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August 1969

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73 MAGAZINE

73 Magazine #107, August 1969

Contents

Features

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...de W2NSD/1

Wayne Green

You may have noticed that the increased size of the magazine has resulted in a crush on the contents page. Frankly, this is a problem that we would like to continue to wrestle with. We can continue to give you a thick magazine every month if you will do three things for us.

1. We can't publish articles if we don't have them, obviously. Construction articles are the most popular, so if you've concocted something that others might be interested in duplicating or even just reading about, write it up and send it in. We pay for all articles and we pay the most and the highest. Perhaps humor is your forte? Or maybe, if you can't write it, you can talk someone like Jean Shepherd, K2ORS, or John Campbell, W2ZGU, into writing for us? Simplified explanations of complicated theory are popular.

If you have been working in one of the newer ham fields such as SSTV or FAX. . . tell us all about it. . .sell us on it. . .get more fellows interested. We need lots more info on RTTY, TV, FM and all the other interesting aspects of ham radio. Write! The basic purpose of 73 is to make amateur radio more fun for you. If you can make hamming more fun for others by writing, then see what you can do. What more important thing is there for you to do in this world than make life more enjoyable for others?

We are now publishing more articles every month in 73 than are published by all the other ham magazines combined, so we need your articles. By count, in May, brand X ran 10 feature articles; brand Y ran 12 articles; brand Z ran 8. Total for the three was 30 articles. We ran 37 feature articles in 73 in May.

2. Your support of our advertisers is the reason that we are able to bring you such a large magazine. Many advertisers in our March issue are still exclaiming over the remarkable results their ads brought. When you talk with manufacturers please tell them that you read 73 and want them to support 73 so that you can have more articles. You may be interested to know that 73 is now leading in advertising. In May brand X had 83 advertisers, brand Y had 50, and brand Z had 62. . .and 73 had 87!

Let the advertisers know that you care! If you can convince a few more major manufacturers to advertise in 73, we can bring you even more articles every month.

3. Share the enjoyment you get from reading 73 by getting a friend to subscribe. . .or by sending in a gift subscription for him. You'll be remembered twelve times a year for your generosity. And if you work DX you will find that just about every foreign amateur wishes that he could get 73. Our international subscription rates are exactly the same as domestic ... $6 a year, $12 for three years! And we are, I believe, the only magazine that can say that! This is our way of trying to help DX amateurs. Hams in India and the communist countries have a special problem. . .no currency. They depend almost entirely on your gifts for magazines. Don't you have a few dollars to spare?

There it is. All you have to do is support 73 with articles, subscriptions and a good word to the advertisers, and you will have a magazine that is bigger, thicker, and takes a month to read. It will also be fun. . .and that is what it's all about, isn't it?

ARRL Board Meeting

Another annual meeting has come and gone with little action on any important measures. Nothing was done about setting up PR which would reverse the downward

(continued on page 107)

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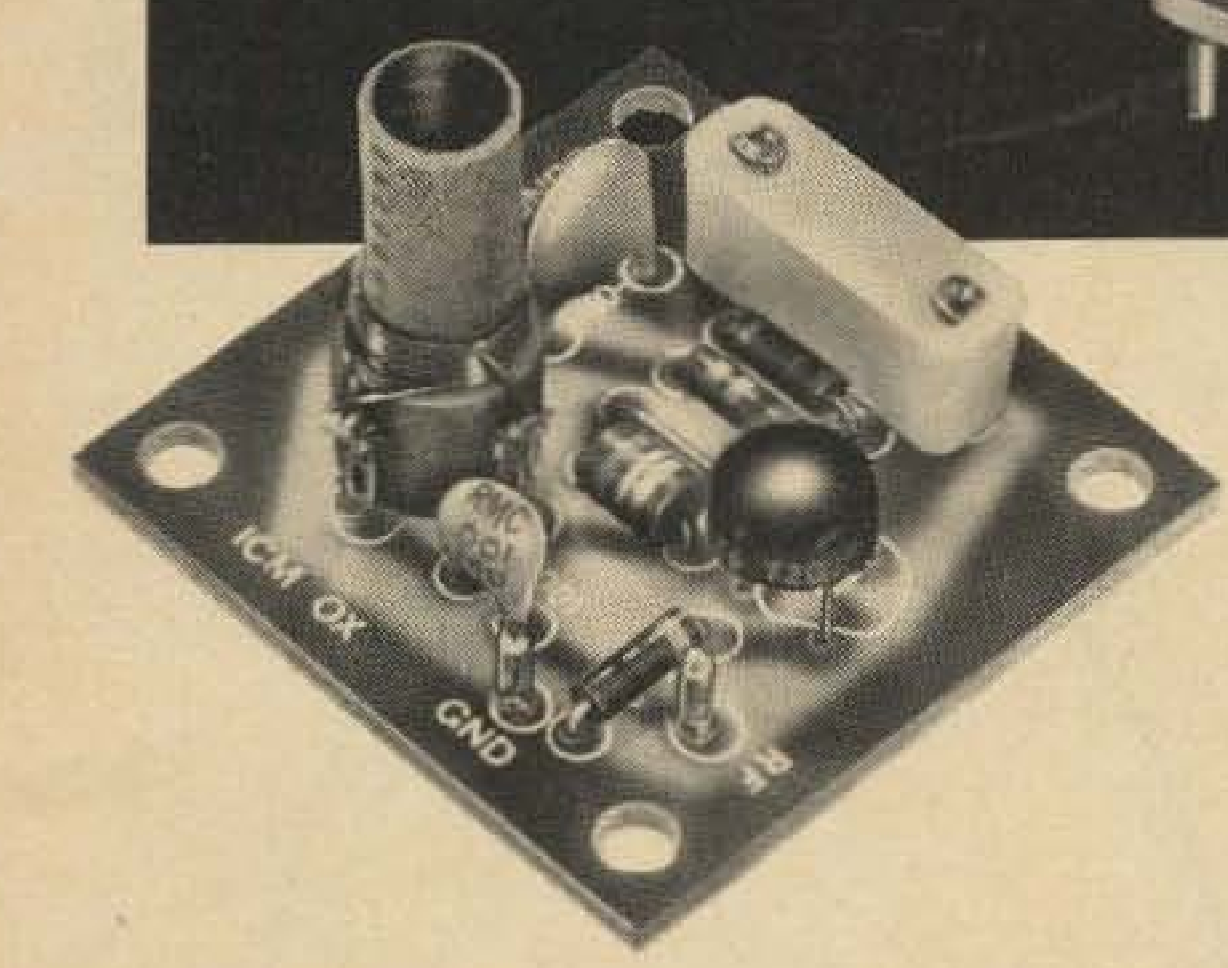

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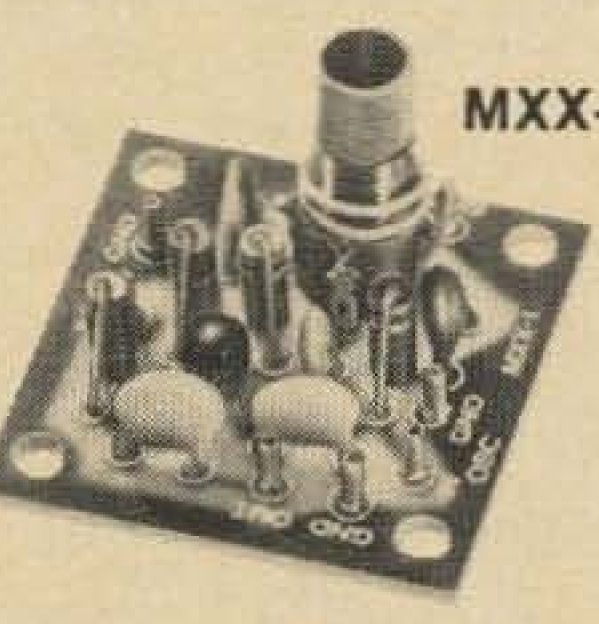
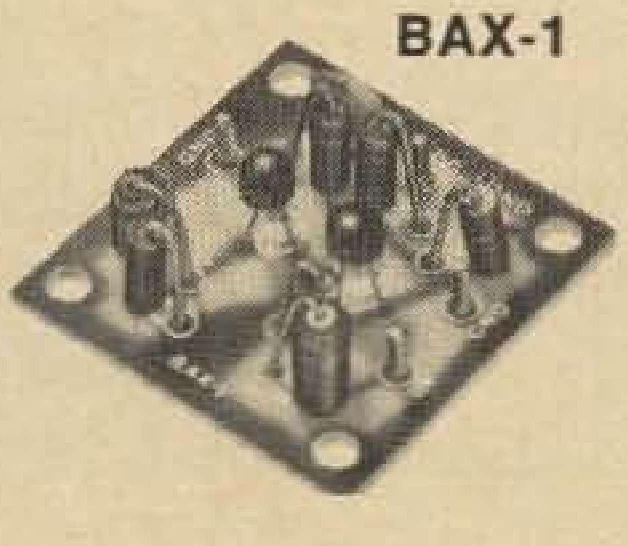


SAX-1

PAX-1

BAX-1



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Listen In on Two-Meter FM Repeater

W. G. Eslick, KØVQY
2607 E. 13th
Wichita, KA 67214

For those who don't have a two meter FM receiver and want to listen to the repeater (if you have one in your area) this little converter will do a very good job into an AM radio.

You will recognize this converter as being similar to police converters. (In fact, changing the crystal and repeaking the antenna coil should put a police converter in the ham band).

The unit is built on a printed board 2-1/8 by 2-5/8 inches. The capacitors are all from my junk box and include small round tubular, round flat ceramics and small milar types.

Q1 and Q2 are 2N2996's, but 2N1141's and TIXM10's all work fine on three volts. Three volts was selected because my converter works into a radio that runs on two penlight cells. If you plan to use 6 or 9 volts, R1, R2, R3 and R4 will have to be changed to other values (found by experiment and measuring base voltages and collector currents). My unit, using 2N2996's draws 8-1/2 ma at three volts.

After building, determine by gdo or receiver if the crystal is oscillating at three times its frequency (I tune my 6 meter rig to the fundamental frequency of the crystal or rather its overtone frequency), or if it is oscillating at crystal frequency, it will be ok at 3 times. Then place the converter near your bc receiver loop antenna and tune it to the approximate frequency (your *if* in this case) or, using a signal generator or a signal from the repeater, adjust the converter loopstick for maximum signal or noise. With a signal picked up from repeater, adjust C1 for maximum. I am near the repeater and I use about a 10 inch whip for my antenna.

You are receiving FM by slope detection, so tune your bc radio for the clearest reception. Some will be clearer than others, depending how close to the frequency they are. You won't receive them as crystal clear as an FM receiver, but this will let you listen in.

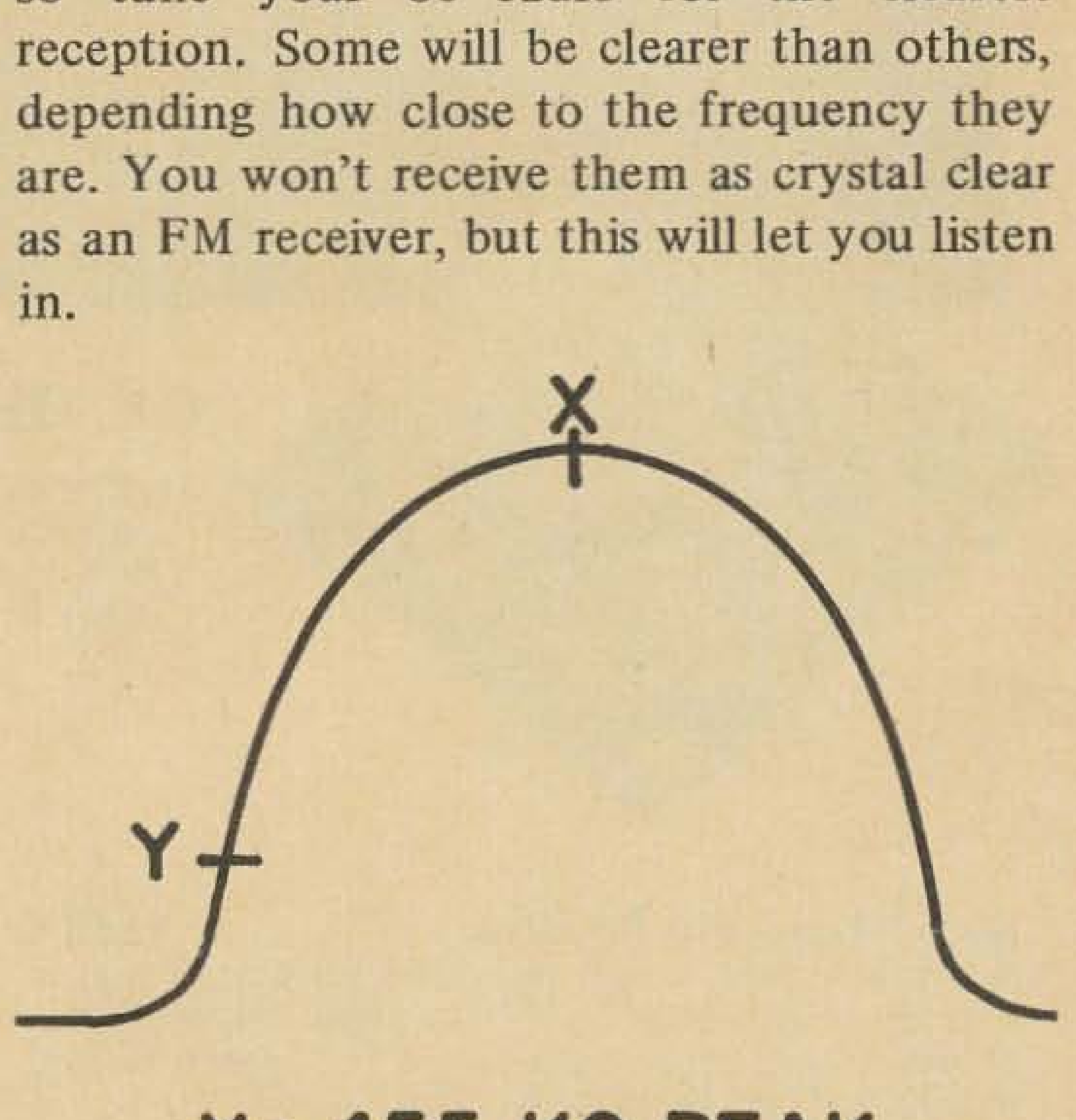


Fig. 1. IF passband used for slope detection of FM signal. Wideband FM will be muffled due to narrow frequency swing between y and x.

Roughly, slope detection works like this (this is a quick and short explanation). Your 455 khz *if* passband looks something like **Fig. 1** with the desired AM signal (when receiving AM) carrier will be at "x" or the top part of the curve while the FM signal should be somewhere around "y" (just high enough on the curve to give a signal through the *if*'s). Then, during FM modulation, the frequency swing can be between y and x, producing a varying signal strength at the detector. As the modulation approaches x on the curve, the *if* is operating with maximum gain and when it is at y, the *if* gain is lower. This varying signal is detected by the AM detector (in other words FM modulation varies the gain of the bc *if* as the signal rides up and down the curve and produces an amplitude voltage at the detector).

Some radios overload easier than others, so vary the distance between converter and bc radio for the best results.

Later, when I scrounge a crystal, I am going to operate this converter into a transistor 10.7 mhz *if*. For those interested, the crystal can be 10.7 lower or higher than the received frequency. The repeater output here is 146.940 mhz, so let's do a little math. Remember that we are using the third overtone crystal circuit as a tripler (that's why we divide by 3).

146.940 + 10.7 = 157.640 ÷ 3 = 52.5476 mhz = crystal on high side.

146.940 − 10.7 = 136.240 ÷ 3 = 45.4133 mhz = crystal on low side.

Either crystal will permit the 146.940 signal to come in at 10.7 mhz, the *if* of most FM sets. The exact frequency of the crystal can be varied according to how much you can swing your *if*'s from 10.7 mhz. In my transistor *if* strip, the slugs vary the frequency very little, less than one mhz.

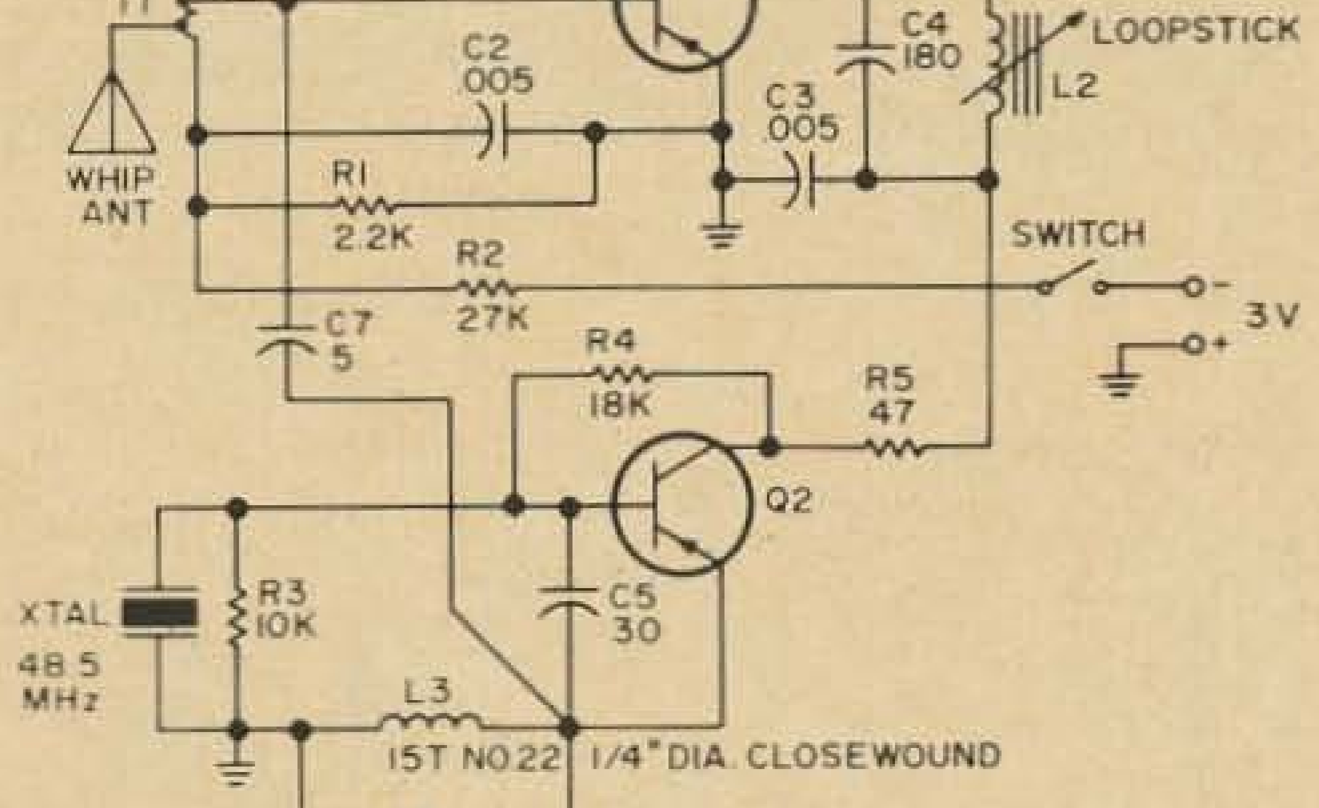


Fig. 2. Schematic of converter for 2M FM repeaters. Or anything else on 2M for that matter.

Getting back to you who plan to use a bc radio. You will have to use this math to suit your crystals and also keep away from bc stations (pick a clear spot on the bc dial). In my rig I used a 48.716 crystal, giving me an injection frequency of 146.148 mhz on the low side of the repeater frequency. 146.94-146.148=792 khz, where I pick up the repeater.

The extreme ends of the bc band, using the xtal on the low side and the high side, are:

146.940 − 1.600 = 145.340 ÷ 3 = 48.4466 mhz low side.

146.940 + 1.600 = 148.540 ÷ 3 = 49.5133 mhz high side.

146.940 − .550 = 146.390 ÷ 3 = 48.7966 mhz low side.

146.940 + .550 = 147.490 ÷ 3 = 49.1633 mhz high side.

There we have it. A crystal between 48.7966 and 48.4466 will permit the repeater to come in between 550 khz and 1600 khz with the oscillator working on the low side of the incoming signal at the antenna, while a crystal between 49.1633 and 49.5133 will permit the repeater to come on the bc band between 550 and 1600 khz with the oscillator working on high side of the signal at the antenna. So, in other words, if you have a third overtone crystal in your junk box between 48.4466 and 49.5133 you can put the repeater into the bc band!

One note of warning of a trouble that cost me a mixer transistor (2N2966). Jamming C3 under the loopstick (which is elevated about 1/4" from the board by a bracket), one lead broke on C3 and when I fired the converter up it was oscillating like mad on the bc band. This made the transistor draw more current and finally destroy itself. So check all parts to make sure a lead hasn't broken. Inspect everything closely and heatsink the transistor leads with tweezers or a long nose while soldering them to the board or, better yet, use transistor sockets.

Good luck and pleasant listening on 2 meter FM.

. . . KØVQY

L. C. Maurer, W6OSA
209 Nob Hill Way
Los Gatos, California 95030

An FET Regenerative Receiver for 3.5 mhz and Up

It appears that almost anything which a bi-polar transistor can do, an FET can do better. The simple regenerative 3.5 to 6.0 mhz receiver described here is another case in point.

Three or four months ago I started out to build an SWL receiver for my ten year old son. I used the circuit shown in Fig. 1 which is similar to that in the December, 1966, issue of *73 Magazine*. There were two problems with it which I could not seem to overcome. The regeneration control was too critical, or at least I could not get it to remain stable over more than three or four hundred khz. It required an excessively long antenna. When I got around to measuring the .power into the regenerative detector, it turned out to be .8 ma at 7.5 volts or .0006 watts. I guess you can't expect to rattle the diaphrams in your earphones with that sort of power. Maybe what is needed is a detector in which the regeneration is not controlled by reducing the collector voltage.

This thought led me to recall the old two tube blooper that started me on my radio career circa 1932. It had a VT224 as a detector and regeneration was controlled with a variable capacitor. From that point the circuit shown in Fig. 2 evolved. I used a TIS-34 FET because: (1) I had some on the shelf; (2) a FET acts like a screen grid tube (with poor screening). Any FET which will oscillate on the desired frequency will work in the same circuit (keep the N-Channels and the P-Channels straight).

The results of this new design were as surprisingly good as the old circuit was disappointing. The regenerative control is so stable that you can actually tune the whole range, 3.5 to 6.0 mhz, without touching the control. The oscillator is sufficiently stable so that it could be used for a VFO. It will not only receive SSB signals, but in fact it will sit on the same signal for a half hour or more without any need to retune. I can pick up plenty of signals with a whip antenna (and in some cases no antenna at all). CW signals have a clear crisp sound to them that makes them pleasing to copy.

Before we get carried away completely, I had better acknowledge that this "blooper" suffers from some of the same ills that caused the decline of the 1932 tube-type "blooper." Selectivity is almost nil. Any other amateur within three or four blocks of your location will put one whole amateur

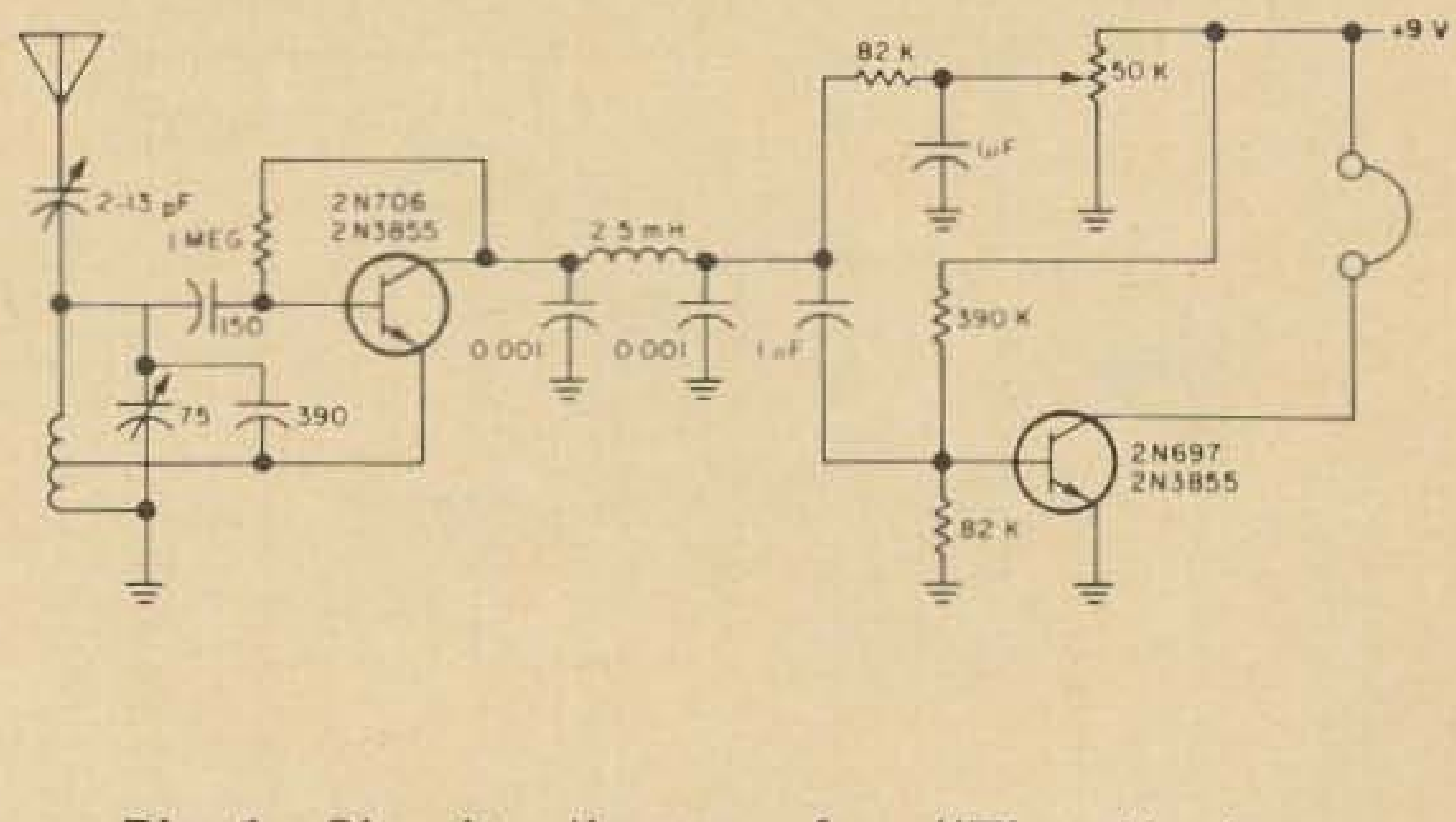
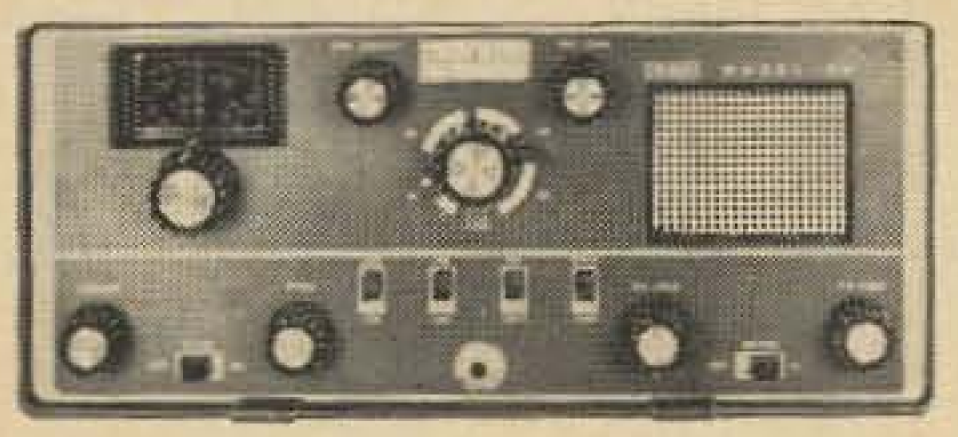
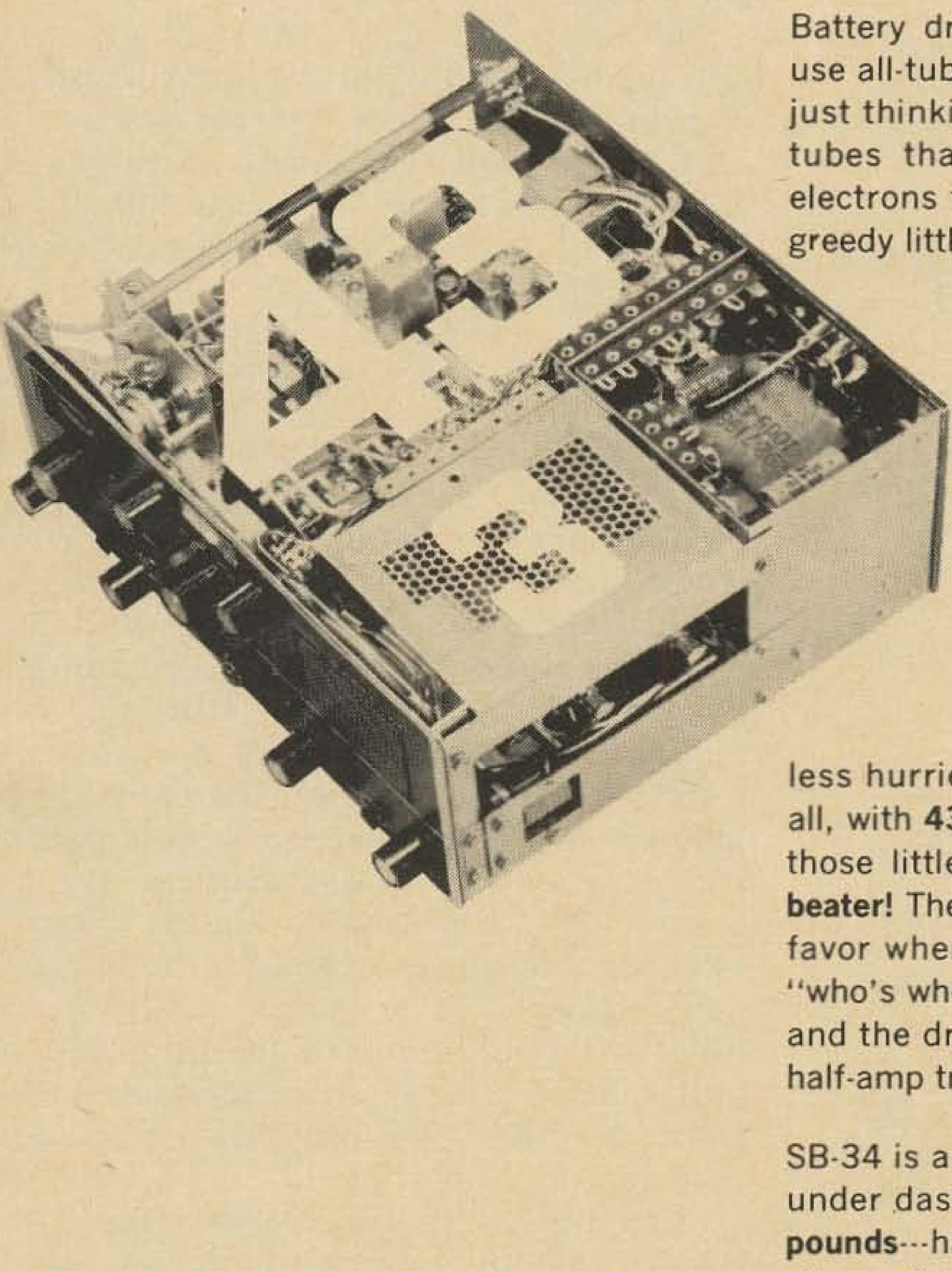


Fig. 1. Circuit diagram for "The Novice Pair," W6JLL, December, 1966, 73.

SBE



heater beater



Battery drain worries many mobile operators who use all-tube transceivers---dampens their enjoyment just thinking about those dozens or more vacuum tubes that are sitting there siphoning globs of electrons from the car battery merely to keep their greedy little heaters glowing.

Sadly also, this wasteful, heat producing current demand keeps right on even when just listening. Thoughts about the cost of a new set of tubes at replacement time can also be very disturbing indeed.

SB-34 owners who operate mobile are apt to be more relaxed. They need not be unduly concerned about battery drain so their transmissions are a little less hurried---conversations more enjoyable. After all, with **43 heaterless semiconductors** and only **3** of those little glass bottles, every SB-34 is a **heater beater!** The odds of **43 to 3** can be even more in your favor when you use only the receiver to check out "who's where". Flip your standby switch---**heaters off** and the drain from the car battery drops to a mere half-amp trickle.

SB-34 is a passenger-pleaser also. **Only 5" high,** fits under dash and leaves leg room. **It weighs only 19 pounds**---handles like a briefcase. This is meaningful at vacation time when you may want to shift it to your plane or boat---or to a motel. Built-in power supply is dual---12V DC **and** 117V AC for just such contingencies. Add, a "hot" receiver, Collins mech filter, selectable SB's, solid-state switching (no relays), dual-speed RX and TX tuning and much, much more. SB-34 just has to be far out in front as the top choice for mobile.

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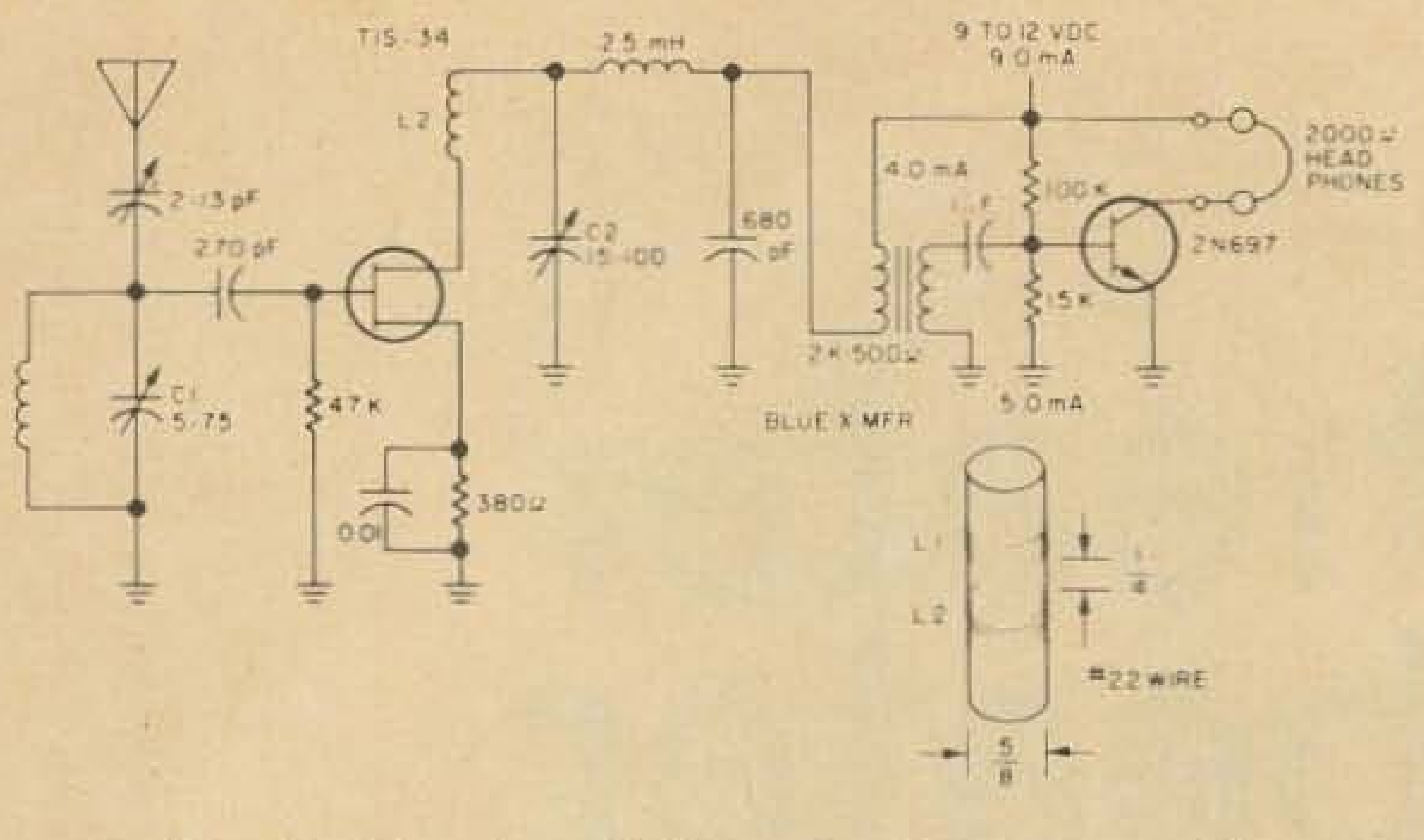

Fig. 2. Circuit which evolved from an old-two-tube "blooper" from 1932.

band out of business. Not only that, but the receiver will radiate a pretty healthy signal itself, which can be heard for three or four blocks.

What is its claim to fame? Well, it is a good project for the beginner in radio or transistors or FET's. It could also be fun on a pack trip into the wilds where P. G. & E. has not yet penetrated with its handy 60 hz wall outlets.

I use it in the 3.5 to 6.0 mhz band. It can certainly go much higher. With a TIS-34 it would work well on 10 meters. Above 10 meters, where CW and SSB signals are not too common, the super-regenerative design becomes more attractive.

Almost any sort of audio amplifier can be used depending on what you have available and whether you want earphone, loud speaker or both modes of reception. What I actually did was to use the rear end of a smashed up transistor broadcast set (my teenage daughter dropped it on the cement). If you have a choice, pick one with a push-pull class AB2 audio. These only draw current when audio signals are driving them and a significant saving in battery power will result. This is a good thing to remember when buying a transistor receiver for broadcast use as well.

In modifying the circuit to operate at higher frequencies, first resonate the tuned circuit (gate circuit) to the desired range. Then add the feedback winding using about 1/5 as many turns as in the gate circuit. You will find that it takes less capacity to obtain oscillation as you go higher in frequency. To get the detector to oscillate, increase the capacity of C3 (plates meshed). If that statement seems odd, you have just joined the club, friend. That is the way it wants to work. If you use a grid dip meter to check the frequency of C1L1, pull the transistor out of its socket first. You won't harm the transistor with a dip meter, but you won't see any dip either.

The TIS-34 is biased to Idss divided by 3. I picked that number out of thin air (sort of halfway between a class-A amplifier and a mixer), but it works so well that I have never tried varying it. The actual drain-source current for this particular TIS-34 is 4.0 ma (when oscillating). The audio amplifier draws 5.0 ma.

TIS-34's only cost a dollar but they are sometimes hard to locate. Hence I will mention that the MPF-105 or the TIM-12 can be used as substitutes.

Referring to **Fig. 1** you will note that there is no forward bias to speak of on Q1. Also note the total amount of series resistance in the collector circuit including the regeneration control. There is 80k in the fixed resistor plus another 20 or 30k in the regeneration potential.

Compare the series resistance in the drain circuit of **Fig. 2**. All you will find is the dc resistance of the interstage transformer T1 which measures 100 ohms in the model in use here. The current through Q1 is really limited only by the 380Ω bias resistor. The reader could vary this bias for optimum results if he cares to experiment. I don't recall ever seeing any equations for the gain of a regenerative detector. However, I do recall that when we replaced the resistance-coupled audio amplifier in the old two-tube blooper with an impedance-coupled (audio choke) amplifier, the signals in the earphones got considerably louder. That, in essence, is one main reason for the improved performance of the circuit in **Fig. 2**. The other main difference is the improved stability and overload characteristics derived from using the FET in place of the bipolar detector.

The push-pull audio amplifier **(Fig. 3)** was built as an outboard unit and not as a part of

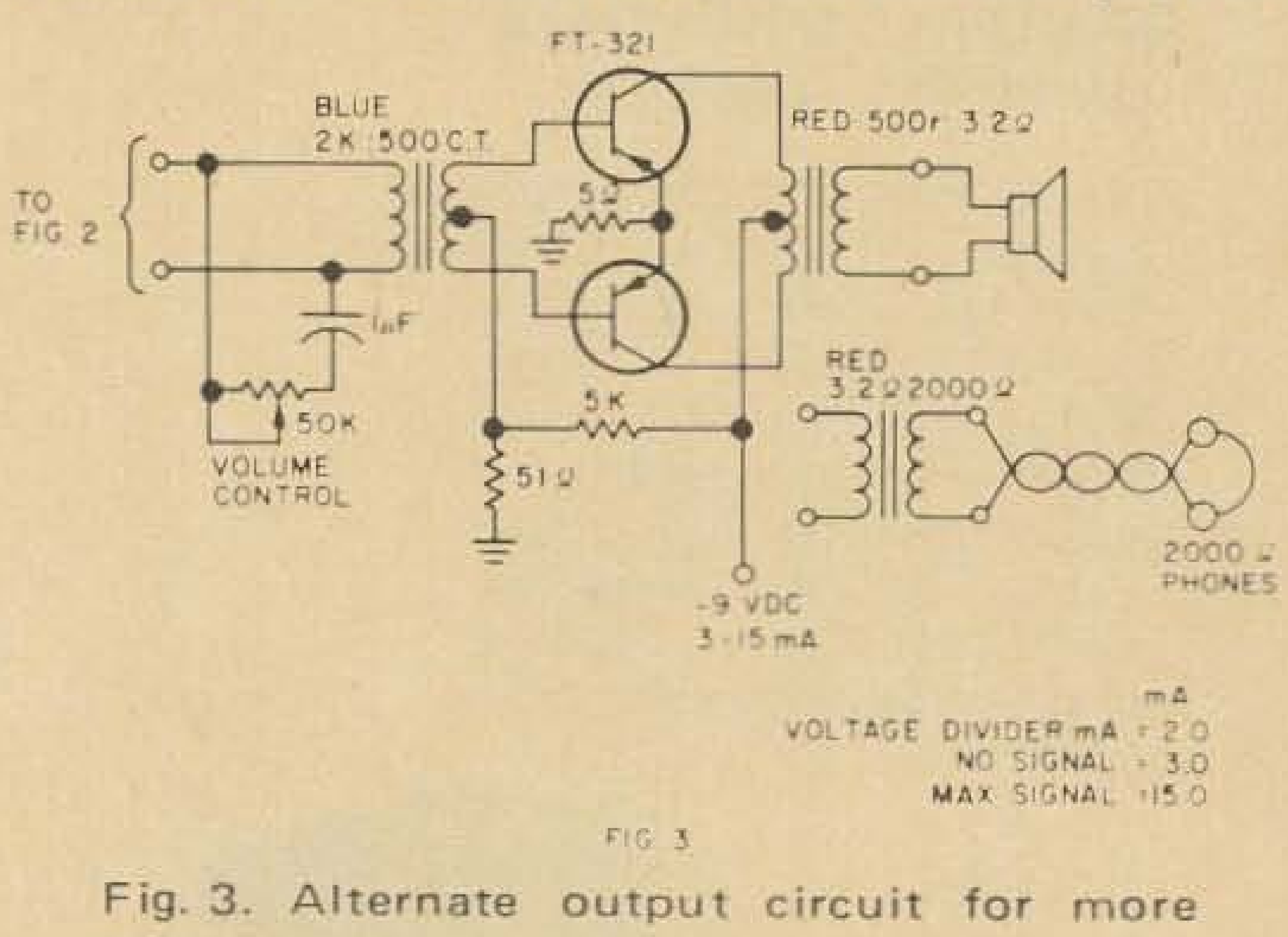

Fig. 3. Alternate output circuit for more gain.

the basic receiver (**Fig. 2**). The intention was to use it as a utility amplifier around the shack as well as with the basic receiver when loud speaker operation was desired. Almost all of the parts, including transformers, transistors and speaker, were taken directly from the smashed broadcast receiver. The one noteworthy addition is the volume control, and that is a W6OSA original as far as I know.* It had to be put where it is instead of in the usual place (in front of the first audio stage) because otherwise it would interact with the regeneration control. Not only is it smooth and noiseless in operation but the combination of the linear potentiometer and the 1 uf capacitor produced an audio taper effect.

The transistors in the Japanese portable happened to be PNP's. The Japanese number is FT-321 if that means anything to anybody. Actually you can use any PNP audio transistor such as the 2N188A. You can also use NPN's. Just reverse the battery and adjust the voltage divider to provide a slightly higher bias (if Si's).

As an added embellishment, I connected my favorite 0-15 ma meter in series with the audio amplifier battery lead. It works almost like an S-meter, and my son can watch the needle go up and down as he tunes in stations. This proved to be a mistake. Now he won't give the meter back.

After I had the basic receiver playing through the loud speaker, it occurred to me that it would be nice to have some extra gain plus a gain control available when listening with the headphones. So I kluged up the alternate output circuit shown in (**Fig. 3**). The transformer is a red output transformer, single ended type, from another defunct transistor radio. I think I can guarantee that once you have tried it this way you won't go back to using the headphones with the barefoot receiver. This being the case you might wish to incorporate the push-pull audio in the basic receiver. I still prefer the outboard arrangement because I envision using the amplifier for utility purposes, subject of course to the whims of number two son.

. . . W6OSA

*That's what I thought at the time. Later I ran across an almost identical circuit in a back issue of *73*, ("A Two Meter Transceiver," I1SLO, *73*, July, 1965, Pg. 8.). I wonder how I1SLO got Q18 to work with no dc return for its base?

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Multi-Channel FM Operation

Over the past few years, hams interested in local work on the vhf bands have been turning more and more to the use of surplus FM equipment. There is one great drawback to the use of this equipment. Generally it is crystal controlled on only one frequency at a time. This means that in an area such as mine (Seattle-Puget Sound), a person wishing to enjoy all the available activity would have to be continually changing crystals.

At home, with the base station, this would not present too much of a problem. You open the equipment, unplug one crystal and plug in another. However, it is another story if you happen to be driving down the freeway at 65 per. The question is, how do you change frequency remotely while mobiling?

The answer to the previous question is not by any means new. It is, in fact, used by some manufacturers of equipment. However, it is little known and used among the amateur fraternity. Many mobileers wish that they could add a second channel to their equipment. At times this is desired to the extent that high priced equipment is purchased because it contains this feature.

Many miniature DPDT relays are collecting dust in surplus stores around the country. These relays are about the size of a standard crystal; hence they are named "crystal-can Relays." The only drawback to the use of these relays, and the reason that they are gathering dust, is that the coil is rated at 28 vdc. This is but a minor thing at most. Experience has shown that even though they are rated at 28 vdc they will operate fine at 12 vdc. At last, for the mobileer, the problem is solved (unless of course he happens to be one of the few driving a car with a 6 volt electrical system).

If you were to look up these relays in an industrial catalog, you would shy away from the $18-$20 price tag. These relays, while not quite flooding the surplus market, are available at $0.35 to $1 each.

The operation is quite simple for dual channel operation in equipment such as a Motorola 5v or the like. For commercial service, most of this equipment came with a socket that accommodates the crystal as well as an oven to keep the crystal temperature stable. This socket will hold 2 crystals. The only thing necessary is to remove all four wires from the socket, install the relay wiring one side of the relay to one side of the socket and the other to the remaining contacts. All that is left is to hook up the supply to the coil and run a wire to the control head.

It is best to key the relay to ground and at the same time install a light to let you know which channel you are on currently.

One other item of importance to the conversion is the use of correlated crystals in the oscillator. This modification can be made without sacrificing on-frequency operation if this precaution is taken.

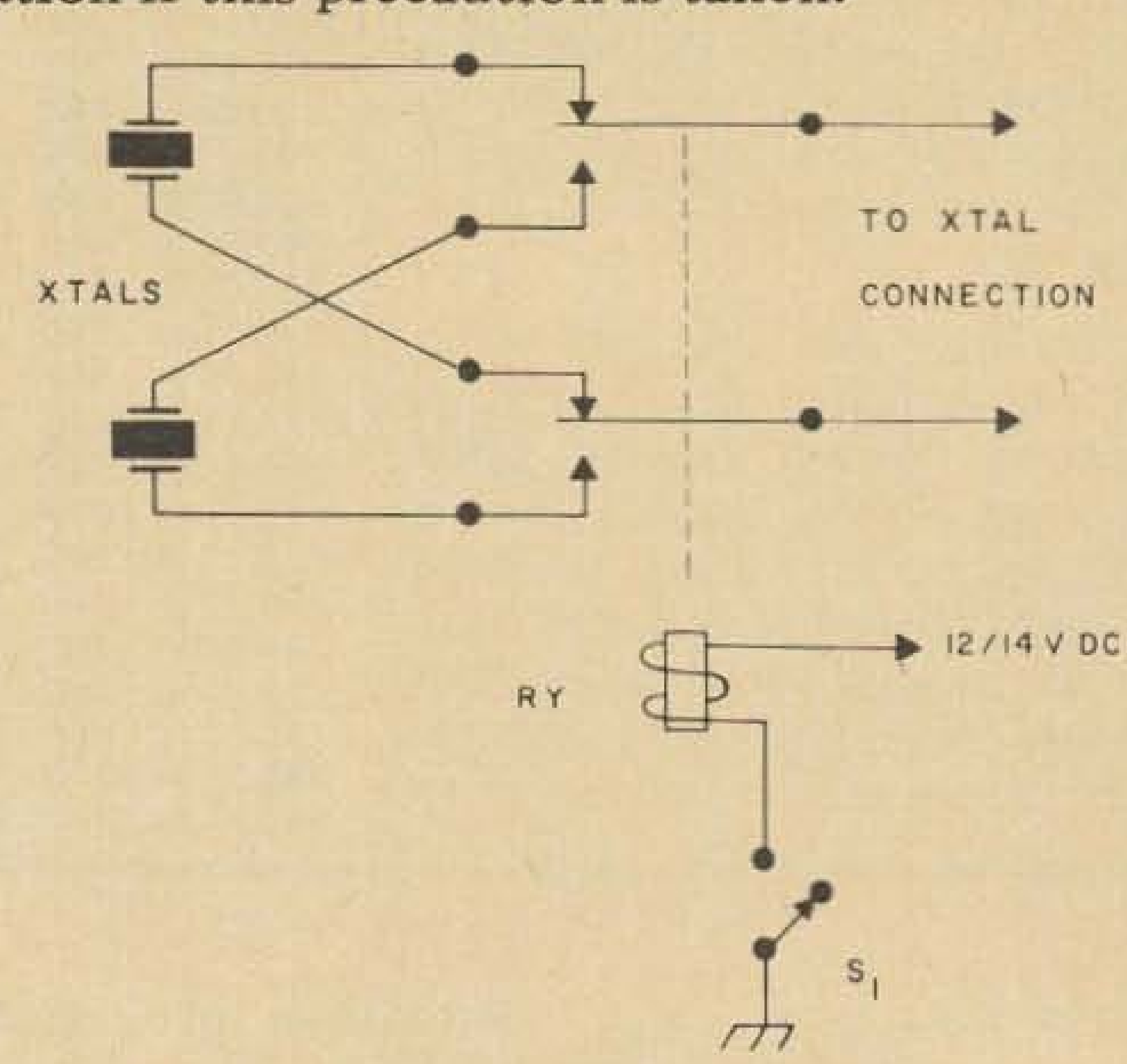

Fig. 1. Switching two crystals.

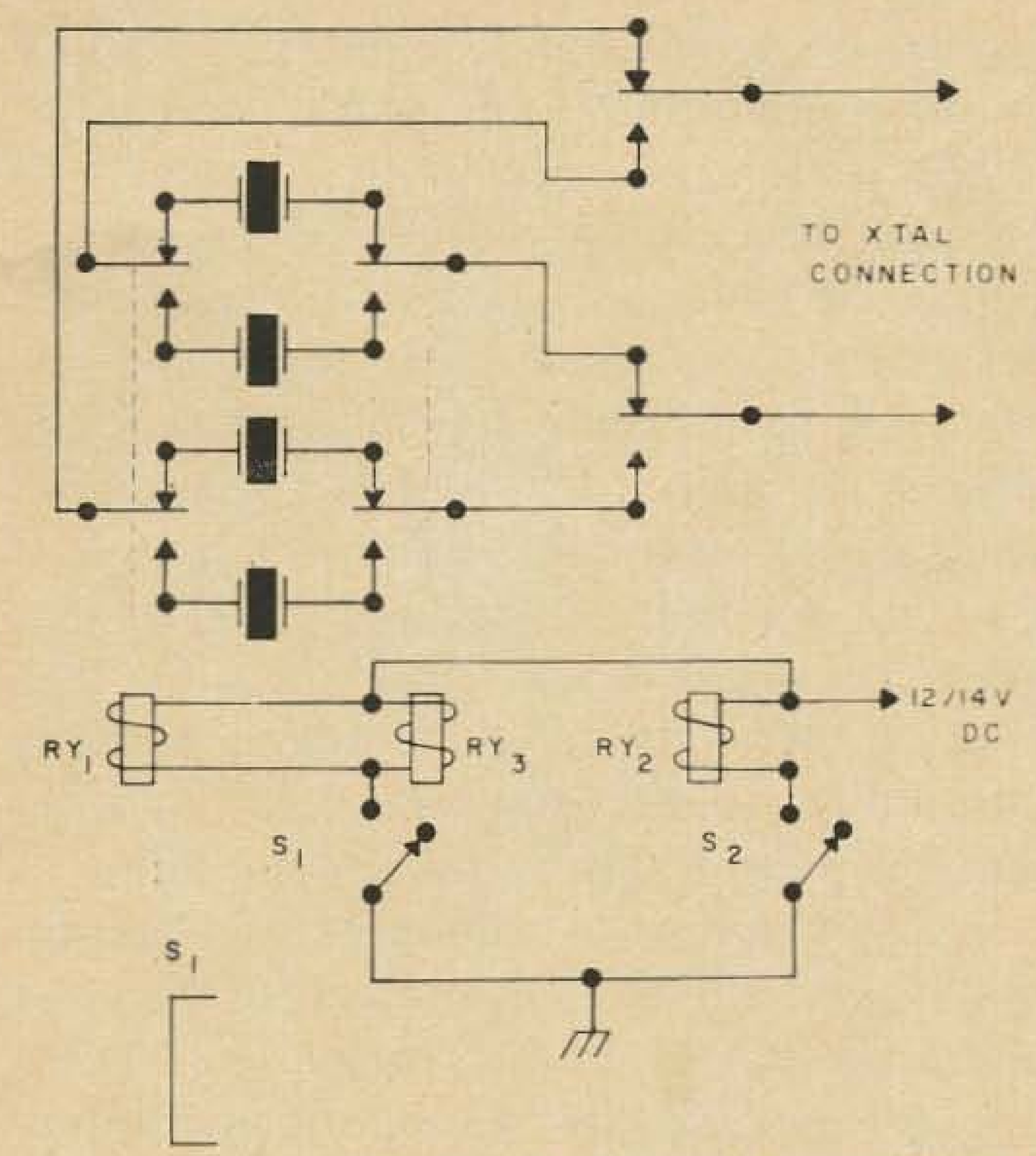

Fig. 2. Switching four crystals.

I have seen this done many times, even with the crystals ordered over a year apart.

The dual channel unit is simplicity in itself. Closing the switch actuates the movable arm of the relay. These arms are connected to the original wires going to the crystal socket.

With the relay inserted, the additional inductance and capacitance may necessitate a small adjustment of the oscillator padder. However, if correlated crystals are in use, the adjustment should be the same for both channels.

On the four channel unit, two relays are used to switch between crystals, and a third to switch between the outputs of the two relays.

Admittedly the system as shown would not allow cross channel operation, but this is not feasible in a mobile installation. On a base unit, this is a different story, though this is going a little beyond the intended scope of this article. Suffice to say that it can be done with little extra effort.

This is the easy way to do the crystal waltz. There are more complicated systems, and all I can say for this one is that it works with a great degree of reliability.

One final word in passing; if good vhf practices are employed, no problems should be encountered.

Be seeing you on multi-channel operation soon.

... WA7EVX/Ø

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The Case for the 5/8 λ Vertical

In fixed-station usage and particularly for VHF mobile use, the 5/8 λ vertical has various advantages over a 1/4 λ vertical or whip. The advantages are discussed and a simplified matching system is presented.

Many amateurs use quarter-wave verticals in both fixed-station and mobile use because of the low radiation angle and constructional advantages that they possess combined with a direct match to a coaxial transmission line. Not every situation will allow extension of the antenna length to approximately twice its quarter-wave length, but, if it can be done, additional gain can be achieved and matching the 5/8 λ vertical to a coaxial transmission line need not be complicated. In a vhf mobile situation, even a construction advantage will be achieved since, as is discussed fully later, the 5/8 λ vertical mounted in the same position as the regular automobile radio antenna will equal or outperform an awkward to mount roof-top quarter-wave whip.

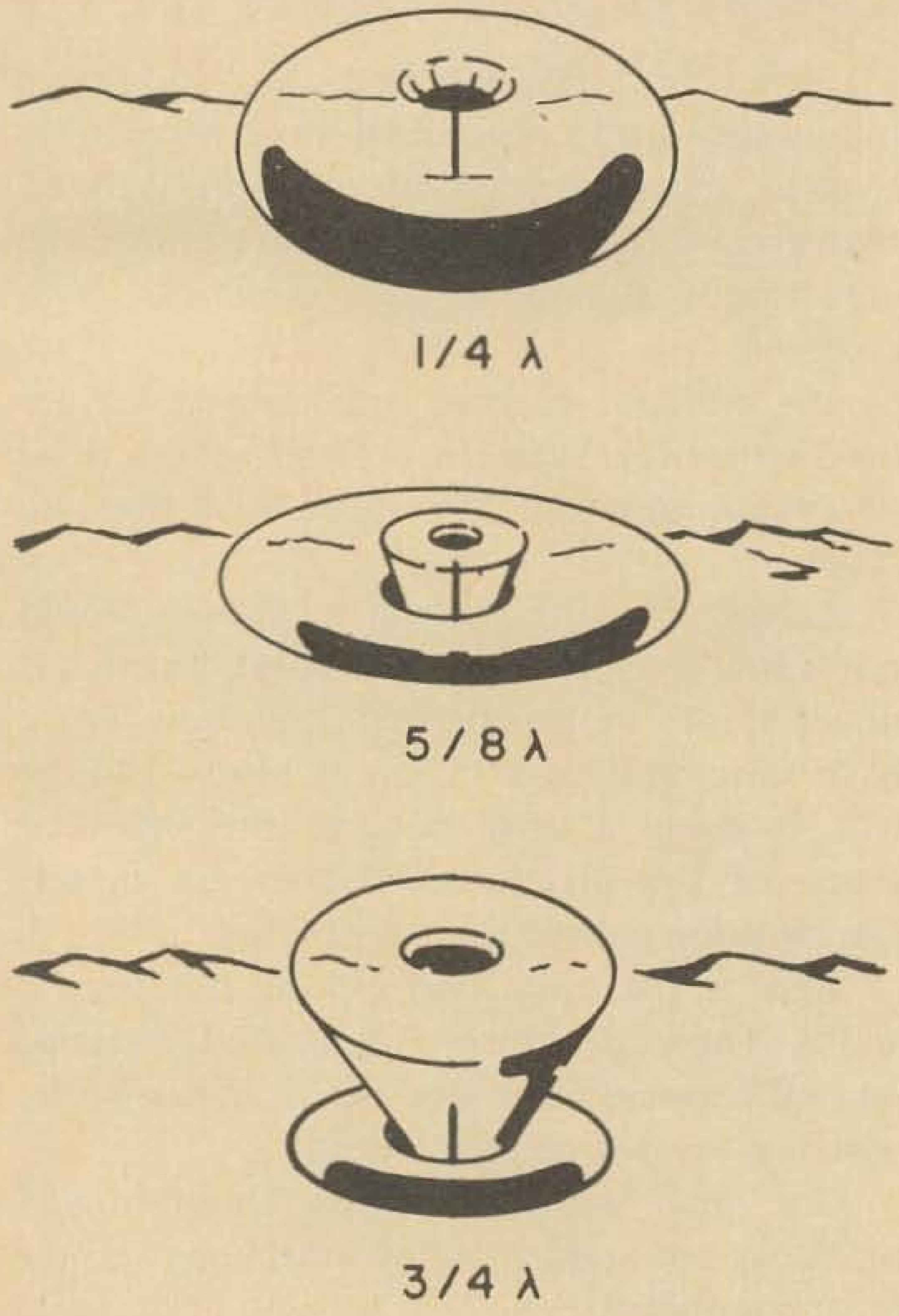

Fig. 1. Pictorial representations of the radiation pattern of various length vertical antennas over a perfect ground.

Why a 5/8 λ long antenna should show a "gain" over a 1/4 λ long antenna while both antennas still exhibit omnidirectional radiation patterns is a subject that many amateurs still find somewhat confusing. So, a brief explanation of vertical antenna gain might be in order.

Gain of Vertical Antennas

The word "gain" itself is often misused with respect to antenna systems. It is defined as the relative amplitude of the maximum radiation from an antenna as compared to the maximum radiation from a reference antenna. The key points are that the maximum radiation determines the gain figure and the figure can vary widely depending upon what antenna is used for a reference antenna. Whether the maximum radiation takes place in a direction or at an angle that is useful in a given communications situation is another question. It is quite possible that an antenna with a higher gain figure will perform poorer than an antenna with a lower gain figure.

A half-wave horizontal dipole is frequently quoted as the reference antenna for directive antennas, such as beams, quads, etc. However, it is not the most basic reference antenna used and is a particularly awkward one to use when speaking of the gain of a vertical antenna. The most basic antenna used is a so-called isotropic radiator. Such an antenna does not exist in reality, but in theory it is an antenna in free space which radiates equally in all directions (its radiation pattern is a perfect sphere which surrounds the antenna).

If one now looks at the radiation patterns shown in **Fig. 1** for various vertical antennas, it should be clear why these antennas have gain as compared to an isotropic antenna. If the same input power is used for the isotropic antenna and the vertical antennas, and all the antennàs radiate all the power fed into them, the vertical antennas must radiate more energy in some directions than the isotropic radiator in order to account for all the power fed into the antenna.

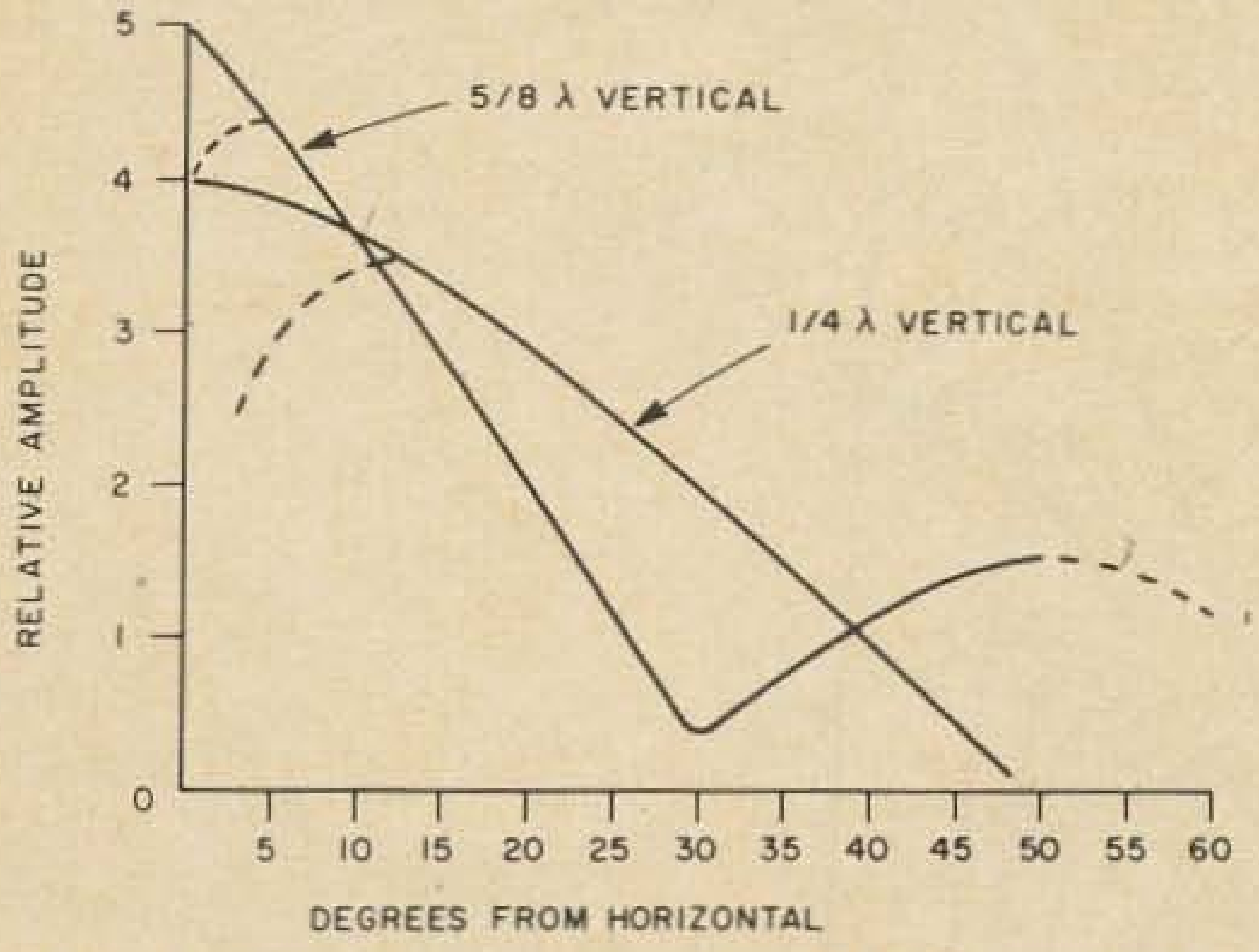

Fig. 2. Graphic representation of the vertical radiation pattern from 1/4 and 5/8 λ verticals. The dotted lines show the approximate effect of ground losses.

Compared to an isotropic radiator, the direction of maximum radiation from a 1/4 λ antenna shows a gain of about 1.6db and that from a 5/8 λ vertical is about 2.5db. **Fig. 2** may provide a clearer illustration of the maximum radiation from the 1/4 and 5/8 λ verticals. The figure shows relative field strength versus the radiation angle measured from the ground plane surface. The 1/4 λ vertical presents a single, constantly decreasing radiation amplitude as the radiation angle increases. The 5/8 λ vertical presents also a constantly decreasing radiation amplitude; however, with a relatively greater amplitude at the extreme low radiation angles and with a secondary peak centered around 50°. If the graph included the 3/4 λ vertical, it would show approximately, the relative amplitudes of the low angle radiation and 50° radiation from the 5/8 λ vertical interchanged. High angle radiation takes place from the 3/4 λ vertical because the currents in various sections of the directly extended antenna do not reinforce each other such as to keep the radiation angle low. By means of phasing networks, it is entirely possible to build a vertical antenna many wavelengths

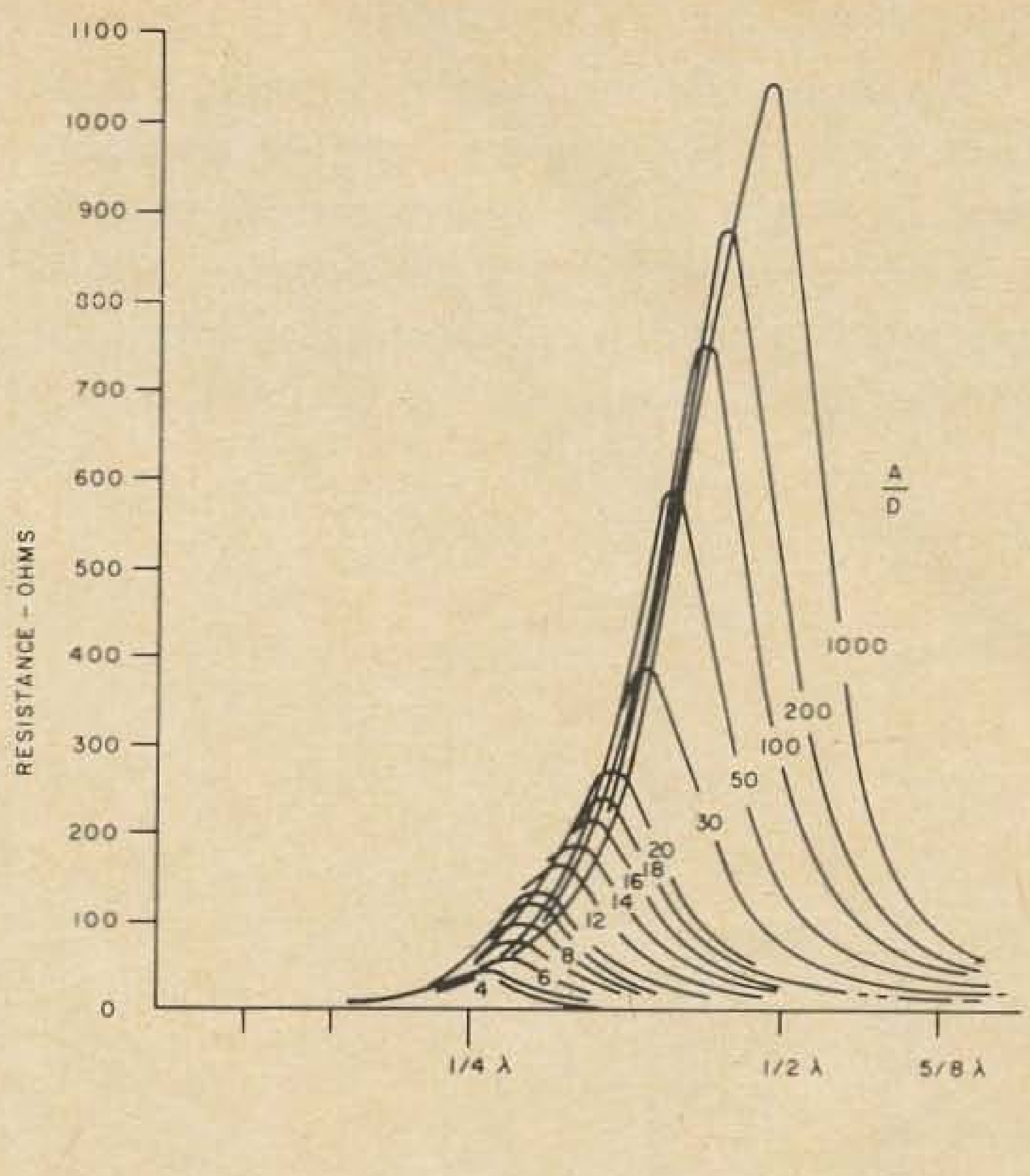

Fig. 3. Vertical antenna terminal resistance as a function of length. A/D is the ratio of antenna length to antenna diameter (d).

high but with extremely low angle radiation. One prime example of such an antenna is a commercial uhf-TV transmitting antenna built by RCA. The horizontal radiation pattern from this antenna is omnidirectional, but yet it has a 60 db gain because all the radiation is concentrated within an extremely narrow band around 1 .

Ground Effect

The solid lines in **Fig. 2** represent the radiation that takes place with a perfect ground surface. This condition can be approached fairly well on the vhf bands where the antenna is placed over a large metal surface, such as an automobile body. However, it is rarely the case on the high-frequency bands unless an extensive ground radial system is used. The dotted lines in **Fig. 2** represent the loss which takes place in extreme low angle radiation over a fair to poor ground surface.

An interesting point to note is that, although both the 1/4 λ and 5/8 λ verticals suffer considerable low radiation angle losses, for the 5/8 λ vertical it is not so severe at the low angles below 5°. For DX operation where one-hop F layer propagation is used, the 5/8 λ vertical usually shows an apparent gain over a 1/4 λ vertical that is considerably greater than the approximate 1db difference theoretically indicated.

Matching to the 5/8 λ vertical.

Although the increase in antenna height from 1/4 λ to 5/8 λ, where feasible, probably represents one of the least expensive ways to gain effective db's either for long-haul DX or extended ground wave coverage on the vhf bands, many amateurs are hesitant to try this approach because a 5/8 λ vertical does not directly match a coaxial transmission line. However, it is quite simple to match the antenna to a coaxial line for single band operation without the need for an antenna coupler or any expensive components.

Fig. 3 represents the terminal or base re-

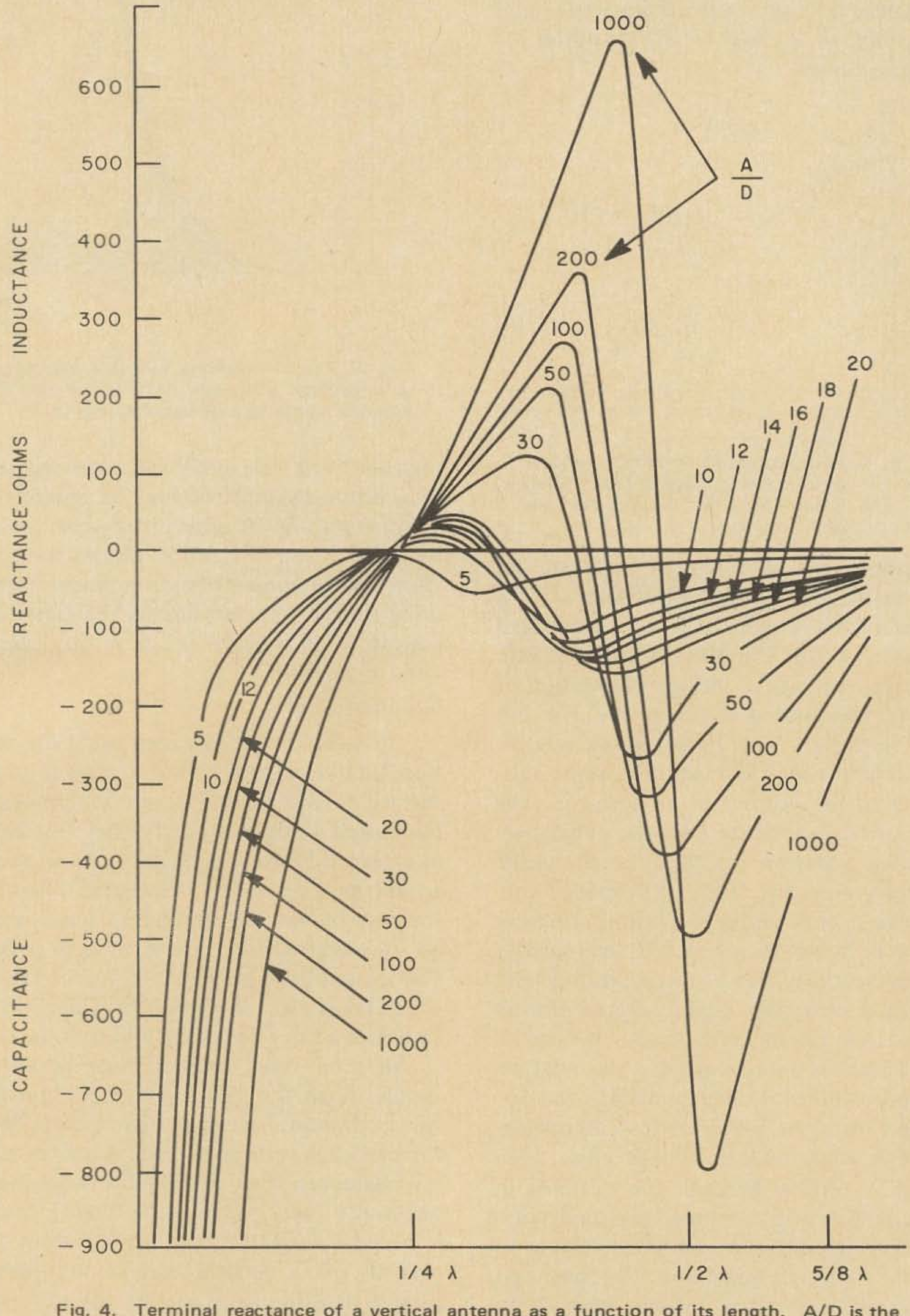

Fig. 4. Terminal reactance of a vertical antenna as a function of its length. A/D is the length/diameter ratio, both expressed in the same units.

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Accredited Member National Home Study Council ST-21 sistance of a vertical antenna while Fig. 4 shows the reactive part of the base impedance. These graphs may appear somewhat complicated but lead to a very simple matching means for a 5/8 λ vertical (or for most other length verticals as well). The graphs are drawn for various A/D ratios. (Antenna length divided by antenna element diameter).

An example should make the use of the graphs clear. Suppose that it is desired to use a 5/8 λ vertical (of about 52" long) on 2 meters which is constructed of tubing having a 4 mm. diameter (which would be the typical average diameter for a telescoping automobile whip). This results in an A/D of about 200-250. From Fig. 3 it can be seen that the resistive portion of the vertical's impedance is about 60 ohms and could present an almost perfect match to a 52-ohm coaxial cable. From Fig. 4, the reactance is noted as being 180 ohms capacitive. Once this reactance is cancelled, therefore, an excellent match to the transmission line will result.

There are several ways by which the capacitive resistance can be cancelled. One of the simplest ways is shown in Fig. 5. A shorted coaxial stub is connected to the base of the antenna and its length chosen to present an inductive reactance that just cancels the antennas capacitive reactance.

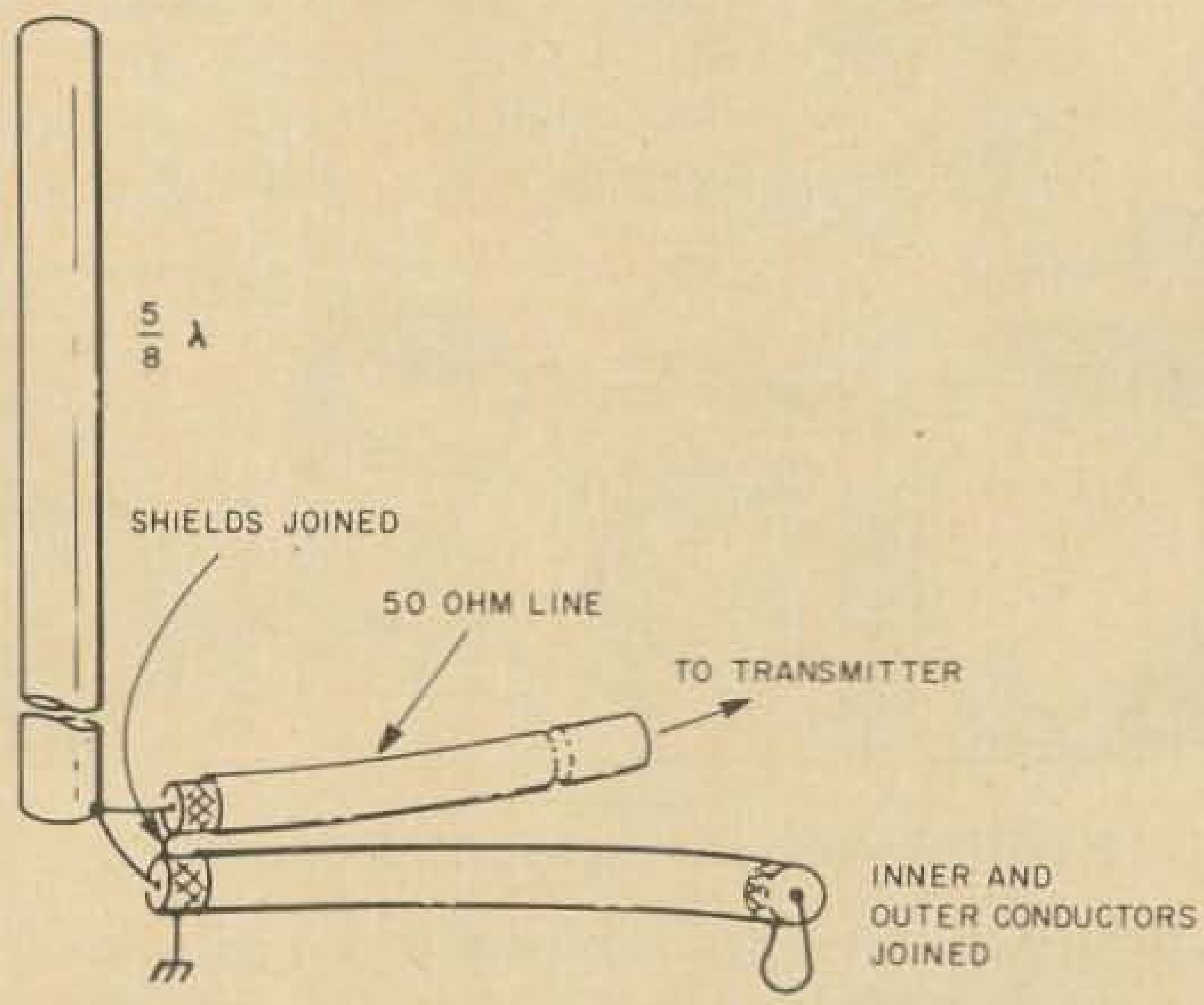

Fig. 5. Use of stub to match a coaxial line to a 5/8 λ vertical. Length of stub can be calculated or determined by experiment, as explained in text.

