath to keep the heads of the pins from shorting out and see how you like them.

Complete *if* amplifier

The whole *if* amplifier is shown in **Fig. 3.** The slight differences between the different stages are due to the first stage input coming from the mixer, the second stage being a true interstage and the third feeding a diode. The first base input uses the RFC for DC base

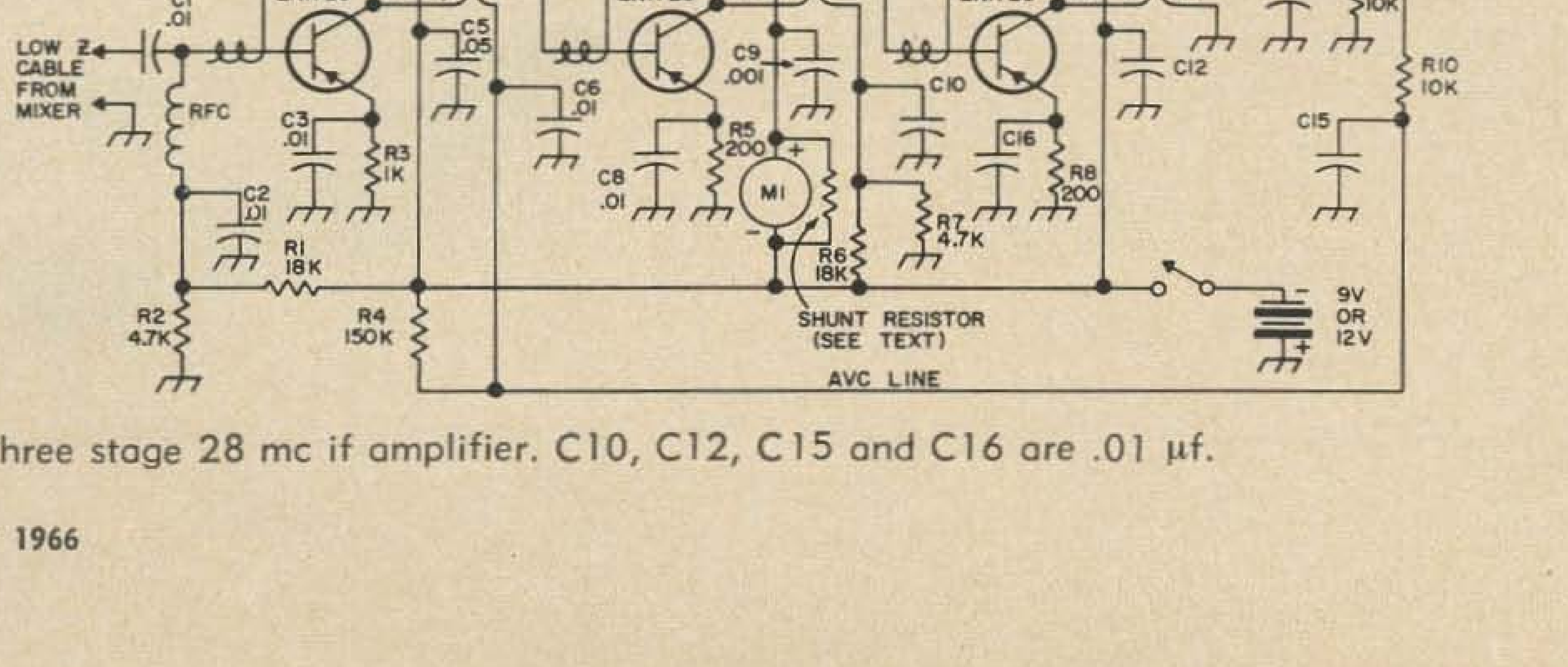
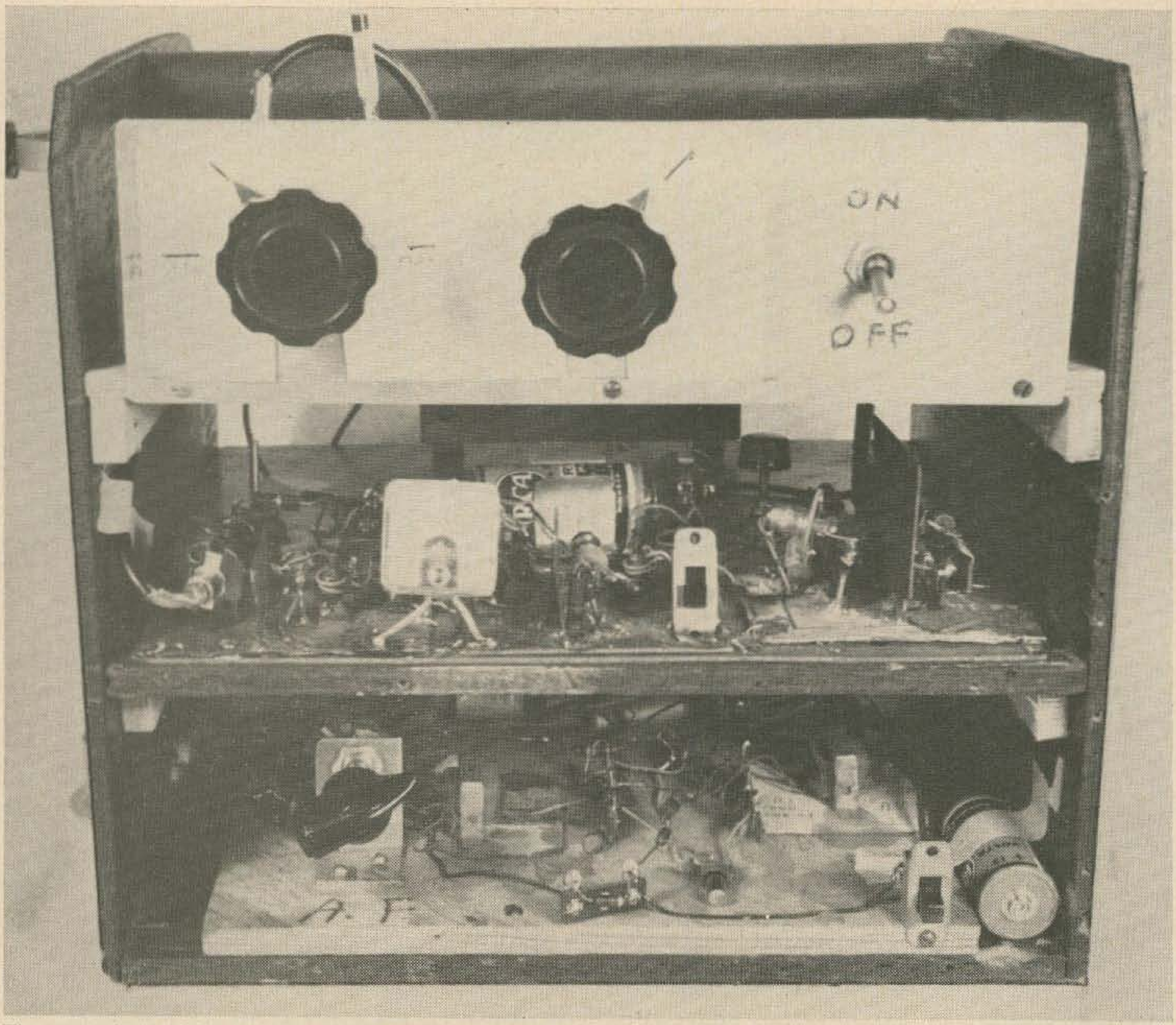


Fig. 3. Three stage 28 mc if amplifier. C10, C12, C15 and C16 are .01 μf.



The complete 1215 mc tunable transistor superhet receiver. The rf components are at top, the if in the middle and audio at the bottom.

security because of a possible open or short of the DC circuit when used with different cables or inputs. The second and third stages do not need rf chokes. L6 feeds the diode, a Sylvania 1N295, which demodulates the signal and also furnishes AVE voltage. A word here about AVC for transistors is needed. In the straightforward circuit used here a balance between diode bias and the *if* stage base bias must be maintained. This balance requirement is the result of the base bias voltage needed, and the diode, which does *not* need any bias other than that which it develops itself from the signal. Several published circuits did not perform well at all in this respect. Using 150 k for R5 leaves the DC

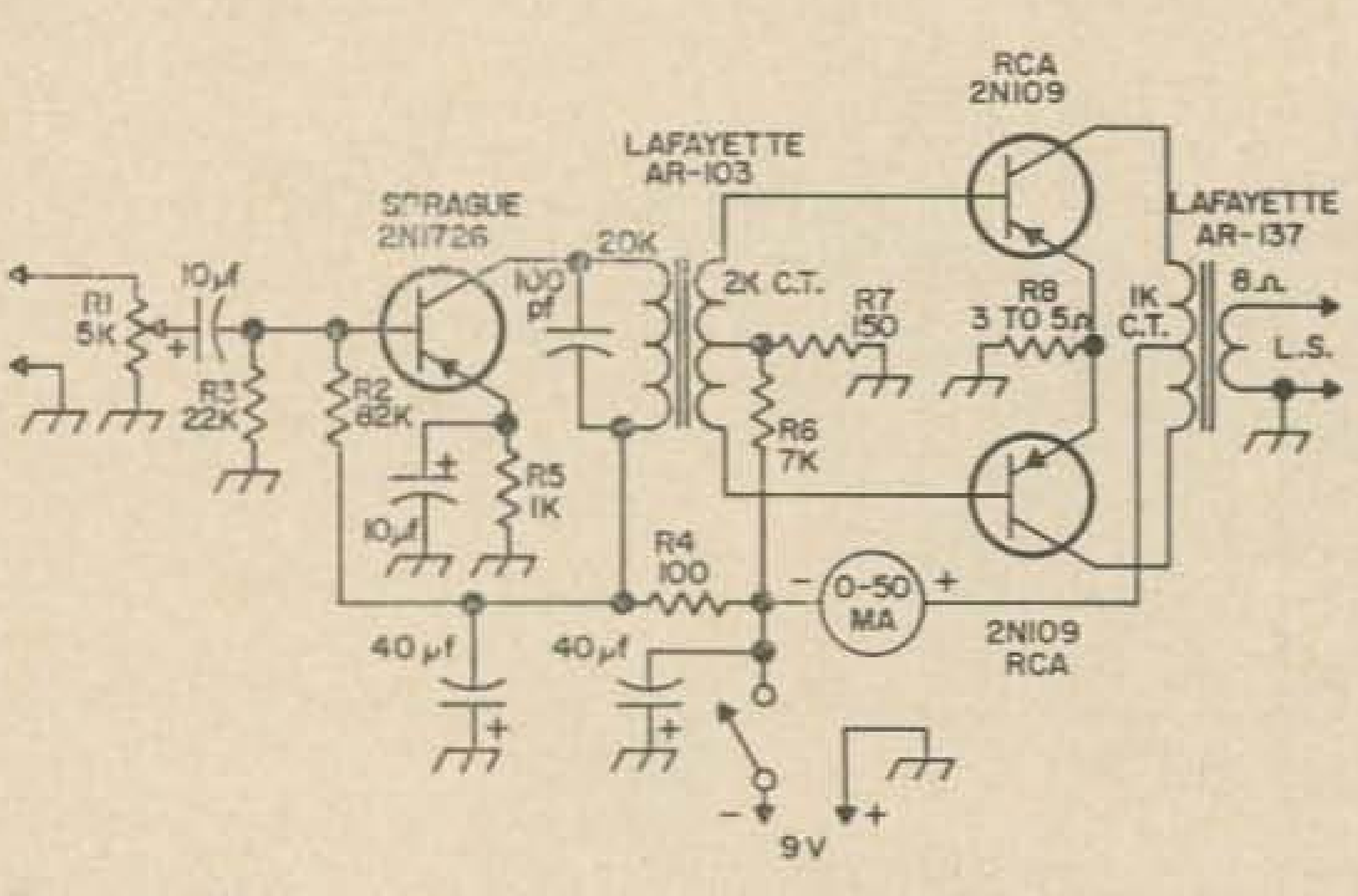
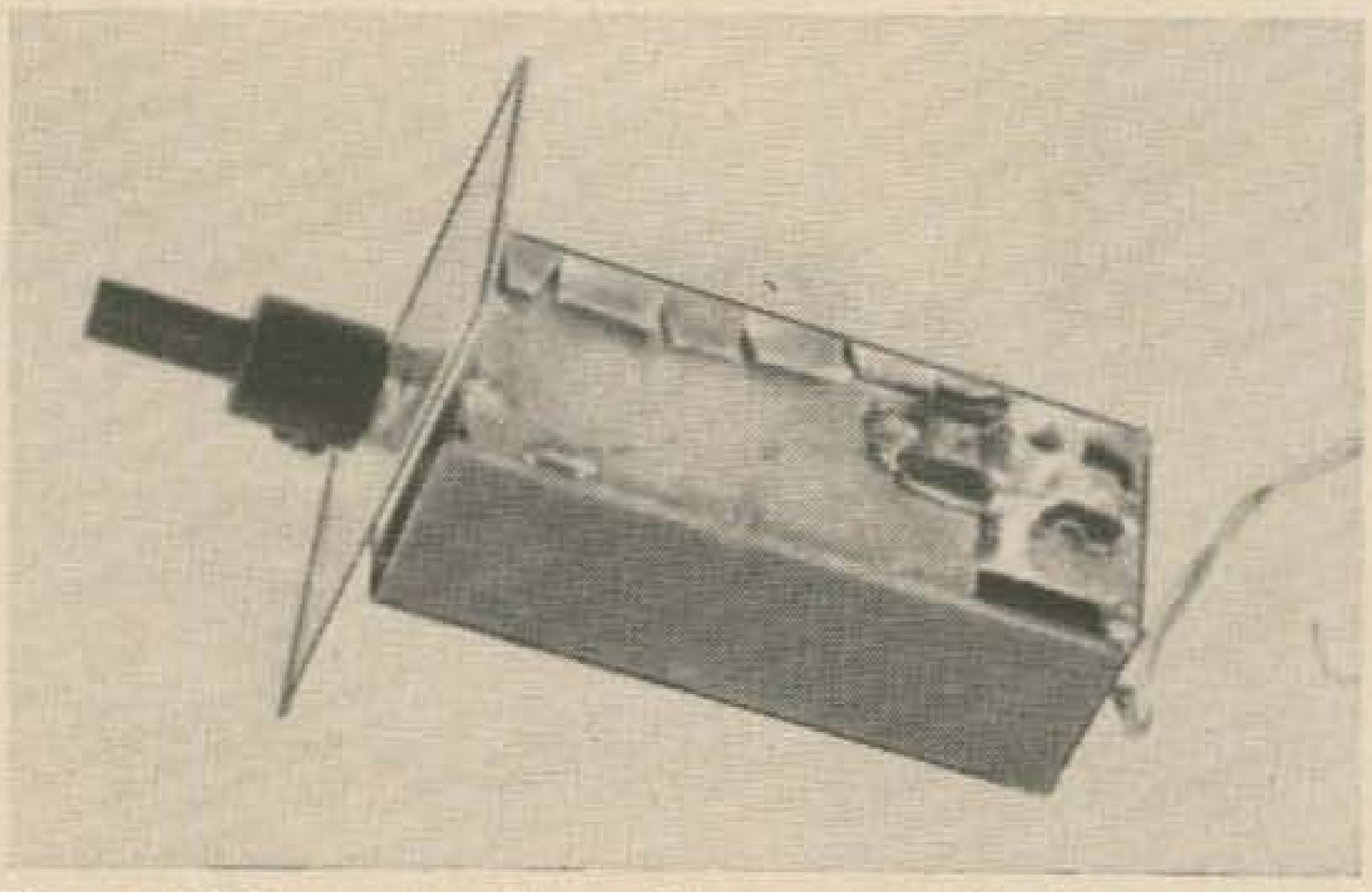


Fig. 4. Audio amplifier for the 1215 mc superhet and other uses.



The 1215 mc local oscillator described in part II of this series.

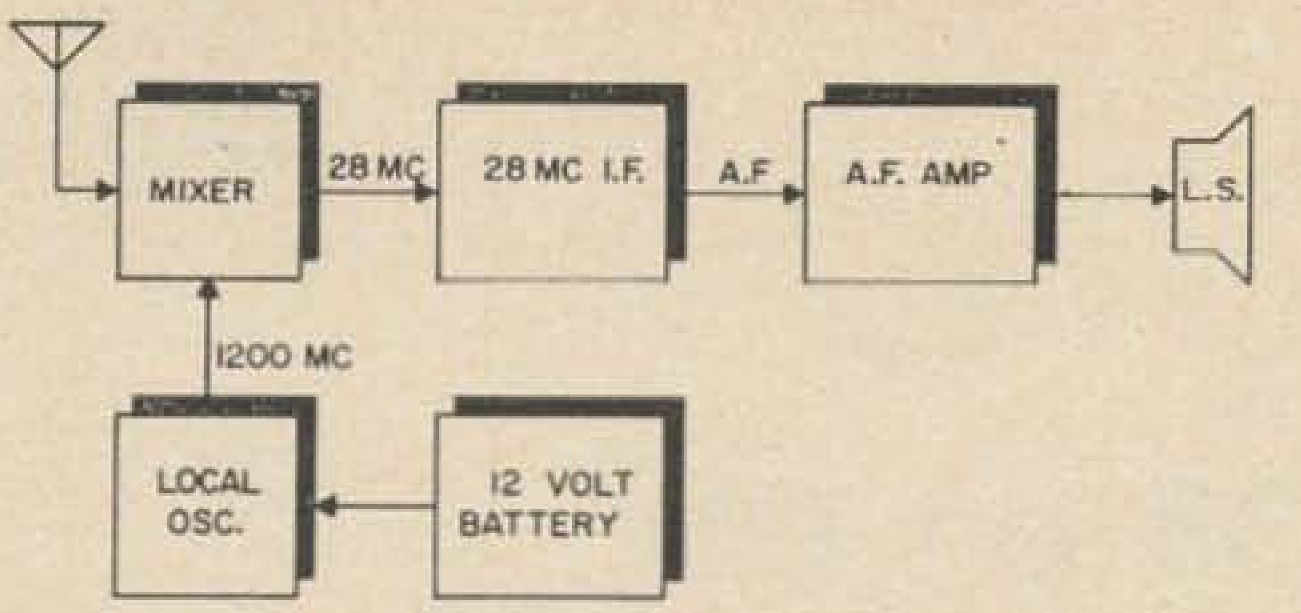


Fig. 5. Block diagram of the complete UHF receiver.

base voltage flexible and 10 k for R9 allows the diode a stiff control of that voltage. This circuit works fine as is with AVC control of the second stage only. I use a 1 ma meter in the collector supply for an S meter, shunted down with just enough resistance to read near 1 ma with not signal. I would suggest a good large meter with correct swing damping and possible a jack and plug, if you intend to use it for much antenna work with the receiver.

For alignment I used the 28 mc modulated transistor oscillator described in part II of this UHF receiver series. It was slid into a piece of waveguide (drainspout) 4½ inches wide, 2¼ deep and 2 feet long, making an excellent infinite attenuator. The usual $29 to $49 signal generators work all right for frequency determination, but as you probably know too well, they are no good for attenuation due to poor shielding, no filters in the power line, etc., on the higher frequencies.

The bandwidth of the amplifier is about one or two megacycles, depending on how you define bandwidth and how you use the amplifier. To sharpen it, you can convert to lower frequencies but it won't work with APX-6's then. To broaden the bandwidth use more stages, more neutralization and shunt resistors across the whole of each L1. My advice is to use **it as it is.**

Audio amplifier

Now for the audio amplifier shown in **Fig. 4.** I'm just going to give the af schematic with practically no talk. After all, you can buy af amplifiers ready made for less than $5. This one has worked well for several years. I built it because I can service it when it stops working instead of throwing it way. Suit yourself. I also use it as a modulator sometimes. R8, the emitter self bias resistor, should be checked carefully as follows: If you go over 5 ohms, distortion will increase, but the current and heating will be less in the 2N109's. As you go towards one or two ohms, more output power and less distortion on volume will be heard but watch out for heat and current creep in the transistors. The original amplifier uses 3 ohms.

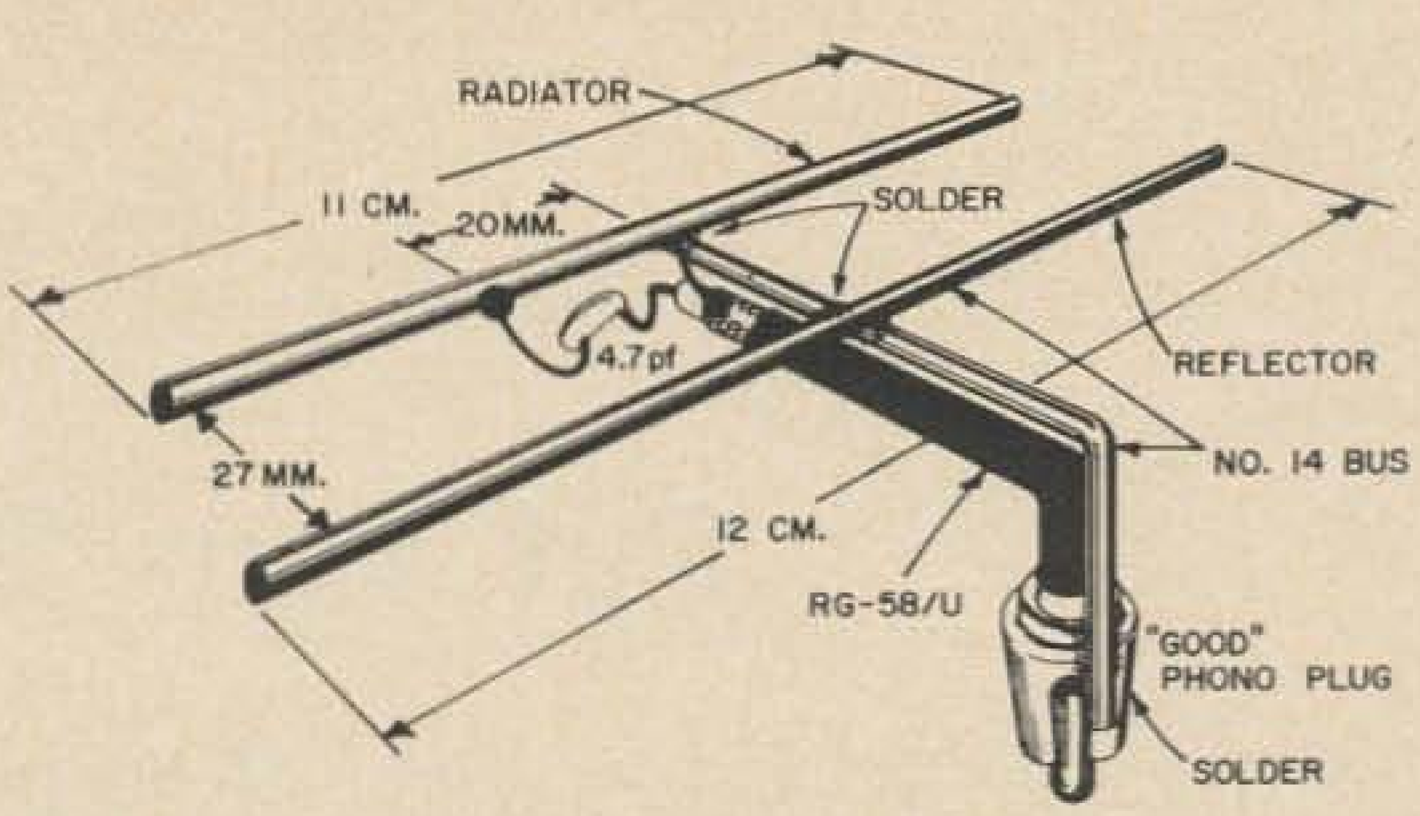


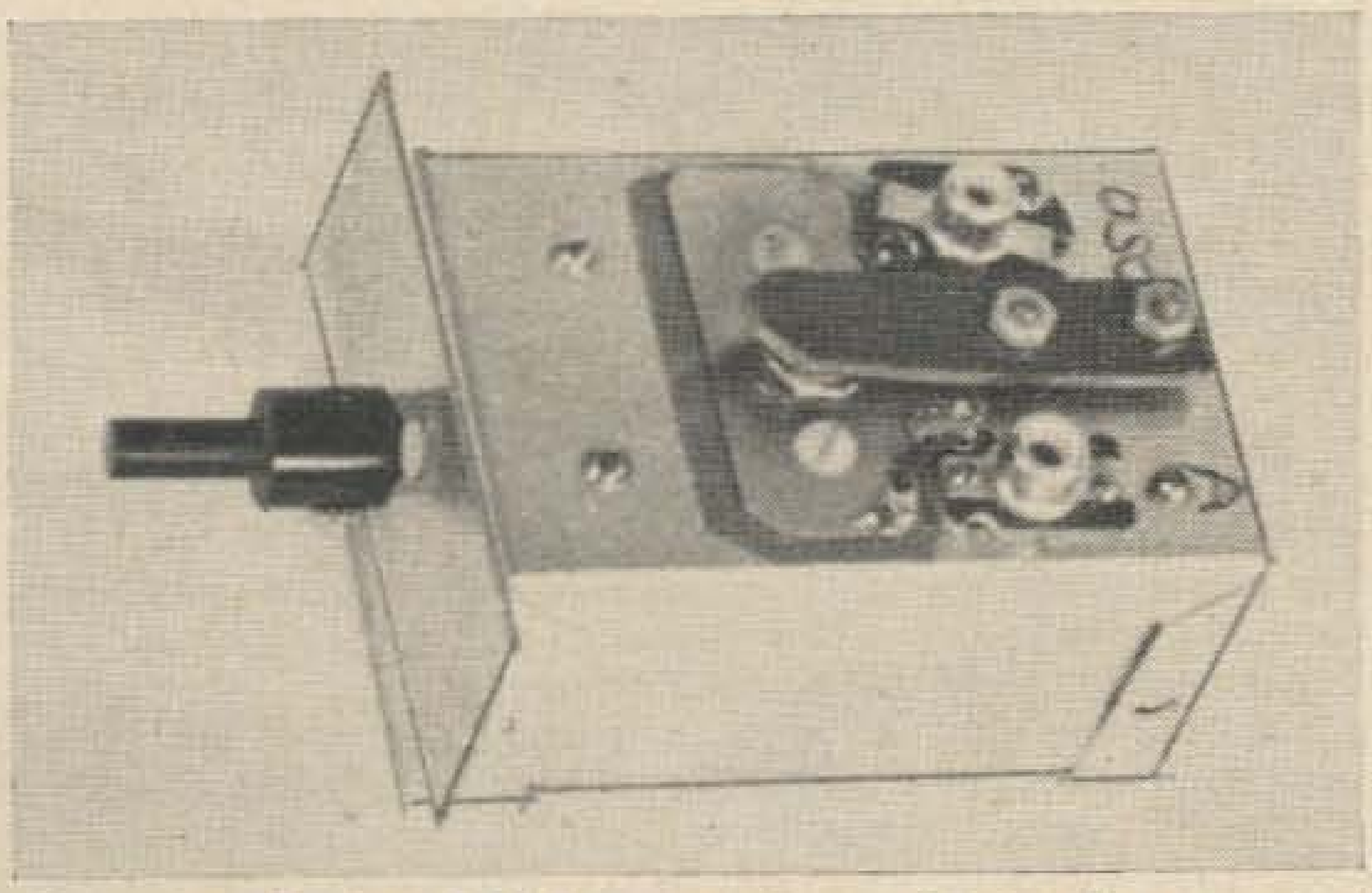
Fig. 6. Two element 1250 mc test antenna.

Receiver assembly

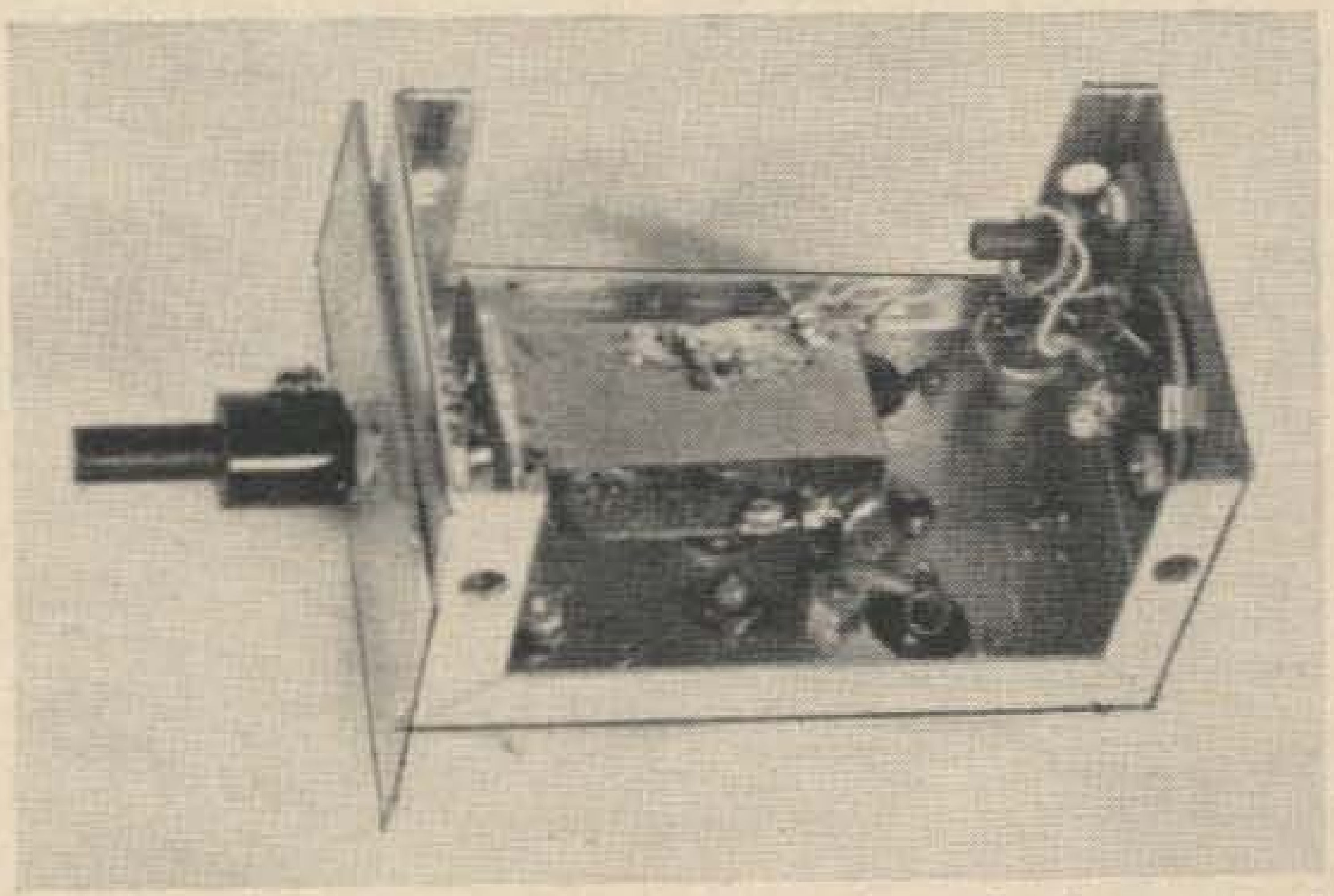
The mixer, local oscillator and battery are mounted on a small aluminum panel on the top shelf. **Fig. 5** shows the block diagram. Not much to it once you've built the units. A low impedance cable connects the mixer to the *if* amplifier, etc. You can, of course, condense this down a lot.