Determining the length of the stub can be done either by cut-and-try or by formula. For those who don't mind wasting a bit of coaxial cable, the cut-and-try procedure involves simply making the stub initially 1/4 λ long at the operating frequency and with an swr meter in the transmitter coaxial line at the antenna base, cutting back the stub until unity swr is achieved. Note that every time the stub is cut back, the inner conductor and outer shield must be shorted together. The starting length of the stub would be, in inches, $\frac{2808}{f\ (mc.)} \times V$. V is the velocity of the coaxial cable used, usually about .66.

The stub length can be determined by formula to a very good degree of accurracy by the formula: L stub inches = $\frac{32.8\ VL}{f\ (mc.)}$.

V is again the velocity factor and L is an angle whose tangent is the value of inductive reactance desired divided by the impedance of the cable used for the stub. For example, for the 2 meter vertical L would be (using a 52 ohm cable for the stub) $\tan \frac{180}{52} = 3.6 \cong 75°$

Placing this value in the formula would yield

$$L = \frac{32.8\ (.66)\ (75)}{144} = 11\frac{1}{4}\text{" stub length.}$$

If one desired to use an actual coil instead of a stub, the required inductance, in microhenries, would be

$$L = \frac{X_L}{6.28\ (f\ mc)} = \frac{180}{6.28\ (144)} = .2\ \text{rh}$$

A coil of this value can be formed but unless one has the equipment to measure its inductance fairly well, the stub method of matching will be found to be far simpler and quicker.

Mobile Application

The 5/8 λ vertical is useful in any situation where the greatest amount of omnidirectional low angle radiation is desired without resorting to a complicated antenna structure. However, for mobile applications on the vhf bands, the 5/8 λ vertical has particular appeal.

It can be mounted on the automobile in the same location as the regular automobile whip. In fact, it can be constructed from any ordinary telescoping automobile antenna since its length would be about 52" on 2 meters. The sections of the automobile whip should be soldered together at the telescoping joints to insure good electrical contact. Fig. 6 shows a comparison of the radiated field from a 1/4 λ whip mounted directly in the center of the csr roof and that of a 5/8 λ vertical mounted in the same position as the regular automobile radio antenna. The 5/8

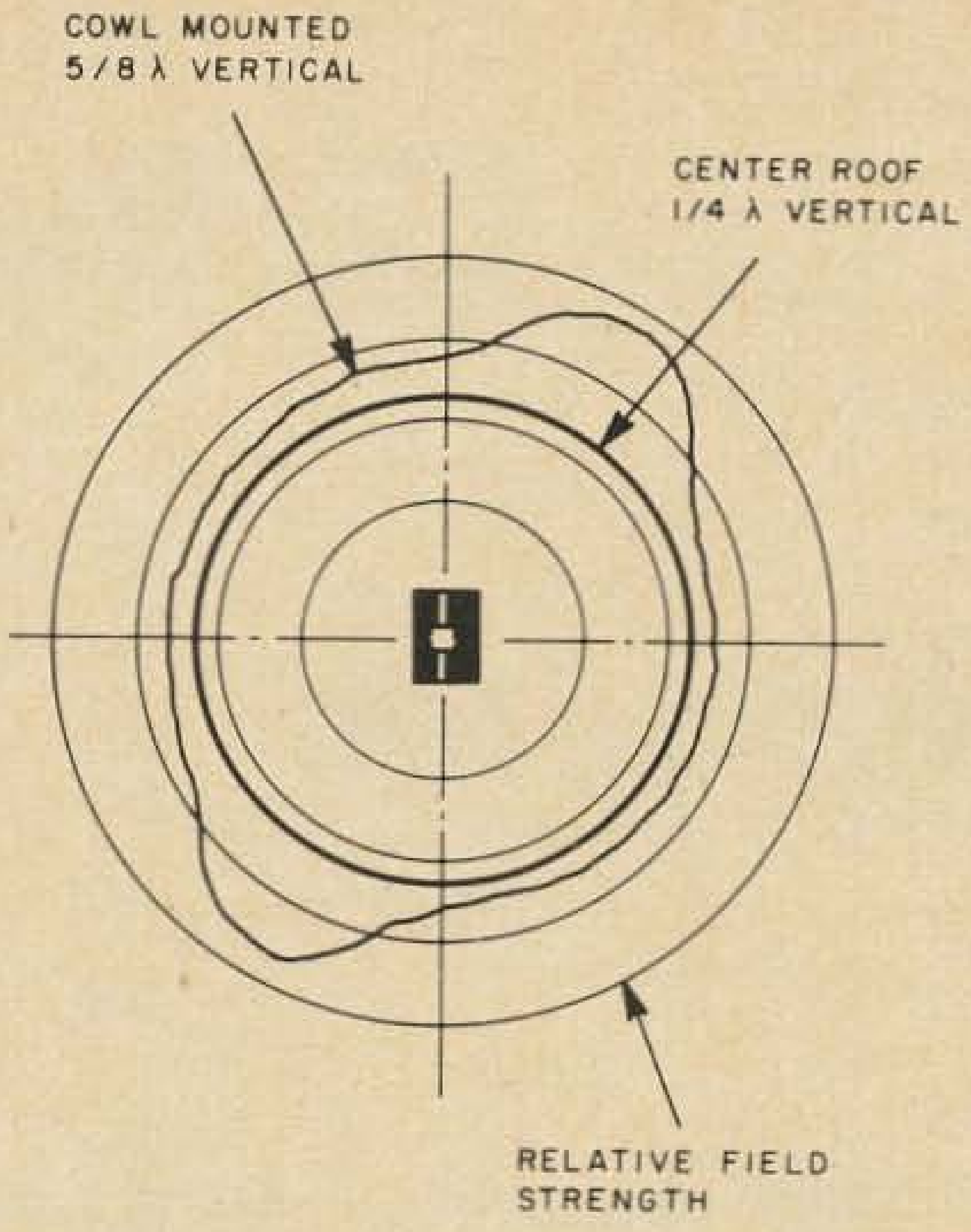

Fig. 6. Tests by many manufacturers have shown that a simple to mount 5/8 λ cowl antenna will equal or outperform a roof mounted 1/4 λ antenna.

λ vertical is never worse than the very-awkward-to-mount 1/4 λ vertical and shows usable gain over the 1/4 λ whip over a fairly broad portion of its pattern.

Other advantages of the 5/8 λ vertical are that it offers a much closer match to a 52-ohm coaxial cable than a 1/4 λ vertical and its bandwidth is broader. The latter results due to the stub matching system since the reactance of the antenna and the stub change in opposite directions (but at different rates) with changes in frequency. At least until the rate change becomes excessive, this means that the reactance cancel each other and the swr will remain very low over almost any band when the antenna is designed for the band mid-frequency.

Summary

The 5/8 λ vertical offers one of the simplest ways to extend the performance of a vertical antenna system where low-angle radiation is desired. On the high-frequency bands for DX purposes, the real gain from such an antenna can far exceed the expected gain since it seems not to suffer the severe loss of extreme low angle radiation that occurs with a more ground "dependent" 1/4 λ vertical.

On the vhf bands for mobile situation, it offers wide bandwidth performance combined with a simple and inconspicuous installation.

...W2EEY/1

The Genesis of Radio Reception

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Recently, in one of the larger electronics stores, my eye was caught by the advertising blurb on the box containing a crystal receiver kit, "using the same circuits used by Marconi. . . . " It struck me as being a rather bold sucker attraction, since the crystal detector didn't really get going for at least a couple of decades after Marconi's history-making transmission.

Strange though it may seem, Marconi was by no means the first experimenter in wireless communications, though he was the first to use radio waves over a great distance. Morse, for instance, had a system for sending telegraph signals across a stream or canal without using wires. Morse used several hundred feet of wire running along each side of the stream which ended in a metal plate submerged in the water. Electric impulses were carried through the water from the system on one side to the other. It had its disadvantages. In order to get any kind of efficiency from the system, the two plates on one side of the stream had to be further apart than the distance between systems. As a result, more wire was used to do it that way than if the stream had been spanned.

In England they had an even clumsier set-up. A complete loop was set up on each side of the stream, parallel to one another. The current in one loop, coming through an interruptor, would magnetically induce currents in the companion loop and make a sound in an earphone. This procedure again used more wire than necessary to span the stream, and so was impractical.

Edison had a patent granted on a system in which electrostatic charges in a large tower would induce similar charges in a similar tower on a ship at sea. This was fine for very short distance transmission, but as the distance increased, it quickly became useless. It did, however, give Edison one advantage. He had patent rights on the aerial, and Marconi paid a pretty price for it.

Hertz's discovery of "radio" waves had no real kind of detection device. He simply discharged a Leyden jar through a metal ring. A ring of similar size would produce a spark. This also was not effective over long distances.

In the early 1890's, a scientist by the name of Branly noticed that a distant spark would affect metal filings. Loosely packed filings normally showed a fairly high resistance, but whenever an electric spark was produced in the same area, the filings would stick together and the resistance would be momentarily reduced. Lightning and other discharges could be detected by a click in a pair of headphones connected to the "coherer" through a secondary battery. In 1894 Oliver Lodge conceived the idea of using a coherer to detect the mysterious waves noted by Hertz. Lodge, however, was

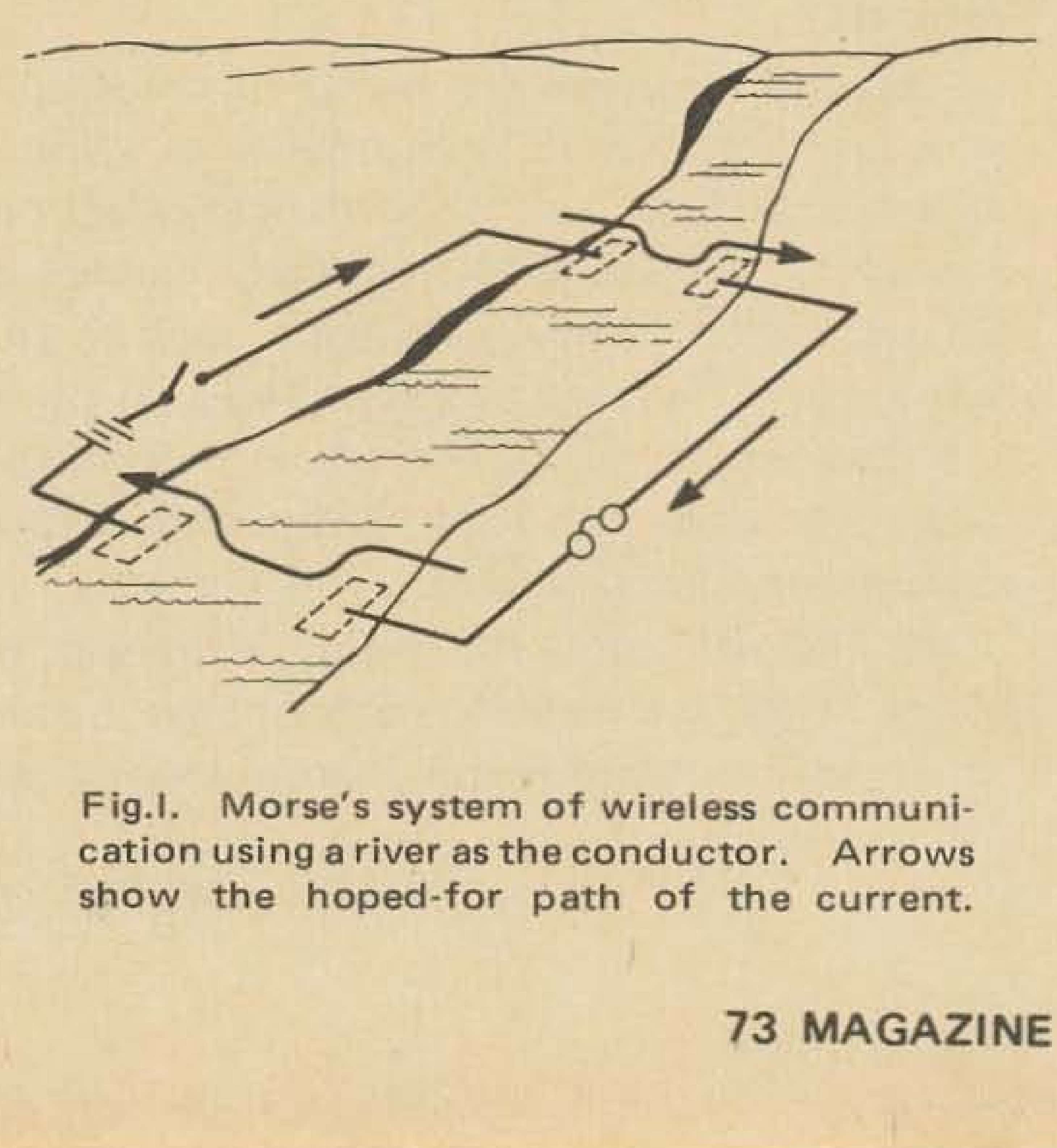

Fig.I. Morse's system of wireless communication using a river as the conductor. Arrows show the hoped-for path of the current.

not working in communication. He was experimenting in the field of electromagnetism, so he never patented his idea. About that time, Marconi entered the picture.

By applying Lodge's idea, and adding an antenna and ground circuit, Marconi was able to transmit for several miles. Marconi's first receiver used a coherer for a detector, coupled to a tuning system invented by Lodge. His first attempts were so successful that he had little trouble getting the backing necessary to form the British Marconi Wireless Telegraph Co. Before long, however, he abandoned the coherer for a system of his own invention (with considerable help from Lodge and Fleming, two top physicists of that day). This consisted basically of a transformer, the primary winding of which was in the antenna-ground circuit. The secondary was connected directly to the earphone. Perhaps the most interesting part of this was the core of the transformer, which was an endless iron belt. This belt was kept moving through the transformer. A pair of large permament magnets kept the core continually magnetized in one direction. This might possibly have caused some sort of a rectifying action, since currents in a direction favoring the magnetic flux of the

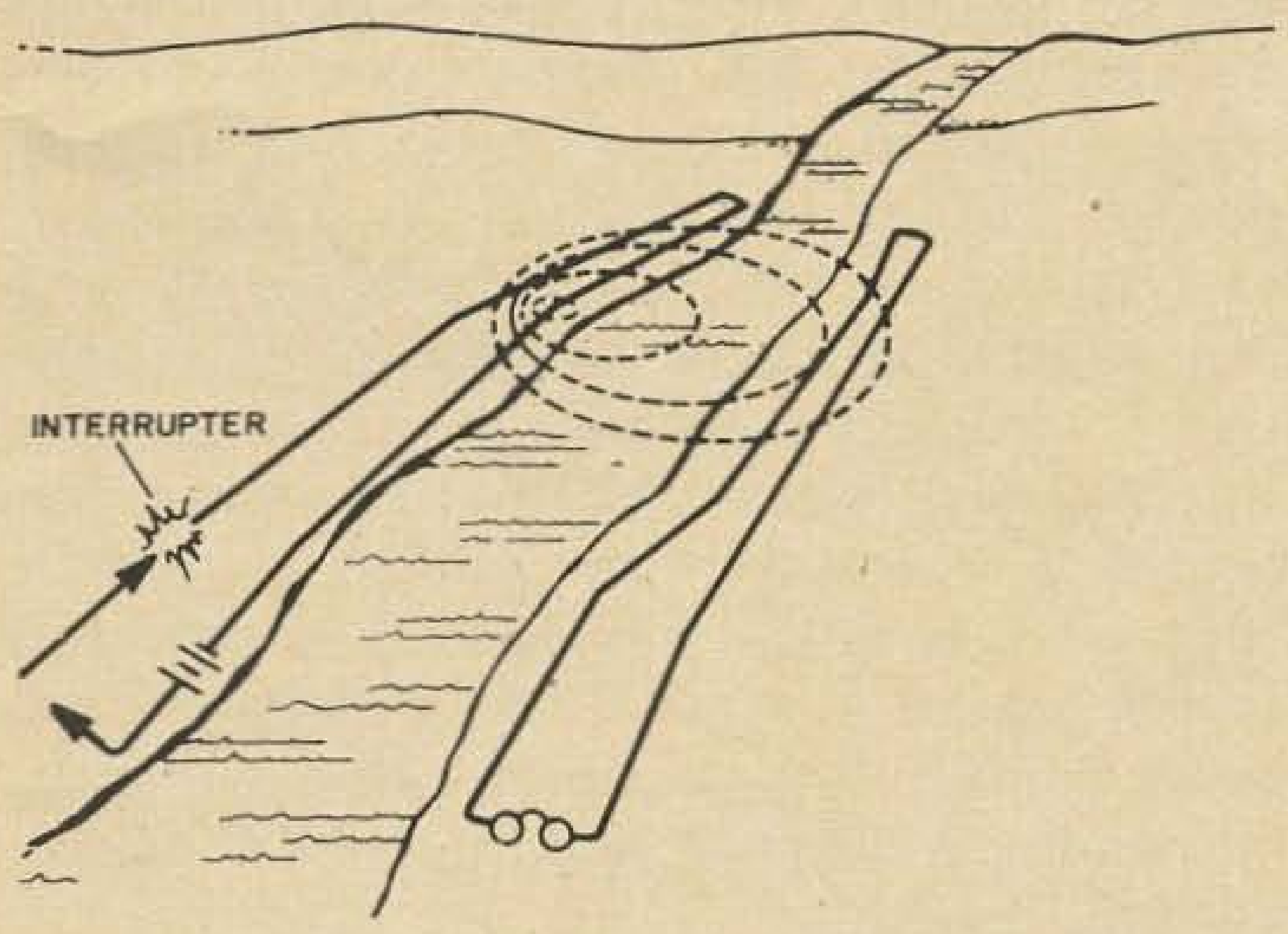

Fig.2. Magnetic induction method of wireless communication. Magnetic flux from transmitting loop induced currents in receiving loop.

core could transfer more easily than the other half cycle. But spark transmitters were rough enough so that I doubt if it were really necessary to rectify the signals at all.

Some two decades prior to this, Edison had been experimenting with various types of incandescent lamps and stumbled across thermionic emission. He failed to see its significance, however, and just jotted the discovery down in his notebook, and then forgot it. Years after, Ambrose Fleming was to apply this effect and patent the vacuum diode, or, as he called it, the Fleming valve. Fleming was, at the time, working for Marconi, but Edison had an ace up his sleeve, since he owned patent rights on the Aerial, an important part of Marconi's system.

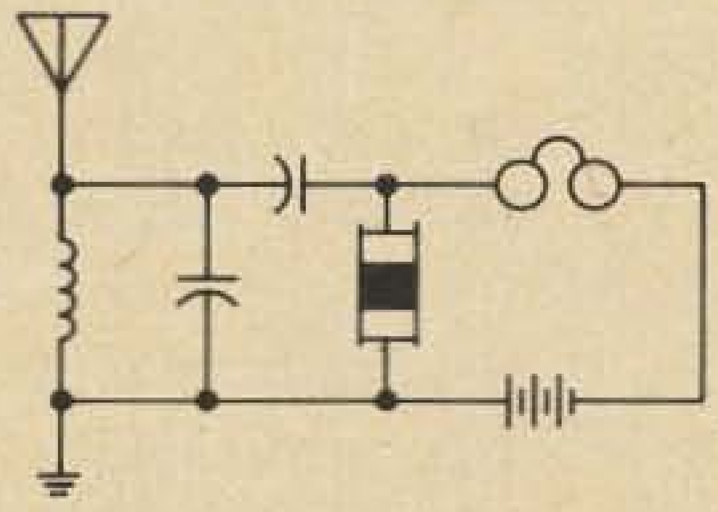

Fig.3. A possible arrangement of Marconi's coherer receiver. Signals selected by the tuner passed through the series capacitor into the coherer, where they momentarily decreased the resistance causing a click in the earphone.

Before Fleming's valve made the scene, however, another type of rectifier saw considerable use. This consisted of a platinum wire touching the surface in a dish of acid. If current tried to flow in the wrong direction, a bubble would appear beneath the wire and prevent conduction. This was called the "electrolytic rectifier." The scientist who invented this, Fessenden, came up with another idea which the reader will

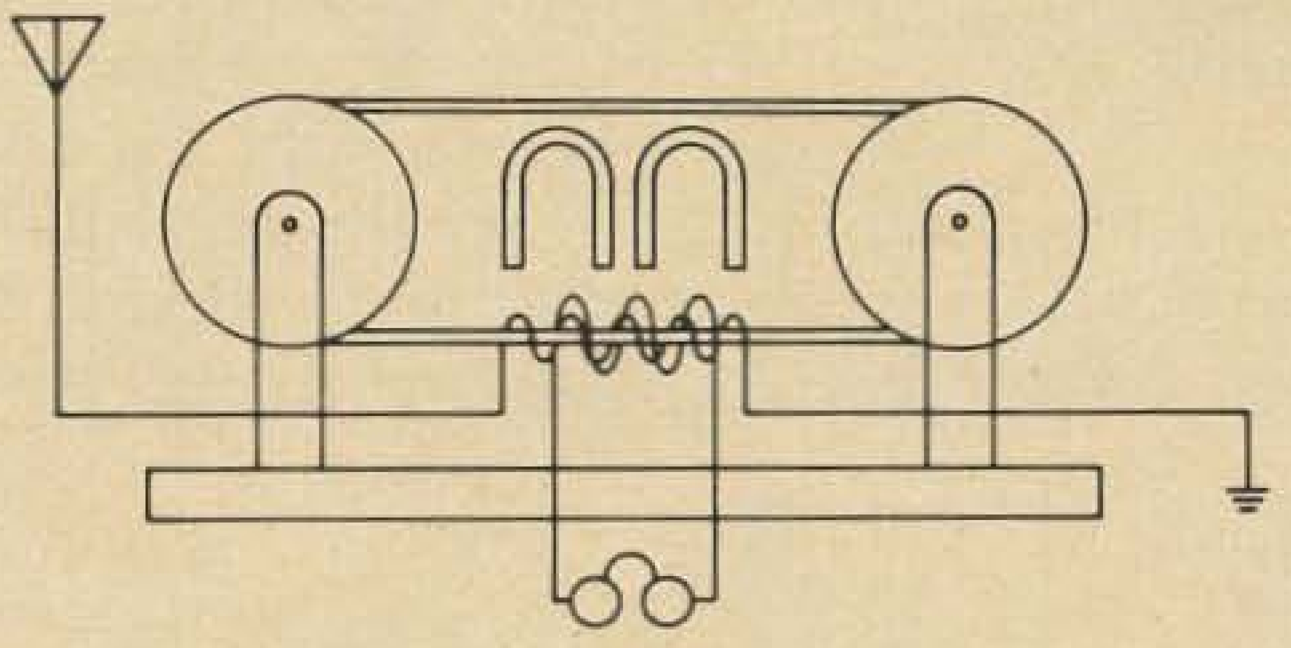

Fig.4. Marconi's magnetic detector. A soft iron magnetized belt was kept moving through the transformer.

be surprised to see hanging around this early in the game.

The idea was called the "hetrodyne," composed from two Greek words meaning "other, and "power." His idea was to use two high frequency signals which were inaudible but capable of traveling long distances. For instance, a 100 khz. signal could not be heard, but if, at the receiving end, a 101 khz. signal were injected at the same time, the combination would make a tone of 1 khz. He also planned to superimpose audible signals onto a carrier signal, the beginning of amplitude modulation, but the transmitters of that day were not good enough to make his idea practical.

Marconi's company owned all rights on Fleming's valve and flatly refused to license it to any American companies. It was superior enough to render his competition ineffectual. In order to keep from going under, a competitive device had to be discovered. The answer came in the form of galena, carborundum, and other crystals which displayed rectifying qualities. The solid-state field was doomed to lie dormant for a long time, however, thanks to a man named DeForest. DeForest had been experimenting with Fleming's valve, trying to make it more efficient. He first wrapped the outside in foil, hoping to ionize the residual gasses inside and therefore cause it to conduct more efficiently. It didn't work too well at first, so DeForest put the foil inside the valve. The results were encouraging. He then made the foil into a perforated plate between the filament and anode. Finally he tried a fine wire *grid*. He had done it! The triode was born, and so was electronics.

The first triodes were so large they were called "bottles," and glowed so brightly they lit up the whole shack. At first they were kept highly secret. DeForest had his first model sealed up in a box with the leads sticking out. When he got it working, he let his assistant listen. "My God, doc, hear those signals!" he cried, "What in H . . . have you got in that box?" DeForest called his new device the Audion. He was able with little trouble, to sell his invention to the U. S. Navy, until some wise-guy technicians tried

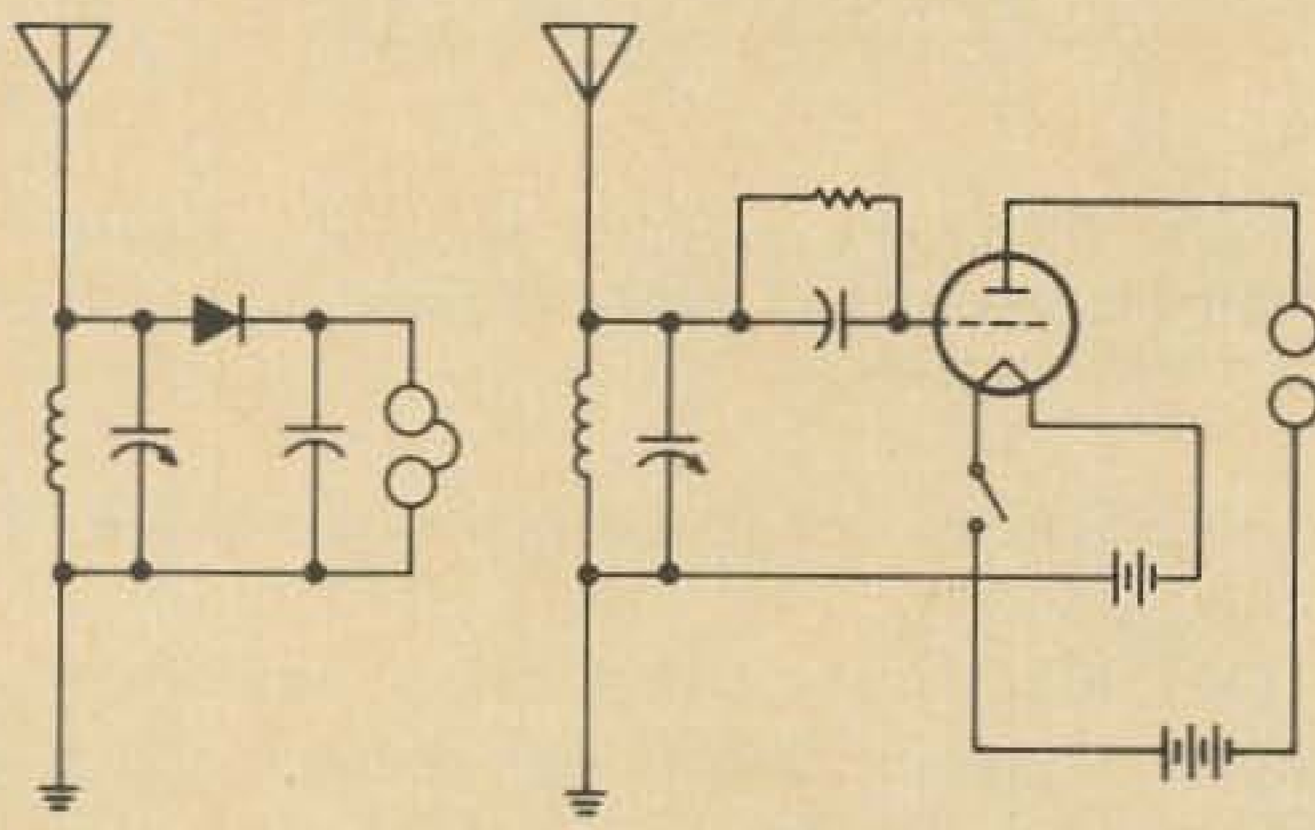

Fig.5. Basic circuit of the rectifier detector, and the audion grid-leak detector "My God, hear those signals . . . ."

to improve the results by running the filaments at a higher voltage and blew them out. The chief clerk, refusing to believe that Navy personnel could do any wrong, passed the order, "No more audions; use your old detectors." DeForest wasn't worried. He was going full speed on an invention that would revolutionize communications. After discovering the amplifying properties of the audion, he had collected nearly two million dollars from the telephone people (Western Electric) who desperately needed an amplifying device.

Meanwhile, DeForest had discovered how to make his audion oscillate and then how to modulate it. He was making daily music and news broadcasts over a decade before some hams licensed KDKA.

Sometime between 1910 and 1920, E. H. Armstrong began experimenting with DeForest's audion. He tried to make the tube amplify its own output. Feeding the signal back to the grid circuit through an additional winding connected to the plate, he discovered that the output level certainly did increase. Not only that, but if the signal was fed back in sufficient quantity, the circuit would oscillate. His hook-up was so similar to DeForest's oscillator circuit that a court case erupted and DeForest was awarded the patent. However, Armstrong had no patent trouble after that. His progress sent him in leaps and bounds far ahead of his competition.

His receiver was called the "regenerative detector," and was developed just before WW I. After the war, it was eagerly bought by the public. About the same time, the crystal detector became available to the public. Armstrong's regeneration however, was far ahead of the "Crystal sets" and regenerative receivers were so popular that their oscillations began to cause serious interference. Something had to be done. The problem was solved by adding a stage of tuner *rf* amplification which, in addition to increasing the sensitivity, isolated the oscillating circuit from the antenna. Browning-Drake put out a popular model around 1924-25.

To compete with Armstrong, Hazeltine came out with the "neutrodyne" circuit in the late 20's and early 30's. This consisted of a straight grid-leak detector preceded by several neutralized TRF stages. You can still find an occasional sample of these monsters in various attics and cellars. They are easily recognized by their many ganged variable capacitors. Hazeltine had another feature which, following the development of an even better receiver, was to help keep them in the communications picture. This was a technique of rectifying the signal and feeding it back as a negative voltage to the grids of the amplifier stages. The result was that a more nearly constant output level was realized over a wide range of input levels. The technique was called "automatic volume control," or AVC. A more sophisticated version of the name is automatic gain control, AGC.

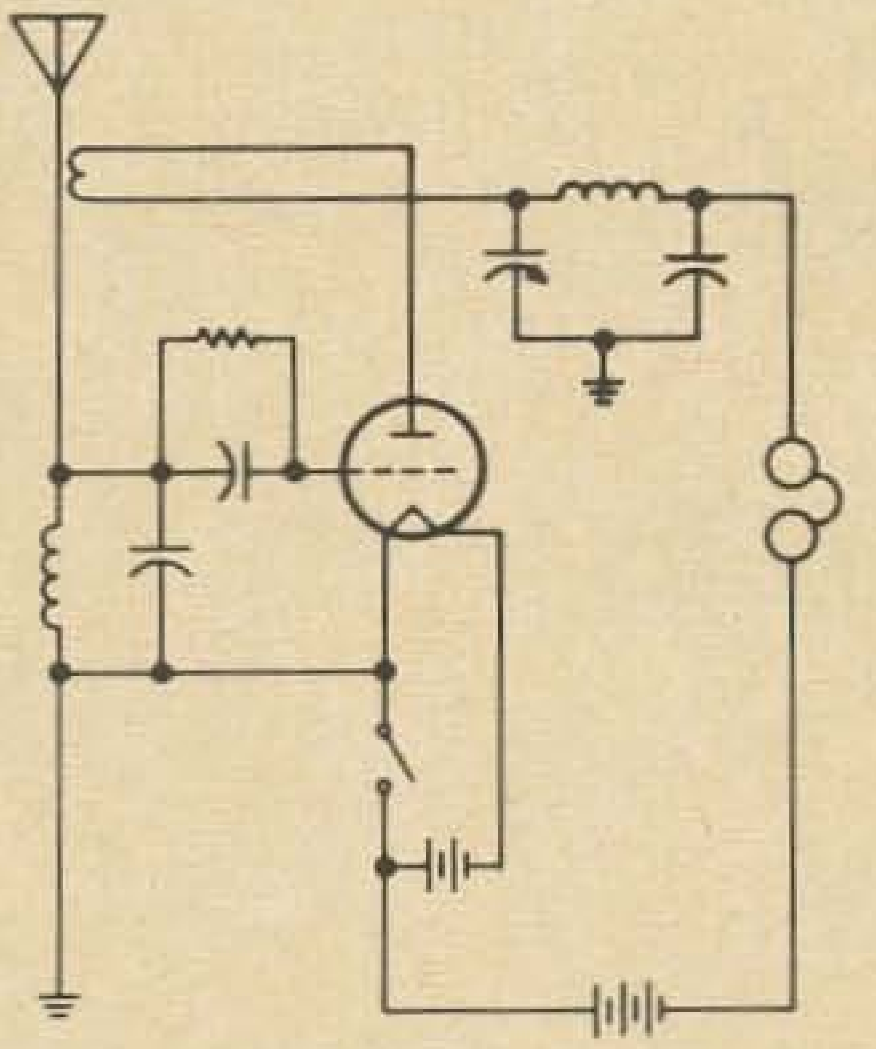

Fig.6. Armstrong added a feed-back winding to DeForest's audion detector introducing regeneration.

Another accomplishment of Armstrong's was the "super regenerative receiver." This circuit, designed for vhf work, was actually a regenerative detector which was switched in and out of oscillation at an ultrasonic rate. This allowed hitherto unheard of amplification, a quality badly needed in the vhf range.

During WW I there was developed a revolutionary circuit which, upon its reaching public hands, was to render all the previous circuits obsolete. I can remember seeing an ancient issue of *QST* in which the ARRL vehemently denounced the new "superhetrodyne" receivers because of a rather disturbing characteristic. The circuit used Fessenden's old hetrodyne technique with a new twist. The oncoming signal would

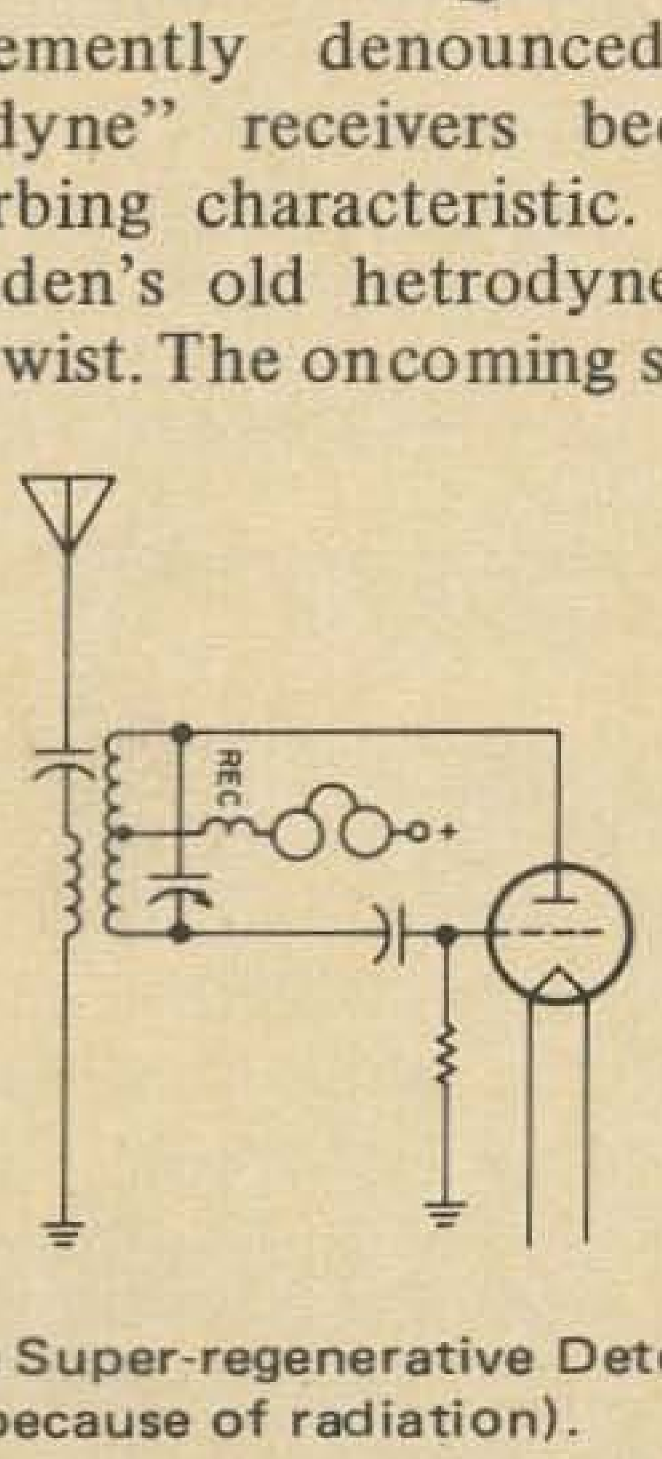

Fig.7. The Super-regenerative Detector (now outlawed because of radiation).

be mixed with an internal signal to produce a new signal, *still at radio frequencies,* which

would be amplified through several tuned stages before being detected. This new frequency, called the intermediate frequency, was quite low, around 175 khz., so the tuned *IF* stages achieved a far better selectivity than ever before. The superhetrodyne was far superior to any other receiver circuits except for one thing. There were *two* possible incoming signals which could produce the same intermediate frequency. Therefore it would be possible for amateur stations to be picked up by this circuit when it was tuned to another frequency, and it would not be the fault of the amateur station – hence the ARRL's objection. The superhet was accepted anyway, and, except for owning the patent for AGC, Hazeltine would have been out of business.

Armstrong's line was done for, too, except for experimenter kits and circuits in the Boy Scout Merit Badge Book. Armstrong wasn't so bad off, however, for he had just come up with another new technique. He called it "frequency modulation," and it goes on and on and on. . . .

. . . W1USM

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An Introduction to Integrated Circuits

There are already two main types of integrated circuits. These are digital and the type that will be discussed here, linear. Digital IC's are used mainly in computer technology using their switching characteristics. Other circuits such as amplifiers, oscillators, etc., require more than the on-off of digital IC's and are thus more complex.

IC Construction

There are two types of IC's, monolithic and hybrid. Monolithic circuits are made on one slice of semiconductor whereas hybrid circuits are small "thin film" circuits wired together on the substrate material.

Monolithic IC's are made in a similar way to the diffusion process in transistors. (See "Basic Theory and Applications of Transistors" by same author.) In IC's this process is called silicon planar technology. Just as in a transistor, the IC begins as a small wafer of silicon (either N or P type). Impurities are added to either make the material N or P. When the process is completed, an insulatory oxide is palted over it. This coating is broken in at certain locations to permit the fastening of metallic leads to the different areas. When this process is completed, a simple NPN transistor is formed. (See **Fig. 1**)

This process may be carried out again inside the previously formed area so that two single transistors may be formed. (See **Fig. 2**)

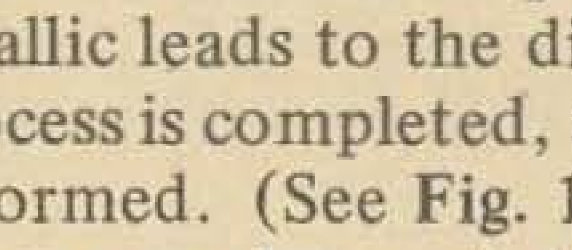

Fig. 1. Single NPN transistor formed on p material.

When an internal resistor is required in the circuit, pieces of resistance wire are imbedded in a P-type region. The total resistance is $R_T = R_S \times 1/W$, where R_S is the pre-determined sheet resistance and W is the width of the material. Therefore, the more narrow the actual resistor, the larger the resistance.

A thin film resistor is formed by depositing some resistive material such as nitrided tantalum, nichrome, or tin oxide over the SO_2, covering the P-type substrate. The resistance may be found by $R_{AB} = 1/dW$.

When a high value resistor is needed and the length is not available, a zig-zag pattern may be used.

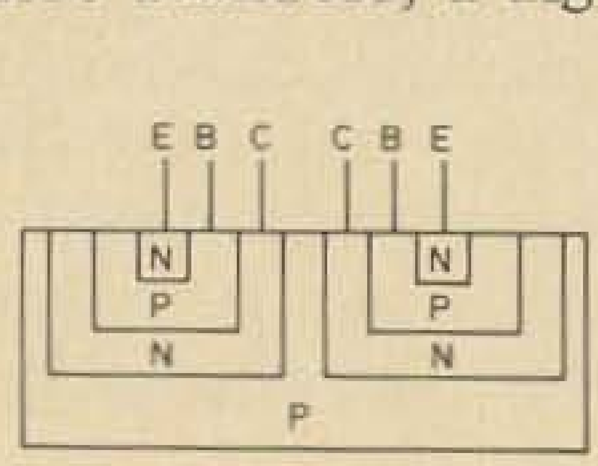

Fig. 2. Double IC transistors formed on one slice of p material.

Capacitors may also be formed on IC's. By using the oxide as a dielectric and N-type material as the other lead, an IC capacitor is formed in the same manner as its big brother. The value of the capacitor is found by $C = A \times E/d$, where A is the area, E is the dielectric constant and d is the thickness of the oxide. This capacitor has the disadvantage of having a small capacity and a variance in values with a change in the collector to base voltage.

Inductors in IC's are usually connected ex-

ternally for the values which may be miniaturized are very small.

Comparisons of IC and "Normal" Components

Values of IC resistors are very critical when they are made. Unlike the normal resistor which depends upon the resistivity of the carbon material contained, the IC resistor's value is determined solely by its geometrical form. The resistors values vary greatly with a change in temperature and so they are designed to operate by ratio rather than by exact value.

The major difference between regular transistors and IC transistors is that IC transistors have less capacitance.

One of the main advantages of IC transistors is that since they are fabricated from the same material under the same conditions, they are very closely matched in their characteristics. When there is a change in temperature, it affects all transistors equally because of their proximity.

Basic IC Circuits in General

One of the best uses of the IC is in a balanced differential amplifier. This amplifier requires few resistors and capacitors and has excellent isolation of output to input thus reducing feedback.

An operational amplifier is a very high gain amplifier which uses its feedback for control. This amplifier may be used in many ways and is the most versatile circuit of the IC's.

Arrays

Arrays of diodes and transistors in IC's have the advantage of all being constructed from the same material and thus all being closely matched. This is useful when a careful balance must be made in circuits such as bridge rectifier and balanced modulators. The diodes are formed by shorting out the appropriate leads from the IC transistors. (See Fig. 3.)

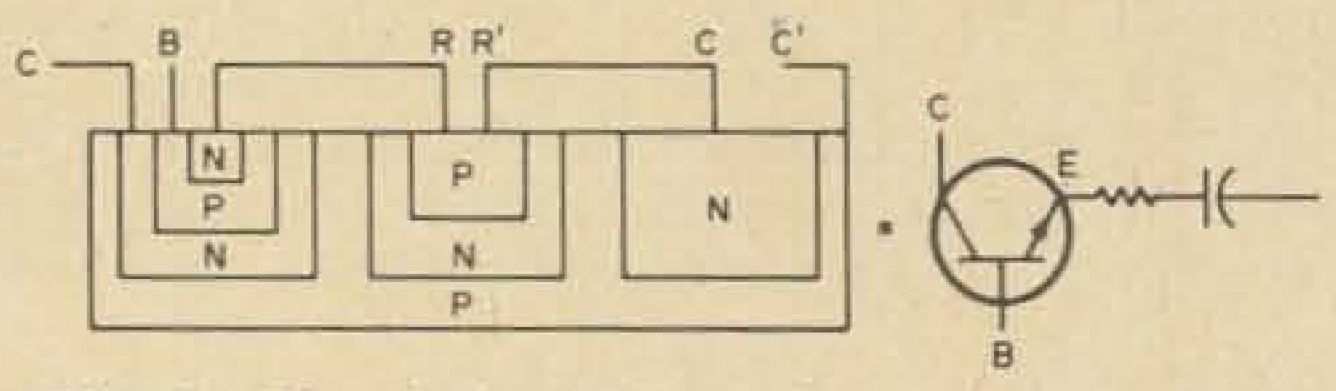

Fig. 3. Simple monolithic IC and its equivalent circuit.

DC Power Supply

The supply voltage to IC's, as in transistors, is around 15 to 35 volts dc. If the polarity is reversed, again as in transistors, excessive current will flow and destroy the junctions. Stray inductance may be eliminated through the use of feed-thru capacitors properly grounded. If this inductance is not eliminated, it will build up and eventually cause a high voltage to flow through the IC. This affect must be compensated for by the use of a voltage shifting circuit which will make the input and the output algebraic sum equal to zero.

Packaging Techniques

There are three main types of packaging now used in the manufacture of IC's. These are the traditional TO-5 transistor metal can, the ceramic flat pack, and the dual-in-line package. The TO-5 package may have 8, 10, or 12 leads. The flat packs and the dual-in-line usually have 14. Although the ceramic packaging is the most efficient (having the best electrical and heat characteristics), it is most expensive to produce. The most practical and widely used package is the plastic-molded. Although it doesn't have the best heat characteristics, it is the cheapest, easiest and most versatile of the many packages available for IC's. (See Figs. 4 & 5.)

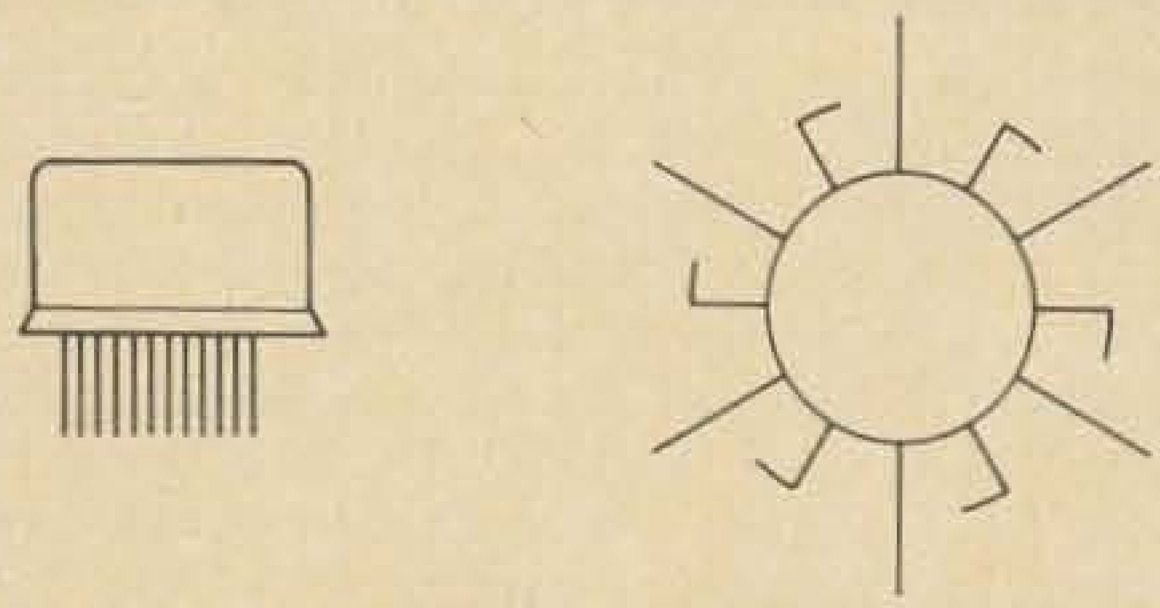

Fig. 4. TO-5 case and off-set bending of leads.

Mounting Procedures

There are several methods of mounting IC's. Like all semi-conductor devices, IC's are heat sensitive at their leads. The TO-5 cases may either be mounted in commercially manufactured sockets (similar to transistor sockets) or directly soldered to the circuit board. The socket is particularly useful when an experimental circuit is set up and many IC's have to be substituted into the circuit.

As previously mentioned, the TO-5 case may be mounted directly to the board. There are several ways of doing this; one way is to simply drill holes in the board in the same pattern as the base and bringing the leads to the appropriate places in the circuit.

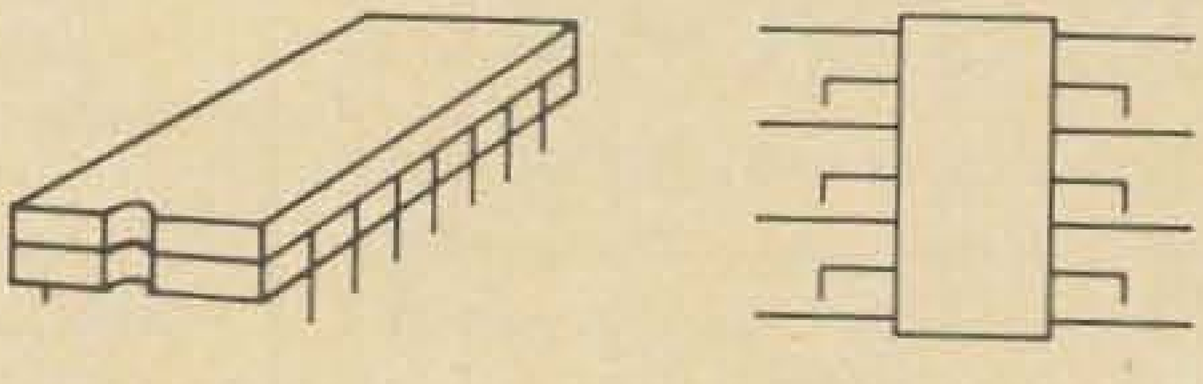

Fig. 5. Dual in-line and off-setting of leads.

If the circuit is crowded around the IC, the off-set method may be used. This is a method in which every other lead of the IC is bent downward so that the leads may be evenly distributed around and outward. (See **Fig. 4.**)

The flat packs and the dual-in-line are mounted in a similar way in that they may be mounted directly or off-set. (See **Fig. 5.**)

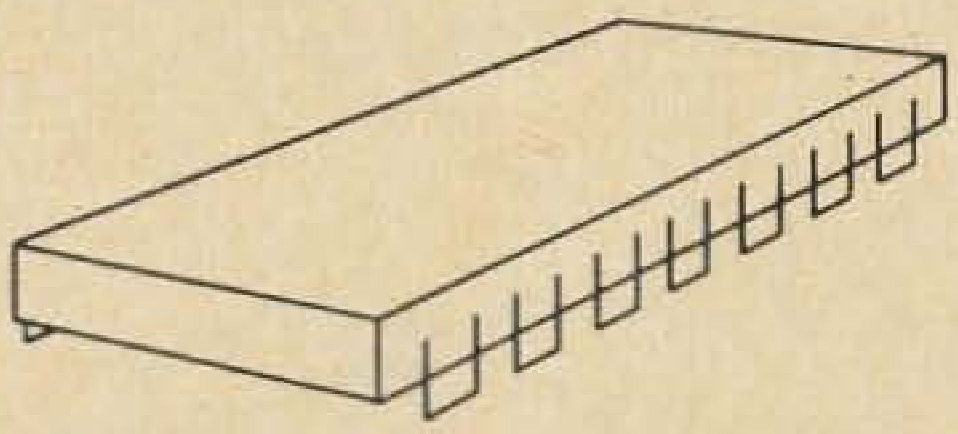

Fig. 6. Molded plastic package.

General Integrated Circuits

The balanced differential amplifier is the basis for most linear IC's. As shown in **Fig. 6A**, the circuit basically consists of two integrated circuit transistors which operate in a similar way to a circuit with two NPN transistors.

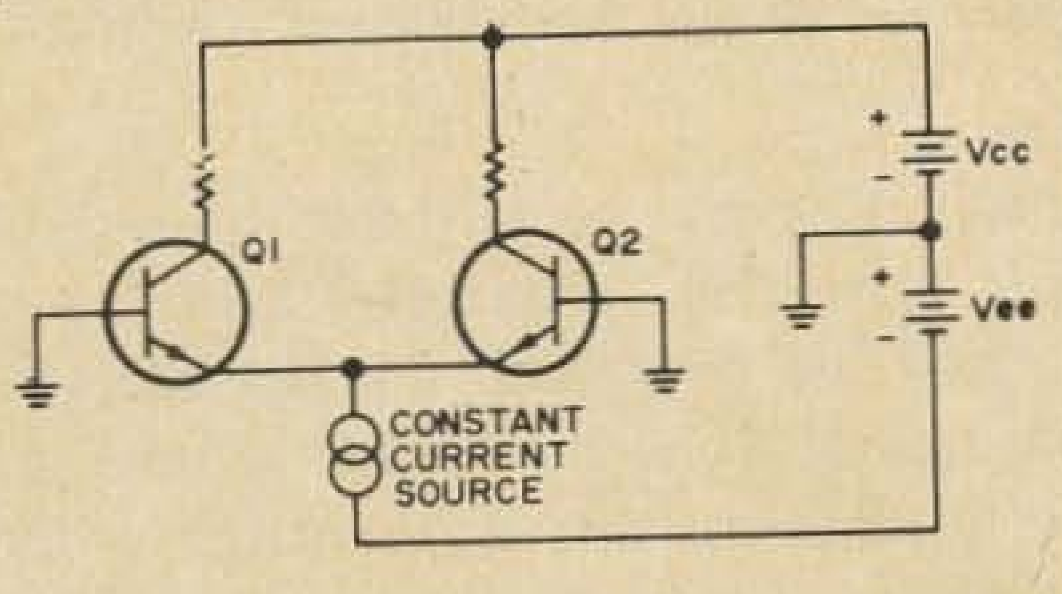

Fig. 6A. Balanced differential amplifier.

General Purpose IC's

For a start of basic integrated circuits, let us begin with the commonly used dc amplifier, as the RCA CA 3000. This circuit is basically a single-stage differential amplifier (Q_2, Q_4) with input emitter-followers (Q_1, Q_5) and a constant current sink (Q_3). The char-

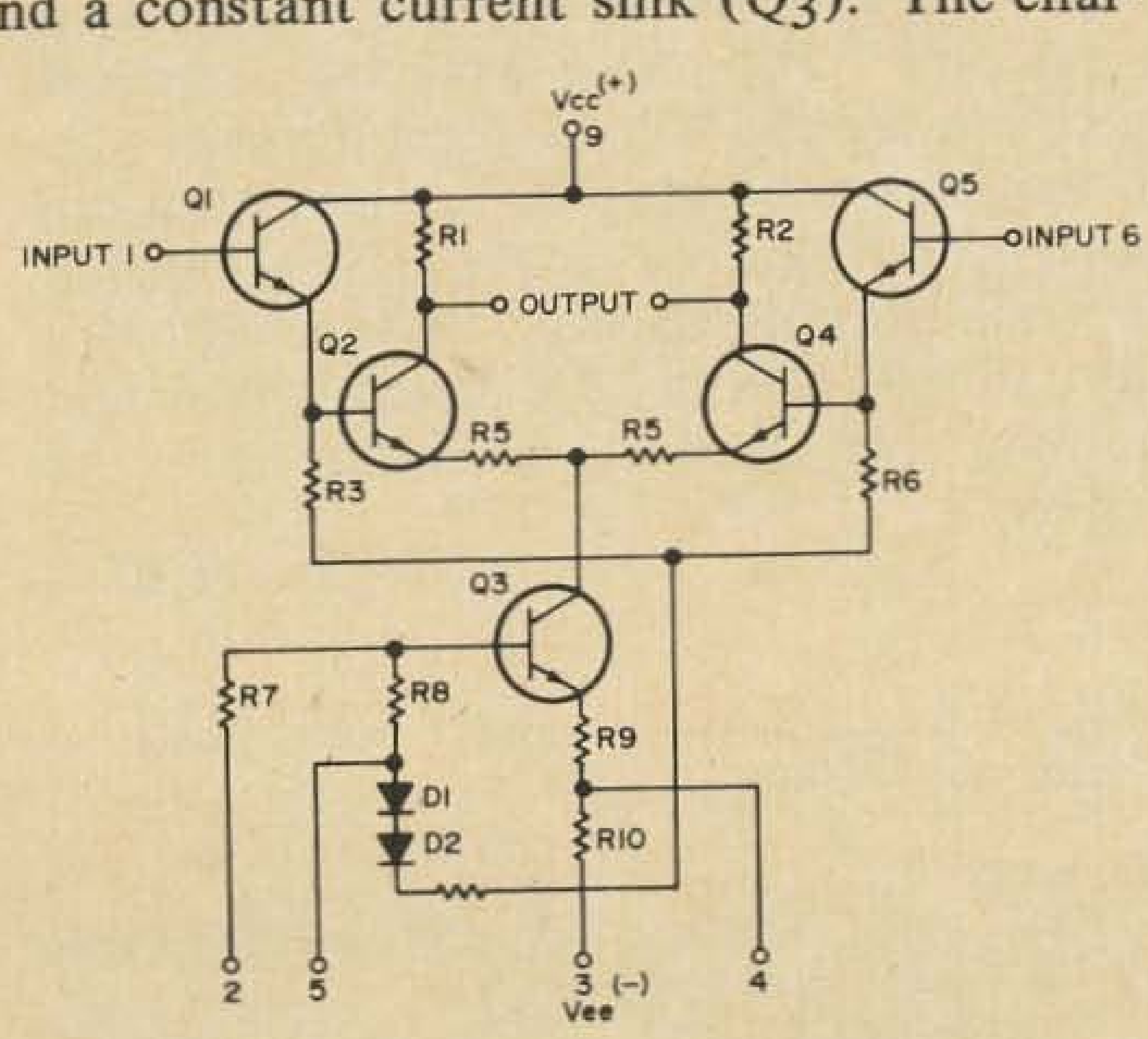

Fig. 7. CA 3000 dc amplifier.

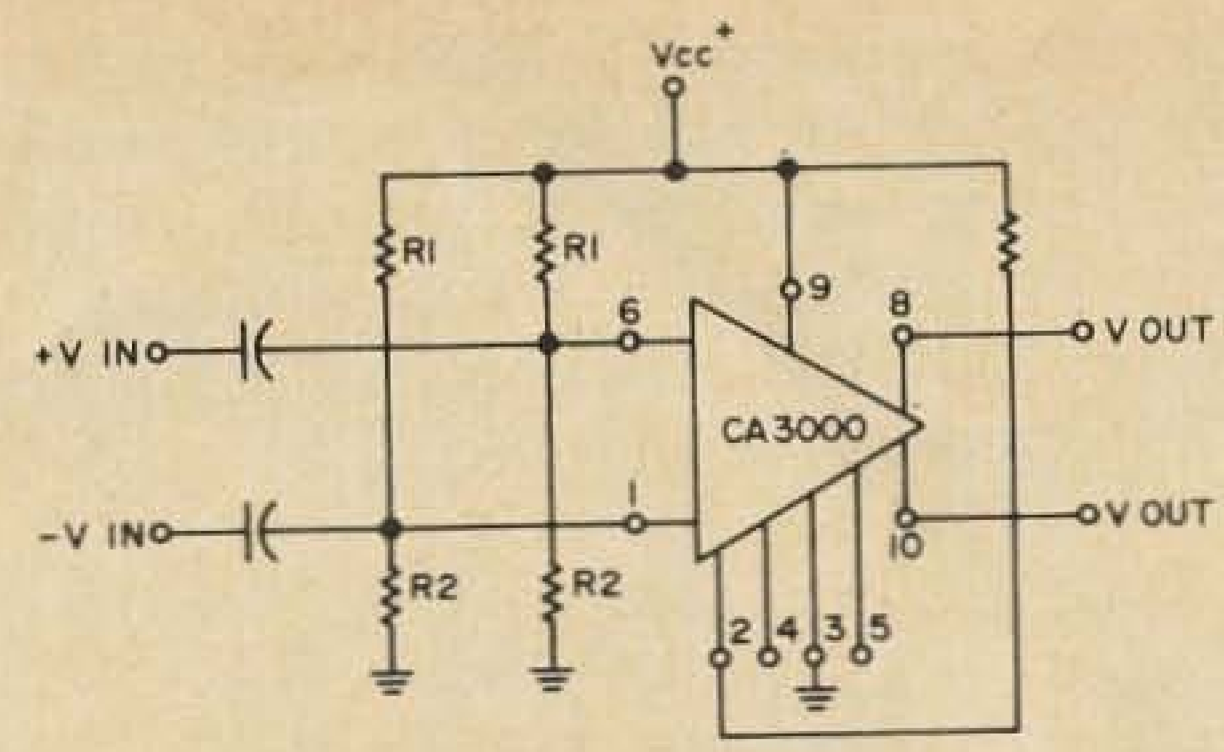

Fig. 8. CA 3000 with a single voltage supply.

acteristics of this amp. include a push-pull input and output. (See **Fig. 7.**)

This circuit is provided with an external means of changing the emitter resistor of Q_3 by shorting out terminals 3-4-5 to suit the user.

Characteristics of the CA 3000 vary from V_{CC} = .4, $-V_{ee}$ = -3 with a 16.6 db gain to V_{CC} = 5, $-V_{ee}$ = -6 with a 32.4 db gain.

The CA 3000 may be used in many applications useful to the amateur such as a crystal oscillator, modulator or a mixer.

The CA 3000 may be used as a crystal controlled oscillator up to 1 mhz in its standard form. Using variable feed-back cleans up the signal by smoothing it out. (See **Fig. 9.**)

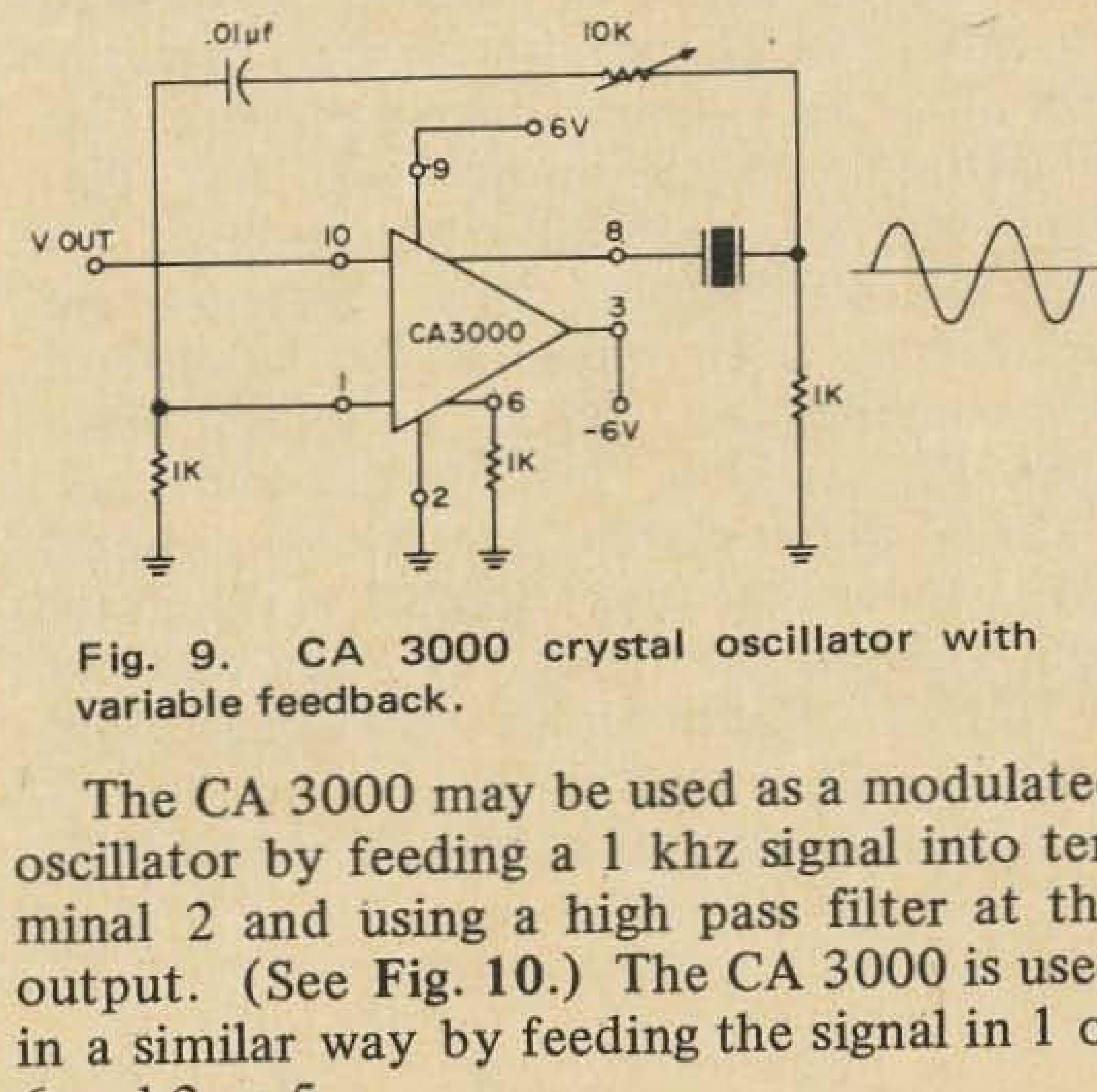

Fig. 9. CA 3000 crystal oscillator with variable feedback.

The CA 3000 may be used as a modulated oscillator by feeding a 1 khz signal into terminal 2 and using a high pass filter at the output. (See **Fig. 10.**) The CA 3000 is used in a similar way by feeding the signal in 1 or 6 and 2 or 5.

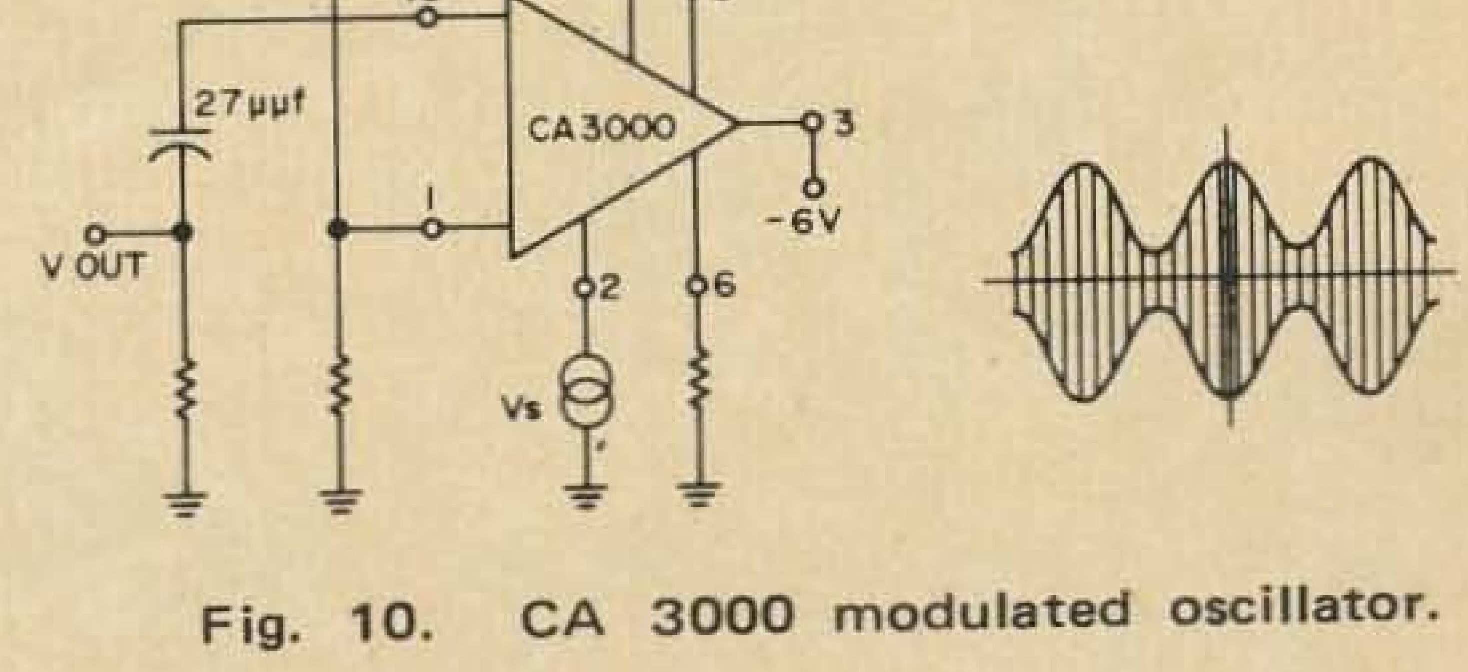

Fig. 10. CA 3000 modulated oscillator.

From this point on, for simplicity's sake, IC's will be treated like black boxes whose circuits are too complex to explain within the scope of this article. When designing is being done, only the function and the parameters are necessary.

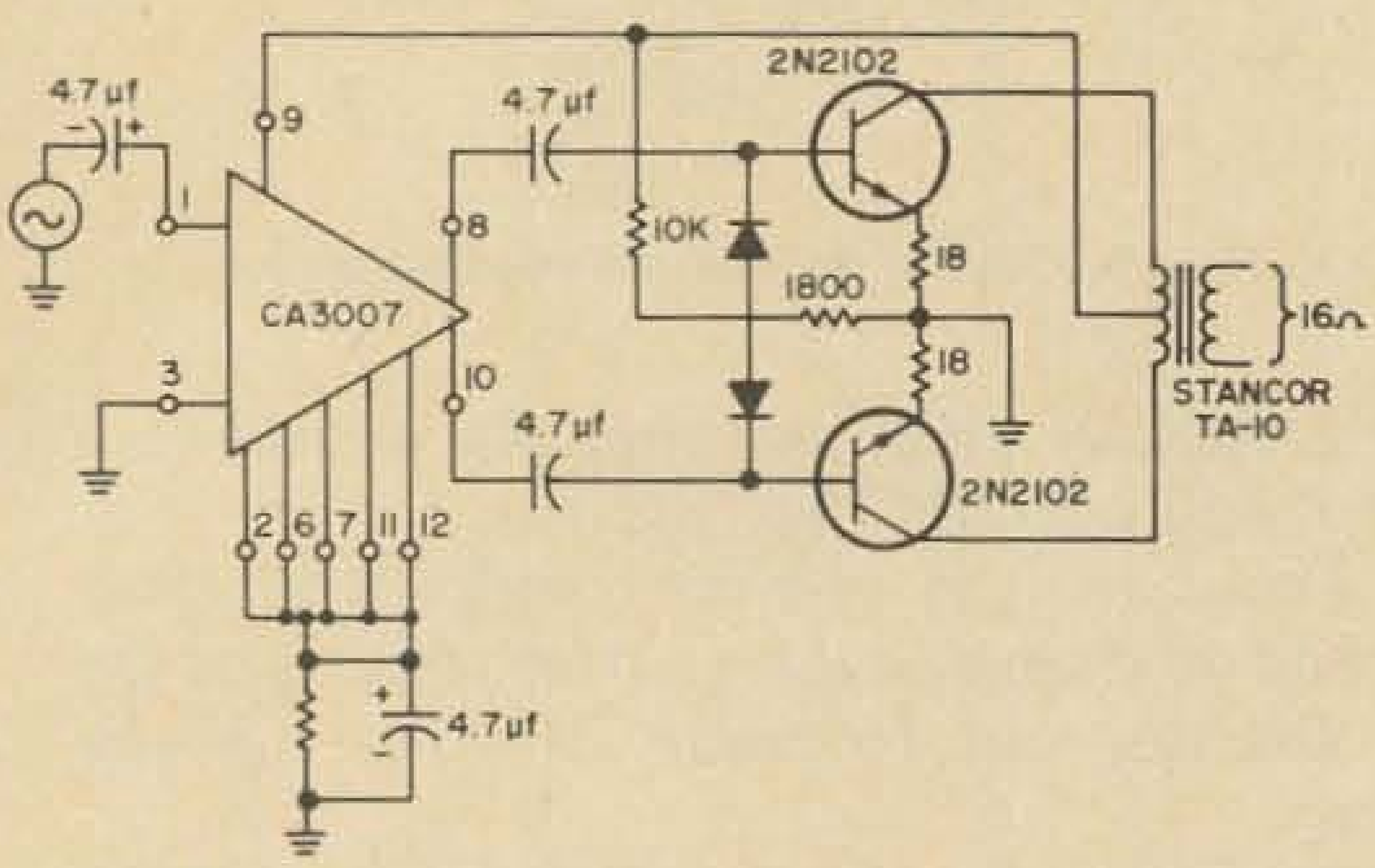

Fig. 11. CA 3007 used in a 30 mw. audio amplifier.

The CA 3007 is a basic IC audio driver. Fig. 11 shows a simple, practical, single supply audio amplifier. The CA 3007 has the capability of 24 db gain with a power dissipation of 20 mw.

Even wide band amplifiers have been replaced by IC's. Such an IC is the CA 3001 shown in Fig. 12. This circuit may be used as a video modulator with typical characteristics of up to 106 mw dissipation with 17.8 db with 6V and 2.8V power supplies. This circuit may easily be taken advantage of for use in the ATV station where amateurs have stayed away from video circuits because of their complexities. There are several other video IC available for similar purposes.

The IC which should have the most appeal to the amateur are the *rf* amplifiers which are the CA 3004, CA 3005, CA 3006 and the CA 3028A. These circuits are designed to operate in the range of dc to 120 mhz. A few of the many uses of this IC are amplification, mixing and frequency generation. These four IC's may be used with external circuits to obtain many other circuits.

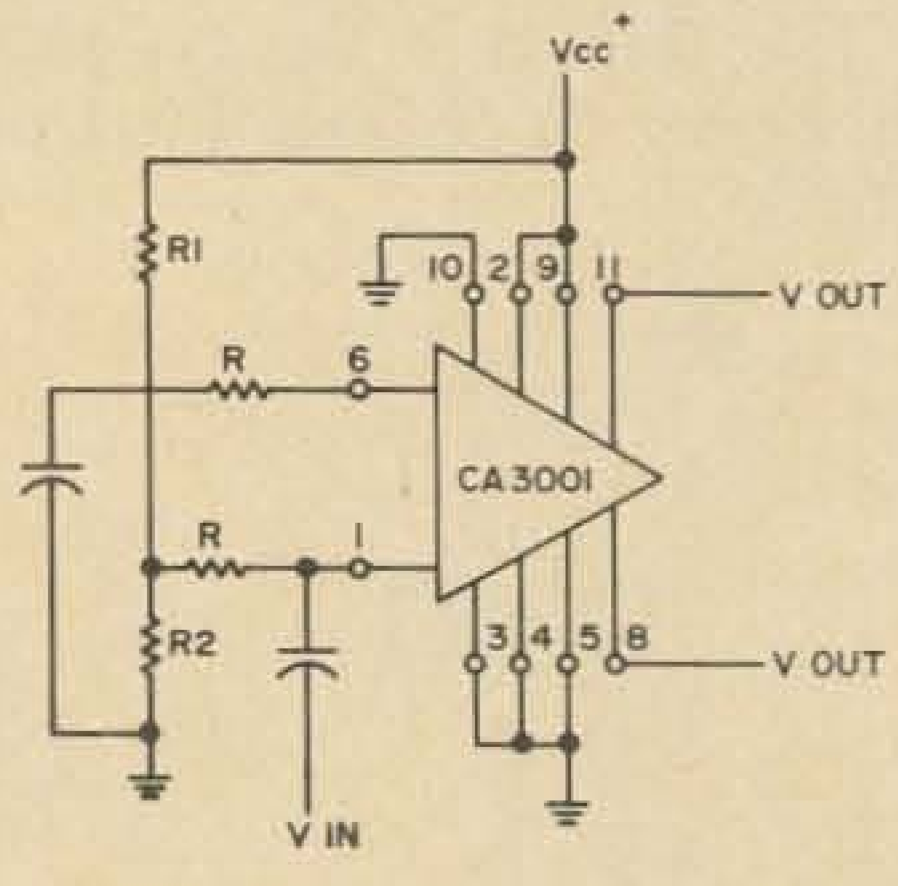

Fig. 12. Circuit connections of a CA 3001 for a single supply.

One typical use of the CA 3005 or CA 3006 is in a double sideband suppressed carrier modulator circuit. (See Fig. 13.) This circuit should have great appeal for amateurs for it may be used as the backbone of a DSB system. For more specific applications and data consult the RCA IC handbook.

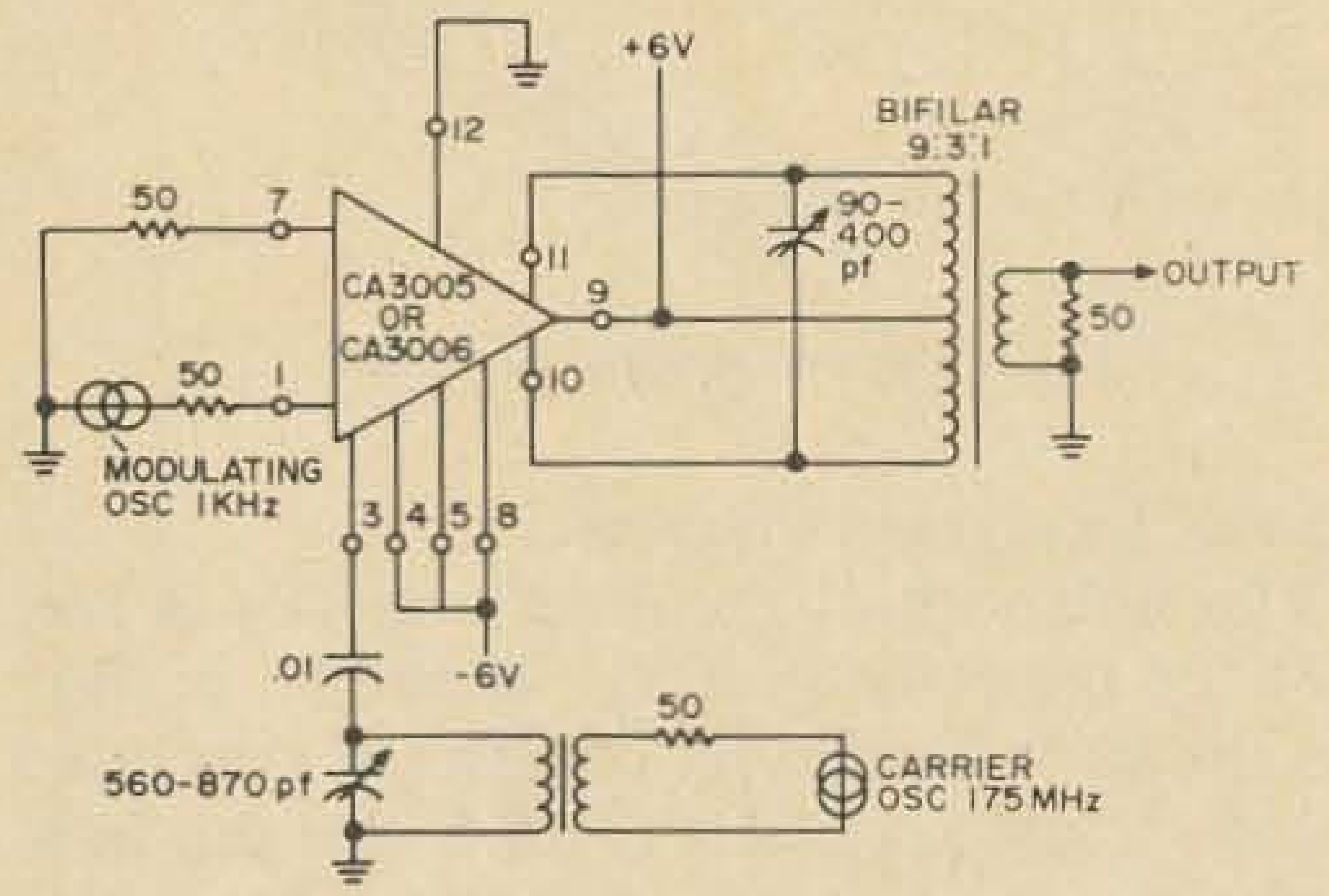

Fig. 13. Double sideband, suppressed carrier modulator using the CA 3005 or CA 3006.

Conclusion

As shown, the use of IC's today is almost limitless for both the "amateur" and the professional. For the professional, the advantages are numerous. IC's are useful where space is valuable and there is not room for conventional circuits. Also, since most of the circuit is built in, a great amount of time is saved in construction. For servicing, the IC cannot be beat. Although if one part burns out, the whole circuit goes, the defective IC is fairly easy to locate and replace.

IC's also have many advantages for the amateur. For those who fear transistor circuits because of their complexity, the IC greatly simplifies construction by combining the circuits. For those who are perpetual experimenters, the IC's are ideal for they permit complete changing of circuits and are available very cheaply in experimental packages from surplus houses. Design with IC's is fairly simple for only the power supply and the input and output parameters must be considered.

. . .WA1FHJ/2

Circuit Diagrams taken from "RCA linear integrated circuits" c 1967.

References

1. "RCA linear integrated circuits" c 1967, Radio Corp. of America, Harristown, N.J.
2. "Electronic Circuits: Discrete and Integrated" Donald Shilling, Charles Belove c 1968, McGraw-Hill.

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1531 McKinnon Court
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RTTY Tone Generator

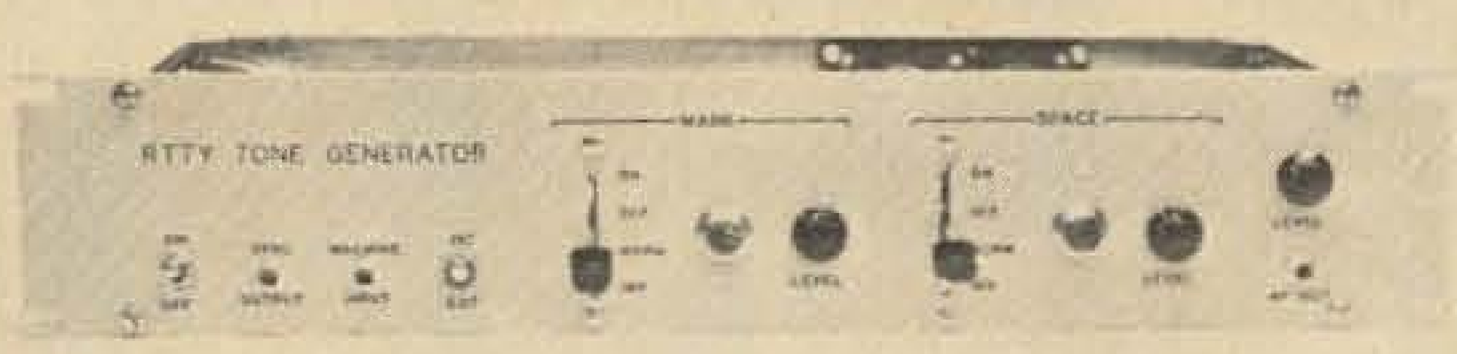
The RTTY Tone Generator is a unique piece of RTTY test equipment. It is capable of simulating a variety of Teletype operating and QRM modes, since it can deliver all possible combinations of the 2125 Hz mark and 2975 Hz space audio tones. When not serving in the test equipment capacity, it functions as a conventional AFSK oscillator.

It may be keyed externally by a contact closure such as from a machine keyboard, or by a 3.5 volt peak-to-peak square wave signal. An internal keying generator provides a zero-bias 22 Hz keying signal. The internal keying signal allows the unit to be used for such things as adjusting TU polar relays and is also a great convenience when chasing signals thru the local system with an oscilloscope.

The unit is designed around transistors and low-cost integrated circuits. It requires 12 vdc (± 10%) at about 450 mA and delivers a maximum audio output in excess of minus 10 dbm into 600 ohms. Front-panel controls adjust the mark/space amplitude ratio and the output level, and select the desired operating mode.

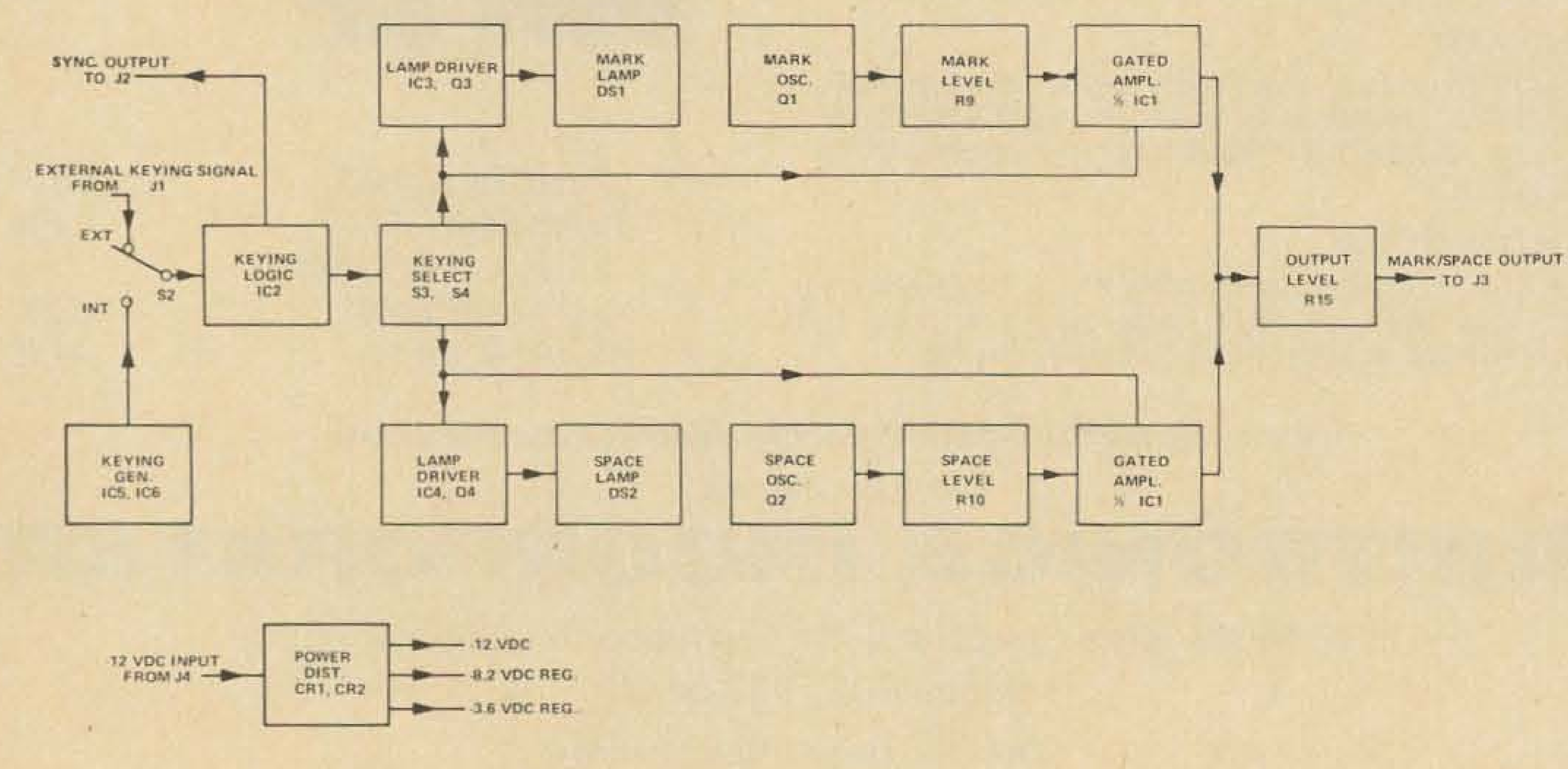
System operation

Fig. 1 is a block diagram of the RTTY Tone Generator. The mark and space oscillator outputs are fed thru separate level controls to independent gated amplifiers. The gated amplifiers stop or amplify their



respective signal inputs depending on the information they receive from the keying logic and keying selector circuits. The audio signals from the two gated amplifiers are combined at the output level adjustment potentiometer. The signal from the potentiometer wiper is connected to the mark/space output jack, J3. The particular combination of the mark and space audio tones present at the output jack depends on the settings of S3 and S4. The following possibilities exist:

a) Mark signal off, space signal off.
b) Mark signal on, space signal on.
c) Mark signal on, space signal off.
d) Mark signal off, space signal on.
e) Mark signal keyed on and off, space signal off.
f) Mark signal keyed on and off, space signal on.
g) Mark signal keyed on and off, space signal on.
h) Mark signal on, space signal keyed on and off.
i) Mark signal keyed on and off, space signal keyed on and off – mark signal present when space signal is absent and vice versa.



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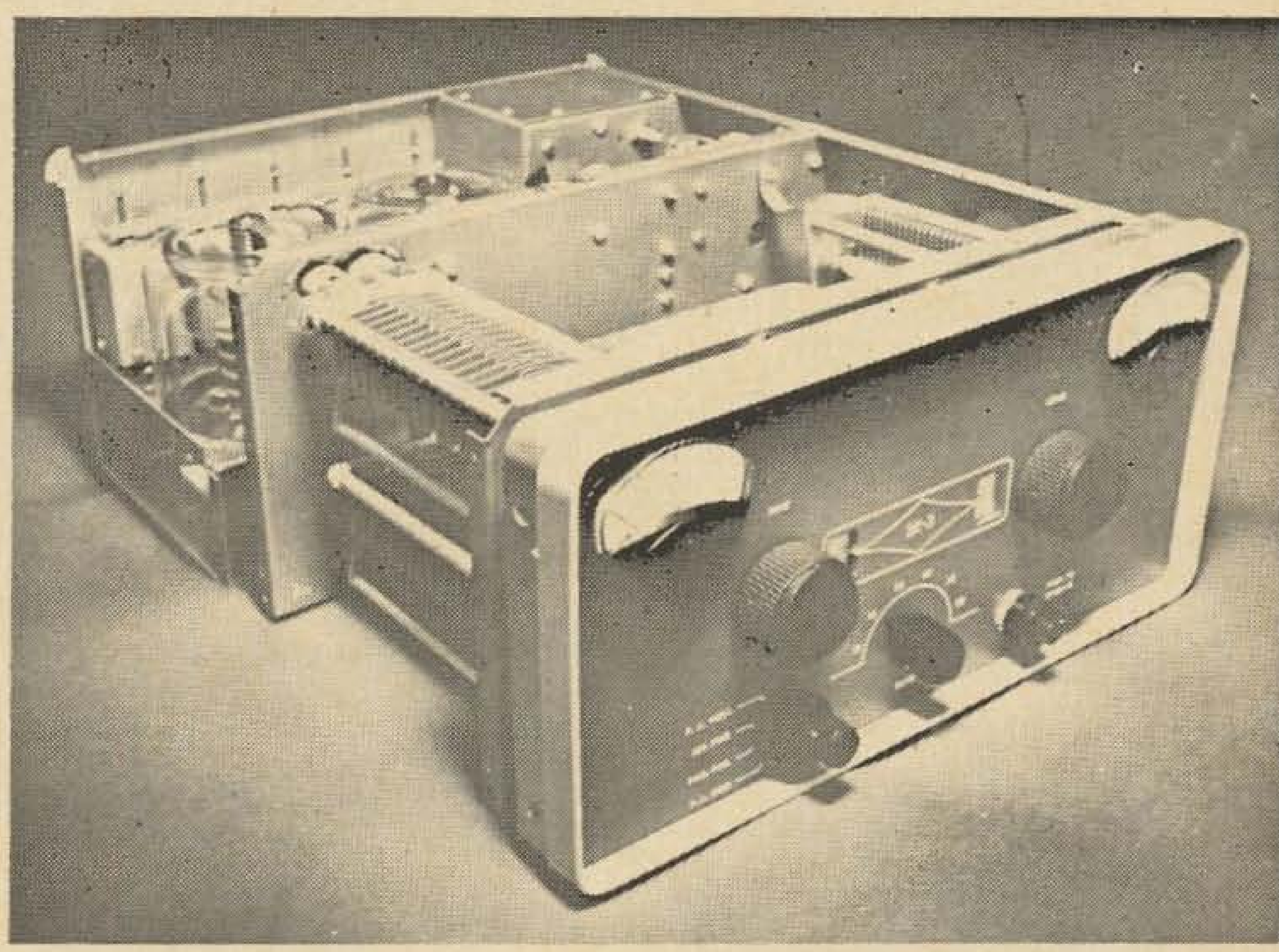

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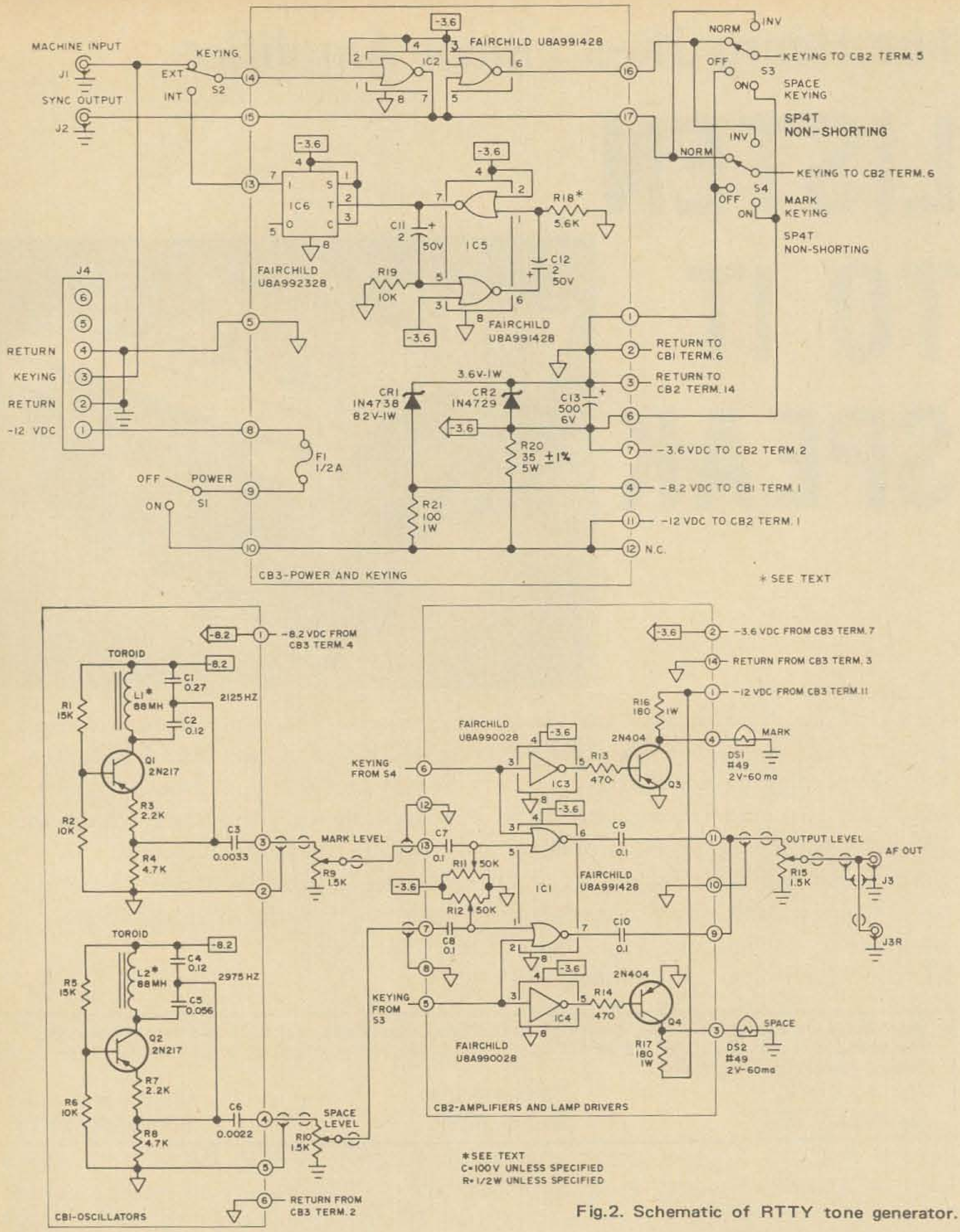
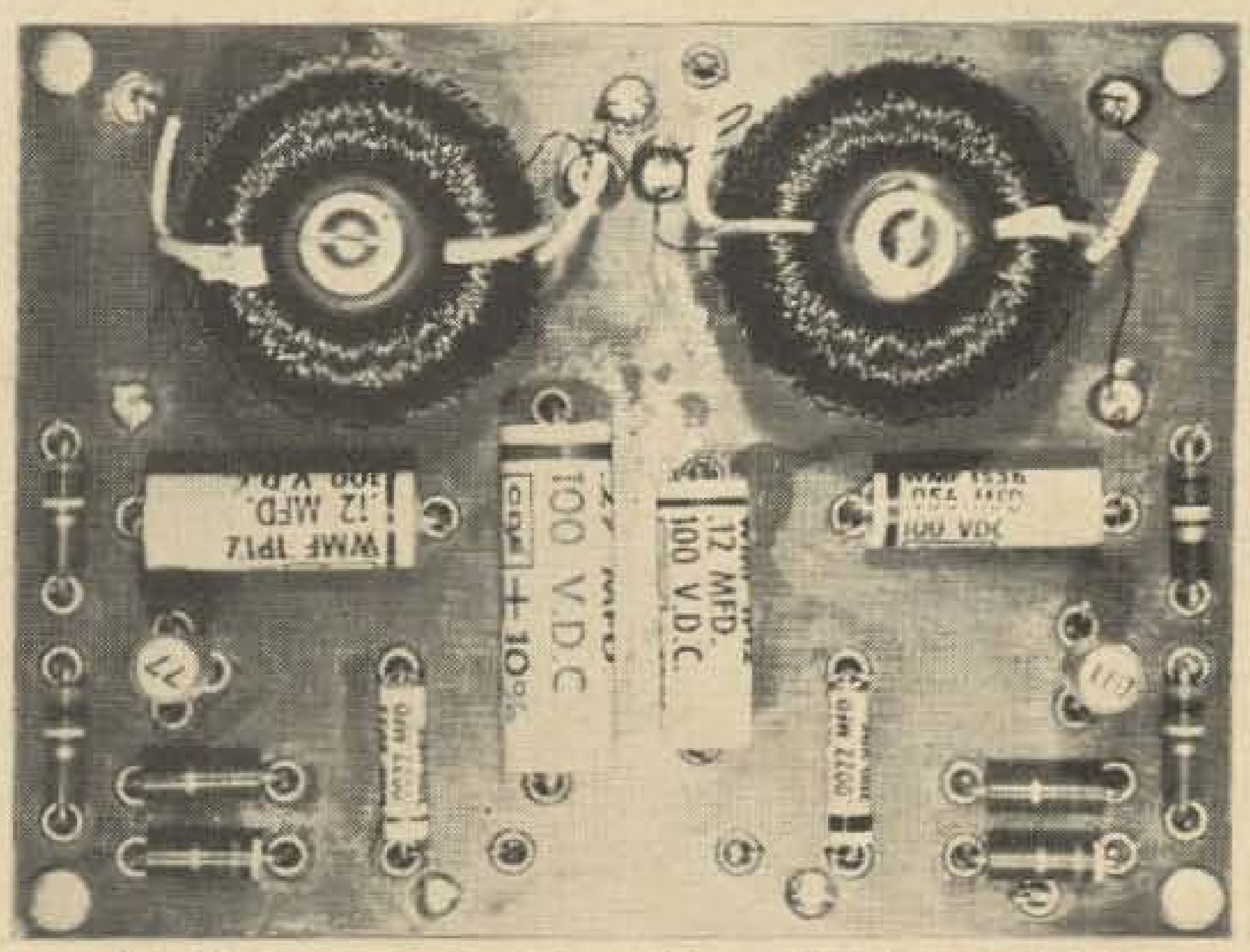


Fig.2. Schematic of RTTY tone generator.

j) Mark signal keyed on and off, space signal keyed on and off – mark and space signal present and absent simultaneously.

The lamps (DS1 and DS2) indicate the state of the two gated amplifiers. They are extinguished when the amplifiers are in the 'stop' mode, and illuminated when the amplifiers are in the 'amplify' mode. The keying selector switch (S2) connects the keying logic input to either the internal keying generator or the external keying input jack. The power distribution circuits provide minus 12 vdc, minus 3.6 vdc regulated, and minus 8.2 vdc regulated to the various circuits.



Oscillator component board. Mark (2125 khz) on left.

Circuit description

The majority of the circuitry is assembled on three 3" x 4" homemade component boards. The mark and space oscillators are contained on one of the boards (CB1), the gated amplifiers and lamp drivers on another (CB2), and the power distribution and keying circuits on the third (CB3). The complete RTTY Tone Generator is shown schematically in **Fig. 2.**

The mark and space oscillators are conventional LC oscillators designed so that their operating frequencies are essentially independent of transistor case temperature. The two inductors (L1 and L2) are the usual 88 mH loading coils. Capacitors C1 thru C6 are mylar dielectric units having a ± 10%

selector switch positions		keying input grounded		keying input open	
mark	**space**	**mark**	**space**	**mark**	**space**
on	on	1	1	1	1
on	off	1	0	1	0
on	norm	1	0	1	1
on	inv	1	1	1	0
off	on	0	1	0	1
off	off	0	0	0	0
off	norm	0	0	0	1
off	inv	0	1	0	0
norm	on	1	1	0	1
norm	off	1	0	0	0
norm	norm	1	0	0	1
norm	inv	1	1	0	0
inv	on	0	1	1	1
inv	off	0	0	1	0
inv	norm	0	0	1	1
inv	inv	0	1	1	0

'0' indicates signal absent
'1' indicates signal present

Fig.3. Mark and space outputs as functions of S3 and S4.

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capacitance tolerance. Do not use ceramic capacitors in any of the frequency determining networks – ceramics are both temperature and voltage sensitive. Turns are removed from L1 and L2 to adjust the oscillator frequencies to 2125 Hz and 2975 Hz respectively. This will be discussed later in the final adjustments. The capacitor values specified should resonate with any of the available "88 mH" inductors.

The mark and space gated amplifier and lamp driver channels are identical. The mark signal from R9 is fed to one input of a two-input NAND gate. IC1 is a *dual* two-input NAND gate. Potentiometer R11 biases this input (pin 5 of IC1) so that the gate can operate as a linear amplifier. The amplified mark signal appears at pin 6 of the gate as long as pin 3 is at or near minus 3.6 vdc. When pin 3 of the gate is at or near ground, pin 6 of the gate is esentially connected to pin 4 of the gate and the mark signal output at pin 6 disappears. The two-input logic gate thus provides a convenient means for switching (or gating) and amplifying the mark signal. The space channel functions in exactly the same manner, utilizing the two-input gate associated with pins 1, 2, and 7 of IC1.

When terminal 6 of CB2 is at or near ground potential, the mark signal output from IC1 is absent. Pin 3 of IC3 will also be at or near ground potential and the output of IC3 (pin 5) will be at or near minus 3.6 Vdc. This voltage drives Q3 into conduction, extinguishing DS1. The whole procedure is reversed when terminal 6 of CB2 is at or near minus 3.6 Vdc; the mark signal from IC1 may be present (depending on the setting of R9), the output of IC3 will be at or near ground potential, Q3 will not conduct, and DS1 will illuminate. The space lamp driver channel (IC4, Q4, and DS2) functions in exactly the same manner, responding to keying signals at terminal 5 of CB2. IC3 and IC4 are buffer amplifiers. Their sole function is to isolate the lamp driver circuits from the keying signals and assure complete switching of Q3 and Q4.

IC2 conditions the keying signal applied to terminal 14 of CB3. When the keying signal is at or near ground potential, terminal 17 of CB3 is at or near minus 3.6 vdc and terminal 16 is at or near ground potential. Conversely, when the keying input at terminal 14 is at or near minus 3.6 vdc (or open circuited), terminal 17 is at or near ground potential and terminal 16 is at or near minus

3.6 vdc. IC2 is a dual two-input gate operating as two inverters. Only one inverter is required to form the complementary outputs at terminals 16 and 17, but two are used to provide complete standardization of the keying signal.

One of the keying outputs is connected to terminal 15 and brought out to the front panel for use as an oscilloscope synchronizing signal. The keying mode switches (S3 and S4) select either of the two keying outputs, minus 3.6 vdc, or ground, and route the selected levels to the keying inputs of CB2. **Fig. 3** shows the presence or absence of the mark and space outputs with all possible keying/S3 and S4 combinations.

A third dual two-input gate (IC5) is connected as an astable multivibrator that forms the time-base for the internal keying signal. One of the primary requirements of the internal keying signal is that both halves of the cycle be of exactly the same time duration. *If* both sections of the gate were identical, *if* C11 and C12 were identical, *if* R18 and R19 were identical, and *if* the multivibrator were not connected to an external load, its output would be time-symmetrical and therefore suitable as the zero-bias internal keying signal. None of these "if" conditions are readily met in practice. There is, however, a simple solution to the problem, as we shall see.

IC6 is a JK flip-flop. Connected as shown, its output (pin 7 in this case) changes state each time the input (pin 2) switches from 0 *to* minus 3.6 vdc. When the input switches back to 0 *from* minus 3.6 vdc, the flip-flop does *not* change state. Bear in mind that 0 and minus 3.6 vdc are only nominal values and that the flip-flop senses only HI (positive) to LO (less positive) transitions of the input signal. In each complete cycle of the multivibrator output, there is only one HI to LO transition. When the multivibrator output is connected to the flip-flop input, the flip-flop output changes state once for every complete cycle of the multivibrator output. The time duration of each half cycle of the flip-flop output is equal to the time duration of one complete cycle of the multivibrator output. If the flip-flop output is used as the internal keying signal, then the internal keying signal is time-symmetrical regardless of how unsymmetrical the multivibrator output is. This is illustrated graphically in **Fig. 4**. The multivibrator must operate at 44 Hz to provide 22 Hz at the flip-flop output.

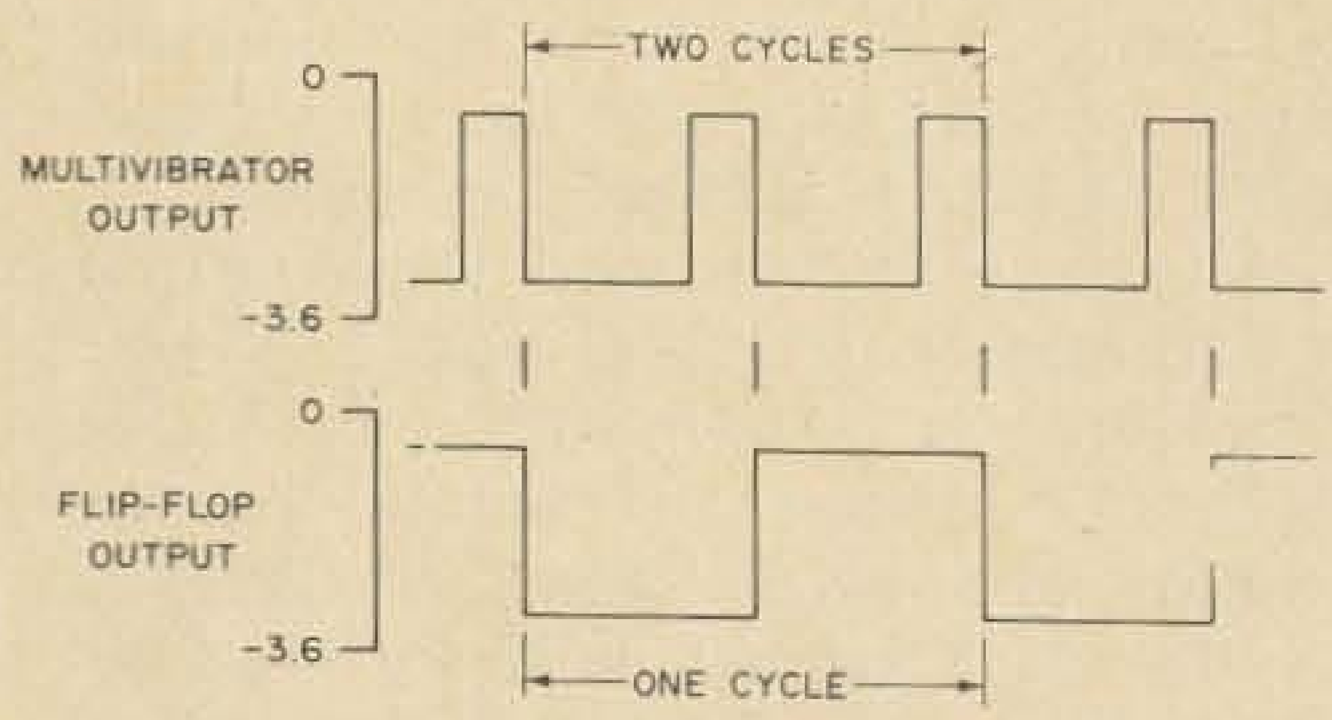
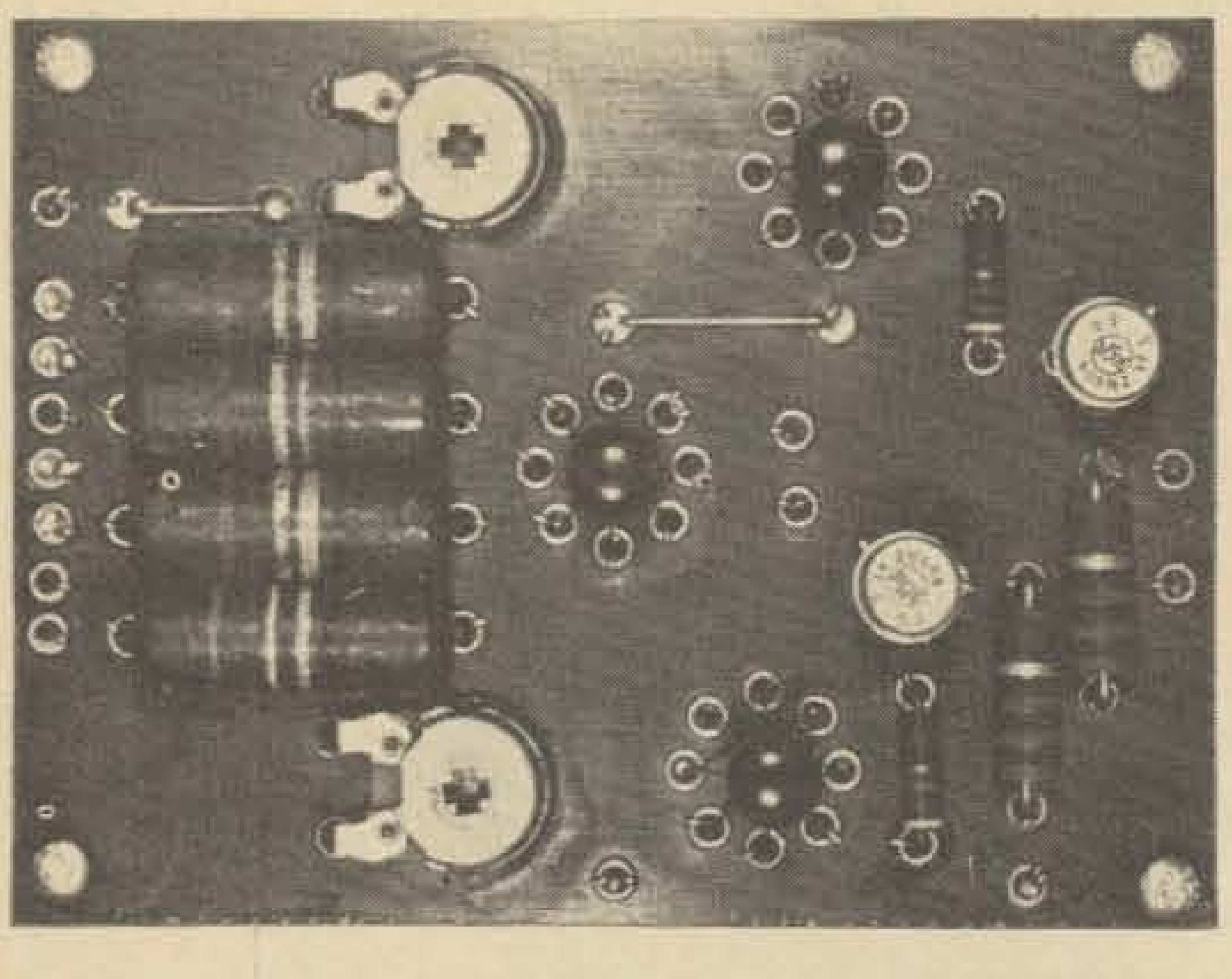


Fig.4. Output of flip-flop.



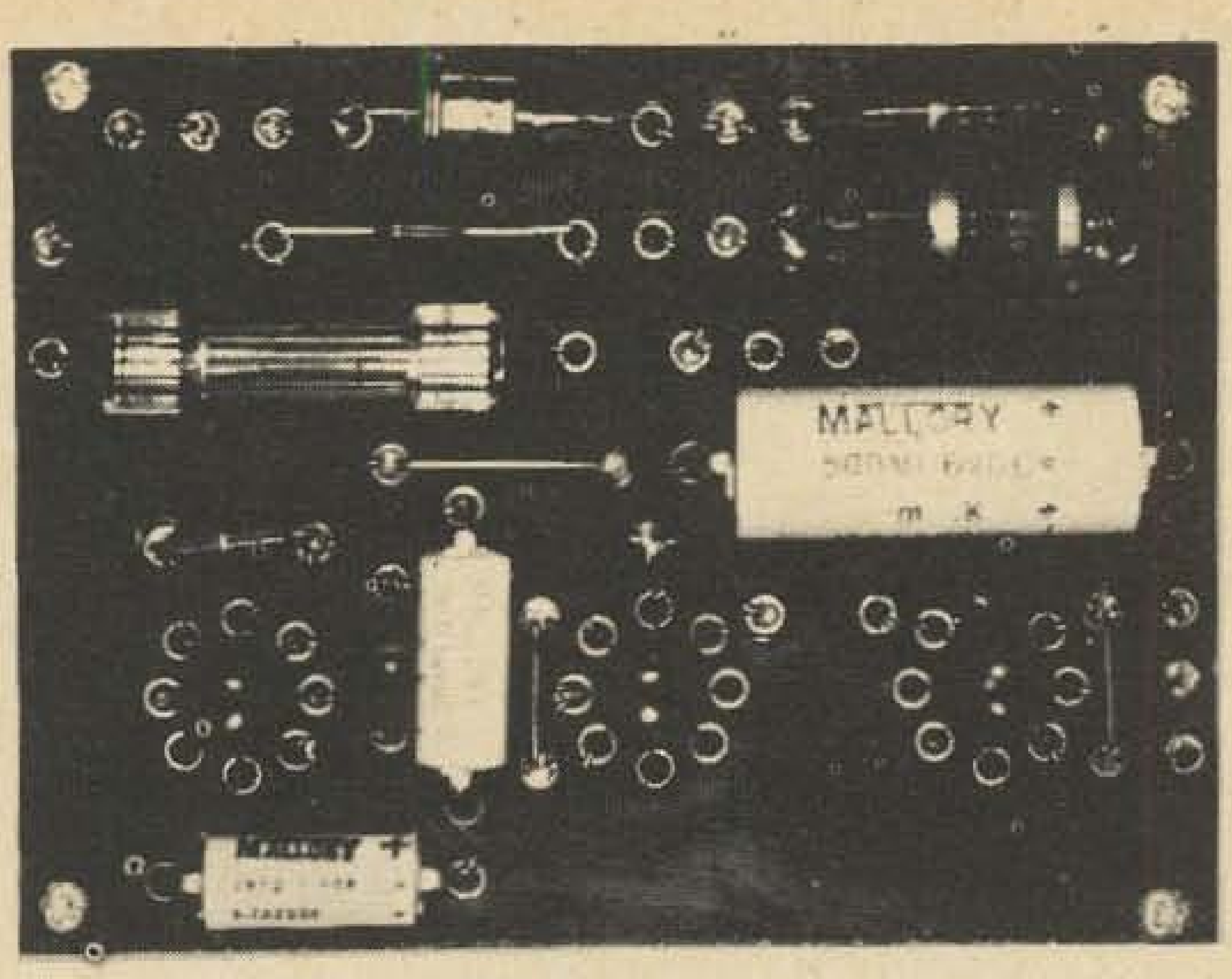
Amplifier and lamp driver component board. The four large capacitors could be replaced with disc ceramics.

The internal 22 Hz zero-bias keying signal from the output of IC6 is connected to switch S2. S2 selects either the internal or external keying signal and applies it to the keying logic input. Referring to **Fig. 3**, the internal keying signal has the same effect as alternately opening and grounding the keying input. When the internal keying signal is at or near zero volts, the "keying input grounded" columns apply. When the internal keying signal is at or near minus 3.6 vdc, the "keying input open" columns apply.

The minus 8.2 vdc and minus 3.6 vdc sources are derived from the 12 vdc ± 10% input by conventional shunt zener diode regulators. Use the resistor and zener diode values and tolerances specified in the parts list.

Integrated circuit data

The integrated circuits I used are manufactured by Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, California 94040, and are available through their distributors. At the time of this writing, the U8A991428 Medium Power Dual Two Input Gate (IC1, IC2, and IC5) costs 80c, the U8A990028 Medium Power Buffer (IC3 and



Power distribution board.

IC4) costs 80c, and the U8A992328 Medium Power JK Flip-Flop (IC6) costs \$1.50. All prices are for quantities of 1 to 99.

These particular IC's are in an epoxy package about the size of a JEDEC TO-5 transistor case. Eight leads spaced on a 0.200" diameter circle protrude from the bottom of the package. There is a flat spot on the outer circumference of the unit – this flat spot is adjacent to pin 8. The remaining pins are numbered *counter-clockwise* looking at the *top* of the package. The ICs are designed for a 3.6 vdc ± 10% supply (pin 8 positive, pin 4 negative). The manufacturer lists their operating temperature range as 15 to 55 degrees C.

Component boards

Each of the three component boards is made from a 3" x 4" x 3/32" piece of micarta or phenolic. Brass eyelets 0.087" O. D. x 1/8" long are used for tie points.

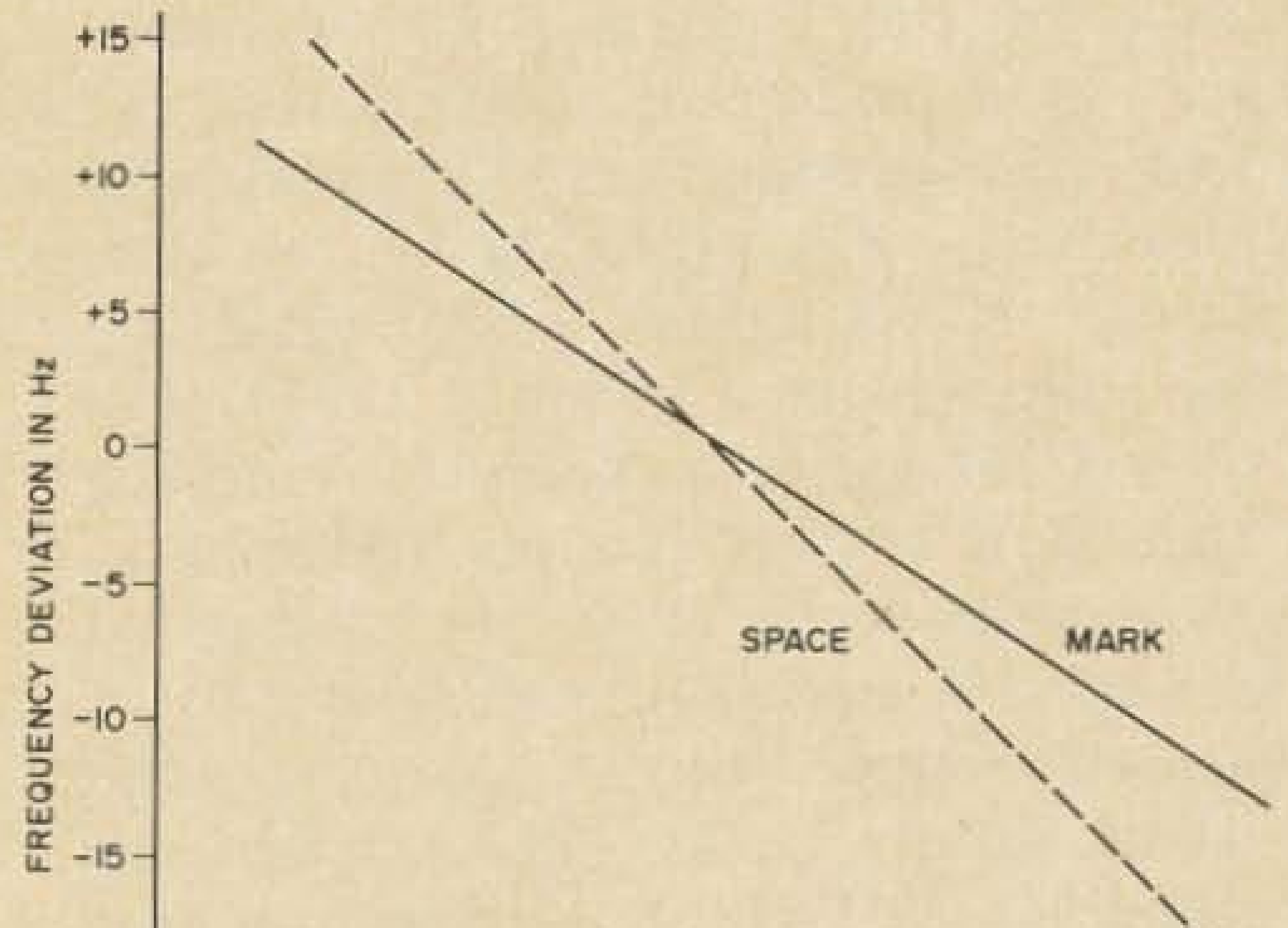


Fig.5. Temperature effects frequency, strangely enough.

The brass eyelets are inserted into all of the No. 43 holes in the component boards from the component side. Make certain the eyelets are pushed all the way into the board, so that the eyelet head is against the surface of the board. Turn the component board over, lay it on a piece of wood and funnel out each of the protruding eyelet 'barrels' with a few gentle taps of a hammer on a 3/8" center punch. I used GC Electronics No. 7251 eyelets and a 3/8" punch identified as 'PROTO 41'.

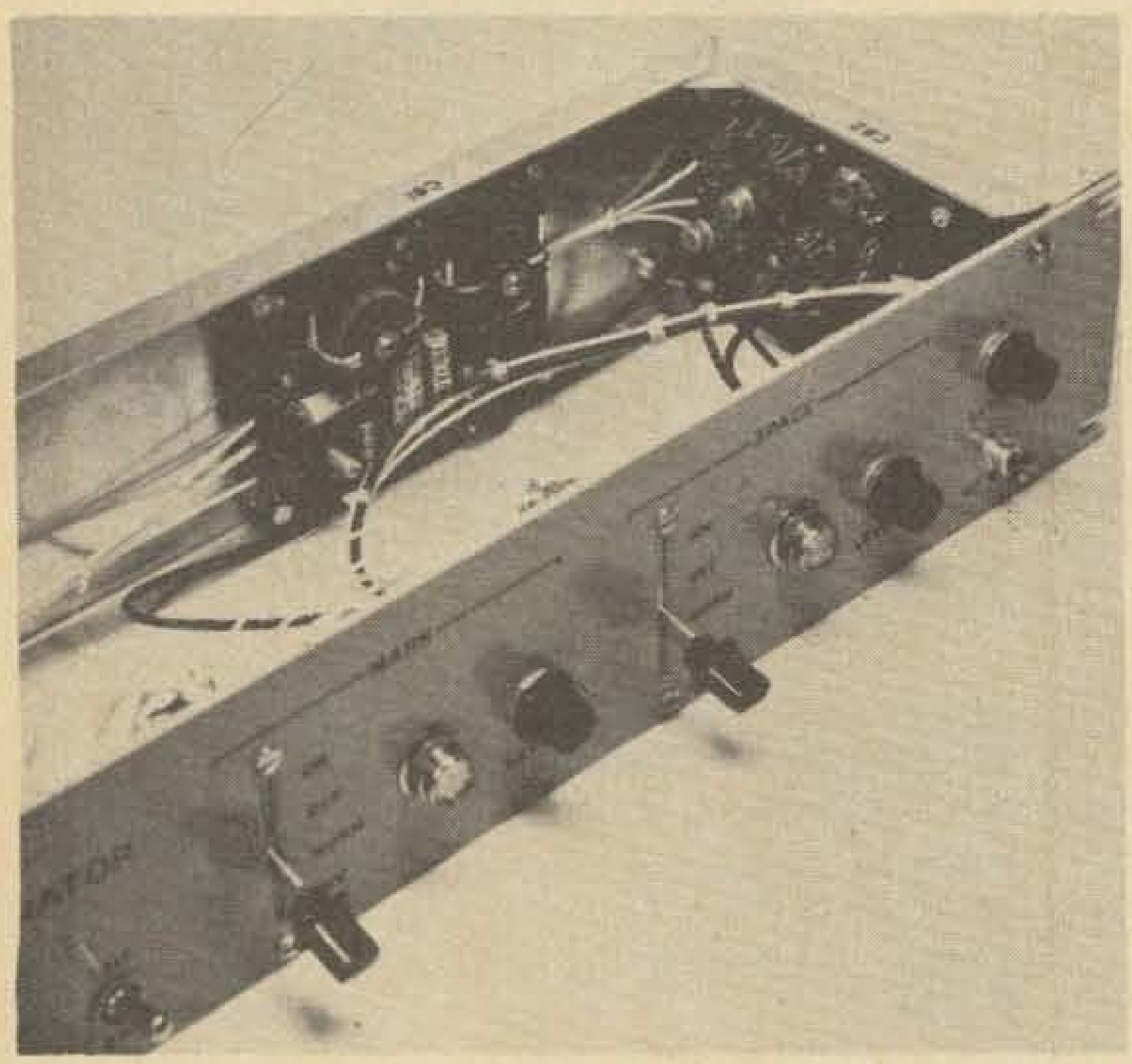
All wiring is done on the back of the component boards in point-to-point fashion with No. 22 AWG tinned bus-bar wire. Insert the wires through the eyelets and bend the ends of each wire over on the component side of the board to hold the wire in place. Clip each wire next to the eyelets on the component side. Insert the components and solder each eyelet from the wiring side. Clipping off the excess component leads completes the component board wiring. The leads of all the semiconductor components should be heat sinked during the soldering operation.

Checkout and Adjustments

After the construction phase is complete, two pairs of electrical adjustments are required to place the unit in service:

a) R11 and R12 must be set so that the gates operate as amplifiers.
b) L1 and L2 must be adjusted (turns removed) to set the exact mark and space operating frequencies.

Connect a 600 ohm (nominal) load and oscilloscope to J3 and set R11 and R12 (on



Component boards 1 and 2 are located as shown. The third board is mounted on the other end of the chassis, opposite CB2.

CB2) to the approximate center of their range. Apply power to the unit and check the minus 3.6 and minus 8.2 voltage levels. Set the mark and space amplitude controls (R9 and R10) to about mid-range and the *af* output level control (R15) fully clockwise.

Place the mark keying selector switch (S4) to "on" and the space keying selector switch (S3) to "off". DS1 should be illuminated and DS2 extinguished. Set the mark amplifier bias by adjusting R11 for maximum amplitude of the mark signal as displayed on the oscilloscope. Maximum amplitude and minimum distortion occur simultaneously.

Place the mark keying selector switch to "off" and the space keying selector switch to "on". DS1 should be extinguished and DS2 illuminated. Adjust R12 for maximum space signal amplitude as observed on the oscilloscope.

Set the internal/external keying switch (S2) to "external". Key the unit at J1 or J4 and check each of the possible keying combinations listed in Fig. 3. The responses of DS1 and DS2 should follow the signal output. Place S2 to "internal" and observe that the internal keying signal keys the unit at about a 22 Hz rate. The synch output signal at J2 should be a 22 Hz square wave at this time. This frequency has no particular significance other than being at about the same rate as the keying frequency of a 60 speed machine. If it is too far off, bring it in by changing the value of R18. Bear in mind that each different set of components will have its own frequency vs. R18 characteristics.

Because of the capacitor and inductor tolerances, it is extremely unlikely that the mark and space frequencies will be correct. The frequencies will probably be too low, but can be set to within a few cycles by removing turns from L1 and L2. Go easy here – it's a lot easier to keep on removing turns than it is to start adding them back. The frequencies may either be compared with an accurate audio (or AFSK) oscillator or measured with a frequency counter. The mark signal should be at 2125 Hz and the space signal at 2975 Hz. Soldering iron heat conducted to C1, C2, C4, or C5 will affect the oscillator frequencies. Frequency measurements should be made only after the capacitor temperatures have stabilized.

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General Purpose Good-Bad Transistor Checker

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A good-bad test on a transistor can be devised on the basis of simple checks which can reveal the existance of a short or open condition between elements.

AM ohm meter reads resistance of a substance by applying a small voltage across the material. If the resistance is slow, the applied voltage can force a relatively high amount of current through the unit. The meter indicates the amount of current on the scale which is calibrated in ohms.

The instrument will bias the transistor in both directions. If forward bias occurs, large current flows indicating the resistance is low. Reverse bias will indicate at least a ratio of 20 to 1, if the transistor is normal. If a transistor does not respond as described, it may be considered defective. However, weak units, or those with leakage between elements, might respond satisfactorily. This test is basic and only intended to indicate whether the transistor is completely inoperative. Better quality checks are possible with a number of commercial testers on the market.

Make sure all checks with the tester described are made with the ohmmeter set to the highest resistance range which gives a convenient reading. Certain types of transistors that are not classed as general purpose may be damaged by the voltage from the ohmmeter.

The purpose of the tester described in this article is to simplify as well as speed the test in a comfortable and stable position. Whether the transistor is PNP or NPN, simply plug in the unit, connect the ohmmeter to the banana jacks input, set the meter to the highest range that will give the convenient reading, set sw2 to the test position (position 1) to - zero the meter. Then make transistor checks for E-B in No-2 position, E-C in 3 position, B-C 4 position and No. 5 for diodes, with the diode in the diode jack, of course.

In the diode position, it is also possible to check condensers for open-short. If it is desired to check components in circuit and if conditions warrant it (one end of component disconnected), simply run a pair of test leads with alligator clips at the diode jacks, leave switch 2 in diode. position and use reversing switch 1 to test forward and reverse currents.

Or if desirable, the No. 6 position can be used to run a pair of test leads directly, or perhaps another set of jacks to hook up the test leads.

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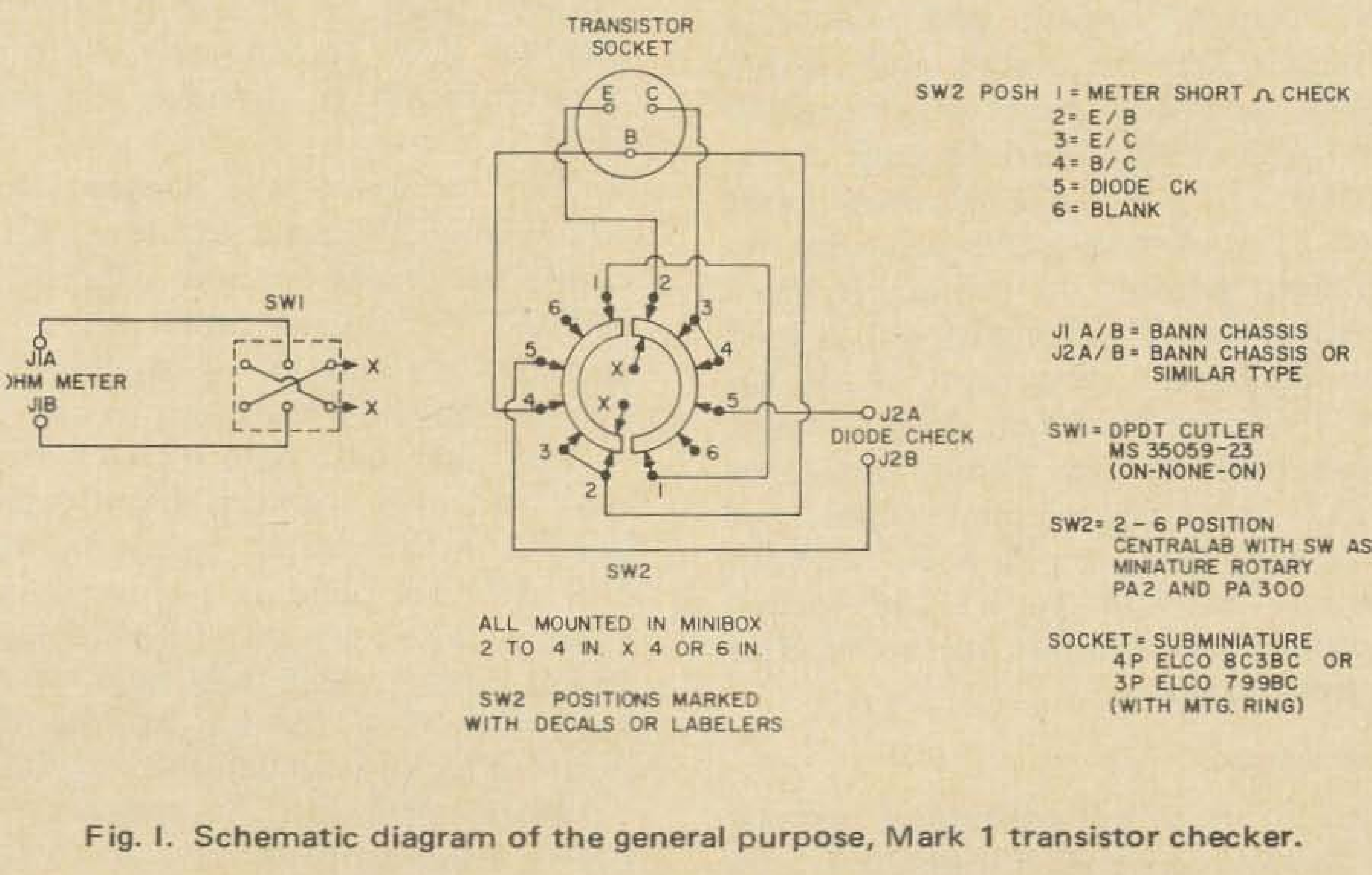

Fig. 1. Schematic diagram of the general purpose, Mark 1 transistor checker.

A Compact Two-Meter Transmitter

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Why must home-brew 2 meter gear always look like a breadboard project? Is it really necessary to rearrange your entire station and break out a vtvm and vswr bridge in order to get it on the air? The answer, of course, is that VHF gear can often be built just as compact and with all the control circuits of HF rigs – without the final serving double duty as a multiplier.

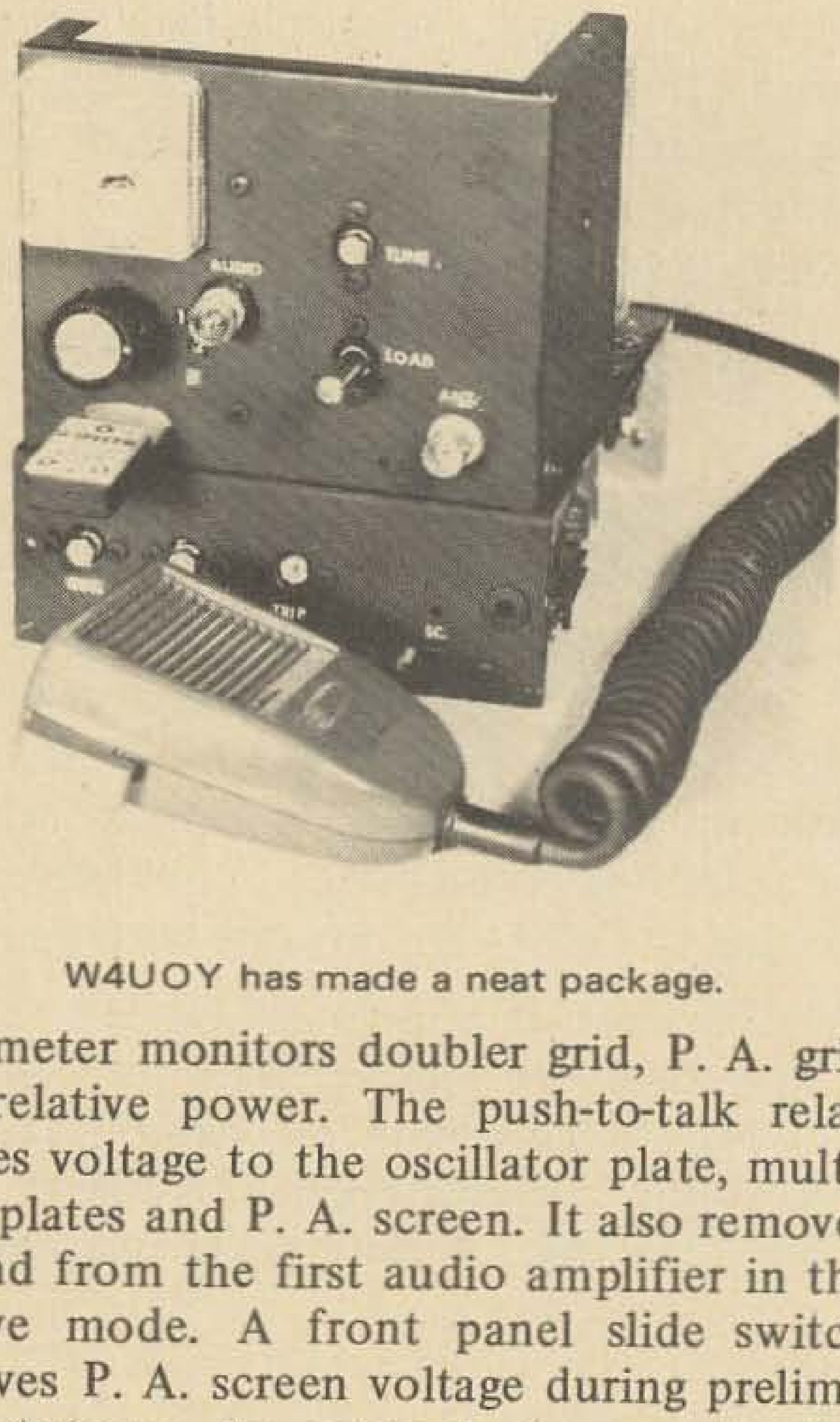
You may make a few isolated QSO's with your nano-watt, super flea powered special, but don't try to sign into a net with it – not even a local net like our MARS club here in Northwest Florida. You'll end up answering the roll, then sitting back and reading the mail until sign-off time. This doesn't mean you have to melt down all the TV antennas in your neighborhood. It does mean you need a respectable 7 to 10 watts with good modulation, and a way to check both without someone warning you that you're splattering all over the band.

Having gone this far, why build it on an open chassis? Why not a small, compact, attractive transmitter with a front panel, push-to-talk control circuits and selectable metering which may be tuned and loaded without once having to tip it up on end to get a vtvm probe on that doubler grid?

This small (5" x 6" x6") rig was built mostly out of junk-box parts and has received excellent reports on the air. It has a measured output of 7 watts with about 85% modulation, and most important of all, has caused my TVI complaints to drop to zero. In net operation, it has about the same power level as most of the small commercial models, enabling you to sign in without apologizing. It may be tuned and loaded from the front panel and put on the air after a few minutes' warm-up.

Circuit Description

The transmitter is self-contained, except for power supply. A small illuminated type



W4UOY has made a neat package.

"S" meter monitors doubler grid, P. A. grid and relative power. The push-to-talk relay applies voltage to the oscillator plate, multiplier plates and P. A. screen. It also removes ground from the first audio amplifier in the receive mode. A front panel slide switch removes P. A. screen voltage during preliminary tune-up to prevent damage to the 2E26.

The oscillator is a conventional Colpitts which may be either excited with an 8 mhz crystal or driven with an external VFO. The oscillator plate is tuned to 24 mhz and contains a fixed 10 pf capacitor to prevent peaking on the wrong harmonic.

The first half of a 12AV7 triples to 72 mhz and also contains fixed capacitance to keep it in the proper harmonic range. If the coil data supplied is followed closely, the tuning will be straight-forward and all of the tuned circuits will only peak on the proper harmonic. The second half of the 12AV7 doubles to 144 mhz and drives the 2E26.

When properly neutralized, the 2E26 offers a low impedance load to the 12AV7.

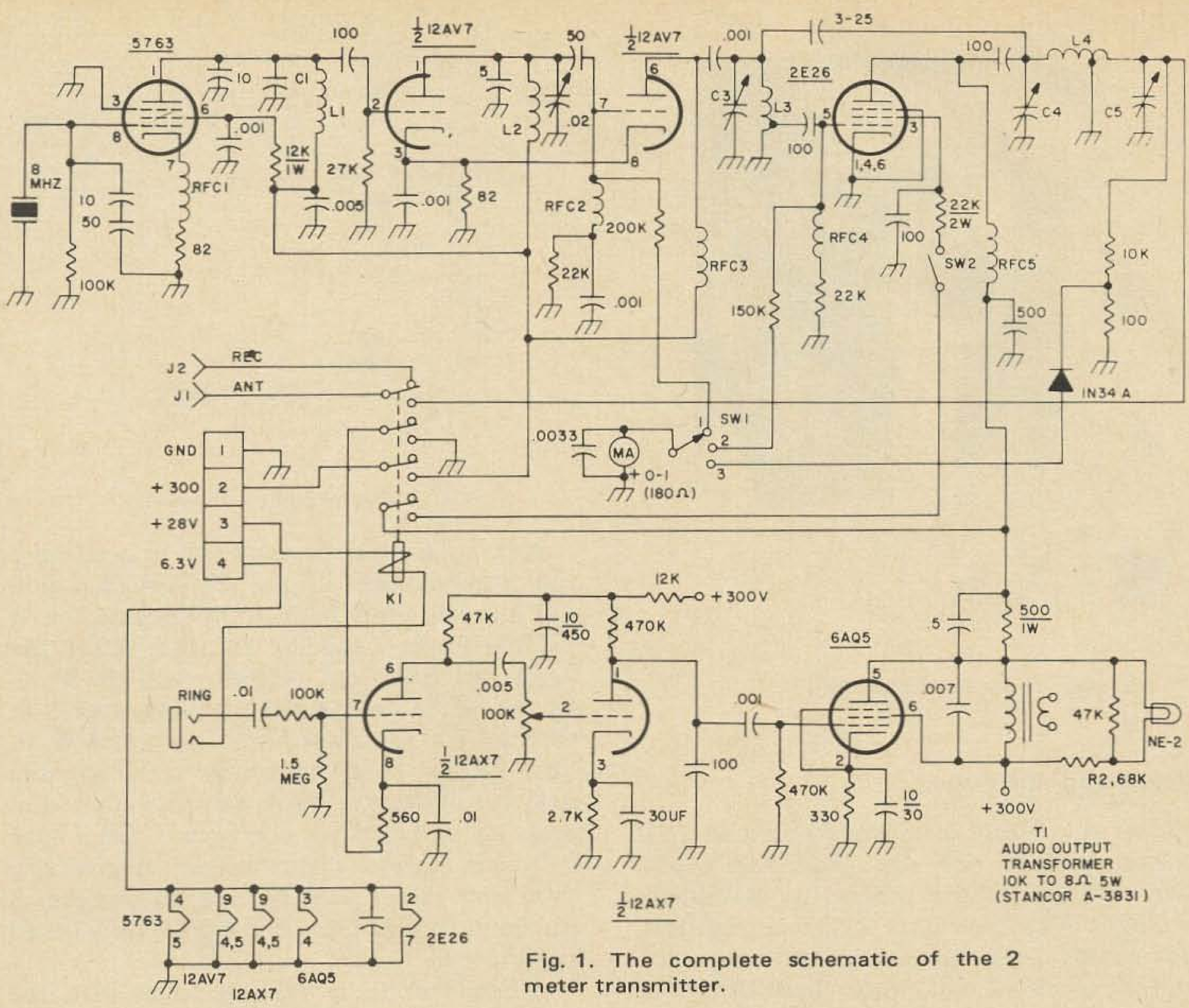


Fig. 1. The complete schematic of the 2 meter transmitter.

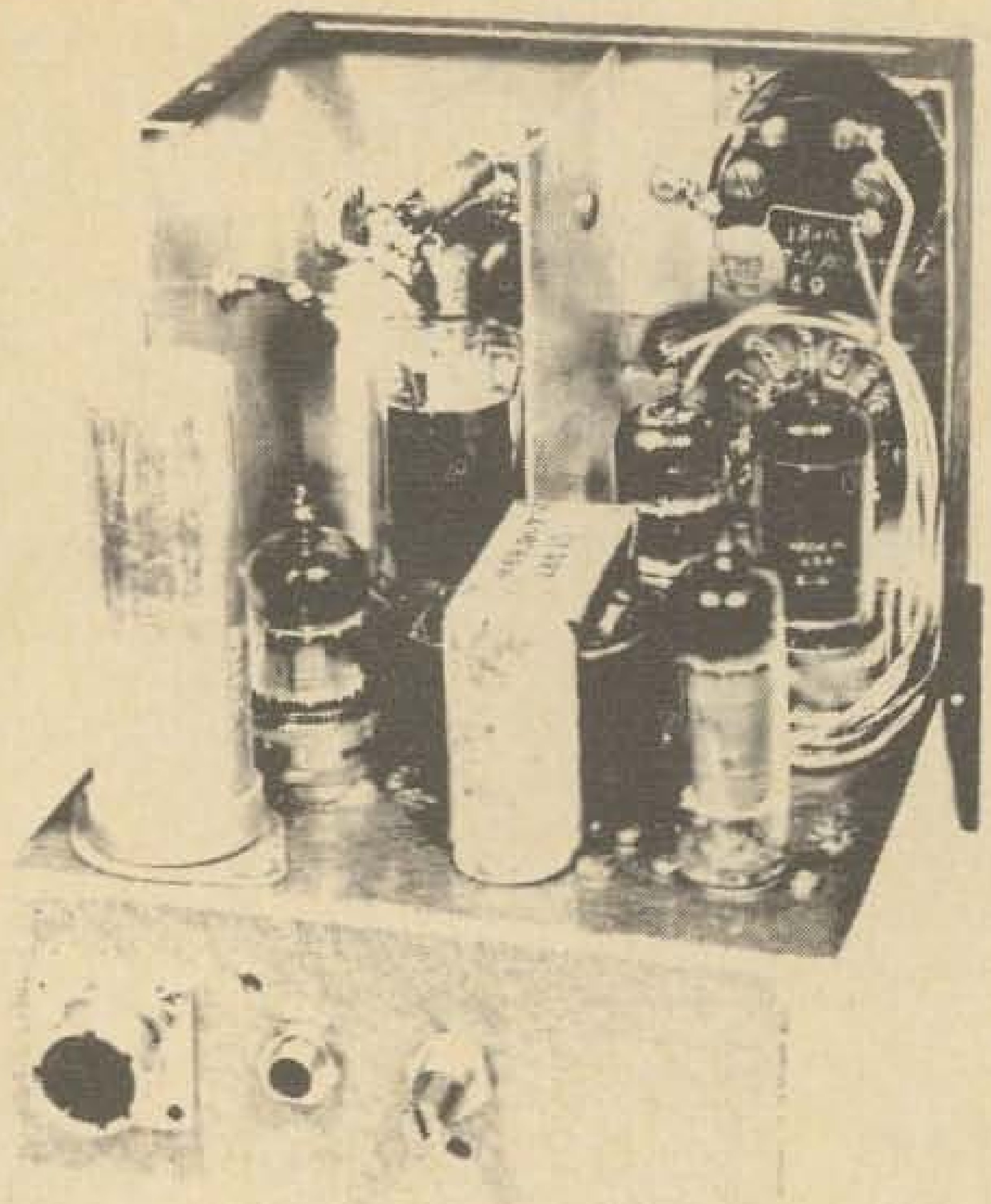
The driving voltage is tapped down on the driver tank coil to provide a proper match. It was found, experimentally, that a point ¾ turn from the ground end of L3 provided the proper amount of drive.

The audio section uses a 12A X 7A and offers a good match to most of the hand-held crystal or ceramic microphones. I used choke modulation because I later plan to build a small companion receiver. By using an audio output transformer for the modulation choke, the audio section of the transmitter will also serve as the audio amplifier and output section of the receiver. For the present, the 8 ohm winding of the transformer is left open. At 85% modulation the voltage drop across R1 just exceeds the firing point of an NE-2, so the bulb was panel mounted for a visual check of modulation. During operation the microphone gain is advanced until the NE-2 just flickers on voice peaks for a safe modulation level.

Construction

The main chassis is a 6" x 5" x 2" U shaped piece of aluminum. The front panel is the cover from a 5" x 4" Mini-box cut to shape. A 3" x 4" aluminum shield is mounted between the 12AV7 and the 2E26. The top, back and sides were covered with perforated cane-metal aluminum (not shown).

Under the chassis, the three coils are mounted at right angles to each other and the three tuning capacitors are mounted in line across the front edge. The microphone jack, microphone gain pot, and power plug are mounted on the rear. The receiver antenna connection is also rear mounted. The push-to-talk relay was scrounged from an old surplus computer chassis, along with the small 24 volt transformer to power it. Any 4-pole double-throw relay would have served just as well and could be powered from a divider across B+. (This, however, would result in B+ appearing on the microphone switch when the transmitter is unkeyed.) A rigidly mounted, preferably silver-plated coil should be used for the output tank coil – the other coils were wound from No. 16 AWG nyclad copper wire.



Top view of the 2 meter transmitter.

Tune-up and operation

After the wiring has been completed and checked, plug in only the 2E26 and apply power. The first step will be to neutralize the 2E26. With the meter switch in position 2 (P. A. grid), set the doubler tuning capacitor (c3) to about half range. Turn the P. A. screen switch on. With the microphone in one hand and the other hand on the P. A. tuning capacitor, key the microphone and quickly rotate the P. A. plate tuning capacitor through its entire tuning range. Do not keep the mike keyed for longer than 2 or 3 seconds or the 2E26 may be damaged. If there is a flicker of grid current while swinging the capacitor (it is almost certain there will be on the first try), change the setting of the neutralizing capacitor slightly and try again. When properly neutralized, the 2E26 will show no grid current at any setting of C3 or C4.

After the 2E26 has been neutralized, remove power, turn the P. A. screen switch off and plug in the other tubes. With the meter switch in position 1 (doubler grid) peak C1 and C2. The meter in this position has a full scale deflection of approximately 200 volts, so you should get at least half scale deflection. C1 and C2 should also be peaked as quickly as possible, since both halves of the 12AV7 depend largely on grid leak bias for protection. Both plates will show color rapidly with the transmitter keyed and the two capacitors not peaked.

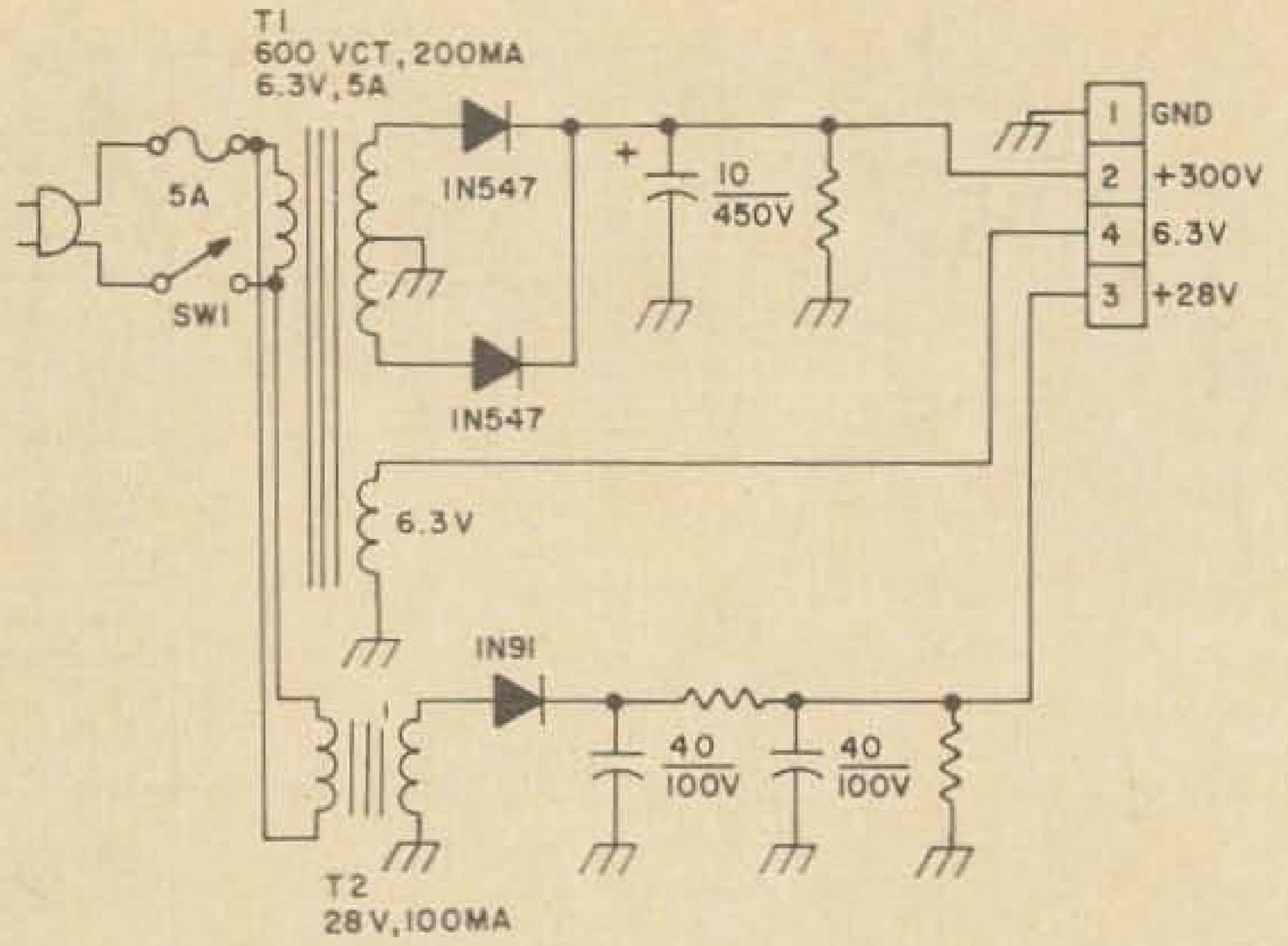
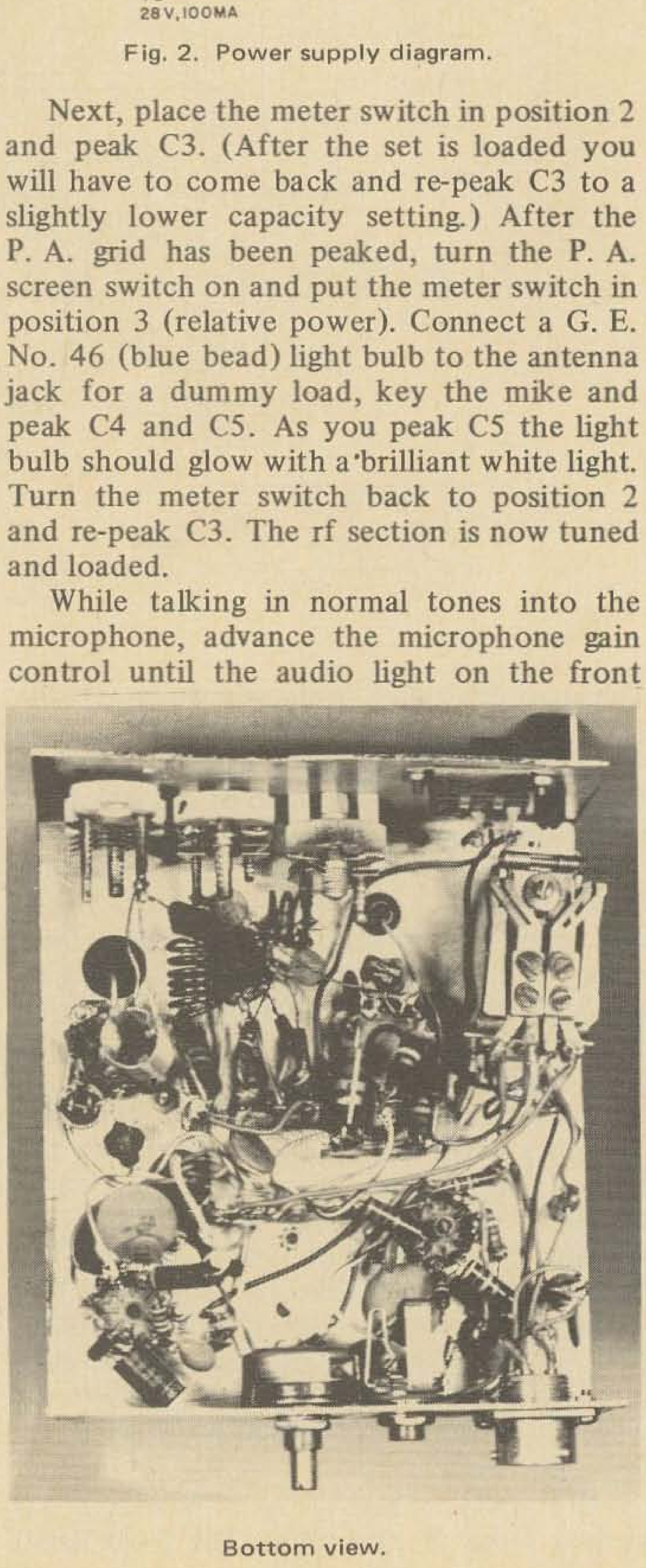


Fig. 2. Power supply diagram.

Next, place the meter switch in position 2 and peak C3. (After the set is loaded you will have to come back and re-peak C3 to a slightly lower capacity setting.) After the P. A. grid has been peaked, turn the P. A. screen switch on and put the meter switch in position 3 (relative power). Connect a G. E. No. 46 (blue bead) light bulb to the antenna jack for a dummy load, key the mike and peak C4 and C5. As you peak C5 the light bulb should glow with a brilliant white light. Turn the meter switch back to position 2 and re-peak C3. The rf section is now tuned and loaded.

While talking in normal tones into the microphone, advance the microphone gain control until the audio light on the front



Bottom view.

panel just flickers on voice peaks. The dummy bulb should show an appreciable increase in brilliance when you talk into the microphone. To load into an antenna, simply peak C4 and C5 with the meter switch in position 3.

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Parts data

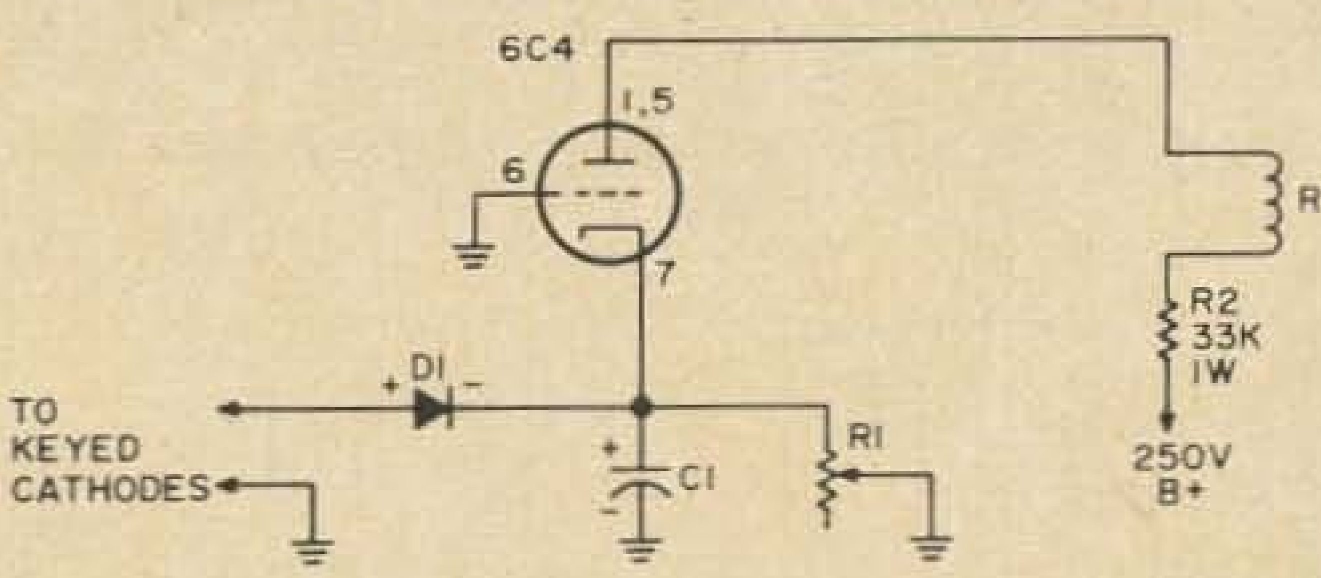
Rfcl – 1 mH
Rfc2 – Ohmite 2-50.
Rfc3 – Ohmite 2-144.
Rfc4 – Ohmite 2-144.
Rfc5 – 22 turns No. 24 CW on ¼" d.
L1 – 11½ turns No. 16, ½" d. (B&W)
L2 – 5 turns No. 16, ½" d. 7/8" long.
L3 – 3 turns No. 16, ½" d. ½" l. tapped ¾" from ground end.
L4 – 4 turns No. 16, tapped 1 turn from ant. end.
C1 – APC50 with all but 8 plates removed.
C3,4 – APC25 with all but 4 plates removed.
C5 – APC50.