A two element test antenna is shown in **Fig. 6.** For more gain use the one described in the 1215'er article in May '65 73. Be seeing you on 1215.

. . . K1CLL



Outside of the 1215 mc mixer. Note the crystal holder between the oscillator and antenna jacks.



Interior of the 1215 mc mixer described in part I of this series.

John Schmid WA6PGA
Star Route (Jalama Road)
Lompoc, California 93436

Put Your SB-33 on CW

If you are one of those happy SB-33 (or SB-34) owners, chances are that you have regretted, at one time or another, the no-CW feature of your rig. If, on the other hand, you are contemplating the purchase of this little rig, but you are hesitating because of that same feature—hesitate no more!

The SBE transceiver model 33 can be put to CW use very easily. Less than one evening's work will do it. The same probably applies to the SB-34 and is even more worthwhile since it covers a part of the CW segment on all four of the available bands instead of just the 40M Novice portion. The CW "generation" described below may not be too orthodox and measurements have not been made to determine whether or not the transmitter remains within allowable power ratings, but the rig has been operated many hours in this fashion for more than a year and no trouble of any kind has developed. Reports on the air have been favorable without exception, including those obtained when specific queries were made as to keying characteristics, back wave, and such.

Following is the long list of needed items:

(a) one code key with normally-closed (NC) contacts[1].

(b) a length of something like RG-196/U coax; not more than 3 ft.

(c) one each ultraminiature plug and jack; Allied Radio 42H556 (45¢) and 44H995 (27¢)[2].

(d) an inch or two of #22 solid copper wire.

Take the chassis out of the case and carefully drill a hole into the front panel of 0.19 inch or 5 mm diameter. Locate the hole in the free space (check inside too!) bounded by the 3-position mode switch knob, the upper edge of the panel, and the meter. Now, don't lapse into convulsions just cuz it said "drill into the front panel"! The hole is quite small, and the jack to be inserted is indeed ultraminiature and will just about not be noticed. While drilling, do not allow metal chips to fall into the wiring. Insert the jack and don't overtighten the mounting hex nut. Connect and solder a short wire *directly* from the "hot" jack terminal to the lug on the front wafer of the mode switch that represents the junction point of one 180 pf capacitor and two 3.3 k resistors (the other end of one resistor is grounded and the other resistor ties to diode CR-5); see SB-33 schematic. This takes care of all the rig modifications.

Now connect the NC contacts of your key to the plug using that RG-196/U or equivalent, so that the key armature ties to ground, that is the sleeve of the plug. The partial schematic then looks like so:

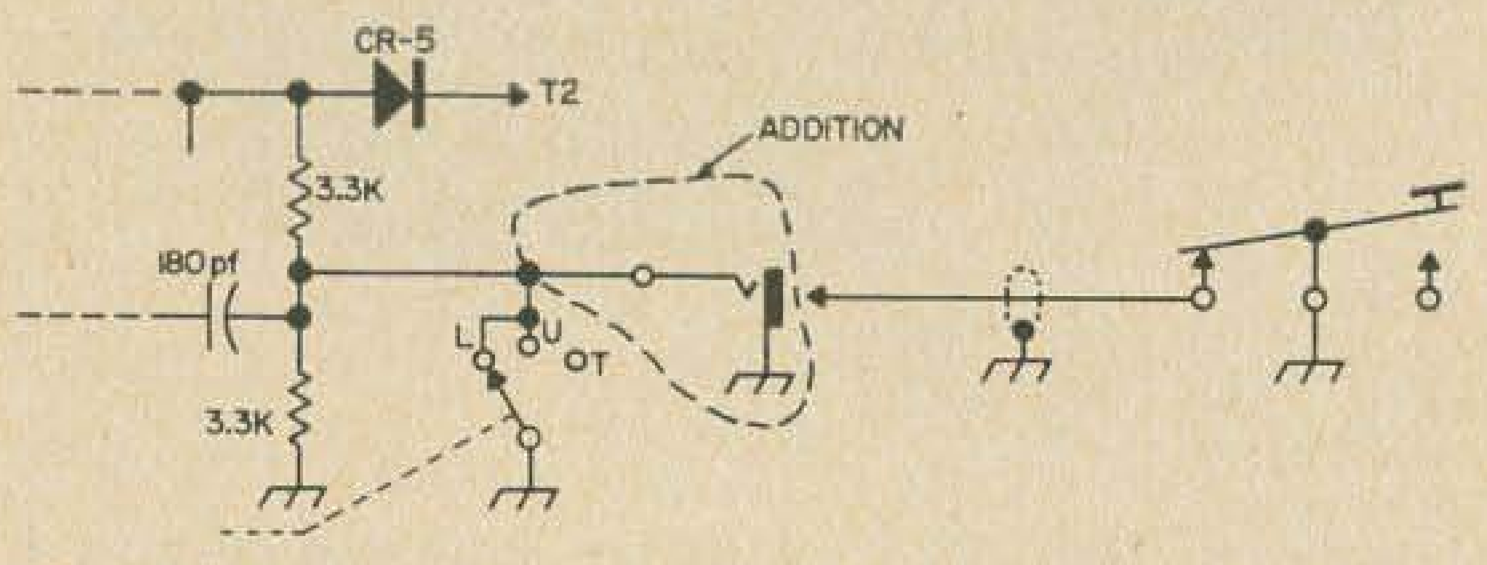


Fig. 1. Modifications to the SB-33.

Since an SB-34 diagram is not available to me, a short explanation of the principle of the modification is presented in the hope that also SB-34 owners will be able to convert their rig to CW use. All that hte modification, or better "addition," consists of is that the "measured amount of carrier inserted into the load resistor of the CR-5 Sideband Selector Mixer" is shorted to ground by the NC key contacts. Only when the key is actuated (with the mode switch on TUNE), is this carrier allowed to get into CR-5 and thus put a signal on the air. By the way, do not use any type of key click filter, the obvious reason being that you are keying RF and not DC.

To operate the rig on CW, tune the transceiver as before. Insert the key plug into the CW jack just installed. Place the mode switch to TUNE, and start on your first SBE CW QSO![3]

. . . WA6PGA

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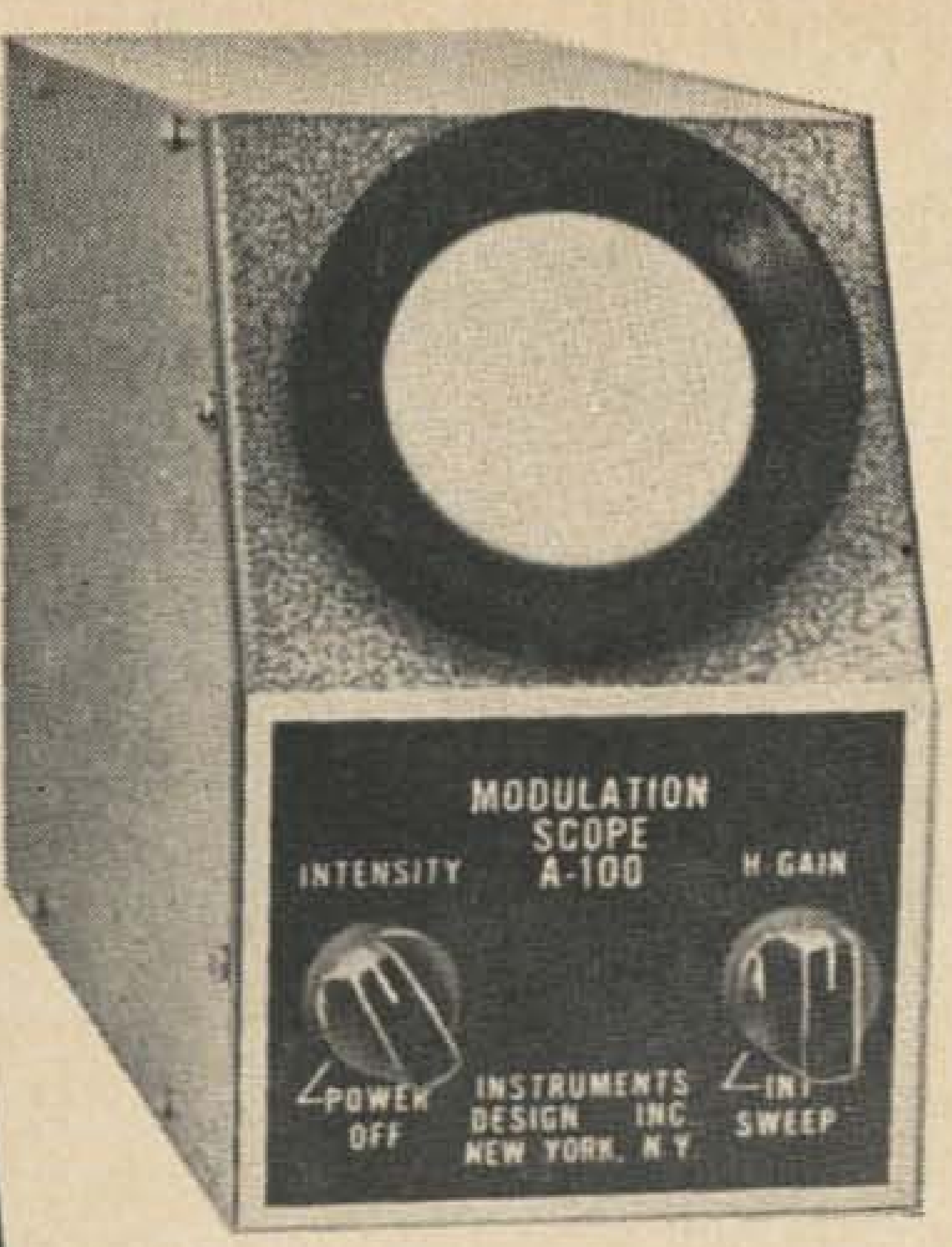
[1] If no NC contacts are available on your key, use the NO contacts to key an appropriately fast relay and use the NC contacts of the relay to key the rig. I'm using an electronic keyer operating into a C P Clare & Co mercury-wetted contact relay HGS-1009 which opens and closes within less than 3 msecs; you don't have to get quite that luxurious!

[2] If the jack has an internal normally-shorted contact arrangement, be sure to permanently disable this shorting feature when the plug is removed (or your carrier will be shorted to chassis whenever you are on TUNE with plug removed).

[3] A similar scheme to put the SB-33 on AM was in the February 1965 73.



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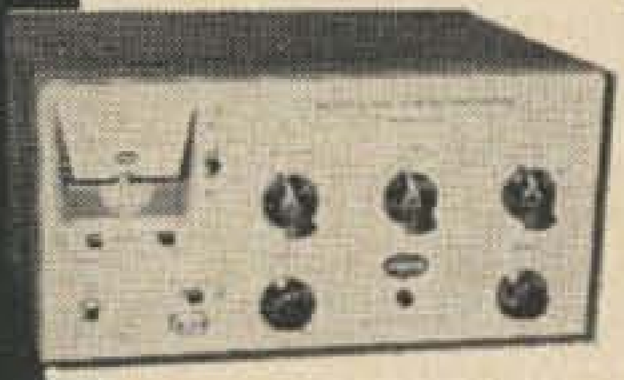

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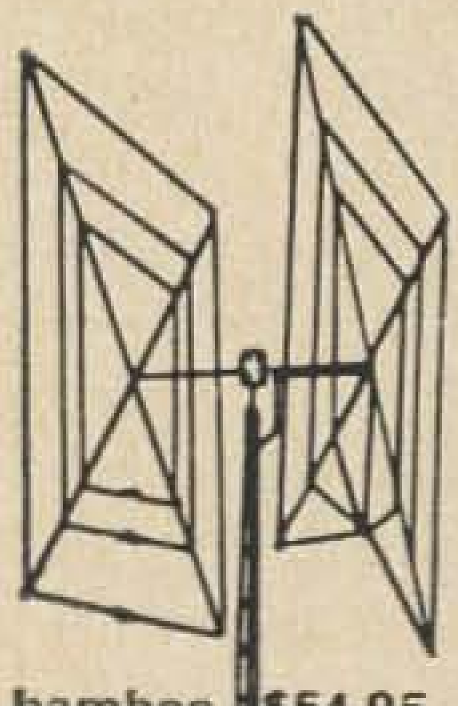

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73 Tests the Tunaverter

What's a Tunaverter? If you don't know, you haven't been paying attention to the ads in 73. It's a tunable transistorized converter made by Tompkins for just about any range you could want. Tunaverters are available for the 2-3 mc marine band, 160, 80, 75, 40, 20 and 15 m, and for 14-18 mc for short wave broadcasters (or VHF *if* use). The ham band ones are available with BFO's if desired. Another Tunaverter covers 37-50 mc for police and other utilities with 10, 6 and 2 m models coming up soon.

We received a model 800 Tunaverter for test. It covers 3.5-4.0 mc and has a built-in BFO. The circuit is quite simple. It's a one transistor autodyne converter with ganged tuning of the antenna and oscillator. The BFO is also tunable and uses another transistor.

Perhaps I've become a bit spoiled with all this complicated equipment around, but I really didn't expect much when I connected the Tunaverter to a little transistor radio using the recommended procedure (wrap a few turns of wire around the radio for coupling to the loopstick). After all, what can a one transistor converter do? I connected a short length of wire to the antenna jack—a terrible mismatch—and turned it on. The results were really quite amazing. The combination pulled in all sorts of 75 and 80 m stations and the planetary tuning was very smooth. Turning on the BFO partially blocked the transistor radio so that I had to turn up the volume, but even so, SSB and CW stations were very easy to tune and were received strongly. I then pulled apart the transistor radio and shorted the AGC and the results were excellent. Terminals are provided for this in the Tunaverter. The Tunaverter is stable, too.

Of course, the Tunaverter is really made for automobile use and a typical car radio is far better than a 6 transistor $6 portable. The Tunaverter has a special gimbel mount for installation in a car, and the circuit includes switching for connecting and disconnecting the converter from the car radio. It's made for 50 ohm input and has separate antenna connectors for the regular car radio and your ham antenna, but as you can tell from the above, worked well even with a short piece of wire or with a car antenna.

A feature of the 80 meter model without BFO (number 80) is that the *if* output is 550 kc so that it is perfect for novice CW use with a BC-453 Q-5'er. It would take a very good (and expensive) receiver to beat this combination for 80 meter Novice use.

The Tunaverter is 4½ x 3½ x 2¼" and has an attractive gray case with black knobs and lettering. The 9 volt battery fits inside and muting terminals are provided for use with a transmitter.

Tunaverters are $19.95 up and there are so many models that you really should get a data sheet. The converters are well made and perform excellently. For more information, write Herbert Salch and Co., Woodsboro, Texas.

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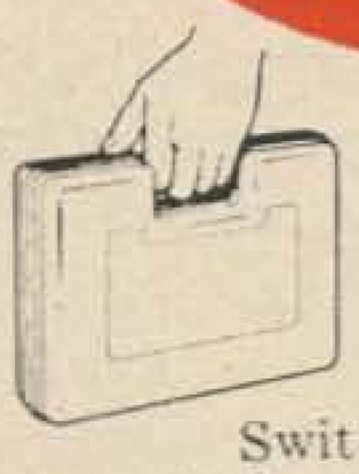

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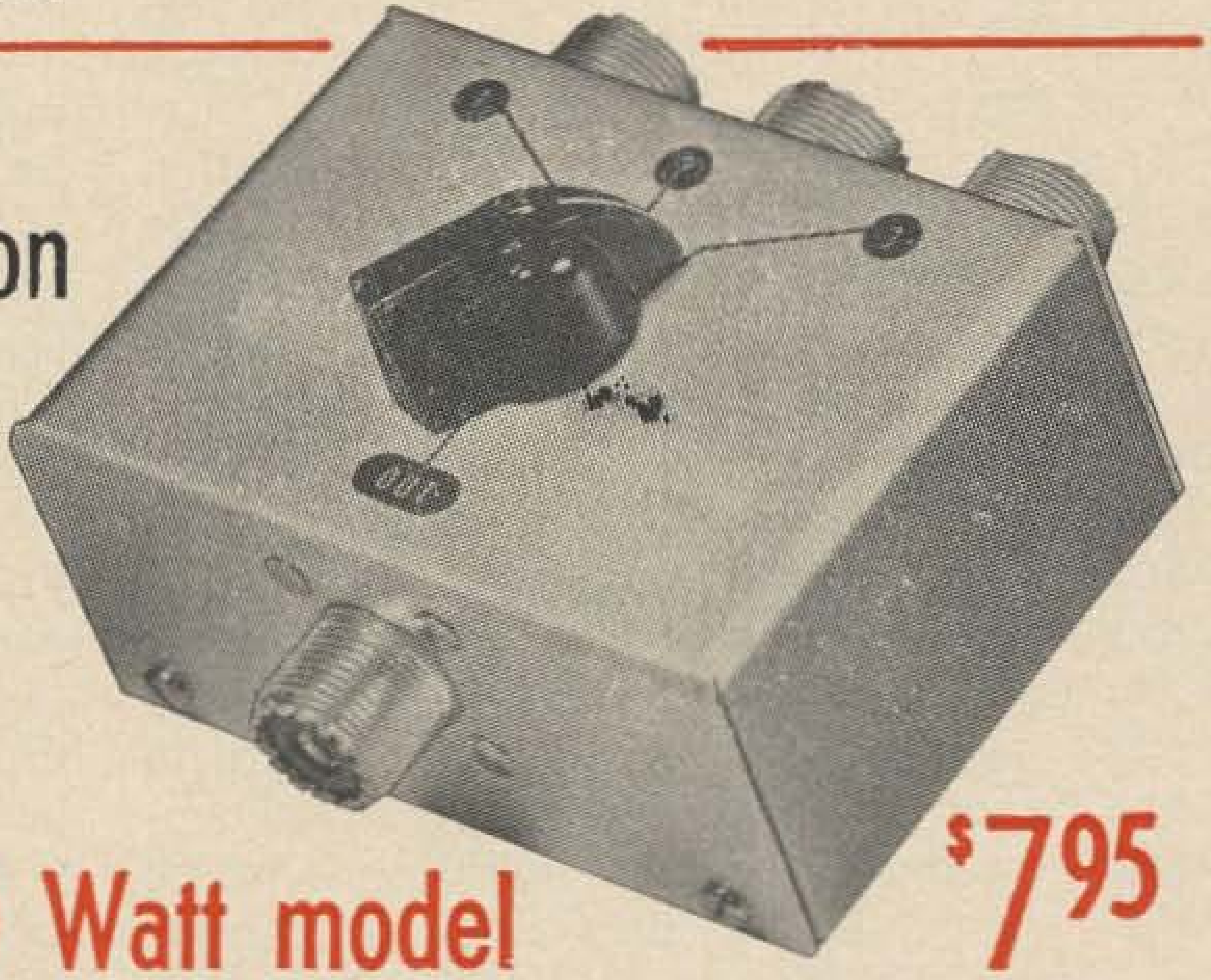

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How to Be a First-Class Lid on Phone

Without really trying

"LID"—a term used in amateur radio to denote a poor operator; one who is inept at the practice of the art.

Lids come in all sizes, shapes, and fashions. Some are beginners, with tickets brand-new; others have been cluttering up the airways since the infancy of amateur radio. Some incorporate only an occasional "liddism" in their radio operating practice, some are moderate and tolerable, while some few seem to work at it full-time.

The term "lid" in its original connotation was coined in the early days of amateur radio to describe the CW operator who was sloppy and careless in the formation of his characters, but nowadays in the phone bands the meaning of the term has been broadened to cover a multitude of other operating sins. This article attempts to deal only with liddisms of the spoken word, and not with other operating malpractices.

A first intimation that you are about to meet a lid on phone dawns when your conversation on the air is interrupted by a voice calling "break, break, break, break, break, break," very rapidly, a half-dozen or more times, usually with no identifying call sign given. I usually don't give this bird an opening at all; I let him wither on the vine, hoping he'll go somewhere else on the frequency to pester another operator and leave me alone.

Perhaps the most irritating lid is the operator who repeats back to you the gist of your previous conversation before going on with his own remarks. This practice always reminds me of the cow re-chewing a regurgitated cud. I get up on the edge of my chair and grip whatever is handy until the white shows on my knuckles when this lid comes along.

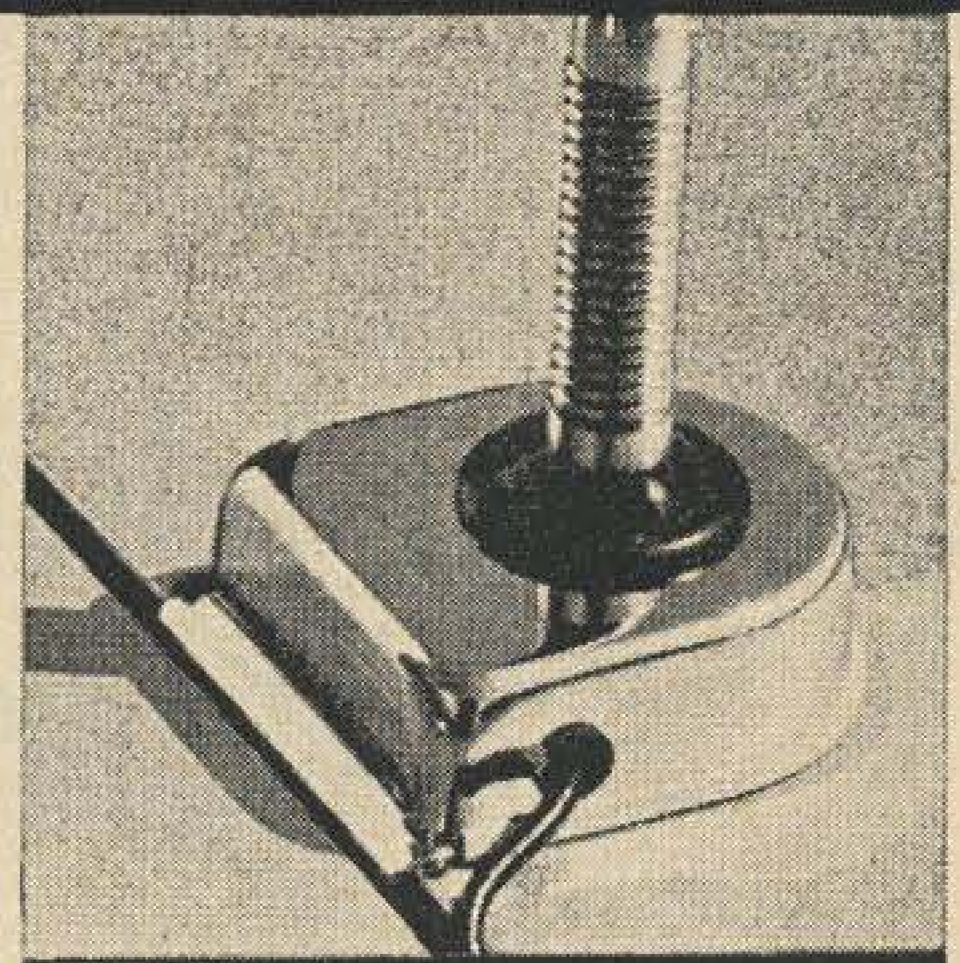
Still another liddism, and probably the one most commonly encountered on the phone bands, is the practice of the operator who engages in long, windy monologues, beating his gums on and on, ad infinitum, repeating himself several times and seeming not to know how to shut up and let someone else talk.

I can't tolerate this type of operator; he sends me walking off into the other regions of the house, muttering about giving up my ticket, smashing my receiver, etc. He is apparently a compulsive talker and lacks the ability to relinquish the mike. I suppose he must feel that, if he ever turns the mike loose, he'll never get a chance to talk again, so he has to say it all while he's got it. And say it all he does—not once, but usually several times, repeating himself over and over.

This operator, as much as any other single factor, drove me from AM to a KW Sideband; when this fellow turns up in a round table, I just talk right through his filibuster. Fortunately, most other sideband operators don't like this fellow either, and several have been broken of the habit when they realize they're being talked through on their filibusters.

Inanities and just pure drivel make up a lot of the liddisms one hears on the phone bands. When I hear an operator state that he is going to "turn it over" or "ship it back" to another station, with so-and-so "in the side pocket," I gnash my teeth in anguish. Another hackneyed term is "fine business"; for the lid addicted to its use, everything is "fine business," from the beginning signal report to the final "73," ad nausea. How this one got such universal acceptance by the lid fraternity is beyond me.

Another bit of lid drivel is the practice of giving one's name phonetically when it is a common, easily understandable name to begin with. For instance: "The handle is John—J-O-H-N, Jonathan, Oscar, Henry, Nancy." Or another one: "Bill—B-I-L-L, Baker, Ida, Love, Love." For Pete's sake, fellows, don't you realize that if your listener can catch those



cotton-picking phonetics, he can understand your name in the first place, and the phonetics are a bunch of tommyrot?

I am also shook by the lid operator who, when he has said something he believes to be funny, supplements it with the word "ha," and then laughs in addition. You'd think he would realize that the two mean the same, and the use of both together is redundant.

Finally, have you heard the jerk who calls CQ a dozen times, then gives his call eight to ten times, then calls CQ another dozen times, then announces he's standing by? My reaction is to wonder just what he's standing by; he should be exhausted and in dire need of lying down to rest after the expenditure of that much energy. Seriously, such a long CQ call when the band is open usually results in a half-dozen or so fellows answering at once, on top of each other, and the resulting QRM is so bad that the lid who called can't separate the answering stations. He has defeated his purpose with the long CQ, and would have been much better off, along with everybody else on the band, to have given a series of short calls, with listening periods in between.

There are many other phone band liddisms in current practice. We have all been and still are addicted to the occasional practice of them to some extent. I catch myself in a recognizable liddism frequently, and no doubt engage in many which I don't recognize but which irritate my friends in much the same manner in which the ones here listed irritate me. The ones I've written about are by no means all, and you, gentle reader and amateur operator/listener, will no doubt be able to add many more to the list.

I am not deluded into believing that this article will have any effect whatsoever on lid operations on the phone bands. Each of us will be quick to recognize that old Joe Blow, or old So-and-So, has this or that fault, but very few will admit, even privately, that we are guilty of any liddisms in our own amateur practice. So the liddisms will continue to flow, and I will continue to grip tightly whatever is handy and the veins will stand out on my face and I will mutter profanely under my breath (to keep from tripping the vox), and you will do the same when I commit a liddism, and we will all continue along in our same old merry way. The leopard doesn't change his spots overnight, and neither will the amateur fraternity change its operating habits. So—shipping it over to you, gentle reader, with old So-and-So in the side pocket, this is . . .

. . . WA5DEL

Doug Jensen K4DAD
6306 Liverpool
Houston, Texas 77023

Some Ideas on Noise-Free CW Reception

The pursuit of single-signal cw reception has generally lead to the use of highly selective *if* and af filters. Unfortunately, the use of sharp filters inevitably results in severe signal distortion, since the shortest rise time a signal may have in order to pass undistorted through a filter is equal to the reciprocal of the filter bandwidth. Because the maximum rise time of a signal at 455 kc is about 10 microseconds, a filter that would pass it without distortion would have to have a bandwidth of at least one megacycle! As the filter bandwidth gets narrower than this minimum, the filtered signal becomes less and less intelligible. The primary deterioration a signal suffers in passing through a narrow filter is called ringing. This effect is caused by the originally square edges of the cw wave becoming sloped by the filtering action. The dits and dahs then become less distinct and melt into a hollow mush.