A Simple CW VOX for Cathode Keyed Transmitters

After sending in my application for Navy MARS, I was left with a juicy problem. Since I didn't have any SSB gear, I was stuck on CW. That meant I had to modify a little CW rig for full break-in traffic handling.

After trying everything in the book, along with some things which aren't in the book, I came up with the following circuit.

This little job can transfer your antenna either at fast keying speeds for traffic handling, or you can set the delay for those long rag-chews with the Novice down the block. D1 isolates the VOX from the transmitter keying circuit. R1 determines delay time.



There is a setting of R1 which keeps the relay closed. If you don't like to fool with critical settings of R1, add a resistor to ground.

Because of differences in key voltage and relay characteristics, you may have to change the value of C1 to get the delay which suits you best. And, you won't even have to send BK. . .That first dot is always on time!

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Measuring f_t of Surplus Transistors

The usual procedure for determining the *rf* capabilities of unmarked transistors involves plugging the units into a standard oscillator circuit and then playing with circuit values until oscillations start or the experimenter's patience gives out. Fortunately, there are simpler and more accurate methods of judging a transistor's capabilities. This article will be concerned with the measurement of a transistor's current gain – bandwidth product, usually referred to as its ft. This is the frequency at which the common emitter current gain has decreased to a value of unity. This is also one of the most useful parameters to know since a transistor can be operated as an amplifier or oscillator up to and even beyond its ft. A simple and practical test circuit will be presented and the theory behind its operation will be discussed.

The most common method of determining the ft involves measuring the high frequency current gain, hfe, at a point which lies above the beta cut off frequency, fB. Beta, or B, usually refers to the low frequency current gain. A simple graph will help illustrate the meanings of the above parameters. **Fig. 1** shows what the plot of a uhf transistor's current gain versus frequency might look like. The definition of fB is the frequency at which the common emitter current gain is down 3 db from its low frequency value (see point A). In this example it equals 10 mhz. At twice fB and higher, the current gain falls off at a rate of 6 db per octave or 20 db per decade of frequency. Finally, at a frequency ft, the current gain has reached a value of unity or 0 db (see point C). In this example ft equals 1000 mhz. This -6 db per octave slope has the property that the product of the current gain and the frequency at any point on the slope equals ft. For instance, at a frequency of 100 mhz, hfe equals 10 and the product of the two equals 1000 mhz (see point B). This is the measurement we shall have to perform on our unmarked transistor to get a firm idea of its high frequency potentials.

Before proceeding into a description of the test circuit, we must define hfe: it is the small signal (linear) current transfer ratio from base to collecter with the collecter and emitter short-circuited and the base open-circuited (for ac current only). This condition can be represented by the circuit shown in **Fig. 2** where biasing circuitry is omitted. The output current is measured by the ammeter Ic, which also presents a short circuit load to the collecter. The open circuit at the base can be represented by a current source Is at a frequency fs, which, theoretically, has infinite output impedance. The

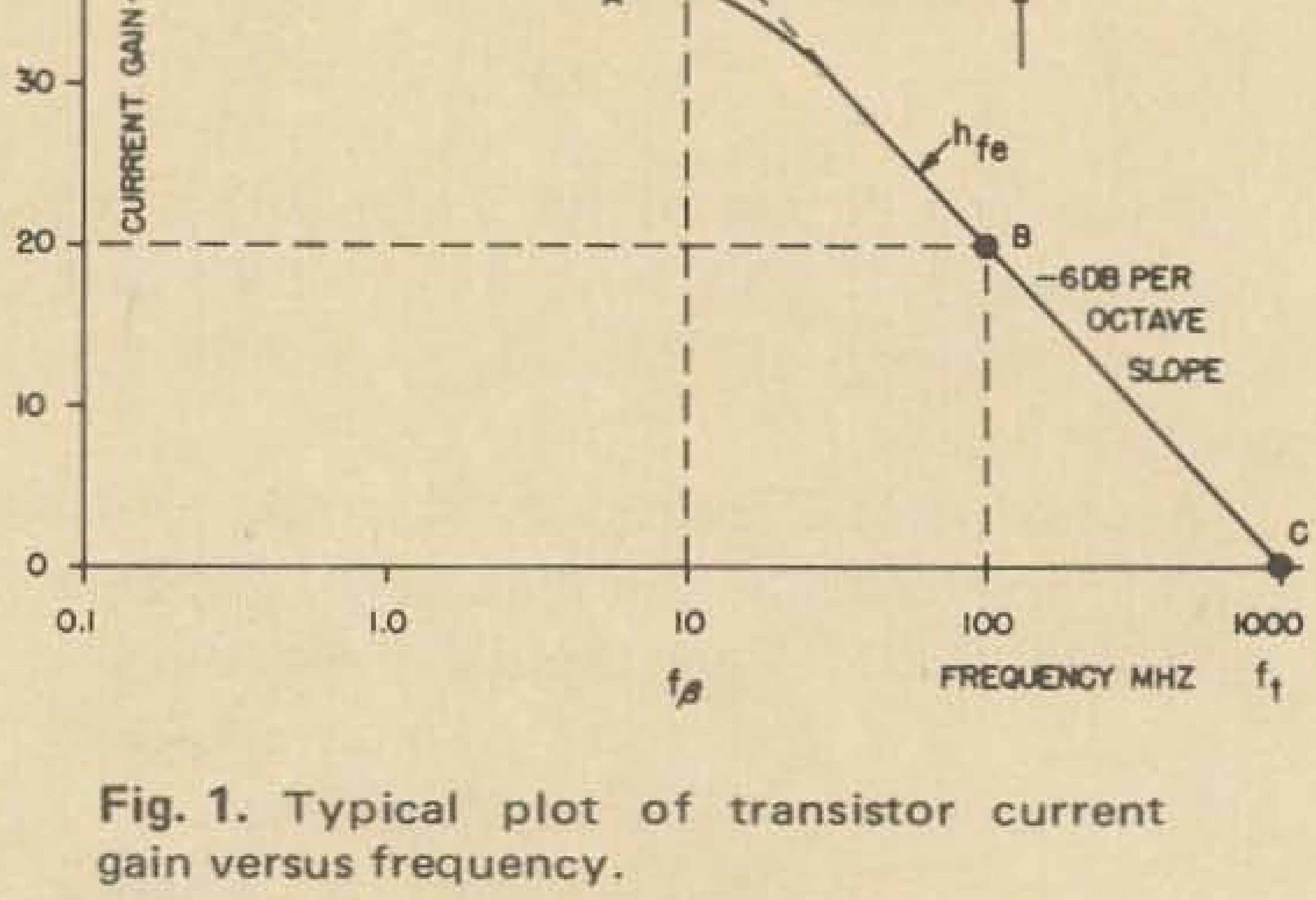

Fig. 1. Typical plot of transistor current gain versus frequency.

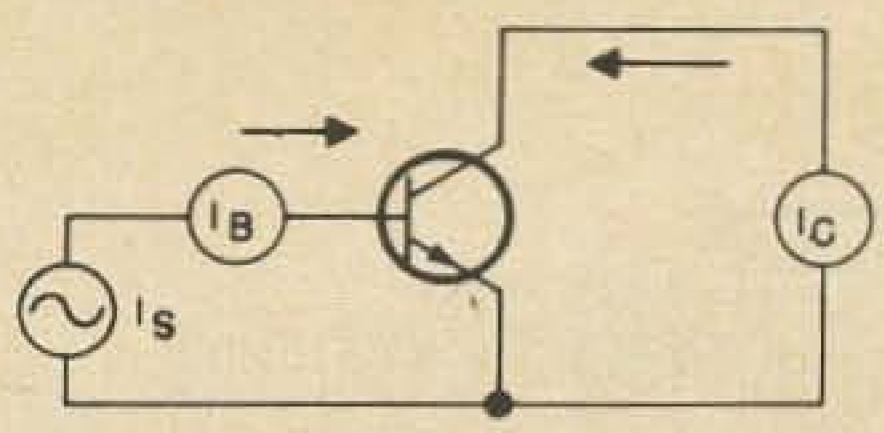

Fig. 2. Idealized test circuit for measuring hfe of a common emitter stage.

base current is monitored by another ammeter labeled Ib. Since the emitter is already at ground potential the circuit satisfies all the requirements imposed on the measurement. It is not, however, very practical since it requires milli- and microammeters capable of measuring currents at a few tens of megahertz.

A practical approximation to the above is the circuit shown in **Fig. 3.** I have designed this particular circuit to sort my personal stock of unmarked goodies into useful regions of frequency. The 10k resistor in the base acts as part of the bias network and also transforms the input voltage vi into a current to drive the base of the transistor-undertest. This resistor makes a fairly decent current source if the transistor input resistance is under 1k ohm. This is a reasonable condition at the dc emitter current level and the frequencies of interest here. The 51 ohm resistor provides a termination for the signal generator used as a source. In the collecter circuit the 68 microhenry choke acts to pass dc current and block ac current. The ac collecter current is almost completely absorbed by the 51 ohm resistor used to approximate the short circuit load. The load resistor converts this output current into a small voltage which can be measured with an *rf* millivoltmeter.

Thus the measurement boils down to measuring vo and vi and then plugging the values into the following equation:

$$\text{equation: } hfe = 200 \times \frac{v_o}{v_i}$$

The factor 200 represents the conversion factor between the voltage gain and the current gain of the circuit. This constant is equal to Rs/RL and was made to be convenient while satisfying the other requirements. ft is found by multiplying hfe times the frequency of measurement. It can be seen that the voltage gain will be much less than one hence the need for a millivoltmeter.

There are a few precautions which must be observed in order to use the circuit successfully. The input voltage should be adjusted such that the output is in the range of 10 to 50 millivolts rms, preferably closer to 10 millivolts. This will insure that the transistor is operating under small signal, or linear, conditions. The frequencies used should be limited to the range of about 5 to 30 mhz. The hfe should be measured at a couple of frequencies and the results examined to insure that the final measurement is being performed on the −6 db per octave slope. The voltmeter ground clip should be attached close to the point of measurement. The supply voltage should be positive for npn and negative for pnp transistors. Either silicon or germanium types can be tested in the circuit.

With a 12-volt supply the collecter current will be about 4.5 ma and the collecter to emitter voltage will be about 9 volts. The collector current can be changed at will by decreasing the value of the 680 ohm emitter resistor for a larger current and increasing it for a smaller current. You may want to characterize a transistor at a number of emitter currents since this has a direct effect on the ft. Starting at low currents, ft increases with increasing emitter current. A region will be reached (usually a fairly high current) where the ft will begin to decrease. The operating point in this circuit was chosen such that it will fill most requirements.

The circuit layout should be as tight as possible. Special care should be taken to keep the leads in the bypass and coupling capacitors as close to zero length as possible. A transistor socket should be used for convenience in testing large numbers of transistors. A copper clad board would be ideal as the bypass caps can be soldered directly to the ground plane. Standoff ter-

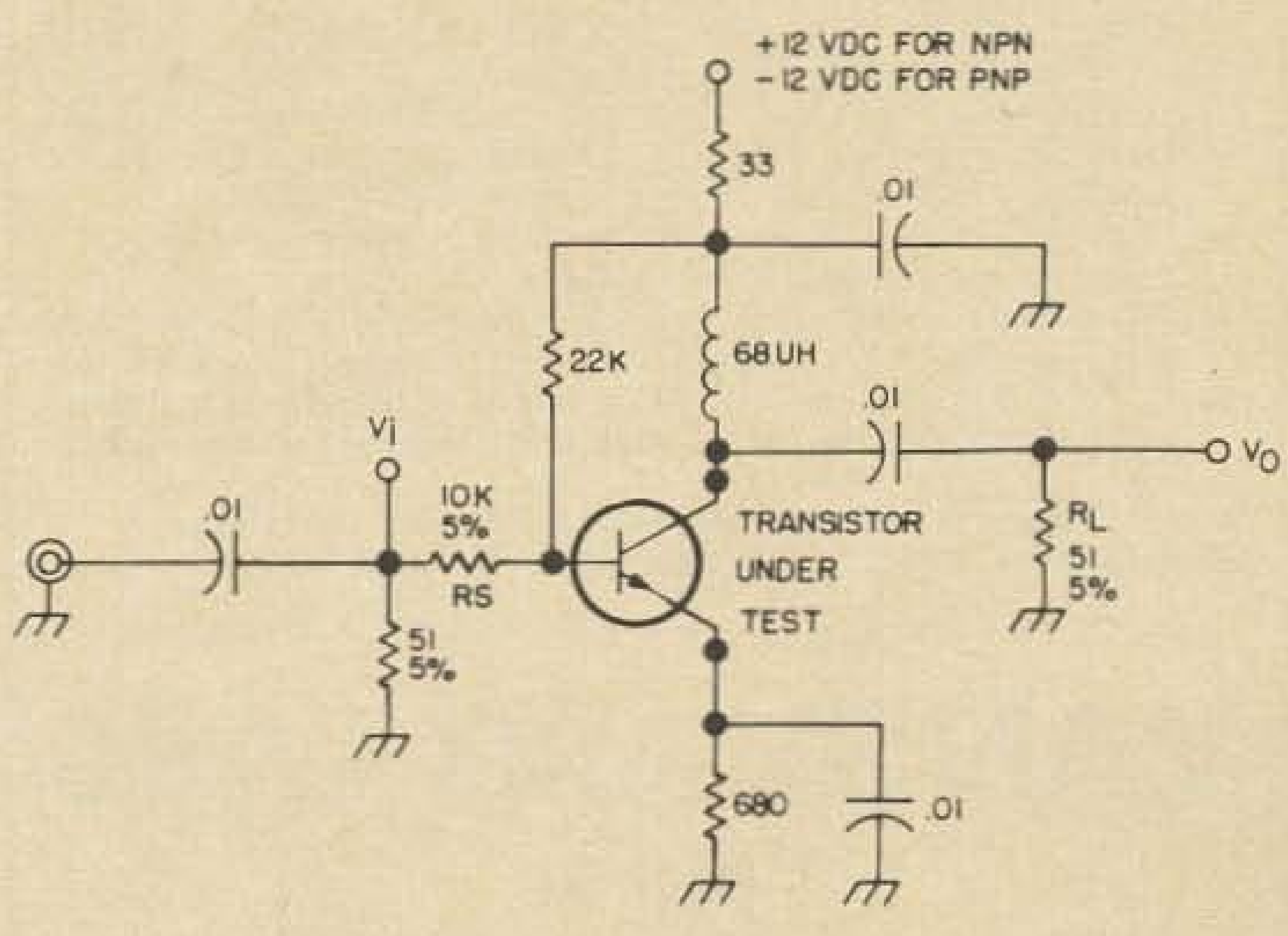

Fig. 3. A practical test circuit for measuring hfe.

minals can be used at the measurement points for easy access with the voltmeter.

Most experimenters own or have access to signal generators for use as a source of *rf*. An *rf* millivoltmeter can be scrounged somewhere with enough searching, or a simple one can be built if you can find a signal generator with an accurate attenuator to calibrate it with. My own voltmeter is homebrew using a couple of crystal diodes and a dc amplifier using FETs and transistors. Lowest range is 10 millivolts full scale. I find an instrument of this sort indispensable when working with solid state *rf* circuits.

No article about test equipment or setups is complete without some comments on accuracy of measurements. Some tests were conducted with transistors having known ft's. The results indicate that the readings will be about 5 to 25 percent low. This error can be attributed to the imperfect current source and short circuit load used. To make the readings more accurate would require either more sensitive meters or a more complex circuit requiring adjustments for each measurement. This set-up fills the bill for making quick tests on a bunch of bargain basement transistors. For instance, one of the IBM boards in my junk box yielded a dozen germanium transistors with ft's in the range of 300 to 400 mhz. In my opinion this piece of information was well worth the time it took to build this test circuit.

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Jim Ashe, W1EZT

Skylines for 160, Made Simpler

About a year ago the value of 160 meters as a ham band was much less than now. The regulations were too confining. New regulations, although complex, offer much more opportunity for local ragchewing, and some adventurous amateurs may be working transoceanic DX even as you sit reading this.

Your on-the-air competition on 160 will be far less than on 80, the propagation much steadier than on 20. Effective ranges are typically several tens or a few hundreds of miles. And at 160's low frequencies you can get by with inexpensive surplus transistors to try out those transmitter ideas. 160 is worth some of your time and money now.

There's a bit of history on 160, too. It is on the dividing line between two very different kinds of radio. Now it's at the bottom of the amateur spectrum, but there is a time in some men's memories when it was at the top. Communications engineers once believed you used long waves for long range communications, since nobody understood how short waves could get over the horizon.

The general thinking then was that the high frequencies had a low practical utility, and the amateurs wound up with a huge chunk of radio spectrum nobody else wanted. Many interesting records date from that time for the hams soon discovered the real potentialities of short-wave propagation.

Now we understand the differences between ground-wave and sky-wave propagation. We know why the ionosphere is responsible for sky-wave propagation, since its effects cannot be ignored by anybody and are very important for the DX that interests many amateurs. And we have a band where the special advantages of ground-wave propagation can be applied and enjoyed.

Ground-wave is made to order for local rag-chewing. Saving the higher-frequency bands for DX, we can easily build simple antennas optimized for 160 meter vertically polarized radiation. In a way this is making a virtue of necessity, but we can come back to that point later. First we should discuss the FCC's complex frequency and power assignments, and review some facts about 160 meter propagation.

Eight Pieces of Pie

When you tune your receiver across 1.8 to 2.0 MHz you will hear a variety of sharp regular beats, quite evidently for some purpose other than communication. These sounds first appeared on 160 during WW2, when a tremendous need was developing for some fast, reliable, and accurate method of navigation. Ship and airplane navigators observe the beats in pairs on an oscilloscope-like indicator. Then, using the resulting time measurements and special navigation tables, they quickly locate their vessels with an accuracy of a thousand feet or so. This service was very useful during the war, and has had a great commercial value since.

The system is called "loran," coined from "long-range navigation." Various engineering necessities plonked this service into the amateur 160 meter band, where it has stayed to the annoyance of many hams. With the loran usage receiving first priority and the hams reduced to low powers in the face of kilowatt pulse interference, 160 meters has become a less-than-popular band for amateur communications.

But navigation technology has been developing, and with the advent of new navigational space satellites, UHF beacon systems, inertial navigation, and computerization (which saves time and improves accuracy) the loran services have lost importance over the past ten or twenty years. Recently the FCC has raised and reallocated its 160 meter power limits. This easing together with the development of amateur technology has made the band interesting again.

Yet the 160 meter band is still a shared service, and the FCC has written a remarkably complex set of rules for the amateurs. The new regulations appear to occupy more space and text than all the other regulations for all the other amateur bands. If you intend to operate legally you have to 1) determine in which of 26 American or several zones you will operate; 2) discover which of the eight 25 kHz frequency segments are available to you in those zones; 3) make a list of the daytime power limits applicable, and 4) add a list of the much lower night-time power limits. Finally, look out for rules changes. Considering the complexity of the allocations, changes seem quite likely.

At this writing, the regulations break the continental U.S. into 26 areas. All dividing lines are among state lines. Some areas, such as California, Texas, or Florida, consist of only one state. And at the opposite extreme, the Northeast U.S. includes the entire W1 and W2 zones as a single allocation area. **Fig. 1** is a representative table of the allocations for New York State and some adjacent areas.

NEW YORK STATE

Segment	Day/Night Power
1800-1825 kHz	500/100 W.
1825-1850 kHz	100/25 W.
1850-1875 kHz	0
1875-1900 kHz	0
1900-1925 kHz	0
1925-1950 kHz	0
1950-1975 kHz	0
1975-2000 kHz	0

Fig. 1. Sample allocations for one state. Which limit applies at 1825 kHz?

In each of the allocation areas the 160 meter band is broken into eight 25 kHz segments with typically different power limitations for each segment. There is no clear pattern, except that the highest power limits *tend* to appear at the edges of the band, and there are very many parts of the U.S. in which the central two to four 25 kHz portions cannot be used at all.

The present power limits range from zero at any time right up to 1000 watts, with 200 and 500 watt limits being quite common. Power is measured in the standard manner. The power limits are reduced by a factor that is typically 4 and occasionally five when the sun goes down, and there are no night-time limits anywhere over 200 watts. This complicated power limit system is going to lead to considerable band-edge or cross-segment operation, and more than any other band 160 will be an easy one to earn a pink ticket for incorrect operation.

Fortunately all of the segment borders are at multiples of 25 kHz, so that you can use a frequency standard consisting of a 100 kHz oscillator followed by a pair of binaries to provide good 25 kHz markers. Since the recent incentive licensing regulations changes for the higher bands also place band segment borders on 25 kHz multiples, appropriate frequency standards are appearing on the market and should also be available as construction articles. Alternatively (since the segments are quite narrow) crystal controlled operation deserves consideration.

160 Meter Propagation

If you know something about radio wave propagation on the higher bands you will not need any new concepts for 160. The principles are about the same as on 80 or 40 but the emphasis has gone from sky waves to ground waves. When operating on 160 meters, especially at night, the skip distance is about zero so that sky and ground waves compete at all distances. 160 can offer severe fading problems.

This fading is minimized by antennas that minimize upward radiation. A 5/8 wave vertical would be a pretty good radiator for 160, and a set of three cophased half-waves stacked vertically would be even better. But all that is out of the question for any builder who is not financed by the Government or a large industry. Work out the dimensions and you'll see why. If you're typically limited in money and resources you must get by with some pieces of wire attached to available structures and trees. Or maybe you can do something with a few lengths of TV tower.

Ground-wave propagation is the apparent passage of the radiated *rf* along the ground. See **Fig. 2**. The wave fronts are the usual one-wavelength apart, and extend far up into the sky. They tilt forward because ground resistance is dissipating part of the wave energy. The tilt is an indication of the rate at which the wave is passing into the ground (where it is permanently lost) and depends

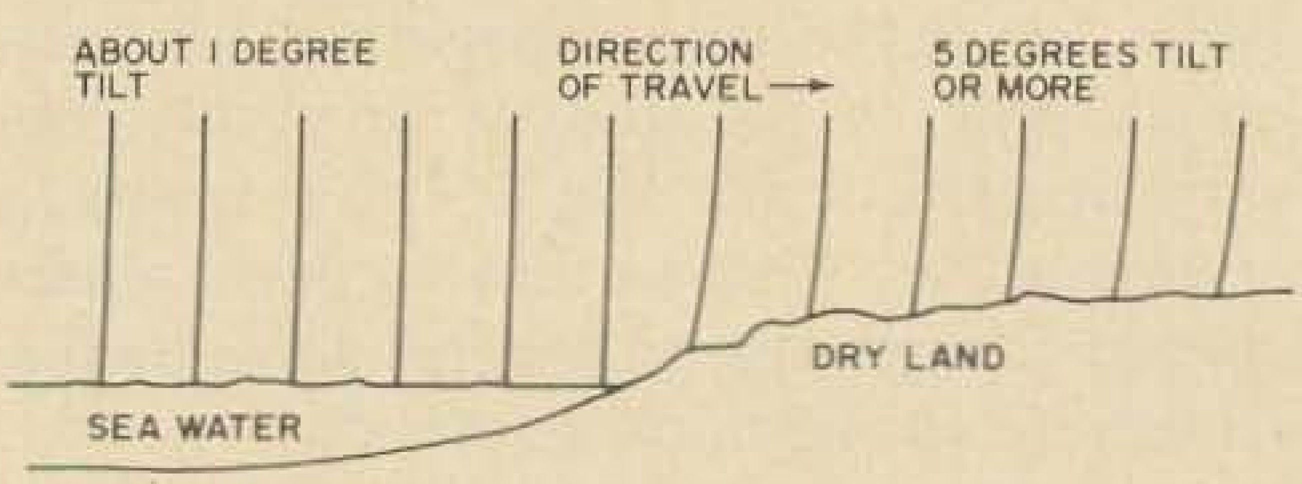

Fig. 2. Since the wave front proceeds at right angles to its surface, the tilt is an indication of the rate at which it is running into the ground. This tilt is applied by the Beverage antenna.

upon the electrical conductivity of the ground. The greatest tilt is seen over the poorest surface, which gives you the least range.

On 160 you can fairly well expect to get out to one hundred miles by ground wave, and you may do very much better than that. It depends upon the quality of the earth in your region, and upon how much competition your signal gets from electrical interference and Loran signals at the point of reception. The Loran signals can be filtered or clipped, and so electrical noise is probably the controlling factor. The situation may be surprisingly good at your site, or worse than you believe. This will have to be learned by test, but you can get some ideas from Fig. 3.

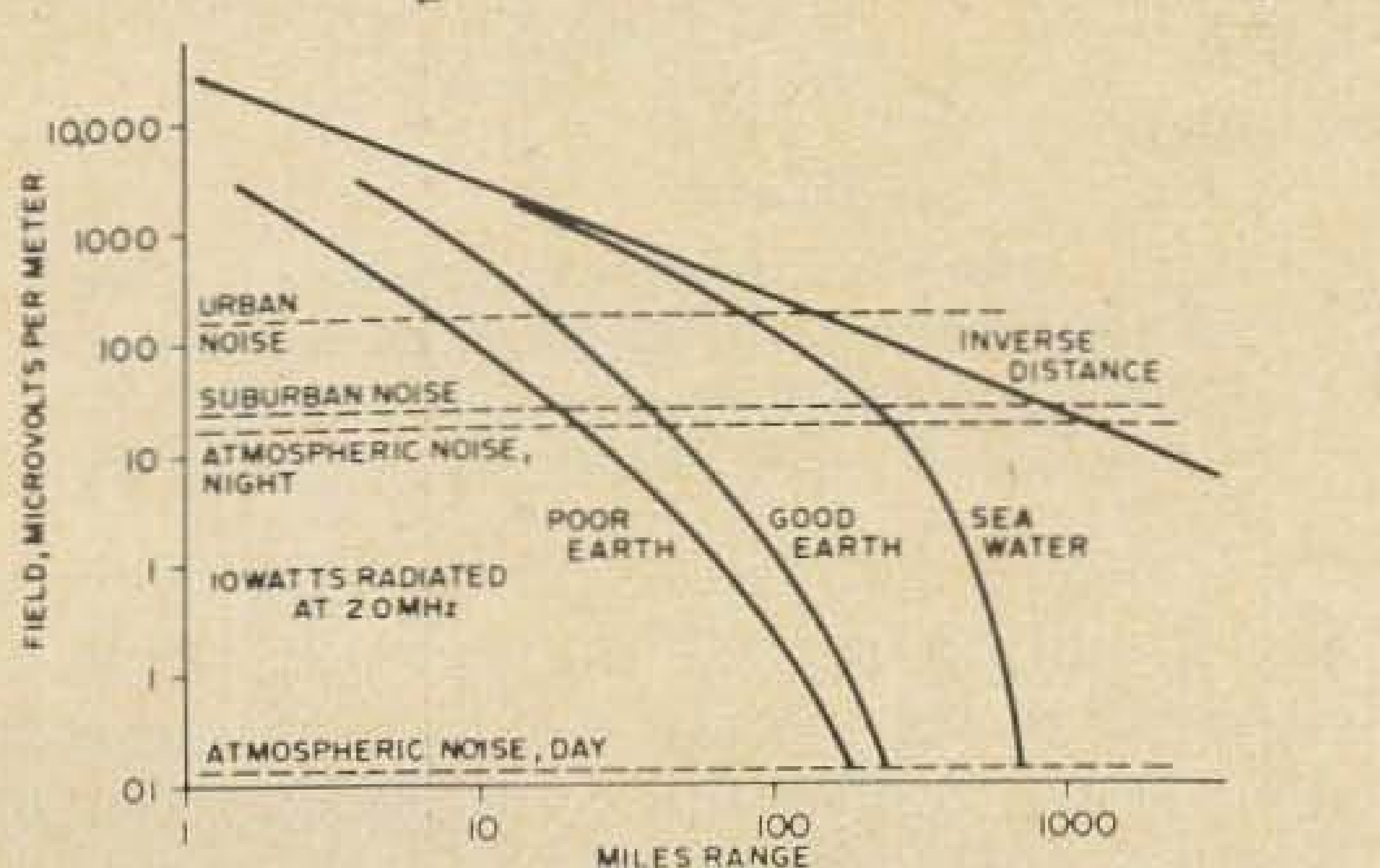

Fig. 3. Local noise, rather than receiver sensitivity, will often limit your effective range. You will not need high powers for reliable contacts if you are in a quiet area.

This chart refers to ground-wave signal strength only. We could draw a few tentative conclusions about the fading zone from this, if we knew the radiation pattern of your antenna, but that is not the purpose. Here we are seeing what 10 watts radiated power is likely to achieve against some typical noise competition. Since you will typically be radiating considerably more power than 10 watts these are probably minimum results. To adjust this chart to higher powers, correct the field strength by the square root of the change. That is, if you were radiating 1000 watts, the received signal at any given distance would be greater by a factor of ten.

Unless you are interested in 160 meter DX you will find sky-wave propagation appears largely as a source of trouble. It is not true that if a receiving antenna picks up the same transmitted signal from two directions the receiver gets twice the input signal. The receiver may not get any signal at all, if the two incoming signals are of equal amplitude but opposite phase. In that case they cancel. When incoming signals are in the general range of two or three to one in power level you have a possible signal-cancellation situation, and if one of the signals is reflected from a moving object or surface you can expect some fading. This is the effect sometimes seen on TV sets as aircraft fly across your area.

Replacing the aircraft by the ionosphere we find that under some conditions the sky wave may return to earth at a region not very different from the transmitter, and compete with the ground wave. See **Fig. 4.** This effect is more noticeable on 160 than on any other ham band, more likely at night than in the daytime. We cannot revise the ionosphere to remove the fading, but we do try to design our antennas for minimum upward radiation.

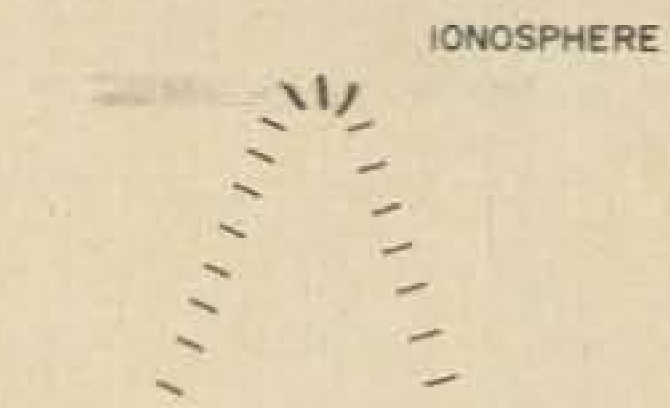

Fig. 4. If the sky and ground waves arrive at an antenna with roughly equal amplitude, a bad fading situation is likely. Good antenna design minimizes sky wave radiation.

160 Meter Antenna Principles

If you are accustomed to antenna work at 20 or even 80 meters your first thoughts about 160 meter antennas may bring a bit of a shock. The 5/8 wave vertical mentioned earlier would be 330 feet high, and the three cophased half-waves would get you up to 780 feet of tower. A mere quarter-wave vertical would be over 100 feet high! Looks like a job for a junior financier to purchase an adequate supply of building materials and

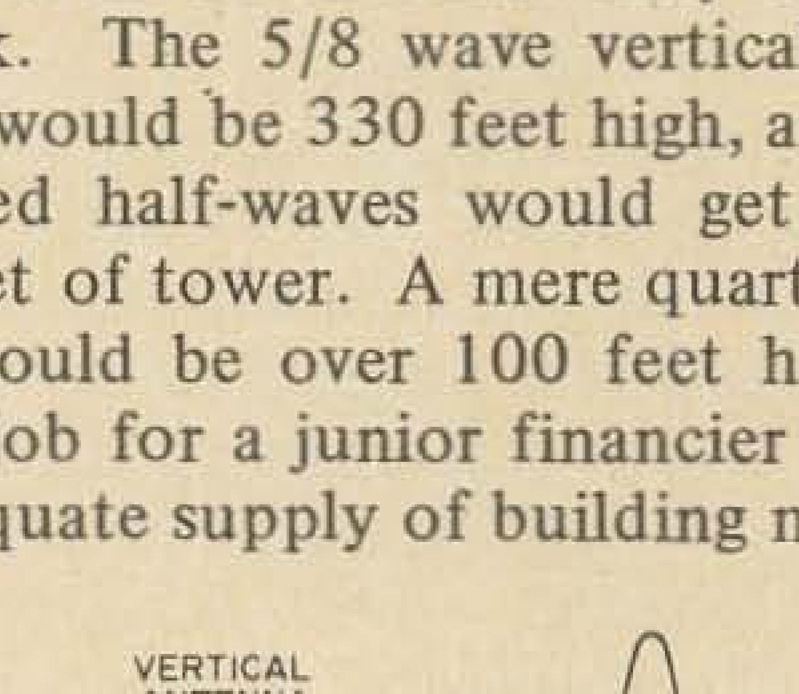

Fig. 5. Here is a partial image of the ground waves radiating outward from a vertical antenna. If the antenna were tilted its radiation pattern would include horizontally polarized components, resulting in an apparent loss of signal strength.

a senior engineer to get them all in place without upsetting the neighbors. Fortunately, we can assemble good 160 meter antennas without forming contracting and legal partnerships. But we must understand two key ideas.

First, as emphasized in the section on propagation, we are concerned with which way the radiation goes, and with its polarization. It turns out these requirements do not conflict, since the vertical polarization we need is most effectively generated by the vertical antenna we can probably build. See **Fig. 5.** This same antenna ideally has zero vertical radiation and if we can only make it tall enough it radiates most effectively toward the horizon. Probably we cannot make it tall enough, but we'll just have to live with that. To see the effects of various antenna heights look at **Fig. 6.**

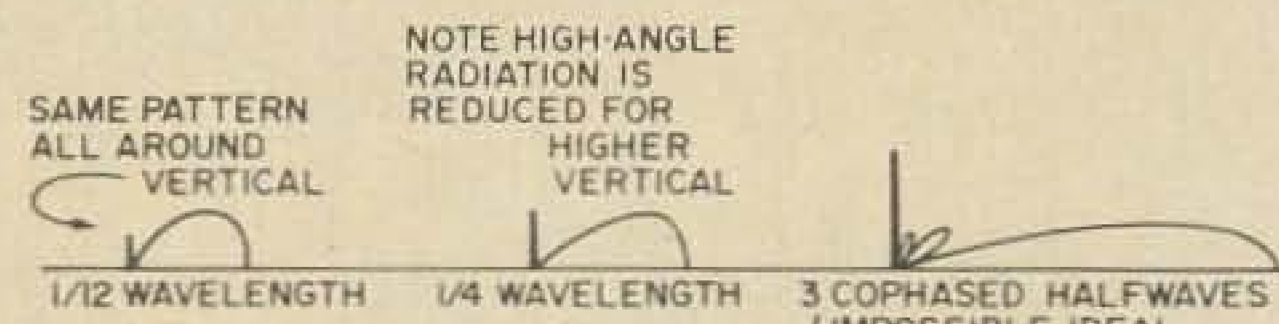

Fig. 6. Increasing the height of the vertical portion of your antenna reduces high-angle radiation *and* increases low-angle radiation.

The second key idea, but not second in importance, concerns matching power into the antenna. Hams use quarter-wave and half-wave dipole elements at the higher frequencies because these electrically special lengths guarantee convenient properties, as illustrated in **Fig. 7.** But it is not true such electrically sizable structures are good radiators *because* they are easy to feed!

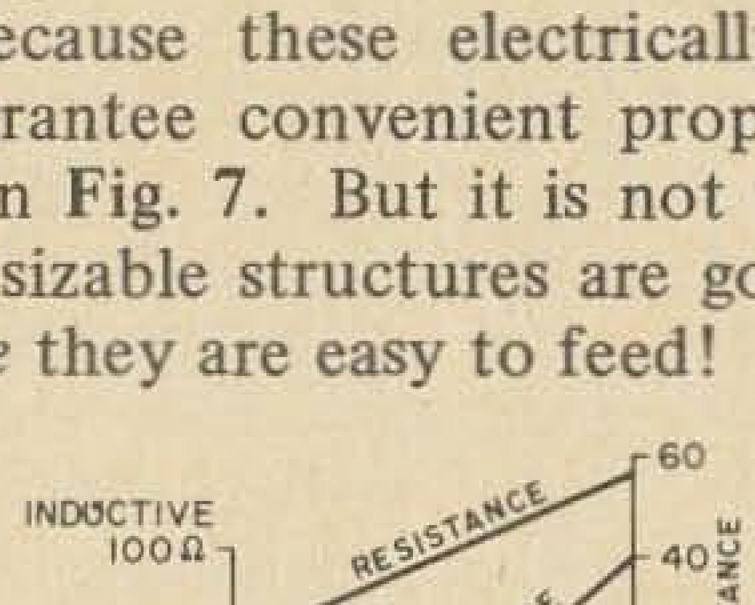

Fig. 7. Here is a quarter-wave vertical working against ground. Its electrical appearance depends upon its electrical length (or upon frequency if the length is held fixed).

A close examination of the VLF engineering literature reveals the pair we think are Siamese twins merely occupy the same cradle. If we apply a bit of intelligence we can separate them completely without disturbing Mother Nature at all. We can make electrically small structures that radiate *rf* power very effectively, if we can solve the feeding problem, and we will have excellent receiving antennas too.

Now we are concerned with the popular VLF problem of feeding electrically small structures. In good engineering style perhaps we decide to start out with an equivalent circuit. Can we draw an equivalent circuit of our antenna even before we have built it? Yes, because the variety of antennas we are likely to construct for 160 meters is not very great, and if we choose the correct equivalent circuit it will work for any antenna anyway. An appropriate circuit appears in **Fig. 8**, which shows an inductance, a capacitance, and two resistances in series. This equivalent circuit relates to our real antenna very simply.

The equivalent circuit shows a complete loop from the coax cable center terminal around to the cable's outer conductor. This is perfectly legitimate, even though we cannot see a wire connection between these terminals in many antennas. The connection is there, completed by the *rf* power that flows in the space surrounding the antenna. Maxwell used the term "displacement current." This current, a voltage, and a magnetic field may be observed in the space between capacitor plates as well as in the space around antennas. If you can accept the completeness of an ac current loop through a capacitor, you can apply the same reasoning to a real antenna in space.

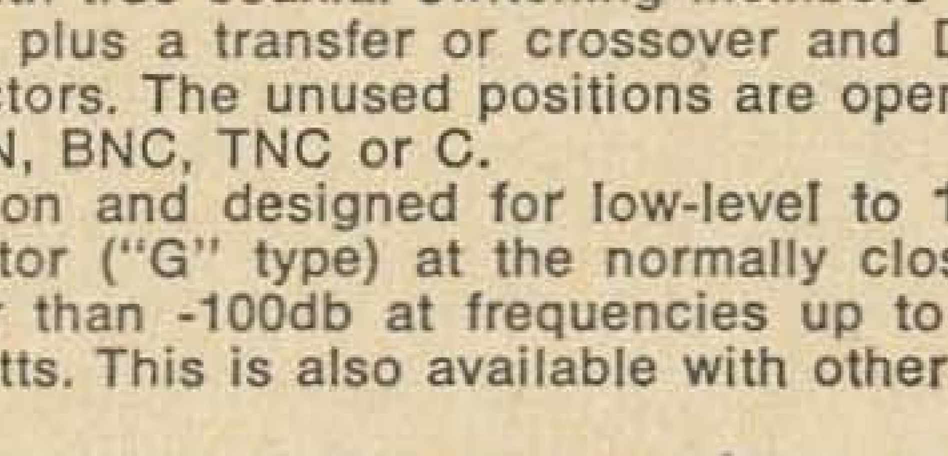

Fig. 8. An equivalent circuit that will express the characteristics of the antenna of Fig. 7, or of any other antenna, at or near a given frequency.

Next, we are concerned with the lumped capacitance, C_e, and the lumped inductance, L_e. This is an approximation of the antenna's real capacitance and inductance, which are distributed along many feet or tens of feet of physical antenna. The approximation works if we suppose we are discussing the antenna at a particular frequency or in a narrow band of frequencies. For instance, if we are thinking about a half-wave dipole fed by twinlead and operating at its resonant frequency, we ignore the capacitive and inductive reactances because at resonance they are equal and opposite in value. On 160 meters we are usually concerned about these reactances since the antenna is probably operating below its natural resonant frequency.

R_c is merely the effective resistance of all the conductors making up the antenna. That includes the very important ground resistance. If we want to achieve the best possible antenna efficiency R_c gets close attention because it sees the same feed current the real radiating part of the antenna sees, but it dissipates that power as heat rather than as *rf* field. R_c will be larger than the dc resistance of our antenna assembly because of skin effect, which confines *rf* current to the surface of the conductor.

This clues us in to a key point. Mere good ground practice is not the best we can do. We want to put up an antenna with the maximum possible amount of current-carrying surface, and that surface should be clean and shiny. We will have to protect it from our polluted and corrosive rainfall with insulation or good paint so that R_c is not gradually increased to some high value.

Finally, and here is the hero of our story, there is R_r. This is the purpose of our antenna, with L_e, C_e, and R_c appearing as unavoidable camp followers. R_r is not a loss resistance, it is the resistance that accounts for the actual radiation of useful *rf* into space. Since this energy seems to be lost from the system the transmitter and the antenna circuit see it as a resistance which dissipates watts as I^2R_r. This is the same familiar rule by which we estimate the watts dissipated by a resistor, and I is simply the current, which you can measure with an *rf* ammeter, fed into the antenna.

Now we can apply these ideas to a particular antenna. We already know our antenna should be as vertical as possible in order to maximize vertically polarized radiation, and that our antenna will be electrically short. This recipe suggests a particular type of antenna, the quarter-wave Marconi. Probably ours will be shorter than a quarter wave. What will this do to our equivalent circuit?

It will make R_c smaller since the current is flowing in less conductor, and it will reduce R_r because our coupling to space is less complete. See Fig. 9. The shorter current path suggests L_e will be reduced, and so will C_e, but we can see that C_e tends to predominate since the shortened antenna is approaching a capacitor configuration.

Our shortened Marconi will have reduced radiation resistance compared to a quarter-wave Marconi, and its reactance will be capacitive. We will want to put a loading coil in there somewhere, and our feed system must feed a resistance which may be much lower than the 50 to 300 ohm values we typically expect on the higher frequency bands. When we are facing up to an uncertain situation, what do we need? We need to be able to make good measurements.

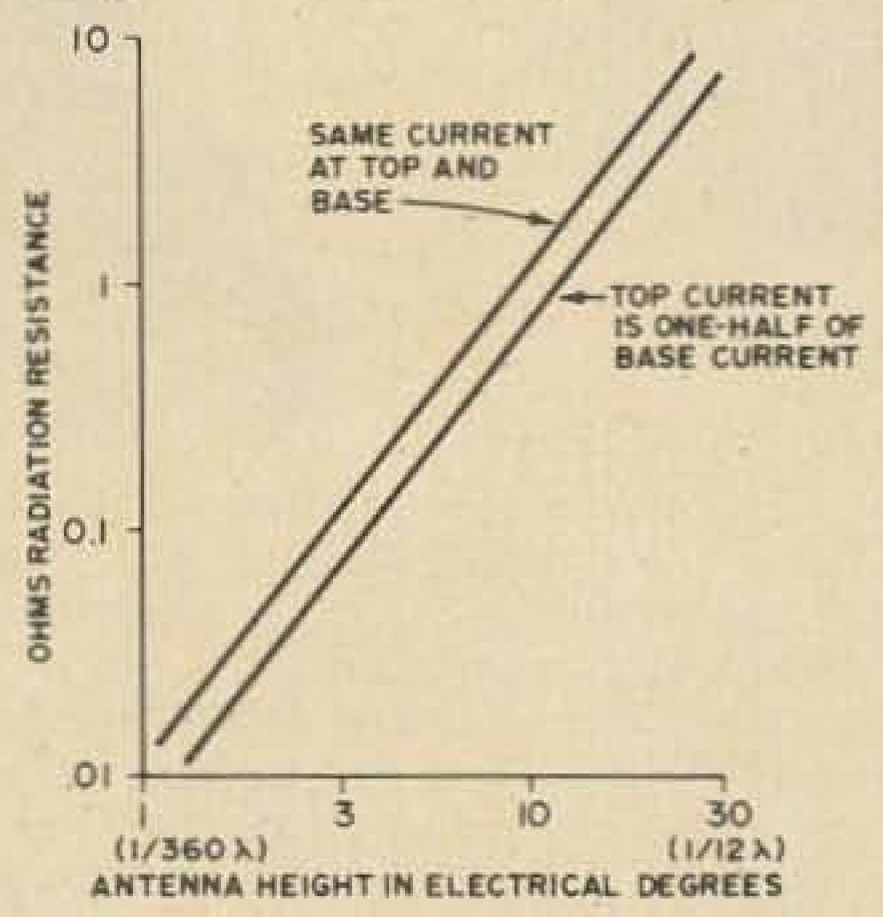

Fig. 9. Use this chart to estimate the radiation resistance of your antenna before you commence construction.

160 Meter Antenna Test Gear

On the higher frequency bands you can set up a cookbook antenna and tune your system with an SWR bridge. Perhaps you can get by on 160 using this approach but I wouldn't recommend it. What if you get a poor swr and your adjustments do not seem to be effective? Then you must proceed blindly, and that is no way to enjoy a bright Spring day. You need an SWR bridge in normal operation but until you have determined what adjustments are "normal" you should have a grid dip oscillator, and some kind of *rf* resistance bridge.

The GDO can be built, borrowed, or it may come along with direct assistance from a friend who already has one and who is interested in your 160 meter antenna project. His views will be different from yours, and this diversity of opinions can be very helpful when dealing with some knotty questions arising from antenna work. But don't tell him he is a part of the project's test gear.

Since *rf* resistance bridges are quite rare you can expect to build your own. It can get its *rf* power from the GDO. The circuit of Fig. 10 is discussed in detail in "How To Hang a Dipole," in the May 1968 issue of 73 Magazine, and so it gets pretty light treatment here. The present version is optimized for 160 meter antenna work, where resistances will typically be quite low.

Basically, this is a Wheatstone bridge, or a resistance comparison bridge. You will get some meter reading when applying *rf* to the input loop, and the reading falls to zero when the LH side and the RH side act as resistive voltage dividers reducing the applied *rf* voltage in the same ratio.

This situation arises when the antenna terminals present a purely resistive connection, since the adjustable resistance has negligible inductance or capacitance, and when the variable resistance is adjusted to the same value.

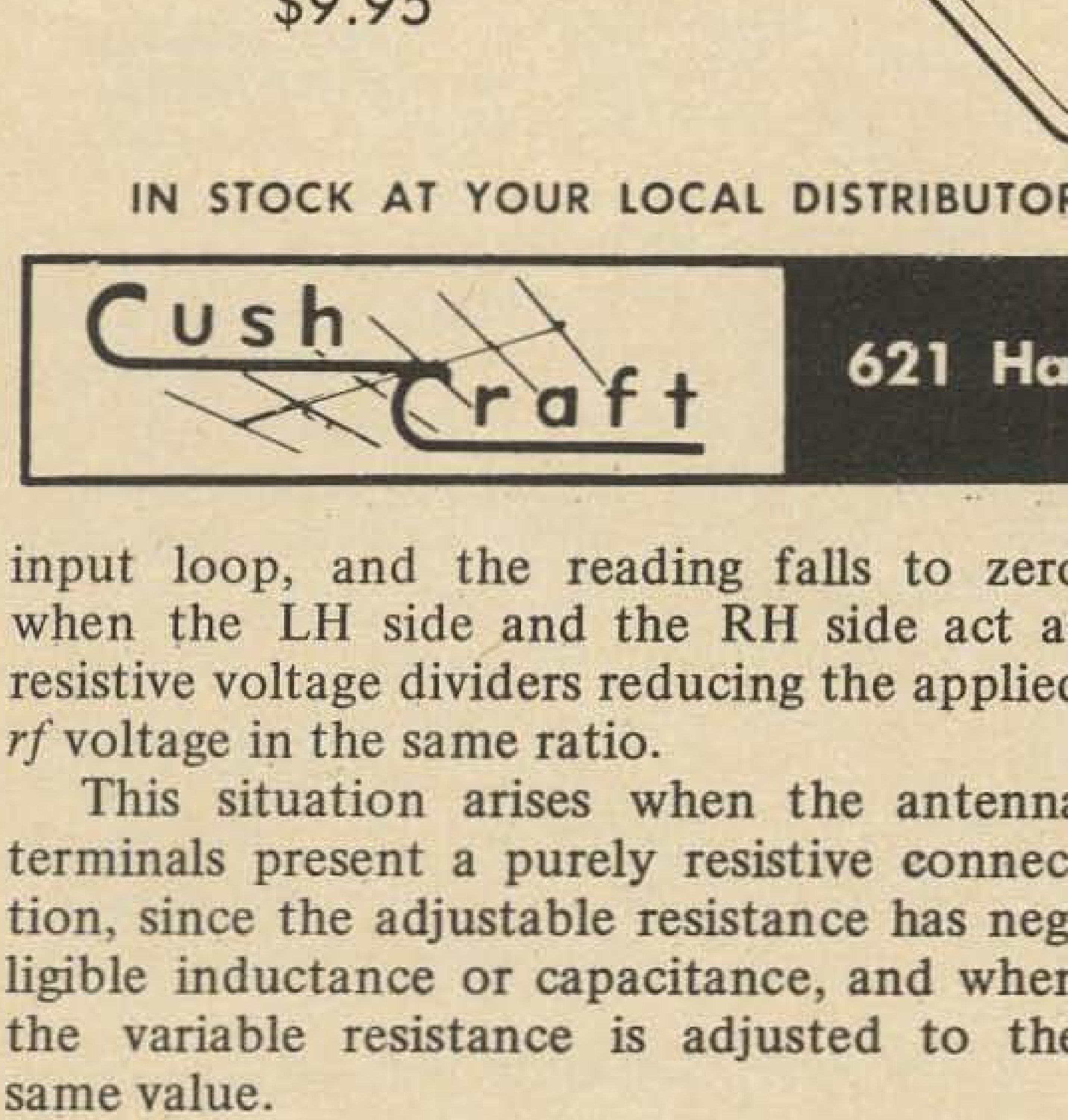

Fig. 10. This simple bridge circuit will measure antenna input resistance at resonance. Remember tolerances on capacitors are commonly very loose. A capacitor checker can do an adequate job of matching.

If you want to put this into a box it makes a handy item, once each year or so. A breadboard assembly, or simply soldering all connections and moving things gently will get you by, and to determine the result of your test you unhook the pot, after nulling, and measure its resistance with a low-range ohmmeter.

Your procedure in applying this gear is suggested by the equivalent circuit of Fig. 8. The best approach goes in two steps. First, you determine the antenna's resonant frequency by dipping it at a high-current point to discover its resonant frequency. Probably you merely add a couple of turns of wire for a coupling loop at the input terminals, and couple in the GDO to this loop. If antenna tuning is indicated, you bring the resonant frequency up or down by appropriate loading coil or capacitance adjustments. And then you apply the bridge to measure the antenna's input resistance, *at the same frequency.*

Since the antenna may have a very low input resistance, you may change its design or use a transformer matching system to increase the input resistance. In this case the *rf* bridge comes into play again to establish that your work has had the intended results. If a certain arrangement was supposed to increase a five ohm input resistance to 60 ohms, and you get a good null with a 60 ohm bridge setting then you know you have achieved your goal. You will be using your antenna while the fellow with only an SWR bridge is still running around with wires, insulators, pulleys, etc.

160 Meter Antenna Construction

Now we are about ready to put up a shortened Marconi antenna. Where will we put it? Since we can place it wherever convenient, it does not need to be very close to the transmitter. In fact, we want it at least a few feet from the building to reduce energy wasted by coupling into house wiring. The possibility of TVI is reduced too.

Having chosen our site and identified a few places where we can attach the top portions of the system, we might make up a sketch something like **Fig. 11**. There is very little detail since we already know about what is available to work with. First we turn our attention to the ground connection.

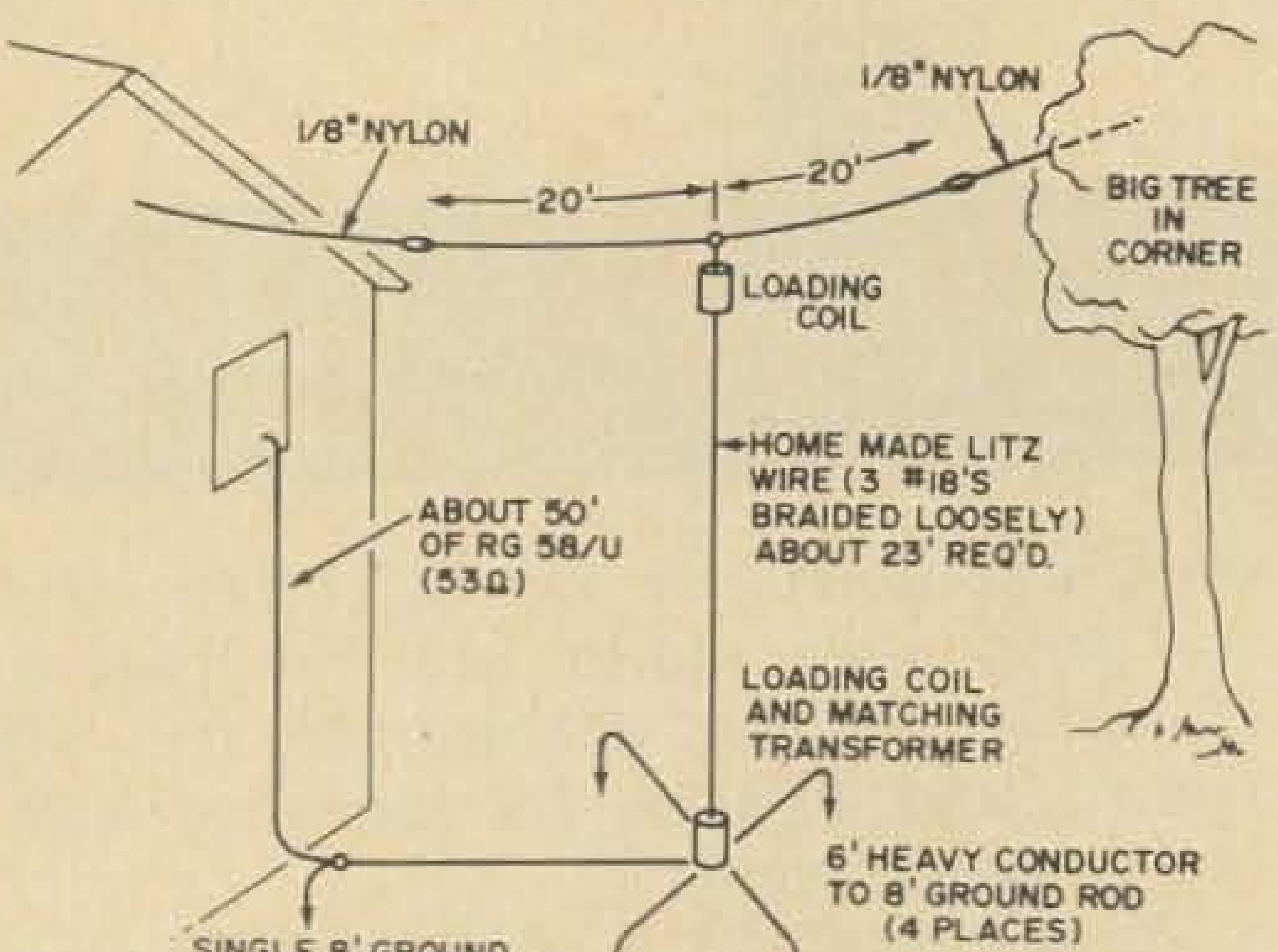

Fig. 11. Ballpark estimate of a real antenna somebody might construct for 160 meters. Note generous grounding.

Because the antenna's radiation resistance will be low, we must have an excellent ground. That could be the subject for another article, but it's basically simple and is well treated in many handbooks. The key points when making a good low-resistance ground are lots of surface contact, and possibly some assistance from chemicals. Remember salt and copper sulfate are plant poisons and may be carried out by ground water to do damage some distance away.

Now, with the ground established, we are ready to start setting up our antenna. The flat top goes up and pulls the vertical portion with it. There is no loading coil, yet. With everything in approximately its finished location we really have a full-scale mock-up of our antenna and we are ready for some cut-and-try adjustments. Careful notes and records will help.

Probably the system resonates at too high a frequency. After determining what the resonant frequency actually is, we let the top down and add a loading coil of, say, 20 microhenries. Pulling everything up again, we measure the new resonant frequency, which will be lower. This gives us two points on a graph of frequency versus loading inductance, and we plot this variation assuming a straight-line relationship to choose a new inductance.

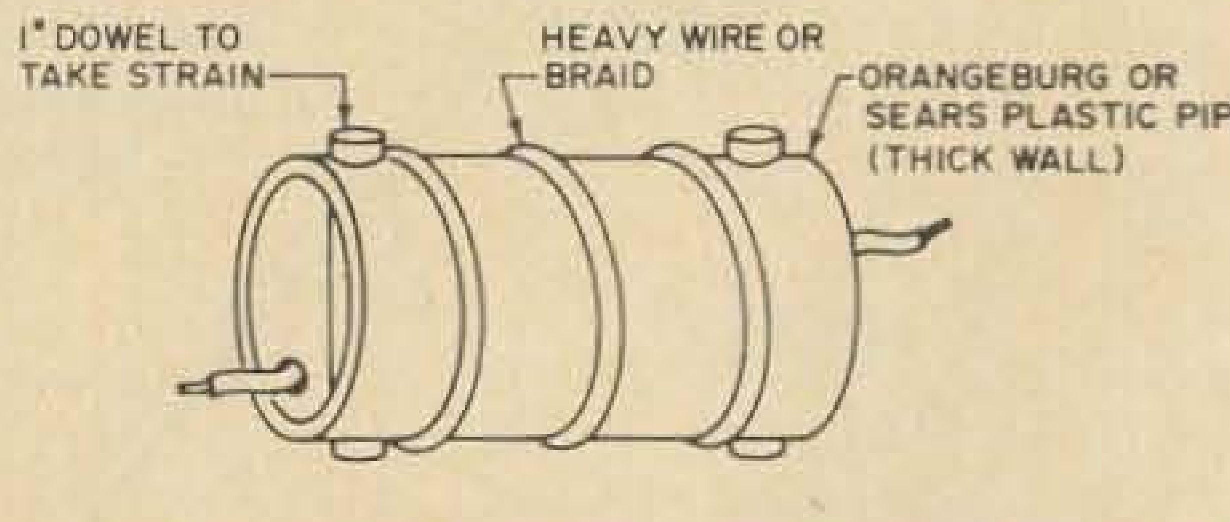

Fig. 12. Sizable loading inductances can be assembled easily from materials available around the house, from Sears, or an Agway farm store.

These three tests should give us an excellent idea of the loading inductance required to bring the resonant frequency down to 2 MHz. Ideally, we want to resonate the system to the top of the 160 meter band, or slightly above that, since we can make final adjustments at the bottom of the antenna without appreciably reducing its effectiveness. We make up appropriate rugged transmitting type inductances, perhaps from #16 vinyl-insulated Sears-Roebuck wire on a piece of Sears plastic sewer pipe as suggested in **Fig. 12**, and assemble the finished antenna.

A final test establishes that we have done the job in a sound workmanlike way, and we wind up with a finished antenna that looks something like **Fig. 13**.

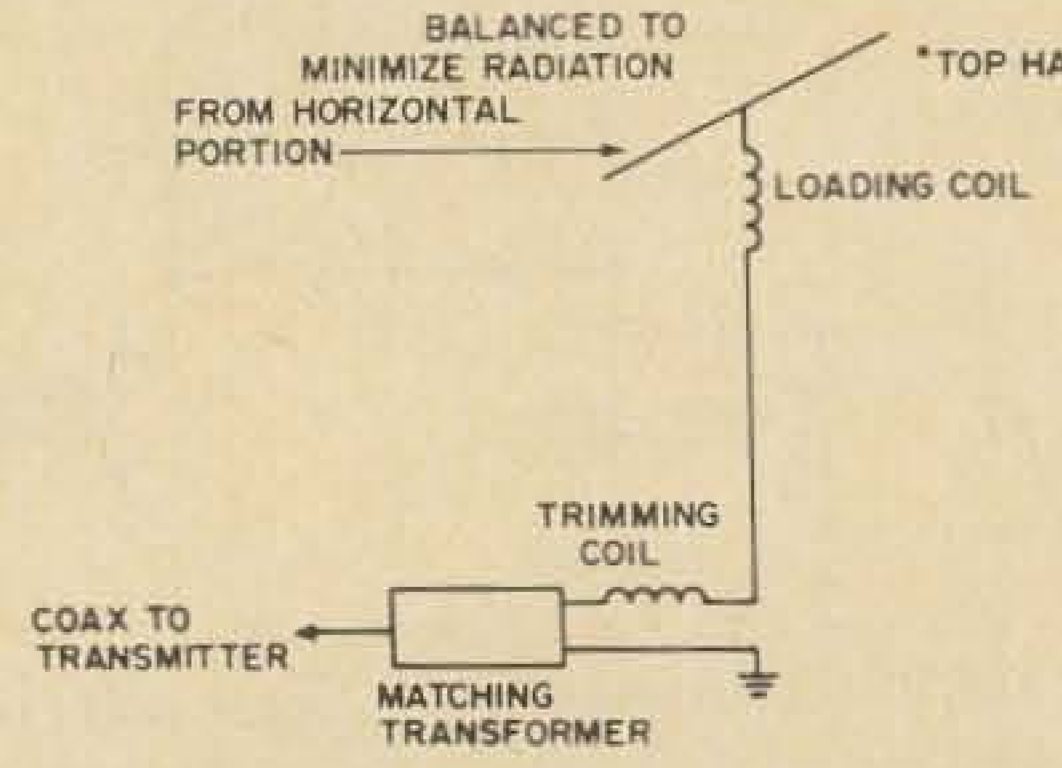

Fig. 13. Electrical appearance of the finished antenna.

Try your understanding of the principles on the two other antenna designs of **Fig. 14** and **Fig. 15**. These are borrowed from the Radio Handbook where their operation is

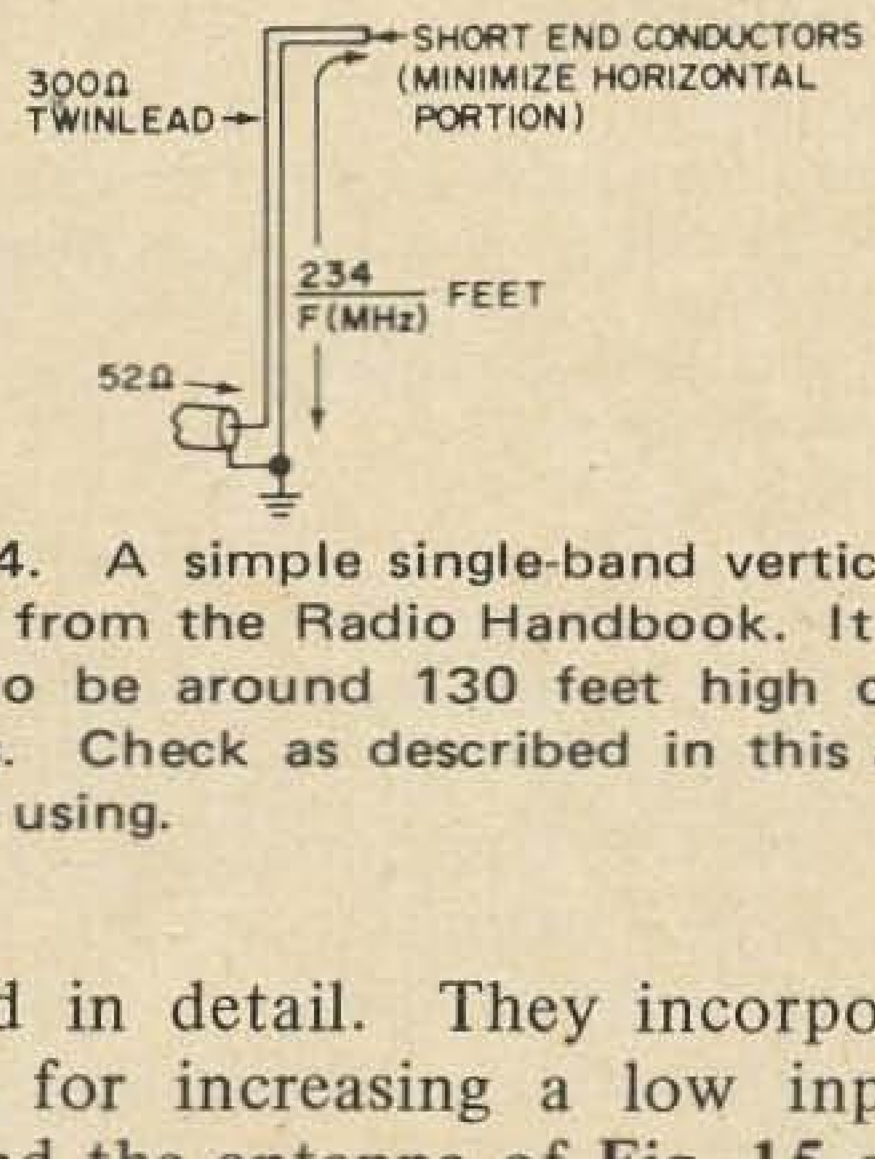

Fig. 14. A simple single-band vertical borrowed from the Radio Handbook. It would have to be around 130 feet high on 160 meters. Check as described in this article, before using.

described in detail. They incorporate two schemes for increasing a low input resistance, and the antenna of **Fig. 15** also has a top-loading effect which operates to resonate the system on the lower frequency band.

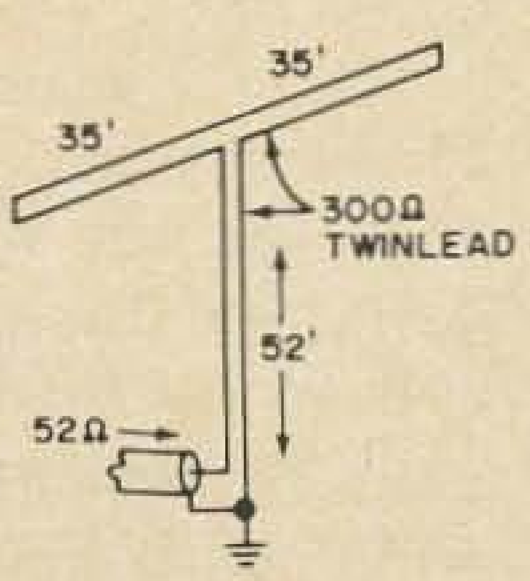

Fig. 15. A two-band antenna, known as the "Multee." Efficient design workable on two bands, such as 160 and 80.

Matching Into 160 Meter Antennas

A 50 or 75 ohm coaxial cable is said to be properly terminated if it feeds a 50 or 75 ohm resistive load. Referring to **Fig. 8** again, we see that if the inductive and capacitive reactances are equal the load must be resistive. We guarantee this by checking and adjusting our antenna to resonance at our intended operating frequency. But, looking at **Fig. 9** we see our shortened Marconi will probably have a radiation resistance considerably lower than appropriate for the kind of system we would like to use for feeding it. What can we do to improve matching?

A trivial answer is that a series resistor will make up the difference. A 5 ohm R_C plus R_r with an added series 47 ohm resistor

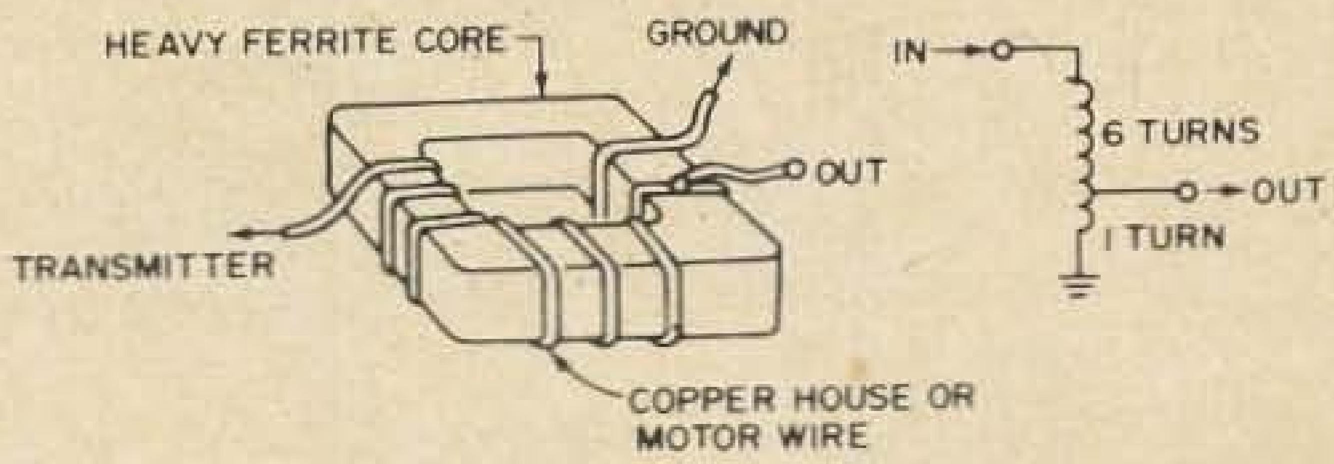

Fig. 16. At RF, a matching autotransformer is not hard to make. Remember the lower end of the coil, inside the antenna tap, will carry a much heavier current than the upper end. A two-winding transformer will work equally well and could avoid mixing wire sizes on the same winding.

makes up 52 ohms, just right for feeding by a standard coax cable. We'll have a matched system, and it won't be worth peanuts.

We can do much better with a nonresonant matching transformer. If you can do it at audio why not *rf*? Imagine we want to match a radiation resistance of 1 ohm up to a 50 ohm cable. We see how to do this in **Fig. 16.** A 7:1 turns ratio will achieve a 49:1 resistance conversion, just what is required. And if we apply a few simple facts about transformers we can determine that our system actually performs as intended.

Our key to sensible tests is that if the transformer is doing its job it will transform a short into a short. That is, our antenna should act the same with its input shorted as with the transformer input shorted. Checking the system's resonant frequency under these two conditions will establish this point.

Once we know the transformer is transforming, we check the system input resistance, looking at it through the transformer to establish that our input is really resistive. Finally, an on-the-air test shows the transformer does not get very warm, indicating core losses are not excessive. Just to make sure, perhaps we check for harmonics or observe the transformer's operation with a scope to discover if the core is going into saturation and generating interference. This is very unlikely. Once we have performed all these tests we have about covered the field, and if we have done mechanically sound work our system will be reliable.

To understand another way of matching the antenna's low radiation resistance, let's suppose we have a vertical antenna that accepts 1 ampere at 20 volts, at resonance. See **Fig. 17.** Now, we split this antenna in two, and feed only one side of it. Since each side carries half the current we feed only one-half ampere into it. But then we will have to double the input voltage, in order to radiate the same power. The effective input resistance, E_{in}/I_{in}, has increased by a factor of four. If we split the antenna three ways we could step up the effective input resistance by a factor of 9.

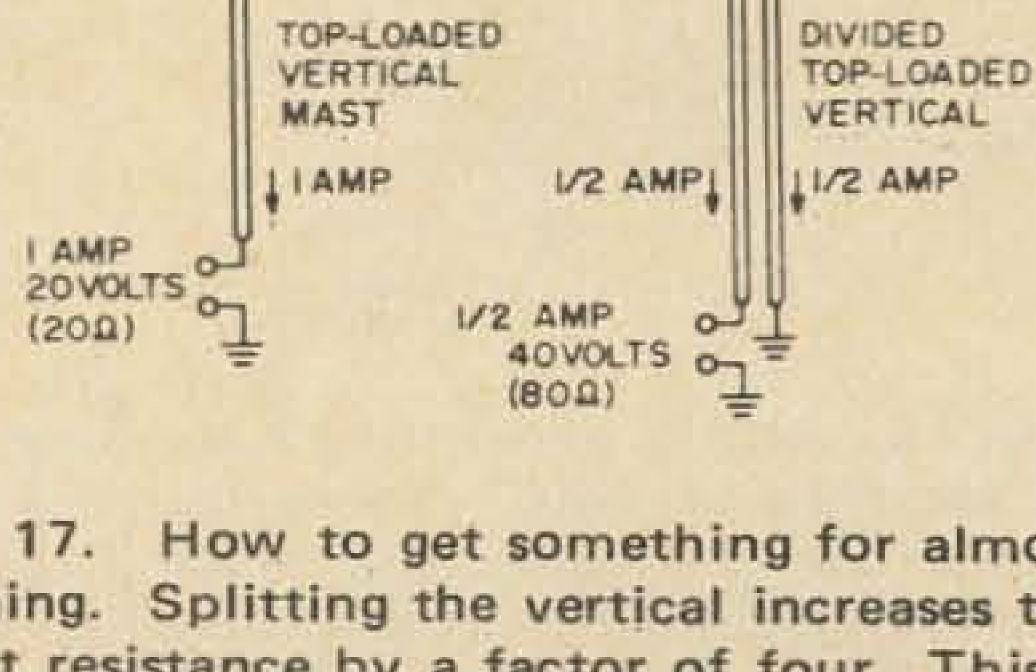

Fig. 17. How to get something for almost nothing. Splitting the vertical increases the input resistance by a factor of four. This is the idea behind the antenna of Fig. 14.

Perhaps that seems strange. But this is the same system used on the higher frequency bands, where a dipole may be divided into two parallel conductors of unequal size, and only one is fed. You see this in Yagi construction. The unequal size acts in the same way as the uneven division of fed and unfed conductors. This arrangement serves in the Radio Handbook antennas shown in **Figs. 14 and 15.**

Finally, we can go to the VLF engineer's trick of using several downleads. This works in the same way as the split-conductor method, but it is more elaborate. See **Fig. 18.**

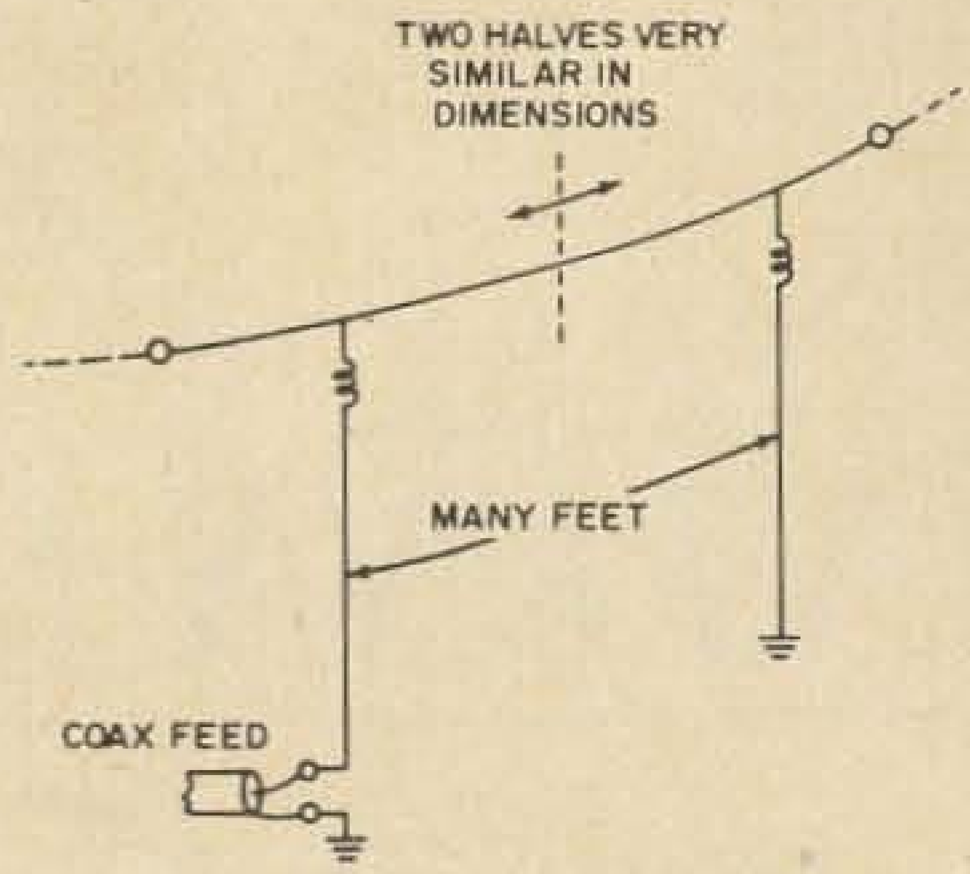

Fig. 18. The idea of Fig. 17 can be used very practically in a more extreme form. Testing and adjustment is more difficult, but this is the way the Navy builds its huge VLF antennas.

Here we have two "downleads", for an apparent radiation resistance stepup by a factor of 4. Since each downlead carries half the capacitive current surging between ground and the horizontal top conductors, ground is less critical. To tune this one imagine each downlead gets half the available top capacitance. Then the inductance per downlead must be twice that of a single downlead, with equal inductance for each downlead. Imagine a commercial engineer setting up a hugh VLF system with several downleads, if you like. I'd rather not! But it is a way to get efficiency from a system that would ordinarily offer high losses.

VLF engineers can get workable efficiencies from antennas for wavelengths in the order of a million feet. Now that mere 530 feet doesn't look so bad after all, does it? So get out there and enjoy that Summer weather while you get your new antenna established.

...W1EZT

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The Triac

Theory and Practical Application

To many of us in amateur radio, "state of the art" is a phrase which conjures up visions of complex solid state circuitry as well as a rapidly diminishing bank balance.

Many a writer, moreover, while professing the simplicity of his brain child, fails to accurately evaluate the contents of his meager junk box. Mine, for one, is truly a poverty area. That 50 mH choke that the author plucked from an old chassis came into my possession as a result of a cash outlay of $1.98. The common 2N4012 VHF transistor set me back $24.00, plus shipping costs.

Having read this far you undoubtedly now assume that I will reveal to your bloodshot eyes a project involving little more than hairpins, razor blades and hookup wire. Sorry to burst the balloon, OM.

Resign yourself to the inevitable. Prepare to wring a little more out of that threadbare wallet. This little gem will cost you—but it will save you quite a bit also.

A Variac is a very useful item around the shack. It will regulate the speed of your drill, run up the B+ on your KW rig, slow down the electric fan or dim the living room lights. The limiting factor is expense. A Variac with a current rating large enough to do a big job often carries a price tag of up to and over $100.

Here then is the story behind an electronic Variac that will handle a full 6 amps of ac current, will operate any kind of electric motor, and will cost a mere $5 worth of components.

What makes this all possible is a recent device which made its debut on the solid state market only last year. Its name, the triac.

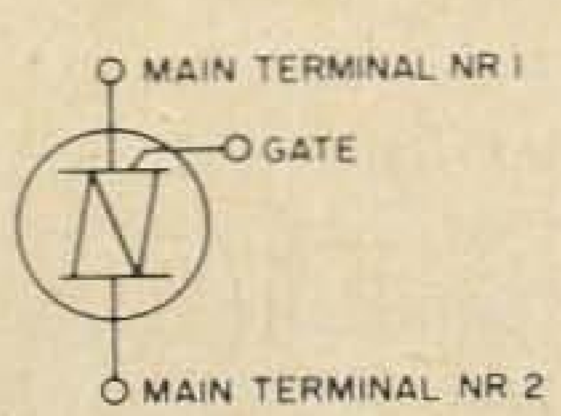

Fig. 1. Symbol for the triac.

The triac is a type of Thyristor, a device having characteristics similar to those of the thyratron tube. **Fig. 1** shows the schematic symbol of a triac.

This three lead package basically consists of two 4 layer semi-conductor structures placed back to back. The layers are composed alternately of P and N type material (**Fig. 2**).

Fig. 2. Internal construction.

The electrodes are the Main Terminal 1, Main Terminal 2 and the Gate or control electrode, analogous to a thyratron's grid.

Where the silicon control rectifier, a common thyristor used in light dimmers, is only capable of half wave operation, the triac will provide symmetrical bidirectional control (**Fig. 3**). It is thus usable with any type of ac electrical load where the SCR control is usable only with ac-dc type devices.

The operation of a triac depends upon three values. These are forward breakover voltage, holding current and gate signal.

When either diode in the triac is forward biased (the anode positive with respect to the cathode), it may either present a high or low impedance to the circuit depending upon the potential applied. The triac will conduct very little until its forward breakover voltage is reached. At this point it will switch to the on state and conduct heavily, presenting a very low impedance to the circuit.

As an applied ac voltage becomes more positive (**Fig. 3**), little current will flow until the breakover value of voltage is reached. At this time the triac will switch on. As the voltage drops to zero, a point is reached at which there is no longer sufficient "holding" current flowing to sustain the triac in its on state and the device will turn off, ceasing to conduct.

The alternating voltage now makes its negative excursion and once more there is no current flow until the breakover point is arrived at.

As seen in **Fig.** 3, the triac acts as a switch turning off during a portion of each ac cycle. The effect of this switching action on a load powered by this circuit is much the same as of a Variac. We can effectively reduce the available power to the external device.

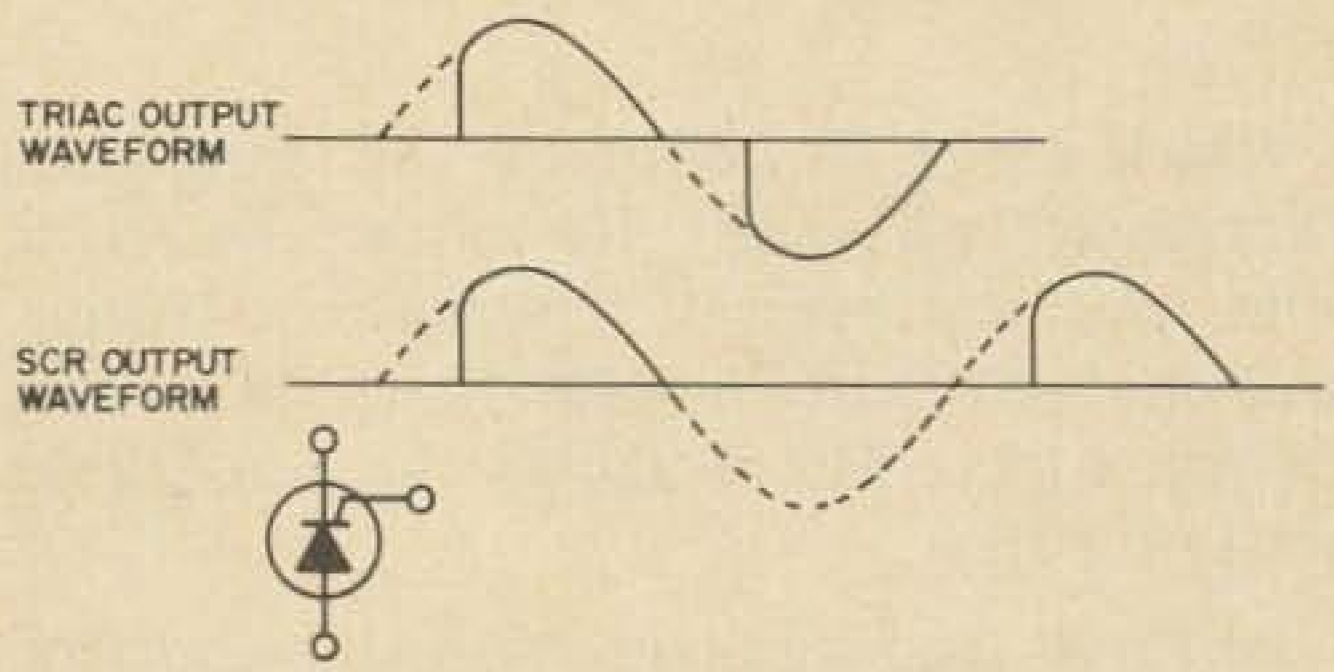

Fig. 3. Silicon control rectifier vs triac.

To vary this switching action is the role of the Gate lead. When there is no voltage applied to the gate, the main terminal voltage must reach the breakover value ($V_{(bo)}$) of the device before current will flow. As Gate voltage and thus Gate current is applied and increased, the $V_{(bo)}$ level is decreased causing the triac to conduct earlier in the ac cycle.

In a practical circuit, the triac is operated far below its breakover voltage and is triggered–at any voltage level desired–by a gate signal large enough to assure that the device will turn on.

Once in the conducting state, the triac, independent of its gate voltage, will continue to conduct until the terminal voltage and current fall to below the holding value.

The circuit shown in **Fig. 4** utilizes a neon lamp as a triggering device. The object is to obtain a pulse of current which is variable in frequency and can therefore be used to trigger the triac into conduction at any portion of the ac cycle.

Fig. 4. Single time constant circuit with neon bulb trigger.

A neon bulb is bilateral; will conduct equally well in both directions, making it a natural for triac operation. On each half cycle, the capacitor is charged through a potentiometer, its rate of charge or RC time constant being determined by the setting of the pot. When it reaches the firing point of the neon bulb (about 50 volts) it discharges through the bulb and the triac gate lead, turning the triac on. By varying the value of the potentiometer, the turn on point of the triac is varied and thus the load receives more or less power from the line.

Neon triggering has a number of disadvantages, however. When used with a common 120 vac line, a voltage loss of up to 10% may result due to the relatively high firing point of the bulb. Also, radiation acts to lower the firing potential, causing the circuit to become unstable.

A more satisfactory arrangement can be realized through use of trigger diodes. These are solid state equivalents of the neon bulb. We need not delve into the realm of solid state triggering, however, since the semiconductor world has simplified the job by building and marketing a triac having its own integral triggering device. A number of these are available on the market with a price tag in the neighborhood of $3.00. Such a device is the RCA 40431–a little beauty which will handle up to 6 amps when operated with a proper heat sink.

The circuit (**Fig.** 5) is of such simplicity that the entire complement of parts may be mounted directly on the terminals of a potentiometer. A double time constant circuit was chosen to avoid the "quick turn on" effect of a single time constant circuit. The triac is kept in some degree of conduction at all times so that a smooth turn on is facilitated.

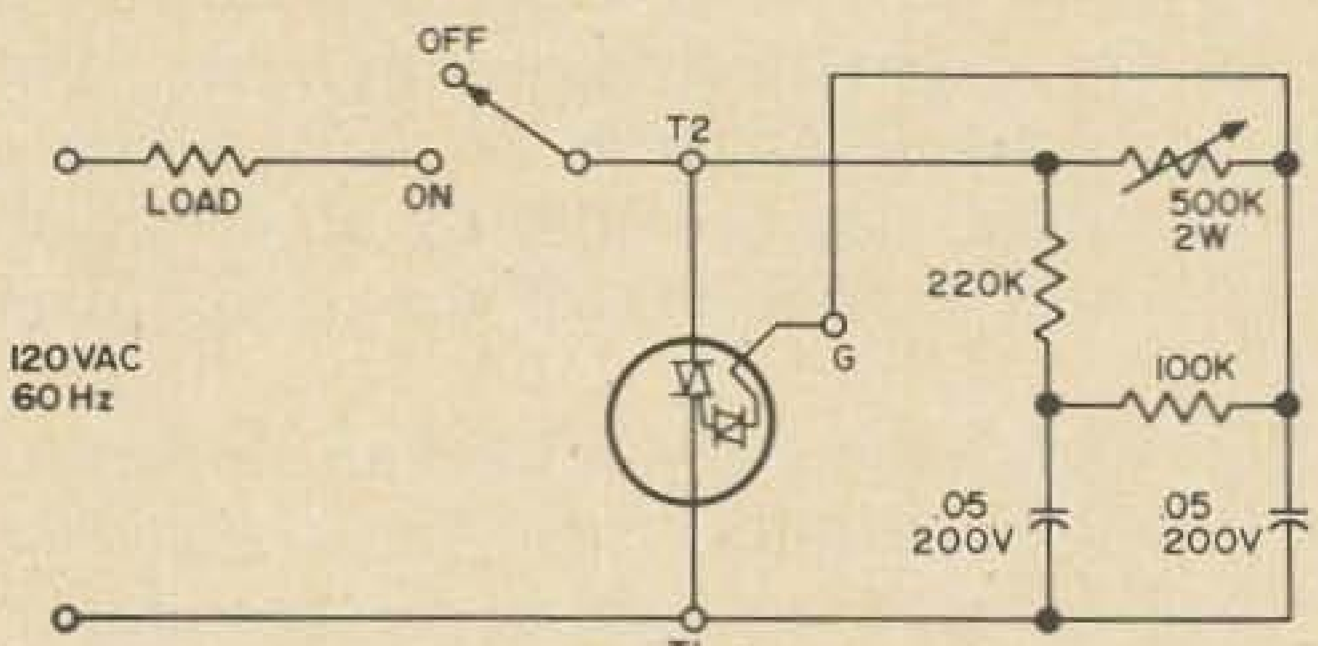

Fig. 5. Double time constant circuit with internal trigger.

In construction of this device, it should be remembered that the triac must dissipate quite a bit of heat. After some experimentation, I have found a Wakefield NC-303K heat sink excellent for this application. A .335 inch diameter hole should be drilled in one end and the triac press fitted into it.

The heat sink will have line voltage applied to it during operation and should be placed in such a way that it will have adequate room for heat dissipation yet not be touched. It is recommended that the sink be mounted in the vertical position so that convection air currents will cool it most efficiently.

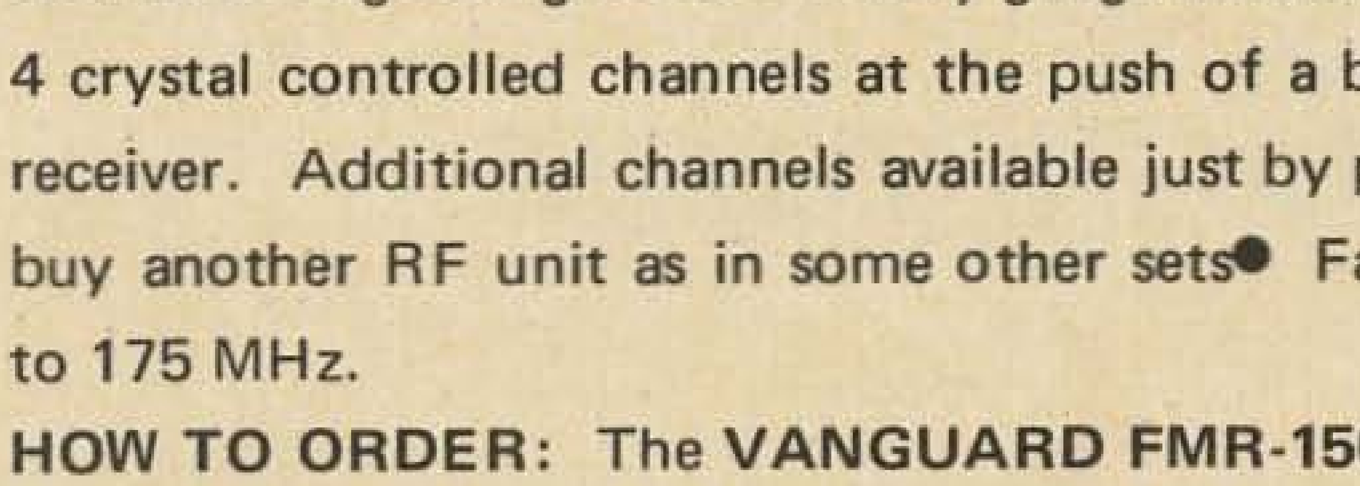

Fig. 6. RF interference filter.

When the triac control is used for operation of an electric tool or lamp, no filter is necessary except if undue interference is experienced in nearby radio or television receivers. For such cases a line filter should be used.

I have made use of the device for control of the speed on a drill, lamp dimming and as power supply control, all with great success. Have a ball OM and amaze the gang with your $5.00 Variac.

...K8TSQ

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430 - 470 khz Sweep Frequency Generator

Here is a simple sweep frequency generator for aligning the most common *if* strips. The unit has only one transistor because the sweep voltage is taken from the oscilloscope it is used with. Most general purpose oscilloscopes have a sawtooth output jack. By using this sawtooth, the frequency is locked to the position of the trace.

The oscillator is made to deviate in frequency in step with the voltage applied to the base bias circuit, either the sweep voltage or the dc voltage applied at the control point. If no sweep or control voltage is applied, the oscillator runs at the center frequency, and may be used as a conventional signal generator.

The 2.5 mh choke and the two 150 pf capacitors form a very broad tank circuit, so it is easy to FM the oscillator without a great change in amplitude. As to how the change in base voltage causes the frequency shift, I am not quite sure. All I know is that it is quite linear and is a positive shift (**Fig. 3**). That is, an increase in base voltage causes an increase in frequency. Also, a change in collector supply voltage will shift the frequency, so be sure to use a stable supply.

Since an rfc is used as part of the tank, you may have to compensate for a variation in center frequency by changing the 150 pf capacitors to some other value to get 455 khz as your center value.

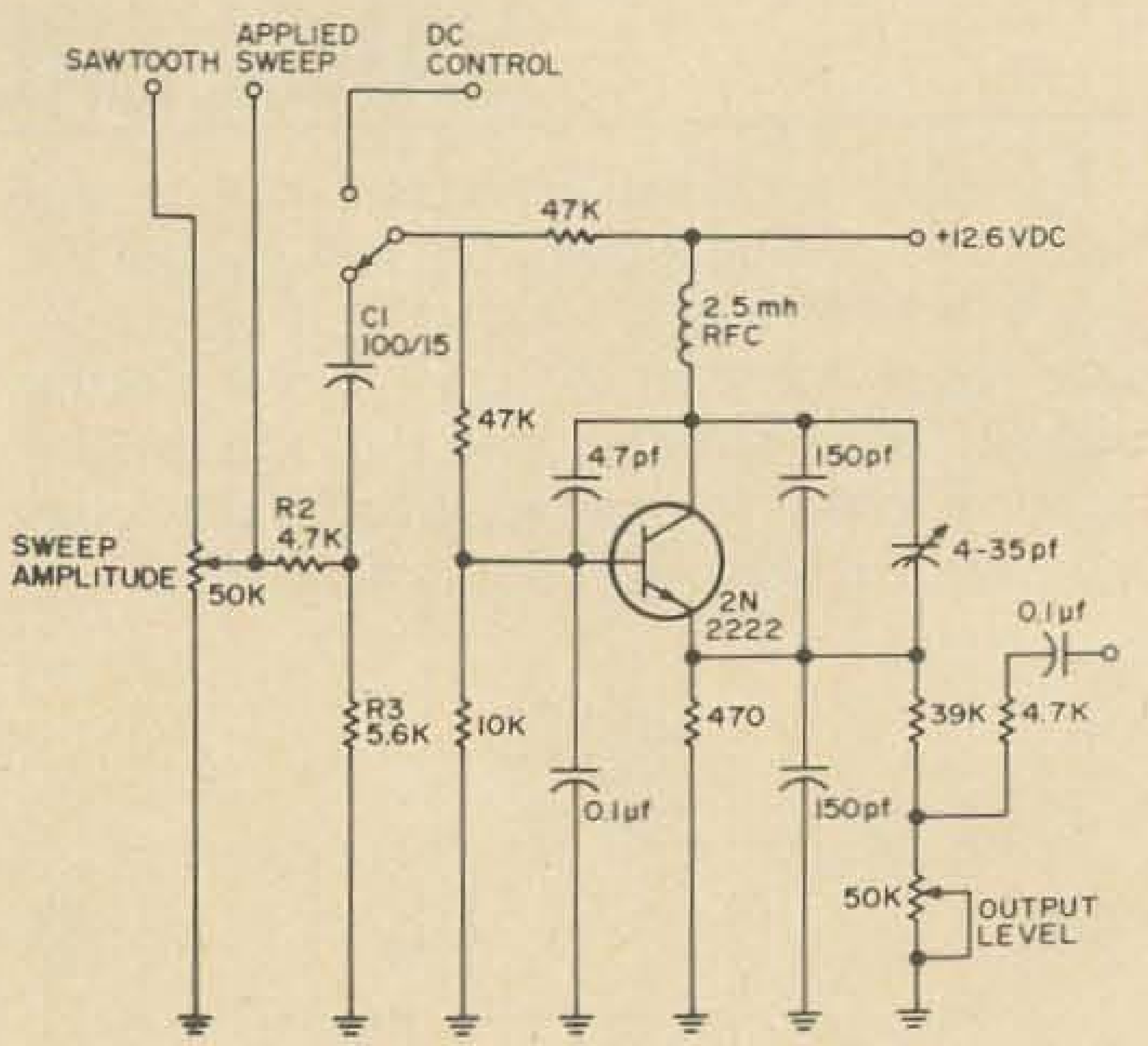

Fig.1. Sweep generator circuit diagram.

If you do, then run a plot of dc control voltage vs frequency and adjust the voltage divider R2 and R3 so that 1 volt P-P at the sweep pot wiper gives plus and minus 5 khz (10 khz total). This is not as hard as it sounds. Just listen for the harmonics on a broadcast band radio. For instance, the second harmonic of 430 khz is 860 khz, and the second harmonic of 470 khz is 940 khz, both handy on the BC radio. Note the dc voltages at the control point required to obtain these frequencies. Take the difference and divide by four. The answer is the P-P voltage required to shift the oscillator plus and minus 5 khz. Then apply a low, known ac voltage to the wiper of the sweep pot with the switch in the *sweep applied* position. Adjust the value of the divider resistors to get the proper fraction. In my case it was 0.43.

It is advisable to run the sweep rate as slowly as possible, in order to display the response curve as accurately as possible. The sharper the skirts, the more slowly the generator must pass through the bandpass. With this generator, the amount of frequency deviation is controlled by the P-P amplitude at the sweep pot arm. If you are looking at the response of a regular *if*, you would set the sweep amplitude high to see the entire response curve. As far as an accurate display is concerned, this is fine, since the slope of the skirts is shallow. But if you were looking at the response of a sharp filter, you could not tolerate such a wide sweep, because the fast rate-of-change would tend to skew the display. To correct this, reduce the sweep amplitude to reduce the frequency deviation down to the edges of the skirts of the response curve. This reduces the rate of change and minimizes the skewing of the display. Also, it is better to display the *if* before detection, if possible, to prevent the detector time constant from possibly distorting the display.

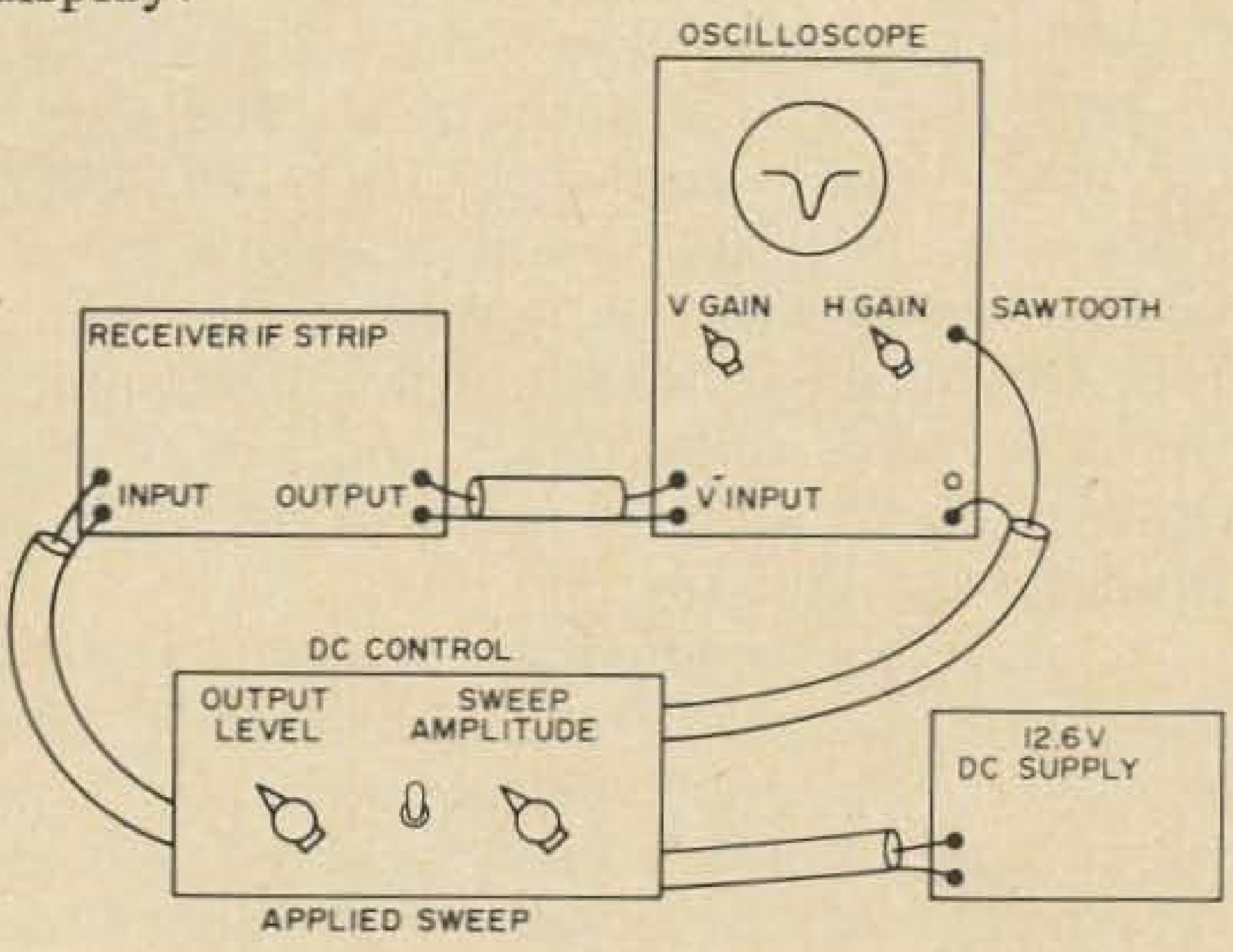

Fig.2. Interconnections of sweep generator.

If you have the sweep generator set up as described, then it is easy to set the sweep for a known deviation, and then procede to read the 3 or 6 db points from the face of the scope. Be sure to disable the AGC for this test.

For those who aren't familiar with the set-up for obtaining the response curve display, refer to **Fig. 2.** and the following outline.

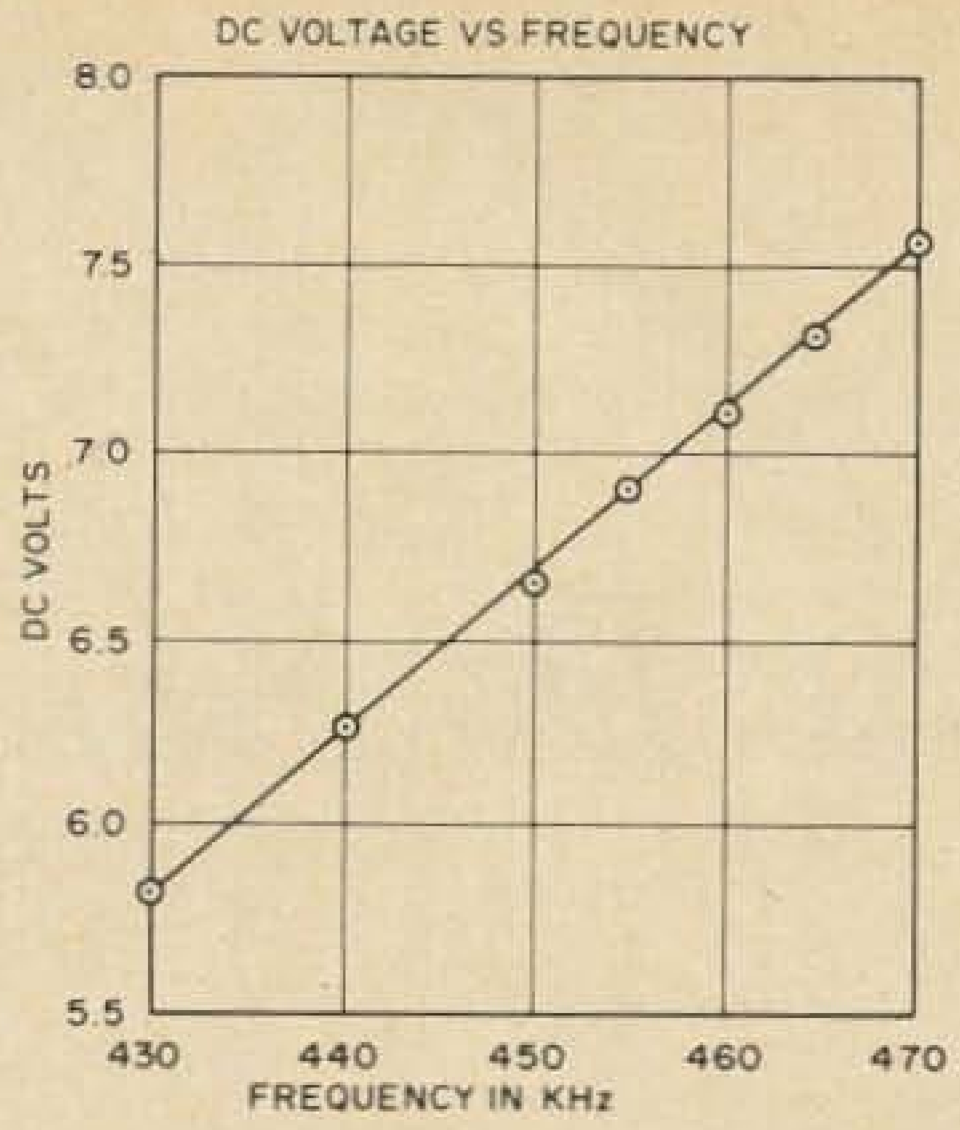

Fig.3. Sweep frequency vs dc voltage.

DC CONTROL VOLTS	FREQUENCY
5.86	430
6.27	440
6.69	450
6.90	455
7.12	460
7.33	465
7.55	470

First, hook up the equipment as in **Fig. 1** Set *horz gain* for desired sweep width. Adjust *sweep amplitude* pot on generator for desired frequency range. Set *output level* to mid-range. Adjust the *vert gain* for the desired pattern height.

If we wish to change the total frequency deviation and the horizontal display width at the same time, use the scope's *horz gain* control. This presumes that the amplitude of the sawtooth output is also varied by the *horz gain* control.

If we wish to change the frequency spread and not change the width of the scope display, adjust the *sweep amplitude* control. This allows you to take a better look at the sidelobes or any ripples in the passband, depending on how the controls are adjusted.

You don't have to use a sawtooth to sweep with if it isn't handy.

Sixty hz can also be used, but it will probably skew the passband you are trying to display, so I don't recommend it. One note here: when the sweep generator is first turned on, or the setting of the sweep amplitude is changed, the frequency will drift for a few seconds. This is due to the charge on C1 changing to a new level. C1 is large to couple the low frequency sweep with as little distortion as possible.

...WA5SWD

The Rev. Robert O. Gardiner, K1OXK
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Andover, Mass. 01810

What Do You Think?

Truth stranger than fiction has been the subject of several very interesting QSO's in which I have participated in the last few years. In most cases the ham relating his experience has mentioned "the long arm of coincidence." In the true story which follows I leave the decision to the reader; was this coincidence or . . . ?

On the 30th of October, the weather man on WBZ-TV mentioned that there might be an aurora during the evening because of a solar flare the day before. To those hams who are familiar with the phenomenon and results which may be experienced on six meters, the announcement of a pending aurora is an invitation to warm up the six-meter rig and turn the beam into the north.

It had been sometime since I was last on six; I therefore welcomed the opportunity to fire up the rig in "studio B." To my disappointment, the familiar noises accompanying the aurora were not to be heard. However, I tuned across the band and very near 50.4 mhz discovered the voice of an old-timer signing his call after a short test. W1KKB, Louie, after many years of operation in Everett, Massachusetts, moved to Exeter, New Hampshire. I gave Louie a shout and was not surprised when he returned my call. After the usual informal opening remarks during which Louie chastized me for not reminding him of our recent ham get-to-gether at Moody Beach, Maine, which has been held on an annual basis for the past three years, he gave it back to me. I apologized for overlooking an invitation to KKB and remarked that this year the preparations and invitations were mostly left hanging until the last moment. I pointed out that we sorely missed John, WA1ANK, who had arranged for mimeographing the announcements the year before and had greatly assisted me in the mailing and in alerting all hams whom he had contacted by radio.

It was while we were on vacation on the second Wednesday in July this year that the XYL, Bette, received a phone call at the camp informing us of the death of WA1ANK. He, Johnny, had come home from his office early in the day feeling quite ill, but as was his custom had turned on the Swan 250 and was in QSO with Joel, K1MUE, in Mason, New Hampshire, He failed to respond when his turn came around again and was sitting there in his chair when Dottie came home for lunch.

We all loved John on six meters and he had literally thousands of ham friends on two and six. He would get on in the contests to help others get their points, and assisted in setting up the hilltoppers in preparation for the VHF contests. He was kind, courteous, and above all, a friend to all. Louie confirmed my remarks concerning Johnny and mentioned how much he missed the days when either from home or mobile rig WA1ANK could be heard in the thick of the six-meter activity.

It suddenly occured to me that I had an appointment, and that I had best sign shortly; I said as much to Louie and was winding up the QSO when it passed through my mind to say to Louie that if Silent Keys could listen in and read the mail, surely John would be right in there. Then as I was about to sign . . . the rig went off the air, the receiver became silent, and the blower on the 4 x 150A spun to a stop.

At first I imagined I had lost a fuse in the modulator-power supply unit. After fumbling around for a slowblow fuse and just as I was about to replace it, I noted that with the rig out, the receiver gone, and the fan disabled, the trouble must be at the main fuse box.

Opening the cover on the box, it was not at once apparent which of the two fuses had blown. I turned on the low frequency power switch in "studio A" and removed a fuse until the low band rig, light and all, went off. Quickly I placed the now proven "good" fuse in the other fuse socket and the power returned to "studio B." I reexamined the nonworking fuse and still saw nothing wrong with it. It was one of those known as a *fustat* plug and had been put in the switch box early in 1967. Then I remembered; because of the great line voltage drop I had been experiencing since we had moved to Andover from Boston, I had hired W1HTY, Bill Howarth, a professional electrician, to run two separate lines from a new switch box.

This was the first trouble I had had since the installation. Bill, W1HTY, died a year ago last August, again, while I was on vacation.

(Our friendly supplier who sold me some replacement *fustats* examined the nonfunctioning fuse and then asked me what was wrong with it. I could only say that I believed that John, and Bill, two Silent Keys, good friends from Andover and North Andover, respectively, were the only ones who really knew what was wrong with that *fustat.*)

When I finally got the rig back on the air, Louie was still on frequency talking to WA1IVT, Mel, and WA1ELZ, Ed, of Methuen, both of whom had been reading the mail when my rig suddenly went off the air. Louie said, "Let's see if Father Bob has his rig back on the air." I turned on the power and explained to the fellows that my troubles were not serious but were not really of this world. What do you think?

. . . K1OXK

Eliminating Hand Capacity

Most experimental circuits are tried out "bread-board" fashion. Hand capacity effects can be troublesome, especially at the higher frequencies. In order to minimize hand capacity effects the following gadgetry was devised. The adjustment screws in trimmer capacitors and slug-tuned *rf* coils is fitted with a flat piece of tin, securely soldered into the slot. Then it may be adjusted with a long hollow tube of plastic or hard rubber which has been slotted at one end for this purpose. This idea may be used to improve the alignment of any piece of electronic equipment, "home-brew" or factory built.

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Leaky Lines

To all of you who served in the Army during World War II as I did, it won't be necessary to explain the term "latrine lawyer." Those who have no first hand acquaintance with this ubiquitous character may know that he is someone who knows everything about everything. He doesn't mind telling anybody within earshot exactly what to do, when and how to do it, and why. If you dig beneath the superficial veneer of this specimen, you will find a faker and charlatan, possessing what Oscar Levant once called a smattering of ignorance. Armed usually with only the sketchiest sort of information, he expands it with a tenuous structure of half-truth, innuendo, rumor and implication. He will fasten onto you like Sinbad's old man of the sea, and will never let you go, haranguing you till your ears ring. The inexperienced, the meek and the gullible; these are his "pigeons." He is one of nature's true phenomena, first, last and always, a phoney!

Ham radio is not immune. We, like the Army, have our share of "bathroom barristers," who may be found, holding forth on the airwaves, counseling all their starry-eyed admirers. Impressionable beginners, ingenuous and naive; more mature persons with fancied grievances and gripes; the inarticulate and prejudiced seeking a voice; misfits who revel in divisiveness; all these gather around his feet, drinking it all in.

There's just one fatal flaw in this idyllic scene. The guy doesn't know what he's talking about. It's all a mish-mash of misinformation, without a scintilla of creditable fact to back it up. Here are some common examples of his hogwash.

"I wouldn't use an electronic keyer for all the rice in China. They make everybody sound just like a tape machine. Why, you lose your identity completely. Give me the good old bug every time."

What hokum! There's more bad sending on bugs, side-swipers and cootie keys than you can shake a stick at. If a banana-boat swing is supposed to be a mark of identification, it escapes me. It doesn't make for individuality of fist, as much as it demonstrates little or no concept of the sound of true CW. Moreover, characteristic individuality of spelling, punctuation, word usage and other unique peculiarities are maintained regardless of the sending instrument. What we need are more electronic keyers, not fewer. Perhaps this would clear up some of the horrendous stuff that's been passing for CW for a long time. In any case, it would help diminish that atrocious syncopated swing, and reduce it to a passably tolerable minimum.

"I'm not interested in having broadcasting quality audio. What really counts is communication. That's the name of the game. Boy, when there's a pile-up, I just crank up my Whatziss Mark III, and turn the gain wide open. I like to watch those needles jump. Then I know the DX station is going to copy."

Yes, and so will everyone else within twenty khz, plus or minus. What can I say about this guy, except that essentially he's just a pig who doesn't consider other people's rights at all. His trademarks are over-modulation, audio distortion, flat-topping, unwanted hash and spurious radiations, and an abusive attitude toward anyone who tries to suggest that he cut back on his gain a bit. Brother, how wrong can you be?

"You guys are not on frequency. I'm crystal controlled, so I know I'm on frequency."

Not a single word about whether that crystal is in an oven. No mention of the associated circuitry, the trimmer capacitor. No awareness that the crystal may be pulled quite a few cycles by manipulation of the tuning condenser. Nothing about voltage regulation, which, if poor, can put that crystal right outside the ballpark in nothing flat. But no! This character makes his unequivocal statement, and all the little shrinking violets let him get away with it, even though they know far better, simply because they don't want to fall into his big mouth. So, he gets by without a challenge.

"You don't have to worry about SWR. Anything less than four to one is okay. Don't worry about reflected power or standing waves. Lookit. If conditions are lousy, sunspots, aurora or wrong skip, you aren't going to get through, even with a kilowatt. And if conditions are right, they'll copy you on a wet noodle. So why worry about getting a unity match? Forget the SWR."

Great, isn't it? I really don't care about him. In fact, maybe we'll get lucky and he'll burn up his final, and we'll be rid of him once and for all. It's too bad that so many gullible people will go along with him.

"I have it on good authority that incentive licensing will never go through."

Does that sound familiar? It ought to; we heard it so often for a couple of years. It was stated with fervor and conviction. It reminded me of the scared kid, whistling while taking a shortcut through the cemetery. These guys were so adamantly set against the re-structuring proposals that they couldn't imagine that anyone would disagree with them. Many of us were against incentive licensing, that's true. But, when it became a fait accompli we simply rose to the challenge, and started to prepare ourselves to meet it. The same jokers are now saying something like this:

"I have it on reliable authority that the FCC is going to take a long, hard look at this fiasco, and is going to refuse to implement the second year sub-band allocations. It just hasn't worked out the way they hoped."

More wishful thinking. They would rather stew in their own venom than come to grips with the obstacle, and exert themselves in order to overcome it.

Here are a few more, about which I will not comment. I leave it to you to draw your own inferences concerning my feelings in the matter.

"What do these nets think they're pulling, anyway? They don't have any right to tell me to move. I've got just as much right on this frequency as they have, and if they want a clear channel, let them use the telephone."

or. . . .

"I listened on this frequency and didn't hear a soul. Just because you claim to be running overseas phone patches doesn't entitle you to take over the whole band. Did the FCC give you this channel exclusively, or something? Boy, a guy comes home after a hard day at the buttom works, looking for some relaxation, and right away some do-gooder tries to push him off the air. I tell 'em nuts. Every time."

or. . . .

"Whaddye mean, I'm on the DX station's frequency? Let him go down to the foreign portion where he belongs. If I feel like working here, it's my business, and if you don't like it you can lump it. It's a free country."

And so it goes, on and on, far into the night. How about this one:

"I didn't copy that last transmission, Mac. Some lid interfering deliberately. He was testing on this frequency before we started, and I'm sure he heard us. But he's still testing. I don't know what's happened to good, old-fashioned courtesy, anymore."

or. . . .

"Take it from me, Charlie, all these here appliance operators with the sideband gear are making a shambles outa this hobby. I've been using this receiver for over twenty years, and I never had any trouble before these quack-quackers came around. They're all over the band, broad as a barn door. Whaddye mean, a product detector? I never needed one of those when a good AM signal came through. And don't tell me about the selectivity, either. This receiver of mine has been doing a great job for me, and I'm not about to modify it just because of a bunch of Donald Ducks. Sooner or later this sideband stuff is gonna fade right outa the picture, anyway."

Well, I just thought I'd get it off my chest, anyway. Anyone for tennis?

. . . K2AGZ

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Cockeysville, Maryland 21030

Magikey – for Automatic Didahs

Flat-walleted brass-pounders, take heart. An electronic key, the Magikey, is a gutless wonder for making self-completing dots and dashes with controlled spacing. Only three plastic transistors are used to generate the keying waveform, and the lot can be bought for about two dollars. A keying relay and driver are available for about another three bucks if you need them, and the single pole key can be anything from a "Vibro-key" to a piece of hacksaw blade.[1] Don't let the cost or size mislead; it's a real performer, almost like magic.

The Magikey uses the Programable Unijunction Transistor (PUT) to develop the timing function and keying waveform. The PUT is a peculiar device introduced by GE a little over a year ago. The PUT exhibits a negative resistance between anode and cathode whenever the anode-gate junction is forward biased and a critical anode eurrent, Ip, is permitted to flow. That is, after the anode is made more positive than the gate, the regeneration inherent in the PNPN structure causes the anode-cathode and gate-cathode voltages to drop to less than a volt above cathode voltage. The device remains "on" until the anode current is reduced below Iv. After the anode current is reduced below Iv, the device turns "off", and the anode cathode terminals become essentially an open circuit.

The ratio of Ip to Iv can be from 5 to 50, depending on the gate voltage source resistance. The highest ratios seem to occur when the source resistance is in the range from 10K to 100K. The lowest ratios occur when the source is in the range of 1K.

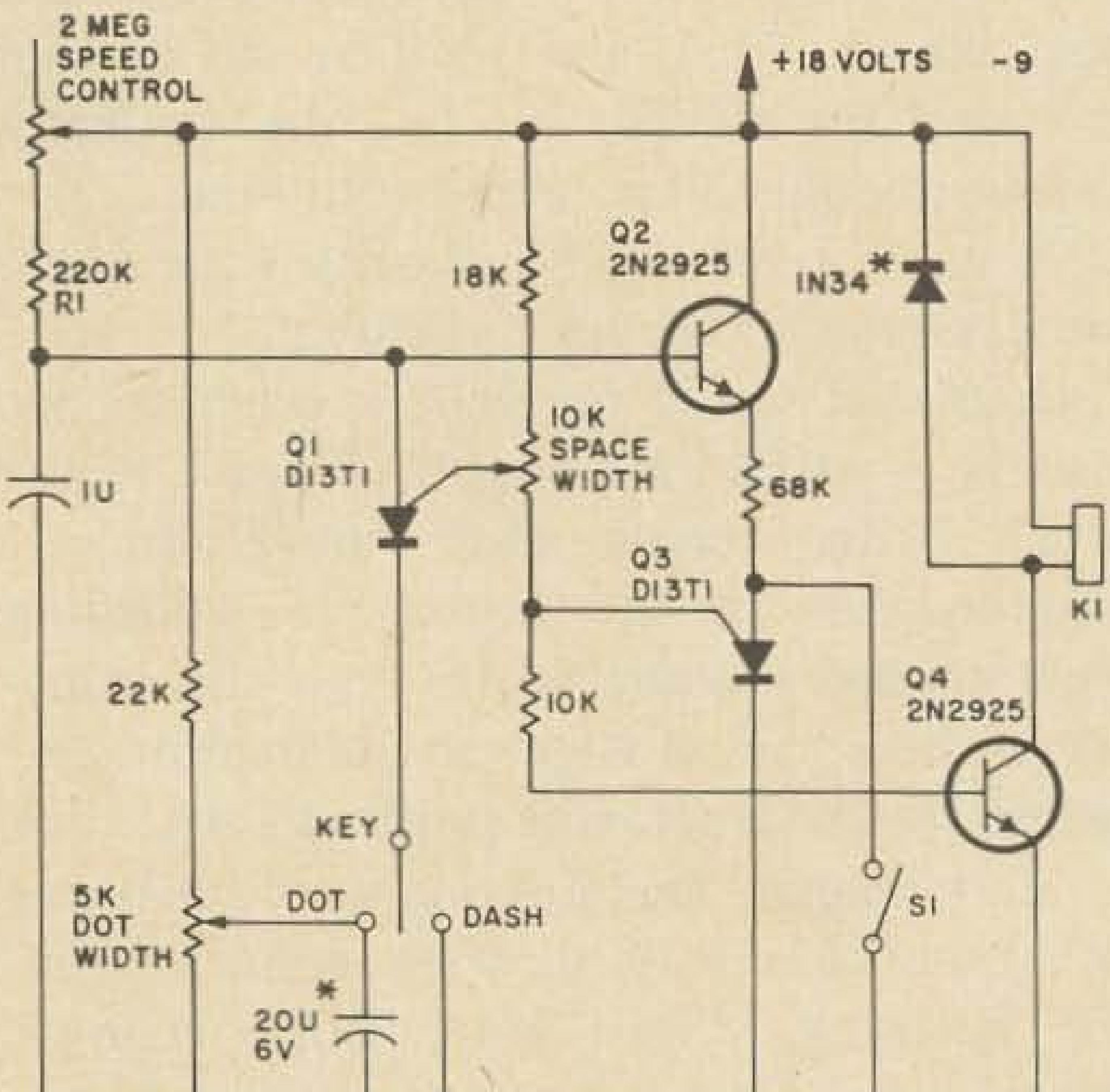

Fig. 1. Magikey electronic key schematic diagram.

The Magikey, shown schematically in Fig. 1, can be divided into three parts: the timing section, Q1; the keying waveform generator, Q2 and Q3; and the keyer, Q4.

The timing circuit basically is a UJT relaxation oscillator. When the cathode is grounded, it operates as follows: The timing capacitor, C1, charges through the speed control R1, and the PUT anode voltage rises at a rate determined by C1, R1, and the supply voltage. R1 is chosen so that its current is greater than the Ip of the PUT but less than Iv for all conditions. When C1 has charged to the gate voltage, Vg, the PUT turns on and discharges C1 to about cathode voltage. After C1 has completely discharged, the only current available to the anode is through R1. Since this is less than Iv, the PUT turns off. The capacitor then begins to recharge to repeat the cycle.

The anode voltage of the PUT, then, is a sawtooth with the maximum positive voltage approximately Vg, and the least positive voltage approximately equal to cathode voltage. When the cathode circuit is open, the anode voltage rises to Vg and is limited there by conduction of the anode-gate junction, and oscillations are interrupted. As soon as the cathode circuit is closed, C1 discharges to cathode voltage at a rate determined by C1 and the impedence in the cathode circuit. In the circuit given, any closure longer than 1 ms is enough to allow C1 to completely discharge.

To generate dash timing, the cathode is closed to ground and C1 discharges to about 1 volt. The time required for C1 to recharge to Vg is equal to the time of a dash and a space. To generate dot timing, C1 is not closed to ground but to a positive voltage, so that the time required to recharge to Vg is reduced to that of a dot and a space. The sawtooth pattern for the word "an" is shown in **Fig. 2**.

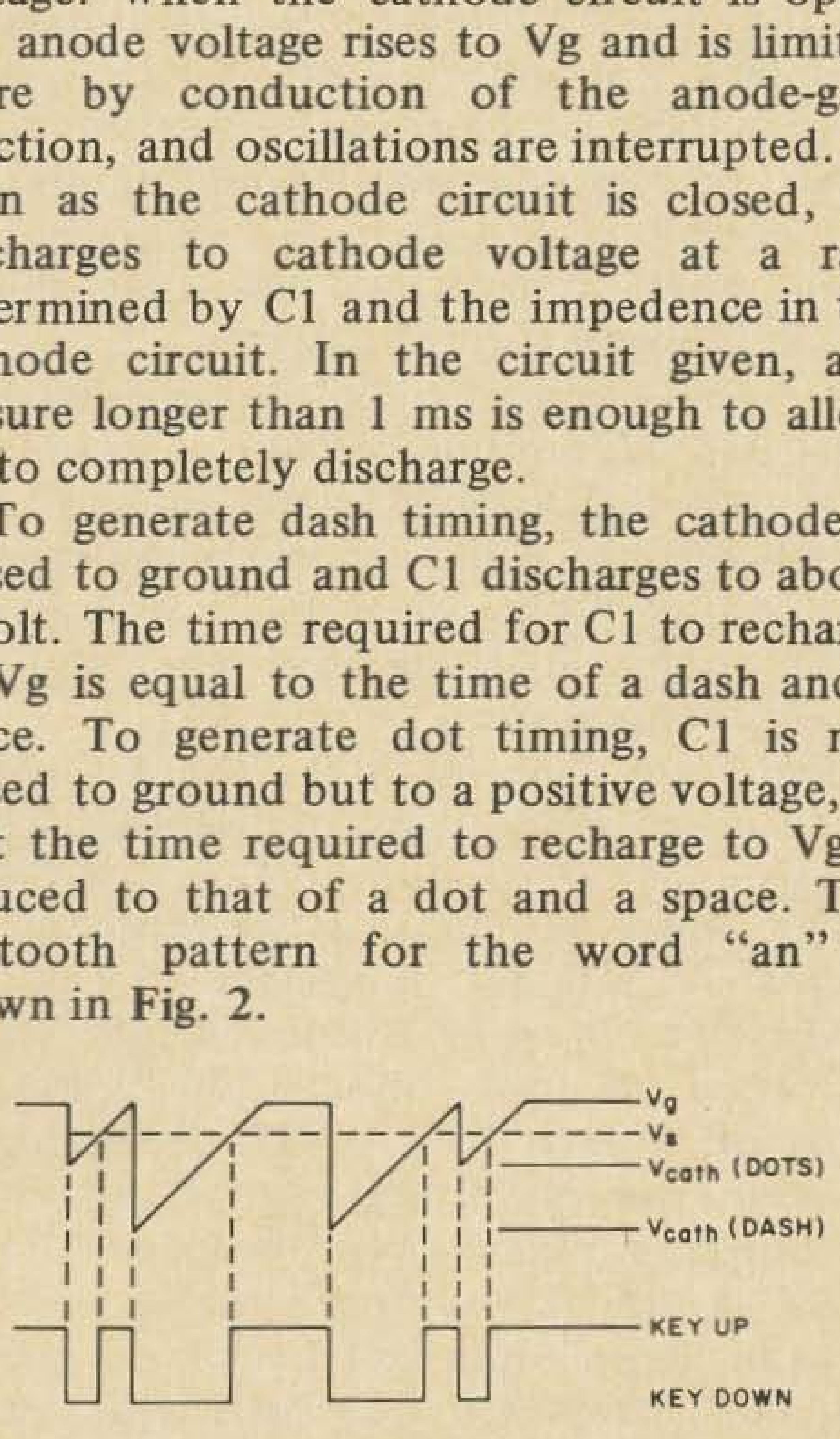

Fig. 2. Keying waveform for word "AN."

The keying waveform shown in **Fig. 2B** is generated by sensing whether the sawtooth voltage is above or below a particular voltage Vs. When the sawtooth is more positive than Vs, a "key-up" voltage is produced. When the sawtooth is less positive than Vs, a "key down" voltage is produced. The time required for the sawtooth to rise from Vs to Vg is the time of a space, or the minimum "key up" time that can be generated.

In the keying waveform generator section, the PUT, Q3, does the voltage level sensing, while Q2 isolates the timing capacitor from the loading effects of Q3. When the voltage on the emitter of Q2 is higher than Vg of Q3 and causes Ip to flow through R4, the PUT turns on, and the anode and gate voltages fall to about 1 volt. This voltage level represents "key up." When the voltage on the emitter of Q2 is reduced, (the timing capacitor is discharged), the anode current available to Q3 is less than Iv, and the PUT turns off. The voltage at the gate of Q3 switches from about 4 volts "key down" to 1 volt "key up." This is more than enough to drive a keying transistor or even a low-power audio side-tone generator.

In the keyer section, Q4 is the keying transistor. The "key down" current varies with power supply voltage, from .25 ma with a 12 volt supply, to .5 ma with a 24 volt supply. This current is sufficient to drive a low current transistor. In **Fig. 1**, the keying transistor is shown driving a keying relay, but the most practical and economical approach depends on the keying arrangement used in your transmitter. A high voltage transistor costs about half as much as the relay, but has limited current carrying capability.

When driving a relay, the power dissipation in the transistor can be very low. The dissipation is less than 75 mw when driving the 500 ohm coil, as shown in **Fig. 1**. The problem is not dissipation; it's the inductive kick when the transistor turns off. The diode across the relay eliminates that problem, so that a low voltage transistor can be used to drive the relay. The diode does extend the relay release time, but it should be significant only if you're batting along at 30 wpm or so. You won't be working me, though, at those speeds, so I'm not too picky. If you are, use a high voltage transistor that can stand the kick.

The circuit given has a keying speed range from about 5 wpm to 50 wpm. If this is a greater range than you need, you can rejuggle the R and C combination in the timing circuit. Just keep the total resistance between 200 K and 2 megohms, and pick a value for C1 that gives the speed you want. C will depend on the supply voltage, among other things, but generally it will be in this range: C(in ufd)= words per minute/3 x R(in megohms).

The switch S1 across Q3 provides a continuous "key down" condition for tuning the transmitter, if you need it. I tune up with a string of dashes, and mentally correct the meter readings to account for the fact that the key is "up" one-fourth the time.

Adjusting the Magikey for proper character formation is a snap. You can use a scope or a voltmeter at the gate of Q3, or an ohmmeter across the relay contacts. Either method is better than trying to go by ear. The adjustments are straightforward when made in this order:

1. Connect the ohmmeter across the relay contacts, or a voltmeter to the gate of Q3. Off-set the meter's zero to read zero with "key up." Note the meter reading with "key down," S1 closed.
2. Set the keying speed control for near maximum speed so that the meter can not follow key closures.
3. Close the key to the dash position and adjust R3, Q1 gate voltage, to cause the meter to deflect to exactly 75% of the "key down" reading. On the ohmmeter this is 75% of full scale, since the contacts are closed three fourths of the time when making properly formed dashes.
4. Close the key to the dot position and adjust R2, Q1 cathode voltage, to cause the meter to deflect to exactly 50% of the "key down" reading. On the ohmmeter this is 50% of full scale, since the contacts are closed exactly half the time when making properly formed dots.

That's all there is to it. The dot/dash/space ratio holds for all keying speed settings.

The power demands of the Magikey are minimal, a nominal 18 volts at 1.3 ma. A pair of small 9 volt batteries like Eveready No. 216 will give about 300 hours of operating time if the keying transistor is powered from the transmitter. If you steal the power for the keyer from the transmitter, it can be anything from 12 volts to 24 volts. Regulation isn't extremely important, but character weight varies with supply voltage. So a zener diode regulator for Q1 and Q3 is a good idea, if you steal the power from an uncertain source.

Construction is not critical, and if you don't use the keying relay, the parts easily can fit on a 2" x 3" PC board. The small size makes it a natural for adding to the base of your key, or even building into a vest pocket CW transmitter. I expect it will take longer to get the "feel" of automatic dots and dashes than it will to build the Magikey. The Magikey has only a limited amount of magic in it, though. It can't transform a lid, but it sure can cure a banana-boat swing.

You can buy the drilled PC board, or kit, from the author.

...W3SGV

[1] "The Polar Key," K4YWS, *73 Magazine*, April, 1968.

Using the Paxitronix Frequency Divider with a Transceiver

The Paxitronix IC-3 Frequency Divider is a little gem which provides 25 kHz markers from your 100 kHz crystal calibrator. With the sub-division of our ham bands, a unit of this type is almost a necessity. However, I feel a word of caution is in order.

Installation of the IC-3 into a receiver is straightforward, and presents no problems. However, the application into a transceiver requires the obvious prevention of *rf* being fed back into the calibration unit; i.e. you just cannot hook the IC-3 output back to the antenna terminal (coax fitting) of the transceiver.

The Drake TR-4 circuit diagram shows a "gimmick" connection running from the plate of the crystal calibrator tube (V-5 Pin #5) to a lead to the grid of the receiving section *rf* tube (V-7). In actuality, they run this lead to a wafer switch and secure it so it couples into the circuit *without any physical electrical connection.* It is possible to hook right to pin #1 of V7 with the blue output lead of the IC-3, but this will require retuning the *rf* coils, and is both undesirable and unnecessary. I ran another gimmick wire to the same wafer switch on the Drake, and utilized one of the spare terminals to hold the blue lead mentioned above. The output is less than the 100 kHz crystal provides, but is more than adequate if the band is quiet or the antenna is disconnected during calibration. More output can be obtained by putting a 6 or 10 pF coupling condenser in series with the blue IC-3 output lead and hook onto pin #5 of the calibrator tube V5. This connection may be more easily made at a circuit board conveniently located in the TR-4. This now couples back, using the original gimmick arrangement and requires no TR-4 circuit changes.

Just to complete the picture, the red wire of IC-3 goes to pin #1 of V-20 (OA2), the yellow wire to pin #5 of V-5 (pick up on circuit board), the brown wire to the cathode resistor R29 on the circuit board. This connects pins 2 and 7 of V-5 so that switching the calibrator off and on, also switches the IC-3.

Equal credit for this idea should go to K4WM. His steady hands did the soldering.

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Ed. Note: A 10K, 2 watt resistor should be placed across R112 (2.5K, 7 W resistor) to compensate for the 10 ma drawn by the IC-3.

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FM = Fun Maker

Most amateurs have heard of FM operation on the vhf ham bands but few are actually aware of "what's happening" and why the trend towards FM vhf, especially why mobile FM. The purpose of this article is to give some insight into an exciting phase of amateur radio that seemingly has been overlooked by most. It is only within the past two years that this phase of amateur radio has grown so large that ignoring it would be cheating oneself of full use of his amateur privileges.

The majority of FM activity is taking place on six meters (called low-band) and two meters (called high-band). Activity can also be found in lesser amounts on the 10 and 3/4 meter bands. All operation is crystal controlled, both on receive and transmit. This eliminates receiver and transmitter tuning and missed calls. Receivers become more sensitive since they don't have to be broad-banded to cover the entire band. FM is noted for its quieting factor, which most say is better than AM. The audio level is constant regardless of how strong or weak the signal is. Two types of operation are generally in use. One is direct station-to-station (mobile to base, base to base, mobile to mobile, etc.). This direct communications is defined as simplex operation. The other is via a repeater function. The use of a repeater increases the average mobile coverage to 30 to 50 miles of solid, noiseless, communications. The repeater and its basic operation is explained later.

For those of us who must satisfy (justify may be a better choice of word) the XYL on the cost of a mobile installation and its appearance, your best bet is FM. Most of the equipment available today is "trunk mount." That is – the transmitter/receiver combination mounts in the trunk of the car and out of sight (point No. 1). All that mounts in the front of the car is a small control head (point No. 2). The speaker can be mounted up against the fire wall if necessary (point No. 3) so all that is showing in the entire mobile installation is the control head. The control head is so small one would never notice it unless it was brought to his attention. The antenna also is a wife pleaser in that two and six meter whips are smaller and less conspicuous than 20 or 40 meter whip antennas.

FM has considerable potential for emergency communications, since operation is simplified and the performance is of commercial quality. If the above does not prove a satisfactory argument for the XYL to allow a mobile installation, seriously consider the safety factor. If you or your wife are out in the car late at night and should the car break down all you have to do is pick up the mike and request help. Since everyone is crystal controlled on the same frequency you will be heard immediately. The larger (more populated) the city you're in, the more you need radio in the car for safety's sake. It also follows that the larger the city, the more FM radio amateurs there are. The need for safety in a large city and the response for help by FM you will receive if plotted graphically would display similar curves.

The FM mobile equipment is turned on with the flip of the ignition key and is ready to monitor without tuning. The mobile equipment is always on the correct frequency. Ninety-eight percent of all equipment in use today is modified commercial FM two way radios that have been taken out of service from Police, Fire, Taxi, etc. The brand names most popular are Motorola, General Electric, and RCA. Most equipment in use runs between 30 to 60 watts output. The amateur can find for sale (from another ham) a complete FM set-up which includes transmitter/receiver (almost always on one chassis), control head, speaker, microphone, and all power and control cables. The price for all this is only between $50 and $150 depending usually upon the age of the unit in question. Tube sets using dynamotors usually go complete, all tuned up with proper crystals and the aforementioned accessories for around $50. A unit that is relatively new (manufactured in the last six years or so) that has a transistorized power supply complete with accessories would sell near the $100 range. There are units now on the market that run 80 watts output and are completely transistorized except for the final, complete with accessories that sell upwards of $350. But no matter what is finally purchased (or horse traded) an FM installation is generally much less in cost than most amateur SSB mobile gear. The price range is generally the same regardless of band chosen. The factor that varies the price of a given unit would be law of supply and demand and popularity of the unit in that given area. If units are purchased directly from a commercial outlet, conversion for ham use requires purchasing commercial grade crystals and retuning various stages. Two meter gear requires padding the front end of the receiver. UHF equipment (450 mhz) generally needs no modification except for obtaining new crystals and retuning. Additional output "sock" can be realized through the use of a gain antenna. Usually in regular amateur mobile service the vertical antenna gain at best is unity (1). On two meters and higher a gain of +3 db can be had by using an antenna of greater than 1/4 wave length. On two meters the 5/8 wave length antenna is popular. The effective output of the transmitter is doubled by use of the gain antenna.

Throughout the country 146.94 mhz and 52.525 mhz are found to be the most active frequencies. These frequencies have been designated National Emergency and Calling frequencies. National repeater frequencies are: six meters 52.80 mhz input, 52.72 output; and on two meters: 146.34 mhz input, 146.76 output. In some areas however, the repeater has output(s) on the main frequency (above).

Repeater stations have become quite popular recently and are now in operation throughout the country. These repeaters receive on one frequency (i. e. 146.34 mhz) and retransmit the received signal on another frequency (i. e. 146.76 mhz) simultaneously. This gives mobile stations the advantage of higher power and an extremely high antenna. Mobile-to-mobile operation is extended greatly. Right now it is possible to travel across the country working through a repeater in one area and working through another repeater as you approach the next area. This is why standard repeater frequencies are a must.

The Maryland FM Association in the Baltimore area has an active repeater on the two meter band. An in-band six meter repeater is scheduled for operation soon. The two meter repeater has an input of 146.34 mhz and retransmits out on 146.76 mhz. Due to my job I am in and out of the car all day long. I can't spend the time tuning in stations, loading up the rig, calling CQ and hoping someone will be listening on the frequency I choose. Since most of my travel is on the highway at 60 mph I'd rather pay attention to the road and traffic. With the FM installation I just pick up the microphone, hit the button and say, "K2PTS mobile listening." Since my signal goes through the repeater my mobile now has the extra sock of high power and an antenna at 200 feet, nine times out of ten I will get a reply.

The FM mode can not be compared to any other form of operation. Even so, FM still holds a place for every type of interest in the amateur field. For the vhf DX man the remote base stations and repeaters make ordinary ground-wave communications through use of these facilities comparable to the best band openings. On the technical side, the builder and experimenter will become engrossed in the complexities of long distance inter-connected repeaters, remote control, mobile telephone, etc. Those interested in net operation find that the FM mode fits in nicely with Civil Defense, RACES, MARS, AREC, etc. For the mobiler the advantages are infinite.

There is so much more to FM than just getting a signal report. The resemblance between FM and any other mode is purely coincidental. Why not give FM a try?

. . . K2PTS

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The SB100 on Six Meters

I am the proud owner of a Heathkit SB100. This rig has performed so well that I just had to invent something that could be wrong, et voila, I found it. It did not work on six meters.

Now, if you are willing to take in stride the loss of the 29.5 to 30 mhz band portion, reduced power output, just one band segment of 500 khz and reversed dial readings on the vfo and mode switch, I can tell you how to

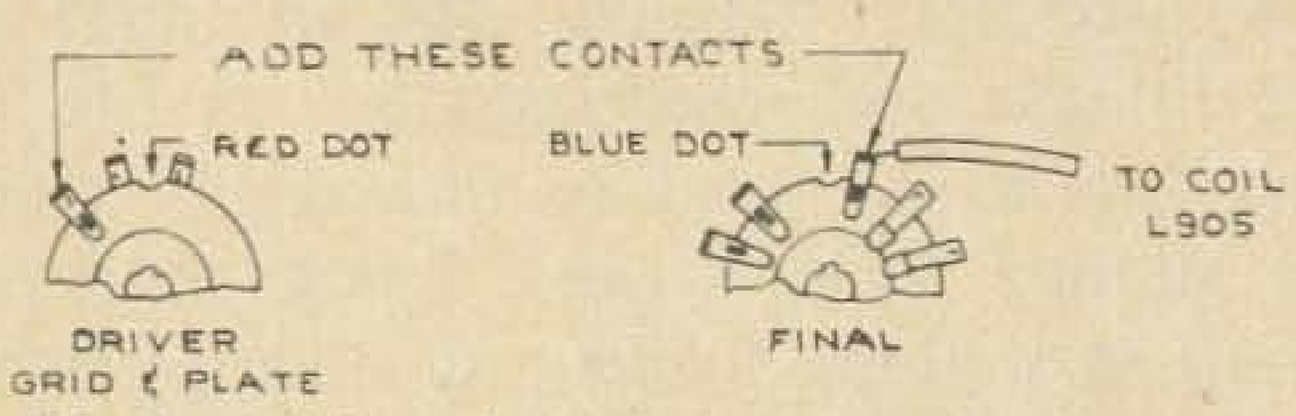

Fig. 1. Adding short switch contacts to the driver grid, driver plate, and final band switch.

put this rig on six meters. Reports received show that it performs on six like a Heathkit

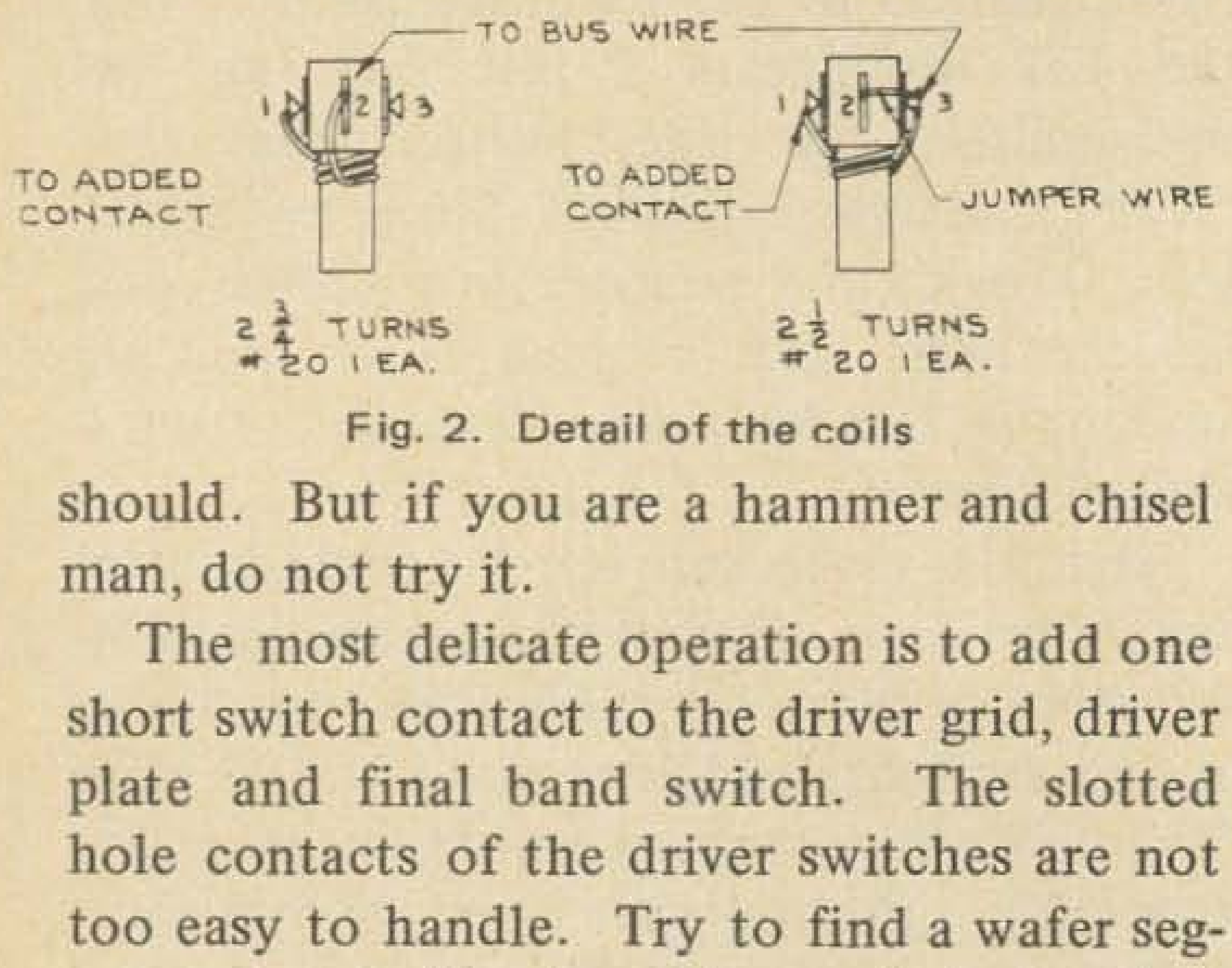

Fig. 2. Detail of the coils

should. But if you are a hammer and chisel man, do not try it.

The most delicate operation is to add one short switch contact to the driver grid, driver plate and final band switch. The slotted hole contacts of the driver switches are not too easy to handle. Try to find a wafer segment that is like the driver switch, break it apart, straighten the tabs that held the contacts with a pair of pliers and pull the tab out of the contact slot. Then assemble the tab to the driver band switches from the back. Fix the contact over it in front of the switch, and solder very carefully together. Be sure that no solder flows in between the contacts. The assembly of the final is done in similar fashion with a round eyelet contact.

The driver coils were made of some old 41 mhz transformers soldered directly to the added contacts for support. I used a No. 20 wire close wound.

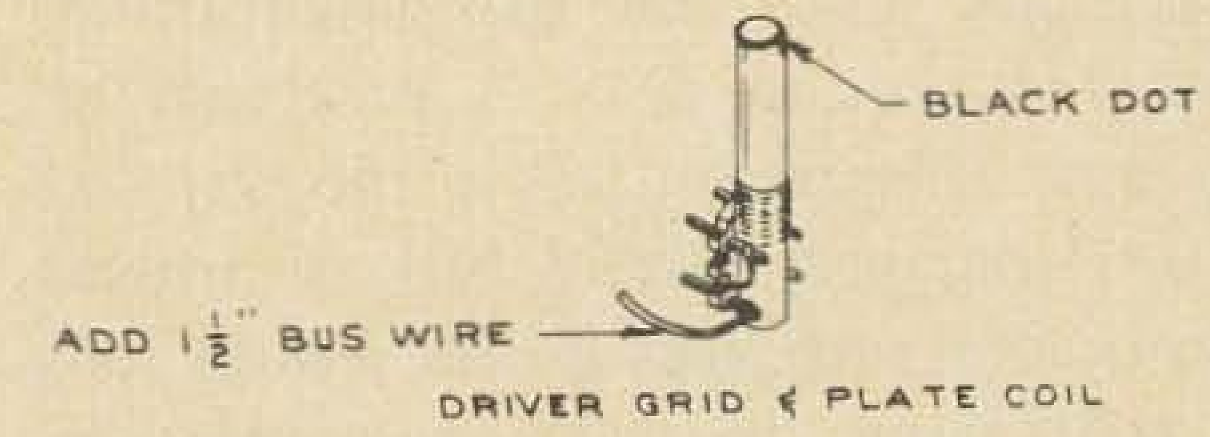

Fig. 3. Driver grid and plate coil with bus wire attached.

Tests have been made to use a 58.395 mhz heterodyne crystal, but this required changes in the heterodyne oscillator circuit, gave less output and was finally discarded. I settled for a low side 41.605 mhz crystal, and quickly got used to switching to LSB in-

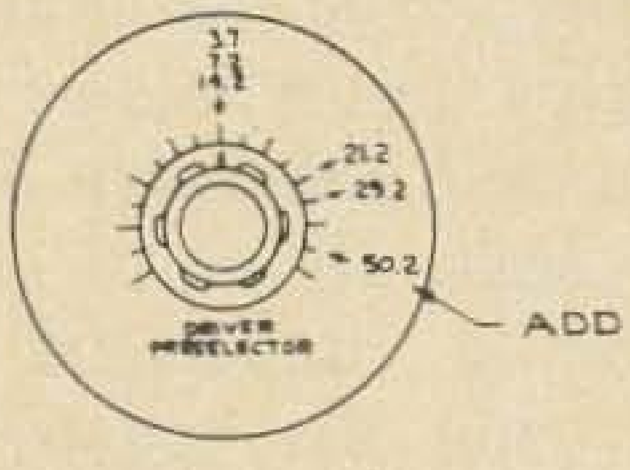

Fig. 4. Adjusting the driver preselector.

stead of USB and to reading the vfo dial backwards:

50.0 mhz=500
50.1 mhz=400
50.2 mhz=300
50.3 mhz=200
50.4 mhz=100
50.5 mhz= 0

Tune up is best done with an SWR meter. ALC and rf output readings are reduced on the SB 100 meter.

The modifications are as follows and are in the proper sequence:

1. Remove coil cover and support rail for better access.

2. Unsolder and remove 38.395 mhz crystal from heterodyne crystal board.

3. Replace with 41.605 mhz crystal (part No. 404-264 SB 110).

4. On heterodyne oscillator board, remove 2 turns from 29.5 mhz coil (blue dot) and resolder.

5. Add three short switch contacts to driver grid, driver plate and final band switch. See Fig. 1 and text.

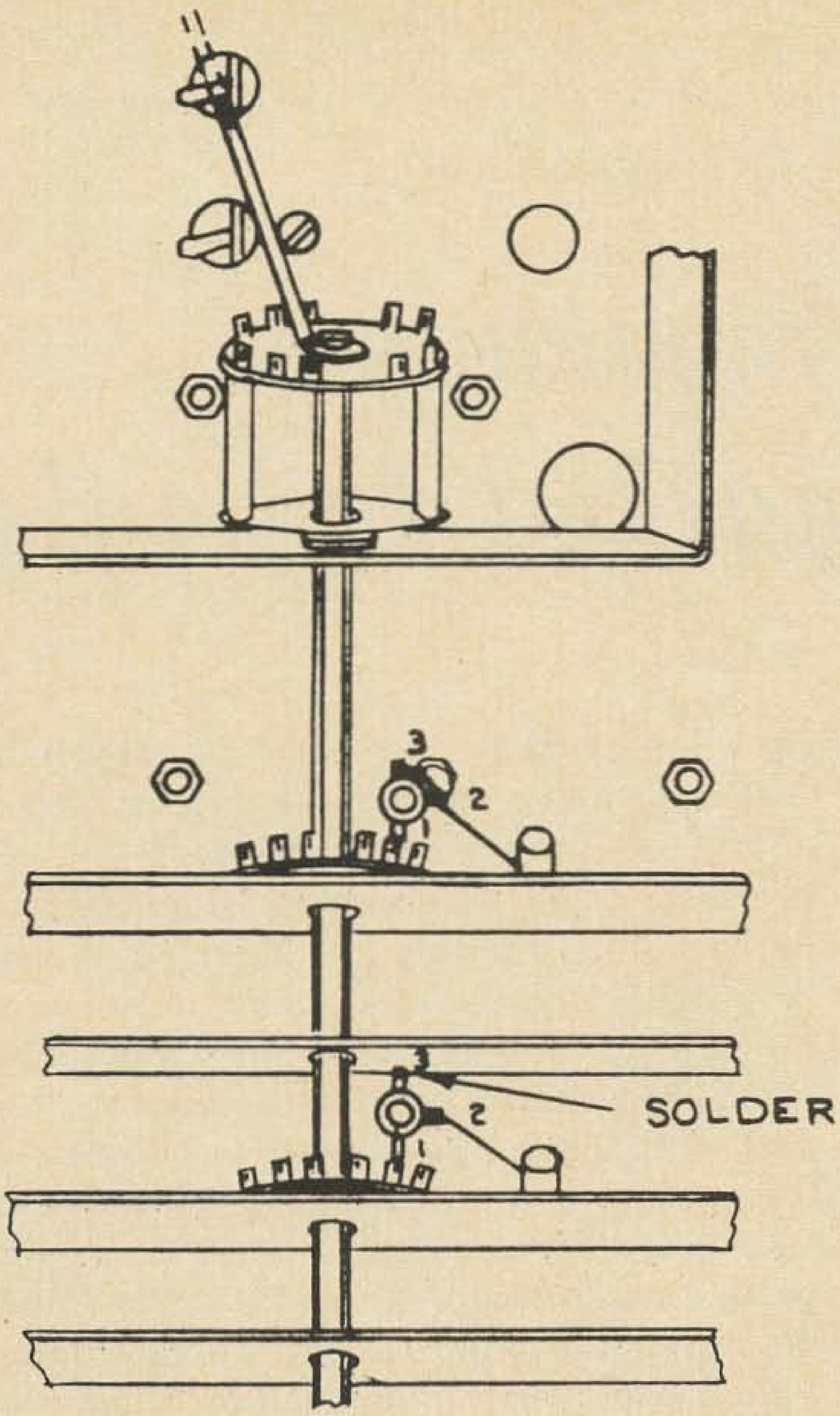

Fig. 5. Completed assembly of the band switch.

6. Tap 10 meter coil L905 in the middle with heavy red wire and run through hole DB2 in chassis to added short contact on final band switch. Solder each end.

7. Make 2 coils. See **Fig. 2** and text.

8. Connect bus wire 1½ inch long to 29 mhz driver grid and driver plate coil form (left hand bottom, see **Fig. 3**) and solder.

9. Solder 2-3/4 turn coil to added contact on driver grid switch and added bus wire from 29 mhz driver coil (black dot).

10. Solder 2¼ turn coil to added contact on driver plate switch and added bus wire from 29 mhz driver plate coil (black dot).

11. Punch two holes for access to new coils into coil cover.

12. Reassemble support rail and coil cover.

13. Adjust heterodyne coil per manual.

14. Adjust driver preselector to **Fig. 4**.

15. Peak driver grid and driver plate for maximum per as manual.

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Measuring the Frequency of Unmarked Crystals

Surplus, unmarked crystals are easy to obtain, but are of little value to most experimenters since the frequencies are unknown. By using a Grid-Dip-Oscillator and/or a surplus frequency meter, the frequencies of the unmarked crystals may be determined to an accuracy exceeding 1% depending on which instrument is used.

Measurement with Grid-Dip-Oscillator

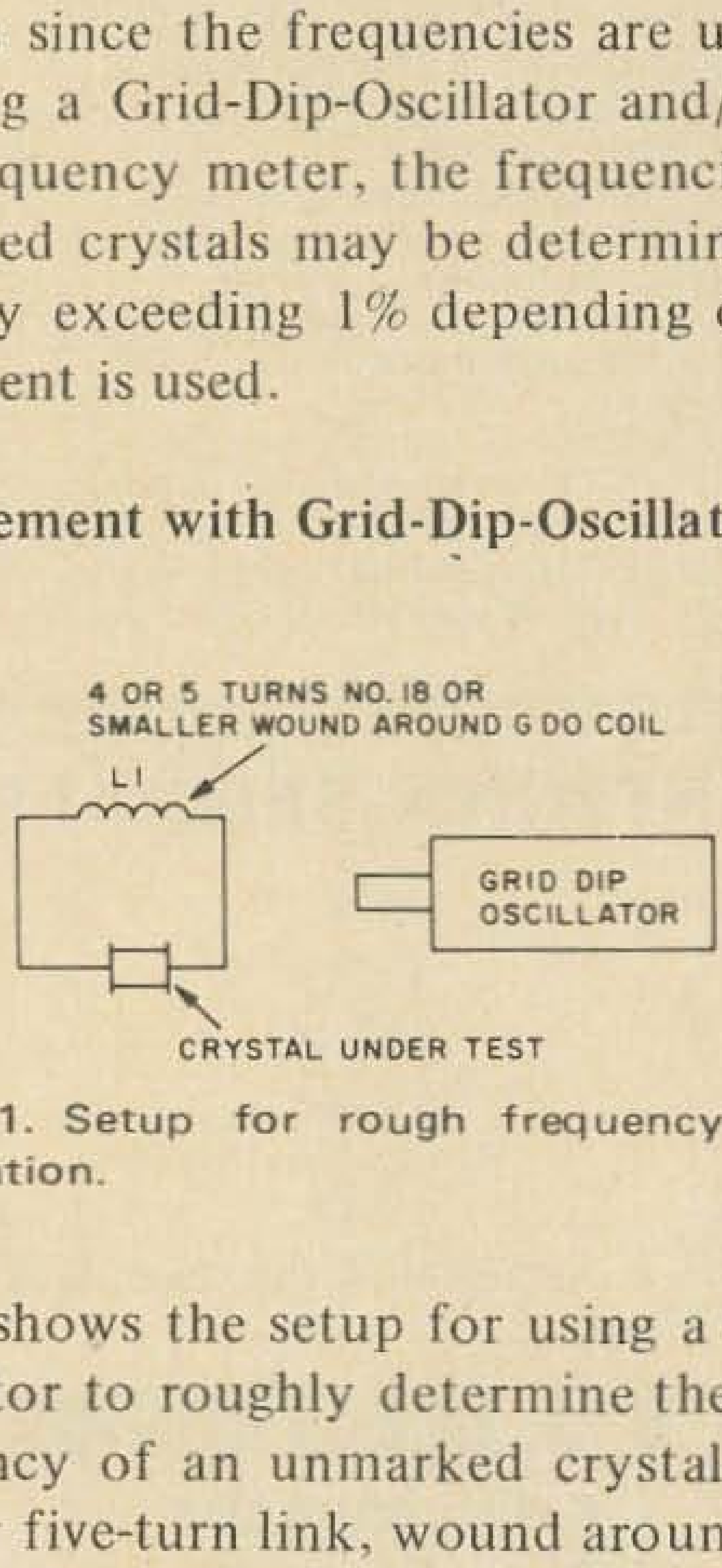

Fig. 1. Setup for rough frequency determination.

Fig. 1.shows the setup for using a Grid-Dip-Oscillator to roughly determine the resonant frequency of an unmarked crystal. L1 is a four or five-turn link, wound around the coil of the GDO. The coil may be soldered to a crystal socket or wrapped around the pins of the crystal being checked. To find the approximate frequency of the crystal, choose a low frequency band coil such as 2 to 5 mhz first, using the higher bands last. Avoid starting with high band coils as the measured frequency may be an overtone. Insert the coil in the GDO, place the GDO in the oscillator position, couple L1 tightly to the GDO coil and vary the frequency of the GDO from low to high very slowly. At resonance, the GDO will dip very sharply. It is important to vary the frequency slowly or the sharp dip will be missed. The dial of the GDO will now read the approximate frequency of the crystal. If a dip is not obtained, it will be necessary to use the next highest coil for the GDO. When resonance is obtained, it will be possible, with careful tuning, to maintain a steady dip, at which point the GDO will be locked to the frequency of the crystal. It is now possible to use a general coverage receiver to pick up the oscillating crystal and thus determine the frequency of the crystal to an accuracy better than that of the GDO. If a general coverage receiver is not available, a surplus frequency meter such as the BC 211, may be used.