In a recent article,[1] W6OI revived a much-neglected technique which permits single-signal cw reception without the destructive ringing and background hash that usually results from the use of a selective filter. The idea is to use the receiver audio output and to key an outboard audio oscillator. This oscillator follows the received cw signal, providing the listener with a crisp clean signal free of distortion and background noise. The way W6OI does this is to hang a 1 kc filter followed by a 1 kc tuned audio amplifier on the receiver audio output. The rectified and filtered output of this tuned amplifier is then used to drive a relay to key the audio oscillator. However there are limitations in W6OI's method, basically due to his use of a relay and its associated circuitry to key the audio oscillator. Relays are subject to a hysteresis effect, which means that it takes less voltage to hold a relay closed than it does to close it initially. A look at the sensitive plate relay spec sheets of several manufacturers shows hysteresis effects of 20 to 80 percent. That is, the relay control voltage may have to drop to 20 percent of the value needed to close the relay before the relay will open. In cases of low signal-to-noise ratios the signal voltage may be only a small percentage greater than the noise voltage. So in no-signal periods the noise voltage will be close enough to the noise-plus-signal voltage to keep the relay closed between characters or parts of characters. When selectivity enough to cause ringing is used, the sharp edges of the cw wave are

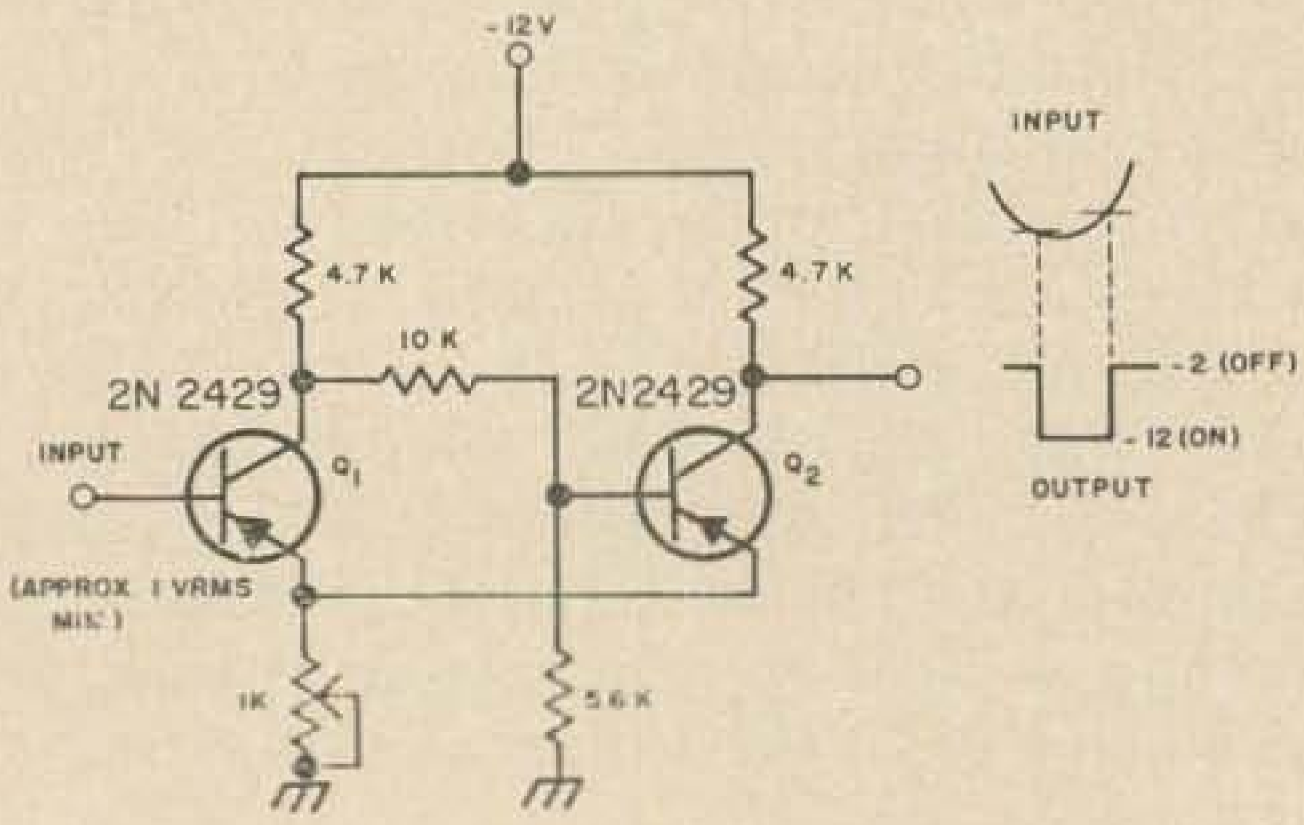


Fig. 1. Schmitt trigger.

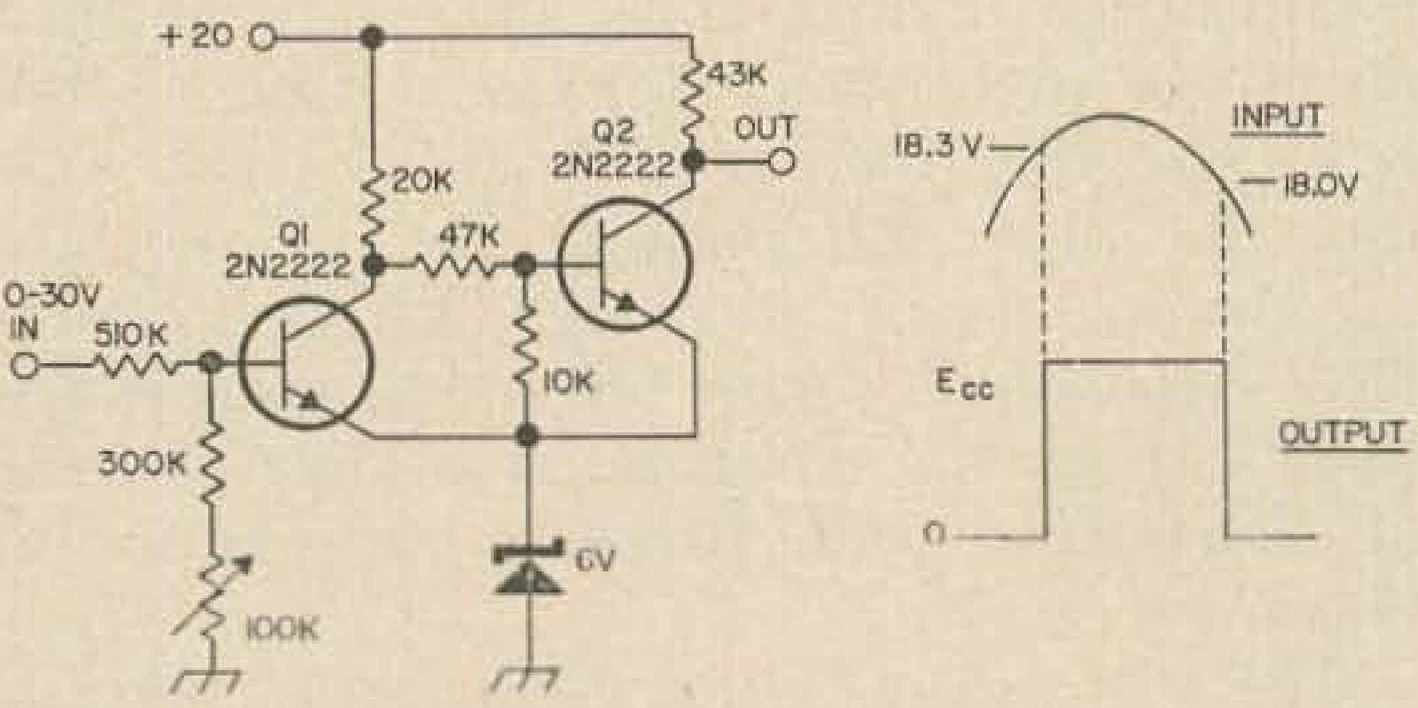


Fig. 2. Using a zener diode to reduce Schmitt trigger hysteresis.

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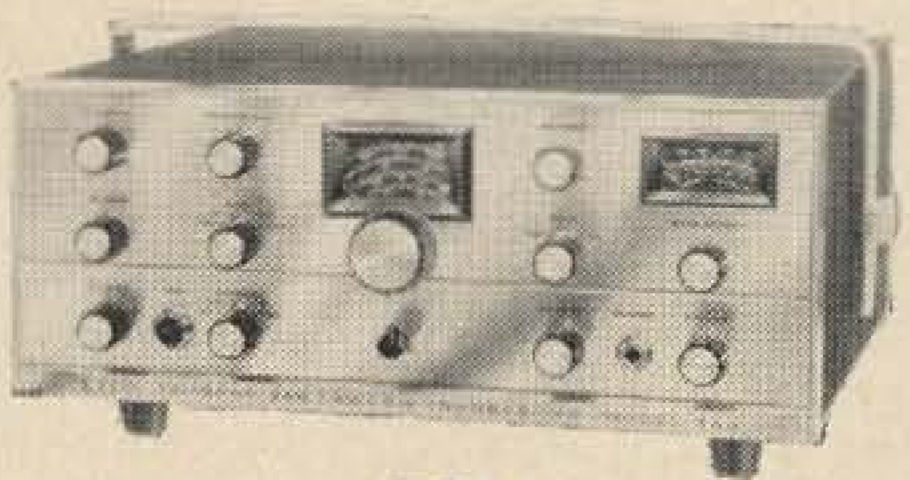

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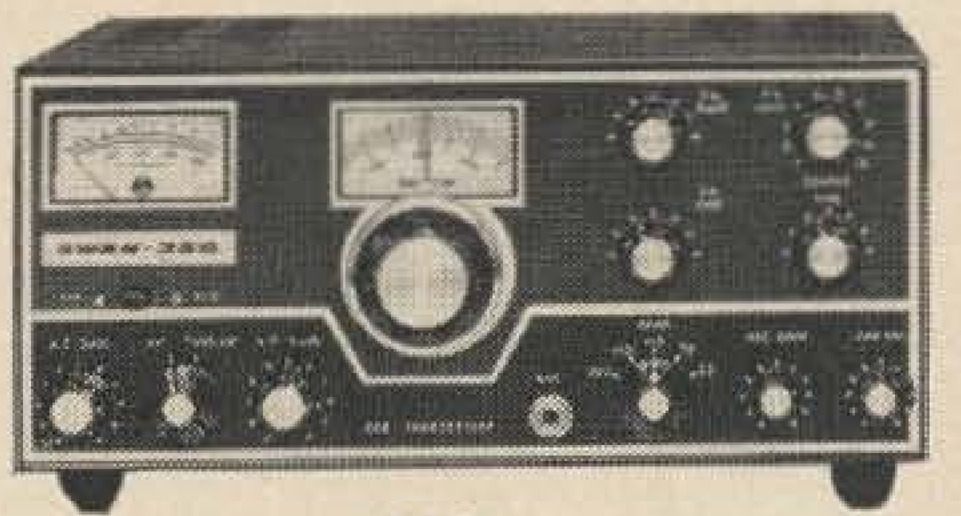

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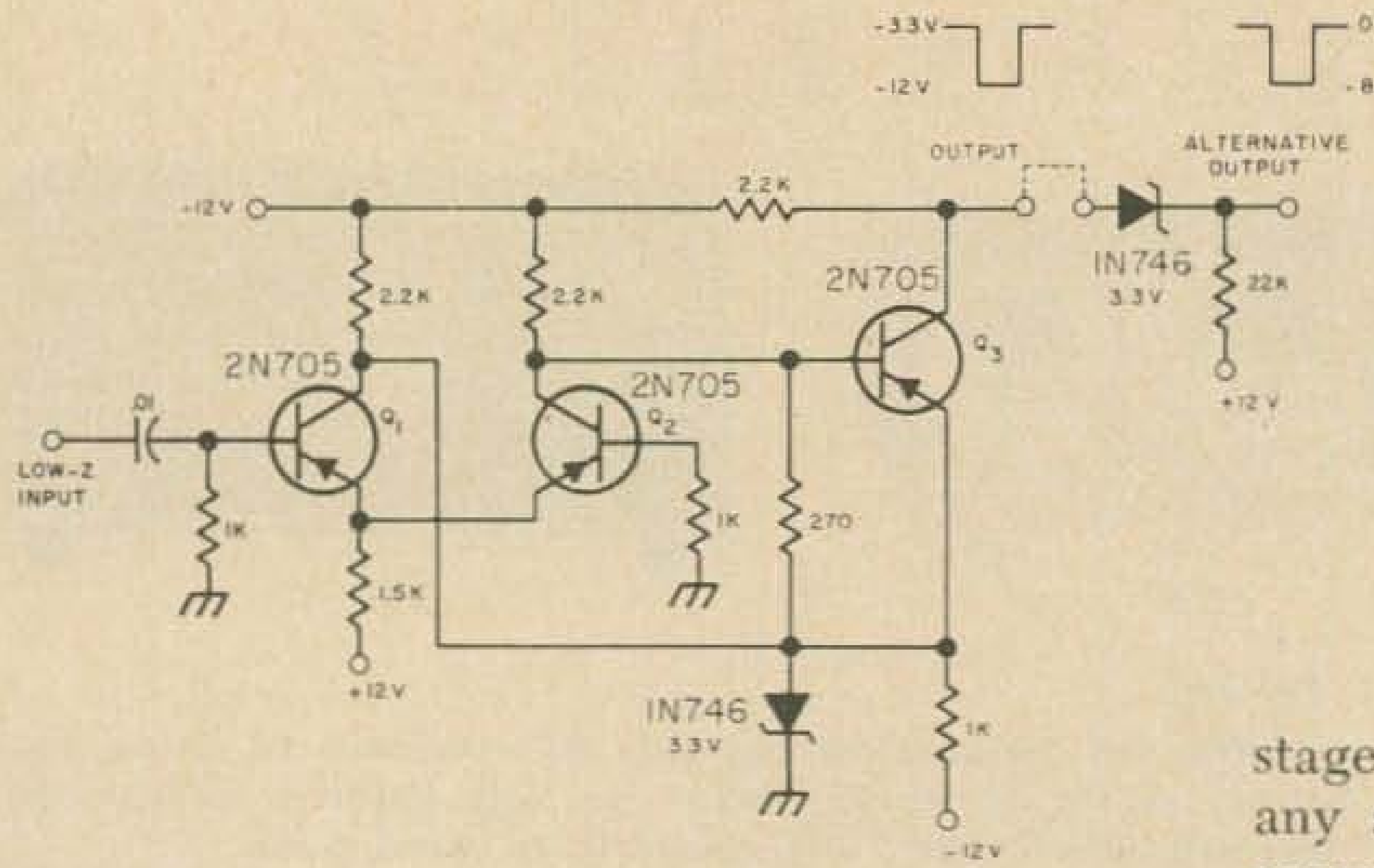

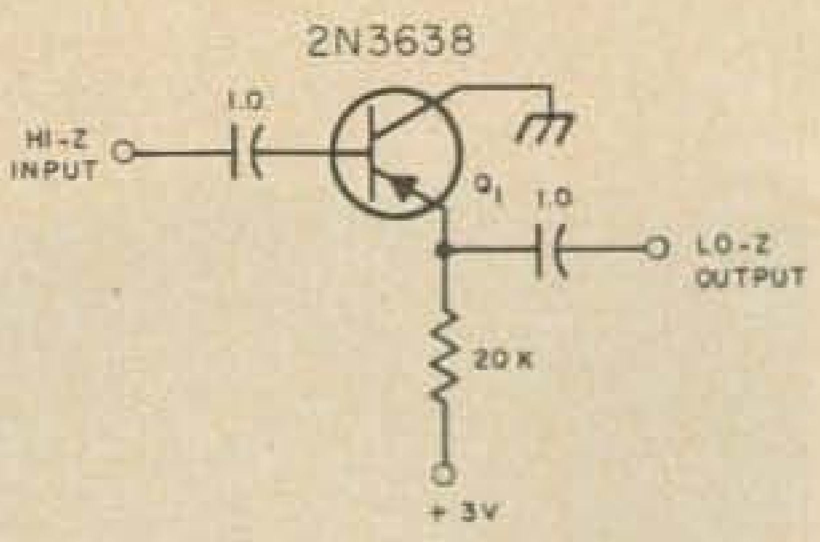

Fig. 3, left. Squaring circuit with no hysteresis. Above, Fig. 5. Emitter follower.

lost, and it is even harder for the audio oscillator to follow the signal. The addition of a dc filter in front of the relay makes a bad situation worse, since it tries to even out the difference in amplitude between the signal and the noise. As the code speed increases, these deteriorating effects cause more and more trouble.

What is needed is an electronic switch to replace the relay. In particular, we want a switch with an adjustable turn-on voltage; we would also like the switch to produce a square output voltage to control the audio oscillator. A popular circuit for switching purposes is the Schmitt trigger. The Schmitt trigger is a bistable amplitude-sensitive device which rests at an "off" output voltage when the input signal is below the turn-on threshold, and flips to an "on" output voltage when the input signal is at or above the turn-on threshold. When the input signal comes back down through the turn-off threshold (usually somewhat lower than the turn-on threshold), the Schmitt trigger falls back to its "off" state. The regeneration of the circuit causes rapid switching between states, which means that the output voltage will have vertical leading and trailing edges. The output wave will also be flat on top, because the input stage of the Schmitt trigger is saturated by any signal above the turn-on threshold. This means that the Schmitt trigger's output voltage is rectangular-ideal for controlling the audio oscillator, as a source of either unblocking or anode supply voltage. The turn-on threshold is set through cathode biasing. By using a variable bias control, the input voltage required to trigger the circuit can be adjusted, providing a means of discrimination against QRM and ringing.

Fig. 1 shows a typical Schmitt trigger. This circuit produces off and on voltages of zero and minus twelve volts, respectively. The switching time is about 12 microseconds at 300 cycles. This trigger is stable from −50 degrees F. to 170 degrees F. There is about a ten percent difference between the turn-on and turn-off thresholds of the Schmitt trigger illustrated. Unfortunately, it is this difference between the thresholds that makes Schmitt triggers only slightly more efficient than relays for our purposes.

The Schmitt trigger's electronic version of the relay's hysteresis can usually be eliminated only at the expense of output wave rectangularity. But Fig. 2 shows how this hysteresis may be greatly reduced without such a sacrifice. The trick is to replace the Schmitt trigger's usual feed-back resistor with a zener diode. The trigger of Fig. 2 has a threshold difference of 4 volts, or more than 22 percent,

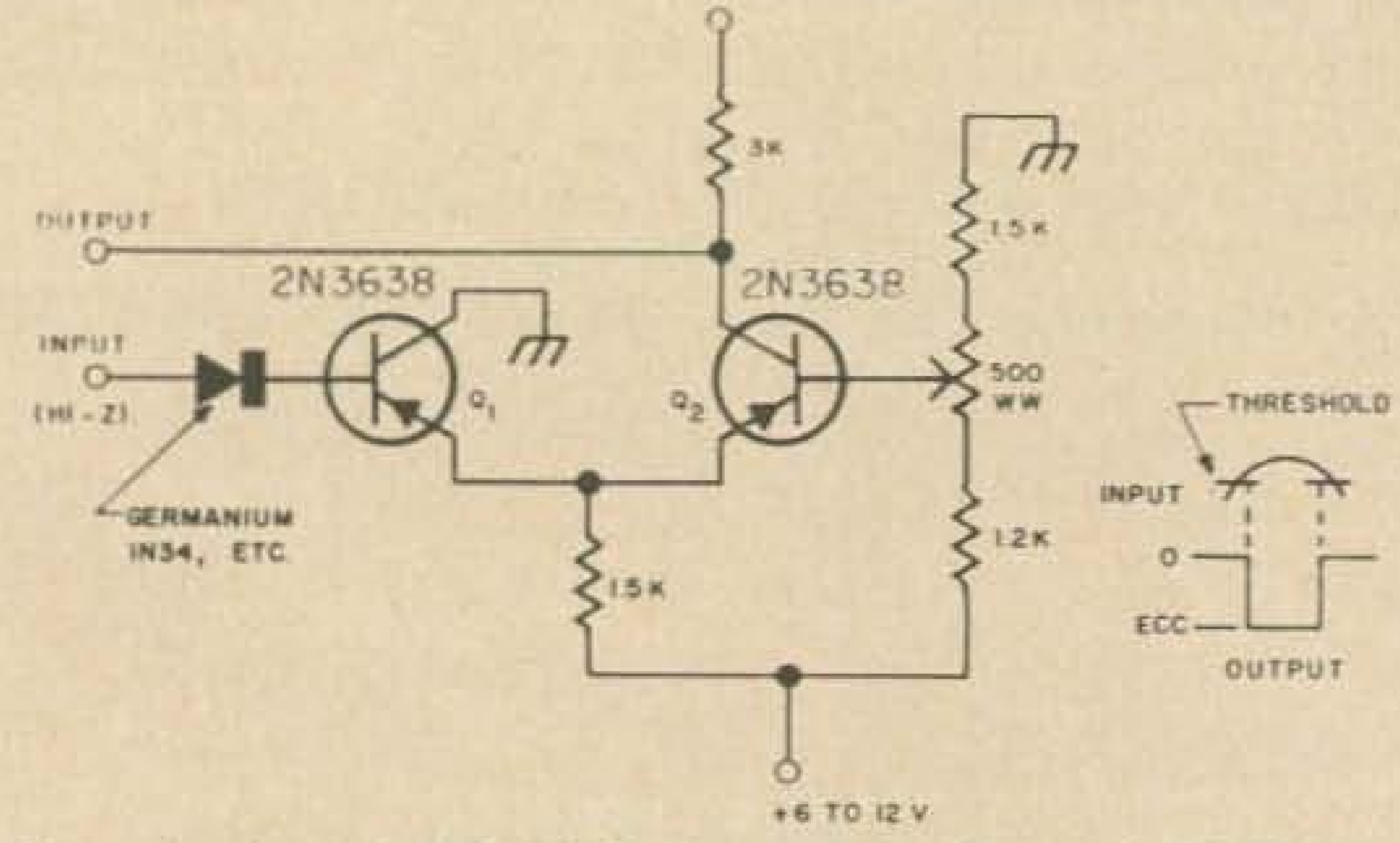

Fig. 4. Amplitude-difference amplifier (ADA).

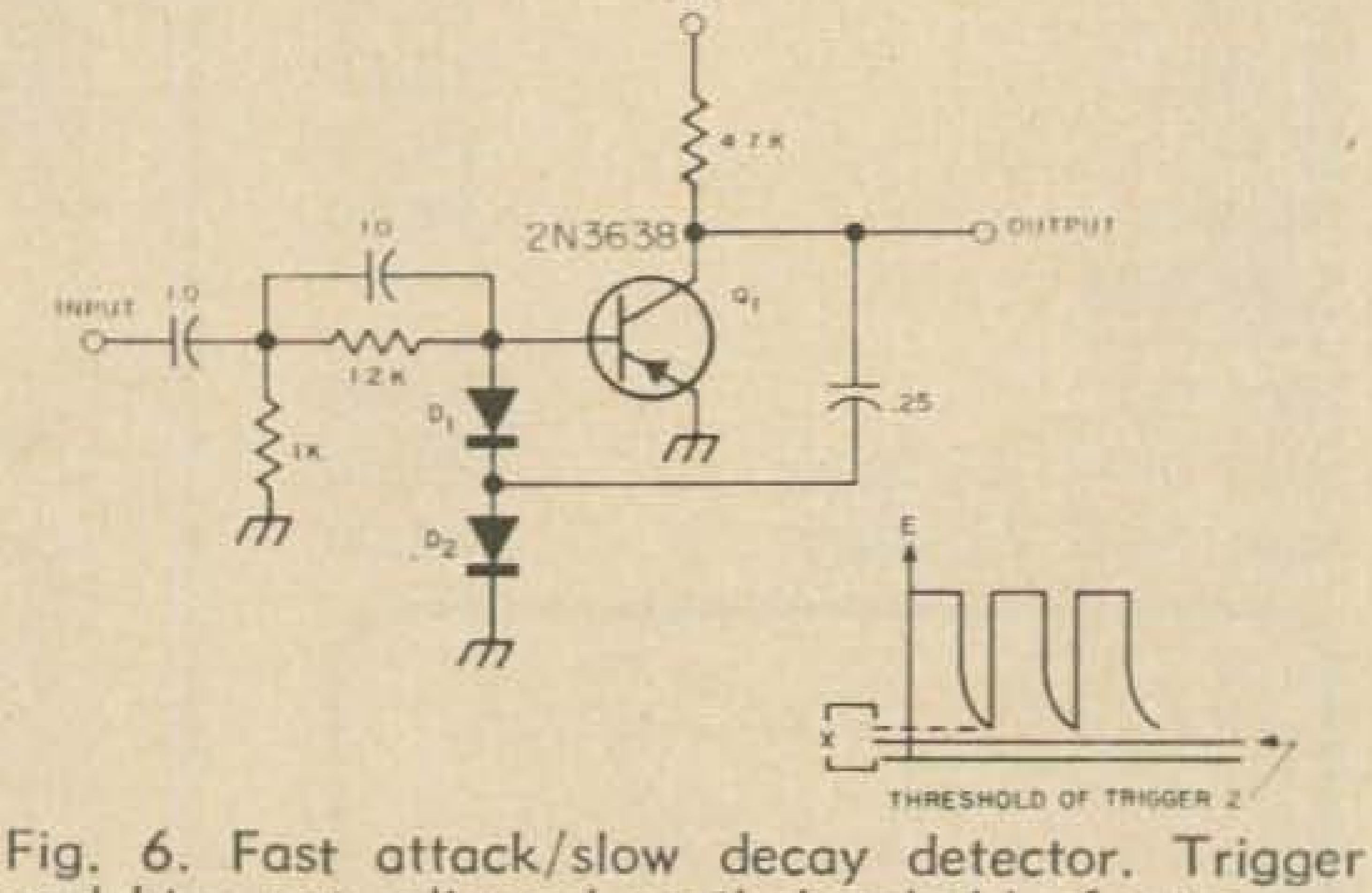

Fig. 6. Fast attack/slow decay detector. Trigger and bias pot adjusted until threshold of trigger a is in region x.

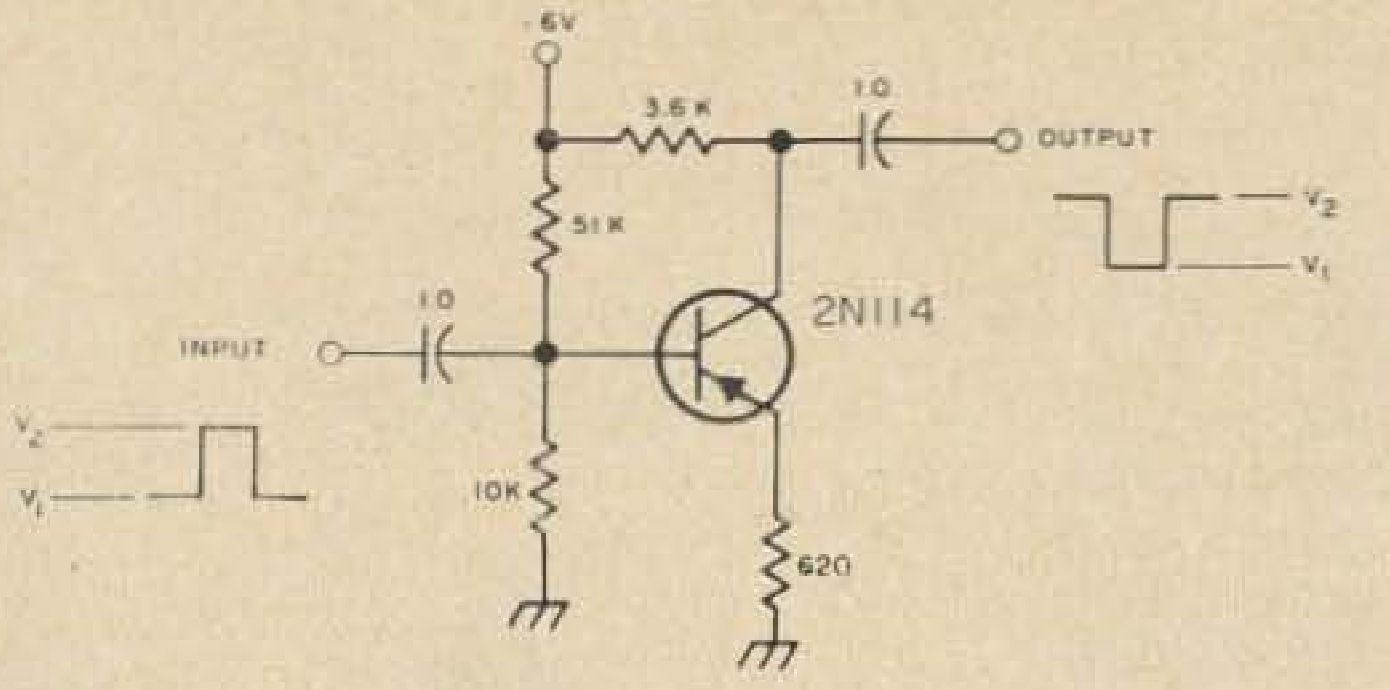

Fig. 7. Pulse inverter.

with the resistor in the circuit. This drops to three-tenths of a volt, or 1.6 percent, when the diode is used instead.

To eliminate this dilemma entirely, it is best to try another switching circuit. Fig. 3 shows one that displays several advantages over the Schmitt trigger. It does not suffer from poor symetry due to hysteresis, and has greater sensitivity (as well as better thermal stability). This circuit consists of a current-mode inverter (Q_1, Q_2) driving a saturating inverter (Q_3). The high degree of sensitivity and stability is due to the symmetry of the inverter. Here, the rise time of the output wave is only 50 nanoseconds.

Another choice might be the amplitude-difference amplifier (ADA) illustrated in Fig. 4. The characteristics of this circuit are similar to those of the Schmitt trigger, except that there is no hysteresis effect. The non-regenerative nature of this circuit results in a rise time of 800 microseconds at 300 cycles. It also has less thermal stability than the previous circuits-performance deteriorates at 140 degrees F. The diode in the base of the input transistor is essential, as the power supply will otherwise be shorted on the negative half-cycles of the input signal. The two transistors to be used here should be checked for beta, and the highest gain unit used as the input transistor. The collector supply voltage would best be chosen with regard to the amplitude of the input signal. If the turned amplifier delivers several volts to the trigger, the collectors should be at about 12 volts; for smaller input signals, 6 volts is better.

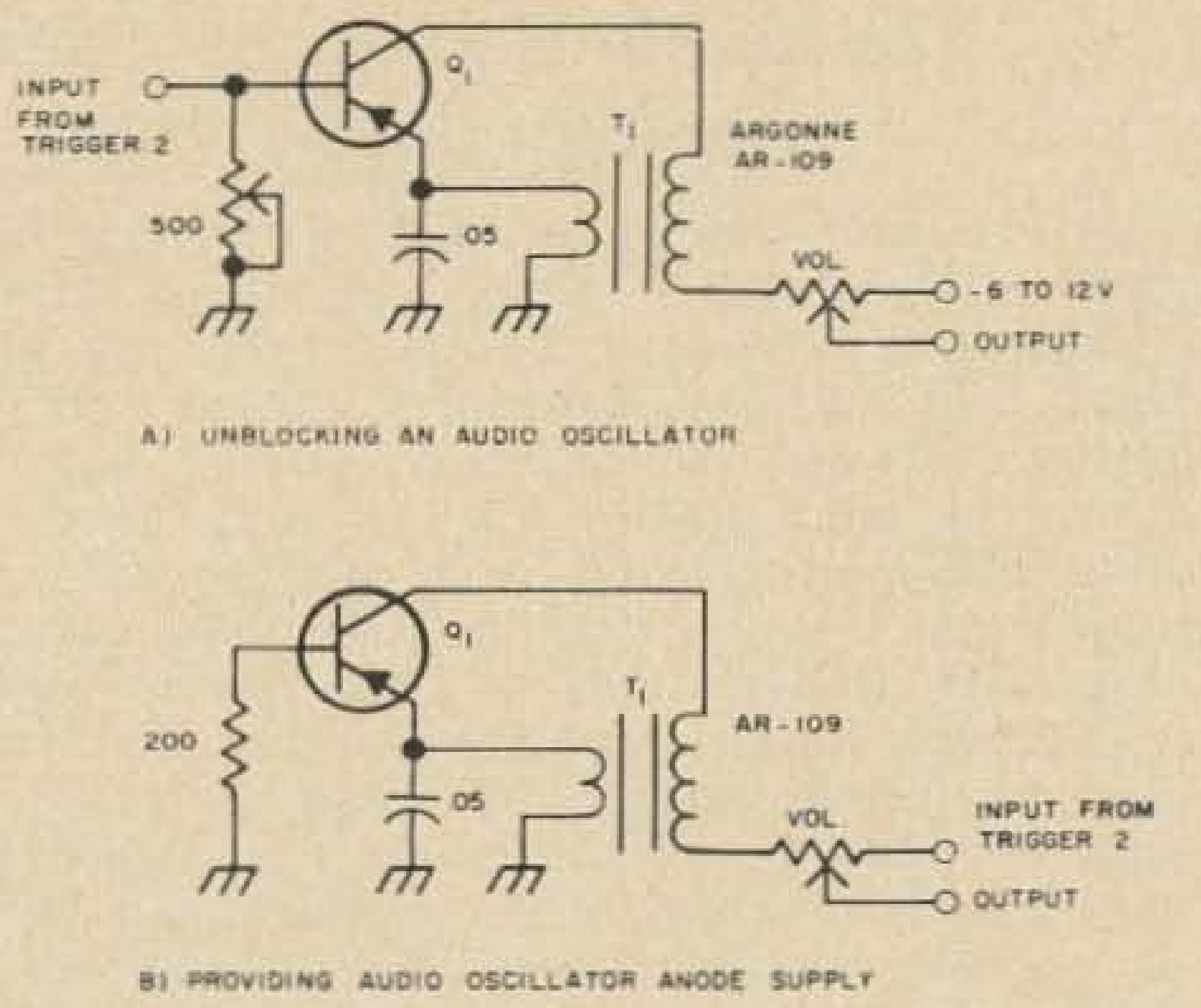

Fig. 8. Using audio oscillator. Q1 is any general purpose PNP transistor with a collector rating of over 12 volts. These are for use with negative going trigger output. Adjust 500 ohm pot in A for correct unblocking action; i.e., oscillation with trigger on and no oscillation with trigger off.

In any of these triggers, the use of a ten-turn linear pot for threshold adjustment will be found to be of great advantage. Also, the components and power supply should have a ten percent tolerance or better. To avoid loading the trigger, it is followed by a simple emitter-follower. Since an emitter-follower operates class A, turn-on time is minimized and transition time is reduced. Thus, this type of circuit will do nothing to damage the fast rise time of the trigger. The emitter-follower drawn in Fig. 5 has a voltage gain of .9 due primarily to the transistor base-to-emitter drop, but it has a current gain equal to the transistor beta/alpha ratio. The power gain from the follower is then considerable.

Since the input to the trigger is an audio sine wave, the output is a string of square waves at the same frequency. Applying this directly to the audio oscillator would result in an audio tone very uncomfortable to listen to. We want to have a dit or a dah come out sounding like a dit or a dah, not like several hundred little tones each a millisecond long. The thing to do is to stretch a dit or dah's worth of little pulses from the trigger into one pulse just as long as the dit or dah. An easy way to do this is to use a fast-attack/slow-decay detector and another trigger. Since hysteresis is not important here, an ordinary Schmitt trigger will do as well as anything. The detector and its associated waveforms

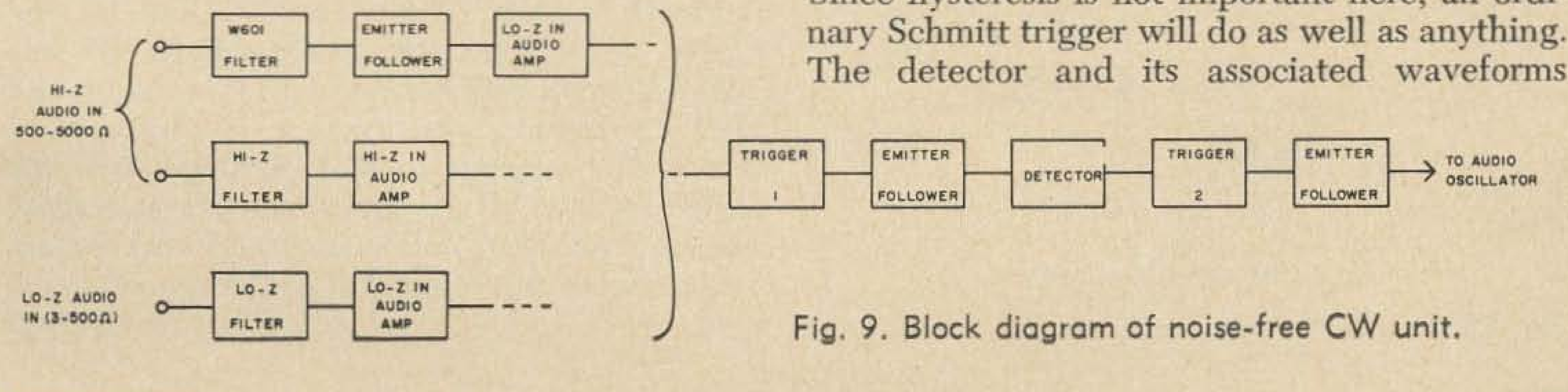

Fig. 9. Block diagram of noise-free CW unit.

The Radio Society of Great Britain Amateur Radio Handbook

This fabulous 540 page hardbound handbook completely and thoroughly covers every aspect of amateur radio; tubes, transistors, receivers, transmitters, vhf gear, antennas, sideband, FM, mobile equipment, noise and interference, propogation, keying, modulation, power supplies, measurements, operating and station layout and much, much more. It is completely illustrated with photographs and drawings. This handbook is very well written and completely understandable. The RSGB tries to help hams improve themselves, so it includes much necessary technical data that some American handbooks ignore. For instance, suppose you want to design a linear for SSB. The Brand X Handbook devotes about four pages to description, including a table of typical values of popular tubes. The RSGB Handbook gives 13 pages to them, plus many pages of construction, figuring bias, resting current, circuit constants, efficiency, etc. The RSGB Handbook is a necessity for the building, technically minded ham. Even if you don't build, this book will help you understand your equipment and radio better. In stock for immediate delivery if you order now. $5.50

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73 Magazine

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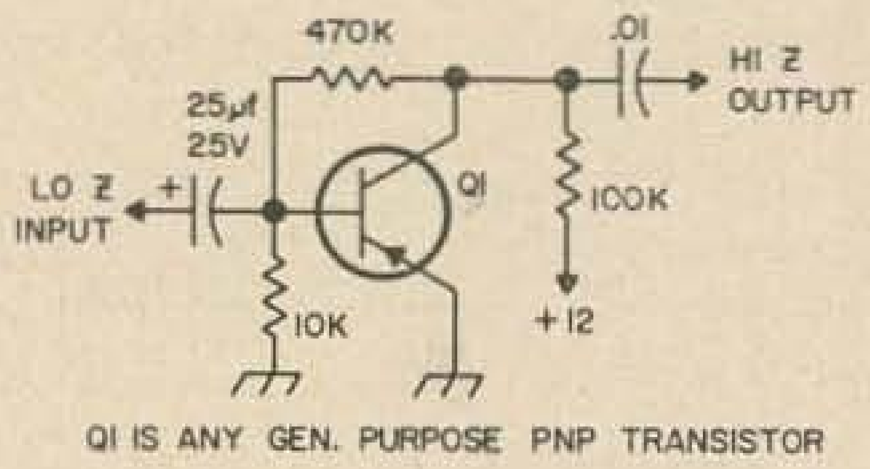
are shown in Fig. 6. The detector pulls the trailing edge of each pulse over into the leading edge of the following pulse, bridging them together at their bases. These go into a second trigger with its threshold adjusted low enough to be in the bridged-together portion of the detector output wave. This trigger then produces a pulse that is almost exactly as long as the original dit or dah. The slight hang-on at the end will be no longer than one-half cycle of the input signal to the first trigger. This second trigger's output voltage is then applied through another emitter-follower to the audio oscillator. If a positive-going signal rather than a negative-going one is desired for this purpose, a suitable inverter is given in Fig. 7.

The incorporation of all this into a noise-free cw unit is quite straightforward. The audio input may be taken from the receiver either at a low impedance point such as the speaker terminals, or at a high impedance point such as the earphone jack. The major consideration involved in the organization of these circuits into a complete unit is impedance matching. The receiver output impedance must match the filter input impedance; the filter output impedance (usually the same as its input impedance) must match the audio amplifier input impedance; the amplifier output impedance must match the trigger input impedance; the detector output impedance must match the second trigger input impedance. To prevent loading a trigger or to provide a low-to-high impedance transition, an emitter-follower may be used. To go from high to low impedance, the circuit of Fig. 5 is appropriate. Filters and audio amplifiers with the desired characteristics can be found in the Handbook, semiconductor reference manuals and ham magazine articles.



QI IS ANY GEN. PURPOSE PNP TRANSISTOR

Fig. 10. Low Z to high Z adapter.

Operation of the noise-free cw unit is as outlined in the W6OI article, but if the device is to be used in situations of low signal-to-noise ratios, heavy QRM, ringing, and high cw speeds, performance of this version will be far superior to that obtained from the W6OI version. Here, the receiver's selectivity can be fully used and augmented without adverse effects on the quality of the signal.

. . . K4DAD

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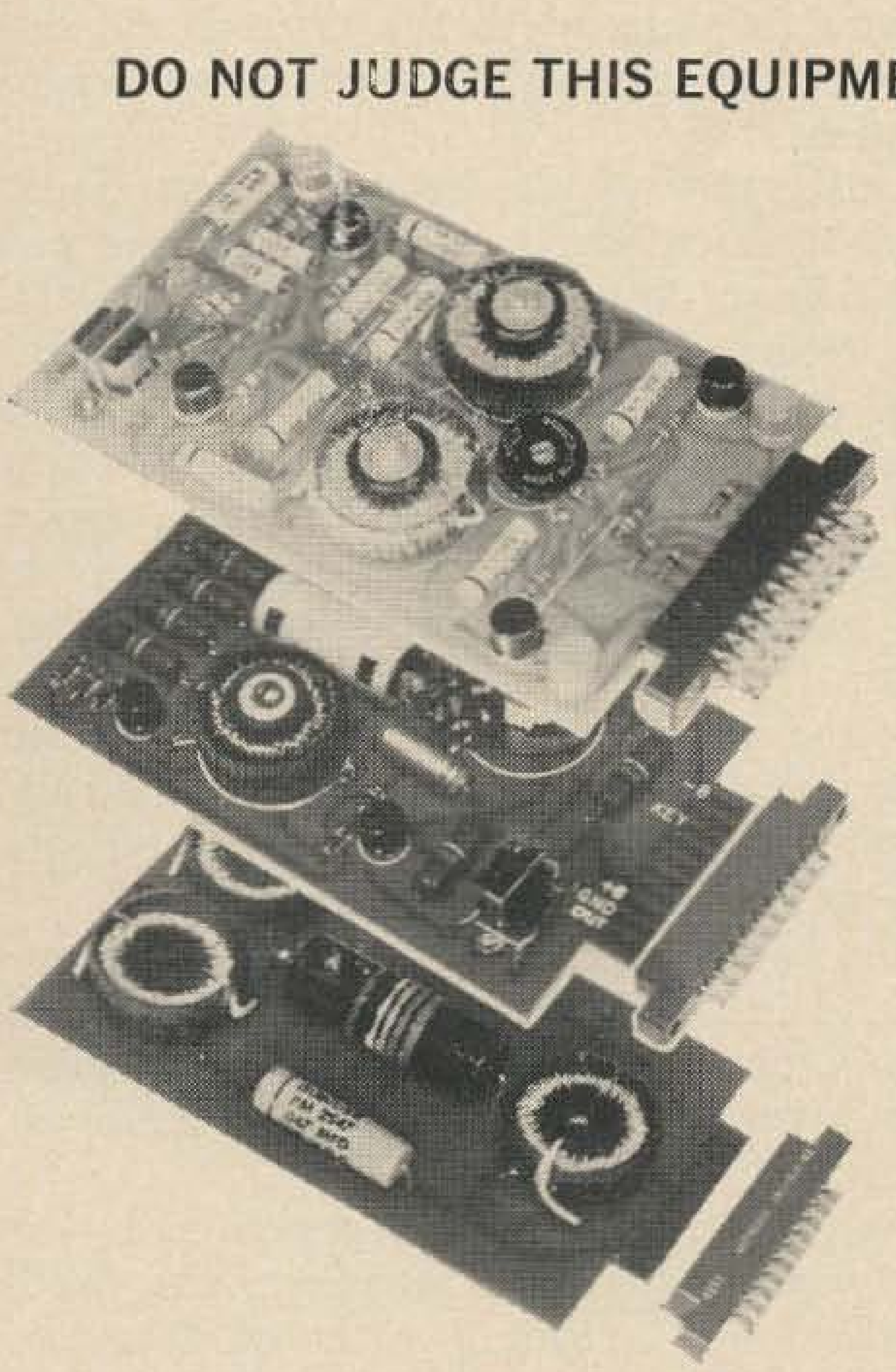

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Huntsville, Alabama

The Crystal Decade

Crystal controlled output at any frequency is possible with this simple frequency-generating system.

The virtues of crystal control are equally appreciated by the scientist who has had to constantly correct the frequency of an expensive self-excited microwave generator or by the radio amateur who has patiently followed a single-sideband signal, wandering jauntily through the spectrum.

In addition to the self-excited oscillators vulnerability to changes in temperature, humidity, barometric pressure, voltage regulation, component and shielding aging, it must also be protected from variations in loading, by isolating buffer stages. Also, its output must be low, for best stability, and this must be built up to a useful level, through the use of suitable amplifiers.

These are only a few of the problems facing the designer of a really stable self-excited oscillator, but will give a general picture.

Crystal control of a generated frequency avoids most of these difficulties, and adds the advantages of short warmup time, less buffering and higher output.

Throughout the years, various methods have appeared to vary the oscillating frequency of a crystal over a limited range. These have included the introduction of an inductive reactance in series with the crystal and an adjustable capacitive reactance across this combination.[1]

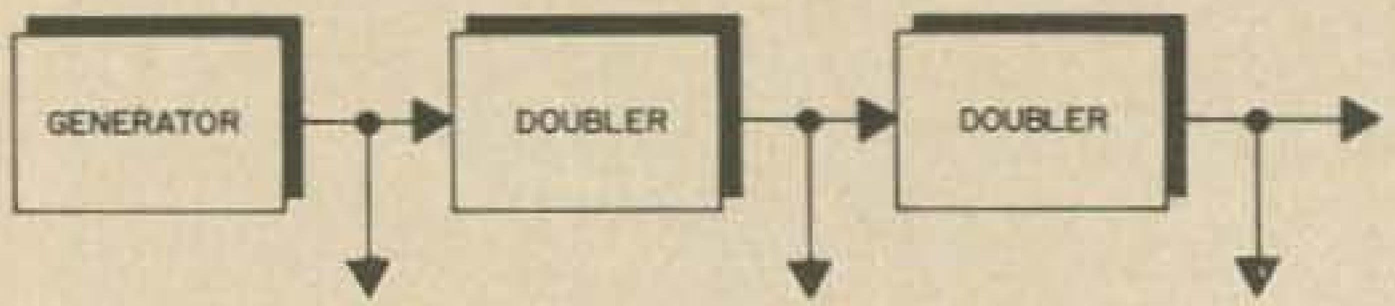


Fig. 1. Using a 1 to 2 range generator and multipliers to produce any frequency.

Satisfactory results over a narrow band are possible, however, as the frequency of oscillation departs appreciably from the crystal design frequency, stability becomes more and more dependent upon the stability of the reactances causing this departure. The temperature and humidity effects creep in again, to modify the inductance and capacitance values and consequently deteriorate frequency stability.

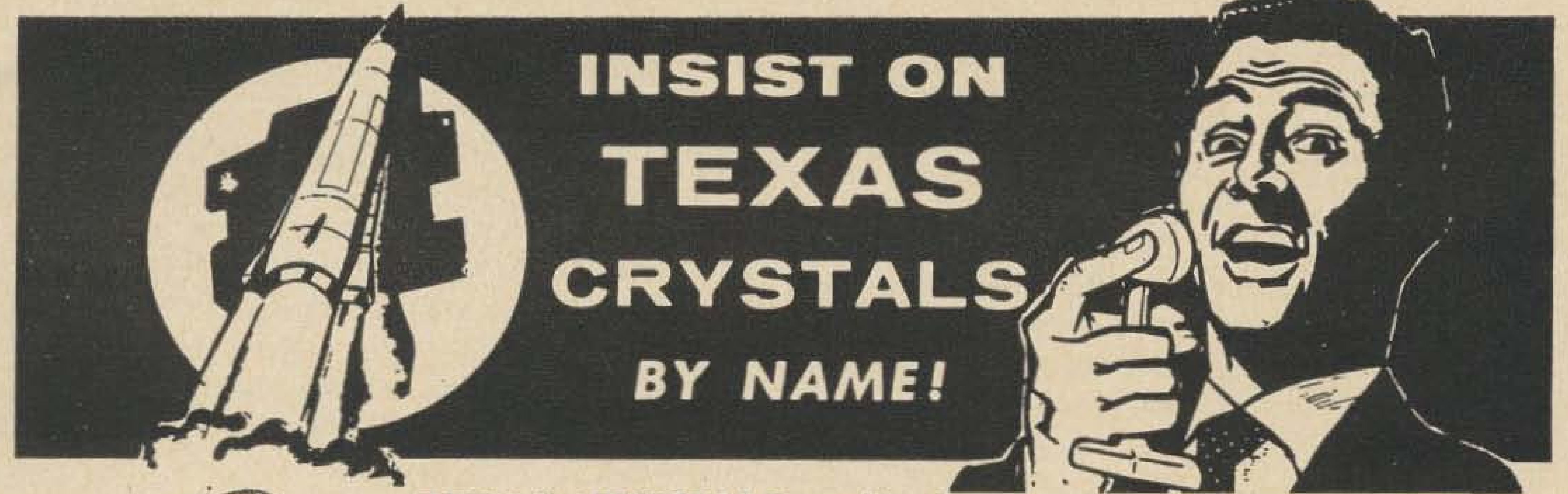
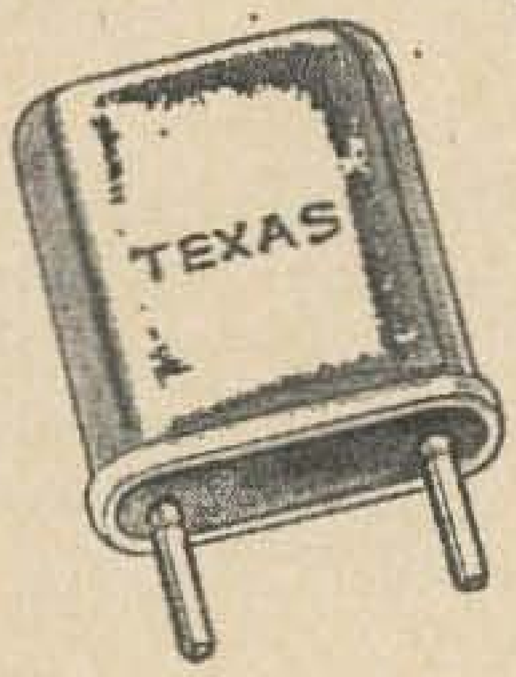
Stated another way, as the crystal is pulled away from design frequency, the order of stability gradually departs from crystal quality and approaches self-excited quality.

The system described here utilizes this method in a very moderate degree, and draws upon other means to achieve the rather ambitious results claimed in the subtitle of this article.

To produce continuous coverage by use of any generator, plus multipliers, the oscillator should have a tuning ratio of 2-to-1. This simply means that the highest frequency produced is twice the lowest generated frequency.

When this is provided, any higher frequency is possible, by use of appropriate multiplier stages. This is illustrated by the block diagram in **Fig. 1.**

The idea of the crystal decade was conceived one day, while admiring the precision built into some laboratory resistance decade boxes. It was noted that the same resistors

were used over and over in varying combinations, to achieve continuous coverage of a wide range of values. The same basic arrangement, using crystals, is the subject of this article. A "coarse" decade of crystals spaced 100 kilocycles apart, also a "fine" decade of crystals spaced 1.8 kilocycles apart is used. A "vernier" control is provided to reach any point between the 1.8 kilocycle values.

Basic elements of the system are depicted in the block diagram in Fig. 2. Choice of a low frequency range, will result in fewer crystals being required for the "coarse" decade. A range of 1 kilocycle to 2 kilocycles would be an economical choice.

Oscillator B utilizes the familiar FT-241-A low-frequency crystals, popular on the surplus market. These are spaced approximately 1.8 kilocycles apart and are used without modification. A continuous series of crystals, covering the range of 400 to 500 kilocycles was used.

Synthesizers requiring fewer crystals have been described[2], however one aim here was to use units which were already on hand.

These low-frequency crystals which were so popular in early sideband generators have now been retired by higher-frequency filters. Complete sets of these excellent low-frequency crystals were bought for five dollars, and are now gathering cobwebs in many shacks.

The outputs of oscillators A & B are combined in mixer C, and their sum frequency is selected by the mixer plate tank. At this point in the description, a crystal-controlled output is possible every 1.8 kilocycle point, by switching in each low-frequency crystal. For example, if oscillator A output is 3500 kiolcycles and oscillator B output is 400 kilocycles, mixer C output is 3900 kilocycles.

In order to produce any intermediate frequency between the 1.8 kilocycle values, the medium-frequency crystal oscillator is made variable over the limited range of approximately 925 cycles. Thus the gaps are closed, and continuous coverage is achieved.

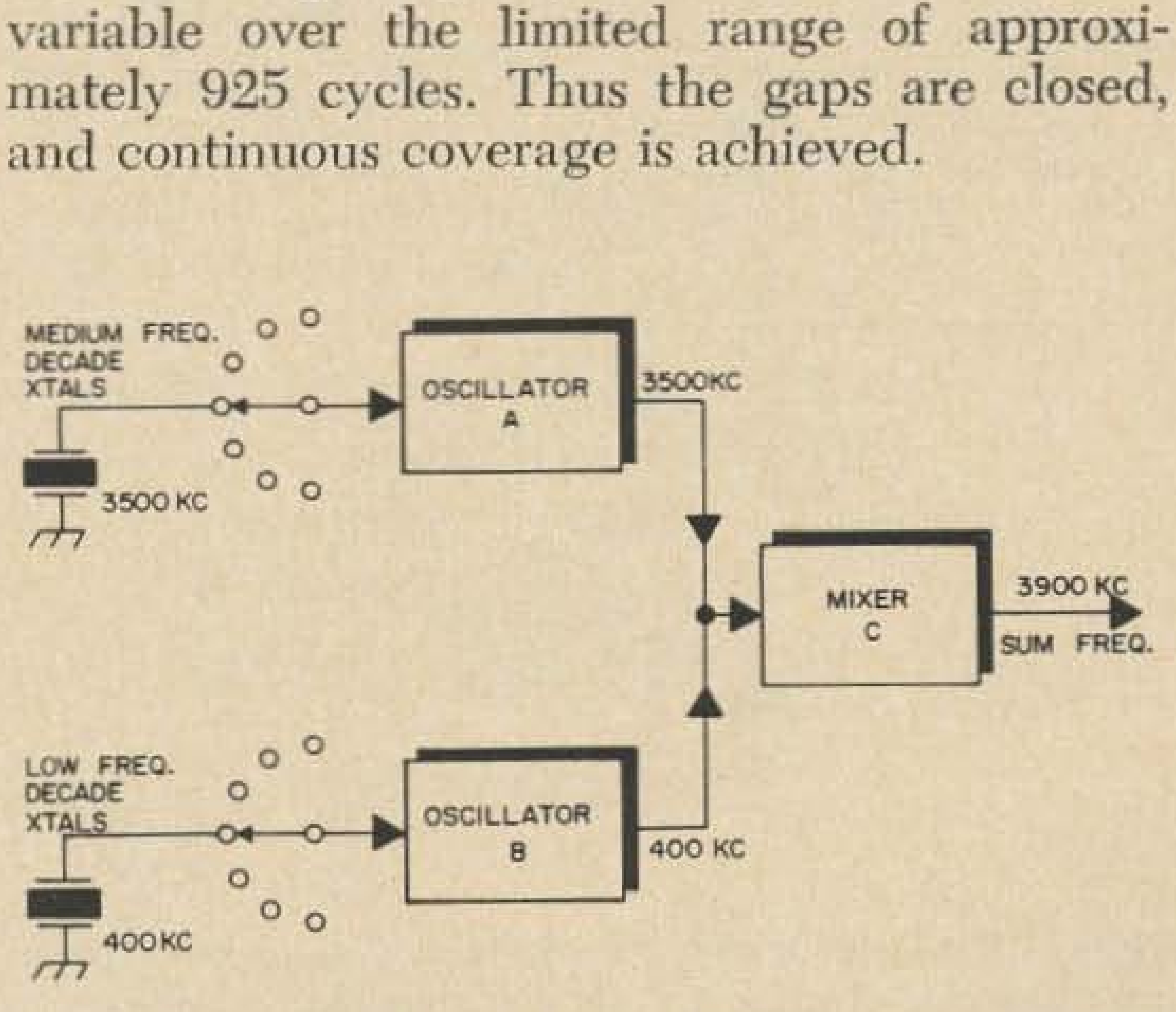


Fig. 2. Example showing how 3900 kc is generated.

Experimental generator

To explore these theories, a working prototype was assembled, based on the schematic of **Fig. 3**. The 6AG7 tube was selected for the oscillators, due to its excellent internal and external shielding and low drive requirements.

The metal envelope 6L6 was selected for shielding and also to probe the possibilities of producing sizeable power output with a minimum of stages. Conventional components were used, and no critical adjustments were encountered.

For the "coarse" decade, type FT-243 crystals were etched to frequency, using the method described in a previous article[3].

The low-frequency oscillators is conventional, with the value of C4 determining the amount of feedback. Transformer T1 in the plate circuit provides matching and isolation between the oscillator and mixer.

The medium-frequency "coarse" oscillator circuit also contains the "vernier" frequency control C1.

The mixer is fed medium-frequency rf at its control grid and low-frequency energy at its screen. This circuit provided more output than any of several other arrangements tested.

Adjustment

Tuneup of the oscillators is facilitated by use of an rf indicator. Small neon lamps, temporarily soldered to each tube plate terminal, served nicely.

Once satisfactory operation of the oscillators is obtained, transformer T1 should be tuned for uniform output over the 400 to 500 kilocycle range. If necessary, one winding may be peaked near 425 kc and the other near 475 kc. All other adjustments are for maximum output.

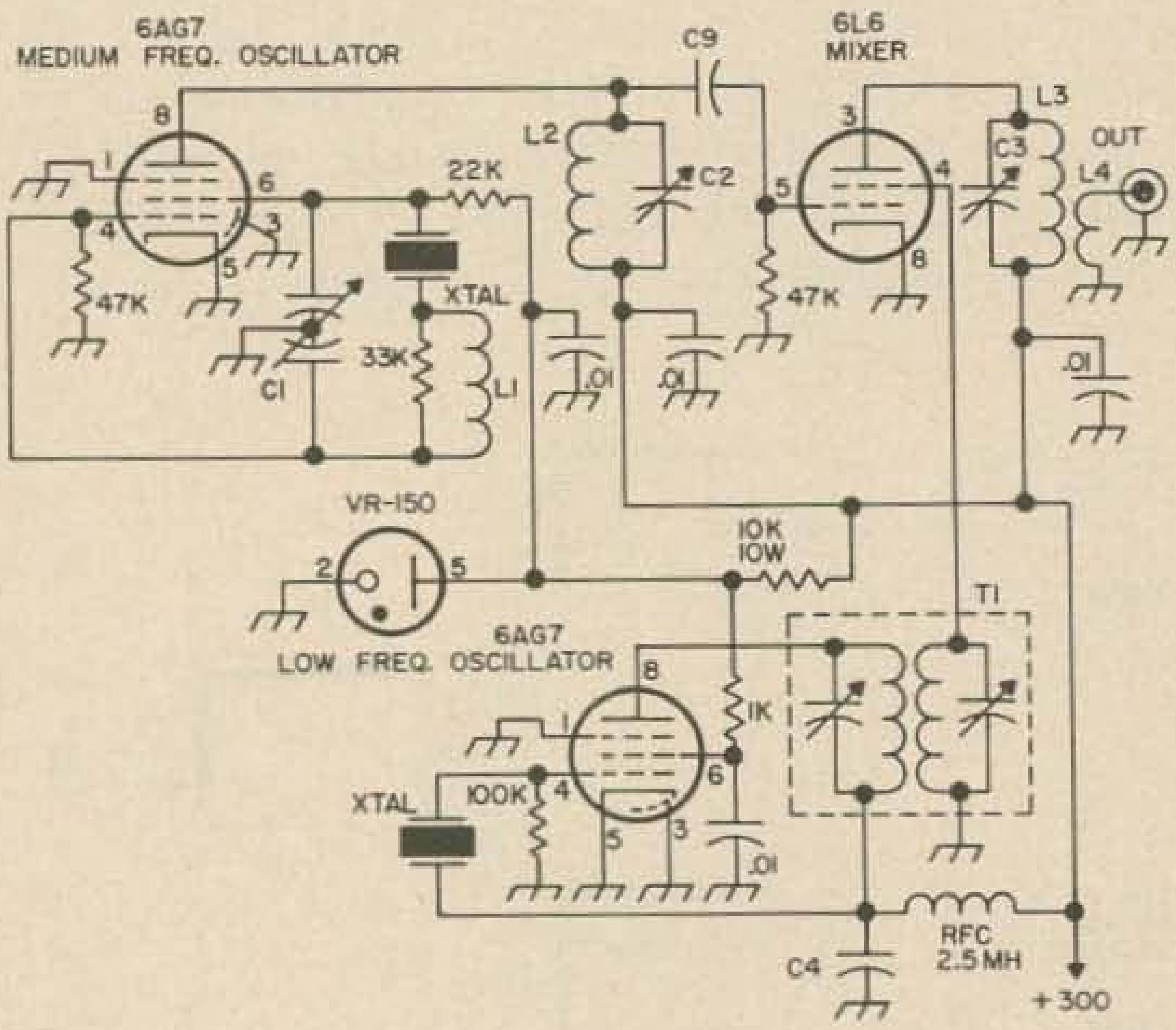


Fig. 3. Crystal Decade Frequency Generator. Components are chosen to include the 80 m amateur band in the generator range.