Measurement with the BC 221

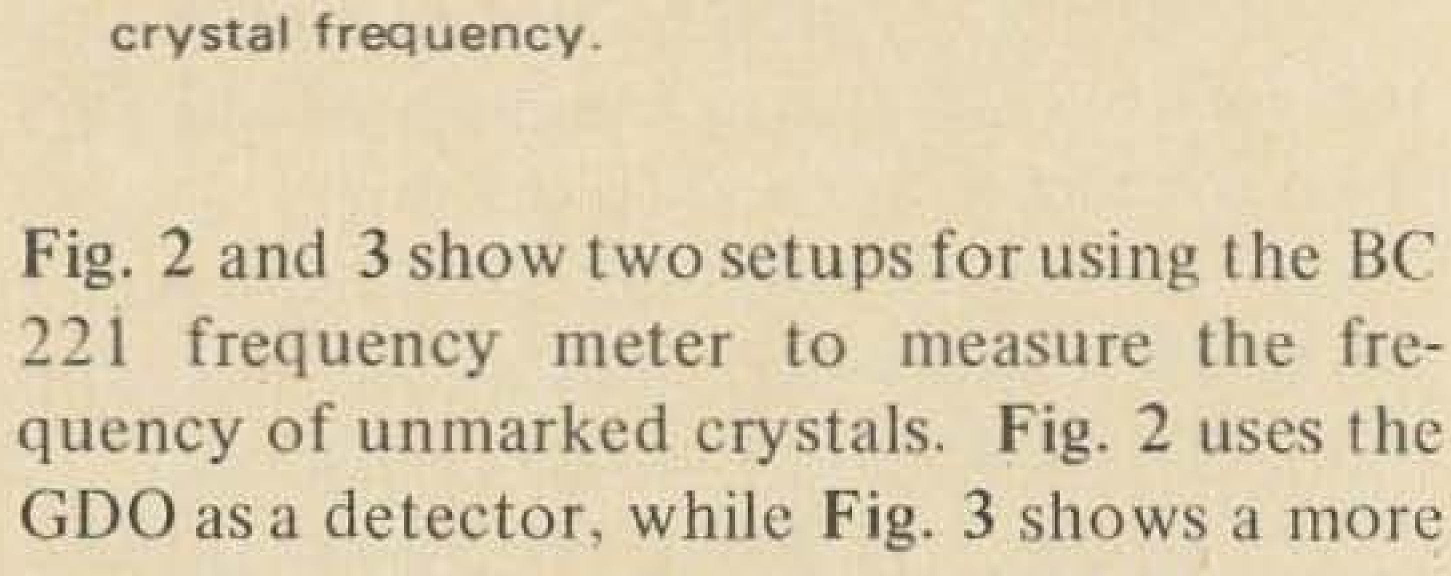

Fig. 2. Setup for accurate determination of crystal frequency.

Fig. 2 and 3 show two setups for using the BC 221 frequency meter to measure the frequency of unmarked crystals. Fig. 2 uses the GDO as a detector, while Fig. 3 shows a more sensitive arrangement using a VTVM as a detector.

With the BC 221 or similar frequency meter, the crystal is connected across the output terminals, and the detector either coupled through a loop in the circuit or directly across the crystal. If a GDO oscillator is a part of the station equipment, the quickest way to determine the frequency is to first roughly find the frequency of the crystal using the GDO as previously described. After the rough frequency has been determined, place the crystal in one of the circuits as shown in Fig. 2 or 3. If the GDO is used as the detector, do not alter the tuning when placing the GDO in the circuit. Starting at a frequency known to be above or below the rough crystal frequency, very slowly vary the frequency of the BC 211 toward the rough frequency, until an indication is observed either on the GDO in the diode position or on the VTVM. The indication in either case will be an upward deflection on the meter. In the case of the VTVM as a detector, there should be some residual reading on the meter which will increase when the crystal frequency is reached. In some cases, depending on the

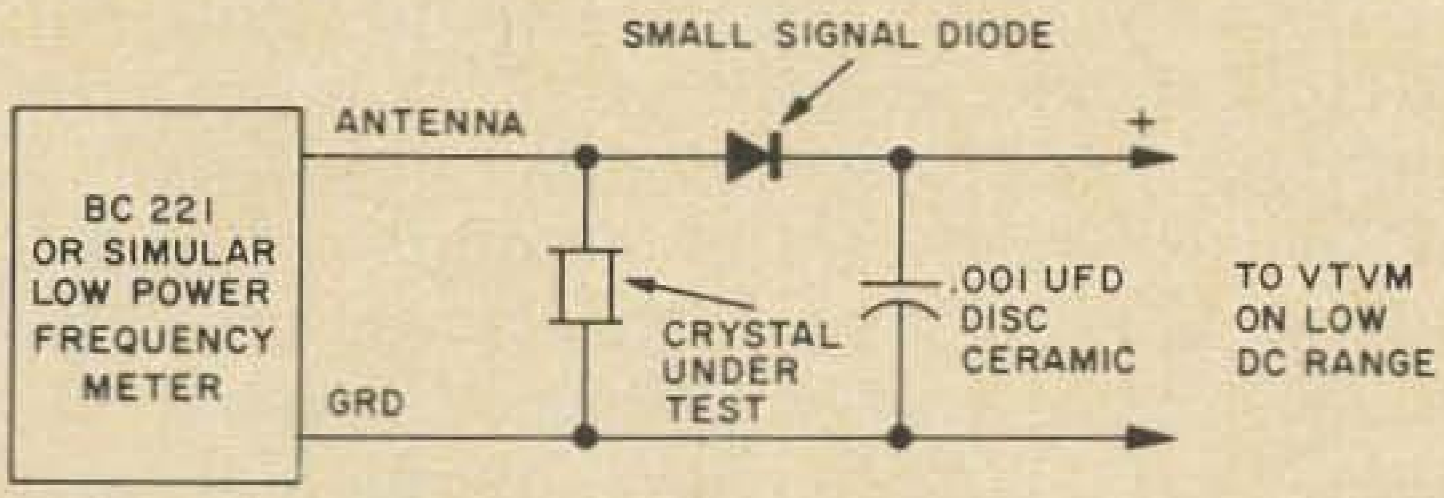

Fig. 3. Alternate setup for accurate determination of crystal frequency.

type of GDO and the frequency, the indication on the GDO may be barely discernible. In this case, it is recommended that the VTVM be used as the detector. If a GDO is not available, and it has been impossible to determine the rough frequency of the crystal, then the task is more time consuming. It will now be necessary to start the frequency meter at its lowest frequency and slowly vary the frequency upwards until an indication is noticed on the detector.

By using the techniques described, I have measured crystals in the range of 2 to 12 magacycles with the results exceeding 1% accuracy. If it's necessary to determine the frequency of a crystal to an accuracy much better than this, then the crystal should be placed in the oscillator to be used, and the frequency checked by using more sophisiticated methods. These techniques are presented because of their speed, simplicity, and reasonable accuracy.

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Getting Your Extra Class License

Part VII - Receivers

STAFF

Last month, we examined the nature of noise and also took a look at the various types of detectors used in communications receivers. In this installment of the Extra Class study course, let's stick with receivers a little longer and find out some of the more exotic details.

In doing so, we'll cover eight of the questions on the FCC study list–a few more than we usually take care of in a single section, but these are all rather closely related. The specific questions involved are:

11. How does a squelch circuit operate? Draw a commonly used squelch circuit.

33. How should a wave trap be connected to a receiving antenna circuit to attenuate an interfering signal?

45. How do receivers for remote control of objects and regular type communications receivers differ in basic operation?

46. How will a long and a short time constant AVC circuit affect reception?

51. How do trimmer and padding capacitors affect receiver tuning?

59. Define the conversion efficiency of a mixer tube.

68. What is the image-response of a receiver? How can it be reduced?

70. What effect will extending the low-frequency response to a signal have on the design of an SSB receiver?

As always, we won't attempt to answer any of these questions directly. If your only interest is in memorizing answers, there are other sources for that kind of information. Instead, we'll frame a set of more general questions which will cover all these and more besides, and in the process of finding the answers to that more general set, get the answers to the study questions and all related queries.

The major subject involved in all these questions is that of receiver design and operation. A logical starting point, then, would be to ask "What influences receiver design?"–but that's just a little *too* big a question for our space. At least one book of more than 1,400 pages has been written on that one, and the only way the subject was met in so little space was to make generous use of references to other volumes throughout!

So we will use a similar starting point, but a more restricted question: "How does the purpose of a receiver affect its design?", which will take care of question 45 among others; then we'll try to determine, "How do signal characteristics influence receiver design?" and this should cover questions 46 and 70.

Most of today's receivers are superhets, and superhets have some special problems. That's our third question–"What are some of the special problems of superhets?"–and it will equip us to answer questions 51, 59 and 68 on the FCC list. Regardless of receiver type, interference is always something which must be faced, and our final generalized question will be "How can we combat interference?" That should take care of questions 11 and 33 among others.

All set? Let's move out.

How does the purpose of a receiver affect its design? Radio receivers are designed for many purposes, and it appears obvious that the purpose of any individual receiver must affect its design rather strongly. The difference in design and performance between an inexpensive transistor pocket portable BC set and a top-grade SSB communications receiver is obvious–but each is adequate for its intended purpose, and neither has too much performance to meet that purpose.

The purposes to which receivers are put are so varied that we cannot list them all. Some of the more common are communications (that's our own use, mostly), entertainment (BC radio, FM, and TV), remote control (R/C models and garage-door openers, for instance), and measurement (a field-strength meter is, after all, merely a calibrated receiver).

The purpose of a receiver affects its design in many ways—but virtually all of the differences are in "performance parameters" such as selectivity, sensitivity, stability of tuning, distortion, and so forth. Regardless of the purpose to which the receiver is to be put, the absolute basics of the design and the principles upon which it operates remain pretty much the same for all receivers.

After all, *any* receiver must perform the functions of isolating a desired signal from the many infesting the spectrum, building that signal up to a usable level, and converting the modulation of the signal back into meaningful operation. This is just as true of the receiver in a garage-door opener as it is of the sophisticated communications receivers used in manned space shots for capsule-to-ground communication; at this functional level there's no difference at all in basic operation between one receiver and another regardless of the receiver's purpose.

However, some purposes require more precise performance in certain parameters than do others. For instance, a garage-door opener need not be capable of being tuned across the entire spectrum, or even across a wide band. It's going to be used with a single transmitter—or at least, a single group of transmitters all of which will be on the same frequency—so the tuning of its receiver need not be easily adjustable. On the other hand, a ham-band communications receiver must be able to be rapidly and accurately tuned to any frequency in any of a number of widely-separated amateur bands.

Similarly, a color-TV receiver must accept signals within a passband almost 6 mhz wide without significant distortion of any of them—but a communications receiver's passband, to be useful today, should not exceed 6 khz, which is three orders of magnitude smaller.

Differences of this sort, which are almost completely dictated by the purpose to which the receiver will be put, require completely different circuit designs to provide the required performance. Viewed at the circuit-operation level, then, the design is dictated completely by the purpose of the receiver, and each different purpose requires a different set of basic operating principles.

To illustrate, here are some of the key performance parameters for several different receiver purposes:

A communications receiver may be either "all-purpose" or "specialized;" a ham receiver would be "all-purpose" in that it must be able to receive many different types of signals from many different transmitters, while a police mobile receiver is "specialized" in that it need receive only one type of signal from one (or a very few) transmitter. Both, however, *are* used for communications.

An all-purpose communications receiver needs to be capable of easy tuning to any desired frequency, with excellent frequency stability once the desired frequency is reached. Selectivity of such a receiver should be adjustable, so that it may be set as narrow as possible for any one desired signal, and the selectivity should be sharp in order to pick one signal out from adjacent-channel interference. The sensitivity of the receiver should be maximum, so that it is not a limiting factor in performance. Distortion of the modulation should be small, but need not be reduced to the vanishing point. Audio power output need be only moderate. Finally, the receiver should be capable of receiving any type of modulation used for communications: AM, FM, SSB, CW, FSK, and so on.

A specialized communications receiver needs to meet essentially the same list of specifications, except for those requiring ease of adjustment of some factor which is absent in the specialized application. An example of such an exception is the fact that a police receiver need not be capable of receiving SSB, nor need it be tunable in most cases.

An entertainment receiver may be a BCB audio receiver, an FM audio receiver, or a TV receiver, and the parameters for each of these three are different.

A BCB audio receiver need cover only the limited frequency range of the broadcast band, with sensitivity adequate for reception of local stations. Cost should be minimized in the design and all unnecessary frills left out. Audio output should be moderate, and distortion reasonably low. Good AVC action is a necessity, and the selectivity should present a passband wide enough to permit reception of music. The number of adjustments should be reduced as far as possible; in most cases only two controls—tuning and volume—are provided.

An FM receiver requires excellent sensitivity, extremely low distortion, and sharp-sided selectivity over a relatively wide passband. Automatic frequency control is desirable since mistuning can create extreme distortion, and inclusion of multiplex stereo capability is also desirable.

A TV receiver is actually two receivers in one; FM for audio and AM for video. It must be easily switched from channel to channel, but continuous tuning is not necessary. The passband must be very wide, and distortion must be even lower than that acceptable for FM audio if color signals are to be received (even in a monochrome receiver). Special detection and sync circuits are also required, as are the sweep circuits for presentation of the recovered video modulation.

Receivers used for remote control of objects need only moderate sensitivity, moderate selectivity, and produce on-off control signals rather than audio as their output. Designers could care less about distortion in simple remote-control units, although if multi-channel tone modulation is used the distortion may become a design factor again.

Finally, the performance parameters for a receiver to be used as a measuring instrument depend entirely upon the measurement to be made.

Now we can answer our original question: The purpose of a receiver has no effect upon the most basic functional operation of a receiver, which is that of receiving and demodulating a radio signal, but it has every effect upon the choice of particular circuits which may be used to perform that basic functional operation.

How do signal characteristics influence receiver design? We have just seen how the purpose to which a receiver is to be put makes the first determination of the types of circuits the designer may include in that receiver–and one of the major areas in which this dedetermination is made is that which depends upon signal characteristics.

A CW signal, for instance, can be received easily with a receiver passband only 100 hz wide (if you can tune that closely, and stay on the signal). A TV signal, on the other hand, is nearly 5 mhz wide, and the receiver's passband must be at least as wide as the signal in order to get all the signal in.

Actually, selectivity is not the only design factor which is strongly influenced by the characteristics of the signal to be received. At least three other areas are as strongly affected: the type of demodulator or detector to be included depends entirely upon the modulation of the expected signal, the audio response (or lack of it) is determined largely by the signal, and the AVC attack and decay times are also tied rather closely to the expected incoming signal and the type of modulation on it.

In the selectivity region, the general rule is that the receiver should accept with a reasonably flat-topped passband a slot of spectrum space as wide as the signal, but no wider. If the bandwidth of expected signals varies, the receiver designer may take either of two courses: if the variance is large, and the user of the receiver can be expected to be a trained or experienced radio operator, the passband may be made adjustable. This is the route taken in ham-band receivers, for instance. If the variance is not so great, or if the receiver user cannot be expected to know how to manipulate many controls, then the passband may be fixed at a width great enough to accept the widest expected signal. This route is taken with FM entertainment receivers, for instance, where the bandwidth at any instant is determined by the modulating signal but the maximum bandwidth is known to the designer.

Fig. 1 lists the maximum bandwidth normally associated with the most common types of signals.

Type of signal	bandwidth (khz)
CW, 10 wpm	0.04
CW, 100 wpm	0.40
CW, x wpm	0.004x
AM communications	6
SSB communications	3
AM broadcast	10
FM broadcast	200
TV broadcast	6000
FSK, 425-Hz shift	1.25

Fig. 1. Bandwidth requirements for various types of signals. Bandwidth for any specific signal depends upon frequencies in modulating signal, which in turn depend upon amount of information being transmitted. High-speed cw requires more bandwidth than does low-speed transmission; voice requires more bandwidth than either.

The choices among detectors were covered in some detail in our previous installment, and we won't repeat that material. The type of detector included in any specific receiver design is rather obviously dictated by the type of signal expected, whatever type of circuit is chosen must be capable of demodulating the expected signal to give the type of output signal required by the purpose for which the receiver is to be used.

The frequency response of the amplifier or amplifiers which follow the detector stage is also influenced greatly by the type of signal expected. For example, a receiver intended to bring in CW only might go to the extreme of including narrow-band audio filters after the detector stage, to help achieve the extreme selectivity which may be needed in CW reception under poor conditions. The audio response of a top-quality entertainment FM receiver, on the other hand, must be wider in frequency range than the human ear, in order to be certain that the receiver in no way limits the quality of the reproduced signal.

For remote-control receivers, if a simple on-off type of control technique is to be used, the amplifiers after the detector need only be capable of triggering a dc signal on or off to achieve the necessary control. Receivers intended to produce audio output, on the other hand, need not have any low-frequency response below 15 to 20 hz since the ear cannot hear signals of lower frequency, nor can most loudspeakers reproduce them.

For communications use, the audio frequency range of the receiver is normally limited to the speech region, from 300 to 3000 hz; elimination of the higher frequencies helps reduce annoyance and operator fatigue from the high-frequency components of hiss, and reduction of the lower frequencies restores a balance to the signal which would otherwise sound "tubby" or "mushy" and be difficult to understand.

If the low-frequency response of a receiver intended to be used with SSB signals is extended to match that of an entertainment receiver, performance may actually be degraded with the SSB signals. This occurs because the locally-supplied carrier used to demodulate the SSB signal rarely is a perfect match in frequency for the suppressed original carrier, and almost never is a match in phase.

Any slight frequency error between original and reinserted carrier frequencies is an absolute rather than relative error, and is usually less than 50 hz (more than 50 hz error renders the signal unnatural in any circumstances). Its effects, however, are relative, because the original effect of the error is to move *all* the speech frequencies within the signal away from their proper positions by the amount of the error but in the opposite direction. That is, if the local carrier is 40 hz too high in frequency, each frequency in the reproduced signal will be 40 hz lower than it should be. (This is true only if the *upper* sideband is being received at the detector input; if the lower sideband reaches the detector, the error will be in the same direction and each frequency will be 40 hz too high.)

The difference between a 2000-hz component of speech and a 1960-hz component is so small as to pass unnoticed, and the difference between a 350-hz component and a 310-hz component isn't particularly objectionable.

But the difference between an 80-hz component and a 40-hz component amounts to a full octave of pitch, and this is considered objectionable by almost everyone. Similarly, for an original component of 120-hz frequency the error would pull it down to 80-hz, which is like the shift from the note of C to the next lower G on the musical scale, and that too isn't very good.

Thus the effects of any frequency error between original and reinserted carrier are most objectionable at the low end of the frequency range. Preventing the audio stages after the detector from amplifying the low frequencies prevents these effects from being objectionable to the operator.

If for some reason a designer felt it necessary to include extended low-frequency response, he would then be faced with the necessity of providing extreme frequency stability and a means for achieving near-perfect tuning accuracy. Since the low tones contribute almost nothing to intelligibility of the signal, communications receivers simply operate with reduced audio response at the low end and thereby simplify these design problems.

Characteristics of the anticipated signals affect design of the AVC circuitry in a number of ways. The most extreme effect is that of determining whether AVC will be included in the receiver, or left out. For some types of signals, AVC need not be included, but in most cases it is anyhow since it adds little to the cost or complexity of the receiver and is frequently an operating advantage.

If AVC is to be included, the manner in which its control voltage is generated is determined by the signal to some degree. For instance, the FM discriminator does not provide an AVC control voltage; if such a detector is used a limiter stage must be included, and the AVC control voltage may be taken from this limiter stage where it is generated as a by-product of limiting action. The FM ratio detector, on the other hand, provides an AVC source as well as performing the demodulation of the signal. The envelope detectors used for AM detection usually provide the AVC voltage as well, but when SSB or CW signals are being received, the AVC must be developed separately from the detection process.

The function of the AVC circuit is to change the receiver gain in accordance with the signal strength; this prevents receiver overload as well as increasing the convenience of operation. Operation of an S-meter is not, contrary to some beliefs, the primary purpose of this circuit.

When the gain is varied, especially in the case of envelope detection of AM, the modulation may be affected. For instance, if a signal modulated with only a 100-hz sine wave were being received, and the AVC were allowed to change receiver gain rapidly enough to follow the 100-hz variation in envelope level, the modulation would be effectively wiped off the signal!

To keep such events from occurring, the time constants in the AVC circuit must be kept long enough so that receiver gain cannot change during a single cycle of any expected modulating signal.

If the lowest frequency to be received is 300 hz, the AVC time constants must not permit the receiver gain to change more rapidly than 1/300 second. Because the gain change is logrithmic with respect to voltage rather than being linear, and because time constants bear only a relative relation to voltage levels, the time constants are usually kept longer than 1/60 second. For communications use, a time-constant figure of 0.02 might be considered typical.

This is entirely too short a time constant for entertainment reception, where frequencies as low as 20 hz may need to be reproduced. The time constants employed in these cases are closer to 1 second.

The effect upon frequency response is not the only factor involved in choice of AVC time constant, however. One of the primary reasons for putting in the AVC in the first place is to combat fading of the signal, and fading may occur at a rapid rate. The fade of an aurora-reflected signal, for instance, occurs at a frequency well up in the audio range, and gives such a signal its characteristic buzz-saw whine.

And the time constants of the AVC circuit also determine how rapidly the receiver will be able to respond to a fade by increasing or decreasing gain. If the time constant is too long, a given signal will appear to be fading or fluctuating in level much more violently than if the time constant is short.

The choice of AVC time constant, then,

always represents a compromise between the long time constant needed for extended low-frequency audio response, and the short time constant necessary to permit rapid response to fluctuations in signal level.

So far our discussion of AVC time constants has been based on normal practice with AM and FM signals. When a designer includes AVC in a receiver intended to handle CW and SSB signals, additional factors come into the picture—but all the previous factors are still present too.

Any CW or SSB signal is always in a state of rapid fluctuation; you might call it a "deep fading" signal even if the transmitter is just down the block. The reason is that the signal level is tied directly to the modulation; with the key up, or the voice silent, there's no signal at all, and with the key down or on voice peaks, there's full signal.

When reception of such a signal is attempted, using conventional AVC design, the necessarily slow time constant keeps the receiver gain wide open in the absence of incoming signal—and holds it wide open for the first few fractions of a second after the signal arrives. During this time, the entire receiver is usually overloaded.

Eventually, the AVC time constants permit gain to be reduced, but by this time the signal is gone again. Gain remains low, now, until the time constants permit receiver gain to vary.

The net result is that the receiver is almost always overloaded, except when it's desensitized and cannot receive a weak signal!

To get away from this problem, the designer uses steering diodes to separate the AVC circuit's action into two distinct phases called "attack" and "decay." The attack phase is the gain change when a signal increases in strength, and the decay phase is the change when the signal decreases. By separating these two phases, different time constants may be employed in each. A fast time constant may be used for attack, and a slow—extremely slow, in fact—one for decay. The receiver then responds to an increase in signal strength almost instantly, and so cannot overload so easily. Once gain is reduced, it takes much longer for it to increase again. This permits the AVC voltage to reach and hold an "average" value during reception of CW or SSB signals.

The slow decay does handicap the receiver's response to a fading signal, and for this reason the fast-attack slow-decay design is usually used only when the CW-SSB detection circuits are in use. If conventional AM is being received, conventional AVC is usually used with it.

The manner in which the AVC action is separated into attack and decay phases is illustrated in the schematic, Fig. 2. This is a

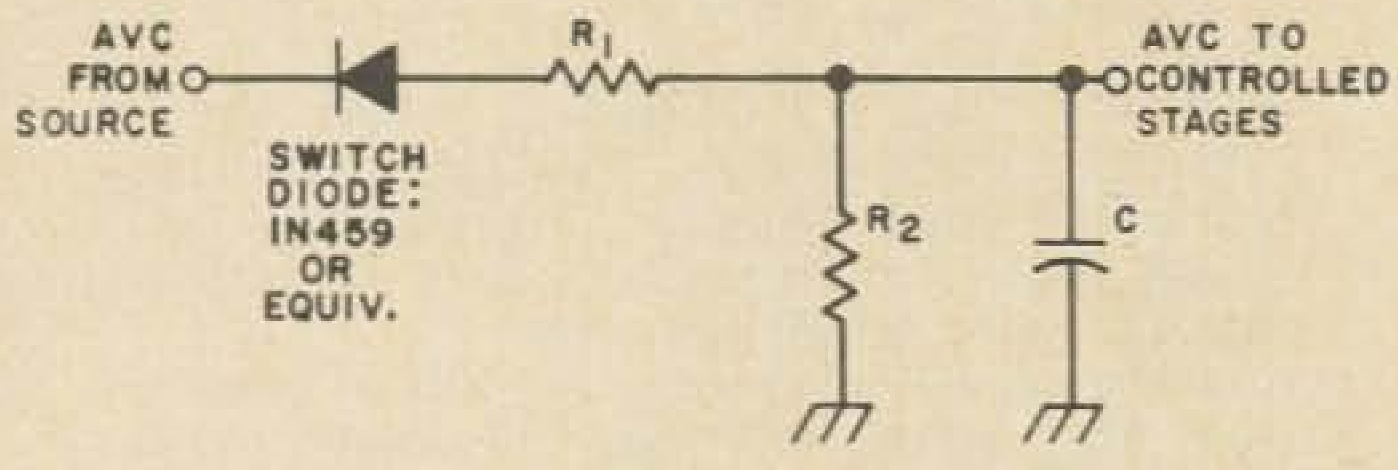

Fig. 2. Fast attack, slow decay avc circuits usually resemble this schematic, at least in basic operating principles. Diode permits capacitor C to charge rapidly, but limits discharge path to r2 alone. R2 has very high value so that time constant c-r2 is long, while attack time constant c-r1 is short. See text for details.

typical application rather than depicting any individual design. The AVC control voltage varies from zero to some maximum negative value, usually not exceeding 25 to 30 volts in absolute magnitude. Let's assume first that no signal is being received, and consequently the AVC line is at 0 volts.

Under these conditions the capacitor is discharged and the controlled stages operate at maximum gain. If a CW signal developing an AVC potential of -20 volts should suddenly arrive at the AVC generator, the voltage at point A would also go rapidly to -20 volts. This provides a 20-volt forward bias for the diode, and the capacitor charges at once through R1. This is the "attack" phase of the action, and the time constant for attack in this circuit is simply R1 times C.

When the "dit" or "dah" of the CW signal is over, the voltage at point A returns to zero, but now the capacitor is charged to somewhere near -20 volts. This is reverse bias to the diode, and so it looks like an open circuit. The only route available for discharge of the capacitor is by way of R2, which normally has a very high value (from 10 to 22 megohms, compared to ½ megohm or less for R1) and so provides a much longer time constant. This is the "decay" phase, and so long as the capacitor remains charged the receiver gain is reduced. Of course, C is discharging through R2 at all times and so the gain is slowly increasing from the moment the signal disappeared, but the time constant is so much longer than that of the attack phase that gain appears to be "constant."

If another signal appears to provide a -20 volts at point A before the capacitor has discharged appreciably, there will still be forward bias on the diode because the capacitor voltage is always less than 20 volts. This restores the "attack" phase and the capacitor recharges.

So long as signal appears before the decay time constant has expired, then, a relatively constant voltage of almost the full potential value appears on the AVC line. The receiver's gain remains low between dits or dahs, and between syllables of an SSB signal.

While the decay time constant is long, in comparison to the attack time constant or even in comparison to communications-oriented conventional AVC time constants, it is short enough to permit full gain to be restored between words of a CW or SSB transmission. This permits round-table discussions between stations of vastly different signal strengths—and can occur only because the attack time constant is short enough to prevent overload for any incoming signal.

What are some of the special problems of superhets? The most widely used type of receiver today is the superhet, which combines a number of features from older designs to achieve almost any combination of sensitivity, selectivity, and stability which anyone is willing to pay for. These advantages, though, have a price in that superhets have a number of special problems which do not occur with the older, simpler types of receivers. Our question now is, what are some of these special problems?

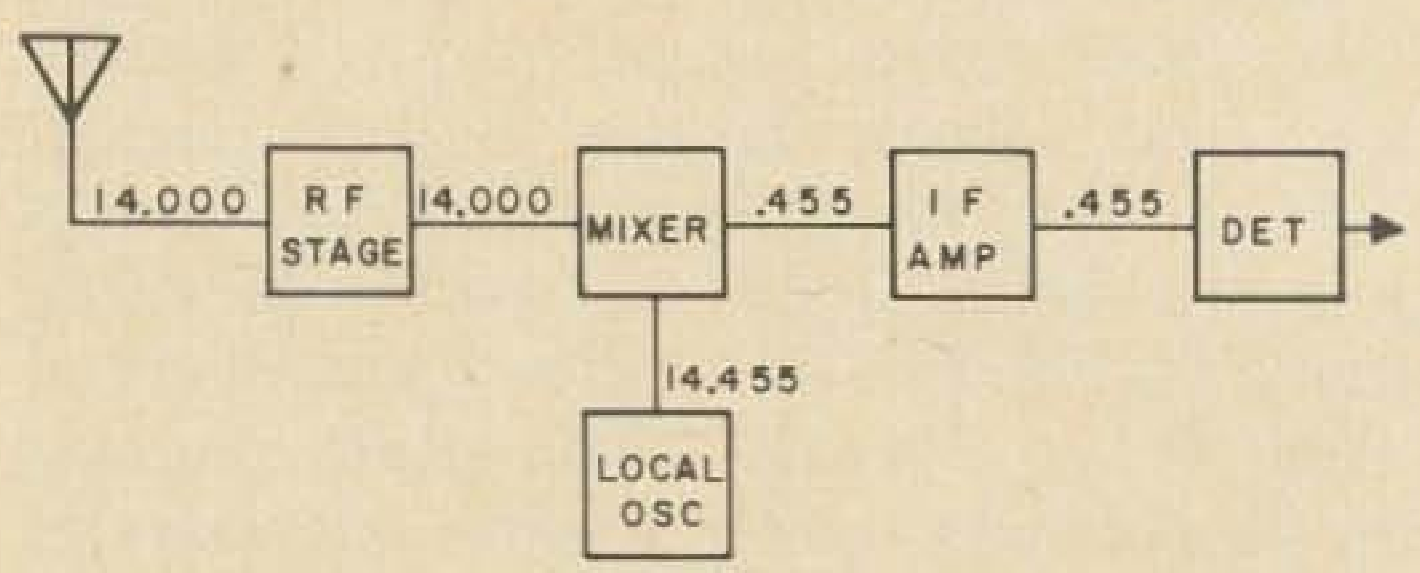

Fig. 3. Block diagram of typical superhet receiver front end shows basic operating principle of superhet design. Incoming signal, in this case at frequency of 14,000 mhz, is amplified and then applied to a mixer stage where it is mixed with a local oscillator signal at a different frequency, here 14,455 mhz. One of the resulting modulation frequencies, here 455 khz, is selected as the "intermediate" frequency and all remaining amplification is applied to it. Detector then converts intermediate frequency to desired output.

The superhet operates, as shown in Fig. 3, on the principle of mixing two signals to produce a third signal at the "difference" frequency which contains the modulation of both original signals. By making one of the two signals come from the antenna while the other comes from a local, variable-frequency, unmodulated oscillator, the resulting difference frequency will have the modulation of the antenna signal only. If the locally supplied signal is offset from the antenna signal by a fixed frequency, the difference frequency will be numerically equal to that offset. That's the secret of the superhet's success: it has permitted *rf* amplification to be done at a single, fixed, "intermediate" frequency so that the desired sensitivity and selectivity can be obtained, while permitting reception of antenna signals at almost any frequency.

The first special problem peculiar to superhets is that of the mixer stage itself; this stage is absent in all other types of receivers.

The next major problem of the superhet is that of local radiation; the local oscillator signal may, unless designers prevent it from so doing, couple its signal back into the antenna and then the receiver doubles as a low-powered transmitter. Mutual interference between superhet receivers is not uncommon —for a number of years the Navy avoided the superhet for shipboard use because too many receivers of this type operating so close together as they must on board ship blocked each other out. However, careful design can solve the problem, and a little later we'll see how it's done.

The third major problem on our list is that of "image response;" it comes about because for any single frequency to which the local oscillator may be tuned, *two* antenna signals may exist to produce the intermediate frequency. For example, if you want to receive a signal at 7250 khz and your *if* is 500 khz, you can tune your local oscillator to 6750 khz (500 khz lower than the desired signal frequency), and the *if* amplifier will accept the resulting 7250-6750=500 khz output.

But, it will also accept the 6750-6250= 500 khz output which would be produced by a signal at 6250 khz, and that undesired response is known as the "image."

Like re-radiation, it can be cured by careful design and we will look at this one too in more detail.

The final problem we'll examine is that of "tracking;" the superhet receiver requires that a local oscillator's frequency be varied to tune in any signal, and normally both the mixer stage and an *rf* amplifier are also tuned—but to the frequency of the signal, rather than that of the local oscillator. Since the two frequencies are offset one from the other, it takes some involved juggling of resonance formulae in order to achieve this "tracking" as the receiver is tuned across any appreciable frequency range.

Let's take these four problems and look at them, in order, a little more closely. We'll start with the mixer stage.

The purpose of the mixer stage is to produce modulation or sum-and-difference frequencies which are the sum and difference of the incoming *rf* signal and the local oscillator signal. One of these modulation frequencies—usually the difference frequency—is selected as the intermediate frequency for amplification and subsequent detection.

If the local oscillator and the mixer stage are combined in a single tube, that stage is usually called a "converter;" if they are separated into separate sections, the terms "local oscillator" or "first oscillator" and "mixer" are used.

To quote the "Electronic Designers' Handbook," intermodulation between two signals can occur only in a nonlinear element; therefore, mixers and converters are necessarily nonlinear devices.

In theory at least, and to some degree in practice, almost any nonlinear device can mix signals, and thus can be used as a mixer in a superhet. At uhf, the most commonly used mixer is an ordinary diode. But at more conventional frequencies, most designers prefer to get more action than mere mixing out of the mixer stage. They like to make it produce some signal gain, some selectivity, and help to isolate the oscillator signal from the antenna, if possible.

For this reason, most mixers employ active devices—either vacuum tubes or transistors. These can amplify the signals, and the proper type of tube or circuit, or both together in most cases, can assist in isolating the various signals properly.

A number of different types of mixer circuit exist, as do several special types of tubes designed for mixing. Some of these special types include the pentagrid converter typified by type 6SA7 and 6BE6, the triode-hexode converter (virtually obsolete today), and the heptode and octode designs.

All, however, achieve their mixing in essentially the same manner: for one of the two signals to be mixed, the stage acts essentially as an amplifier. The gain of an amplifier is determined by the transconductance of the active device in it; in the mixer, this transconductance is varied by the second of the signals to be mixed.

The result is an amplifier whose gain varies at a rate determined by one *rf* signal, while it is amplifying another signal. Both original signals will appear in the output, and since the change in gain is anything but linear (see Fig. 4) the two signals intermodulate each other to produce side frequencies which are the sum and difference.

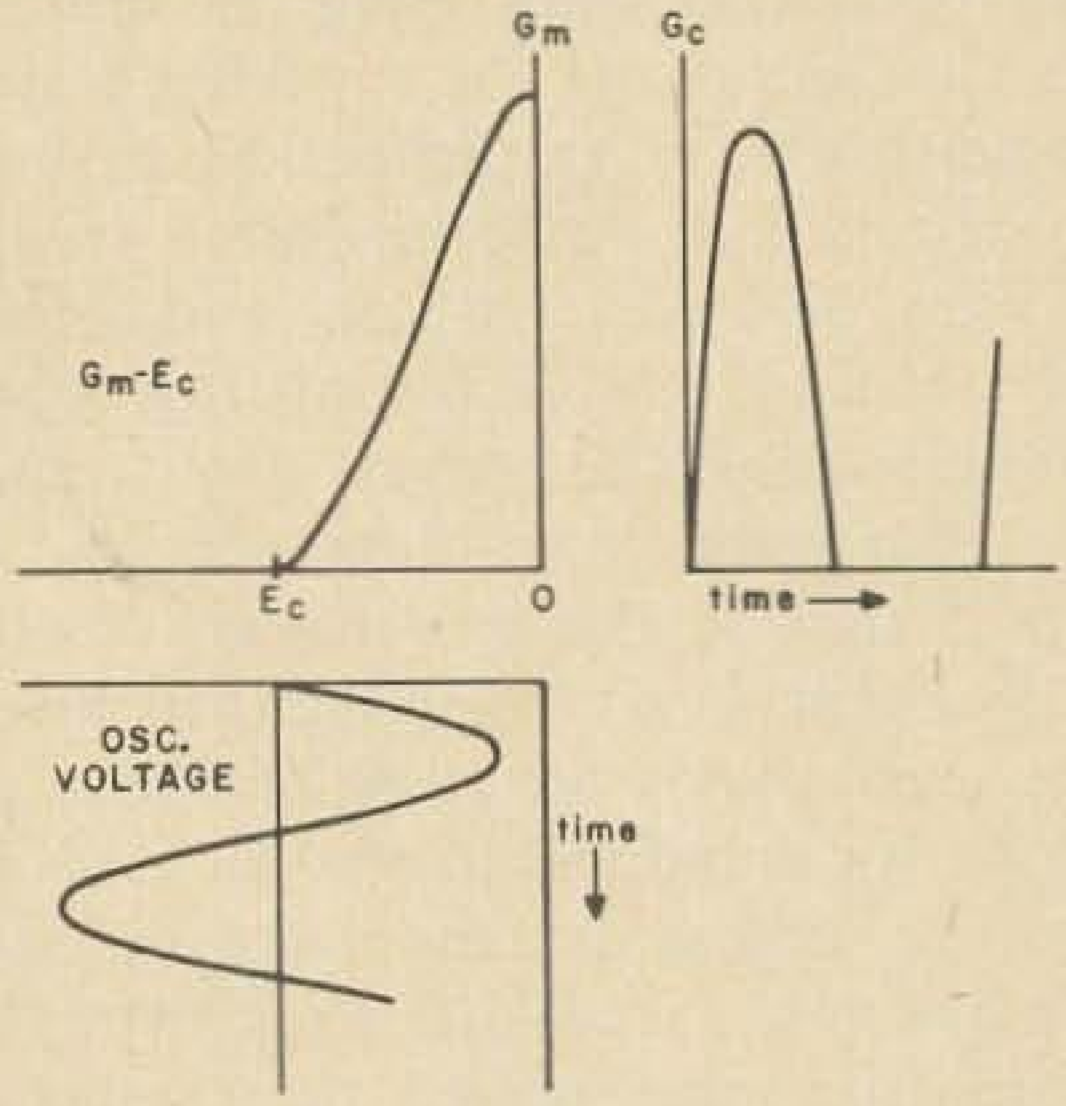

Fig. 4. This composite graph which relates tube transconductance to instantaneous grid voltage (upper left portion), oscillator voltage applied at grid to time (lower left), and resulting conversion transconductance to time (upper right) shows where the nonlinearity necessary to provide mixer action comes from. Oscillator voltage swings grid past cutoff at times, and conversion transconductance drops to zero during those times; even when tube is conducting, conversion transconductance is in constant state of change, and change does not follow a linear rule.

The output circuit of this "amplifier" is tuned to the desired output frequency, which is usually the difference frequency. Thus, both of the original frequencies as well as the sum frequency are by-passed to ground, while the desired output frequency is amplified.

The fundamental property of a mixer tube—or any tube used as a mixer—so far as the engineers are concerned is its "conversion transconductance," which is defined as the ratio of the peak output *current* at *intermediate* frequency to the peak input *voltage* at *signal* frequency. This value depends upon oscillator injection levels as well as upon the tube's inherent characteristics, so it must be measured under carefully controlled conditions. The difference between conversion transconductance and the more familiar plain "transconductance" of the tube is that conversion transconductance relates an output at one frequency to an input at another, while ordinary transconductance simply relates output current to input voltage, with both being at the same frequency.

The term "conversion efficiency" is apparently unknown to professional receiver designers. At any rate, it is not mentioned in "Electronic Designers' Handbook," the "Radiotron Designer's Handbook," Terman's "Electronic and Radio Engineering," or Bill Orr's "Radio Handbook." The only publication we could find which *does* mention this phrase, in fact, is the ARRL Handbook! The professionals in the field call this factor "mixer amplification" rather than "conversion efficiency"—but whatever the name used, it's the ratio of intermediate-frequency output voltage to signal-frequency input voltage, and you can calculate it by multiplying the *if* load impedance in the mixer plate circuit by the conversion transconductance of the stage.

Aside from achievement of adequate stage gain—or "conversion efficiency"—the major problem presented by the mixer stage is that of adequately isolating the local oscillator and the input signal each from the other, while providing enough injection to permit proper mixing action. If isolation is insufficient, the oscillator may be "pulled" by strong signals with a resulting frequency shift. In addition, the oscillator signal may be radiated to cause interference to other receivers, and performance will suffer due to circuit loading in the mixer and preceding stages.

Use of separate mixer and oscillator stages helps in control of signal isolation, as does the use of specially designed mixer tubes which minimize interaction between their two input circuits. When conventional tubes are found desirable, special circuitry may be used. See the previous installment of this study course for one such circuit which uses a pair of triodes to provide almost complete isolation of oscillator and signal frequencies while achieving good mixing action over a wide range of signal strengths and providing exceptional stage gain. For additional mixer circuits, refer to any of the books listed at the end of this installment.

The second problem we'll examine is that of preventing radiation from the local oscillator. This is tied up to some degree with the mixer circuit, but is not confined to the mixer alone. Several other factors must also be considered.

For instance, the re-radiation problem is always more severe when the mixer is connected directly to the antenna than when an *rf* amplifier comes between antenna and mixer. The oscillator signal is always present, to some degree, in the mixer's grid circuit even when the most isolating mixer possible is

used. If this grid circuit is coupled directly to an antenna, that small oscillator signal may escape. With the better mixer designs the amount of oscillator signal which can escape through the grid circuit is small enough to be within legal limits—but an intervening *rf* amplifier can reduce it still more, and will.

No number of intervening stages can prevent radiation, however, unless the local oscillator signal is rigidly confined within the receiver to the areas where it is necessary. This means that the oscillator circuit should be shielded as completely as possible, and that all leads to and from this circuit be either shielded or filtered, to make certain that no signal escapes to be coupled accidentally to any part of the antenna or power-line.

Re-radiation of the local oscillator signal can have serious consequences. Not long ago, radiation from garage-door openers was found to be interfering with the radio navigation equipment on jetliners in the crowded Los Angeles airport area. Fortunately no accidents resulted—but it was strictly a matter of good luck, because on at least one occasion the airliner was coming through overcast skies on a dead aim for the offending garage door when the pilot recognized that something had gone seriously wrong!

Because the consequences can be so serious, the FCC has set limits on the amount of radiation permissible from any electronic devices. These limits compose Part 15 of the Commission's Rules and Regulations—and the "Part 15" license-free transceiver units are legal to operate precisely because they come just inside the limit of permissible radiation. Only a small minority of the users of electronic equipment are aware of the existence of this part of the FCC regulations—but, the Commission holds the *user* of the offending equipment liable for any violation. Any receiver with more radiated signal than Part 15 allows is considered by the commission to be not a receiver, but an unlicensed transmitter! For this reason alone, radiation is one of the most serious problems faced by the designer of a superhet receiver.

The special superhet problem most obvious to the user of the receiver is that of images. As we saw a few paragraphs back, the image response comes about because *two* signal frequencies, rather than one, are capable of producing the proper intermediate frequency, and the receiver cannot tell the difference by the time the signal gets to the mixer output circuit.

Response to images can be minimized in only one way—by providing adequate selectivity *ahead* of the mixer stage. In some cases, this means that as many as two *rf*-amplifier stages may be necessary, but in others the mixer-stage input circuit may provide adequate selectivity by itself. It all depends upon the ratio between signal frequency and local oscillator frequency.

For example, an ordinary 5-tube clock-radio operating on the AM broadcast band covers a frequency range from 550 to 1600 khz, and normally has an *if* of 455 khz. The local oscillator could be operated either above or below the signal frequency, but if it were below its tuning range would have to be from 95 to 1145 khz which is greater than a 10-to-1 ratio from high to low frequency.

By using "high-side injection," the oscillator need only cover the range from 1005 to 2055 khz, or a little more than a 2-to-1 ratio from high to low, and so high-side injection is the universal choice.

When the receiver is tuned to 600 khz, the oscillator is then tuned to 1055 khz, and the image response point is 455 khz higher or 1510 khz. When the receiver is tuned to 700 khz, the image response is 910 khz higher or 1610 khz; this frequency is outside the broadcast band and very few signals can be expected there.

The result is that images can only be objectionable from the low end of the dial up to 690 khz, and the FCC helps keep even these down by setting up frequency assignments so that any area in which the local stations operate below 690 khz has few, if any, stations operating 910 khz higher.

Even when an image can be encountered with this simple receiver, it takes a strong signal to get through the 3-to-1 mistuning which exists at the mixer input circuit.

At the higher frequencies we use, though, the situation is rather different. The distance between desired signal and the image is still just twice the *if*, or 910 khz if the standard *if* is used—but this is such a small percentage of the signal frequency that both the desired signal and any possible image roll right on thru a single tuned circuit.

Sometimes, even the additional selectivity offered by one or two *rf* amplifier stages isn't enough. In such cases, a preselector may be used to reduce image response still more. The preselector is nothing but an additional, outboard *rf* amplifier—but it adds a few more tuned circuits to the signal path between antenna and mixer, and in addition it may if necessary be deliberately mistuned to one side of the desired signal in order to cut down the image's strength still more.

A better answer than the use of the preselector is to use an additional mixer stage so that the first intermediate frequency is a much larger fraction of the signal frequency. The image response of such a setup is then removed much farther from the desired signal, and the preselector's action is much more effective. The resulting rather high *if* produced by the additional mixer stage is then converted again down to a low *if* for gain and selectivity. A process such as this is known as multiple conversion; if two intermediate frequencies are employed, it's called double conversion, and if three are used (as often happens, especially in uhf and vhf operation) it's triple conversion. The added stages may be outboard to the main receiver; in this case the whole outboard unit is known as a converter. Use of a converter is the standard technique for vhf operators, and finds much favor with hf operators who specialize in the higher-frequency bands where image responses are most troublesome.

Fig. 5 shows, graphically, the causes and cures of the image problem.

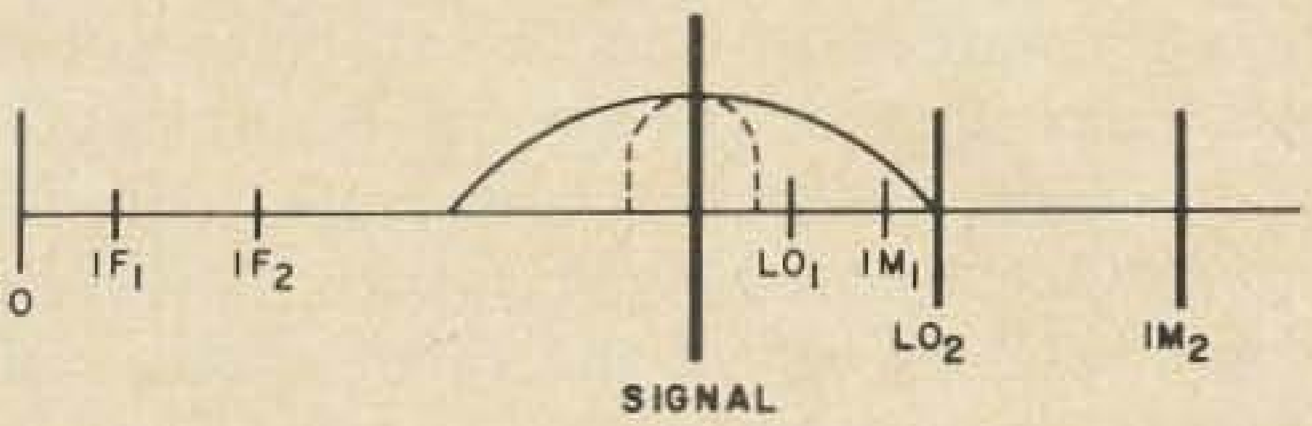

Fig. 5. Causes and cures of image problem are shown here. Heavy vertical line represents desired incoming-signal frequency and solid curve represents typical receiver front-end selectivity at this frequency. If if is low in comparison to signal frequency, as is the case with if1, then oscillator offset is small also (lo1) and the image response (im1) is still acceptable to front-end selectivity curve. Image response will be poor; images will come through almost as well as desired signals. Changing to higher if, as for instance if2, pushed oscillator offset out to lo2 and moves image point well outside front-end acceptance range to im2. If signal is sufficiently strong it can still get through, but image response characteristics will be much improved since only strong images can make it now. Alternate action to cure problem is to increase selectivity of front end as shown by dotted curve; this is usually done by using preselector accessory.

The final special problem of the superhet which we're going to look at this time is that of tracking. The object of tracking a receiver is to be able to simultaneously set to some desired frequency each of several tuned circuits, all of which are mechanically connected to each other and operated by a single control.

What complicates the situation in the superhet is the fact that the desired frequency for the oscillator's tuned circuits is different from the desired frequency for the signal tuned circuits, by the amount of the *if*.

In broadcast receivers, the tracking problem is simplified greatly by specialized mechanical design of the tuning capacitors. The plates of the oscillator tuning capacitor are shaped differently than those of the mixer and *rf*-stage (if any) capacitors, so that at any one position of the tuning control, the different circuits are automatically tuned to the appropriate frequencies.

In receivers which must cover more than a single frequency band, however, such a simple solution cannot be used, because the required shape to produce the necessary constant frequency difference differs from band to band. In these cases, tracking must be achieved by electrical means.

It's relatively simple to make the difference between signal and oscillator frequencies equal to the *if* at any two points within the tuning range, by proper choice of L-C factors in the different tuned circuits involved. The problem is not so simple when you want to make the difference at all points within the range equal; in fact, it's incapable of solution for *all* points in the range. The best the designers can do is to make tracking coincide properly at *three* points within the range. One of these three points is near the low end, another near the high end, and the third somewhere in between.

When three-point tracking is achieved, the oscillator will be lower in frequency than it should theoretically be at all points between the low-end tracking point and the mid-band point, and will be too high in frequency between the mid-band point and the high-end point. However, the error seldom exceeds a few khz—and in a superhet it's the oscillator frequency which takes charge, so the operator never becomes aware that any error exists.

To see how tracking is achieved, let's look first at single-point tracking. This is the kind of situation which exists in a fixed-frequency receiver—and of course if the frequency is never going to vary the term "tracking" isn't really applicable, but single-point tracking gives us a place to get started into the problems.

Fig. 6 shows schematically portions of the *rf*, mixer, and oscillator circuits which are involved with tracking. We'll assume that the three tuning capacitors C_{t1}, C_{t2}, and

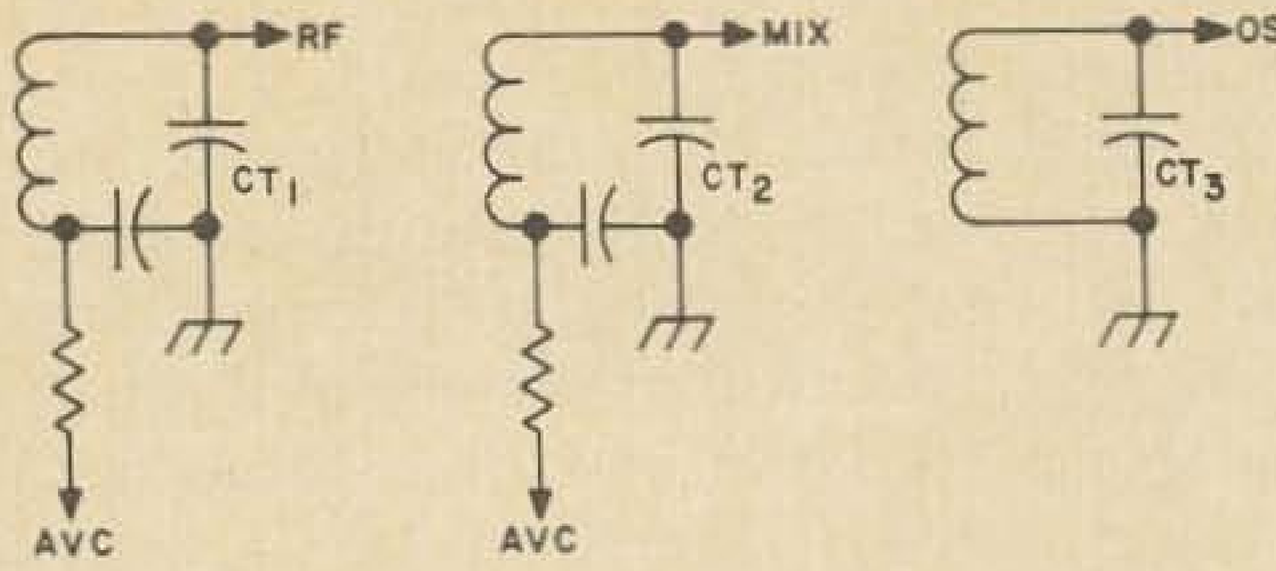

Fig. 6. Starting point for look at tracking problem is "signal-point" tracking such as for fixed-frequency receiver. Shown here are, left to right, rf-stage, mixer, and oscillator tuned circuits. With all tuning capacitors having same value, circuit can easily be adjusted to desired frequencies by varying inductance of coils. Single-point tracking has no problem.

C_{t3} all have the same value. In a single-frequency receiver this is not necessarily the usual case, and in fact is seldom the practice—but in a tunable receiver using multiple-ganged capacitors all three or more variables in the gang will have the same value at any position of the shaft, so this serves as our introduction to tracking.

To get the proper tracking condition at a single point, all we need do is to adjust the inductance values so that the three tuned circuits each tune to the proper frequency. If the oscillator operates above signal frequency, the oscillator coil will be set for a lower inductance than either the *rf* or mixer coils. When each coil tunes to its proper frequency, we have achieved single-point tracking.

Now let's see what happens when we try to achieve two-point tracking. This can be thought of as the design of a two-frequency receiver to receive either of two fixed frequencies. We can no longer adjust the coils individually for both of the frequencies, although we still have the option of adjusting coils for either one of the two. We must get our tracking at the other frequency by some other means.

To make our illustration as close as possible to the real tracking problem we're working toward, we'll modify the circuits of Fig. 6 so that they look like Fig. 7. The 3PST switch cuts in additional capacitance across the three tuning capacitors to select the lower frequency, and cuts it out to switch to the upper frequency. Again, all capacitances are identical, and the extra capacitances are also matched because what we're really modelling is a 3-gang variable capacitor. However, we now have added also a "trimmer" capacitor across the oscillator circuit. This trimmer is always in the circuit, at either frequency,

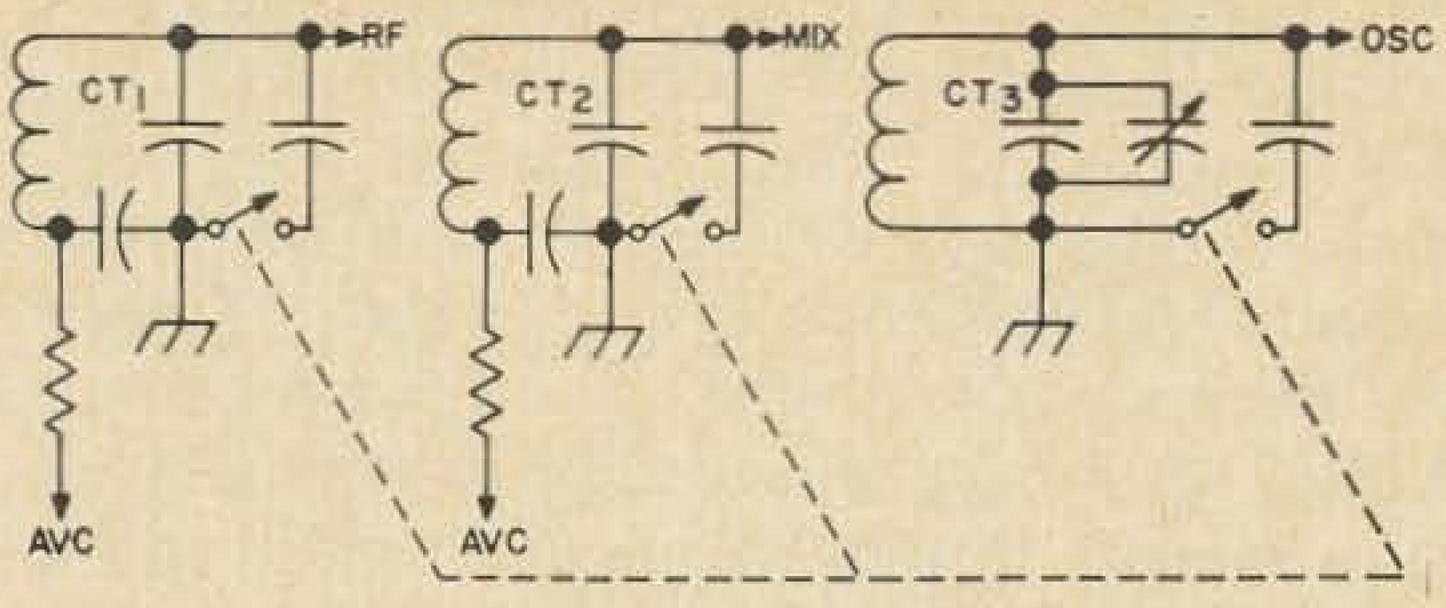

Fig. 7. Circuit of Fig. 6 is modified to require two-point tracking by addition of switch to permit choice of either of two frequencies. Trimmer capacitor across oscillator-circuit tuning capacitor makes it possible to find combination of capacitance and inductance values so that perfect tracking occurs at either frequency. At this point we can replace fixed running capacitors ct1, ct2, and ct3 with variable ganged capacitor shaft, to move from low to high capacitance. At any settings other than the two at which initial adjustment was made, tracking errors will exist. Over small tuning range though, error is not serious.

and it may be adjusted when we align the unit just as may be the three coils.

With the addition of the trimmer capacitor, we have made ourselves able to achieve two-point tracking. First we switch in the extra capacitance to tune to the lower frequency, and we adjust the coils for perfect tracking just as we did in the single-point case.

Then, though, we switch out the extra capacitors to tune to the higher frequency. With the extra capacitance out of the circuit, the trimmer represents a much larger proportion of the total capacitance in the oscillator circuit, and it's not in the signal circuits. We now adjust only the trimmer to pull the oscillator to the proper frequency. This assumes, of course, that the signal circuits are already at proper frequency; that's taken care of in our choice of capacitor values originally. In practice, all three tuning capacitors have "trimmer" adjustments on them which are used to get the proper frequency setting for each individual circuit. This permits adjustment to compensate for stray capacitance and such things.

Since we readjusted the amount of capacitance in the oscillator circuit to get our high-end tracking, we cannot be at the proper adjustment at the low end any more. To correct this, we switch back to the low frequency and readjust the oscillator coil to correct the frequency. This adjustment pulls the high end off, but not so much as it originally was. We must go round in circles, adjusting first the low end, then the high, then the low again, until we finally reduce the error to zero at both tracking points. This occurs reasonably rapidly, and we have achieved two-point tracking.

We can now replace the fixed capacitors and tuning switch, if we like, with a 3-gang variable capacitor. We have two-point tracking, which means that everything is all right at our two tracking frequencies but that some error exists at all other frequencies.

If our tuning is to be only over a narrow range with respect to frequency, such as the 7% difference between band limits of the 10-meter band, two-point tracking will suffice. The error will never be large enough to warrant any attempt to eliminate it.

But if a fairly wide frequency range is to be covered, such as the 2-to-1 ratio from limit to limit of the broadcast band, the tracking error will be excessive near the middle of the band, and we must go all the way to three-point tracking.

Three-point tracking is achieved by connecting a "padder" capacitor in series with the oscillator tuning capacitor. In most cases, additional capacitance must also be connected in parallel with the coil to restore total circuit capacitance. Fig. 8 shows the mixer and oscillator tuned circuits only, including all components ever required for 3-point tracking. In some cases one or more of the components may be omitted; in such cases series capacitors are replaced by short circuits, and parallel capacitors are simply removed.

The oscillator's effective tuning capacitance, in Fig. 8, is the total produced by C1 in parallel with the series combination of C_p and the parallel Ct/Ctrim pair, as enclosed by the dotted line. This total effective capacitance tunes the coil to proper frequency.

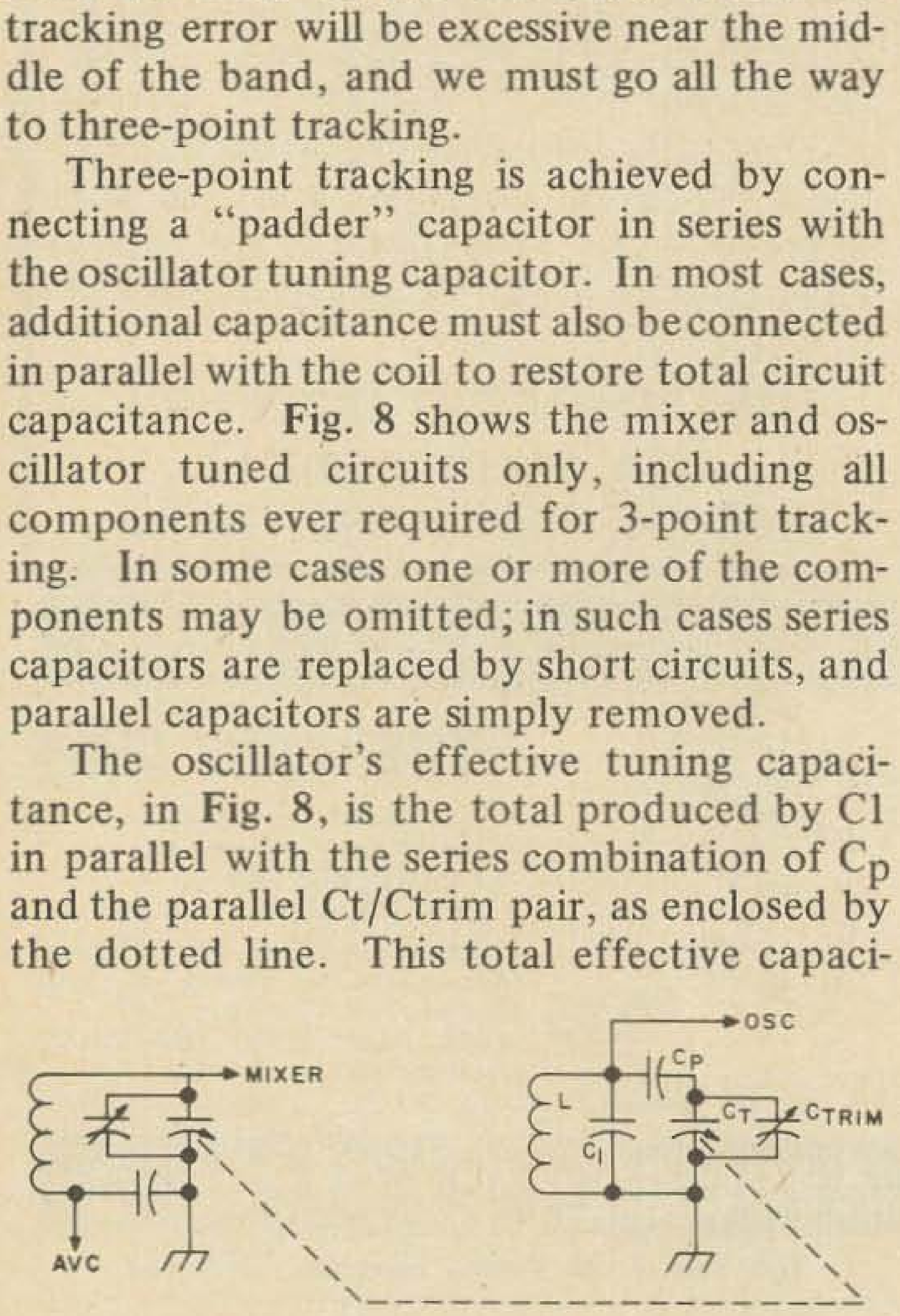

Fig. 8. Final modification of circuit to reach three-point tracking conditions involves addition of two more capacitors to oscillator circuit. One, Cl, serves purpose similar to that of trimmer in Fig. 7 and established minimum capacitance present in the circuit. The other, cp, is the "padding" capacitor and established both the maximum value of capacitance possible, and the way in which capacitance changes as tuning capacitor ct is rotated through its tuning range. See text for details.

When capacitor Ct is varied to tune to a different frequency, it varies the total effective capacitance—but the amount of variation is much less than it would be without C1 and Cp. Even if all other capacitors were completely removed, C1 would set a minimum value of capacitance in the circuit. Even if Ct were to be replaced by a dead short, Cp would set a maximum value on the effective capacitance. The only thing Ct can do to the total effective capacitance value, then, is to change it within the range established by C1 at the low-value end and C1/Cp together at the maximum end.

Choice of the exact values to be used for C1 and Cp is the difficult part of the three-point tracking problem, and we won't go into that here; if you're interested in designing a receiver, see pages 1002 through 1017 of *Radiotron Designers Handbook* for a complete discussion including worked examples and seven graphs to assist in the choices.

When the values are properly chosen, however, the low-end tracking frequency is controlled primarily by C1 together with the maximum value of the Cp/Ct/Ctrim combination, the high-end frequency is controlled primarily by Ctrim together with the modifications introduced by the rest of the capacitors, and the mid-point frequency is controlled by the ratio of the coil's inductance to the composite capacitance of all four capacitors. If inductance is too low, the mid-point tracking frequency will be lower than desired, and if inductance is too large, the mid-point frequency will be higher than intended.

Since Ctrim—and in fact all trimmer capacitors—establish the minimum capacitance values present in the circuits, the effect of the trimmers is greatest at the upper end of the frequency range. Cp, the padding capacitor, on the other hand establishes the maximum value of capacitance which can be put into the circuit, and so its effect is greatest at the low end of the frequency range. This is a general rule; trimmers affect high-frequency performance and padders affect low-frequency operation.

How can we combat interference? Interference can come from many sources. Most of us tend to think in terms of interfering signals of qrm—but the hiss, sputter, and crash of a dead band in the absence of any incoming signals also interferes with anything else we may be doing while waiting for things to open up. In this section we'll look at ways to combat this type of interference as well as the more common problem of unwanted signals riding through.

The only effective way to handle too

many signals is to add additional selectivity to the receiver. This may take the form of a steep-sided filter to shave off the interfering signals, or even of audio filtering to let through only signals of one specific frequency. Such a solution is frequently used by CW hounds.

If the interference is produced by image responses or front-end overload from strong signals at far-removed frequencies, though, the extra selectivity won't do any good. By the time the signals get into the *if* stages where the selectivity can act, they're already contaminated. Use of a preselector, as we have already seen, can reduce this type of interference if it's due to image responses.

A preselector will hurt rather than help, though, if you happen to live across the street from a 50-kw transmitter and can't hear anyone but him on any band. To get rid of this type of interference you must use a filter or a wavetrap in your receiving antenna feedline. The filter will let through only those signals in its passband, while the wavetrap will remove signals on or near a single specific frequency. Fig. 9 shows the schematic of a BCB wavetrap and how to hook it up.

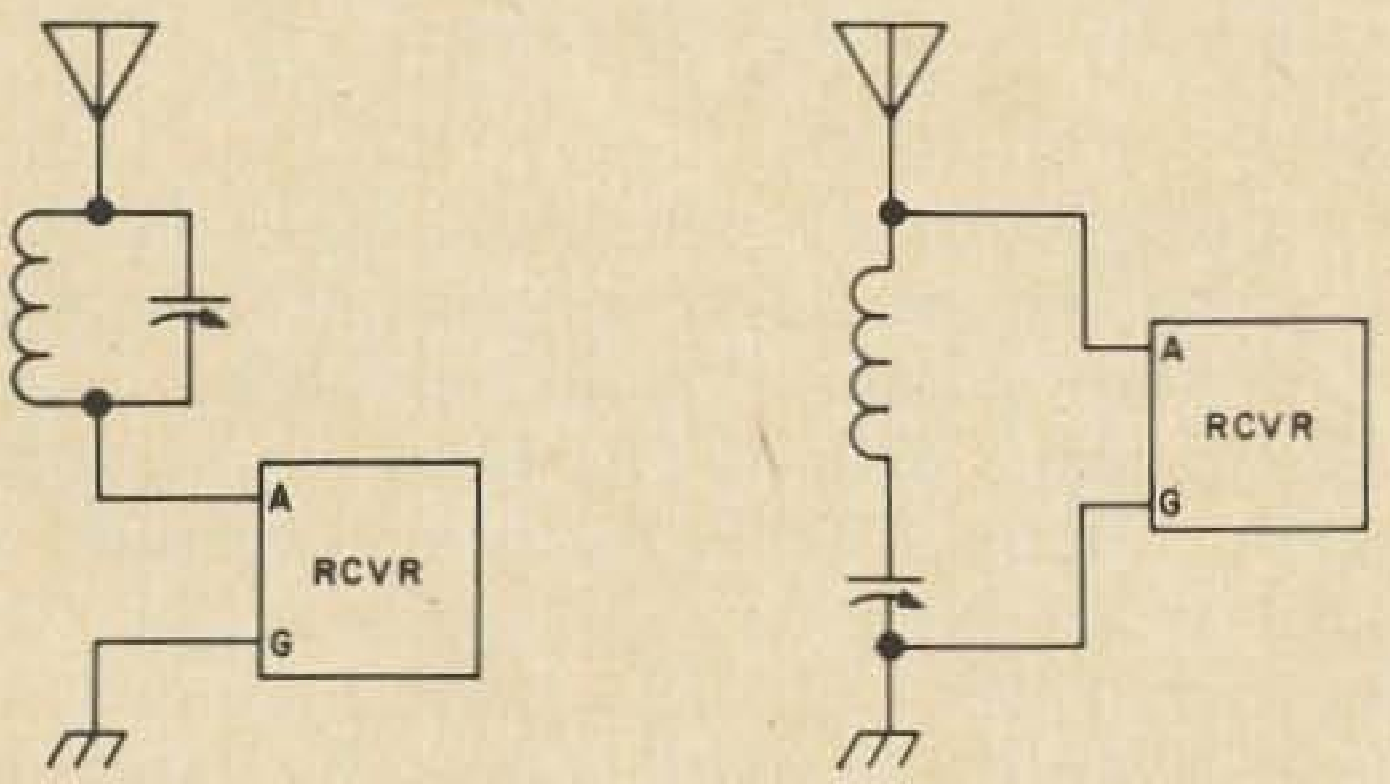

Fig. 9. Wavetraps to attenuate interfering signals and their connection to receiving antenna circuit. At left is patallel-resonant wavetrap which presents signals at its resonant frequency from going on down the line; at right is series-resonant trap which shorts out signals at frequency to which it is tuned. Both may be combined if necessary to reduce exceptionally strong signals, or to trap out two signals at different frequencies from same receiver installation.

Now let's turn our attention to that less usual "interference," the noise in a dead band in the absence of signal.

This clutter of sound is always present; a signal must come in through it, but because of AVC action it usually drops to an acceptable level as soon as a signal appears. When no signals are present, the receiver operates at wide-open gain and the roar of a dead band can quickly drive even the most steel-nerved operator to distraction.

A number of anti-noise circuits have been developed to combat this kind of interference, and they go under the general name of "squelch circuits." All operate on the same basic principle, which is to cut off any audio output from the receiver unless a signal is present, but they achieve this purpose in a number of different ways.

Possibly the most classic squelch circuit is the CODAN; the name is a telephone-company acronym for "carrier-operated device, anti-noise" and the circuit is shown in **Fig. 10**.

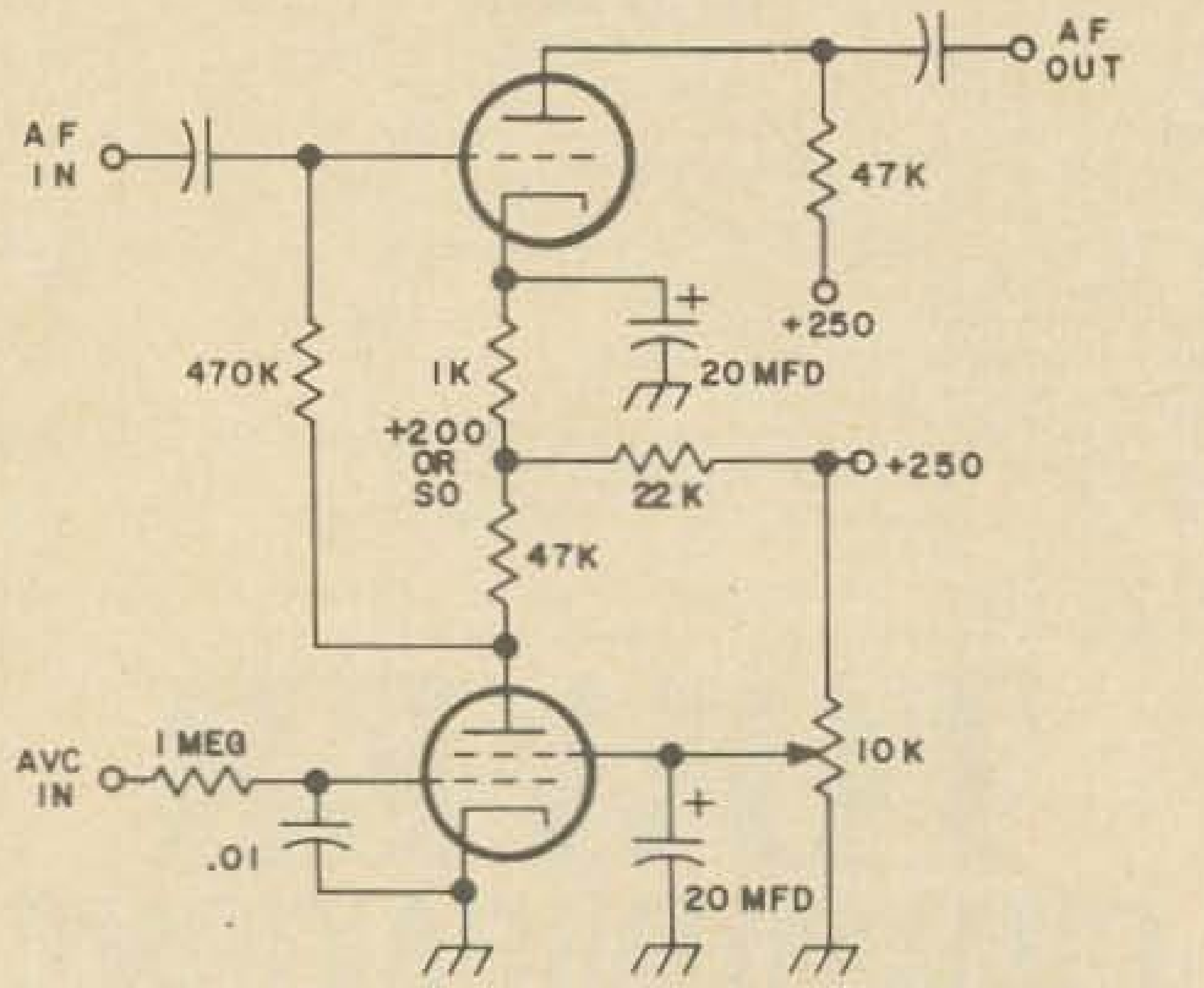

Fig. 10. CODAN squelch circuit schematic diagram. This circuit turns audio amplifier (V2) on or off by means of avc voltage applied to squelch tube (V1). Complecity and audio distortion are two major disadvantages, but circuit is still the most commonly used squelch in amateur practice.

Circuit operation is relatively simple:

In the absence of incoming carrier, the AVC voltage is zero and tube V1 is unbiassed. It can thus conduct a heavy current, limited only by its plate load resistor and screen voltage. The voltage drop across the plate load resistor produces a negative bias on the triode amplifier tube V2, which cuts V2 and prevents any audio from going through.

When a carrier arrives, AVC voltage goes negative and cuts off V1. When V1's plate current drops, so does the voltage drop across the load resistor. This reduces bias on V2 and permits the audio to be amplified. To change the amount of AVC voltage required to cut off V1 and open the squelch, the screen voltage of V1 is adjusted by potentiometer R1. This adjustment is known as the squelch level control; the lower the screen voltage, the lower the signal level required to open the squelch. In fact, with low enough screen voltage, V1 is effectively cut off with no AVC, and the circuit is locked open. This condition is used to operate without squelch action, and when squelching is desired, the adjustment is run up until the receiver just goes dead. Any increase in AVC voltage will then open the audio and permit the signal to be heard.

This circuit has several disadvantages; the largest, aside from its complexity, is that it introduces distortion into the audio because the bias on the amplifier stage depends upon the signal strength.

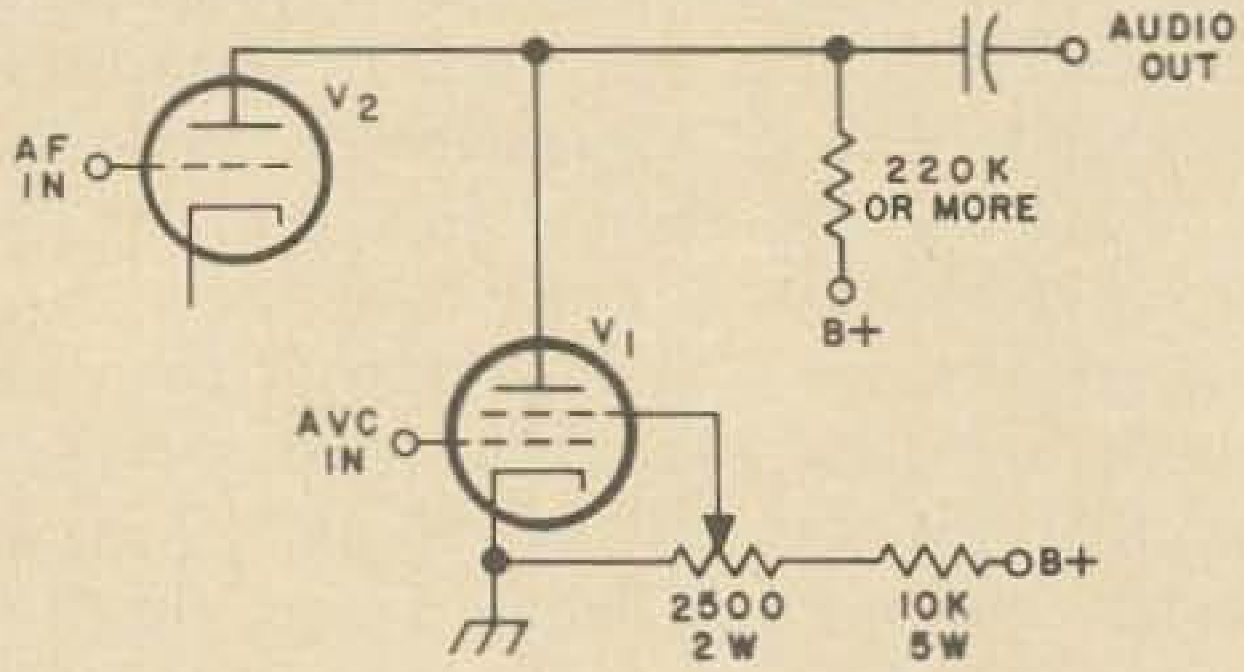

Fig. 11. Shunt squelch circuit. The design loads down audio amplifier stage (V2) by conduction through squelch tube (V1). Distortion is less than with CODAN, and circuit is simplier. In both this and CODAN circuit, squelching level is set by adjusting screen voltage of squelch tube. The higher the voltage on the screen, the more signal is necessary to open the squelch.

A simpler circuit which operates much the same but has less distortion connects the pentode stage across an audio amplifier rather than in series with it. **Fig. 11** shows the schematic. When AVC is absent and screen voltage is set high enough, pentode V1 (the squelch tube) conducts heavily enough to load down the amplifier stage (V2) and prevent audio from passing through. AVC voltage cuts off V1 and removes the load; V2 then operates normally. The screen voltage adjustment of V1, as in the CODAN circuit, controls the point at which squelching occurs.

With the rise in use of diodes for switching purposes, still another squelch circuit was developed; it has the lowest distortion of the three, and is also the simplest. **Fig. 12** shows the circuit.

This circuit uses a diode as a switch controlled by voltage levels. When the diode is conducting, the switch is closed and audio can pass through from input to output. When the diode is cut off, the switch is open: no audio can pass and the receiver is silent.