It would be wise to calibrate at least roughly, the tuning dial of C3, to avoid selection of an undesired output frequency. This may be easily done by temporarily removing the low-frequency oscillator tube and driving the mixer with the medium-frequency oscillator alone, using crystals covering the desired output range. The mixer output is peaked for each crystal, and C3 dial is labeled to correspond with the crystal frequency marking.

Operation

To select any frequency, the next "coarse" decade crystal below the desired frequency, is selected. Next, the "fine" decade crystal producing the lowest beat tone in the receiver, is switched in. Last, the exact frequency is "zeroed in," using the "vernier" control C1.

Notes

In the prototype, simple, single crystal sockets were used. A finished product should incorporate a convenient switching system for the two crystal decades, preferably coupled to a digital type dial.

The prototype described has been used as a transmitter on the 80 meter band for six months, with excellent stability reports. No change in the frequency of either oscillator is detectable when the mixer is keyed.

Excellent break-in cw characteristics may be achieved, by thoroughly isolating through the use of shielding and adequate bypassing. Under these conditions, no output will result until the mixer is keyed. If just the popular amateur bands are to be covered, using multipliers, only five crystals will be needed in the "coarse" decade: 3100, 3200, 3300, 3400, and 3500 kilocycles.

With reasonable care during construction, a really stable frequency generator which is a pleasure to hear, will result. . . . W4ATE

---

[1] Shall, "VXO—A Variable Crystal Oscillator" *QST*, January 1958.

[2] Briggs, M. R. and Morrison, H. J. *QST*, January 1964.

[3] Brizendine, G. "Quartz Crystal Etching," Radio & Television News, May 1954.

Parts Table

C1. 50-50 pf dual variable capacitor.
C2. C3. 100 pf variable capacitors.
C4.500 pf mica capacitor.
C9. 1000 pf mica.
L1. 40 turns #22 enameled wire scramble wound on 11/32" diameter ferrtie core, 1" long.
L2. 45 turns #22 on ⅞" form.
L3. 27 turns #18 on 1-5/16" form.
L4. 5 turns #18 wound over ground end of L4.
T1. 455 kc air tuned *if* transformer.

"HAM'S HEAVEN"
"DXER'S DELIGHT"
"EXPERIMENTER'S PARADISE"
"ASTONISHING"
"I NEVER SAW SO MUCH RADIO EQUIPMENT IN MY LIFE"

No, we didn't say these things about ourselves because we don't talk this way, but these are actual quotations about us from people who stop for the first time to see our set-up, and they were all describing their reactions to what they saw here in Harvard.

We have one of the largest accumulations of electronic material in the country, and certainly one of the most interesting places to display and demonstrate this type of equipment. With better than 30 years of experience as a ham and more than 20 years of experience in selling to hams, we think there is room for this kind of an operation.

An interesting paradox prevails today. On the one hand there are more and more hams than ever before, and on the other hand there is less chance to purchase the kind of equipment hams want to buy or build than ever before. For example, here in Worcester County there is not one ham supply store left except our own, and yet the area serves more than 400,000 people. In all New England I don't think we have more than 3 or 4 fully qualified ham supply houses, and should you as an individual wish to build your own set you would soon find out that there are very few places left in the United States that can furnish everything you want—an amazing inconsistency. Our goal, therefore, is to try to remedy this situation by carrying in depth a broad variety of material suitable for the experimenter or the do-it-yourselfer, and we *have* been able to provide one of the largest such inventories in existence for this purpose.

We have all kinds of tubes, transformers, chokes, diodes, stocks of wire, chassis, cabinets, resistors, condensers, and the specialized material needed. We have the amateur antenna supplies, the coax, the fittings, the baluns, the beams, and the towers to boot and, of course, we have the equipment—hundreds of pieces—in all standard brands, new and used, possibly the largest variety of used ham equipment in New England. What's more, we are always buying this type of material just to make our stocks that much more attractive to you, our customer.

Once in a while we get in a nice deal such as the Hammarlund HQ-105 which is the exact equivalent of the HQ-100A general coverage super-heterodyne receiver. Made to sell for $219.50, we can sell it now for $169.95 delivered to you in the continental U.S.A. This is factory-fresh merchandise with a 100% guarantee from Hammarlund and ourselves. For a better description, see our ad in the December issue of 73.

For those of you who haven't yet looked on the map to learn where Harvard is, we are located half way between Lowell and Worcester via Rt 110, and half way between Concord and Fitchburg via Rt 2. We are approximately 40 minutes driving time from downtown Boston, and we are easily reached via Rts 495 or 2. When you get into Harvard, we are just a half mile east of the center, off Oak Hill Road. You can see our towers from the center of town and guide yourself accordingly, or you can ask anyone at The General Store. We are open 6 days a week and most evenings, Sundays by appointment. We would like you to stop around and look at our new facility and try out the gear of your choice. Remember, we are distributors for Swan, Johnson, Hammarlund and many, many others.

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NEWS FROM THE INSTITUTE OF AMATEUR RADIO

Compiled by A. David Middelton W7ZC, Secretary

IoAR membership

The success of any group activity depends upon its membership and leadership! IoAR is bound to succeed if a sufficiently large number of amateurs will accept the Institute's concepts and if they will join, work for and with IoAR and support its ideals—and ideas.

Membership is recruited from the ranks of all who have a bonafide respect for and sincere interest in amateur radio.

IoAR must have a *large membership*—and is seeking them in the vast majority of amateurs who have *not* found what they were looking for, even if they are or were, members of some other national organization!

Membership and support of at least one national amateur organization should be a "must" in the "design specifications" for an active, participating amateur!

More than *two thirds* of all the American amateurs have *not* found what they desired, or have felt they were *not* being properly represented. It is to those Amateurs who are not satisfied, that IoAR offers the greatest appeal and an opportunity to belong to a group they do believe in—and wish to support!

IoAR must have many thousands of members if its realistic and logical program is to be accomplished. This membership must be gained quickly and without delay—if the Institute's intriguing program is to be placed into effect.

IoAR's strength and bargaining power (a phase now understood and respected in all circles) depends upon the Institute's *numerical and political* strength and the integrity of its leadership.

What do *you* get for your IoAR membership dollars?

First, you get a membership card and certificate, an IoAR button and a supply of IoAR stickers.

Second, your membership dollars will provide you with a "pass" to what may be the biggest Donnybrook in the history of Amateur Radio! The Founding Members of IoAR are not naïve. They are fully aware that the founders of IoAR, the Institute membership, IoAR's columns in 73, even the basic concepts of IoAR will be the target of a terrific barrage attack!

The Institute has no intent or money to stage a war! We plan to put all the possible effort and resources, gained through membership income, or other IoAR-secured funds into *furthering* the *ideals* and *ideas* of IoAR, *not in waging a WAR!*

Amateurs who have given any thought to the conditions that have existed for far too many years know full well that the American radio amateur has been cleverly brain-washed into believing that there could be only ONE national amateur radio organization.

Even to hint of the possibility of "another group" arising and having the temerity to "represent" some portion of Amateur Radio, is and has long been tantamount to HERESY—or worse!

"Don't rock the boat!" is a cry that goes back into the '20s. Perhaps if the "boat" had been rocked a bit more, some of its occupants, too long in power, would have been tossed out, and replacement made with persons more conscious and considerate of the wishes, needs and importance of true representation of the amateur body politic!

Therefore, IoAR extends to you, through membership, a chance to a part of a bold, vitally NEW CONCEPT in *representative* amateur radio. It is your opportunity to help form a NEW and POWERFUL force for good in your chosen hobby!

IoAR—Totally Dedicated to the Betterment and Preservation of Amateur Radio.

Third—your IoAR membership is your "ticket" thru the gate of opportunity to DO something—you, Mr. Joe Q. Ham, for your *interests in your own hobby!*

IoAR will need many "workers in the vineyard"—persons who are unafraid of work, struggle, criticism, ridicule, and even defamation of character!

IoAR must have member-amateurs who will offer and give their valuable and varied services to help build the Institute into an overwhelming power that will restore and add dignity to amateur radio. IoAR will find a place for your talents!

Fourth—your IoAR *membership* permits you to subscribe to 73, at a *reduced* rate, and also allows purchase of 73 manuals and other publications at a 25% *discount.*

Note that IoAR has separated membership fee from any compulsory magazine subscription in the belief and hope that MEMBERSHIP in a national association of Amateurs will *again* become *important* and vital—rather than something one automatically receives when he subscribes to a magazine!

The Institute believes that IoAR can acquire the qualified leadership required to BUILD—and to guide YOUR activities in a forward, cooperative fashion that will enhance amateur radio in all its facets.

IoAR MEMBERSHIP Representation will be the NUMBER ONE task of the Institute. IoAR's income will be ploughed back into its workings and not into a large portfolio of stocks or a fat bank account.

With MEMBERS—the IoAR can DO things! Without membership assets (and membership assistance) the Institute will fail!

You can be a part of IoAR with your effort, unified with that of many thousands of others—you can help make the Institute a potent weapon in the defense and enhancement of amateur radio.

You have now been given the "word". Many of you have long expressed the desire to DO something. Now is your chance! For the few dollars you can become part of a national movement that just might preserve amateur radio!

Think it over. Is amateur radio worth anything to *you?*. If you are satisfied and content with the present "representation" and status quo— then IoAR is NOT for you!

If amateur radio *does* mean something to you, and is worth fighting for, and if you recognize the need for an *abrupt change* in national amateur radio leadership—and the necessity for more *POLICY* and less politics—then IoAR has a place and a job for you and your membership will let you participate and help!

Buy into this NEW concept—or sit back on your duff, keep your money in your pocket and watch what happens to YOUR hobby in the next few short months.

IoAR is one means of preventing amateur radio from further drifting into a morass of confusion—more "deals" and less frequencies!

These are but a few of the features that YOUR IoAR Membership will support. How many of these—and when they will be available, will depend entirely upon how swiftly IoAR obtains a sizeable membership, and money to work with!

It must be noted that some of these IoAR proposals are now but *ideas* and *ideals*. Much hard work on the part of the Directors, IoAR HQ, *and the membership* will be required—with full cooperation, and coordination of effort—to bring these facilities into actuality!

The Founding Members of IoAR believe it can be done. How about it? We'd like to hear from you!

Important IoAR Addresses

For all correspondence except that regarding membership and supplies:
Institute of Amateur Radio
Springdale, Utah 84767

For membership correspondence and IoAR supplies:
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INSTITUTE OF AMATEUR RADIO MEMBERSHIP APPLICATION

(Use separate sheet if desired)

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

. . . .$5 enclosed for one year membership in the IoAR.

. . . .$7 enclosed for IoAR membership and one year of 73.

. . . .I am a new member of the IoAR.

. . . .I am a Charter member and desire to have my membership continuous.

Institute of Amateur Radio
Peterborough, N.H. 03458

Carol Allen K9AMD/W5NQQ
155 Karen Drive
Lafayette, Louisiana

A Hero of the Ham Bands

Did you ever work a hero on the ham bands? You probably have and didn't even know it, for the airwaves are full of signals from folks who have earned their tickets in spite of illnesses, accidents, and birth defects that handed them crippling handicaps. They neither expect nor want any flag-waving about their accomplishments, but now and then attention drawn to an out-standing individual helps the whole hobby.

Paul Graden K9YMZ, better known as "Deke" around Illinois and neighboring states, knows the feeling of triumph over a handicap. A victim of a hereditary eye condition, Deke had to quit his job as a creamery route driver at Nokomis, Illinois, some years ago and drastically curtail other activities, too, as his eyesight failed. Rather than resign himself to an easy chair, he followed the advice of a friend and bought an amateur radio license manual. His instructor was Dan Hoover, W9VEY, of Hillsboro, who dreamed up graphic descriptions of formulas and ways to interpret theory to his student.

Shown with his copying device for code is Paul Graden K9YMZ, known as "Deke," and his wife, Verna.

"Getting a ticket is rough enough for a person with normal vision," said Hoover, "but Deke refused to be discouraged."

His patient XYL, Verna, attended all his lessons and worked as hard as any prospective ham so she could help her OM at home.

"I thought I had met my Waterloo with the code," Deke recalls, "but I finally figured out some aids that did the trick."

He fashioned his own Braille system in blocks. Cutting small pieces of soft wood measuring 1¾" by ¾" and ⅜" thick, he drove in gimp nails for dits and flat staples for dahs using one block for each letter and number. Arranged alphabetically and numerically in small trays, the nails and staples brought the code alive. While listening to records or W1AW, Deke reached to the trays and found the proper blocks, helping to place the characters in his mind. Although he remembers call letters by the dozens now, he still sets up frequencies, handles, and other pertinent scoop in the trays so that a touch of the hand jogs his memory.

The next hurdle was finding a way to convert the code from mind to paper. This called for another invention, a code-copying device that feeds paper something like a washing machine wringer. Deke writes along the guiding slot and dials fresh paper when the line is full. Now that he copies code in his head, he uses the invention mostly for recording times, calls, and other important information which Verna transfers to the log book when the dishes are done.

Although three other licensed amateurs live in Nokomis, they weren't very active until

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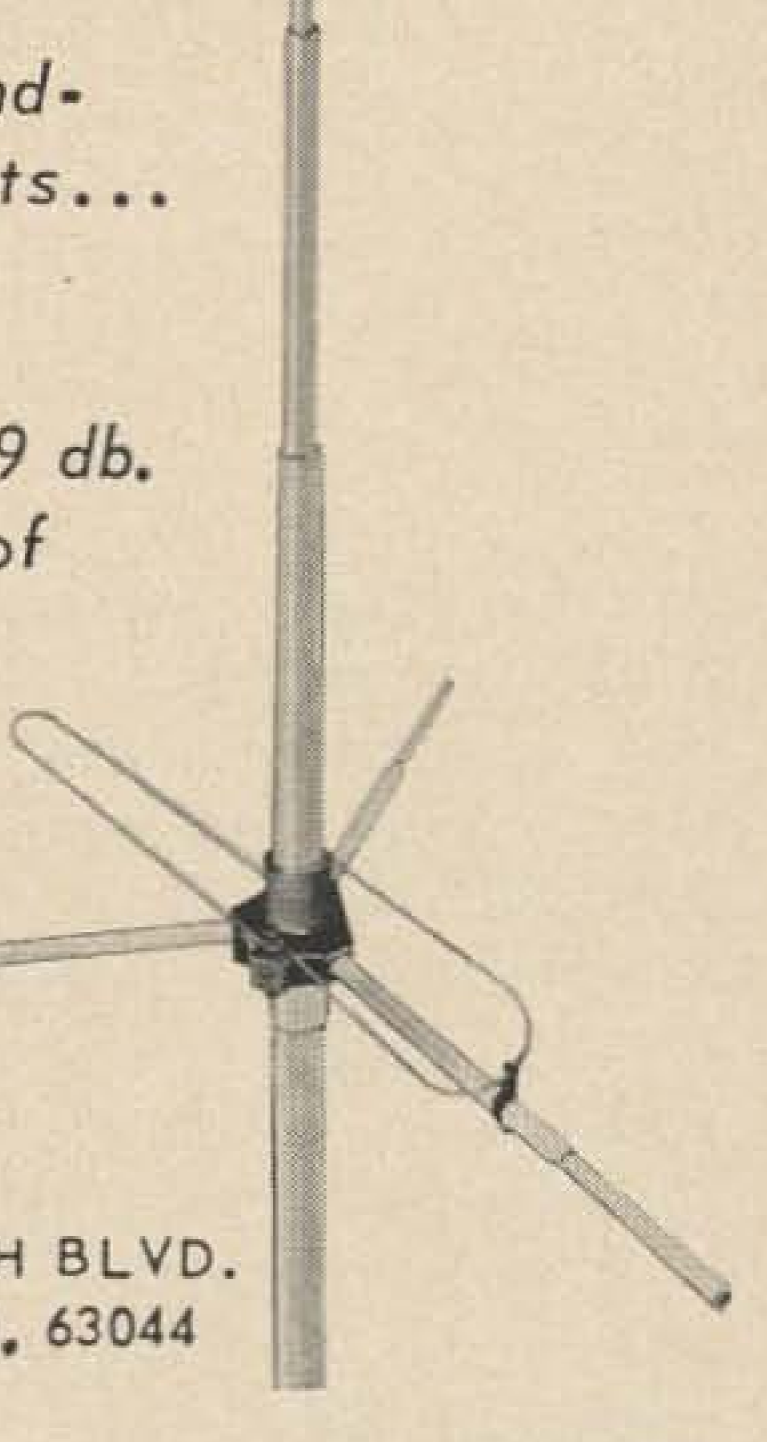

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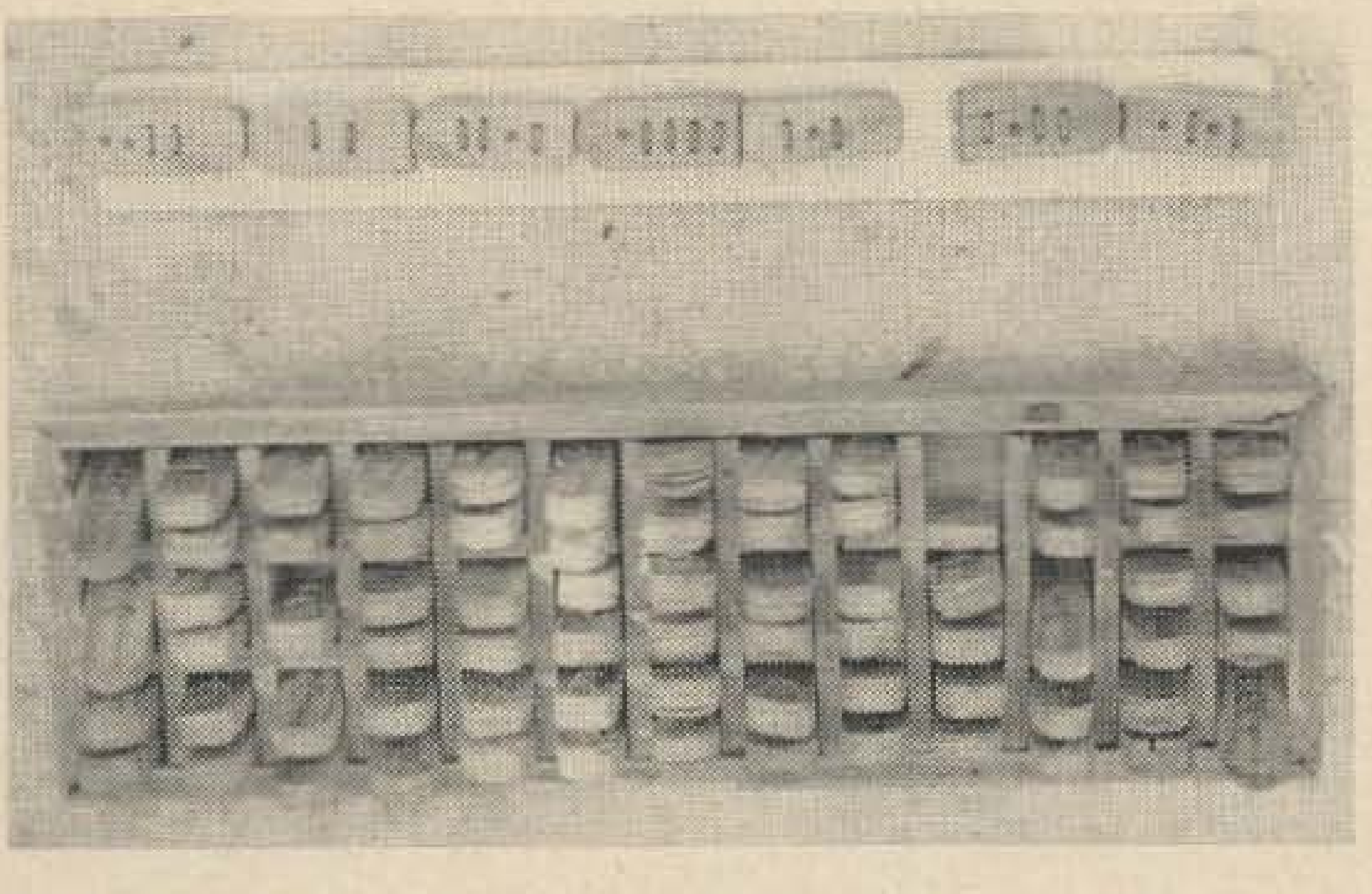

Deke got on the air. With a Viking Valiant, HQ-170, and doublet, he works 80 through 10 and uses a Heathkit Two-er for Montgomery County contacts.

"Deke has really put Nokomis on the map," said one of his rag-chewing partners. "It may be a small town but it has a mighty big voice."

Any Hiawatha fan will recall the "land of Nokomis" and Deke's QSL card is complete with Indian brave, teepee, and smoke signals. A QSO with the friendly fellow "in the valley of the moon" leaves any ham smiling, and those who personally know of Deke's courage and accomplishments in amateur radio can't help being proud of him, too.

. . . K9AMD

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Amateur Frequencies

At the recent International Amateur Radio Club Convention in Geneva, Mr. D. Schmelling of the German PTT Monitoring Service read a paper on amateur frequencies. Alfred Schädlich DL1XJ, a member of the Editorial Board of IARU Region 1 Bulletin, who was present, prepared this translation of the paper, which was taken from the IARU Region 1 Bulletin for October 1965.

A point of major interest in your discussions today is the problem of "frequencies"—especially frequencies for radio amateurs—but before going into details allow me to make a few general remarks. The development of communications by means of radio throughout the world, brought about by extensive political, sociological and economical changes, has led to an acute frequency shortage and, consequently, to an increased susceptibility to mutual interferences of the telecommunication carrier—"radio."

Although the International Telecommunication Convention requires:

- an economical use of frequencies and frequency bands,
- a reduction to the minimum of the number of frequencies used for a satisfactory service,
- the operation of all radio stations in such a manner as not to cause harmful interference to other radio stations or radio services,

a number of member countries allow their radio services, occasionally, a rather free interpretation of the internationally-accepted rules, thereby involuntarily causing harmful interference to other radio services. This happens quite often to the Amateur Service as well as to other services. The ITU is deeply concerned about this problem and does everything in its power to alleviate it. Following the Geneva Radio Conference in 1959, a panel of experts was set up and came forward later with a number of proposals showing how the general shortage of frequencies could be reduced somewhat. Time does not permit to go into this matter more deeply here. Our concern in the frequency shortage and usage as far as the Amateur Service is affected. You all know that the congestion on the amateur bands has been constantly increasing during the last few years.

Observation methods

The radio monitoring service of the German PTT Administration is closely following the development in the entire frequency spectrum and in this connection, of course, in the amateur bands, too. Our method of observation is twofold; firstly, the *subjective method* is done manually by operators. It is mostly used to identify an emission and assess its quality. The *objective method* is done automatically by means of apparatus running unattended over specified periods. This method allows us to record the frequency of an emission, the time of occupancy, the bandwidth and, if desired, the automatic recording of the signal-to-noise ratio. Automatic observations are obtained by means of a frequency sweep recorder, a special piece of photographic recording equipment called a Frequentophot-camera and frequency-amplitude analyzers. The frequency sweep recorder, which we have developed according to our requirements, is nothing particularly special. Such recorders are universally used nowadays.

Since sweep recordings normally give only general information about band occupancy without showing the finer details, a frequency-amplitude analyzer, with photographic recording facility—was developed. This device, (the Frequentophot) permits us to make automatic observation of the more important parameters such as frequency, class of emission, bandwidth and signal-to-interference ratio. With the Frequentophot we can easily make wideband sweeps or scrutinize a narrow band of frequencies.

Principle of the device

The signal received by the antenna is passed through an adjustable attenuator to the receiver input. The receiver is automatically tuned by a motor over the band of frequencies to be analyzed. The intermediate frequency of 525 kc is applied to the radio frequency spectrum analyzer. In the r.f. spectograph the signal is converted down to 8 kc and after detection applied to a dc recorder. At the start and at the end of such a recording an amplitude calibration is made by means of a field-strength measurement. This semi-automatic method gives us rather good recordings of any chosen part of the spectrum with adequate resolution.

Band occupancy in Central Europe

Let us now turn our attention to the problem at hand, namely, the occupancy of the high-frequency amateur bands as they present themselves in Central Europe.

(1). "Top Band" (160 m) is not really an amateur band at all. As it may only be used by amateurs of certain countries on a non-interference basis to the Maritime Mobile Service, with rather severe restrictions on amateurs, we can leave it out of the picture.

(2). In Region I the 80 m band is shared with the Fixed and Mobile Services (except Aeronautical Mobile) on an equal-right basis. This equal-right basis is, however, under the present regulations, rather problematic. Whereas frequencies for stations of the Fixed and Mobile Services must be notified to the International Frequency Registration Board and eventually entered in the Master Frequency Record (which gives them a measure of protection against harmful interference), no such procedure exists for the Amateur Service. In fact, the IFRB receives no official information whatsoever as to the number of amateur stations or their modes of operation.

From an examination of IFRB information concerning Fixed and Mobile stations registered to operate in the 3.5-3.8 mc band, we find more than 400 entries occupying a total of 249.85 kc. This means, that a spectrum width of 50.15 kc remains for the Amateur Service but this is, of course, not concentrated in one lump; instead it is scattered over the entire band. This is only the theoretical side of the problem; the practice is worse, when consideration is given to the major operating hours of amateurs. If we look closely at the number of stations officially recorded by IFRB we find that only 70% use their assignment, the remaining 30% are never, or very seldom, heard. Yet the frequency usage is still heavier.

From observations made by my Administration during past years regarding the band between 1600 and 6000 kc, it has been found that per frequency usage *recorded* with the IFRB, a factor of 1.6 to 2.1 *unrecorded* usage exists. In other words if we revert back to the 70% active officially recorded stations in the 80 m band the actual number of non-amateur stations operating there is somewhere between 175 and 217. These are plain figures of stations without taking into account their occupied bandwidth.

Our frequency sweep recordings and the frequency versus amplitude analysis which were made under constant ionospheric conditions on two different week-days show that the peak frequency usage occurs on a week-day (Friday through Saturday) between 14.00 GMT and 04.00 GMT. The week-end (Saturday through Sunday) shows the peak usage between 18.00 GMT and 04.00 GMT in the morning. The amateur operation on Saturday sets in heavily at 18.00 GMT, has its peak one hour later and diminishes after midnight.

In addition to sweep recordings, we have made at three-hour intervals a closer analysis of the spectrum, showing frequency usage and the respective field-strength values. Since a very slow scanning speed was used for the sake of accuracy, no clear indication of the class of emission is given. Our main objective was to show the density of occupancy and the associated field-strength values. The recordings were taken at a scanning speed of about 3 centimetres per minute, the whole recording taking about 10 minutes. By a judicious choice of the scanning speed, the class of emission and occupied bandwidth can also be recorded. The identification of the various types of transmission from such recordings does, however, require some experience.

Another matter may be of interest in this connection is the variation of the general noise level. During daytime this is at 10 db above 1 microvolt per metre and during the night at about 30 db above 1 microvolt per meter at an analyzing bandwidth of 100 c/s.

(3). We come now to 40 meters which is restricted in Region I to the frequency band

7000-7100 kc. Propagation conditions on this band are often of such a nature that it cannot be regarded as a "playground" for the beginners or a "rag-chew" medium for the old-timers as is often the case with 80 m. On 40 m serious amateur work starts. The band is allocated exclusively to the Amateur Service, at least the Radio Regulations say so. The practice is entirely different as we all know. Sweep recordings made on a Friday, Saturday and Sunday show a constantly-increasing intrusion by broadcasting stations which cover nearly the whole band with their occupied bandwidth, and this during hours which are by nature the best operating hours for the Amateur Service (16.00-23.00 GMT).

The most prominent of the intruders squatting constantly in the exclusive amateur band are:

Frequency kc	*Station*	*GMT*
7006	Serrai Greece	0500-1300 1500-2000
7019	Radio España Independenta	1600-2300
7035	Radio Peking	1500-2100 2130-2230
7040	Kozani Greece	0430-1730 1000-1200 1500-2100
7050	Cairo	0200-2330
7060	Peking	1600-2400
7064	Teheran	0200-0600 1200-2030
7075	Cairo	0300-0700
7080	Peking	1600-2230
7082	Cedaye Melatte Iran (Albania)	1400-1930
7085	Jeddah Saudi Arabia	1530-2300
7090	Tirana Albania	0400-0700 1500-2300

Most of these stations operate outside the broadcast bands in blatant disregard of the provisions of the Radio Regulations. Geneva (1959).

If we assume that the bandwidth of these broadcast stations is 9 kc—in some cases it is much wider—we arrive at a total occupied bandwidth of 108 kc. Since there is, however, some overlapping of the broadcast sidebands some small gaps are left free in this 100 kc wide band for its only legal user—the Amateur Service. The casual observer might assume that the programmes are intended only for local or national use but as those transmitted by Radio Peking are beamed towards Europe and those of Radio Cairo to the Middle East it is clear that this is not so.

The number of normal non-amateur telegraph stations heard on 40 m is not high; they do not present a severe problem, though legally they are frequency "pirates" in the same way as the "intruder" broadcast stations.

A further source of severe interference which cannot be passed over lightly are the jamming stations which try, with very high power, to render certain broadcast programmes unreadable. These stations often work simultaneously from different widely-separated locations, spoil with their very bad modulation, wide sections of the spectrum, thus making conditions still worse for amateurs.

Sweep recordings show that, on normal working days, amateurs use the 40 m band only sparsely but on Saturdays, and even more so on Sundays, a distinct rise in occupancy can be seen. Frequency-amplitude recordings taken for comparison purposes on a week-day and on a Sunday show a similar distribution. The general noise level during daytime between 09.00-15.00 GMT was found to be at 0 db above 1 uV/m and during the rest of the time at about 12 db above 1 uV/m taking into account the scanning bandwidth of 100 c/s used. For a receiver operated under normal conditions this would correspond to a noise level of 10-25 db above 1 u/Vm.

(4). In regard to the bands 14000-14350 kc and 21000-21450 kc conditions are much easier to describe. Both bands still enjoy more or less their exclusiveness even if in the 14 mc band occasional stations appear and operate outside their assigned service bands. Frequency amplitude recordings have been taken for these bands supplemented by sweep recordings both for a normal weekday and a Sunday.

(The lecturer then presented a recording showing the effects of a campaign launched by German radio amateurs for the defense of amateur bands. The recording showed the spectrum of a broadcasting station in the exclusive amateur part of the 7 Mc band and simultaneously various stages of a strong amateur signal approaching the center frequency of the "intruder." The lecturer doubted whether this or similar actions will be of value. He agreed there was no evidence that the amateur had intentionally tried to interfere with the broadcast transmission.)

Conclusion

The best defense against intruders into exclusive amateur bands is for amateurs throughout the world to use these bands more fully. Only by the full use of the bands by those legally authorized to use them, will administrations or radio services which try to intrude without international right be discouraged from doing so.

The general increase in interference, due to universal frequency shortage, affects, of course, not only the amateur bands. I would like you to take account of this fact in your deliberations.

(The lecturer then showed some frequency sweep recordings representative of many cases of interference noted by the Monitoring Service. The recordings showed an A7B emission in the spectrum of which a broadcast signal was literally ploughing about. Two further recordings showed technical irregularities of the emission which caused harmful interference to other services on frequencies nearby. Also seen was the recording of spurious emissions of an A2/Hellscriber transmission which impaired a frequency band more than 30 kc wide. A further recording showed some trouble on an F1/Morse transmission which for hours interfered with a spectrum width of 5 kc. The lecturer explained that such imperfections did not reflect on the technical standard of the commercial operators concerned, in fact, causes were quickly removed as the result of collaboration by the international Monitoring Services).

Finally allow me to suggest how, in my private opinion, the further influx of foreign stations into the exclusive amateur bands can be brought to a halt.

(a). The ITU might be induced to recommend administrations to carry out a world-wide observation programme of the various amateur bands by using national monitoring services.

(b). The ITU might be requested to analysise these observations (in a manner similar to the analysis made of the aeronautical, maritime mobile and broadcast bands) and then request the administrations concerned to remove radio stations from frequency bands which are not allocated to them according to the Radio Regulations.

(c). If the foregoing proposal is not acceptable to the ITU the Amateur Radio organizations should carry out world-wide observations of the amateur bands. When intruders are found to be operating in exclusive bands the national society concerned should approach the appropriate administration and point out the infringement of the International Convention asking at the same time for measures to be taken to remedy the situation.

NOTE. Copies of the graphs and charts referred to by the Lecturer can be obtained by sending two International Reply Coupons to Mr. Alfred Schadlich, DL1XJ, Post Horn 8, 61 Darmstadt, Federal German Republic.

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Semi-Modernizing Vibrator Power Supplies

There are probably many small vibrator power supplies relegated to gathering dust on shelves due to the popularity of transistor mobile supplies. Well, dust off those "vibrapacks" because here's a way to get more output from them, thanks to silicon rectifiers and the use of a bridge rectifier circuit.

Our vibrator supply shown in **Fig. 1**, rated by the manufacturer at 300 volts at 100 ma, actually delivered only 265 volts at 100 ma, after filtering. This was obviously nothing that would power a transmitter into generating much excitement on the lower-frequency bands, so we started tinkering.

First substituting silicon rectifiers for the 12X4 tube rectifier, in the same center-tap circuit in which the 12X4 was used, increased the output to 300 volts at 120 ma. Flushed with success and seeking even higher output, I remembered the old idea of increasing the voltage by using a bridge rectifier circuit. Normally, in the case of transformers rated for ICAS (intermittent amateur and commercial service), about all this buys you is doubling the output voltage over the full-wave center-tap circuit, with the requirement that the output current has to be reduced to half of the previous value in order not to overload and damage the transformer. However, most vibrator transformers are rated for CCS (continuous commercial service) and are tolerant of overloading for periods of over 10 minutes and do not get appreciably warmer than when operated in the lower-output, center-tap circuit over the same period.

The modified circuit is shown in **Fig. 2**, and the results have been most gratifying. Typical voltage/current combinations achieved are given in **Table I**. The silicon rectifiers used are rated at 400 PIV at 750 ma, and by careful shopping can often be obtained for as little as 50¢ each.

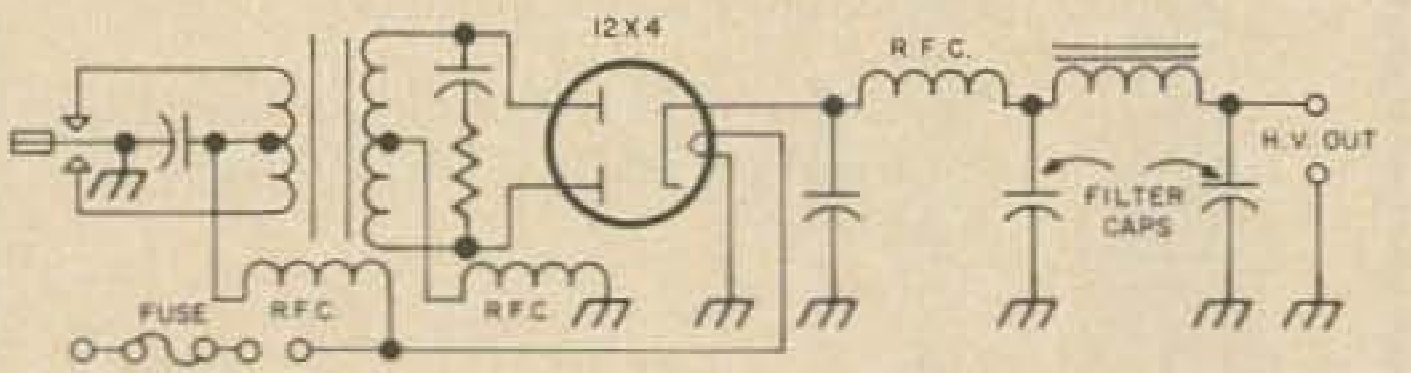
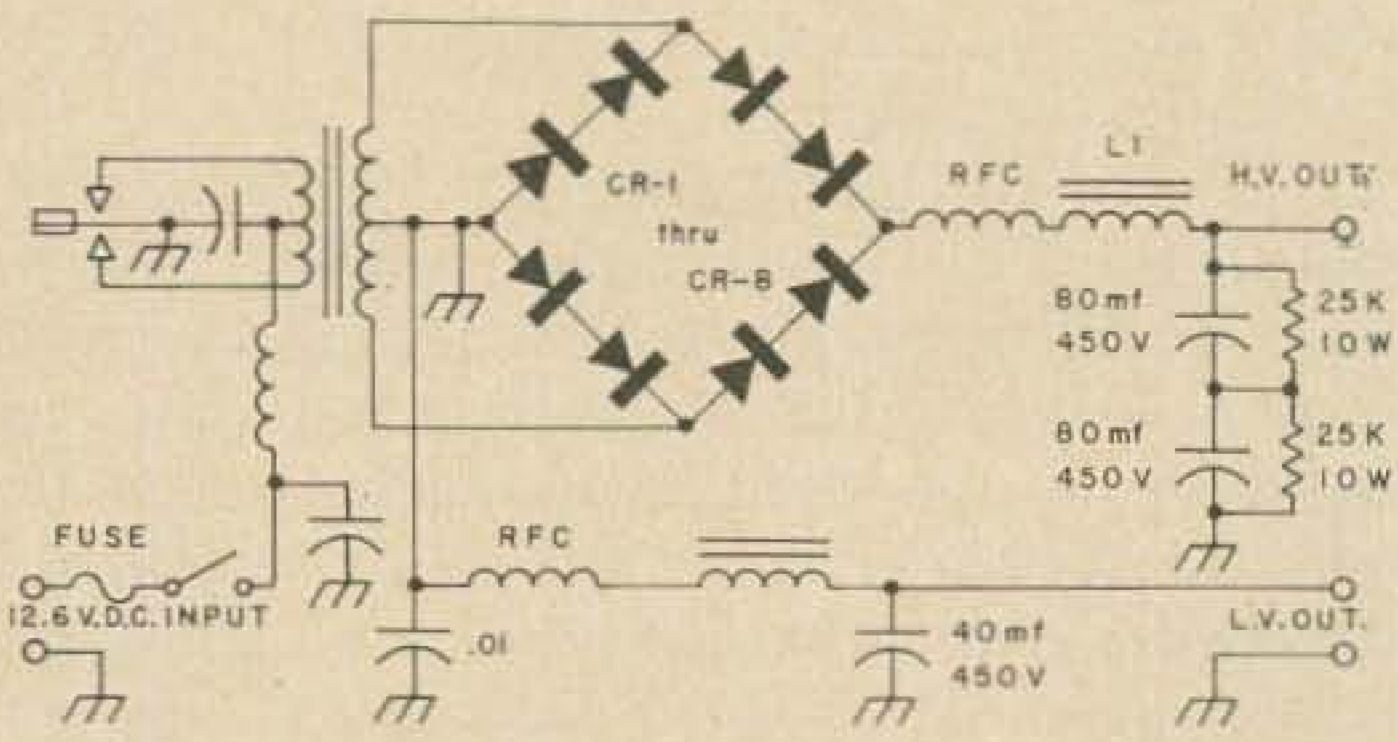


Fig 1 Original 300 volt, 100 ma vibrator power supply circuit.

My modification included the use of a choke input filter rather than the original capacitor input filter. Grammer[1] observed that for the same dc load current the secondary power loss was between 2 and 2.5 times as great with a capacitor-input filter than the loss with the choke-input filter. Thus, approximately 50% more current can be taken from the transformer with choke input than with capacitor input, for the same secondary heating. The problem with choke input is that the output voltage is much lower than with capacitor input, a drawback that is more than compensated for with the illustrated bridge-rectifier, choke-input system.

You have probably by now observed, from the figures and table, that there is another advantage to our modified circuit. The transformer secondary center tap now provides a low-voltage source, suitable for operating speech amplifier stages and rf oscillator and driver stages.

Another advantage you may not have noticed is that it is no longer necessary for the



CR1—CR8 : 400 PIV. 750 ma

L1—Triad 611X or equivalent (6hy., 110 ma, 160 ohms)

Fig. 2 Vibrator power supply modified for bridge rectifier operation, using silicon diodes. All components for which values are not indicated are same as original circuit.

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[1] Grammer, "More Effective Utilization of the Small Power Transformer," **QST**, November, 1952, p. 18.

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Table I

	Low B+ Tap	High B+
With 50,000 ohm bleeders on low B+ tap and on high B+; no other load	360	695
Examples of voltage/current combinations	215 v @ 25 ma	425 v @ 90 ma
	200 v @ 55 ma	410 v @ 85 ma
	175 v @ 35 ma	350 v @ 145 ma (See Note 1)
	185 v @ 70 ma	400 v @ 90 ma

Note 1: At this condition, representing highest total power output of any conditions shown, total battery drain (at 12.6 volts) is 6.5 amperes. Efficiency approximately 70%.

vibrator supply to run continuously. The silicon rectifiers allow the supply to be keyed on and off with the push-to-talk circuit of the transmitter, and battery drain is kept to an absolute minimum. (My mobile converter uses tubes of the "hybrid" type, designed for 12.6 volt filament, screen grid and plate operation, and the total drain of the converter is only 400 ma!)

From **Table I** it can be seen that it is possible to draw as high as 50 watts from the high-voltage tap 200 volts at up to 35 ma—a big improvement over the less-than-30 watts total power available with the former tube rectifier, center-tap circuit.

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Use Your GDO and Z-Meter

The GDO is one of the most versatile pieces of test equipment available. Yet there are many hams who don't know how or when to use one. The writer will try to describe and explain some of its various functions.

The GDO is basically a variable high frequency oscillator with a frequency range of approximately 550 kc to 250 Mc. It may also be used as a diode detector or wave meter. The GDO gets its name from the fact that a meter measures the grid current and when the oscillator circuit is coupled to a resonant circuit a reduction in grid current is obtained. This is called the grid dip. However, when it is used as a wavemeter and coupled to an rf source, an increase in current is obtained at resonance.

The GDO and impedance meter can be used to accomplish the following:

1. Determine the resonant frequency of tuned circuits, including antennas.
2. Determine the impedance of circuits, receiver inputs and antennas.
3. Determine the length of half-wavelength or quarter-wavelength transmission or tuning stub lines.
4. Determine the "Q" of a circuit or component with the aid of a VTVM.
5. Determine the resonant frequency of individual coils, capacitors or crystals that are within the range of the GDO.
6. Determine the rf frequency of energized circuits.
7. Monitor a radiated rf signal with the aid of headphones.
8. Neutralize rf stages.
9. Locate parasitic oscillations.
10. To align receivers and television sets.
11. Determine where BCI and TVI is entering the radio or television receivers.
12. Determine unknown inductance.
13. Determine unknown capacitance.

Now if you will step into the lab we will try to demonstrate how these instruments can be put through their paces. Let's begin with the simple functions and then gradually creep up to those which are more complex so they don't scare us before we get started.

An oscillator-detector

Simply plug in a pair of headphones (if GDO has facilities for them) and "zero-beat" with the radiating signal. This then will be the frequency of the radiating signal.

Crystal frequencies

Connect a one turn loop of wire across the crystal and couple the GDO close enough to get a dip of the meter when resonance is obtained. It is always wise to check lower frequencies to be sure it is the fundamental frequency that is being indicated.

Frequency determination

Generally the GDO has a switch which is used to remove the plate voltage from the tube. The tube will then serve the function of a diode and the meter as a diode load.

When a peak deflection of the meter is obtained, this will indicate the frequency of the radiating signal.

Resonance of an RF choke

When an rf choke is used as a parallel or shunt fed circuit, it must be free of self resonance over the operating frequency range of that circuit or it may burn up. The popular pi tank circuit is an example. Place a short circuit across the choke and then determine its self resonant frequency by coupling the GDO close enough to indicate a dip on the meter when the resonant frequency is obtained.

Neutralization

Apply plate power to the exciter stages and filament power only to the stage being neutralized. Use GDO as a wavemeter and couple close to the tank coil in the stage being neutralized. Vary the frequency of the GDO until maximum reading is obtained and then adjust the neutralization for minimum GDO meter reading. The circuit being neutralized may have to be retuned and the above procedure repeated with a closer coupling of the GDO to the Tank coil.

IF alignment

Tune the GDO to the desired frequency and couple it close to the if coil to be aligned. Adjust the if coil until a dip is observed on the meter. The if coil will then be tuned to the desired frequency.

Inductance and capacitance checking

To determine the value of an unknown capacitor, connect it across a known inductance and use the GDO to find the resonant frequency of the circuit. With these known values a reactance chart will give the value of the capacitor. Some GDO's supply a chart which corresponds to the coils supplied with the GDO as the known inductances. To determine the value of an unknown inductance, connect a known capacitance across the coil and use the GDO to find the resonant frequency. Again, the reactance chart may be used or the following formula (which may be used for either inductance or capacitance) for resonant circuits:

$$L = \frac{1}{39.48\ (f^2)\ C} \quad \text{or} \quad C = \frac{1}{39.48\ (f^2)\ L}$$

Where f = cycles per second
L = inductance in henries
C = capacitance in farads

The inductance of an air core coil can be estimated by the following formula:

$$L = \frac{(rN)^2}{9r \neq 10w}$$

Where L = inductance in microhenries
N = number of turns
r = radius of coil in inches
w = length of coil in inches

Q measurements

Connect a condenser across the coil so the tank circuit resonates at the desired frequency. Connect a VTVM across the tuned circuit and tune the GDO until maximum reading is obtained on the VTVM. The GDO coupling may be changed until a convenient value is obtained on the VTVM and then it must not be moved during the remainder of the test. Note the resonant frequency f_c then detune the GDO to a lower frequency until the VTVM reads 70.7 percent of its original or peak value and call this frequency f_1. Now detune the GDO to a higher frequency until the VTVM again reads 70.7 percent of its original or peak value and call this frequency f_2. The Q is then calculated by using the following formula:

$$Q = \frac{f_c}{f_3}$$

Where f_c = is the center of resonant frequency
f_3 = the difference between f_1 and f_2

Parasitic oscillations

By using a pair of headphones with the GDO, the parasitic oscillation frequency may be determined. Turn the power off of the stage being checked and then use GDO to find the circuit which resonates at the parasitic frequency by moving the GDO slowly around the wiring. When a "dip" is observed, moisten the finger and touch an ungrounded point of the circuit. If a change in the dip is observed, it indicates that it is the portion of the circuit that would be a likely suspect.

BCI and TVI locator

Most of the BCI and TVI problems can only be resolved at the receiver, either by installation of filters, resistors or condensers or a combination of all three. The problem is—where is the rf entering the receiver? Use the GDO tuned to the frequency which produces the greatest amount of interference. Probe around with the GDO until the most sensitive spot is located, which is indicated by watching or listening to the receiver interference. After the point of entry is determined then the appropriate corrective action can be accomplished.

Antenna measurements

Space does not permit to discuss all types of antennas and adjustments so only a few will be mentioned to give some idea on the use of the instruments. At this point it should be mentioned that inductive type coupling should be used between the GDO and antenna when checking near the current maximum point and capacitive coupling when checking near the voltage-maximum point.

The beam antenna has gained tremendous popularity in recent years plus many headaches for those striving to obtain the maximum effectiveness. Most of the headaches can virtually be eliminated by using the GDO and Impedance meter (Z-meter). Let's take a look at a 3 element yagi and see what has to be done to obtain a good adjustment. The element lengths must be physically adjusted or electrically loaded to obtain resonance at the desired frequencies and the feed point impedance must match the impedance of the transmission line. These two points are not the only considerations for beam adjustment but they are the most important factors. The GDO can be inductively coupled to each element and the elements adjusted until each one is resonant at the desired frequencies. It is best to make the measurements while the antenna is in operating position. This is very difficult to do in many cases but let's assume you can. After the elements have been adjusted, the feed point must be adjusted to match the line. The Z-meter and GDO will be used to accomplish this adjustment. The Z-meter is basically a resistance type bridge with a calibrated potentiometer as one of the bridge arms. Connect the Z-meter directly to the antenna feed point. Couple the GDO to the Z-meter inductively thru a couple loops of wire connected to the other terminals of the Z-meter. Tune the GDO to the resonant frequency of the beam and adjust the Z-meter to the dip or null. If the impedance indicated by the Z-meter is not the same as the transmission line then readjust the matching network and redip the Z-meter until the impedances are equal.

Now—if you can't adjust the antenna in the operational position you still can determine the resonant frequency and the impedance by standing on the good old Terra-Firma. The procedure is a little more involved but effective. First—we must have a means of electrically connecting the instruments to the antenna. This is best accomplished by a transmission line a half-wave or a multiple of a half-wave in length. Determine the height of the antenna above ground and calculate how many half-wave lengths of line will be required by using the following formula for a half-wave length of line:

$$L = \frac{(492)\ (K)}{f}$$

Where L = feet
f = megacycles
K = propagation constant (RG/8 is .66)

This is an approximate length so be sure and cut it extra long because now we will find the exact physical length. Why an exact physical length? A halfwave length of transmission line will reflect the resistance placed across the output at the input end of the line, i.e. if a 50 ohm non-reactive resistor is placed across one end of a half wave or multiple length thereof, the GDO and Z-meter will indicate 50 ohms at the other end of the line. Cut the line somewhat longer than calculated above, short one end and connect the Z-meter to the other end of the line. NOTE: Keep twin lead off the ground and away from metal objects. Set the Z-meter to zero impedance and couple the GDO inductively to the Z-meter. Adjust GDO frequency until the fundamental frequency causes the Z-meter to dip or indicate a null. The frequency indicated should be lower than the desired frequency. Simply cut a few inches of cable off, short the end again and readjust the GDO. Repeat this procedure until the desired frequency (which should be the same as the resonant frequency of the antenna) is obtained. You will then have an electrically halfwave length of line or a multiple thereof.

Coax or twin-lead may be used for the half-wave length line when checking the impedance of the antenna. Connect the line to the antenna, hoist the antenna up to its operating position and adjust both the Z-meter and GDO for the null indication. If the antenna is not resonant at the desired frequency, the driven element should be readjusted a measured amount and then note the frequency change. This will give you an idea how much the resonant frequency changes with a corresponding element change. Now adjust the matching network to the desired impedance. This will be accomplished when the Z-meter dips at the desired impedance with the GDO set at the resonant frequency of the Antenna.

What would you do if your 100 foot coax cable developed a short someplace along the line? Replacing the whole line would be too expensive. Simply connect the Z-meter to one end of the line, adjust the Z-meter for zero impedance and then adjust the GDO for lowest frequency which will produce a null on the Z-meter. Use this frequency in the formula given for a halfwave length line and carefully calculate the length which will be the distance from the input end to the short.

A quarter wave length tuning stub can also be determined by using the procedures just outlined for the halfwave length line except a quarter wave line reflects a short at the input when the output end is electrically open. Now that we have mentioned the quarter wave length line, some may be wondering just what useful purpose does it serve. The quarter wave tuning stub (as it is sometimes called) may be used for antenna matching, TVI elimination or matching two units which have different impedances. The quarter wave matching stub can be used as a matching device on antennas which is explained in most antenna handbooks. It may also be used to eliminate an interfering frequency from entering the TV. This is accomplished by connecting a quarter wave stub to the TV antenna terminals which is a quarter wave in length at the interfering frequency.

Another use for the quarter wavelength matching stub is to permit maximum signal transfer between the source and a load which have different impedances. If the signal source impedance was 100 ohms and the load impedance was 52 ohms, a 72 ohm quarter wavelength of line would give a good impedance match. Hold it just a minute, how in the world did we come up with that 72 ohm business? Simple—another formula will give us this information.

$$Z_o = \sqrt{Z_s\ Z_a}$$

where Z_o = Impedance of quarterwave matching stub

Z_s = Impedance of the source

Z_a = Impedance of the load

Very little has been said concerning the various methods of GDO coupling. Actually—only two types of coupling are used; inductive and capacitive. Capacitive type coupling may be used on shielded coax cable, the ends of antenna elements and generally where the voltage maximum exists. To obtain the greatest accuracy, the GDO should be loosely coupled. Parallel coupling to inductors can be used to obtain maximum coupling.

. . . WØBMW

Charles Landahl W5SOT
121 Barranca Road
Los Alamos, New Mexico

The Care of Storage Batteries

Lead-acid storage batteries will deteriorate rapidly unless given proper care. When it is remembered that millions of people in automobiles call upon the "box full of pickled amperes" to start them rolling each day, it becomes easier to realize how much mechanized America depends upon the battery. It is a silent servant that is often taken for granted until a car won't start, a mobile radio system fails to respond to the press of a button, or a hole appears in your clothing due to a splash of electrolyte.

Many standard quality batteries can be made to perform at peak capacity for unusually long periods; sometimes as much as a year beyond their guarantee, provided some thought is given to their care and upkeep. In the fully charged lead-acid storage cell, the active material in the positive plate is usually lead peroxide, and in the negative plate is found pure sponge lead. All of the acid is in the electrolyte which is a dilute solution of sulphuric acid. A direct indication of full charge is that the specific gravity is at its maximum. A hydrometer reading will lie between 1.210 and 1.275, depending upon the type of service for which the battery was designed. For example:

1.210 Emergency lamps
1.245 Standby light duty service
1.260 Automobiles
1.275 Heavy duty such as electric fork lifts

As a battery discharges, both the positive and negative plates are gradually converted to lead sulphate. The charging process re-converts the plate material back to the lead and lead peroxide, and returns the acid to the electrolyte. The charging process usually produces a "gassing effect" in the cells. As full charge is approached, the cells cannot absorb all of the electrical energy and the excess energy acts to break up the water of the electrolyte into hydrogen and oxygen. This then is the primary reason for the need to add water to batteries which are in service. As a matter of interest, you may have noticed on automobiles having ammeters, that the "voltage regulator" tends to automatically take care of reducing the charge as the battery builds up after a particularly hard start, or, if some other drain has occurred while the generator was not operating.

In order to extend the life of your battery you should keep the outside of the case clean. If electrolyte or water has spilled onto the top, wiping with a cloth is not adequate. Use a solution of common baking soda and water (4 tablespoons to a quart) to flush the top of the case. A foaming action will be noted as the soda neutralizes the acid. When the foaming stops, wash the residue off the surface with clean fresh water and allow the top to dry. *Be extra careful not to get the soda solution inside the cells.* A convincing experiment which demonstrates the need for a clean dry battery top can be made with a volt-ohmmeter. Using the volts scale in the lower range, say 10 or 12 volts, put one lead on a terminal of the battery and probe with the other test lead in the mastic of the top. If the surface is damp and dirty, a reading of several volts will be noted. A moment of reflection will lead you to the realization that here is a "thief at work." A small electrical discharge path through the surface dirt is continuously draining the charge out of the battery.

Water should be added to the cells as they need it. Try to maintain the level of the electrolyte above the plates. Use distilled water whenever possible. The tap water in most cities and towns contain among other things iron and minerals. These impurities can act to harm the battery and shorten the life by creating internal losses. Distilled water can usually be bought at drug stores and hospitals and sometimes in super markets. A source of reasonably pure water is the "frost" on the cooling coils of refrigerators.

Batteries on standby or light duty service should be cycled when specific gravity drops to 1.180 and at 30 day intervals regardless of specific gravity readings.

Some of the meanings of the words used by technicians in the care of batteries are as follows:

Cycled, cycling, cycle charge: refers to complete discharge, followed by complete recharge . . . (start at 20 amps per 100 ampere-hours of capacity, continue until the electrolyte reaches 110°F, or is beginning to gas rapidly, then drop to finish rate.)

Equalizing, finishing: An extended finishing charge to insure driving off all sulphate from plates and equalizing the specific gravity readings between cells, 4 to 8 amperes per 100 AH of battery capacity for several hours. *Initial charge:* A forming charge of long, low rate; used when placing new batteries into service.

Trickle, constant current: A continuous long low rate used to keep a battery in charged condition. (example: 100 milliamps/100 AH) *Emergency, hot shot:* Used to put maximum energy into a battery in the shortest time *without seriously damaging* the battery. The emergency charge should be avoided unless close supervision is made of the charge so as to avoid excessive gassing, or, temperatures above 110°F. Another danger flag during an emergency charge is a cell voltage greater than 2.4 volts while the charging current is above the "normal or finish rates." During a charge, gassing occurs when the cell voltage reaches 2.3 volts per cell and will increase as the charging progresses. When a point is reached where most of the energy goes into gas, the amount of hydrogen released is about one cubic foot per cell for each 60 ampere hours input. A 4% concentration of hydrogen in the air can be an explosive hazard. Avoid the emergency charge.

Temperature: The preferred operating temperature is about 70°F. Temperatures of 125°F and more can cause early failure of the cells. Low temperatures reduce the capacity of a battery to deliver current. Winter becomes one of the times that batteries require careful attention. For example, it is known that the electrolyte will freeze at the following temperatures and specific gravities:

Degrees F.	Approx. Spec. Gr.
+20	1.100
+10	1.150
0	1.185
−10	1.120
−20	1.235
−40	1.265

Dry-charged batteries: These are usually manufactured with the intention of storage for a period before use—say up to two years. The process consists of charging and drying the plates in a carefully controlled atmosphere free of air or oxygen. When placing these batteries in service, they should be filled with an electrolyte about 10 points weaker than the rated full charge specific gravity marked on the case. These batteries should receive an equalizing charge before use.

In conclusion, lead-acid batteries do not require routine overhaul or solution changes during their life except as a result of accidental damage or spill. . . . W5SOT

OSCAR IV Is Up!

December 21, 1965

Dear Editor:

As I write this information, time being 12:30, the Titan 3C was a success. The Oscar 4 should be in the proper orbit and ejected now. The amateur satellite should have been turned on by 12.08 PST time. It is expected that it will be ejected over Equador.

The frequencies listed in the Sentinel were the ones that we were going to use, but Bill Orr (Oscar headquarters) changed them to input: 144.1mc—output center freq.: 431.972 —/+ 10kc—beacon freq.: 437.962mc.

The TRW Systems Radio Club back in August, also known as the STLEA Radio Club, was approached by John Chambers, Jim Ewing, Skip Freely, W. R. Hillard, and others, with the blessings of Bill Orr, as to the possibilities of the Club becoming engaged in the Oscar project. We were asked to be a back-up for Bill Orr in case they could not make their payload on time for the equatorial orbit launch. We talked it over and came to the conclusion that since we have a lot of good junk around and the experience of past satellite communication systems under our belts, the President, Mac McGrew, W6YCZ, said "why not". Mac left the Company for his own Business a little later and William McClellan, W6BJU became president. He also works in the r.f. and communication lab. Hector Nadal, K6RVO, Sec'y. and Andy Dolak, W6VHF, Treas.