Control voltage for the diode is taken from the screen of any AVC-controlled *if* amplifier tube. In the absence of an incoming signal, AVC voltage is low and amplifier

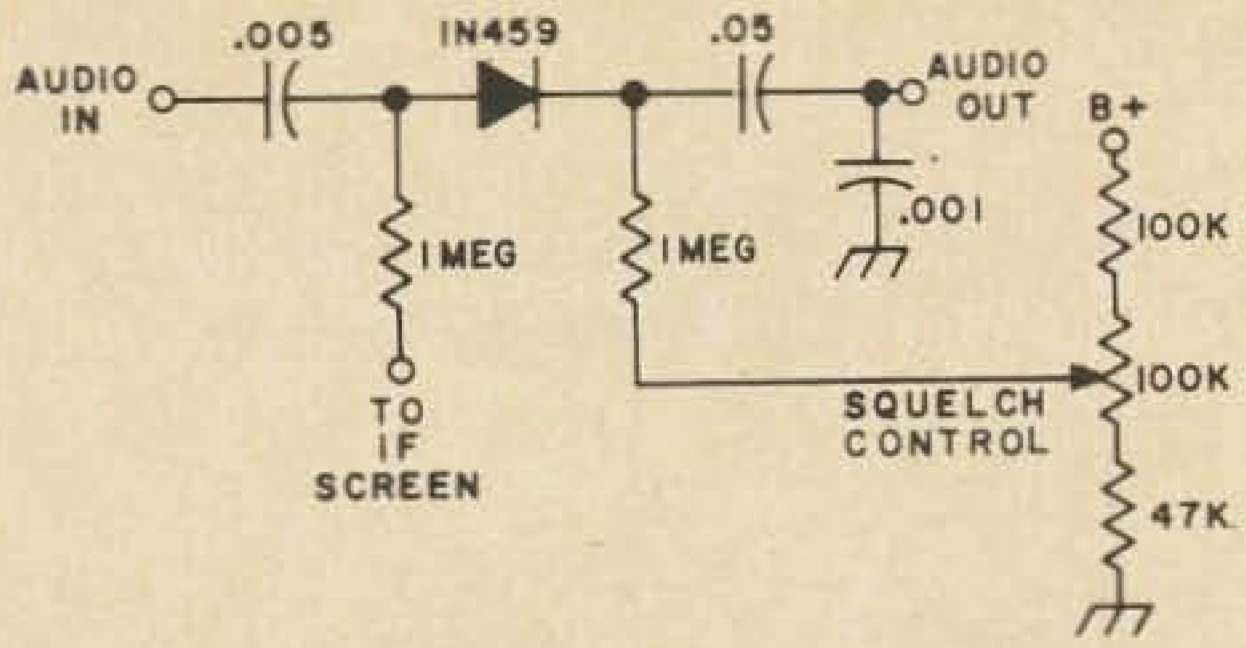

Fig. 12. Simplest squelch circuit which gives satisfactory performance is this diode-switch arrangement. Only nine components including the diode are required; existing circuitry supplies the rest. Relation of screen voltage level in if amplifier to voltage set by squelch adjustment determines squelching action. A 10-volt difference is adequate to operate the diode switch, and audio level up to 5 volts can then be passed or blocked by the switch.

current is high, with a resulting low screen voltage. When a signal arrives, AVC voltage goes negative and amplifier current comes down with a consequent rise in screen voltage.

The screen voltage is connected through a high-value isolating resistor to the anode of the diode, while the cathode of the diode is returned through a similar isolation resistor to an adjustable voltage source. When the cathode voltage is set so that it is greater than the at-rest screen voltage, the diode is then cut off. When signal arrives and the screen voltage rises, the diode turns on and lets audio through. The two capacitors merely block the dc switching voltage from the audio circuits.

This circuit introduces little or no distortion because it has no effect upon any amplifier operation; when the diode is "on" it represents merely a low-value resistance to the audio signal and when "off" it's a multimegohm resistance.

Unfortunately, this circuit has not come into "common usage;" the CODAN remains one of the most common circuits in use despite its disadvantages.

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6. *Receivers*, K5JKX, published by 73.

Now You Too Can Have A Deviation Meter

Mr. Glen E. Zook, K9STH
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Richardson, Texas 75080

In the world of amateur FM one of the most important test items is a deviation meter. Such a device allows the transmitter deviation level to be accurately set. Basically a deviation meter consists of an FM receiver with one of two types of visual display: meter output and oscilloscope output. The oscilloscope display method allows instantaneous deviation whereas the meter display reads average deviation. Either or both methods are relatively easy for the amateur FM'er to build and use.

The easiest method for amateur use is the oscilloscope method. However, this assumes that the individual amateur has in his possession a general purpose oscilloscope. Since this is not always the case, use of the meter method will also be outlined.

The oscilloscope method involves connection of the vertical plates of the scope to the discriminator output, as in **Fig. 1.** The output of the discriminator is ac voltage directly proportional to the deviation (± khz) of the transmitter. Calibration of the oscilloscope may be accomplished easily by use of three crystals. One crystal should be at the low *if* frequency of the receiver (455 khz in most commercial and obsolete commercial units used by amateurs) and the other two crystals should be either 5 or 15 khz above and below (450 khz and 460 khz or 440 khz and 470 khz) the *if* frequency. The purpose of these crystals is to set the limits of deviation. To calibrate the receiver oscilloscope combination first set the oscilloscope up for DC operation. Then set the sweep of the oscilloscope to the center of the calibrated scale on the CRT when a 455 khz (or other center frequency) is applied to the low *if.* Next apply the high and low frequency (e. g. 440 khz and 470 khz) and set the resulting line one division for each khz difference from the center *if* frequency above and below the center line. For example, set the lines 15 divisions above and below for ± 15 khz (wideband deviation) if 440 khz and 470 khz crystals are used. When deviation is read, each division on the scale will represent 1 khz. Use of the deviation display involves only "zeroing" the transmitter to the receiver and then modulating the transmitter.

An alternate method of calibration is to apply a continuous tone to a transmitter which has had its deviation set with another standard and then adjusting the height of the resulting oscilloscope pattern above and below the center line a number of divisions equal to the limits of the known deviation. However, this method is not as accurate as the former and should be used only if a standard at the *if* frequency (either crystal or variable) is not available.

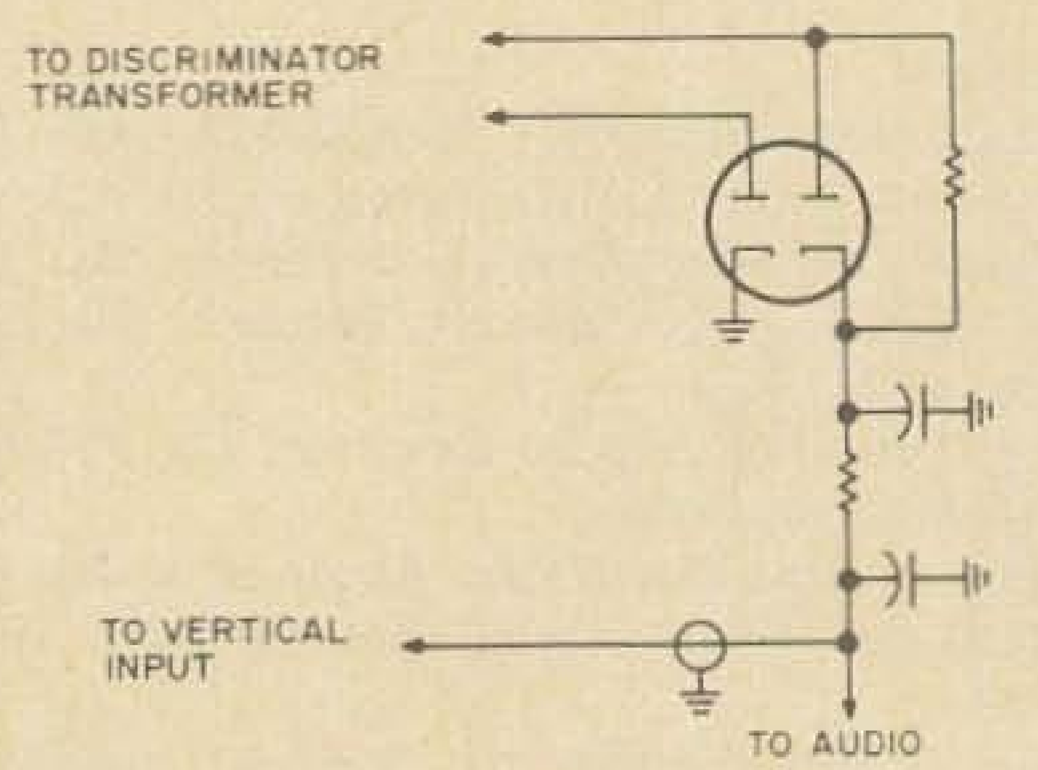

Fig. 1. Oscilloscope Display.

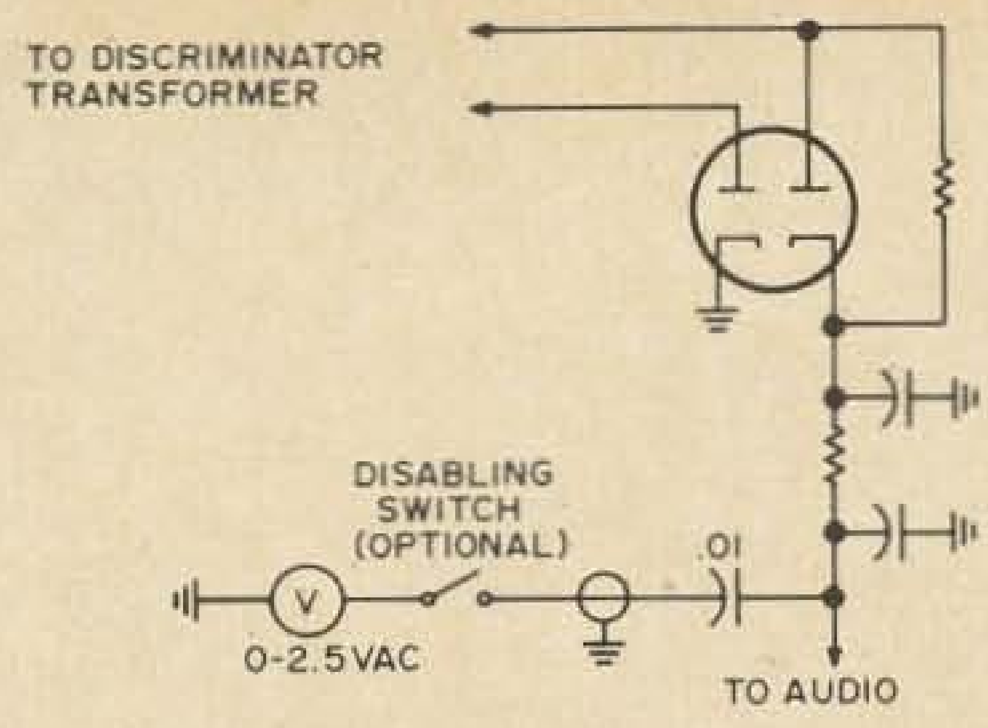

Fig. 2. Meter Display.

The second method of reading deviation (meter method) is cheaper to obtain (less than $5.00) if an oscilloscope is not available. The only drawbacks are the fact that it reads average deviation (no problem in amateur service) and the audio output of the receiver is slightly reduced. Also, an oscilloscope is necessary for initial calibration. Basically the meter method consists of an ac voltmeter connected to the discriminator output through a blocking capacitor. The meter movement may usually be of the garden 0-3 vac type, or a vom in a low ac voltage range may be used. The former is preferred so that a new scale may be added and calibrated directly in khz of deviation. The hookup is pictured in Fig. 2.

Calibration requires an oscilloscope to be calibrated as in the first part of this article. After the oscilloscope is calibrated (borrow, rent, etc., one for a day) a tone is applied to a transmitter and the deviation level adjusted to varying khz levels. The meter should be connected,. the reading noted, and then disconnected for each level. This is necessary because the meter will distort the oscilloscope level when connected. It is suggested that one khz steps be used up to 15 khz. A new scale then can be prepared and glued over the old vac scale. When the meter is connected, the audio output level will be down slightly, but most FM equipments have audio to spare when used as base stations.

An alternate method is to borrow a commercial type of deviation meter or a signal generator with calibrated deviation output and to calibrate the meter using the borrowed instrument for a standard. This method is not quite as accurate as the oscilloscope calibration, but since a continuous tone is used, the average deviation read on the standard meter will be the same as the peak deviation read on the scope. The error lies in the reading of the standard meter which is not as easy to interpolate as on the oscilloscope.

The use of the deviation meter (be it oscilloscope or meter movement type) will allow any number of amateur FM transmitters to be accurately set to an agreed upon standard (either ± 5 khz for narrowband or ± 15 khz for wideband or ± 7 to 9 khz which is usually compatible to both wideband and narrowband receivers). When care is taken in calibration, such a setup will closely approximate commercial units costing several hundreds of dollars. The major difference is that use of the meter described herein is limited to only the frequencies for which the operator has crystals (unless the receiver is tunable, which is usually not the case), whereas the commercial types are usually usable over the four major commercial FM ranges either directly or with sub harmonics. Since amateur operation in most areas is limited to a few specified frequencies, this is no drawback. Thus, this instrument can be another factor in many enjoyable hours of amateur FM'ing.

. . . K9STH

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Two Transistor 1500 Mile Transmitter

Transistors being my number one hobby, I decided to try to beat some of the QRP records that others have claimed and to show what I could do with 'milliwatts' while others are building 50 and 100 watt rigs for six meters. The two transistor model has earned 'its building'. I have had reports of 10 over 9 from South Carolina, S8 from Tennessee, S7 from Arizona, and S6 from Montana, plus working all locals.

The ¼" ceramic slug tuned coil form designed for printed board use was bought from Vanguard (they advertise in *73*). The HC18/U crystals can be had from JAN Crystals (see *73*, June '67, pages 88 and 89). The modulator is a Birnbach (sold by Radio Shack and others) 5 transistor unit, with pp class B output. It has a shielded input transformer with both 50 ohm and high impedance inputs, and 500 and 8 ohm outputs. A word of caution, when I increased the voltage from 12 to 16 volts I lost the two output transistors and a 5 ohm resistor! The output is 300 milliwatts, which is enough to modulate a ¼ watt rig. The modulator has lots of gain so be sure the gain control isn't too high or you will splatter. When I tried to mount the modulator and the transmitter in the same case the *rf* got into the modulator in spite of shielding and by-passing. I gave it up. If you try this you may hear a high pitch audio whine in the receiver and find that the modulator output transistors get hot fast.

A regulated power supply (or batteries) must be used. If not, on voice peaks when

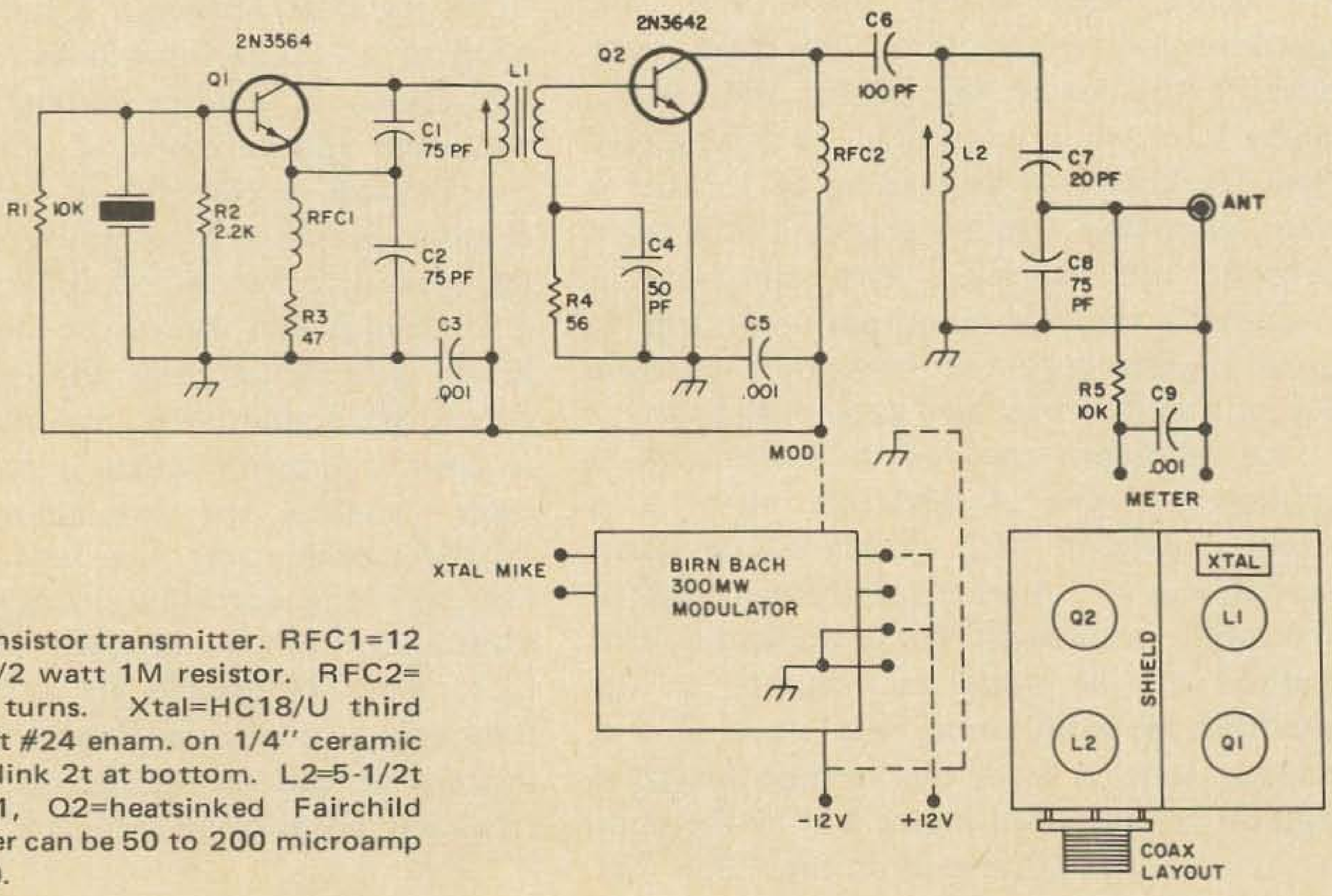


Fig. 1. Two transistor transmitter. RFC1=12 turns #26 on 1/2 watt 1M resistor. RFC2= ditto with 20 turns. Xtal=HC18/U third overtone. L1=6t #24 enam. on 1/4" ceramic iron core form, link 2t at bottom. L2=5-1/2t ditto L1. Q1, Q2=heatsinked Fairchild 2N3642's. Meter can be 50 to 200 microamp or Simpson 260.

the transmitter final and modulator stages draw current, your voltage will drop and the final result is downward modulation plus FM'ing.

In designing the transmitter, be sure all emitter and collector leads (either wiring or printed board) are very short. The shields between stages are printed board cut to size and soldered on. Make all grounds on the printed board wide (I make a wide ground all around the board and down through the center where the shield goes. See **Fig. 1.** Coat the printed board 'wiring' with solder to lower the resistance (it pays!).

Be sure the coils dip out (with a grid dipper) a little higher in frequency with the transistor out as the "extra" capacity with the transistor in will lower the frequency. You will find out (you tube boys) that in some circuits the transistor loads the coil (lowers the Q) to such an extent that you cannot find the dip. So have your receiver handy to check signals also. Also be careful, in some circuits; the oscillator transistor's not oscillating will draw more current and get hot (due to its being a class A stage till it oscillates and then it is class c). Transistors are easy to blow, ask me!

Using the grid dipper in the diode position you can check each stage to see if it is working. After the oscillator is working and the final transistor is installed, be sure the oscillator isn't loaded so it will stop. It may have to be retuned. Be sure it will fire every time the power is applied. If not, retune.

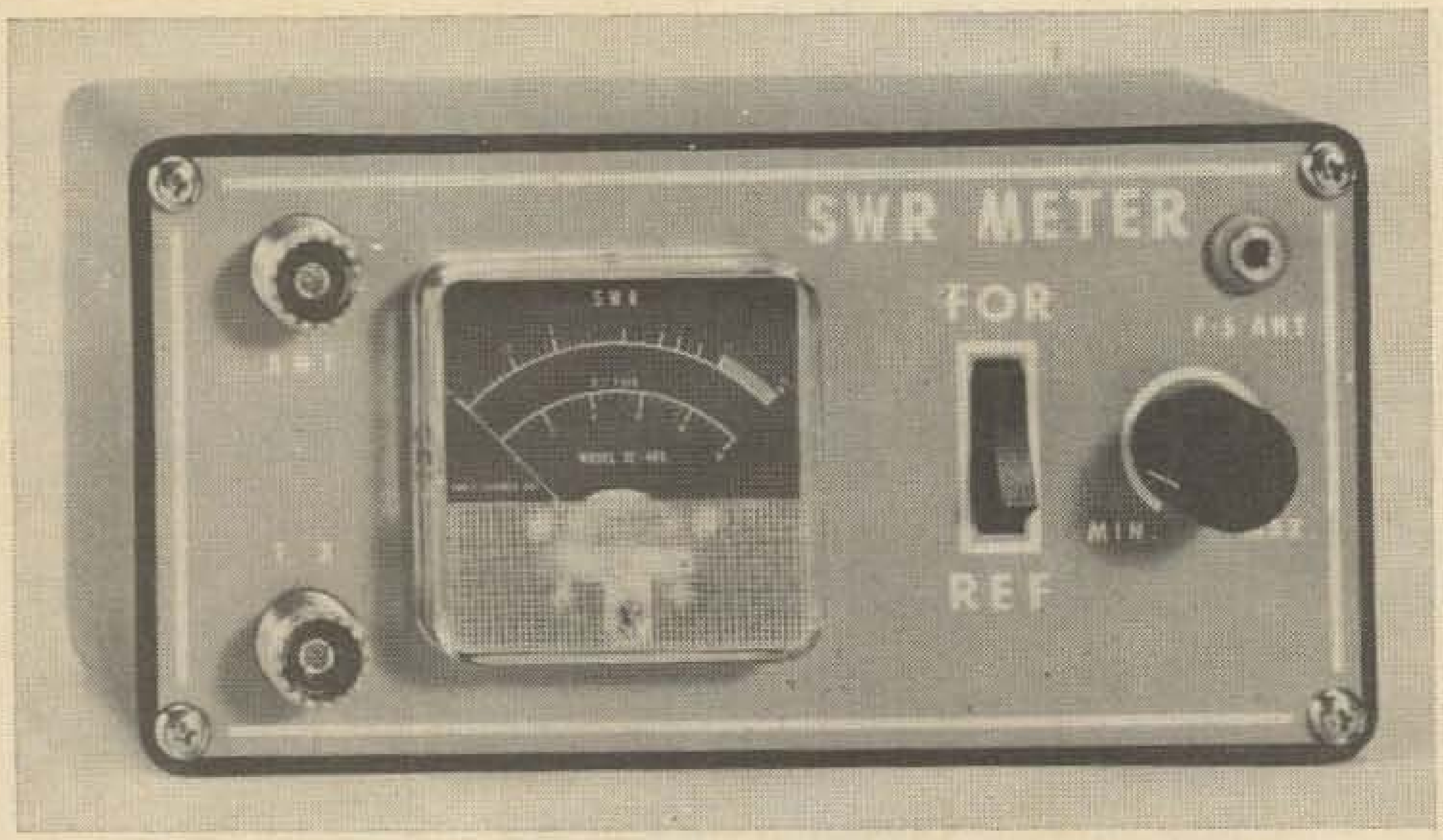
With a #49 dial bulb as a dummy load and everything connected (and working), whistle in the mike and tune the final slug for maximum brilliance and upward modulation. (I blew one bulb under modulation). Now connect the antenna and, with meter connected in output (see diagram), check for maximum output. Now check with your re-

ceiver – or better, have a ham friend a few miles away check your modulation. Set the gain control for clean audio. Don't set the gain while you are a foot or two away from the mike and then *climb* in the mike while dx'ing or you will overmodulate.

With good design, a good beam antenna, and of course, good skip conditions, you ought to do as well as I did or better. Good dx'ing.

Don't forget, in this design, that the "ground" on the transmitter is minus and the ground on the modulator is plus. Follow the diagram carefully – or, so sorry – you have ruined some transistors!

...KØVQY



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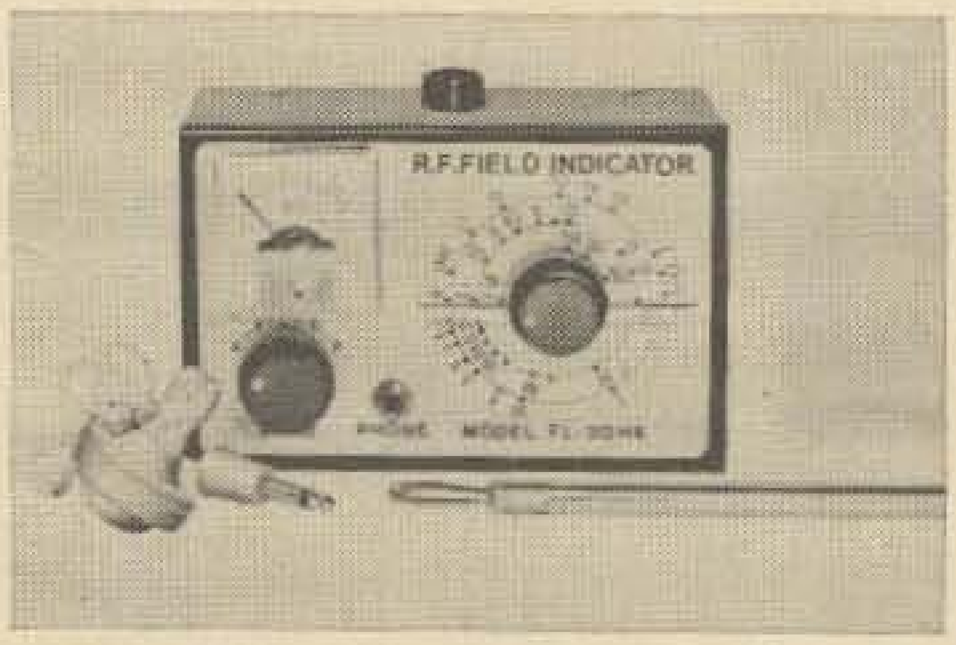

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Ralph W. Campbell, W4KAE
316 Mariemont Drive,
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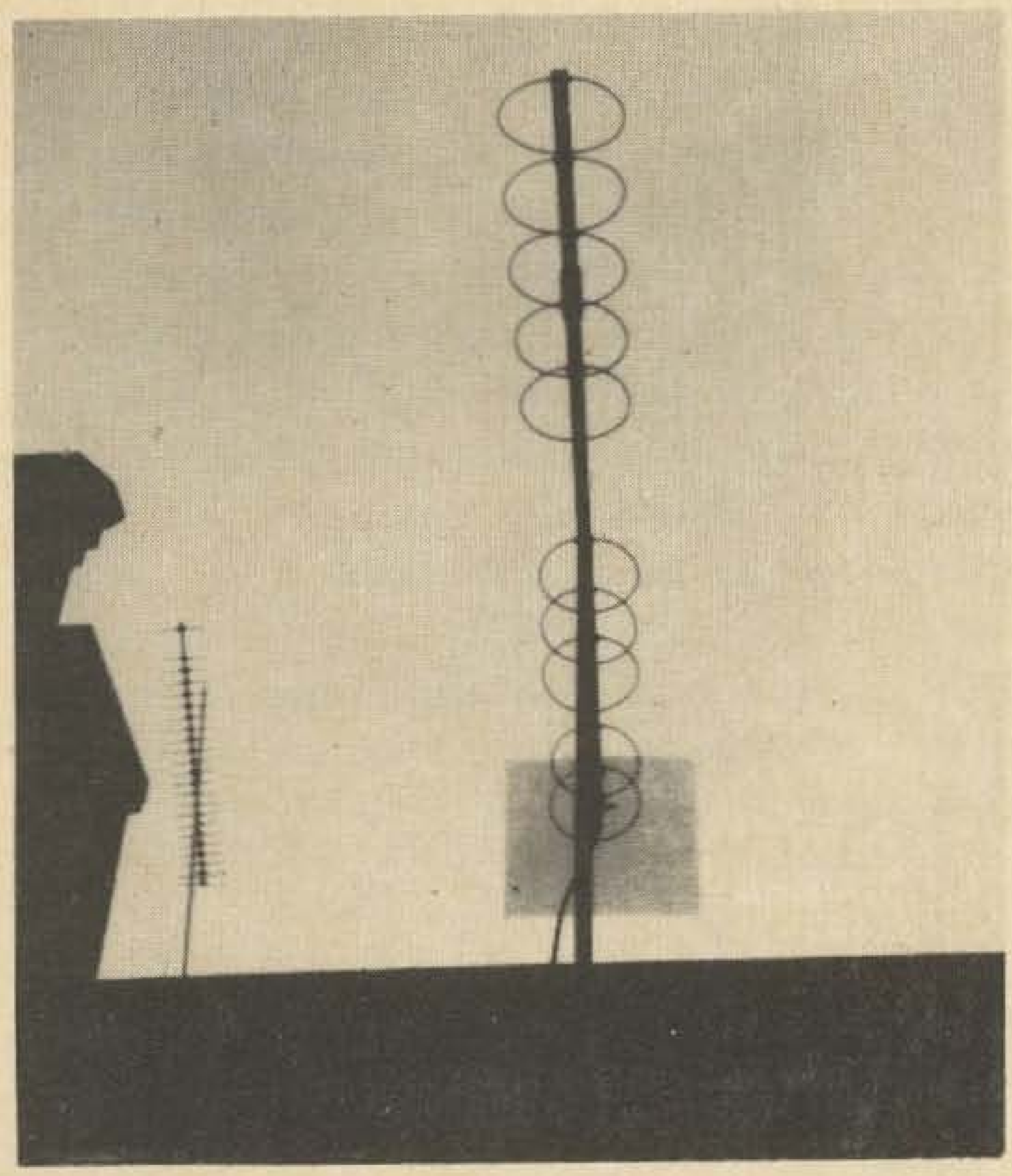
Long Circular Quads



A 23 element yagi was defeated 2:1 by the long circular quad antenna.

The 11 and 18 Element Long Circular Quads are Semi-Circularly polarized when properly fed from a one-quarter wave-length stub (or with 200 ohm balanced line) concentric in its arc with the axis of the antennas. The driven element may be fed in this manner, with a very low SWR. Polarization of any of the antennas described in this composite article can be affirmed by using a vhf/uhf field strength meter or a sensitive dipole and diode detector such as the 1N38B and a small-signal transistor dc amplifier.

By elevating these arrays to at least 17 feet[6] off ground or roof, it's possible to get a good plot of the directivity and gain. Ideally the reflector should be round and have a minimum diameter of 5/2 wave-lengths; however, a square screen 5/2 wave-lengths on a side should be adequate. If difficulty is encountered in "circularizing" the arrays from reflections or standing waves within the induction field, simply change the feedpoint from 3 o'clock to 6 o'clock, etc.

Introduction

This article gives an insight into new types of vhf and uhf antennas which are now patent pending by the author. They are usable on 2 through 3/4 meters and into the uhf television spectrum. Frequency considerations of bandwidth, patterns plotted and element tapering are discussed with curves from Project OSCAR tests and our own observations with uhf television on Channel 32. Tapering was performed on the 8 element Long Quad only. Propagation on Channel 32 was limited to a faint forward scatter signal on the premises of Radio Station WBLG, in Lexington, with their approval. The other antennas described use parasitic elements cut to the same dimensions as the driven element (DE). The round element antennas were tested in our shop as well as in the field; with precise matching on 432 mhz, with the "business end" of the array pointed up. It was found to be interesting to note that the quarterwave circular stub presented about 60° (approx. 1 radian) arc-length when unity SWR was obtained on 432 mhz. Use of RG-58/U was preferred for this band, while 300 ohm line was chosen for use on Channel 32 reception. Reception was so good that we observed about double the signal strength using the 11

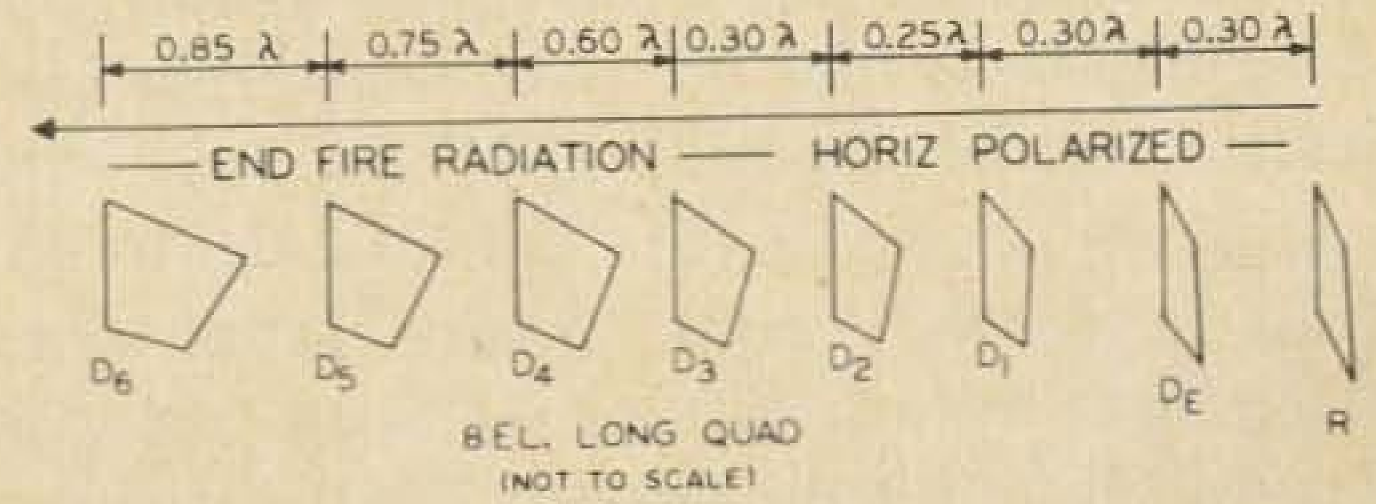
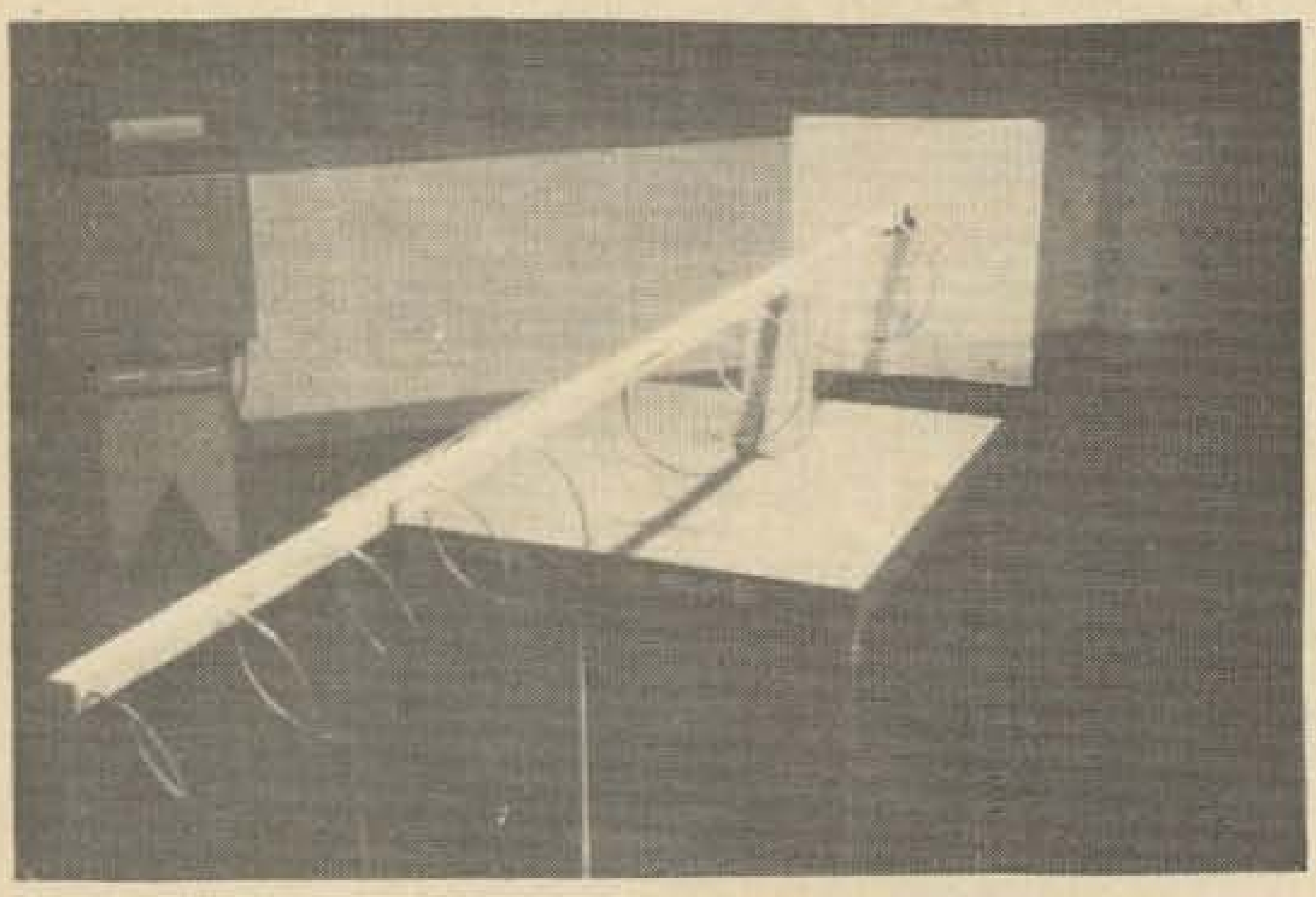


Fig. 1. 8 element long quad.

element Long Circular Quad as compared with 23 element Long Yagi built by station engineers.

The following paragraphs show without mathematics properties described. RG-9/U is a minimum size coax to be used, with preference for Foam Heliax^{tm} as in commercial installations. Silverplated RG-9/U has about the same rating as RG-8/U but has a non-contaminating jacket: and the shield-braid (2) remain interwovenly conductive within (look at your RG-8 after two years!). Both RG-8/U *and* RG-9/U are adversely affected by dew, and as much as 20% variation in reflected power can be expected, even with a perfect match! For experimental



Laboratory development of the long quad.

use and testing, the RG-58/U and an Amphenol coaxial termination are a necessity, mostly because of element length-to-surroundings scale, etc. Heliax^{tm} is the only answer on 100-ft. runs.

The first photo shows the 11 element Long Circular Quad being tested with the 23 element Long Yagi in the background. Both antennas were matched to balanced 300 ohm line. The test site had a clear horizon. On the 18 element Long Circular Quad shown later, RG-58/U was made exactly 1/4 wavelength *on the outside* for proper connection from the screen (*rf* ground). Preliminary comments on the circular quads show a nearly perfect major lobe whose half-power-beamwidth gives 15 db gain over a matched half-wave dipole. This means that we can say 18 db over a point source. And these calculations were taken from the pattern itself, plotted through a research laboratory antenna range. These patterns were traced by an automatic pen recorder which was apparently servo-controlled. Some breakdown into vertical and horizontal modes were observed, but this model was not very well balanced or completely matched when tested. Calculations are accurate, since the minimum amplitude for each graph is shown to be above "zero" or presents a plotted minimum value on the same scale factor as the peak pen travel.

Also in this article, construction is detailed thoroughly for the home craftsman. Air-dried seasoned oak is preferred for the 18 element antenna 12-ft., 6-in. boom; however, a sturdy fiberglass quad arm may be better in the long run. With a heavy round quad arm, a spring brass U-bracket could be fashioned, similar to an auto radiator hose clamp with tightening pressure similar to a metal TV stand-off insulator (this would be from the underside). The other solution is to use epoxy as described fully later on.

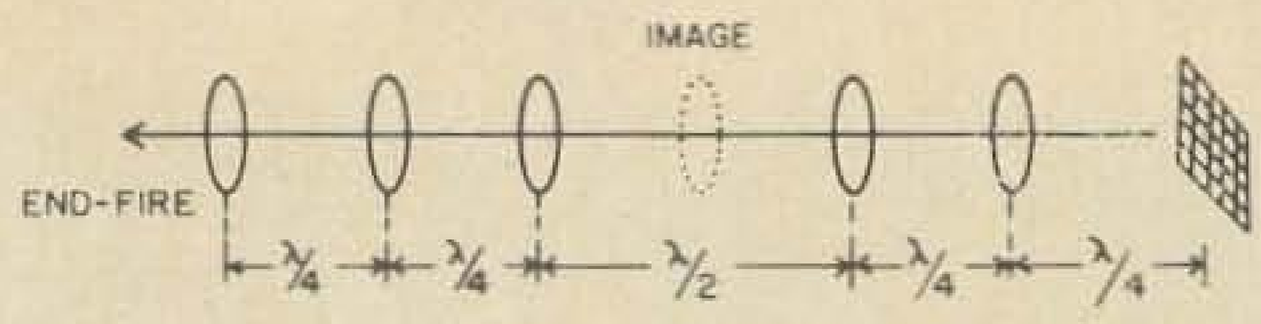


Fig. 2. Untuned reflector gives mirror image of the elements.

Long Quad Development

First in our discussion of these new antennas is the 8 element long quad of more conventional design. The approach was this: Make a regular quad with a screen reflector on the APX-6 transponder and add elements to make it "long," meaning in Yagi terms to increase the boom length with extra elements in excess of a total of 5. Using approximately 984 mhz *rf* from the transponder with a Heath Tunnel Dipper as an FS meter (diode position), we found that maximum gain and directivity was obtained with the eight elements staggered, aperiodic and quad-shaped; the directors tapered to 95% of the driven element circumference, combined to product optimum results!! All the directors were the same 95% circumference of perimeter of the DE. The elements were cut to 984/Fmhz or at this frequency 1 foot, for convenience. The reflector screen was moved back-and-forth to match the array the first time; the second try was to build a 1/4 wave stub (shown in the quad development photo) and vary its spacing from the soldered feedpoint connections. Of course, 984/Fmhz is free-space wavelength, and we used a 4% shorter length for the DE. Unity SWR was not consistent with maximum forward gain (a corollary of Murphy's Law); so we settled for one condition consistent with near optimum with the other. The six directors were staggered as shown in **Fig. 1.**, with the closest director spacing being between D2 and D1 (not between D1 and DE as would be expected). We claim 2 *honest* db gain over an equivalent 8 element Yagi of the same boom length, or 13 db[1]. Once we realized this array would work as described, we went further.

Circular Quad Development

The next step was to make our elements circular. The APX-6 was cranked up to about 1160 mhz, where one wavelength was close to 24 cm. and one-quarter wavelength was approximately 6 cm. We have no photo of this antenna; however, we observed that none of the expected characteristics of the long quad or long Yagi were to be found. Instead, it turned out that one-quarter wavelength spacing intervals, and staggering of our dimensions were of prime importance. The parasitic directors were cut to 95% of the DE length and odd-numbered groups of director elements, with quarter-wave intergroup spacing, gave the highest gain for the array. Also, the staggering of these groups of elements allowed a "gap" or space between for the DE and D1 reflected image to appear in phase in the right "place" on our wooden boom, for more gain. Keep in mind that the reflector was untuned and presenting an electrical "mirror image" of the elements discussed. See **Fig. 2.**

Polarization was semi-circular, in an axial mode (end-fire directivity) and not sideways from the boom. There was considerable horizontal radiation similar to that obtained by feeding a regular quad at its apex. Little vertical radiation was noted. Our conclusion was that some degree of imbalance was imparted by standing waves on the line or a non-perfect match at the antenna terminals.

No balun was used. The largest portion of the radiation is horizontal with an additional "circularizing effect" possible[2] because of the circular shape of the directors themselves. Also, the vertical and horizontal components are similar which makes the antenna fine for OSCAR and vhf Moonbounce work. Incidentally, "Circular Quad" is a misnomer which we use to show how the antenna was derived. With the circular quad there is no 30 db winding sense[3] loss, a characteristic of the Helical Beam Antenna. Faraday rotation, which is simply defined as rotation of an incident wave upon passage through (the Earth's) magnetic fields, should be no problem.

Mechanical Details and Performance

To prove that this antenna has promise for the amateur and experimenter, as stated in the introduction, I constructed a fringe-area uhf model of the circular quad for Channel 32, using 11 elements; and the results were fabulous. (See tabletop photo from our laboratory.) Working at 579 mhz with the driven element cut to the picture carrier, we found the gain/aperture at least equal to two commercial corner reflectors, yielding a snow-free picture of this elusive signal (see first photo). In addition, turning the array on its axis back-up a prior conclusion that we had circular polarization. The vertical and horizontal beamwidth was approximately 20 degrees.

Performance

Two lobes were reported, with gain figures based on beamwidth plotted from the *VHF Handbook*, by Orr & Johnson.[4] Note that gains of 14 db horizontal and 8 db vertical were calculated. This plot is at 5% below the normalized frequency of 1,000 mhz. At the normalized frequency, only a single plot was obtained, composed of both lobes equally (we assume) yielding 16 db power gain over a dipole. The screen reflector is about 12 by 15 inches square (not critical) and an N connector with hood is at the base of the decoupling sleeve, with RG-9B/U inside it. The SWR was high. L-shaped steel corner braces hold the N connector and base of the decoupling sleeve securely, as well as the screen.

At 5% above the normalized frequency for design-center, we have 16 db power gain over a dipole. The major lobe is clean and very little energy went into the others. The effective aperture for the array is approximately 6.5 wavelengths squared. Aperture is an interesting measure. Physical aperture of the Long Quad is twice that for any other array, I think. Or, it is like expanding a 2-wire folded dipole into a circle. We suspect the physical aperture is at least 1.4 times that of any Yagi; and perhaps as much as 2.5 times, taking into account "wavelength factor."[5] Any opinions? The equipment used consists of a two'er, a 25-watt 2-meter linear, a diode varactor and a Cesco Reflectomenter.

Performance and Theory

Assuming a standing wave of current to exist on the structure looking "down" on the vertical plane of each loop, a reflection from the imaginary "screen image plane" gives the expected 3 db gain over a single dipole. See **Fig. 3**. Based on the assumed stationary wave phase, one of several current maxima (we chose the one ahead of the sixth element) allows the amateur (or professional) to select his mounting point, depending on mast material. As the traveling wave progresses, with each peak displacing 1/4 wavelength more, gain increases. If it's difficult to visualize, simply start at the 6 db "bar" and follow the standing wave as a "point" moving from the first current negative maxima, up through zero, then positive maximum, and back to zero. The zero point on the sixth element plane is in the same plane of the bar marked 9 db, below. Observe that it is only displaced 90° *relative* to the repeating (transcendental) maxima of the assumed standing wave, which does not move. And notice that the first negative maxima referred to is positive-going, while at the sixth element the amplitude is negative-going. What's wrong? Nothing. *Both* wave motions are still from left-to-right, and add in time, giving the 9 db circular gain figure which results. In the first place, it can be asked why we picked the 6 db current bar as reference. Well, we could not use the dashed-in 0 db bar because it exists as a non-reinforced reference, without physical dimensions; however, this image *and* real element above do add to produce 3 db. This leaves the 6 db bar our choice, to eliminate confusion.

We built several models of the Long Circular Quad. After much testing and refinement of our use of instruments, starting with an APX-6 on 984 mhz, enough data was accumulated from building a uhf reflectometer and the 1000 mhz scale model that we could conclude the information presented here. Further study has led to the conclusion that the parasitic directors must be shortened a "mystical 5," as some have said, for maximum gain.

Looking back at the tabletop photo, the first group of directors from the end are all spaced one-quarter wavelength gap; then the a three-quarter wavelength gap; then the next group of three loops, each at one-quarter wavelength spacing, with a one-half wavelength gap; and on to D1 and DE, each at one-quarter wavelength. Finally, we come to the reflector (R) which is made of "expanded" aluminum and is made approximately 5/2 wavelengths, minimum, square [9]. In this model, notice that the feed-point is at 12 o'clock, with heavy 300 ohm twinlead feedline. The boom length is 3-1/3 wavelengths at 579 mhz. Estimated gain (from Gain and Aperture Nomograph [10]) is 12 db, including a 3 db polarization loss from transmitted horizontal to receiving circular. There appears to be no sense to the antenna, as there are two helices. Please note that we are looking into groups of 5, then 3, and then 2 physical one-wavelength loops from the opposite end of the boom on which rests the sheet screen reflector, R. The staggering is 3/4 wavelength gap *between* the groups of 5 and 3, with 1/2 wavelength gap between the next group of 3 and 2; and 1/4 wavelength from the DE to R. More gain can be obtained by placing 7 elements with a gap of one wavelength ahead of the 5 shown; and you can add 9 with a gap of 1 and 1/4 wavelengths ahead, if you wish: the limit is what beamwidth is practical so that you can accurately "steer" the array. Matching, as we add elements, is not a difficult problem with a DE loop configuration.

18 Element Long Circular Quad Construction

The 18 element Long Circular Quad is

mounted on a piece of 1-1/4 inch steel TV mast with U-bolts and nuts. A front "nose" brace of wood keeps the array from drooping, and it is lashed to the seasoned oak boom with filament tape. The feedline is RG-8/U, with N connectors. The boom length is 12 feet (a little short for all 18 elements); however, allowance was made for 6 inches "over-length" by crowding the elements 1/3 inch each, with no loss in performance or SWR hike. The reflector screen is connected to the boom in paddle-wheel style, using 3/4 by 3/4 inch air-dried seasoned oak as the cross members. The reflector itself is made of "expanded aluminum," 2-feet square, which is about 5/4 wavelength on a side. One very important thing about this type of mounting is that 1/4 wavelength ahead of the second group of elements is a voltage null which permits the use of a metallic support. At other distances on the boom there are nulls that can be used for U-bolting a vertical conductive support; but this position is nearest the balance-point of the array. It wouldn't be a bad idea to use a V fiberglass support arm (\Kirk J quad arm). But don't forget to balance the antenna with the coax weight on it. Foam Heliax is heavy.

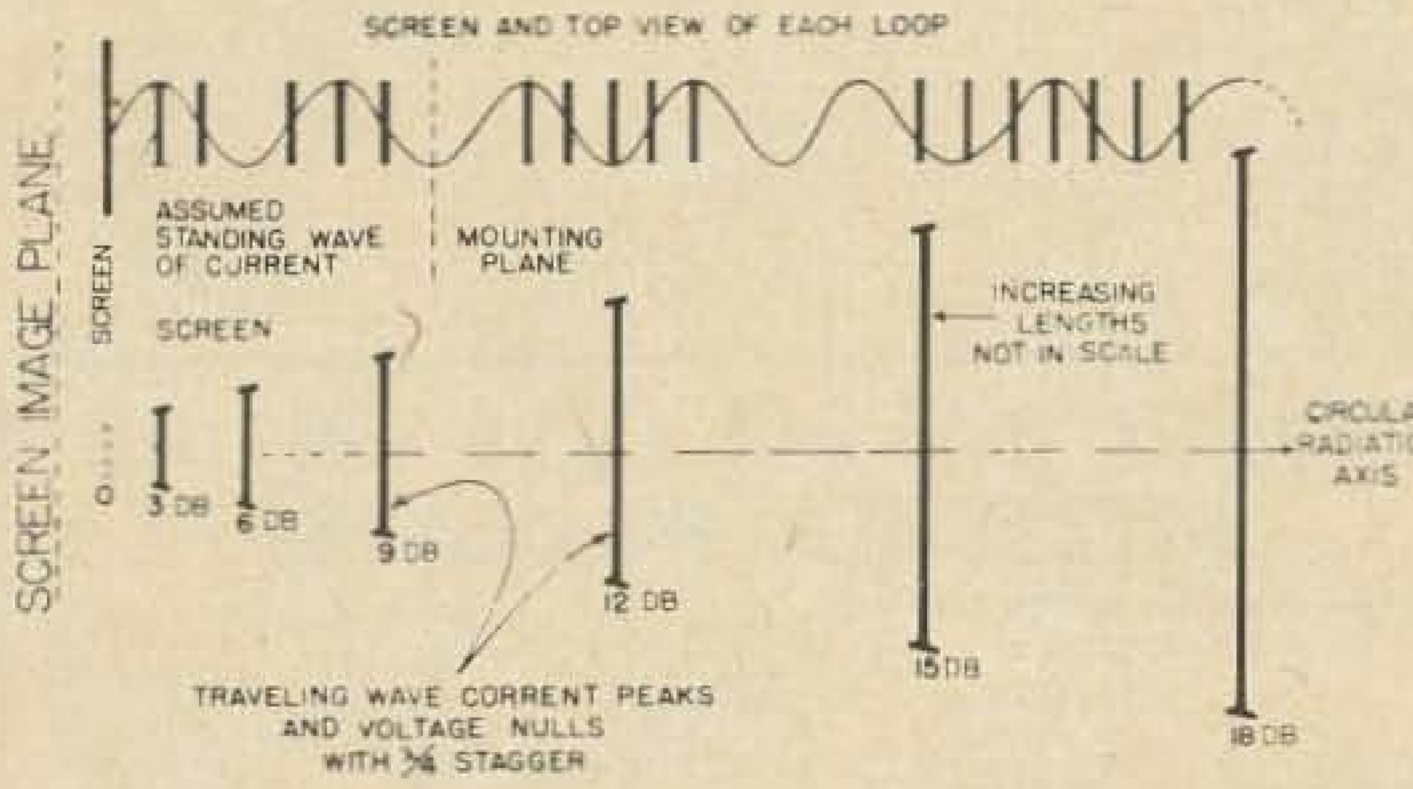
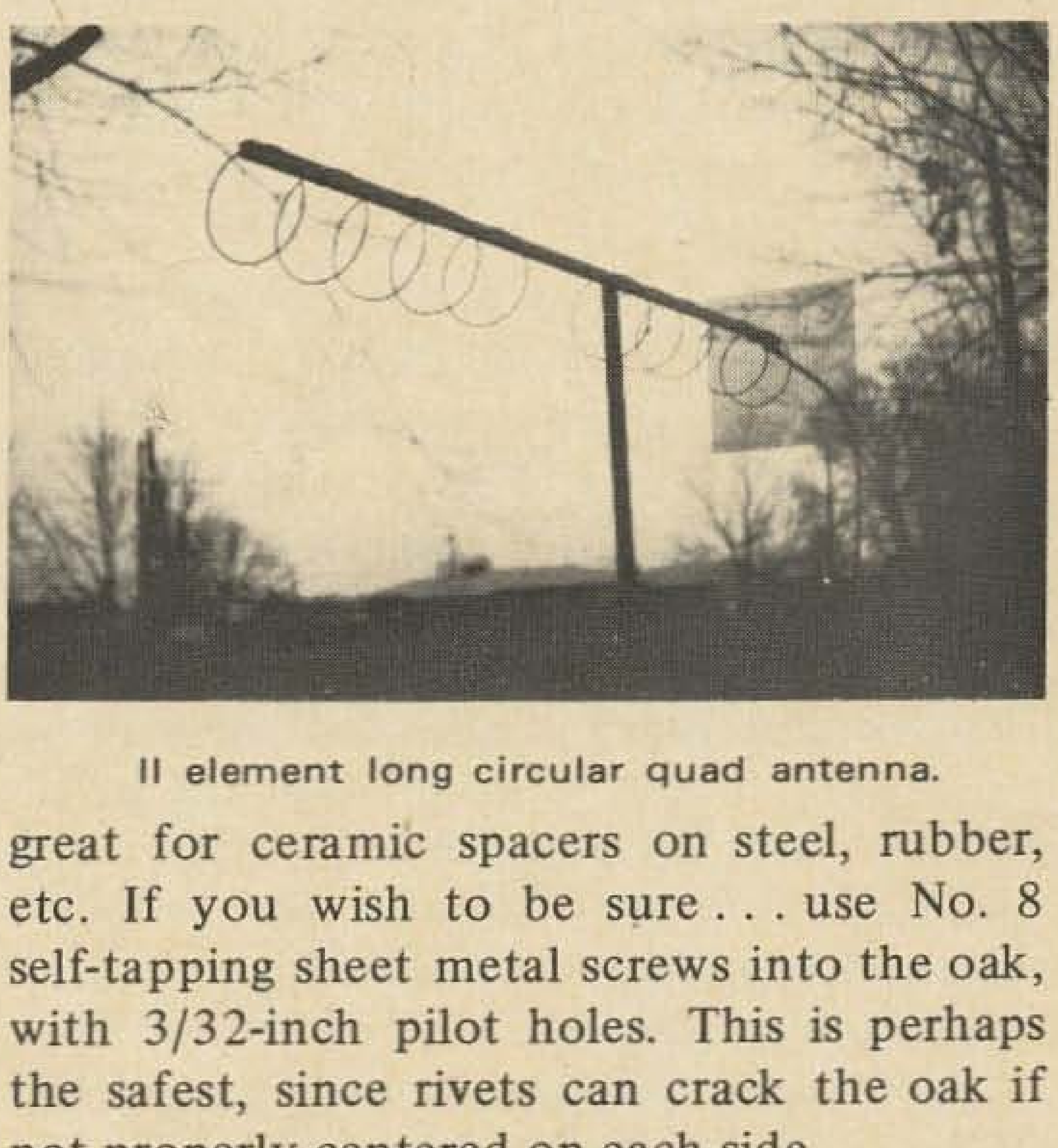


Fig. 3. Relative phase and gain of 18 element quad.

The elements were glued to the boom with epoxy, but it was first necessary to coat the rounded No. 6 hard copper with a thin layer of epoxy diluted with a very small amount of rubbing alcohol. Of course, the epoxy must be pre-mixed and the alcohol should not contain any glycerine. Prior to this, the element surface should be clean and dry and roughed-up with cabinet paper. After all 17 loops are coated, allow two days for the undercoat to dry. This method is the only simple way of gluing that works and was tested by the shipment of an 18 element 1215 mhz model to Project OSCAR group for scaled down tests at 1000 mhz (their choice for best results). Once the undercoat was dry, we inserted the No. 6 hard-drawn copper elements and gave a final coat to them and the wooden boom, which was previously drilled for 3/16-inch holes. The No. 6 cannot be bent by hand; take these elements to a sheet metal shop (pre-cut to 26 inches, as in our case), where they have a roller press just for this. Also, we tried wood riveting with the United Shoe "Rivetool," and found that by using 1/2 inch by 1/8 inch diameter steel pop-rivets, we successfully mounted the reflector screen to the paddle-wheel arms. The "pop-rivets" mentioned work only in oak. Referring to the gluing method above, we also tried the "Thermogrip Glue Gun," and it was not satisfactory; nor was our "Eastman 910 adhesive." 910 won't stick to wood, but it's



II element long circular quad antenna.

great for ceramic spacers on steel, rubber, etc. If you wish to be sure . . . use No. 8 self-tapping sheet metal screws into the oak, with 3/32-inch pilot holes. This is perhaps the safest, since rivets can crack the oak if not properly centered on each side.

A semi-closeup of the Long Circular Quad with leads to equipment is shown in the photo. This time we had a 4 to 4 quadfilar transformer on Ami-Tron T-50-10 core with poor results. The SWR was no lower than 2:1 on the reflectometer. Using Foam Heliax^{tm} is preferred to RG-8/U. An Amphenol or Andrew coax termination should be used for properly balancing and matching the one-radian electrical length of the circular stub. Total length of the circular stub and balun section is 90°, or one-quarter wavelength (we used 6.5") of No. 12 tinned copper, with 30 of the 90°, approximately, being used for balance. Reiterating: Just ahead of the first group of three parasitic elements (but behind the helper's hand) is *the* first complete null for mast mounting with metal U-bolts and clamps. With a sturdy fiberglass mast, the mount can be made anywhere on the boom not contained within a group of elements.

Conclusion

Looking back, there are several points which should be summarized: (1) The Long Quad is semi-circularly polarized when correctly matched and thoroughly *balanced*, with some breakdown into vertical and horizontal lobes which can occur when the antenna is held less than 17 feet[6] above ground; approached with less than 50 feet from the measuring site, and used too far below design-center. With 1.00 to 1.05 on the reflectometer and no standing waves *on the outside* of the feedline, it is semi-circular,[8] at least relative to the reflecting screen. (2) The gain of the array, when considering a boom length sufficient to hold 27, 38, or 51 elements (which are the next groupings of elements) places it in the category of a small dish, but with less physical aperture. (3) Frequency limits of +5% and -10% make it useful over a band of frequencies, and the loop wavelength can be calculated by 24,500/Fmhz, with lengths in centimeters. This formula is for a one-wavelength loop, physically. (4) There is no winding sense rejection such as characterizes a Helix; and a single support arm through the reflector screen material may be used with a counterweight to aim properly.

Try these arrays out in your own shack . . . get it matched *before* buying a pair of TR-44's on our say so. Crank it up 17 feet, balance it, and using Fig. 3 (extrapolated) as a guide to the nulls and gain with more elements, pick your mast position with RG-8/U cable taped on the boom for mechanical balance, then try the Foam Heliax (you might try the Phelps-Dodge Aluminum Foam-Flex which may be even better.) For an in-the-air mount, use an aluminum Y hanger from a separate U-bolted clamp with old garden hose binding the clamp to the upper portion of the mast. Good 432'ing!

. . . W4KAE

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8. Opinion expressed by Dr. John Kraus, December 6, 1966: "loops of wire as elements should have a circularizing effect," as paraphrased.
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(continued from page 2)

trend in amateur licenses. Nothing was done about setting up a small office in Washington for someone, even on part time, to lobby in Congress for our hobby. A second meeting is scheduled for November this year, so those few amateurs who are interested in their hobby have another chance this year to get the directors of the League to get off dead center.

There goes Wayne again, lambasting the League! No, I'm not anti-ARRL at all, only pro-amateur radio. All of you have put your eggs in one single basket: the ARRL. If there are any reasons whatever for amateur radio not paying for some national publicity I would welcome them and give them space in 73. If there are any reasons why amateur radio should have fewer amateurs instead of more I would like to know what they are. I know a lot of reasons why we should have more amateurs and why we need publicity and need it desperately, but I sure have yet to hear anyone speak up in QST or anywhere else and give reasons why we should not try to grow.

Along the same line, I have heard many reasons why amateur radio should have a working lobby in Washington, but I have yet to hear a single reason against it. Yet year after year we don't have one. Will someone, anyone, please write an article for 73 explaining why amateur radio should be the only radio service with no protection in Washington?

What did the directors accomplish? Well, for one thing they decided to petition the FCC to open the 29.5-29.7 band to Techs. We do need more activity up there, no question about it. Perhaps, since the only real difference between the Tech and the General license is a matter of code speed, this is the break-through that Techs have been waiting for and which will eventually get them a foothold on all our lower bands. I would think that there might be a survey taken to ascertain the activities of the Techs. How many of the active amateurs on 1296 are Techs? What percentage and how many on 432? On 220? On two meters? On six? There are some 60,000 Techs today. I think we should know how many are active, and what bands they are using at present. If we open ten will it siphon off everyone from six meters? Or will it just make for more activity in total?

The directors directed the ARRL to petition the FCC to open the remainder of two meters to Techs. This is long overdue, as I mentioned in an editorial several years back. I don't know why no Tech has taken the effort to petition the FCC for this change. This would integrate the band and eliminate the second-class citizen feelings of Techs who hear the Generals working aurora, CW, contests and satellites down on the low end of the band, unable to really join in the fun.

They directed the League to petition the FCC to reduce the waiting period for Extra Class to one year from two. This is probably a good idea too, but I doubt if it will have much effect on the massive resistance to the Extra Class we have seen so far.

They directed QST to start publishing info on VHF repeaters, put out a booklet on the subject, and get it into the Handbook. Great, but why was a board directive needed to get QST to this important phase of our hobby?

The $100,000 fund for amateur radio promotion worldwide was refunded. Excellent, But am I being rotten to suggest that some of the members may be interested in accounting of funds already spent? Nothing whatever has been published that I recall seeing. Where there is secrecy there is usually a good reason for it. Or does anyone else care where the money is going?

Dialog in 73?

Though I have written quite a few provocative editorials down through the years, I have had few letters as a result that were worthy of publishing. Sometimes I wonder if there is anyone out there. Isn't there anyone that has the hankering to write an editorial among our readership?

How about opening 3650 - 3700 for phone operation? I would suggest 3750 - 3800, but then the ten Canadian phone stations that operate in that band would get all upset and descend on me as a newly born devil. No, let's leave those VE lads their own private perserve to sit and talk with their own and QRM the hapless European and African stations that try to work through to the U.S. How about a nice phone band down below the Novice segment? Why? Why not?

Or perhaps it is time to extend the U.S. phone band down to 14,150 mhz? That still leaves plenty of room for the foreign phones that want to avoid contact with U.S. stations to operate from 100 to 150. Does anyone care one way or the other? Write to 73. Write to the FCC with 14 copies. Do something!

Do any of these things ever get discussed at club meetings? Come on, fellows, let's not spend the entire meeting reading the minutes of the last meeting. They are going to install a VHF beacon at W1AW. How does that strike you? Do you care one way or the other? If not, then why should they spend your money for such a thing? If VHF beacons are needed, why hasn't anyone written about it? There is a grave communications gap here.

What do you think of having our radio clubs examine prospective amateurs instead of FCC? And how about our clubs sending a representative each year to the National Convention to represent the members and come up with proposed changes in our regulations and allocations? You like the idea? You hate it? How about some dialog? The pages of 73 are as wide open to you as they are to me. With the expanded magazine we have a lot more room for opinions and such.

Radar Trap?

Jake, WB2PAP, sent in a newspaper clipping that makes life a little more worth while. It seems that a chap down in Madison, New Jersey was stopped for speeding (41 mph in a 25 mile zone) in a radar speed trap. "$16" (dollar a mph) said the judge, "plus $5 court costs." The victim, being a ham, decided to check a little. Sure enough, he found that the license for the radar had expired, a matter that could bring a $10,000 fine, if someone decided to file a complaint. If I were the judge I think I would have a strong tendency to agree with the victim that the 25 mph speed limit was unrealistic.

Visit to Quement

Just south of San Francisco, in San Jose, I found a mammoth radio store. I realize that they do everything big in California, but this is stretching things! Though he doesn't

make much of it in his ads, Frank Quement has a corking good ham department. Quement is probably best known around the country for his swr bridges, which he has sold by the thousands via mail order. Frank, I found, takes a great interest in amateur affairs and is ready to talk ham the minute you can pry him away from the salesmen and reps that hound his footsteps at every turn.

Visit to Jennings

Having a few hours before my plane back east, I hopped into a rented car and hied myself to Santa Cruz to drop in on Ozzie and Jo. By now you must have seen their ads.

They have pretty well filled their medium sized plant already and were working over plans for a new and bigger building when I arrived. After looking at the mountains of diodes they have on hand I see no reason to question their claim of the largest collection of diodes in the world. They showed me the testing machines that run curves for every diode they turn out.

Their ads claim that they can make up rectifiers for any application. Ozzie showed me some welding rectifiers that would handle a thousand amps. . .and others in remarkably tiny packages that would handle thousands of volts. They are turning out little plug in units that will replace any of the common tube rectifiers as a direct substitution. These are imaginatively and attractively colored. I'm hoping that they will be able to line up a bunch of them for a beautiful color cover shot for 73. The 5Y3 replacement is small . . .the 5U4 a little bigger. . .the 816 replacement still a bit larger. ...the 866 is about the size of a 5Z4. The 872 is about 6L6 size and the 575 replacement is almost 866 size! All are ready to just plug in and solidly epoxied.

From what I could see, Ozzie Yeager and Jo Jennings have established a firm beachhead as the kings of diodes and rectifiers. Purchasing agents have already begun to find the way to their door and it looks to me as if they should be about ready for an enormous growth in sales. I don't think that they even realize the potential.

They have an interesting little vacuum antenna switch package about ready for production now too. This, too, could have a profound effect on amateur radio. Imagine a vacuum antenna switch at not much more than a good coaxial switch! The UHF crowd should be the first to grab this break-through Eventually we may see them built into most linear amplifiers.

We can also look for Jennings to market some of those fabulous Jennings vacuum variable capacitors. . .but at amateur prices. Now and then, in the past, a handful of these jewels would break loose in surplus, but they never were available for long.

Keep your eye on Jennings and watch their ads for some startling new ideas.

Outgoing QSL Bureau

With the exception of the ARRL, virtually every national amateur radio society in the world provides an outgoing QSL service for their members. It is not a difficult or expensive service to provide since most of the cards just have to be sorted into a couple of dozen boxes to be bundled and bulk mailed to other QSL bureaus.

If we neglect the cost of the QSL card itself, which is not an insignificant item, and just consider the postage involved, we may be surprised. The average 73 reader makes well over 100 contacts a week, which comes to about 5000 a year, unless he likes contests, in which case his total can be easily double that. Card postage costs 5¢ in the U.S. and Canada and 8¢ elsewhere. If you figure that 20% of the contacts are DX, the bill would come to $80 for mailing the DX cards and $200 for mailing domestic cards: $280 a year. It would seem that the members of amateur radio societies in other countries are getting quite a lot more for their membership fee than we are in the U.S.

Not a few ARRL members have become aware of this unnecessary expense, but somewhere between their director and final action by HQ the matter has always come to a dead end. Asked recently about this, John Huntoon is alleged to have explained that the League is afraid that the drop in postal revenue to other countries might cause difficulties.

The mailing of QSL cards in bundles to foreign QSL bureaus is entirely legal and there seems to be no real reason other than pure laziness, according to those that are intimately familiar with the situation, for a society not to provide this valuable service. And it is a valuable one, there is no question about it. Neglecting the domestic cards for a moment, if the 80,000 ARRL members each spent our estimated $80 per year on QSL postage, that would amount to $6,400,000 per year!

That seems like a lot and something certainly should be done to cut out this waste. One amateur who has grown increasingly concerned over the situation is Lloyd Colvin W6KG, who probably has one of the largest QSL collections in the world. He certainly has the largest one kept in order in file cabinets. Lloyd first put what pressure he could on his director and then on ARRL HQ, but he was able to get nowhere. Being more than average in obstinacy, he decided that dammitall he was going to do something about it. Thus started the World QSL Bureau, which has been advertised recently.

For 3¢ each Lloyd will handle all of your domestic QSL cards: foreign are only 4¢. Right there the postage costs of sending cards is just about cut in half. If the 100,000 or so active amateurs spent only half our above estimated postage per year this would come to some $14,000,000.

Lloyd also has a nice scheme for printing QSL cards in bulk at a very low rate that should be of interest. When cards cost 5¢ to 10¢ or even more each, many of us are a bit cautious about sending them out unless they are persistently asked for.

Lloyd and Iris, his lovely wife, may turn out to be two of the best things that have ever happened to QSL'ings.

Lloyd Colvin (W6KG) and Iris in the World QSL Bureau office. Note the dozens of QSL card storage bins used for sorting cards to be sent to QSL bureaus around the world.

Recently, while in the San Francisco area on the Don Miller case, I had the opportunity to get together with quite a number of the Northern California DX Club at the home of Don Schliesser WA6UFW. I enjoy getting a chance to meet devoted Wayne Green haters and Don managed to get one or two to turn out. After I explained the difference between what I have written in 73 and what they had heard that I had written, tensions eased considerably. I recognize that one of the problems is that I am much too brief in my editorials and that many of my ideas don't come across well in this format. But I can't take an entire issue of the magazine and fill it with editorial. . .and this is essentially what happens when I speak to a club. They get a hundred or so pages of material all at one time and I have the opportunity to explain my ideas at better length and develop them in logical order.

Lloyd and Iris were at this meeting and I had a chance to stop by and see the famous W6KG QSL collection after the meeting. . . and to see first hand the World QSL Bureau which they have set up on the first floor of their apartment building.

Lloyd, retired from the army a few years ago, has gone into the building contracting business and has done very very well at it. He and Iris wrote a book which my contracting friends tell me is the best book ever written on the subject, *How We Started Our Own Home In Our Spare Time and Went On To Make $1,000,000 in the Home Construction Business.* This book is available from the Radio Bookshop postpaid at the regular price of $6.95. . .or can be ordered from your local bookstore. Radio Bookshop, Peterborough, N.H. 03458.

Lloyd took me through the World QSL Bureau and explained how it worked. He and Iris have a beautiful setup there and they should be able to save U.S. amateurs hundreds of thousands of dollars. . .or more. Their club plan passes along a nice slice of this to clubs. . .club secretaries please take note. Lloyd explained how he will soon be able to provide QSL cards at a very low cost by ganging up a simple type of card on a large offset press and printing a few hundred of many different cards all at once. Clever idea.

Radio Series

"QSO with W2CFP" is available on tape for any radio station interested in broadcasting a series on ham radio. Write to Dave Flinn, W2CFP, 10 Graham Road West, Ithaca, NY 14850 for info.

There seems to be a strong tendency for old timers to color their memories of amateur radio's past glories and for newcomers to idealize the olden days. Bunk. The old timers, with very few exceptions, built only what they absolutely had to and few of them understood much of what they had done when they got through. They built their rigs from articles in Radio or QST and put out the most horrendous signals you've ever heard. The hams of yesteryear were nice guys. . .but then almost everyone was a nice guy in those days. . .and the intelligence was about the same as today. I have seen no data whatever that suggests that higher grade licenses result in more consideration on the air. Some of the very worst offenders are refugees from old folks homes. Why, there is one old timer out in California that gets on twenty meters and makes most of the CB channels sound like Sunday school. He is a Bad Xample. The First Phone, which I passed, didn't seem that much different than our blessed Extra Class exam. I suspect that we must look elsewhere for the reasons for bad manners on the bands. We may be suffering from the same blight that has hit our schools, our cities, and our whole society. This seems to be a world-wide phenomenon, and seems worth some study. Can we blame Spock? The bomb? Or sunspots?

FLASH!

Navassa is open for business again.

The State Department informed us that henceforward any and all amateurs interested in visiting Navassa may do so, provided they obtain prior permission from the Coast Guard. This permission will be given if you can assure them that you will not require rescue.

I suppose that someone will rush right down there and take care of the need that has built up since a few of us operated from there back about ten years ago. I sure would like to get my old KC4AF call back again and get on for a few days from there. Perhaps we should work up a giant DXpedition of all those interested in going and go down enmasse?

. . .Wayne

Homebrew Genealogy

Have you ever built a piece of gear out of a book or magazine, used it for a few years, and then found that when you wanted to repair or modify it, you had forgotten its exact parentage, how it worked, or why? Have you ever spent the entire evening trying to go through a 20-year collection of magazines looking for that same article without stopping to read all the other interesting articles you ran across? Join the crowd!

On your next trip to the stationery store buy a small package of pressure-sensitive labels. The next time you build something, pencil in any changes from the original on the diagram. Record the magazine name, issue, and the page number on the label and put it on the equipment in a spot which is easy to see. This way you can quickly get your project out of the way and spend your spare time reading those articles without feeling guilty.

William P. Turner, WAØABI

Tubes to Diodes — Pep Up a Lazy Rig

Through a little research, experimentation, and a few shocks, I have found that old rigs can be considerably improved with very little time and trouble. Your receiver will be more sensitive and your transmitter will sound cleaner if you just give 'em a little more voltage. Most of the components are conservatively rated, so it shouldn't hurt.

How? Throw away (into the junk box) those old rectifier tubes! This is the age of solid state and miniaturization. Use diodes. The lower internal voltage loss puts more on the plates, which in turn puts a little more in your speaker or antenna. Their small size and versatility make them adaptable to almost any situation. And they don't need filament power. And they don't have to be replaced as often as tubes either. Here are a few ideas for you.

6BW4 – Instead, use two Sylvania F8 (or similar) diodes. Solder them between pins 7 and 9 and pins 1 and 9. Use a heat sink and *be sure to observe polarity!* Transformers ain't exactly cheap!

6AL5 – Use two general purpose diodes such as 1N198's. Solder them between pins 2 and 5 and pins 1 and 7.

Poly Paks (Box 942, Lynnfield, Mass, 01940) sells direct plug in units of diodes to replace tubes. OZ4, 3DG4, 5U4, etc., and 6AU4 are \$2.40, the 5R4 is \$4.40, and the 866 unit is \$10. Add 25¢ for postage and handling. No, I don't work for them, I just recommend them.

When done correctly, these modifications work quite well. A little hint: always use a high PIV and you'll never see that whiff of blue smoke from the power supply.

Be careful when using a diode fed output monitoring circuit in a transmitter, such as those found in the Twoer and Sixer. They can cause TVI and they do bleed away some power.

Some more of this type of valuable information can be obtained from the "Diode Circuits Handbook" by WA1CCH, available for \$1.00 from 73 Magazine.

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Philadelphia, Pennsylvania

Measuring FM Receiver Noise Figure

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Much has been written about the use of noise generators for noise figure measurement of AM receivers, but the available information on their use with FM receivers is scarce. The purpose of this article is to discuss briefly the theoretical aspects of noise figure measurement of FM receivers and then to show a practical, experimental method for accomplishing this result. The method to be described can also be used to improve the accuracy of AM receiver noise figure measurement.

In order to keep the discussion short, it will be assumed the reader is familiar with noise generators and their application to AM receivers. A complete, detailed description of the theoretical and experimental aspects of FM receiver noise figure measurement can be obtained from the author upon request.[1]

Noise in FM Receivers

The noise generated in the front end of an FM receiver has the same characteristics as the noise generated in the common noise generators such as the temperature-limited diode,[2] microwave diode,[3] gas-discharge tube,[4] and a thermal source[5] such as the Monode noise generator.[6]

One characteristic of this type of noise is that it is random; i. e., the amplitude of the noise voltage (or current) is unpredictable, meaning that if the noise voltage is known at some instant of time, the value at some time in the future cannot be predicted. This is unlike the more common functions such as a sinusoidal voltage where, once certain simple facts such as the frequency and peak amplitude are known, the instantaneous value of the voltage can be predicted for any future time.

Random noise generated within most electronic devices such as transistors, tubes, and resistors can be considered to contain all frequencies of the spectrum; the term "white noise" is used to describe this characteristic. Actually, not all frequencies are present in what is ordinarily called white noise because there is always some upper frequency limit resulting from transit-time effects, energy considerations, or stray reactance, but in most cases the strays, etc., occur at frequencies far removed from the frequency range of interest so the noise approximates true white noise. When passed through the tuned amplifiers in a receiver, most of the frequency components are filtered out leaving only those frequency components coinciding with the pass-band of the circuit. In spite of this frequency-filtering process, the amplitude variations of the noise still have the same random distribution possessed before the band-limiting; i. e., it is still a random noise, it just has a narrower bandwidth.

In an *rf* or *if* amplifier the band-limiting or frequency-filtering process is independent of the amount of noise present. Therefore, when the noise present in a receiver is increased by applying a source of white noise from a noise generator to the antenna terminals, the amount of noise appearing at the output of the *if* stages will increase but the frequency content will remain the same.

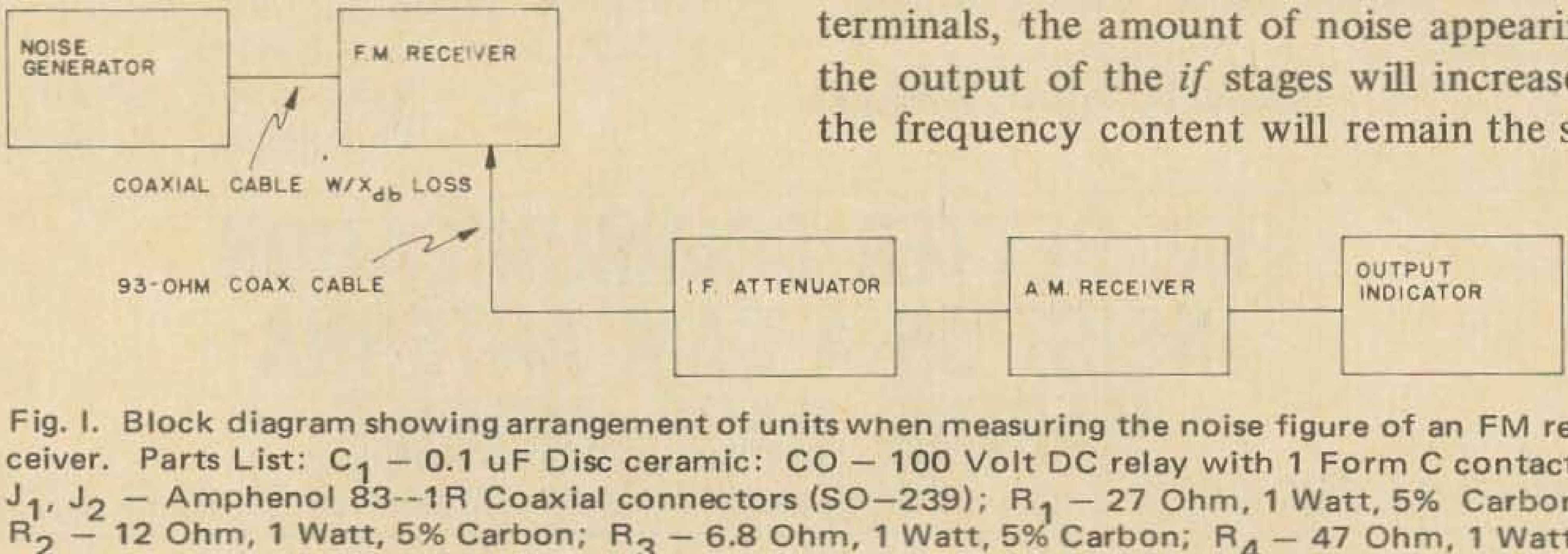

Fig. 1. Block diagram showing arrangement of units when measuring the noise figure of an FM receiver. Parts List: C_1 – 0.1 uF Disc ceramic: CO – 100 Volt DC relay with 1 Form C contact; J_1, J_2 – Amphenol 83--1R Coaxial connectors (SO–239); R_1 – 27 Ohm, 1 Watt, 5% Carbon; R_2 – 12 Ohm, 1 Watt, 5% Carbon; R_3 – 6.8 Ohm, 1 Watt, 5% Carbon; R_4 – 47 Ohm, 1 Watt, 5% Carbon; R_5 – 1K, 1 Watt Carbon; S – 1 Pole, 5 Position, Non-shorting rotary switch.