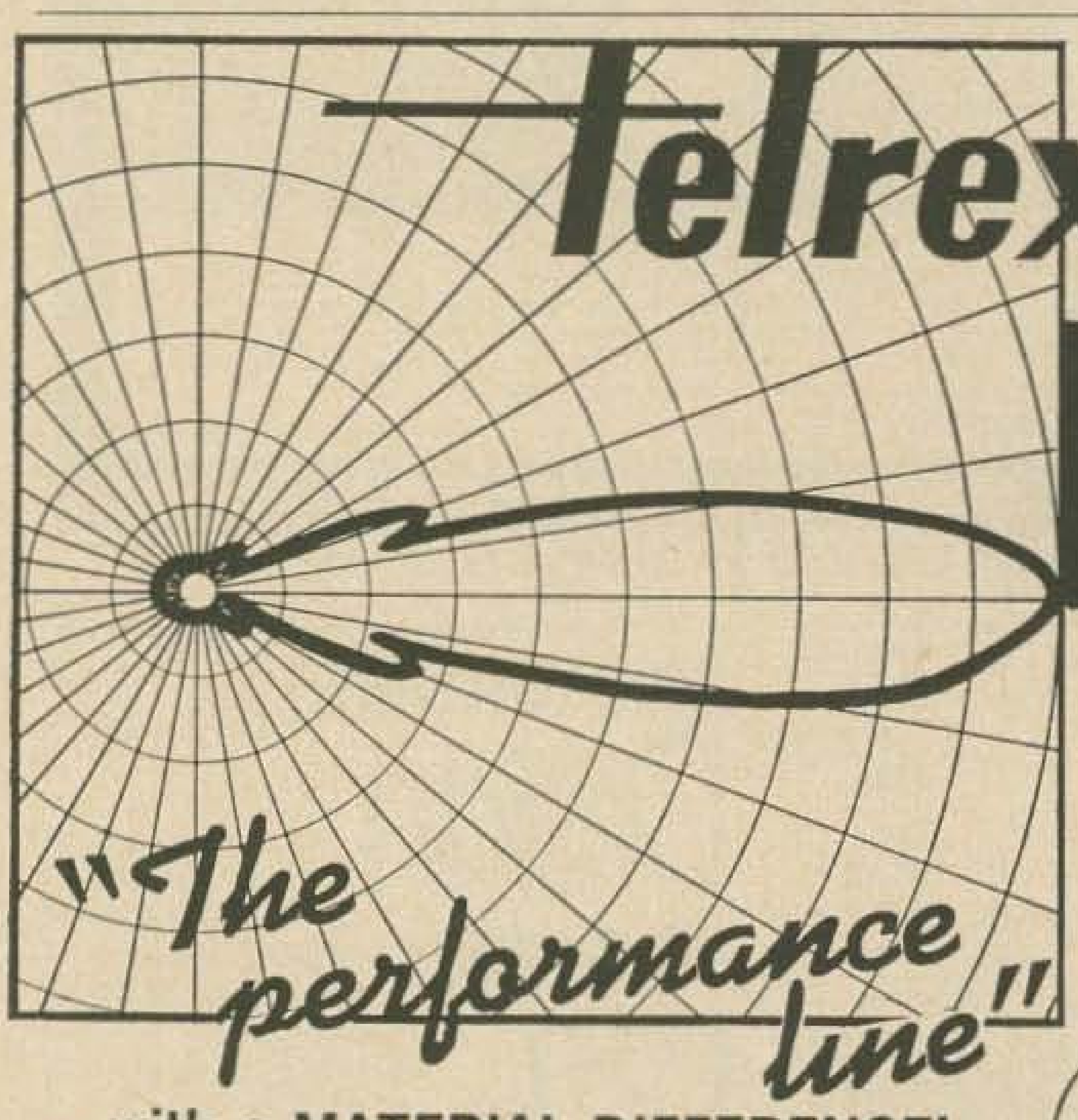
The transmitter was built by Al Jensen, WV6DOW, of Pacific Semiconductors, a branch of TRW Systems. Output of the transmitter is approximately 2.7 watts. The solar cells are capable of producing 15 watts of power. The output of the transmitter had to be sacrificed to keep it linear for sideband operation. The transmitter has the capability of 6.5 watts, but had to be compatible with four modes: SSB, FM, AM and CW. The checkout of the transmitter was done by Herb Gleed, K6ZPX. The receiver is of comparable design to any other major satellite, as the boys here at TRW Systems have built them before. Ray Eastwood, K6MWR revamped 138 mc receiver to a 144.1 mc receiver with a passband of 11 kc. The xtals used aboard Oscar 4 are those made by International Crystal Co. Jim Ewing, K8RJM/6, was a great help with the entire project. He and Al Lee, W6KQI, and others helped with the beacon logic and the remote control. The remote control is a NASA and FCC requirement. The beacon timer interval is 8 minutes, which is subject to change with temperature encountered. The 431 mc antenna was designed by L. A. Cholewski, K6CRT, and is a coaxial dipole. The mounting heighth of the antenna was selected for the best radiation pattern. The three 2 meter antennas are all hooked up in phase. There is concern among many of the boys as to the faraday field polarization in space which will be a slow change and a loss of about 3db of signal strength. Skip Freely, K6HMS, who did pioneering with past Oscars, is putting some gears and other mechanism to his 8 ft. dish to compensate for the faraday field. John Chambers, W6NCZ, also a pioneer with past Oscars, has elevation and a 16 ft. dish with a probable 24 db gain. He has made up the 3db loss with gain. There was a thin metal foil scroll made by Andy Dolak, W6VHF, on his teletype machine, and it has the names of all the participants, giving them the honor of having their names travelling in space.

The Oscar 4 has the boys stamping out chassis for 432 mc converters. Many are getting their feet wet in the higher frequencies. There is much thought being given to the high frequency antennas as well.

Archie Landry, K6MSQ, "mechanical genius", gave the first shot in the arm to the project. He made everything look so simple. Jim Williams, W6RTG, worked out problems encountered in some of the stages of the game. D. E. Moore, not a ham yet, flew to Denver, Colo. to check the mounting holes in the frame that housed all four satellites. He was impressed by RCA's sliding rack which their satellite was mounted on. He also flew to Florida to mount the solar panels and set the spring type ejection system. The pin which holds the spring is sheared off by a squib upon command. The spring not only tosses the payload out, but starts it spinning like a top. Roger Trap, K6SSN, was on the antenna project. Harry Gold, WB6AWB, who works with solar cells, did a great job on the solar panels. He at first encountered road blocks. No one would give him data on the cells we were to use. This is where W. R. Hillard, K6OPZ, came into play. He is the boy who greased the skids a little. He would go right to top management, then a little while later people came carrying the specifications to Harry Gold. There are many hams at TRW, both management and employees. Dr. Ruber Mettler, Dr. Thiel and others gave their blessings to the project, as well as the Air Force. John Chambers gave technical direction and handled the political end. Ron Pitcher, not a ham, worked the hardest on the project.

There were a few problems along the way: xtal changes, trouble with logic, getting three similar banks of solar panels. We had a little trouble getting the shaker to get to 14 G's random vibration for about 30 seconds. This vibration test was witnessed by a representative from Martin Aircraft. He had to be sure that our tetrahedral-shaped satellite would not fly apart and injure their satellite which was adjacent to ours. The shipping crate which was 1½ in. too big for the plane it was scheduled for for flight created a hunt for a plane with a bigger door. We were told about a month and ½ ago that we were "it", #1. Bill Orr couldn't make it. Oh well, we made it . . . only to hear that they knocked us into a lop-sided orbit.

Andy Dolak W6VHF



Power Tubes

This is only for oldtimers. You youngsters who got your ticket in the last ten years know all about this, so just quit reading now and go on to something more exciting.

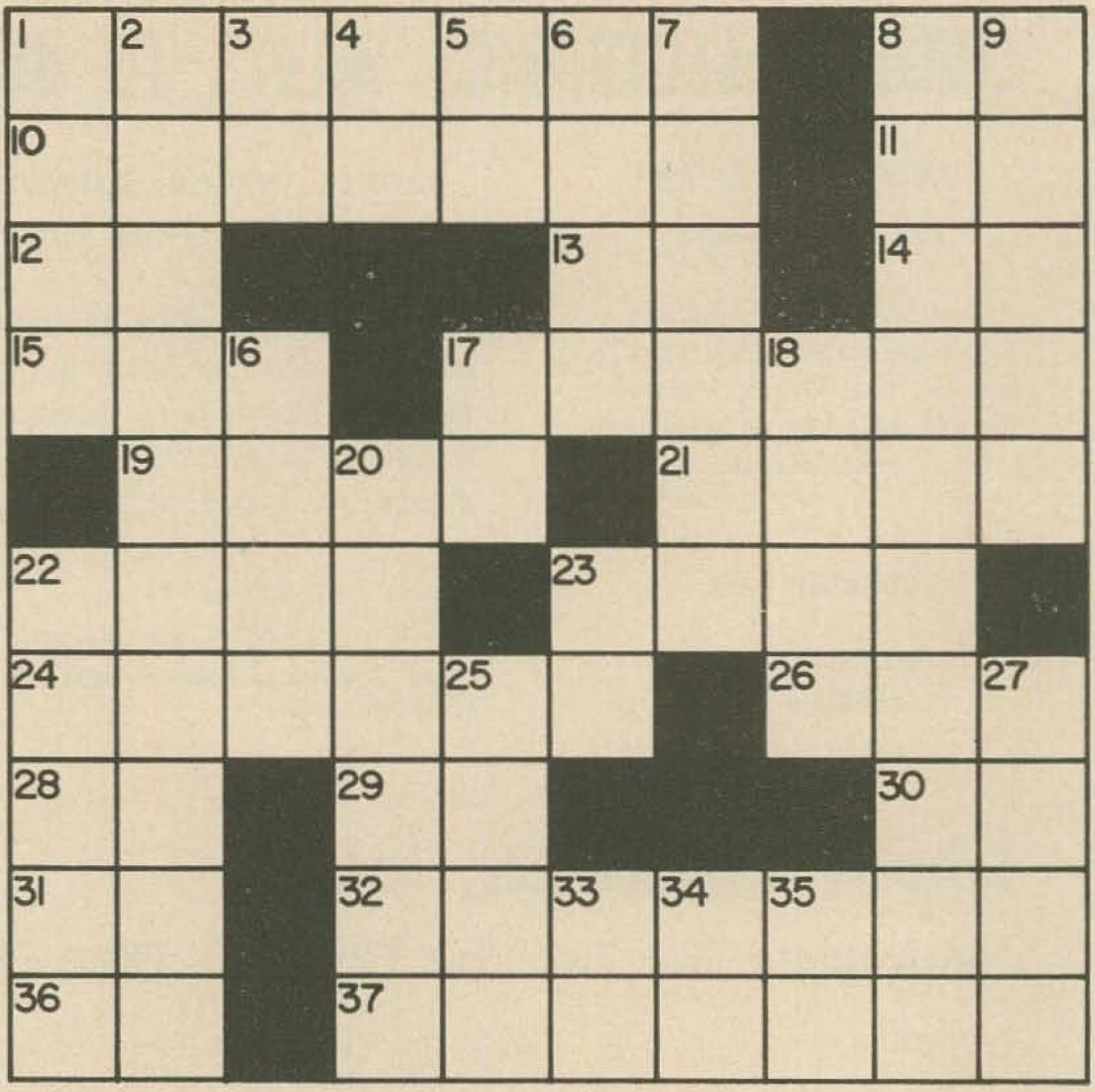
I have said many times that when you get a new Handbook, don't throw the old one away. There is information in the old books which is not in the new ones—and really good stuff, too. For one thing there is no diagram of a superregenerative receiver. It's mentioned, but no construction articles.

Anyhow, about power tubes. Before WW 2, a Taylor T20 was a real good tube that would handle about 75 watts with 700 volts on the plate. RCA-809 would take 100 watts but needed 1000 volts. Now these were transmitting tubes especially made for transmitters and cost a fair price of change, about $5.00 20 years ago. They were quite large, too; about the size of an 866. A 100 watt transmitter took up three units the size of a DX-100 and if you had a rack to put all this stuff in, then you really had something to make you proud.

Today, look at the size of a 200 watt transmitter, then take a look at the plate voltage. The tubes are nothing but receiving type tubes as shown in the RCA tube manual. This is where the new Handbook lets us down. The old books told what and how to run a receiving tube in a transmitter . . . but not so any more.

A few examples of good receiving type tubes that thanks to TV (the beast) gives good tubes at half the price of the big tube cost 20 years ago should include 6DQ6, 90 watts for $2.08, and the 6DQ5, a whopping 315 watts if you air cool and for only $4.20. If you want small size, look at a 6CZ5, smaller than your thumb, which loafs along at 20 watts with only 350 plate volts for $2.05. If you want a compact but potent rig, take a look at some of the dual purpose tubes like the 6CX8. Here are all the makings for a crystal oscillator and final for 160 through 6 at 12 watts for $1.83.

What fun we could have had with tubes like this just running them at their rated value and not like we did a pair of the old 45's with slotted bases and 800 volts on the plates to get about 10 watts in the air on a bread board 30″ long × 12″ wide, and the power supply on the floor. . . . W8QUR



Joseph Gaudet
61 Adele Avenue
Haverhill, Mass.

Crossword

Across

1. Ham
8. Algeria
10. The Ticket
11. Beam material
12. Volume level (ab.)
13. Spain
14. Ha, ha
15. Automatic load control
17. To make certain
19. Sorts
21. The band is ——
22. Rag chew
23. Soon
24. What you should do in a net
26. New Ham Shire
28. Belgium
29. Calcium
30. **Eire**
31. This —— that
32. Citadel in UA1
36. Between Canal Zone and Marshall Islands
37. Known only to a few

Down

1. Inventor of electric bulb
2. Unit of inductance
3. Type of current
4. Chemical element
5. Printers' measure
6. Put into action
7. Motive
8. Temperature scale
9. Strange
16. Fasten
17. Wait!
18. On top of
20. Raps
22. The guy who stole my rig
23. Nearby
25. Nearby
27. Evils
33. ARRL appointee
34. OM
35. airebil

Solution on p. 114.

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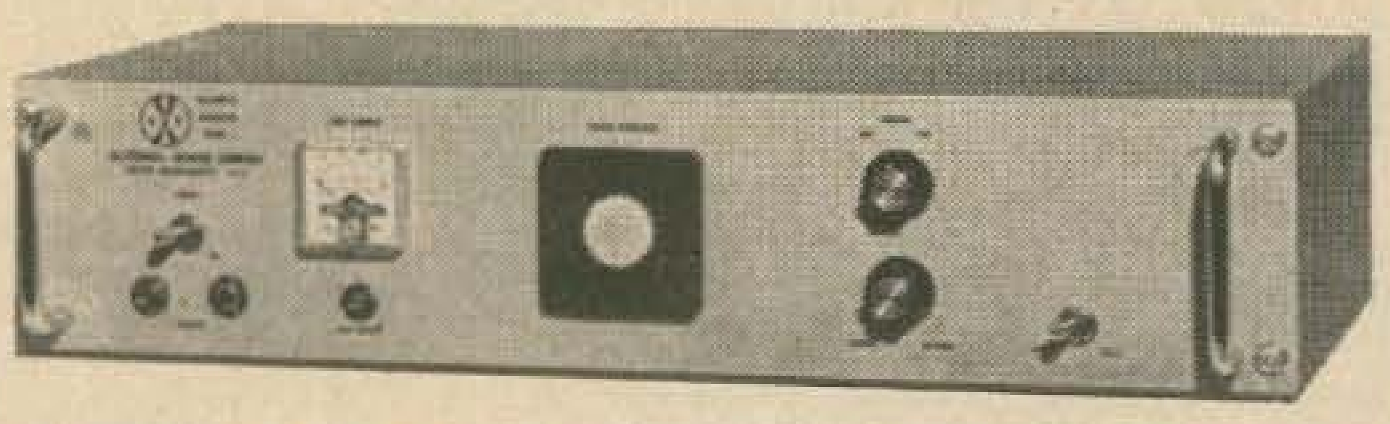

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advised by my lawyers that
don't you ever proofread y
are a bunch of crooks and
th for
have no other recourse but
should be tarred and feath

Letters

Dear Sir:

In response to the article in the November issue of *73* "Lovers Lane" by Marianne Lattak, I must say that it drew many similarities with a few escapades in hamming here at WA0JHH. When my lovely YL saw the article, she sweetly told me, "I told you so". Since then I've learned to keep the rig at home when I date.

Tom Holland WA0JHH
Minneapolis, Minnesota

Hi Wayne:

Re *QST* for August, p. 64, Bill Orr's letter, "The Multiple Untruth." You have a printing press—would you please challenge Bill to stop speaking darkly of "masters in the art of fantasy" and rumbling like an old volcano. If he is upset, let him name names, name inaccuracies, and with documentation correct them. You know, considering his recent cold objectivity, I think he means you and K6BX, hi!

And while you have it open, reread the editorial on p. 9. At first I thought John Troster wrote it, but for fun, try to picture Arthur Godfrey as he might read it aloud with his inimitable inflections.

Marty Barrack WA2ZKR

Dear Wayne,

This business about our working only certain DXers or deliberately avoiding or delaying DXers from any of our spots is absurd. Chuck and I work absolutely everybody we hear in the order we hear them, with one exception. We've recently gotten pretty fed up with the rude operating tactics and poor sportsmanship of a number of DXers and, by way of a hint, we may delay working them until they behave. Unfortunately some of the fellows high up on the honor roll are the worst offenders. For the record we have now hit twelve spots. Four of them never having been active before (8F Indonesia, 1S9 Spratly Island, HC8E Ebon Atoll, and T19C Cormiran Reef), another four quite rare (BY Communist China, ZM7 Tokeleaus, HS Thailand, and XZ Burma), and have had about 60,000 contacts during the last three months doing this. The only favoritism shown contributors is to mail direct cards to the 300 or so DXers who are making this possible.

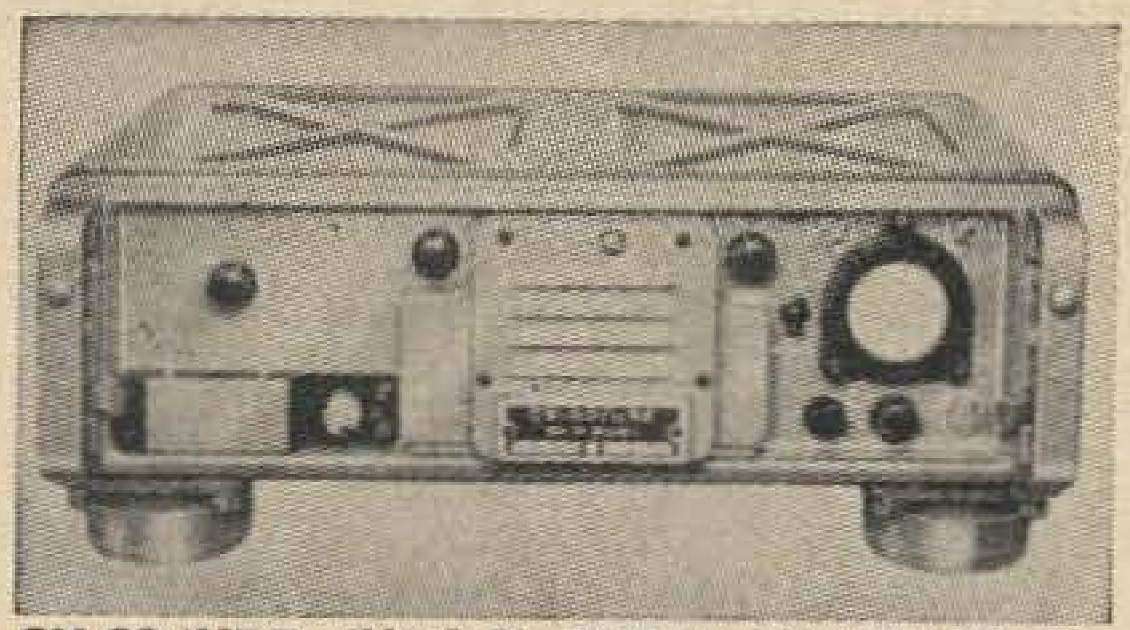
Don Miller
Fiji Islands

Dear Wayne,

A note about the article on Pi-Networks by W8QUR. He states that the big disadvantage to the pi-nets is low efficiency. I would like to say that the low efficiency is not due to the pi-net, but to the all-band feature usually built into the network. I have been a commercial broadcast engineer for several years and have built and designed commercial broadcast stations. I have yet to see a pi-net or for that matter, a t-net, that will not give at least 75% efficiency. Where I work, we run 5,000 volts at 1.2 amps to the final amplifier. Giving us 6,000 watts of input. Of this we get 5,000 watts measured at the antenna common point. This is over 80% efficiency. Not bad for a pi-net I'd say. Of course the final is class C, but even a Class C amplifier can't give anymore efficiency than the coupling network will allow. Trouble with low efficiency pi-networks is the result of "low-efficiency" design, not the nature of the network.

I certainly enjoy the fine work you're doing Wayne, in bringing good articles to the ham public. It's about time someone got the scoop over QST. Thanks again.

Jan Chadwell K7JBS
Ogden, Utah



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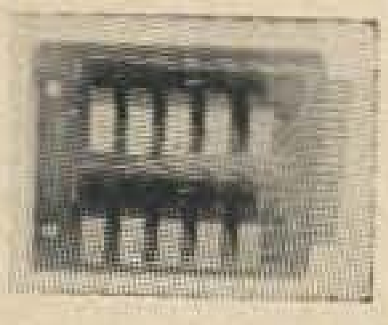

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ARC-5 Transmitter 7-9 mc. Written up many many times, but try and buy one. Perfect condition in original gov't renew packages, each with individual log and work sheets. This will no doubt be the last of them. **$23.00**

LM FREQUENCY METER with book **$60.00**

CRYSTALONICS FET (Field Effect Transistor) with spec sheet. See December 73 for more information on FET's. **$1.50. 4/$5**

JOHN MESHNA JR.
19 Allerton St., Lynn, Mass.

Dear Wayne,

I've been reading A.G.W. Cameron's book on Interstellar Communication. Very interesting. They have such complete proof that interstellar travel is impossible and that radio communication is the Only Answer.

It just happens that I have also recently read a book translating a scientific work about 500 years ago. I'll quote a passage from it:

> *To travel instantly from one place to another:*
>
> The genie *Ampharoil* presides over instant travel to all places, and he is the genie who was called by King Solomon the King of the Genies of Flying. And he comes to you when you know his name, and it's thus—
>
> A M PH A
> R O L A
> MPH A R
> O L A M
>
> And this is the way in which it is done. Five days after the full Moon, five things are to be taken, and they are five stones, each from a place where no sun is to be seen. Then the magician, taking his hat and his shoes in his hands, goes to a place where there are high winds, and he calls in a loud voice, so that the genie may hear him. And he calls upon him in these names, *"Ampha, Rola, Mphar, Olam!"* as it is written in the square.

I can't help having a strong feeling that a lot of what we're writing now will look somewhat similar 500 years hence.

So radio communication is the *only* possible means of communication?

Hah! and a magically summoned genie is the *only* way to cross the Atlantic in a single day, too. It is, if you don't know any useful amount of physical science. And if you know a little physical science, you can "prove" conclusively that interstellar travel is impossible, that UFO's can't exist, and that radio is the *only* possible communication method.

Wonder what the speed of thought is?

Maybe telepathy doesn't depend on electromagnetic phenomena, and isn't, therefore, subject to relativistic limitations.

John W. Campbell W2ZGU
Editor
Analog Magazine

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NEW PRODUCTS

Knight-Kit VHF FM Receivers

The new Knight-Kit VHF FM receivers are an ideal, inexpensive way to monitor communications services for emergencies, business or just plain snooping. One covers 30-50 mc and the other 152-174 mc. They come with prewired and aligned front end and are very easy to build, as are all Knight-Kits. Squelch is provided with a front panel adjustment so you won't have to listen to all sorts of ignition noise, hiss and other racket. Price is a low $39.95 and you can get more information from Allied Radio, 100 W. Western Ave., Chicago, Illinois 60680.

Broadband Receiver Protectors

Why buy protection? Radiation Devices Company claims in their brochure RP-1,2 that you need it to prevent transmitter leakage through inadequate antenna transfer relays from damaging costly transistors, mixer diodes, and other solid state units in your receiver front end. Two models are offered: the RP-1 covering from 3 to 54 megacycles with better than 70 db isolation and the RP-2 for low noise VHF-UHF use with better than 40 db isolation from 50 to 450 megacycles. The RP-1 also may serve as a T/R switch with transmitters of less than 25 watts output. Neither model requires tuning or will generate harmonics which cause TVI. Power for operation may be derived from your transimtter or receiver. Choice of type N, BHC, UHF or RF Phono connectors. RP-1, $10.95; RP-2, $12.95 postpaid. Box 8450, Baltimore, Maryland 21234.

Amperex Varactor Theory and Applications

A new Amperex application booklet covers theory of veractor multipliers, practical multipliers, filters and a working tripler using the 8458 twin tetrode and a 1N4885 varactor (very similar to W9SEK's article in March 73) to get 22 watts on 450 mc at lost cost. Copies of the report S-124, S-125 can be obtained by writing on company letterhead to Amperex, Hicksville, N.Y. 11802.

Servicing with Dip Meters

A useful new Sams book is *Servicing with Dip Meters* by John Lenk. All hams know how valuable dip meters are, and this book tells you how to use them for the many measurements they can make: resonance frequencies, capacitance, inductance, antenna matching, crystal and filters, impedance, Q, wavelength, field strength, SWR, etc. The book, catalog number DML-1, is available at your distributor for $2.95, or from Howard Sams, 4300 W. 62nd St., Indianapolis, Indiana 46206.

Harvey Radio Catalog

Harvey Radio's fat (over 500 pages) new 1966 catalog is now available. It covers about all the industrial, amateur, consumer and professional parts. You can get a copy from Harvey at 60 Crossways Park West, Woodbury, N.Y. 11797.

Cambion Chokes

Cambridge Thermionic (Cambion) has announced a series of new shielded chokes that provide high impedance in an extremely small package. They're only about .4 inches long and .2 inches in diameter, but come in values from .1 μh to 100 mh. For more information, contact W. G. Nowlin, General Sales Manager, Cambridge Thermionic Corp., 445 Concord Avenue, Cambridge, Mass.

New B and W TVI Filter

The new B and W model 427 rf filter will virtually eliminate extraneous TVI-causing frequencies from transmitters operating in the 25-50 mc range. It can handle 1000 watts at 50-75 ohms, and comes with UHF connectors. Price is $19.86, shipping prepaid. Barker and Williamson, Inc., Bristol, Pa.

ABC's of Microwaves

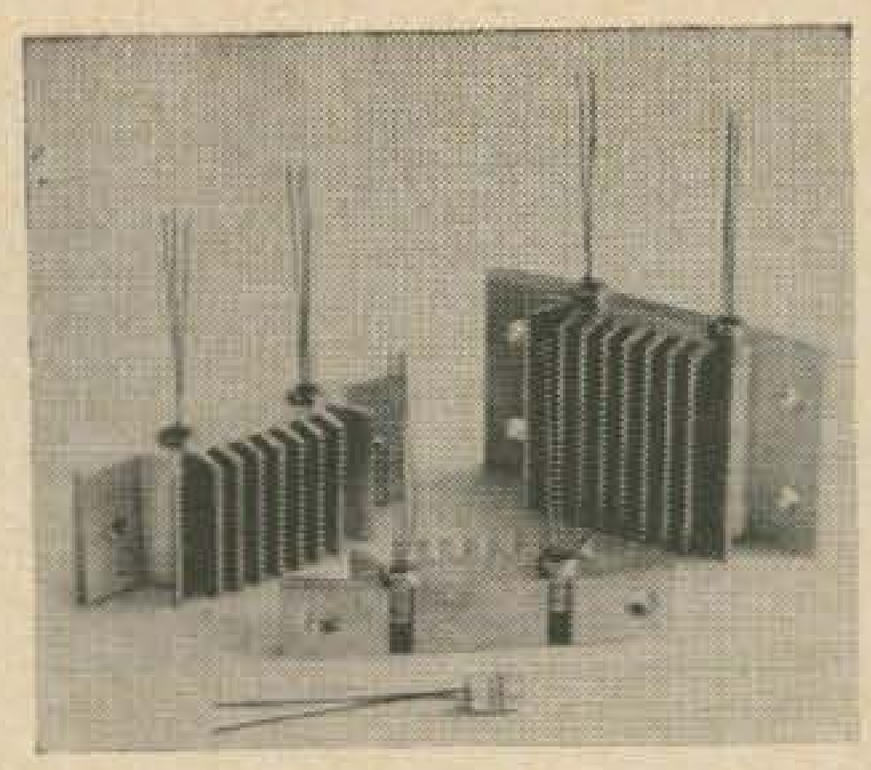
As our use of the spectrum extends higher in frequency, it becomes increasingly important for hams to know as much as possible about UHF and microwaves. A simple way to do that is with the new *ABC's of Microwaves* by Charles Woodruff. This easily understood book makes extensive use of the pictorial techniques and clear language that has marked the other books in Sams' ABC series. AMW-1 has 144 pages and costs $1.95. It's available from your local wholesaler or from Sams, 4300 W. 62nd St., Indianapolis, Indiana 46206.

Inventor's Idea Book

Want to invent something that can make you rich? The new *Inventor's Idea Book* by George Lawrence explains the challenge of new inventions, stimulates your creativity and outlines 175 specific suggestions for needed inventions. It's 128 pages and the price is $1.95 from the publisher, Howard W. Sams and Co., Inc., 4300 W. 62nd Street, Indianapolis, Indiana or from the better distributors.

Two-Way Mobile Radio Maintenance

This practical field servicing book by Jack Darr is an up-to-date guide covering modern mobile servicing, planning, installation and maintenance. The author writes from practical experience and the book is well illustrated with on-the-job photos. *Two-Way Mobile Radio Maintenance*, TWD-2, 256 pages, $4.95 from Sams, the publisher or your local electronic distributor.



Amperex Heat Sinks

Here's another clever idea from Amperex. It's a heat sink for manufacturers of solid state phonographs, etc. The interesting thing is that the sink is slightly bowed so that it's easy to insert TO-1 transistors in it, but tightening the sink to a chassis straightens it out and clamps the transistors very firmly for excellent heat dissipation and low thermal resistance. It could save a lot of time for manufacturers since there aren't any separate pieces to put together, align, etc. More information from Amperex Semiconductors, Slatersville, R.I. 02876.

Silver Plated Wire and Tubing

Radiation Devices Company offers silver plated wire and tubing of pure copper for use in critical tuned circuits of preamplifiers, converters, and transmitters. The plating is 0.5 mils thick in accordance with Federal Specification QQ-S-365A. Wire is available in #16, 14, and 12. Tubing is ⅛" outside diameter. Price of any size is 40¢ per foot. Minimum order $2.00 postpaid. Box 8450, Baltimore, Maryland 21234.

Wide Band Amplifier

Modular, solid state silicon, wide band amplifiers for preamplifier and general lab use in 50 ohm coax systems are available from Radiation Devices Company. Frequency response is within one decibel from 10 to 250 mc. Spot noise figure is 5db at 200 mcs. Gain over the one db bandwidth is guaranteed to be 10 db minimum. Modules may be cascaded for higher gains without instability. Maximum input voltage for linear operation is 500 millivolts peak-to-peak. Model WB-II is internally powered by two 9 volt transistor batteries and model WB-1E by an external power source. Connectors: N, BNC, UHF or RF Phono. Price: $20.50 each, either model, postpaid. Box 8450, Baltimore, Maryland 21234.

Precision Coaxial Terminations

Two series of precision coaxial terminations are offered by Radiation Devices Company. The LP-1 series are capable of dissipating one watt and are useful for terminating test pieces, noise generators, directional couplers, and may be used as standards in SWR bridges. VSWR of LP-1 series terminations is less than 1.05 from d-c to 1300 megacycles. Connectors: Type N male or female. Price: $12.00 each, postpaid. The MP-1 series are designed for medium power; up to 10 watts continuous in 50 ohm coax without heatsink and up to 25 watts with suitable heatsink. VSWR of MP-1 series terminations is less than 1.10 from d-c to 1300 megacycles. Connectors: Type N male or female. Price: $22.50 each, postpaid. Write for brochures LP-1 and MP-1 for more information. Box 8450, Baltimore, Maryland 21234.

432 mc Preamp

All of you on or planning to go on 420-450 mc will be interested in this inexpensive transistor preamp. It gives over 17 db gain and less than 5 db noise figure. Bandwidth is about 4 mc. It tunes the whole ham band and even up to UHF channel 34. Size is 2 x 2 x 2, power required is 12 v at 1.5 ma, and the preamp comes with BNC connectors. They'll even make them up for other frequencies. Price is a low $12.50. Tom O'Hara W6ORG, 10253 East Nadine, Temple City, California 91780.

ATV Research Catalog

Interested in ATV? Isn't everyone? You should get the ATV Research catalog. It contains many interesting goodies: complete kits of coils and other hard-to-find parts for TV cameras, lenses, mounts, vidicons, shields, printed circuit boards, etc. For a copy, write to ATV Research, P.O. Box 396, So. Sioux City, Nebraska.

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(Continued from page 4)

big guns would be glad to spare a little time on intruder duty with a vigilante net providing some extra mark or space signals for commercial RTTY stations. These stations must have absolutely perfect copy you know, so it really wouldn't be difficult to make it profitable for them to find a better channel. Darned shame if Cuba, Haiti, etc., get pushed out of our bands . . . right?

If any amateur or club or net is interested in coordinating the Vigilantes I will cooperate to the fullest with 73. I suggest that those interested in helping out on such a project get together on 3815 kc at 0000Z and get things started.

ITU Report

The crushing defeat suffered by the U.S. at the Montreux, Switzerland, I.T.U. conference in November poses even more problems for the next conference . . . the one where ham radio stands to lose its shirt. What happened? Well, the French, Soviets, Africans and Asians got together and clobbered us. The U.S. came out of the conference with not one single proposal adopted and with not one American national on the executive roster of the governing body of the I.T.U.

The French have always been extremely uncooperative about amateur radio. Their regulations are, I believe, the most strict in the entire world and they certainly have one of the smallest ham populations of any modern country in the world . . . about one ham per 20,000 population as compared to one in 800 in the U.S. France made a determined effort to take away much of 10 meters in 1959. One wonders what France might be like today if the government had encouraged amateur radio, thus making it possible for them to have a large and growing electronics industry built, as it is elsewhere, on a foundation of amateur operators.

There is little amateur operation in the Asian and African countries and thus little reason for these countries to support amateur radio. We have an important story to tell these countries for amateur radio could be of great value to them . . . but I wonder if we will get that story told in time. The only organization in the world that is working on this problem is the Institute of Amateur Radio. Frankly, if every amateur doesn't jump immediately to support the Institute, I think we will have an awful time with our consciences along about 1970. I think the disaster can be prevented, but it is going to be a lot of work and be expensive. . . . Wayne

AREA news

Though few of you have probably ever heard of the Amateur Radio Editors Association, it is a "club" made up of the editors of ham club bulletins . . . or at least it is supposed to be. AREA was started by W8BAH back in 1961 with the idea of keeping editors informed on current amateur events. Unfortunately it evolved into a monthly bulletin devoted to biographies of those that paid their $7.50 to join the Association and not much else. All told some 200 people, most of them hams, paid to have their biographies published.

Things began to look up for the AREA when Bill Welsh WA6VTL, an Edison Award winner, was voted President. Bill got together with the Directors of the Association and drew up a new constitution which would put AREA back to sending out news. The new constitution was sent to the members for ratification. Well, W8BAH had to do something fast to hold onto his $7.50 biography business so he ignored the new and old constitutions and sent out word that he was holding an election immediately with DL4HU as the only candidate for president. I wrote DL4HU about this and got word from him that he knew absolutely nothing about it and that he was writing to BAH to tell him that he was not available.

BAH apparently sat down at his typewriter and held an election for AREA. I got an announcement from him that he had elected himself president, vice president, secretary and treasurer. Quite a landslide for him.

In the meanwhile the members turned in one of the largest votes in AREA history overwhelmingly accepting the new constitution. It looks as if the Association is going to continue on and grow healthily, but without W8BAH . . . one of the little dramas that are part of amateur radio.

For information on joining AREA drop a line to Bill Welsh, 2300 W. Clark, Burbank, California 91506.

W2NSD/6

I'll be out in Los Angeles for the first week or so of February and would like to visit as many clubs as I can during this period. There are many fascinating things going on behind the scenes of amateur radio that I can't possibly write about in 73. In person I can spill the beans. Bill Welsh WA6VTL will set up my schedule of speaking so program chairmen should get in touch with him at 848-9340. Skeptics and official ARRL hecklers are most welcome. I am seldom dull.

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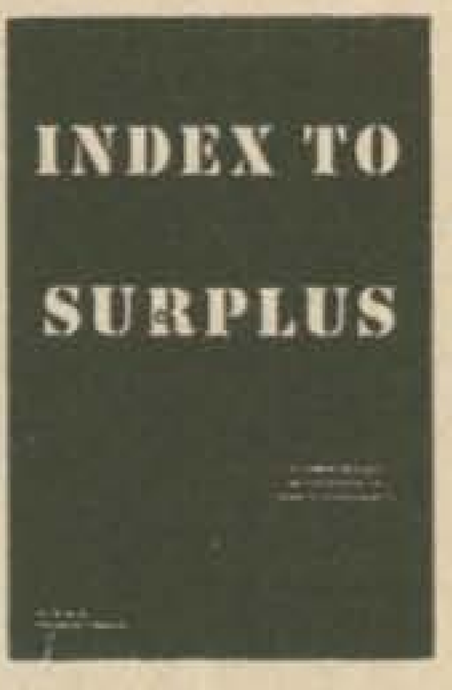

INDEX TO
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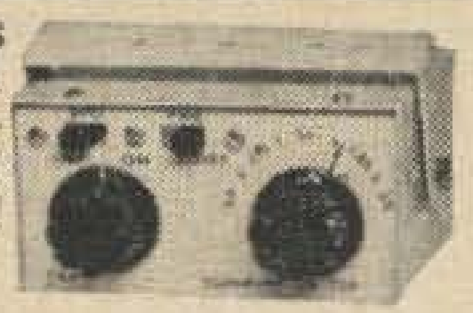
TRANSFERRING TO DENVER, Colorado April '66. Need QTH for XYL and myself. Reply airmail. TSgt Ernie Wachter K4UGL/DL4AM, Box 171 Det 100, 601st TCS, APO NY, NY 09670.

TUNAVERTER



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Belgium
Bolivia
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Bulgaria
Burma
Burundi
Byelorussian S.S.R.
Cambodia
Cameroon
Canada
Central African Rep.
Ceylon
Chad
Chile
China
Colombia
Congo (Brazzaville)
Congo (Leopoldville)
Costa Rica
Cuba
Cyprus
Czechoslovakia
Dahomey
Denmark
Dominican Rep.
Ecuador
El Salvador
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Finland
France
Gabon
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If you're a Real Rag Chewer, you can keep it going for at least six hours. This certificate is for hams who have had a single two station contact going for six hours with no interruptions. Include signed statement to that effect.

Each certificate application must include $1 to help cover the costs of administering the program, etc.

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COLLINS 75A3, $250, Central Electronics MM-2, $60. Heath AJ-10, $35. WAP2, $12. W5M, $40. Jules Fantaski W8EYO, Rt. 1, Box 460, Stevensville, Michigan 49127.

COLLINS KWM-1, AC and DC power supplies, mobile mount, $400. Globe Highbander VHF-62, $60. Johnson 6N2 converter, $40. Cliff Alsop, 5927 Primrose, Indianapolis, Indiana.

3-6 MC ARC-5 receiver converter to the marine band, power supply, AC, complete $25. W6BLZ, 528 Colima Street, La Jolla, California.

EICO SIGNAL GENERATOR, model 320, 150 kc to 102 mc, $22. BC453 receiver, $14. BC459 transmitter, TVI'd, $12. Heath condensor tester CT-1, $7. Fitzgerald, Box 508, Moravia, New York.

RME VHF 602 transmitter, model number 65-440. Need schematic for this rig. Made by GC Electronics, they do not have one. Rush your price. Barney Sprayberry WA4UXW, 749 Oak Hill Drive, Trion, Ga.

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CLEGG VENUS with AC power supply. Apollo Linear $575. Will separate. Inquire. Heath HX-30 6 meter SSB exciter $175. Drake R4 receiver $275. Will ship or deliver within 100 miles. All inquiries answered and offers considered. Robert Klein WB2UKS, 96-09 67 Avenue, Forest Hills, N.Y. 11374.

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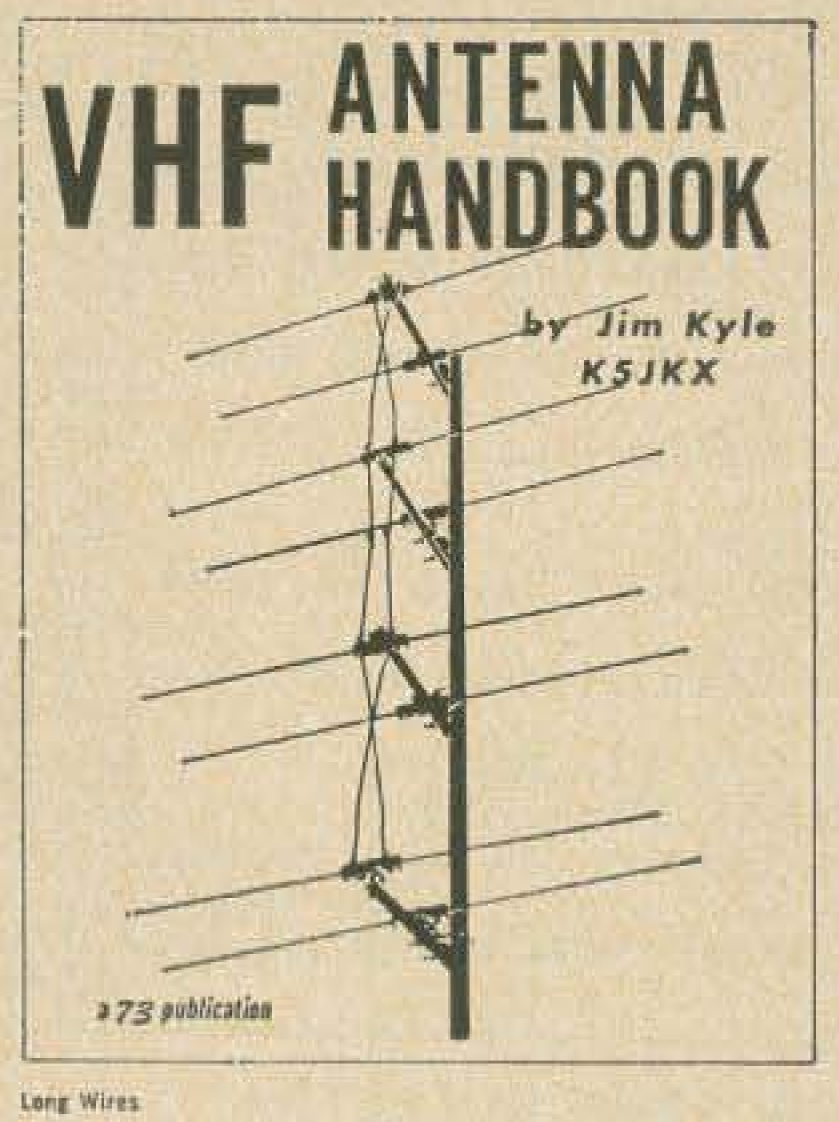

INDEX TO ADVERTISERS

Propagation Chart

February 1966

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	7	7	7	7	7	7	7#	14	14	14	14*
ARGENTINA	14	7#	7#	7	7	7	14	21	21	21	21*	21
AUSTRALIA	14	7#	7#	7#	7	7	7	14#	14	14	14	21
CANAL ZONE	14	7	7	7	7	7	14	21	21	21*	21*	21
ENGLAND	7	7	7	7	7	7#	14	14	21	14	14	7#
HAWAII	14	7#	7#	7	7	7	7#	7#	14	21	21	21
INDIA	7	7	7#	7#	7#	7#	14	14	14	7#	7#	7
JAPAN	14	7#	7#	7#	7	7	7	7	7#	7#	7#	14
MEXICO	14	7	7	7	7	7	7	14	14	21	21	14
PHILIPPINES	14	7#	7#	7#	7#	7#	7	7	7#	7#	7#	7#
PUERTO RICO	7	7	7	7	7	7	14	14	14	21*	14*	14
SOUTH AFRICA	14	7	7	7#	7#	7#	14	21	21	21	21	14
U. S. S. R.	7	7	7	3*	7	7#	14	14	14	7#	7#	7
WEST COAST	14	14	7	7	7	7	7	14	14	21	21	21

CENTRAL UNITED STATES TO:

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

WESTERN UNITED STATES TO:

ALASKA	21	14	7	7	7	7	7	7	14	14	21	21
ARGENTINA	21	14	7#	7#	7	7	7#	14	21	21	21	21*
AUSTRALIA	21	21*	14	14	14	7	7	7	14	14	14	21
CANAL ZONE	21	14	7	7	7	7	7	14	21	21	21*	21*
ENGLAND	7#	7	7	7	7	7	7#	7#	14	14	7#	7#
HAWAII	21*	21	14	14	7	7	7	7	14	21	21	21*
INDIA	7#	14	7*	7#	7#	7#	7#	7	7*	7#	7#	7#
JAPAN	21	21	14	7#	7	7	7	7	7	7#	7#	14
MEXICO	14	7*	7	7	7	7	7	7	14	14	14	14
PHILIPPINES	21	21	14	7#	7#	7#	7	7	7	7#	7#	14
PUERTO RICO	14	7#	7	7	7	7	7	14	21	21	21*	21
SOUTH AFRICA	14	7	7	7#	7#	7#	7#	14	14	21	21	14
U. S. S. R.	7#	7#	7	7	7	7#	7#	7#	14	7#	7#	7#
EAST COAST 2	14	14	7	7	7	7	7	14	14	21	21	21

Very difficult circuit this hour.
* Next higher frequency may be useful this hour.

Good: 1-3, 7-8, 10-12, 16-19, 23, 24, 26

Fair: 4-6, 14-15, 20-21, 28

Poor: 9, 13, 22, 25, 28

VHF DX: 9, 23-26

"TAB" • TRANSISTORS • DIODES!!

GTD! FACTORY TESTED — FULL LEADS.

PNP 100Watt/15Amp HiPower TO36 Case! 2N441, 442, 277, 278, DS501 up to 50 Volts/VCBO $1.25 @, 5 for $5. 2N278, 443, 174 up to 80V $3 @, 2 for $5.

PNP 30 Watt, 2N155, 156, 235, 242, 254, 255, 256, 257, 301, 392, @ 35c, 4 for $1
PNP 2N670/300Mw 35c @, 4 for $1
PNP 2N671/1Watt 50c @, 3 for $1

PNP 25W/TO 2N538, 539, 540, 2 for $1
2N1038 6/$1, 1039 4/$1, 1040 $1
PNP/TO5 SIGNAL 350Mw 25c @, 5/$1
NPN/TO5 SIGNAL IF, RF, OSC 25c @, 6 for $1

Silicon PNP/TO5 & TO18 25c @, 5 for $1
2N1046/$1.40 @, 3/$4. 2N1907/$2 @, 4/$6
Power Heat Sink Finned Equal to 180 Sq" Surface $1 @, 6 for $5
TO36, TO3, TO10 Mica Mtg 30c @, 4/$1
Diode Power Stud Mica Mtg 30c @, 4/$1

ZENERS 1Watt 6 to 200v 70c @, 3/$2
ZENERS 10Watt 6 to 150v $1.45 @, 4/$5
ZENER Kit Asstd up to 10w 3 for $1
STABISTORS up to 1watt 5 for $1

TRANSISTORS—TOO MANY! U-TEST

Untested Pwr Diamonds/TO3 10 for $1
Untested TO36 up to 100Watts 3 for $1
Untested TO5/SIGNAL/sistors, 20 for $1
Untested Power Diodes 35 Amp 4 for $1
Untested Pwr Studs up to 12Amp 12 for $1

D.C. Power Supply 115v/60 to 800 Cys. Output 330 : Tap 165V up to 150Ma, Cased $5@, 2 for $9

SILICON POWER DIODES • STUDS

DC AMP	50Piv 35Rms	100Piv 70Rms	150Piv 105Rms	200Piv 140Rms
3	.08	.14	.17	.24
12	.30	.55	.70	.85
18*	.20	.30	.50	.75
35	.70	1.00	1.50	2.00
100	1.65	2.05	2.50	3.15
240	3.75	4.75	5.75	8.75

DC AMP	300Piv 210Rms	400Piv 280Rms	500Piv 350Rms	600Piv 420Rms
3	.29	.30	.40	.48
12	1.00	1.35	1.45	1.70
18*	1.00	1.50	Query	Query
35.	2.15	2.45	2.75	3.38
100.	3.75	4.60	5.50	8.00
240	11.70	17.10	23.94	29.70

*P.F. PRESS-FIT AUTOMOTIVE TYPE!

18 Amp Press Fit up to 200Piv 4/$1
2 to 3 Amp Studs up to 600Piv 6/$1
35 Amp Studs 150 to 200Piv 5 for $5

"TAB" • SILICON 750MA DIODES

NEWEST TYPE! LOW LEAKAGE

Piv/Rms	Piv/Rms	Piv/Rms	Piv/Rms
50/35 .05	100/70 .09	200/140 .12	300/210 .14
400/280 .15	500/350 .19	600/420 .23	700/490 .27
800/560 .35	900/630 .45	1000/700 .65	1100/770 .75

GTD ALL TESTS AC/DC & LOAD!

1700 Piv/1200 Rms/750 Ma/$1.20 @, 10/$10
Same 1100 Piv/770 Rms 75c @, 16/$11
3 Kv/2100 Rms/200 Ma/$1.80 @, 6/$10
6 Kv/4200 Rms/200 Ma/$4 @, 3/$9
12 KV/8400 Rms/200 Ma $8 @, 2/$14

SCR—SILICON CONTROL RECTIFIERS!

PRV	7A	16A	PRV	7A	16A
25	.80	1.30	250	2.70	3.00
50	1.00	1.35	300	3.00	3.45
100	1.60	2.15	400	3.75	3.90
150	1.95	2.45	500	4.75	4.80
200	2.20	2.80	600	5.45	5.85

UNTESTED "SCR" Up to 25 Amps, 6/$2
Glass Diodes 1N34, 48, 60, 64, 20 for $1

Two RCA 2N408 & Two Regulators RCA 1N2326 on prtd ckt. 30c @, 4/$1

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THAT'S A BUY

"TAB" Tubes Factory Tested, Inspctd. Six Months Guaranteed! No Rejects! Boxed! GOVT & MFGRS Surplus! new & Used

Low Prices! New XMTTG Tubes!

4-65A	$7.00	4X150A	$6.75	OB2	.55
4-125A	15.00	826	Query	5R4WGA	3.50
4-400A	25.00	829B	7.20	24G	Query
4-1000A	75.00	872A	3.50		
		OA2	.65		

We Swap Tubes! What Do/U Have?

OA3	.80	5R4	1.00	6F7	.99
OC3	.70	5T4	.90	6F8	1.39
OD3	.59	5V4	.89	6H6	.59
OZ4	.79	5Z3	.89	6J5	.59
1L4	.82	6A7	1.00	6J6	.59
1R4	5/$1	6A8	.99	6K6	.59
1S4	.78	6AB4	.59	6L6	1.19
1S5	.68	6AC7	.72	6SN7	.72

Send 25c for Catalog!

1T4	.85	6AG5	.65	6V6GT	.90
1T5	.95	6AG7	.75	12AU7	.69
1U4	6/$1	6AK5	.69	12A6	.45
1U5	.75	6AL5	.55	25L6	.72
2C39A	Q	6AQ5	.66	25T	4.00
2C40	5.50	6AR6	1.95	28D7	.89
2C43	6.50	6AS7	3.49	50L6	.59
2C51	2.00	6AT6	2/$1	83V	.95

We Buy!		We Sell!		We Trade!	
2D21	.65	6BA6	.59	250TL	19.45
2K25	9.75	6BE6	.59	VR92	5/$1
2K28	30.00	6BK7	.99	388A	3/$1
2V3	2/$1	6BQ6	1.19	416B	16.00
2X2	.48	6BY5	1.19	450TL	43.00
4X250B	30.00	6BZ6	.91	813	9.95
5BP4	7.95	6C4	.45	815	1.75

Top $$$ Paid for All Tubes!

"VOLT-TAB" 600Watt Speed Control 115VAC $4.50 @, 2 for $8

866A Xfmr 2.5V/10A/10Kv/Insl $3 @
Ballentine #300 AC/Lab Mtr. $54
(Sd) Choke 4Hy/0.5A/27Ω $40 @, 2/$6
"VARIACS" L/N 0-135v/7.5A $15
"VARIACS" L/N 0-135v/3A $10
TWO 866A's & Fil. Xfmr. $6

SILICON TUBE REPLACEMENTS
0Z4 UNIVERSAL $1.75 @, 2/$3
5U4 1120Rms/1600Inv $2 @, 3/$5
5R4 1900Rms/2800Inv $9 @, 2/$15
866 5Kv/Rms - 10.4Kv Inv $11 @, 2/$20

Mica Condsr .006 @ 2500V 4/$1
Snooperscope Tube 2" $5 @, 2/$9
Mini-Fan 6 or 12Vac/60Cys $2 @, 3/$5
4X150 Ceramic Loktal $1.25 @, 2/$2
Line Filter
Line Filter 50Amp/250VAC $10 @, 2/$16

DC 3½"/Meter/RD/800Ma $4 @, 2/$7
DC 2½" Meter/RD/100Ma $3 @
DC 2½" Meter/RD/30VDC $3 @, 2/$5
AC 3½" Meter/RD/130VOC $5 @, 2/$9
DC 4" Meter/RD/1Ma/$5 @, 2/$9

Battery Charger 6&12V Charges up to 5Amp "Approved" Heavy Duty Design with Klixon Circuit Breaker. Operates 220 or 110VAC @ 50 or 60 Cys $8, 2 for $15, 7/$49

Transformers—All Input 115v/60Cys VCT @ 250Ma, 6V/8A/5A/3A $6, 2/$10
400VDC Supply @ 200MA & Silicon Rect & Filters $10
20VAC & TAPS/.8,12,16, 20V @ 4A, $3
32VCT/1A or 2X16V @ 1A, $8 @, $2/$5

Line Filter 4.5A @ 115VAC 4 for $1
Line Filter 5A @ 125VAC 2 for $1
Converter Filter 400 Ma @ 28VDC 4 for $1
Converter Filter Input/3A @ 30VDC 4/$1
2.5MH PiWound Choke/National 5 for $1

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Each "TAB" Kit Contains The Finest Selection!!!

- Kit 35 Precision Resistors
- Kit 75 Resistors 1/2/1&2W
- Kit 12 Electrolytic Cond's.
- Kit 65 Tubular Condensers
- Kit 500 Lugs & Eyelets
- Kit 10 Bathtub Oil Cond's.
- Kit 5 lbs. Surprise Package
- Kit 10 Transmit Mica Cond's.
- Kit 8 Phone/Patch Xfmrs
- Kit 10 Insltd Tuning Tools
- Kit 6 "SunCells" Battys
- Kit 10 Sub-Min Tubes
- Kit 12 Alligator Clips Asstd
- Kit (6) Tube Clamps Asstd
- Kit (32) Transistors PNP & NPN
- Kit (12) 2Amp Stud Rectifiers
- Kit 75 Mica Condensers
- Kit 10 Crystal Diodes
- Kit 200ft Hook Up Wire
- Kit 4 Rolls, 500ft/ea. Assorted Color
- Kit 5 FT243 Xtal Holders
- Kit 10 Xtal Osc. Blanks
- Kit 4 Asstd Rectifiers
- Kit 100 Self/Tap Screws
- Kit Adj Wire Striper & Cut
- Kit Hi Gain Xtal Mike
- Kit 2 pair SO239 & PL59
- Kit 12 Binding Posts Asstd
- Kit (3) TO36/50Watt Untested
- Kit (50) TOPHAT 3/4A/Diodes Untested
- Kit (12) TO3/3A Transistors Untested
- Kit (4) PF/PressFit 18Amp Studs

Order Ten (10) Kits—We Ship Eleven

One Each Above Kit Only. Each Kit 99c

W.E. Polar Relay #255A/$5 @, 2 for $9
W.E. Socket for #255A Relay, $2.50
Toroids 88Mhy New Pckg $1 @, 6/$5
6.3VCT @ 15.5A & 6.3VCT @ 2A $4 @, 2/$6
200KC Freq Std Xtals $2 @, 2/$3
Printed Ckt Bd New Blank 9x12" $1 @, 6/$5
Klixon 5A Reset Ckt Breaker $1 @, 8/$5
2K to 8K Headsets Good Used $3 @, 2/$5
Xtal Blanks Asst Types 12 for $1

WANTED TEST SETS & EQUIPMENT

Bandswitch Ceramic 500W 2P/6Pos $3 @, 2 for $5
6Hy-305Ma Choke Cased $3 @, 2/$5
7-½Hy-400Ma Choke Cased $7 @, 2/$12
250Mfd @ 450 Wv Lectlytic 4/SSB $3 @, 4/$10
Cndsr Oil 10Mfd x 600-2x2.5 & 5Mfd $1 @, 15/$10
Cndsr Oil 6Mfd @ 1500V $4 @, 4/$10
880Vct @ 735Ma for SSB $9 @, 2/$16
480Vct @ 40Ma & 6.3 @ 1.5A CSD $1.50 @, 4/$5
10Vct @ 5A & 7.5Vct @ 3A CSD $6 @, 2 for $10

WANTED LAB METERS! BRIDGES! K-POTS!

Pwr Sup Kit 900VDC @ 500Ma & 4/Silicon Diodes 1700Piv FWB $12
Pwr Sup Kit 1200VDC @ 200Ma/Xfmr & FWB Silicon Rect $10 @, 2 for $18
Modulation Xfmr 60W/15K to 5.7K $5
Headset Rubber Bunyon Pads pair $1
Socket Ceramic 1625 Tube 4/$1
Socket Ceramic 866 Tube 4/$1
Socket Ceramic 4X150/Loktal 4/$2

WANTED YOUR - ORDER - TODAY!

6MTR Ground-Plane Ant (R Exp) $4
Knob Spin-Crank BC348 Type $1
MiniFan 6 or 12 VAC $1.50 @, 4 for $5
Beam Indicator Selsyns 24VAC 2 for $10
Precision TL147 Feeler Relay Gage $1
8 foot Elec. Cord #18ga & Plug 39c @, 3/$1
Fuse 250Ma/3AG 5 for 30c, 100 for $3

DON'T C-WRITE & SEND ORDER!

XMTTG Mica Condsr .006 @ 2.5Kv 39c @, 5/$1
XMTTG Mica Cndsr .00025 @ 8Kv 75c @, 4/$2
Mini-Rectifier FWB 25Ma @ 115VDC 3 for $1
Micro-Switch Rated 40Amp AC & DC 4 for $1
BandPass Filters 60 or 90 or 150Cys 3 for $5
T30 Throat Mikes $1 @, 4 for $3
"Bruning" 6" Parallel Rule #1 @ 3 for $2
Linear SawTooth Pot KS15138/W. E. 3 for $1

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COMPACT — 80-40 METER SSB TRANSCEIVER. A LOW COST RIG—WITHOUT SACRIFICE OF POWER AND PERFORMANCE. INCLUDES BUILT-IN SPEAKER AND GIMBAL MOUNT! E-Z TUNING WITH BANDPASS EXCITER DESIGN — JUST PEAK OUTPUT FOR SMALL QSY. Illuminated VFO dial with **2 kc** calibration. High impedance mic. input with push-to-talk operation. Combination S-Meter/Output indicator. Smooth vernier (12:1 slow and 2:1 fast) VFO tuning.

300 **Watts** PEP-SSB input, covering 3.8 - 4.0 and 7.1 - 7.3 mcs. (LSB-80 and 40 meters). A pair of **proven 6HF5** final tubes. Separate, relay switched, tuned RF receiving stage, **½ uv. sensitivity** at 10DB S/N. Rugged printed circuit boards, combination tube-transistor circuitry for best performance. **Stable solid state VFO** and balanced modulator, zener regulated. **Selectivity 2.5 kc** @ - 6DB receiving and transmitting with a 4 crystal filter. Carrier and unwanted sideband suppression - 40DB. 1 watt of audio with built-in speaker. Fixed 50 ohm input/output impedance. Excellent AVC. COMPACT SIZE: 5" high, 11¼" wide, 10" deep, less power supply. Net weight 10¾ lbs. Shipping weight 15 lbs.

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Definitely not. It's a cold fact that no competitive linear amplifier compares with National's NCL-2000—regardless of price. Take the time to look at the chart below and plug in the specs of *any* amplifier next to those of the '2000 — not a single competitive unit in the maximum power classification offers even half the features of the NCL-2000:

FEATURE	NCL-2000	COMPETITION
POWER	Entire equipment I.C.A.S. rated for full 1000 watt average, 2000 watt peak input; output tubes and all RF components rated for C.C.S. operation. Power input and efficiency identical on all bands — 80 through 10 meters.	
SIZE	Completely self-contained, including power supply, in desk-top cabinet (dimensions only 7⅝" H, 16¼" W, 12¾" D).	
DRIVE REQUIREMENTS	Adjustable passive grid input and use of high power ceramic tetrodes in final permits drive to full output with exciters delivering as little as 20 watts or as much as 200 watts.	
METERING	Separate rear-illuminated precision D'Arsonval plate and multi-meters for simultaneous measurements.	
ALC	ALC output to exciter for maximum talk-power with greatest linearity.	
SAFETY AND PROTECTIVE DEVICES	Fuses, time delay and plate current overload relays, plate power lid interlock and automatic HV mechanical shorting bar.	
CLASS OF OPERATION	Grid-regulated AB_2 permits easiest tune-up, low drive power for maximum exciter linearity, and protection from destructive peak currents.	
EASE OF TUNE-UP	Internal dummy load in grid circuit makes adjustment of exciter into amplifier possible without turning on NCL-2000 and without radiating a signal.	
STYLING	Award-winning design matches NCX-5 transceiver and complements **any** equipment.	
GUARANTEE	National's exclusive One-Year Warranty.	
PRICE	Only $685.00.	

The NCL-2000 is a rock-crusher of a rig built to *commercial* standards. That's why you get I.C.A.S.-rated maximum legal power in a one-piece desk-top package, and why you get ALC and drive power compatibility with high quality exciters. It's why you get two precision meters, and sensible protection afforded by proper safety devices. Match the NCL-2000 with all the others before you buy — then see your National dealer for easy terms and trade-in deals.

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