In a good FM receiver there are at least two limiter stages preceeding the discriminator. Usually the limiters are "hard-limiting" meaning they are slicing the incoming noise at an amplitude much less than the average value. Normally, there is so much gain in the receiver that the limiters are hard–limiting even with no external noise applied to the FM receiver. Consequently, the maximum amplitude of the noise signal appearing at the limiter output is constant regardless of the amount of white noise applied to the antenna terminals. The frequency distribution of the noise at the limiter output is random and is related to the bandwidth of the receiver.

The output from the discriminator is proportional to both the amplitude and the frequency of the signal applied to its input. Because the noise is amplitude-limited by the limiters, and frequency-limited by the *if* transformers, and because these limiting processes are independent of the amount of noise present, the noise output from the discriminator (and the audio system) will not change when a noise generator is connected to the antenna terminals. This means a noise generator cannot be used in the manner in which it is usually employed with an AM receiver.

The test setup

Because of the nature of noise, the amount of noise can be detected in any convenient manner and the noise performance of the receiver relative to its internally-generated noise will be established. A simple method for determining the amount of internally-generated noise consists of providing the FM receiver with an AM detector at some point before *any* amplitude-limiting takes place. (A little care is required to be sure no limiting has taken place prior to the AM detector.)

Fig. 1 is a block diagram illustrating the arrangement of the noise generator, the FM receiver being tested, an *if* attenuator, the AM receiver acting as an amplifier-detector-amplifier, and an output meter.

The output of the noise generator is connected to the antenna terminals of the FM receiver being tested. The noise output of the noise generator should possess the proper randomness of amplitudes and it

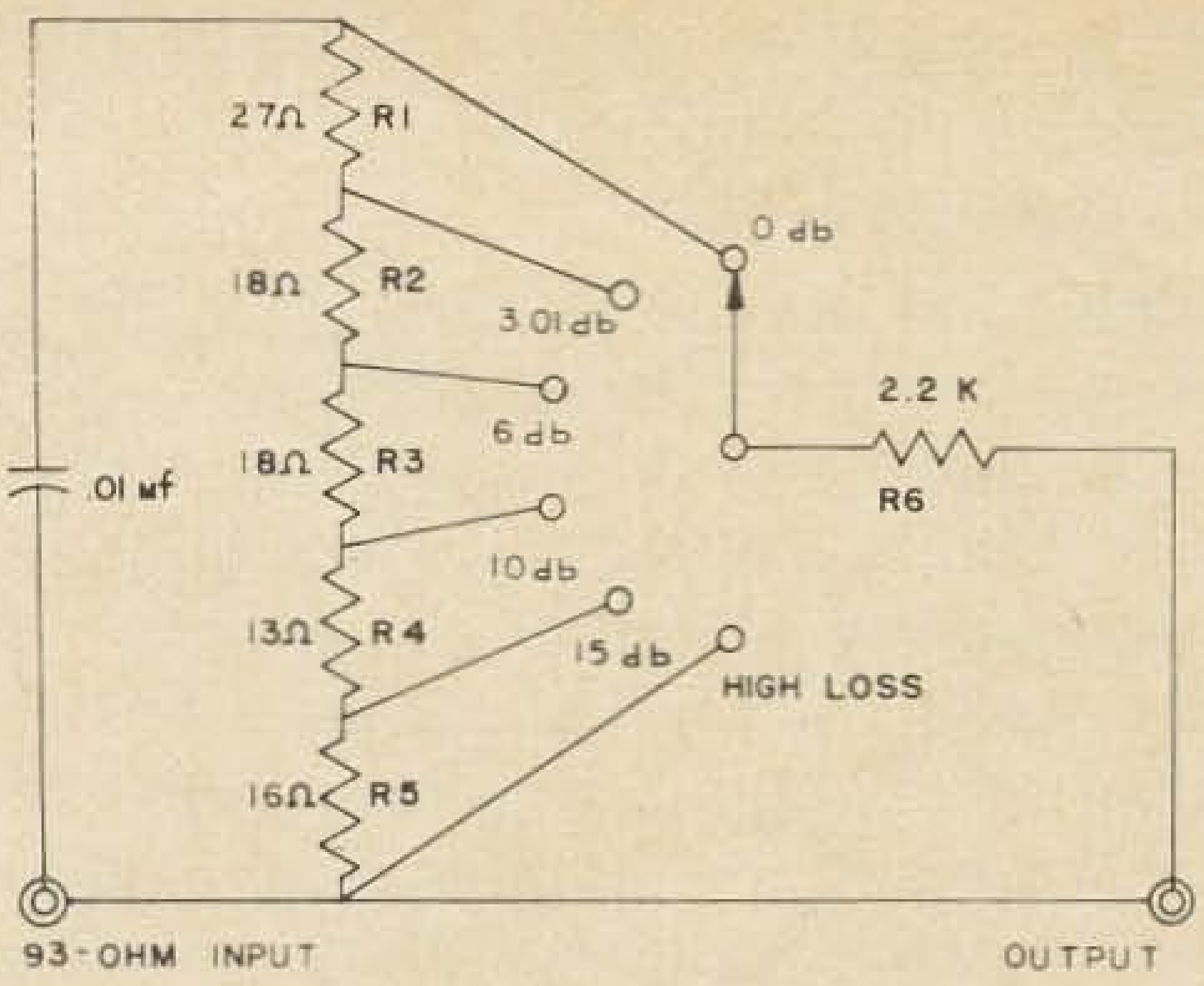

Fig. 2. The 93-ohm if attenuator. R1 thru R5 are the nominal values of 5% carbon resistors; if more accuracy is required, see text for exact values. Parts List: C_2 – 1000 uF, 6 Volt Electrolytic (see text); D_1 to D_4 – 1N34 Diodes; M – 50 uA Meter; R_6 – 22K, 1/2 Watt Carbon (see text); T_1 – Universal output transformer

should contain frequency components that are constant over a range larger than the pass-band of the *rf* section of the FM receiver. Any of the noise generators mentioned previously are suitable.

The *if* attenuator is connected to some point in the FM receiver *if* system before the limiters. The best place seems to be the plate lead of the last high *if* stage. This point is preferred because the signal at that point is relatively large but has not been amplitude limited. The output of the attenuator is connected to the antenna terminals of the AM receiver.

The AM receiver can be practically any receiver capable of being tuned to the *if* of the FM receiver. It is preferable to have an *rf* gain control on the AM receiver because this permits selection of the detector operating point. We have used successfully a Hallicrafters S-38 and a modified Heath GR-54. The output of the AM receiver is connected to some form of output indicator.

The output indicator can be a simple rectifier-microammeter combination or an ac vtvm. The major requirement of the output meter is that it be average- or rms-reading and not peak-reading This eliminates most vtvm's because they are peak-reading although the scales are marked in volts, rms. The meter must also have a long time constant. A Heath IM-21 is an average-reading meter and is excellent for use as an indicator if its time constant is increased by placing a 500 uf capacitor across the movement.

The attenuator

When measurements are made on any system, the most important items are the signal source and the output indicator. The most common source of error in noise figure measurements is the noise detector. This error results from the generally-unknown detector characteristics in the receiver being tested (usually the detector is assumed to be linear but is actually square-law, giving, as a result, noise figure values that are much better than they actually are). In the method of measurement being described here, the burden of measurement accuracy is placed upon the *if* attenuator.

The schematic diagram of the *if* attenuator is shown in Fig. 2. It is a simple voltage-divider type having a 93-ohm input impedance. It gives six steps of accurately-known attenuation; 0.0, 3.0, 6.0, 10.0, 15.0, and some value greater than 40 db at 10 mhz (the last step isn't accurate and doesn't have to be). The actual attenuation is not known and is not relevant. Resistors R1 thru R5 are mounted on a good-quality rotary switch using the shortest lead-length possible. R6 is used to provide a relatively high load impedance to the attenuator independent of the input impedance of the AM receiver; its value is relatively unimportant but should be at least 2.2k. The capacitor is used for dc blocking. The entire unit should be mounted in a Minibox or similar shielded housing. A piece of RG-62B/U or similar 93-ohm cable with a connector on one end and clips on the other end is used to connect the attenuator to the receiver being tested.

The secret of the attenuator accuracy lies in the form employed. When attenuators of the T- or Pi-type are used, their accuracy is critically dependent upon the source and load impedances presented to them. The impedance of an *if* amplifier or the antenna terminals on a tunable receiver are nebulous. Because of this, when T- or Pi-type attenuators are to be used it is recommended that at least 60 db of attenuation be placed on each side of the attenuator in order to present a reasonably-well known impedance to the attenuator in question.[7] In addition, if the attenuator is to be variable, three elements must be changed for every step of attenuation. For noise figure measurement only relative attenuation is important. Therefore, a voltage-divider type is ideal.

If 5% carbon-composition resistors having the values shown in Fig. 2 are used, the attenuator accuracy will be much better than that of the average AM receiver diode detector. However, if more accuracy is desired it can be obtained by one of two methods. Which method is used is dependent upon the type of noise generator to be employed when making noise figure measurements. The methods are:

1) Determine the actual attenuation values after the attenuator is built and mark the switch positions with these values, or

2) Trim the resistors to the exact values required for steps of 3.01, 6.0, 10.0, and 15.0 db; the exact resistor values are: R1 = 27.2, R2 = 19.2, R3 = 17.2, R4 = 12.8, and R5 = 16.6 ohms.

The first method is difficult to do directly because precise vtvm's at *if* frequencies are rare. However, an indirect method can be employed by measuring the resistors with a Wheatstone Bridge and calculating the expected loss from the dc values. So long as good construction practices are employed and good non-reactive resistors such as Allen-Bradley type EB, ½-watt, 5% carbon, are used, the calculated losses should be accurate.

The second method requires some means of determining the dc resistance and is therefore similar to the first. Precision resistors can be used, so long as they are non-reactive, or the Allen-Bradley resistors can be used with their values "adjusted" by selecting individual resistors from a batch or by filing.

If a variable-output type noise generator such as the 5722 diode is used when taking noise figure readings, the "3 db" step should be exactly 3.01 db. This would indicate that the second method should be used. If a fixed-output noise generator such as the Monode is to be used, the first method is acceptable. The attenuators we built were calibrated and adjusted using a combination of the above techniques. A quantity of Allen-Bradley resistors were obtained and the values selected to give a 3.01 db step and to make the rest of the steps as close to the desired values as was practical consistent with not too much work. For example, one attenuator came out with steps of 3.01, 5.9, 9.8, and 14.9 db.

Making the measurements

Connect the components as shown in **Fig. 1**. The cable between the noise generator and the antenna terminals of the FM receiver must have a known amount of attenuation. The input of the attenuator is connected to the FM receiver *if* system by connecting the braid of the RG-62B/U coaxial cable to the chassis of the receiver and clipping the center conductor over the insulation of the plate lead of the last high *if* stage.

Set the attenuator to give 0 db relative loss. Disable the agc in the FM receiver, if so equipped, and disable the avc and the anl in the AM receiver. Tune the AM receiver to the *if* frequency of the FM receiver. Set the *rf* and *af* gain controls on the AM receiver to give nearly full-scale deflection on the output meter. Set the attenuator to the high loss position. The output meter should go to zero. If it does, the equipment is ready for measurement. If it does not there is insufficient shielding or the AM receiver is too noisy, and the condition will have to be corrected.

The remainder of the measurement discussion is divided into two parts according to whether a variable- or fixed-output noise generator is to be used.

A variable-output generator:

The detector in the AM receiver should be as non-linear as possible in order to give the largest change in output indication for a given change in noise level. The detector operating point is adjusted by using a low *rf* gain setting and a high *af* gain setting on the AM receiver. If possible, set the detector operating point to give a 6 db change in output when a 3 db change is made in the attenuator setting. When adjusted, set the attenuator to the high-loss position and note the output from the AM receiver. It should go to zero. If it does, all is well and the attenuator can be set back to 0 db relative loss and the measurement may proceed. If it does not, find out why not and correct the difficulty.

Note the noise level indicated by the output meter. Set the *if* attenuator to 3.01 db relative loss and increase the noise generator output until the output indicator reads the same as it did with no noise applied and the attenuator set to 0 db relative loss. The FM receiver noise figure is found by means of the formula: NFdb = ENdb - Xdb, where EN is the excess noise of the noise generator and X is the loss of the coaxial cable connecting the noise generator to the FM receiver. If directly connected, X is zero.

A fixed-output generator

The AM receiver will have to be calibrated. This can be done by varying the attenuator and noting the change in the output indicator reading. The *rf* and *af* gain controls on the AM receiver are adjusted to make the output indicator reading change the same amount as the attenuator setting is changed. Once the receiver is calibrated, the measurement procedure is as follows: Connect a "quiet" termination to the FM receiver antenna terminals thru the same cable used to connect the noise generator to the receiver. Set the *if* attenuator to 0 db. Note the output from the AM receiver. Connect the noise generator to the FM receiver in place of the "quiet" termination. Note the increase in output from the AM receiver. The noise figure of the FM receiver is found from the formula: $NFdb = ENdb - Xdb - 10 \log_{10} (Y - 1)$, where En is the excess noise of the noise generator, X is the loss of the coaxial cable connecting the noise generator to the FM receiver, and Y is the ratio of the output power from the AM receiver with the noise generator connected to the FM receiver to the output power from the AM receiver with the "quiet" termination on the FM receiver. Some of the burden of the output change can be taken up by the attenuator. This is done by increasing the attenuator setting when the noise generator is applied and calling the change in output the sum of the attenuator setting change and the output meter reading change.

It is advisable to listen to the noise output from the AM receiver while taking the measurements in order to detect signals that will cause erroneous results.[8]

Measuring AM receiver noise figures

The techniques described can be applied to an AM receiver as well as an FM receiver. The accuracy of measurement will be much better than it is with the "usual" technique because the *if* attenuator is used. The noise generator is connected to the AM receiver being tested and the input of the *if* attenuator is connected to the plate of the last or next-to-last low *if* stage. Of course, the AM receiver used after the attenuator must be able to tune the *if* of the AM receiver being tested.

Summary

The noise figure of an FM receiver cannot be measured in the "usual" manner because of the nature of FM receivers. However, it is possible to measure the noise figure by employing an AM receiver as a noise detector. Measurement accuracy can be improved when measuring the noise figure of FM or AM receivers by employing a simple, accurate *if* attenuator. The attenuator was described and the technique using the *if* attenuator was given.

Further information on noise generators and the general technique of AM noise figure measurement can be found in references 2 and 6 and in Rheinfelder.[9] A very interesting discussion of noise appeared in *73 Magazine* in January, 1967.[10]

. . . W8BBB

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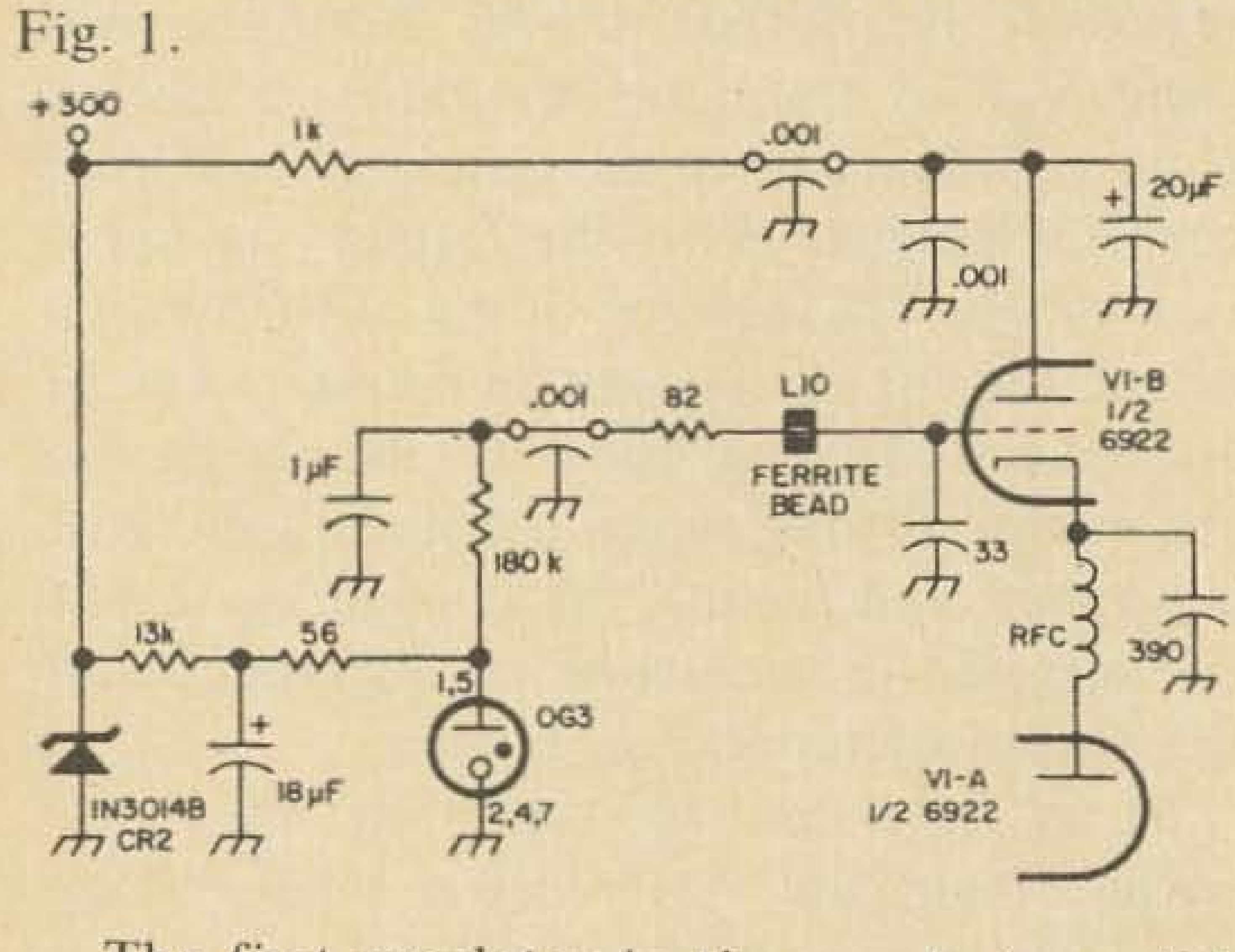
Ultra-Stable Power Supply for Master Oscillator

While performing some modifications on a commercial FM transmitter, my attention was drawn to the power supply which is used to supply dc to the master oscillator. The MO works in the 50 mhz range, but the principles of dc regulation utilized are such that they can be applied to any master-oscillator or vfo on other frequencies as well. Refer to Fig. 1.



The first regulator in the supply is a solid state zener diode, rated at 180 volts. This 180 volts is also connected to the plate of the cathode-follower tube, V1B. Note that this is a dc cathode follower. The supply voltage, further dropped to approximately 86 volts, is impressed upon the anode of the type OG3 voltage reference tube. This is an extra-stable voltage regulator tube which draws only a few mils. The high-stability 86 volts dc is impressed upon the grid of the cathode follower. The cathode is constrained to follow, and this presents an ultra-stable B-plus supply potential to the master oscillator. According to the manufacturer, RCA, the net result is a signal so steady that it can run for several hours, without benefit of AFC, and still meet FCC spec's for frequency stability in the FM band. Obviously, the MO is built of high quality parts and well designed. A frame grid tube, type 6922 is used for both the MO and the dc cathode follower. Amateurs and experimenters could use a less expensive type, such as the 12AT7, especially if the vfo is designed to operate on a somewhat lower frequency.

Neil Johnson, W2OLU

Raymond C. Sills, K2ULR
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East Brunswick, N.J. 08816

Would You Like To Be A Broadcast Engineer?

I'm sure many a ham has a little of the broadcaster in his blood. After all, both the ham and the broadcaster transmit information by means of electromagnetic radiation. Perhaps the only real difference between the two is in the intended recipient of the information: a fellow ham or the general public.

It's often said that ham radio has launched many careers in electronics, and broadcasting is no exception. In the early days of radio, there was little distinction between amateur and "commercial" operation; and the fellow who had the technical know-how to put a rig on the air for ham use could certainly put a commercial station on the air. And it's true today, too, that many broadcasting people are amateur operators, especially in the technical end of broadcasting.

I'm sure that many a Novice, having built his first rig, wonders what goes into a 50 KW broadcast rig in one of those big city stations or perhaps even his local 250 watter. There are many similarities between any one station and all the others. Obviously, each station needs an antenna system, transmitter, audio (or video) control and distribution equipment, and a place to originate the broadcasts. But apart from that, each station invariably has its own special technical needs, equipment, and facilities which are like no other station's.

It is probably safe to say that most hams in broadcasting are in the technical end of things, although there are a few well-known entertainment, personalities who have a ticket. Of those fellows who do work in the technical department, most stations give them the title of "engineer," even though they might not have a degree in electrical engineering. An engineer's duties usually consist of operating the transmitter – that is, observing the operation of the transmitter, since most of today's transmitters need little attention in day-to-day operation; and/or operating the studio equipment; and/or repair and maintenance of all the station's electronic gear; and/or clerical duties related to the technical operation of the station – ordering spare parts, new tubes, scheduling manpower, etc. I use the "and/or" because the total number of job duties will depend on the size of the station at which an engineer is employed. At stations in small markets (cities) or small stations in large markets, the engineer will do most or all of the above duties. The *Chief Engineer,* in addition to these duties, has the overall responsibility and legal obligation to the station ownership and the FCC to see that the station is operating within the terms of its license and the FCC rules and regulations. To be sure, all licensed transmitter operators (and all transmitter operators must be licensed) have the same responsibility, but it is the Chief Engineer at whom the FCC and the station management will glare if there are any technical irregularities.

Job duties are often highly specialized at the "large city" stations and network operations. Very often, a man will specialize in one small area in the broadcast technical field. For example, he might be a maintenance man, in charge of only one type of equipment, such as a particular model of tape recorder. But since large stations have many of those tape machines, he is usually quite busy just keeping them all running properly with routine maintenance: lubrication, cleaning, checking tubes, alignment, and so forth. Some of the fellows who do this specialized maintenance are so proficient and familiar with their tape machines that they can diagnose and repair a fault in 10 minutes which would take the average engineer two hours to fix.

At one of these large stations, an engineer – or technician, as he is sometimes more accurately called, – is almost invariably a member of one of the major broadcast engineer's unions: IBEW, NABET, or IATSE. As such, he is collectively bound to a contract with his employer, and this contract spells out, quite precisely, what his duties shall be.

As you might expect, some fellows (and gals, too) show a preference or an aptitude for one or more of the various specialties in the broadcast technical field. One chap might be a great studio console operator; another, a great tape editor; a third might be a transmitter expert; and yet another might enjoy working in the maintenance shop. And, of course, some people are quite competent in more than just one specialty.

If you're still all hot about becoming a broadcasting engineer, plan to make a visit to a station, TV or radio, whichever is available or preferable, and talk to some of the boys. Almost all of the fellows in the broadcast business would be glad to show you around and answer your questions. Most probably, you'll be told that you should get your commercial radiotelephone operators license.

There are three grades of licenses: First Class, Second Class and Third Class, from top to bottom, and a total of five exam "elements" that you must pass for a FCC ticket. If you can pass elements 1 and 2, you are qualified to receive a third class license. If, after passing elements 1 and 2, you pass element 3, you get the Second Class ticket. Finally, when you pass the fourth element, you get the First Class License. You could, if you like, take all four elements in the same day, but most people prefer to "come up through the ranks" and get all of the licenses, or at least the Second Class and then the First Class. The First Class License is very much like what the General Class ham license used to be: you get all operating privileges for all types of radiotelephone (no CW) and TV stations in the commercial field: broadcast, police, taxi, government, microwave relay, etc. This is the license that all Chief Engineers must have, and the one that most regular engineers have. It is a very, very valuable asset to have if you intend to get a job in the broadcast technical field (or announcing and DeeJay work, for that matter.) Without it, you cannot legally tune up *any* broadcast transmitter or operate certain classes of broadcast stations: TV, AM stations with directional antenna or stations running more than 10 KW. The Second Class allows you to service and tune up CB and two-way communications gear (police, taxi, etc. rigs) and the Third Class lets you only operate two-way gear and marine radiotelephone equipment. There is a provision of the rules that allows second and third class men to operate certain types of broadcast stations: those running less than 10 KW with a non-directional antenna. The operation is limited to turning the carrier on and off at the beginning and end of the broadcast day or for EBS tests, and adjusting the power by means of a simple control to compensate for changes in line voltage, loading, etc., that might put the transmitter more than the legal limits of 10% below or 5% above the licensed power. If a third class man works at a station, he must pass an additional exam element: element No. 9, which deals with simple routine tasks at a station, such as taking meter readings, keeping logs, frequency and power tolerances, etc.

If you are pretty good at theory, you can probably train yourself to pass the FCC test. Also, you might enlist the aid of a friend who is also studying for a commercial license. Here, the use of a license manual will no doubt be very helpful. Otherwise, it might be worthwhile to investigate one of the resident or correspondence schools that specialize in training people to pass FCC exams. As I recall, there are even some schools that guarantee you a ticket – they'll keep training you at no additional cost until you pass, should you not make it on the first try.

Once you have a license, or are at least well on your way toward getting it, get to know someone who works at a station.

Don't bug him by constantly calling or visiting him. If you use good judgment and don't overdo it, chances are he'll be more than glad to help you along with the license test or getting a job. There's usually a fairly good grapevine between stations in any one area, and when a job opens up, the word usually travels along to other nearby stations. Also, quite a few of the small local stations will train young fellows by hiring them on a part-time basis at a very nominal wage. In the large cities, inexperienced men *with a license* can often find work as summer vacation relief engineers. If they catch on quickly to how things are done at that particular station, chances are the station will ask them to return the next year. This is an excellent opportunity for a college fellow to earn extra money during the summer.

I can't emphasize too strongly this bit about having a license. It is true that many broadcast engineers in the large cities do not have a license. But you are worth much more to an employer if you have a ticket: you can legally operate transmitting equipment and this allows him greater flexibility in assigning you your duties. Also, a license is proof to an employer that you do know something about electronics.

Another training possibility is to offer your services gratis to an educational non-commercial FM station. These stations often operate on very limited budgets and can use all the help they can get for free. See if there are any college FM stations in your area. (Hint: if you have *any* FM stations in your area that operate below 92.0 mhz, they are non-commercial by FCC definition. There are, however, a few "listener sponsored" stations that operate in the commercial band, 92.0 to 108.0 mhz.)

Money

Pay is often not as much as you might expect for a "show biz" industry – probably on the order of five to six thousand dollars annually at the average station. For a beginner with something less than a first class ticket, remuneration will be $1.25 to $2.50 per hour at a small or medium-sized station. At large metropolitan stations where there is a union involved, you can expect salaries in the $200 to $300 per week bracket, with overtime pay, night-time differential pay, penalty payments for missed meal periods, and "short turn-around" (less than 12 hours between shifts) compensation. The big companies, like ABC, CBS and NBC, etc., have elaborate employee benefit programs in the form of insurance, hospitalization, pensions, stock purchase plans, liberal vacations, and so on.

So it's not surprising that many people would like to get to work for the "big" companies, since that's where the money and the action is. There is a reasonable chance that you can land a job at one of the big city outfits if you have some experience, good recommendations, and perhaps some formal training. The large companies have large manpower needs and lose a few men every year through retirement and job-hopping. The need for manpower is being reduced somewhat these days by the increasing use of automation and automated devices to control programs, perform switching, operate transmitters, and so forth. And today's solid-state gear doesn't break down as often as its vacuum tube predecessors. Also, programming – at least radio programming – is not as elaborate as it was in years past: deejays, talk, news, sports, etc. are now the rule, instead of the soap operas and variety shows which now fill our TV channels.

Good luck on the test, and welcome to the club, OM.

. . . K2ULR

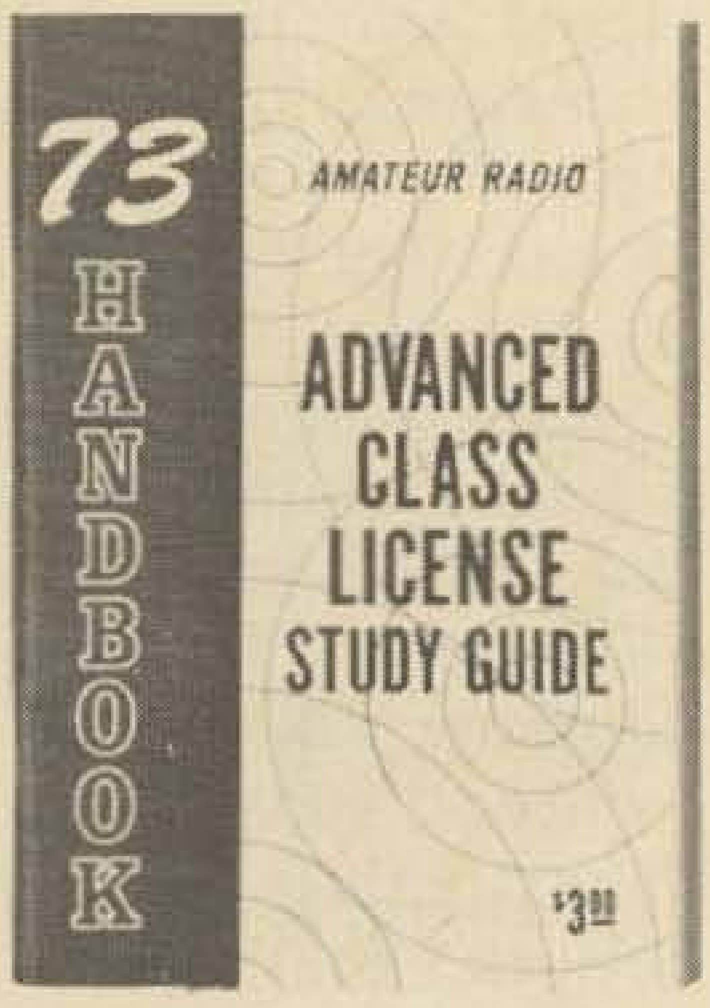
Footnotes:

IATSE: International Alliance of Theatrical Stage Employees, 1270 Avenue of the Americas, New York, N.Y. 10019.

NABET: National Association of Broadcast Empployees and Technicians, 135 West 50th Street, New York, N.Y. 10019.

IBEW: International Brotherhood of Electrical Workers, Local 1212, 150 Fifth Avenue, New York, N.Y. 10014.

73 Books for Hams



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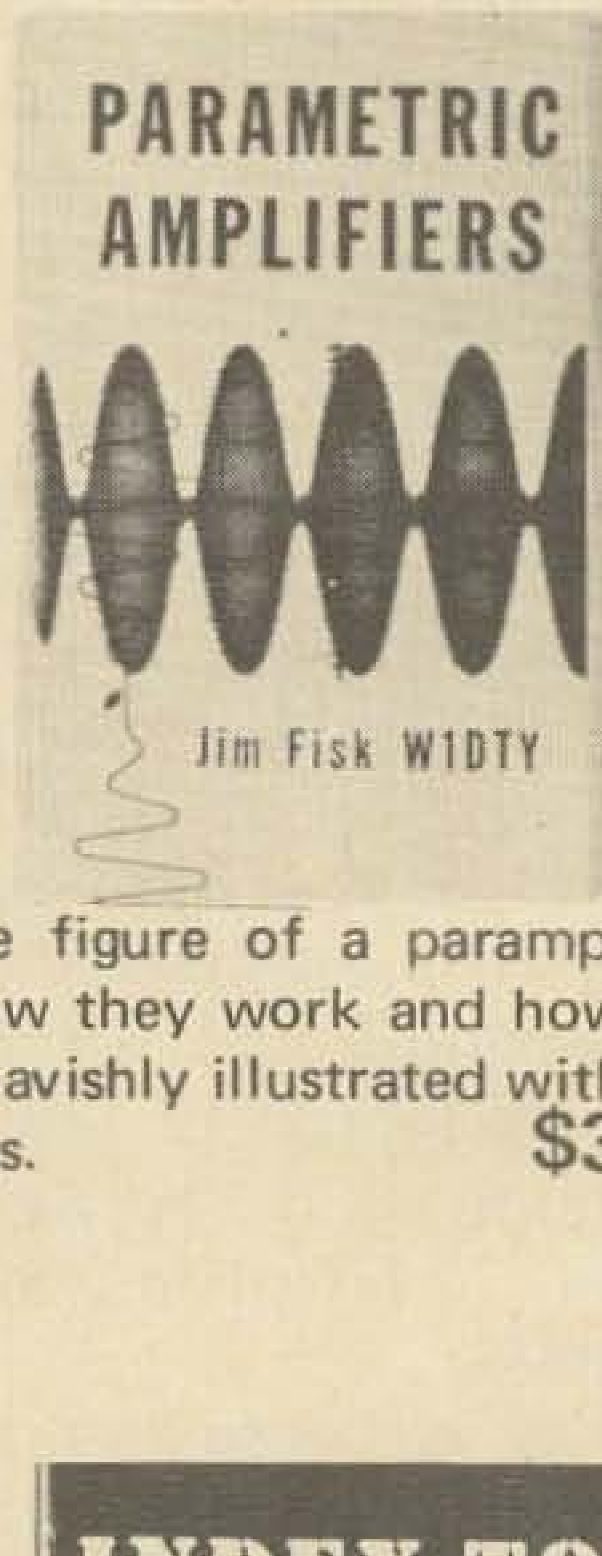
DX HANDBOOK

Includes giant world country-zone wall map. Articles on QSL design secrets, winning DX contests, DXCC rules, DXpeditions, reciprocal licensing and many more. World postage rates, WAZ record lists, time charts, propagation, etc. Special ham maps and bearing charts. A must for the DXer. **$3**

COAX HANDBOOK

Invaluable book for the ham or the lab and for everyone else who doesn't want to have to keep a whole library on hand for reference. . .or even worse, have to write to the manufacturer for coax spec. **$3**



PARAMETRIC AMPLIFIERS

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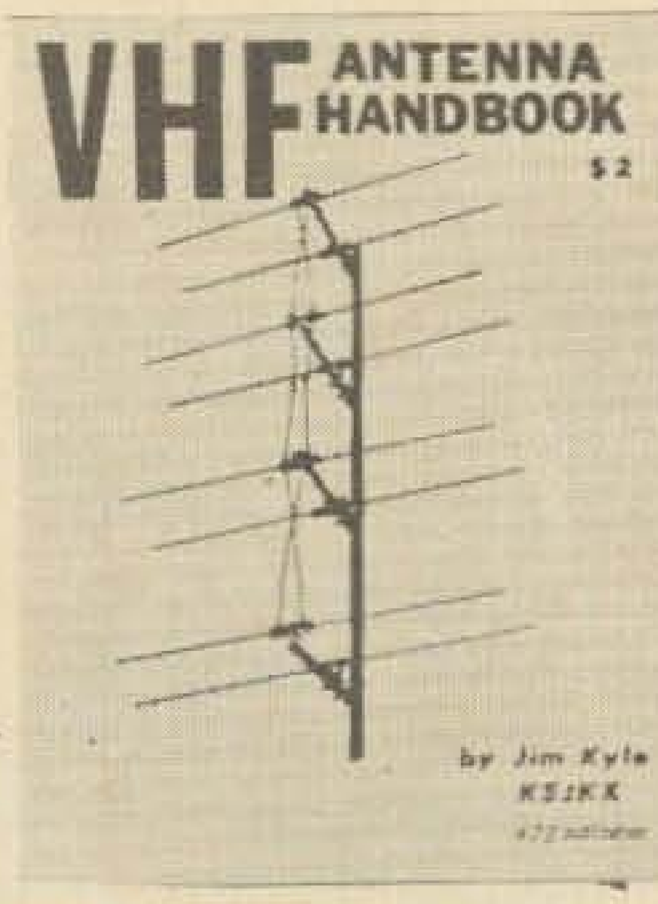

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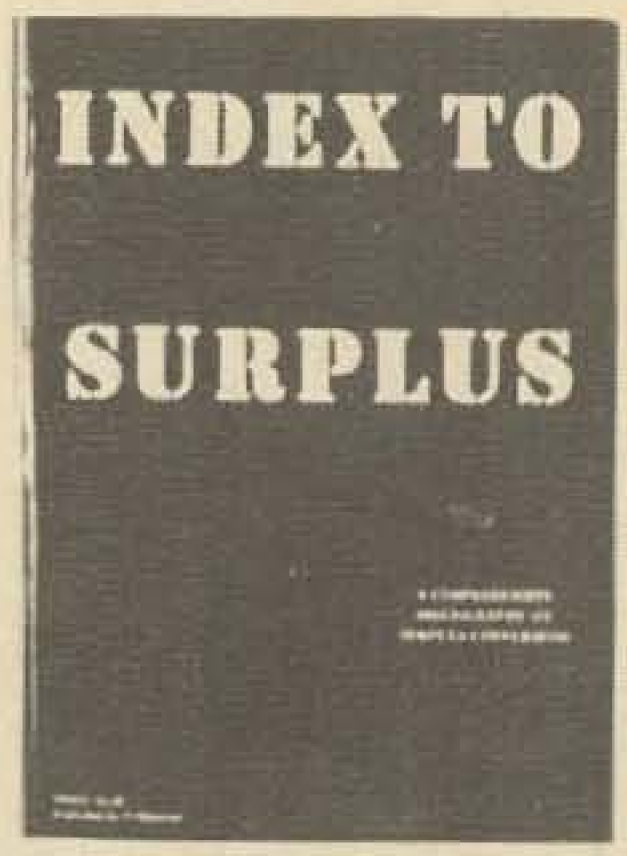
This handbook is a complete collection of up-to-date information about VHF and UHF antennas, with design hints, construction and theory. If you've been wondering what array you need, this book will give you enough background to make the right decision. **$3**



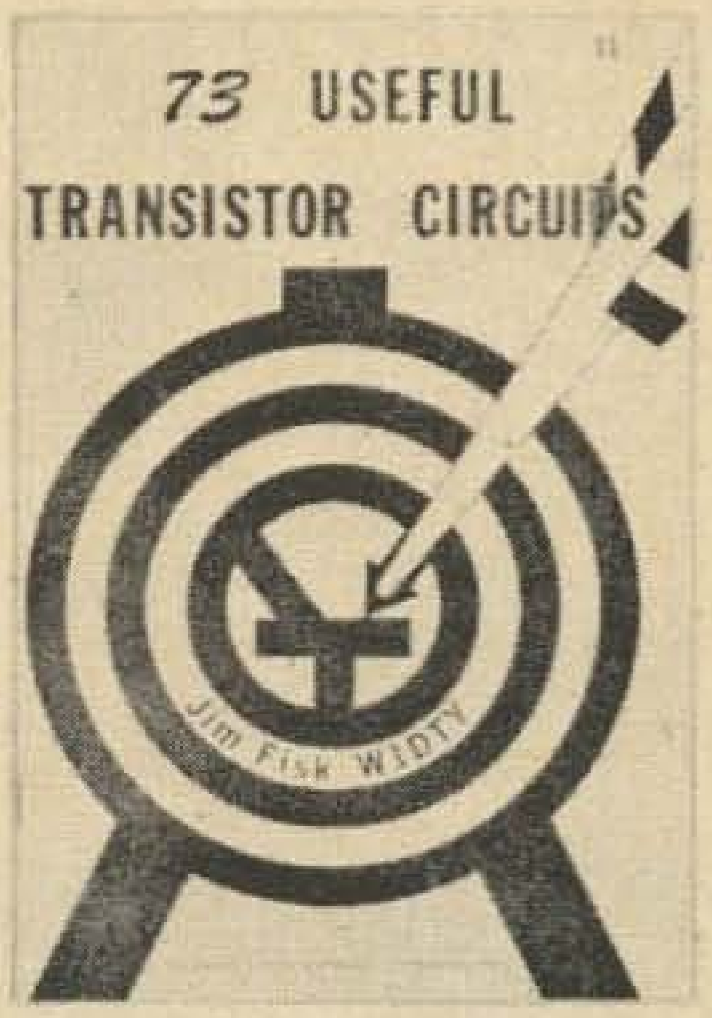
INDEX TO SURPLUS

Do you have a piece of surplus equipment that you want to convert but can't find an article? If so, this is the book you need. It lists all of the surplus articles and conversions in popular electronic and amateur magazines from 1945 to 1966. **$1.50**

DIODE CIRCUITS HANDBOOK

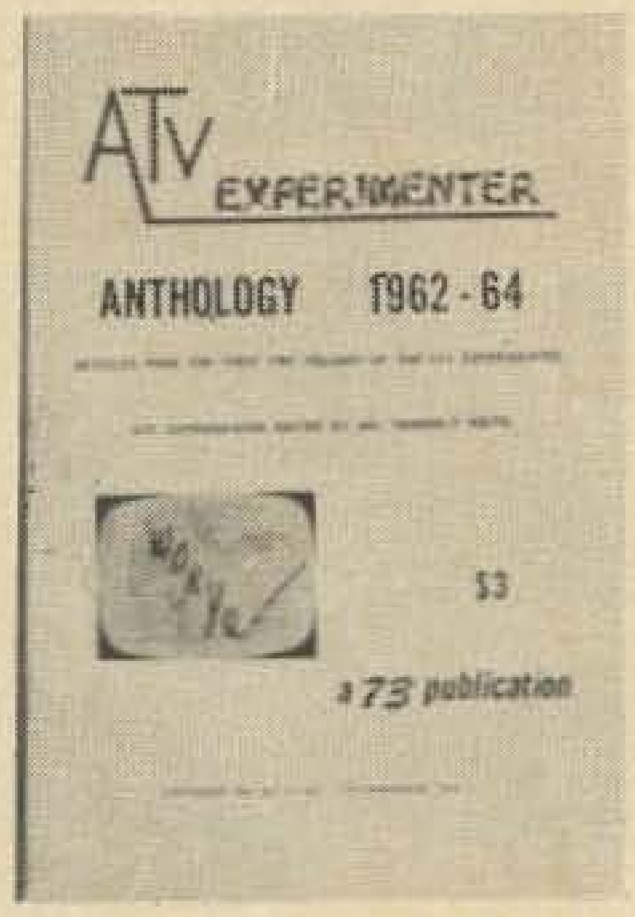
An invaluable reference book. Covers rectifiers, mixers, detectors, modulators, FM detectors, noise limiters, AGC, BFO'/Q-multiplier, AFC, Varicap tuning audio clippers, balanced mods, field-strength meters, RF probes, zeners, control circuits, etc. 111 different circuits. **$1**

73 USEFUL TRANSISTOR CIRCUITS



If you've been looking for a transistor circuit to do a special job, chances are there is a circuit in this book that will give you a head start. It covers circuits for audio, receivers, transmitters and test equipment. **$1**

HAM TELEVISION



The Amateur Television Anthology is a collection of the technical and construction articles from the **ATV Experimenter,** edited by WØKYQ. If you're interested in ATV, this is the book for you. It covers the gamut from the simple to the complex in amateur television equipment. **$3**

MILITARY SURPLUS TV EQUIPMENT by W4WKM is a necessity to the surplus-scrounging ATV addict. **$1**

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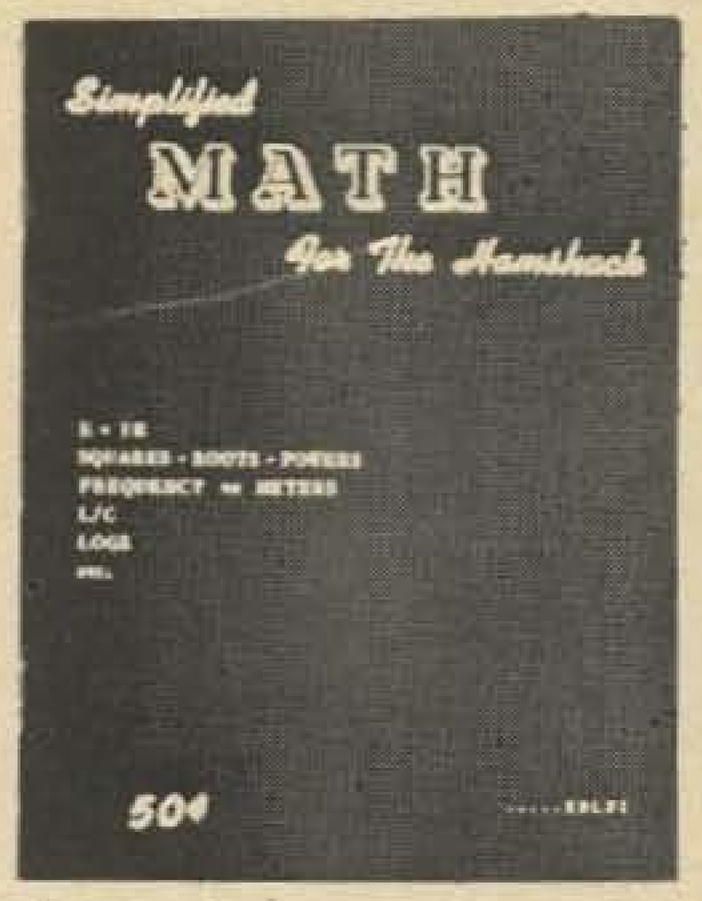

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CW by W6SFM explains code and how to learn it. **50¢**

CUMULATIVE INDEX lists all the articles in **73** up through December 1966. **25¢**

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73 Magazine

Peterborough, N. H. 03458

Distress: The Amateur Operator and the Coast Guard

John E. Fail, U.S. Coast Guard WB6UKX
P. O. Box 193
Walnut, California 91789

Official U. S. Coast Guard Photo.

U.S. Coast Guard Cutter Cape Higgon is a 95-foot all-steel cutter capable of 21 knots speed. The cutter carries a crew of 14 and the primary mission is SAR and law enforcement. The author served in this vessel in 1966, 1967, and part of 1968 as the ship's Executive Officer.

At one time or another every ham will probably handle, directly or indirectly, some type of distress traffic relating to an emergency on the high seas.

This article will delve into the maritime distress, how to handle it, what information to get, who to call with the information and how to call. The first thing that enters the average person's mind when he hears or observes a maritime emergency is *"call the Coast Guard."* One mission, by law, of the Coast Guard is to render aid to persons and property in distress on navigable waters of the U. S. and on the high seas. The Coast Guard is ready, willing, and able to accept information and coordinate the efforts needed to effect a successful rescue mission. Many persons are under the false impression that when they call the Coast Guard and pass the barest of information, the Coast Guard can pinpoint and evaluate the situation in a matter of seconds. Sometimes this is true, but not very often. Accurate and complete information must be passed to the Coast Guard.

The Coast Guard is broken down into 12 Districts **(Fig. 1)** in the United States and includes many other parts of the world. Each District is assigned vessels ranging from 378-foot high endurance cutters to 30-foot utility boats. The major components of most Coast Guard Districts are its SAR (Search and Rescue) vessels. These types of boats and vessels, mostly 30- and 40-foot utility boats, 44-foot motor life boats, 82- and 95-foot patrol boats and 210-foot vessels, are the primary SAR tools of each district. These, of course, are backed up by aircraft, both fixed wing and helicopters. Most districts have vessels and aircraft that are particularly suited to their area.

The Coast Guard in recent years has

embarked on a large shipbuilding program with many SAR vessels being constructed. Of the several class vessels being built, one of the most notable is the 210-foot medium endurance cutter. These vessels are capable of operations with a helicopter and have many innovations found in only the most modern of ships in the world today.

Search and Rescue vessels are strategically placed in the Coast Guard districts so that they are within the major boating population areas as well as being readily available for long range SAR operations. Each of the SAR vessels is controlled by the District Rescue Coordination Center (RCC). Each district has its own RCC and supporting radio stations. The geographical limits of each Coast Guard District is outlined in **Fig. 1**. This map shows the headquarters of each district at which the RCC is located.

We have covered very lightly the basics of a Coast Guard District SAR force. Now let's go into the RCC and find out just how it operates, and enlighten this dark area for the Amateur who will probably never see one of these busy centers of activity. I am assigned to the RCC in Long Beach, California, as an assistant controller. I have also been assigned to the RCC in Honolulu, Hawaii. All watches are stood by at least two people; a commissioned officer is the controller, and a senior enlisted man is the assistant controller. All RCCs in the Coast Guard are manned and ready to serve 24 hours a day, 365 days a year. The RCC is the control point for all rescues within the assigned area of responsibility. Included with this article is a picture of the RCC in the Eleventh Coast Guard District. The caption on the picture explains the major functions of the RCC. There are, of course, many other parts of the RCC not shown in the picture; plotting tables, communications center, etc.

Official U. S. Coast Guard Photo.

The Vigilant, one of the new 210 foot cutters mentioned in the article, is shown here operating with a coast guard helicopter. The Vigilant is capable of 20 knots speed, is all steel construction, and carries the latest electronic equipment available.

PROPAGATION CHART

J. H. Nelson

August 1969

SUN	MON	TUES	WED	THUR	FRI	SAT
					(1)	2
(3)	(4)	[5]	6	7	8	(9)
(10)	(11)	(12)	13	(14)	(15)	(16)
(17)	[18]	19	20	[21]	22	23
[24]	(25)	(26)	(27)	28	29	30
(31)						

Legend: Good O Fair (open) Poor □

EASTERN UNITED STATES TO:

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

CENTRAL UNITED STATES TO:

ALASKA	14	14	14	14	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14	14	21	21	21	21A
AUSTRALIA	21	21	14	14	14	7B	7B	14	7B	7B	14	14
CANAL ZONE	21A	14	14	14	7A	7	14	14	21	21	21A	21A
ENGLAND	14	7A	7	7	7	7B	14	14	14	14	14	14
HAWAII	21	21	14	14	14	7	7	14	14	14	14A	21
INDIA	14	14	14	7B	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	7B	7	7	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14	7B	7B	7B	14	14	14	14	14
PUERTO RICO	21	14	14	7A	7	7	14	14	14	14A	14A	21
SOUTH AFRICA	14	7B	7	7B	7B	7B	14	14	14	14A	14A	14
U. S. S. R.	14	7B	7	7	7	7	7B	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	14	14	14	7A	7	7	7	7	7A	14	14	14
ARGENTINA	21	21	14	14	14	7	7A	14	21	21	21	21A
AUSTRALIA	21	21A	21	21	14	14	14	7A	7B	7B	14A	21
CANAL ZONE	21	14	14	14	7A	7	7	14	14	21	21	21
ENGLAND	14	7A	7B	7	7	7B	7B	14	14	14	14	14
HAWAII	21A	21A	21A	14	14	14	14	14	14	21	21	21
INDIA	14	14	14	14	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	14	14	7	7	14	14	14	14	14
MEXICO	14	14	14	7	7	7	7	14	14	14	14	14A
PHILIPPINES	14	14	14	14	14	7B	7B	14	14	14	14	14
PUERTO RICO	21	14	14	14	7	7	7	14	14	14	21	21
SOUTH AFRICA	14	7B	7	7B	7B	7B	7B	14	14	14	14	14
U. S. S. R.	14	7B	7B	7	7	7	7B	14	14	14	14	14
EAST COAST	14A	14A	14	7	7	7	7	14	14	14	14	14A

A - Next higher frequency may be useful this period
B - Difficult circuit this period

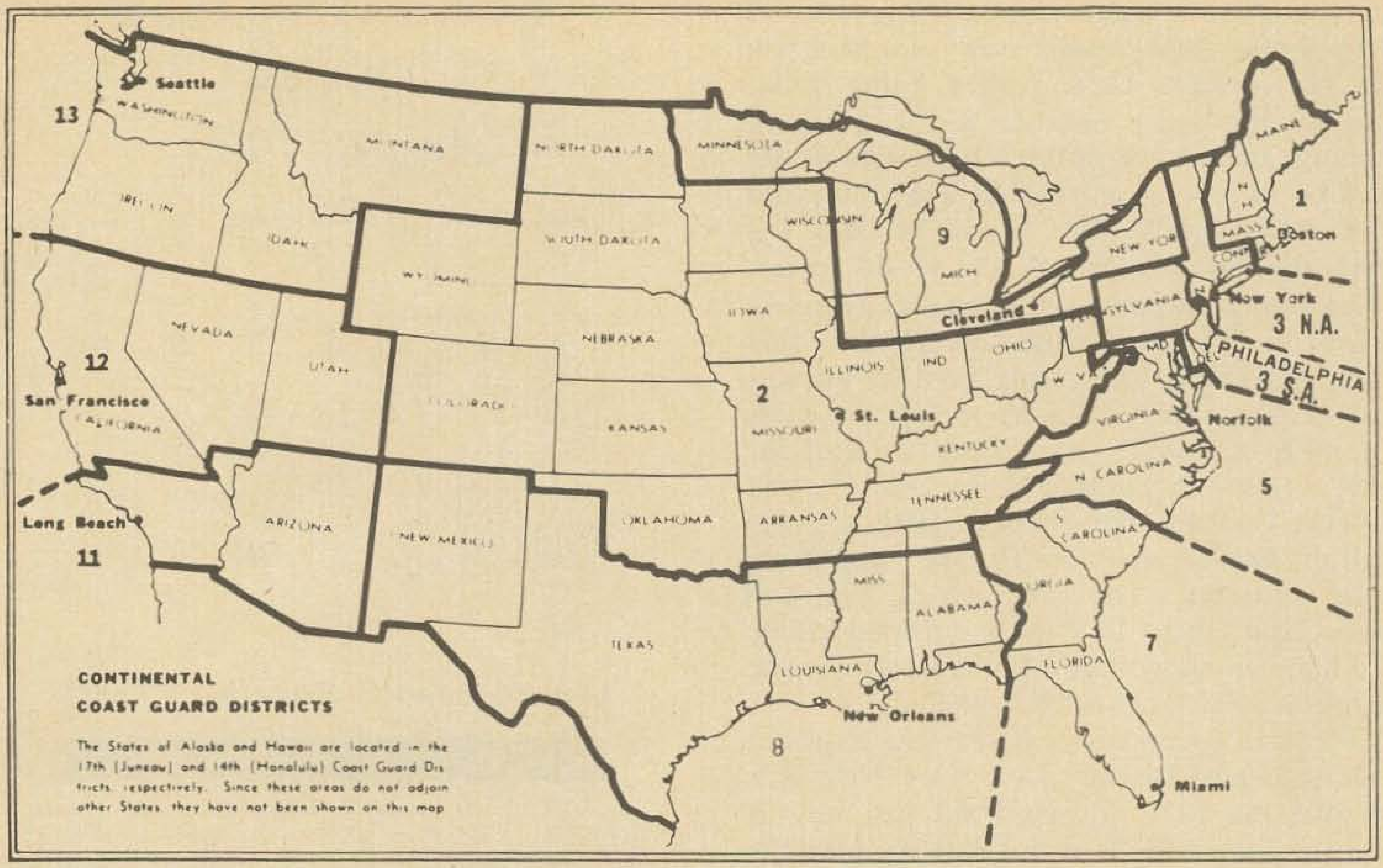


Fig. 1. Chartlet of the geographic limits of each of the 12 Coast Guard districts. The limits of each district is shown in heavy lines; the headquarters of each district is shown in heavy lettering. All of the cities on the chartlet have an RCC in them.

How does the Amateur contact his local Coast Guard? In all large population areas the number of the local RCC is listed in the front of your local telephone directory under "Air and Sea Emergencies" or "U. S. Coast Guard, Search and Rescue." Of course, if you live in Denver, Colorado, you had better forget it, since there is not much water for us to sail on there. An RCC would not normally be maintained in such an area, but frequently the Coast Guard will maintain small units such as Recruiting Stations, Boarding Teams, etc. in such a large population area. If your telephone book has no listing for an RCC in the front, look in the classified section under United States Government, Department of Transportation, Coast Guard. This will give the phone number of your nearest Coast Guard unit.

Any RCC will accept long distance phone calls from Amateurs concerning distress cases. In some instances the number listed will terminate at a switchboard in the Headquarters of the District Office you are calling. In this case all that is required is to ask for the RCC. Many foreign governments also maintain RCCs in their respective countries doing essentially the same job that is being done by your Coast Guard.

While you are casually tuning around,

looking for some DX, you happen across the signal of WB1ZZZ/Maritime Mobile in his 25-foot cabin cruiser, frantically calling "MAYDAY" on 20 meters. You answer him and he says he is sinking fast. What do you do? The first and most important thing is to get the vessel's position! Give the Coast Guard a place to go! If the water comes up five seconds later and shorts out his gear, we are at least armed with a position to go to and conduct search and rescue operations. We are not left in the "outfield" with nothing but the knowledge that somewhere someone is sinking. Any position given the Coast Guard should be given in latitude and longitude or range and bearing from a prominent object. Example: 250 degrees magnetic 10 miles from Long Beach lighthouse, or 40° N, 120° 10' W. Avoid positions such as "about 1 hour south of Catalina Island." Such positions are confusing in most instances, since many vessels travel at different speeds and would travel different distances in one hour, causing the position reported to possibly be in great error. This error in position could be greatly magnified if a guess had to be made as to the speed of the vessel in distress. The time saved in getting an aircraft or surface unit to the scene of such a distress could very likely save a life.

The second most important item in SAR is to maintain communications. Don't take the information and then sign off with the distressed station. Even in the most routine of cases, this could be disastrous. Maintain

Official U. S. Coast Guard Photo.

This is a view of the main console of the RCC here in Long Beach. Included is a complete telephone switchboard, vhf, hf communications system. The console can accomodate three persons operating it at one time. Hot lines are maintained to many Coast Guard units and Civil agencies, FAA etc. On top of the console our new data display system can be seen. This is a fairly new innovation in the Coast Guard. A slide projector is installed in the lower part of the console and via a system of mirrors a projection can be displayed on the screen of local boating areas, a specific harbor, or geographic area. The projector is capable of up to 80 different projections on each slide tray. The desired projection is obtained within 4 seconds of selection.

communications with the distress unit until a Coast Guard unit arrives on the scene or the distressed vessel has communications with a Coast Guard unit and you are released by the Coast Guard and/or the distressed unit. FCC regulations clearly states that distress traffic takes priority over all other communications.

Third comes the miscellaneous information, but of course this is still very important and should be obtained in every case possible. These are items such as the length of the vessel, hull color, trim color, type of vessel, name of the vessel, registration numbers, number of persons aboard, nature of difficulty, radio frequencies available, call sign of the vessel, etc.

Medical cases take on a different light, but all of the aforementioned information still applies, as it is still basic information that is required in all cases.

In a medical case it is important to contact a doctor as soon as possible. This can be done via the Coast Guard. The RCC works with the United States Public Health Service in providing medical advice to vessels with medicos (medical case) on board. In many cases the doctor will advise that an evacuation is necessary. This will normally be carried out by the Coast Guard or arranged for by the Coast Guard. The most important items required in a medico case are complete symptoms of the patient's ailment (description of injury, pulse, temperature, respiration), age, sex, name, treatment already provided and what first aid materials and medicine are aboard the vessel. Any medical history connected with the symptoms that the patient is experiencing, next of kin, address of next of kin, nationality of the patient, and of course, once again, the position of the vessel. This has a great bearing on the case to the Coast Guard, especially if an evacuation is recommended by the doctor handling the case.

When calling an RCC to pass distress information, always give your name, telephone number, and call sign so that credit will be given where it is due. The RCC may also want to contact you again to get further information or clarify the original information.

In many cases the Amateur has a phone patch in his station. In this case the RCC Controller may prefer to be phone patched directly to the distressed vessel. This, of course, eliminates the middle man and assistance is dispatched all the sooner to the assistance of the vessel.

This is especially true of the medical cases where the Coast Guard may not always have firm communications with the vessel. The RCC may ask you to call the doctor so that you may phone-patch the doctor directly to the vessel to provide medical advice.

The Amateur radio operator is and can be a most important and useful tool in the complex machinery of the SAR business, but only if he has obtained complete and accurate information. Double check important items: position, nature of difficulty, size and description of the vessel.

Since being assigned to RCCs, I have in many cases worked directly with Amateurs concerning distresses. Recently, an Amateur in Santa Maria, California, obtained information via 20 meters concerning a heart attack victim aboard a ship several hundred miles off the Southern California coast. He called the U. S. Public Health Service doctor in San Pedro, California, and passed all the medical information to the doctor. The doctor called the Coast Guard RCC in Long Beach, California, where, incidentally, I was on watch. He requested that the Coast Guard provide an evacuation for the patient. The Amateur involved in this case had very complete and accurate information. So, without a doubt, the timely and quick action of this Amateur led to a successful evacuation of the patient. After the doctor's call to the RCC, we contacted the Amateur directly and obtained further information on the position, type of vessel, etc. The RCC passed the position information to the AMVER (Automated Merchant Vessel Reporting System) center in New York and requested a SURPIC (surface picture) for vessels in the area with doctors on board. Within minutes a SURPIC was received from the AMVER center. I provided the position of several ships in the area of the vessel with a doctor on board. Within five hours of the receipt time of the first information on this medico, the patient was aboard a large passenger ship with a doctor on board and on his way to a hospital in San Francisco. The Amateur who so capably handled this case was W6ELH. The speed with which this mission was carried out contributed greatly to the saving of the life of the seaman involved.

I mentioned the AMVER system. This system consists of a computer located at the

Coast Guard Base in New York. Many merchant vessels participate in the AMVER program by providing SAR capability information, as well as voyage information, course, speed, etc., which is fed into the computer and is stored until the vessel's voyage is completed. Any RCC can ask the computer at any time for information on ships which may be in the area of a distress. The computer will reply with information (SURPIC) on these vessels via teletype within minutes. The AMVER system could be the subject of a complete article in itself. It suffices to say here that the computer can provide immediate information on many merchant vessels in a large portion of the world.

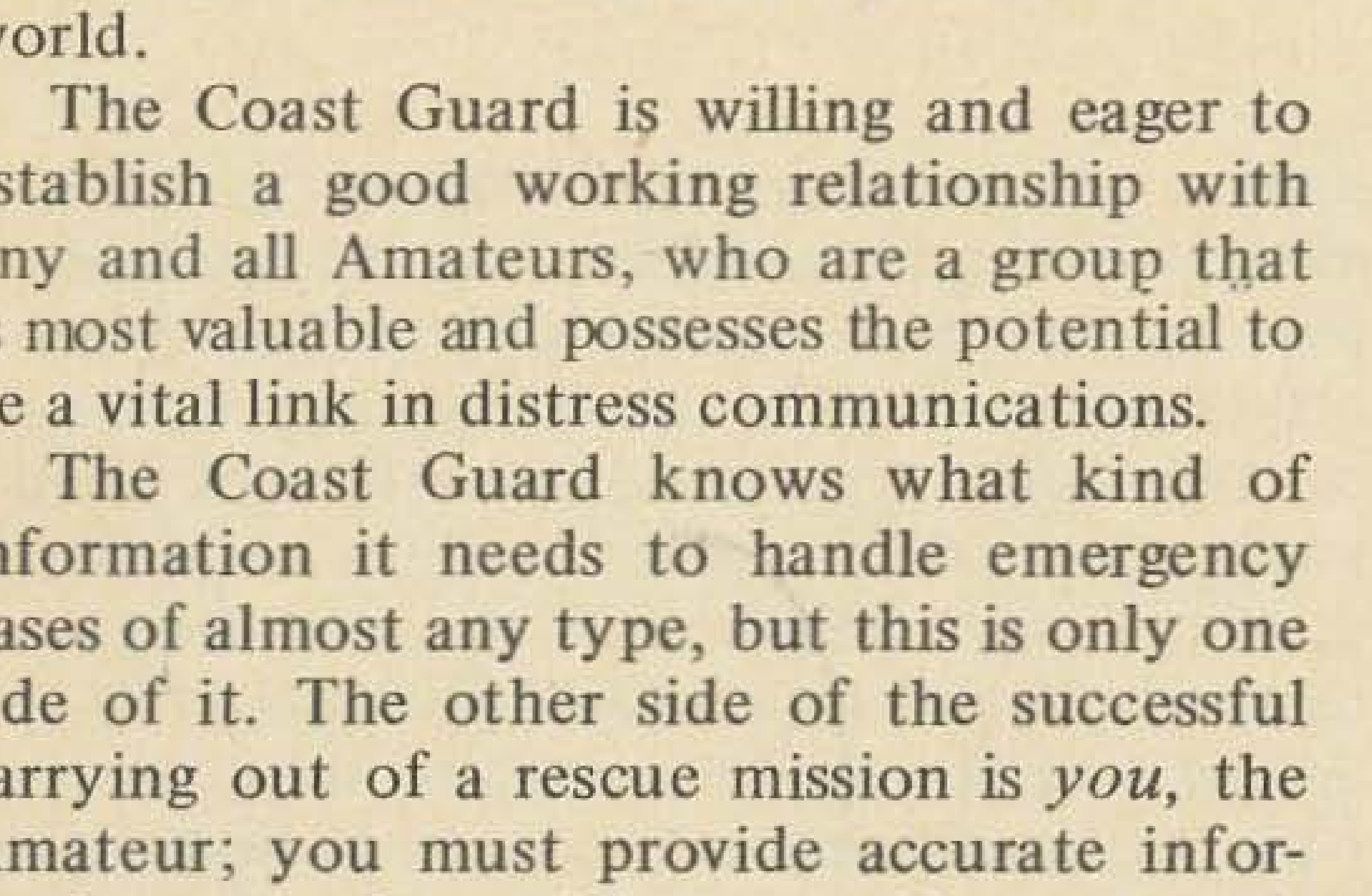
The Coast Guard is willing and eager to establish a good working relationship with any and all Amateurs, who are a group that is most valuable and possesses the potential to be a vital link in distress communications.

The Coast Guard knows what kind of information it needs to handle emergency cases of almost any type, but this is only one side of it. The other side of the successful carrying out of a rescue mission is *you*, the Amateur; you must provide accurate information, get the position, provide communications and maintain those communications.

Distress traffic can easily excite a person to the point where he makes many mistakes, this can lead to tragedy. If there is a nervous tone of excitement in your voice when working the distressed unit, it could upset the persons aboard the distressed unit and lead to disastrous consequences. Keep your head, speak normally and reassuringly, double check all information, and assure the distressed unit that assistance is being summoned. Tell the vessel that help is on the way when you are so informed by the Coast Guard. The vessel should be told what kind of unit is coming to their assistance. The Coast Guard will provide you with this information, as well as an estimated time that the Coast Guard unit will arrive on the scene.

I hope that this information will be of benefit to Amateurs and others as well. Any questions or comments concerning the various aspects of SAR are most welcome. You may write to me at my mailing address; any and all inquiries will be answered. Review all the information in this article, use the forms, study the procedures, and you and your station, as well as the United States Coast Guard, will be *"semper paratus."*

. . . WB6UKX



NEW BOOKS

KNOW YOUR VOM–VTVM, 2nd Edition

This authoritative text explains volt-ohm-milliammeters, vacuum-tube-voltmeters, and solid-state electronic voltmeters of the types of circuits used. In addition, the text explains uses, care, and repair of the instruments. Basic concepts are thoroughly presented to help provide for an understanding of electrical measurements. Questions at the end of each chapter help to reinforce learning progress. $3.50 from Howard Sams.

UNDERSTANDING AND USING UNIJUNCTION TRANSISTORS

Explains in detail the construction, operation, and characteristics of the unijunction transistor (UJT). Describes the various applications of UJT's, and typical circuits in which they are used. Separate chapters are devoted to the use of UJT's as oscillators, voltage controls, time delays and flashers, and in sensing circuits. $2.50, Howard Sams.

RTL COOKBOOK

Explains the principles and uses of RTL (Resistor-Transistor-Logic) digital integrated circuits. Provides the experimenter with an understanding of RTL in integrated circuits as they are used in everyday electronic projects. Shows the technician how these circuits work and how they are maintained. Provides the engineer with convenient form circuits that can be easily adapted as building blocks in larger systems. $5.25 by Sams.

F. Dale Williams, K3PUR
HRB-Singer, Inc.
Box 60 Science Park
State College, Pennsylvania 16801

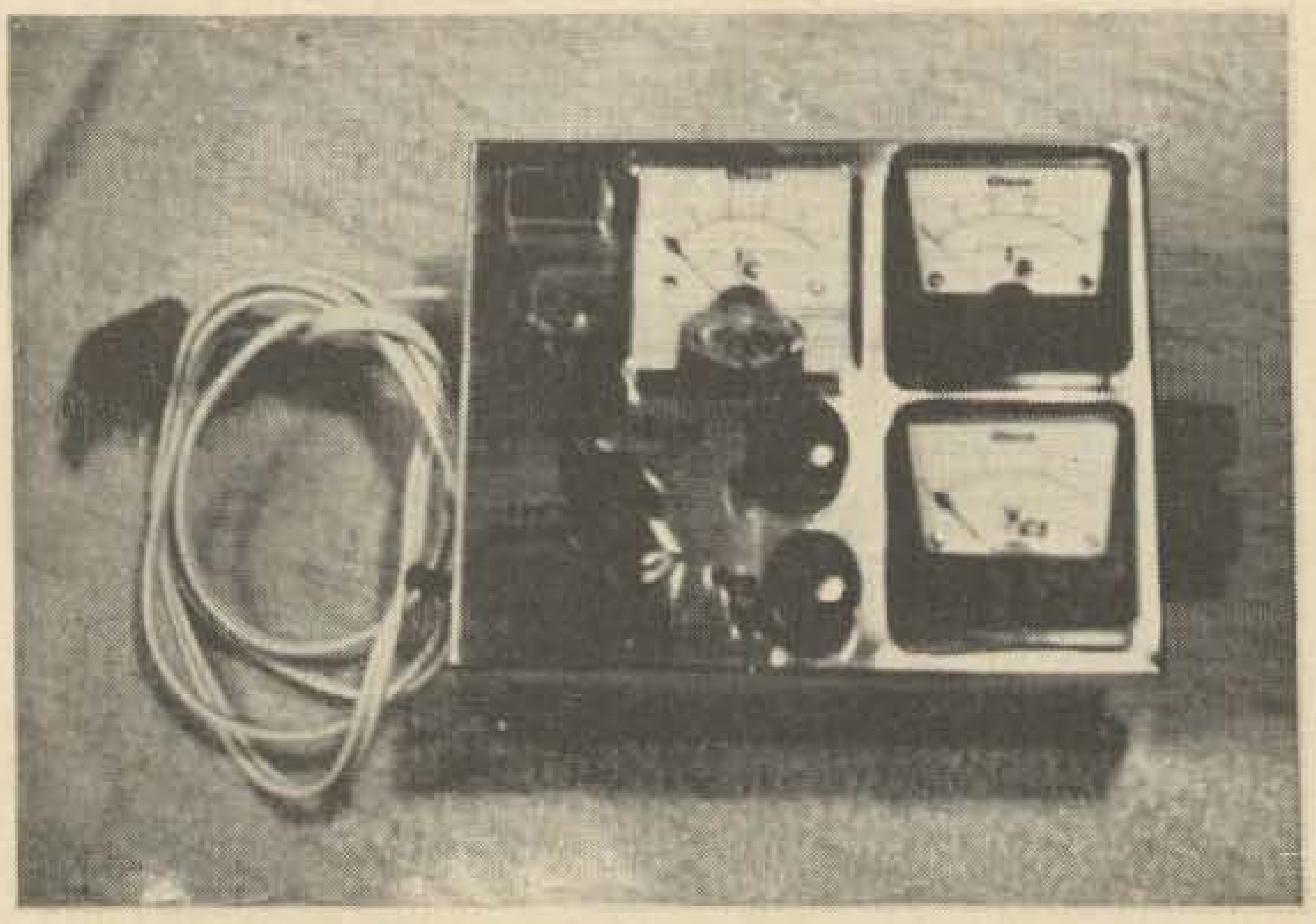
A Transistor Parameter Tracer

At the author's overseas QTH there are presently three projects under design and construction, all utilizing transistors. In the usual cigar box search for components, fifteen transistors of different types were found. However, a subsequent look through the reference file showed specification sheets for thirteen of the fifteen transistors, but only one with dc biasing curves.

Most manufacturers include on their spec sheets such data as maximum allowable voltage measured from collector to emitter (VCE), maximum allowable collector current (IC), maximum voltage collector to base (VCB) or base to emitter (VBE), maximum power dissipation at 25° Centigrade (PD) with derating factor for other operating temperatures, and typical beta (hfe) or forward current transfer ratio measured at a given set of parameters. This amounts to the minimum amount of data necessary for basic design purposes, but once the transistor is purchased and a circuit must be constructed, a number of problems suddenly arise. For instance, if the specifications for a gain of 100 are given as VCE = 5 V, IC = 1 ma, f = 1 khz, what change in the value of beta can be expected when VCE = 12 V, IC = 2 ma, and f = 7mhz? Just as important is the missing value of base current (IB). Since the transistor is a current amplifying device this parameter is as important for optimum gain as the grid bias in voltage amplifying tube circuitry.

The test unit to be described here is essentially a variable dc transistor power supply with three meters which allow the parameters VCE, IC, and IB to be monitored simultaneously. Thus, the designer may vary one or more dc parameters and, by plotting the resulting values on linear graph paper, have a permanent record of the dc curves for each individual transistor. This is important, due to the fact that most transistors are produced in "batch" quantities and no two of the same type have exactly the same parameters. In addition, the value of beta at different bias points may be computed by using the set of dc curves. The value of such design data should be apparent. With the dc parameter information obtained from the Transistor Tracer, circuitry can be designed and constructed without the usual trial and error method. By selecting a suitable bias point on the dc curves for the required value of beta and computing the necessary resistances by Ohm's Law, there will be no question of possible saturation, cut-off, or low gain. An additional feature of the Transistor Parameter Tracer is its ability to be utilized as a power supply with variable voltage control and a safe output of 12 V at 400 ma or 15 V at 300 ma.

The unit shown in the photographs was constructed using a Bud 5 x 4 x 3 inch Minibox. As can be seen, no extra panel



Overall view of completed Transistor Parameter Tracer.

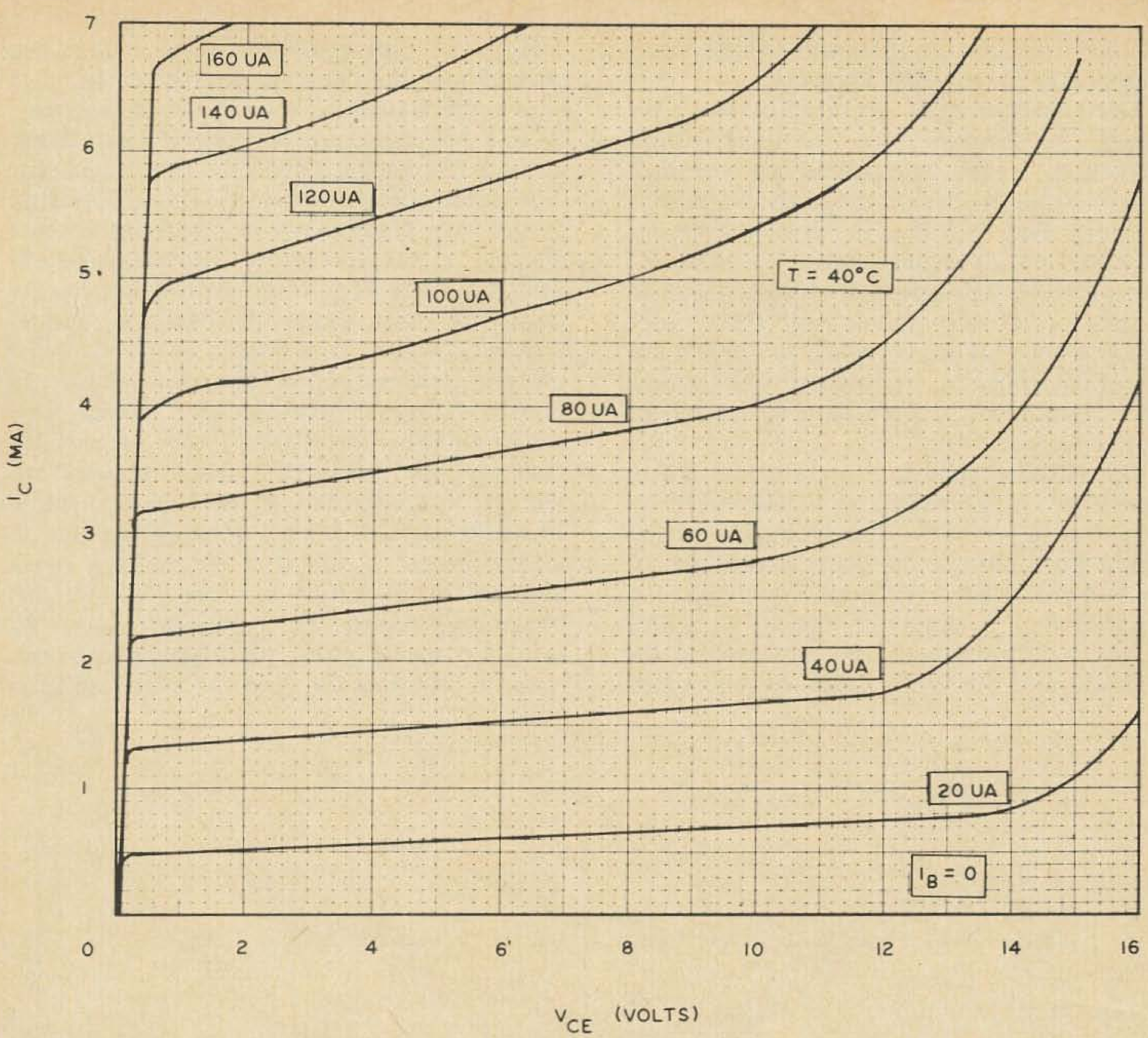


Fig. 1. DC curves of 2N918 transistor obtained with the Transistor Parameter Tracer.

space is available and the SPST power switch is mounted on the left side of the box. The size of the meters used determines the space left for the controls when using standard-size miniboxes. The author sacrificed greater accuracy for economy and space by utilizing Japanese meters. The 0-15 Vdc meter is model ME-102, 0-50 ma model ME-98, and

$$\text{beta} = \frac{I_C\ (\text{uA})}{I_B\ (\text{uA})};\ V_{CE} = 12\text{ V}$$

I_C	I_B	beta
1.4 mA	20 uA	70
2.3 mA	40 uA	58
3.5 mA	60 uA	58
4.8 mA	80 uA	60
5.8 mA	100 uA	58
7.2 mA	120 uA	60

Table 1 - Values of beta taken from Fig. 1.

0-500 ua model ME-101, all available from Olsen Electronics, Inc., 260 S. Forge Street, Akron, Ohio 44308, at a total cost of $8.65.

Pre-installation testing of these meters showed two to be inoperative. The armature had to be loosened by resetting the tension screw on one, and a loop of the moving coil had to be removed from its inadvertent position under one of the cross arms of the pointer on the other, before normal operation was obtained.

For greater accuracy and reliability, other meters, such as those produced by Evans Radio, Inc., may be used. The neon pilot light was obtained from Olson, order number KB-164, and is supplied with dropping resistor (3 for 99 cents). The transformer shown is a 117/12.6 V at 1 A unit from Olson, order number T-304, for $1.49. Each diode in the bridge network must have a minimum current rating of 350 ma. The silicon rectifiers used by the author were

500 ma units purchased from Olson, order number RE-70, four for 99 cents.

The transformer is mounted on the right side of the minibox with the wires toward the center of the top panel, and just high enough to allow clearance for the bottom of the box. The four diodes, 2-watt resistors, and pilot light dropping resistor are mounted on a piece of Vectorboard which is attached to the top of the transformer frame with epoxy glue. Not much space is needed for mounting these components, but overall board dimensions will be determined by the depth of the meters.

Due to the change in parameters which occurs when a transistor is subjected to temperature variation, the transistor socket should be mounted on the opposite side of the box from the transformer. A number of holes, ¼ inch in diameter, should be drilled above the transformer on the side of the minibox and on both sides of the other section of the enclosure, just below the transformer, to allow air circulation. In cases where the transformer produces excess heat, it will be necessary to place a heat shield around the socket. The first filter capacitor is soldered across the bridge and is supported by its own leads. Two electrolytics are not necessary, but the added filter capacity is desirable. The 25 k ohm control is a 5-watt miniature unit made by Mallory, model number VW25K. It is smaller in size than the average potentiometer, but well within its power rating. Unfortunately, it was not tested before installation and subsequent trials of the completed tester showed no voltage or current on the meters while adjusting the 25 k ohm control through its middle range. Removal of the rheostat cover exposed the outer contacts which are dependent upon the pressure from an insulated metal spring plate attached to the cover to depress the clamped metal ends of

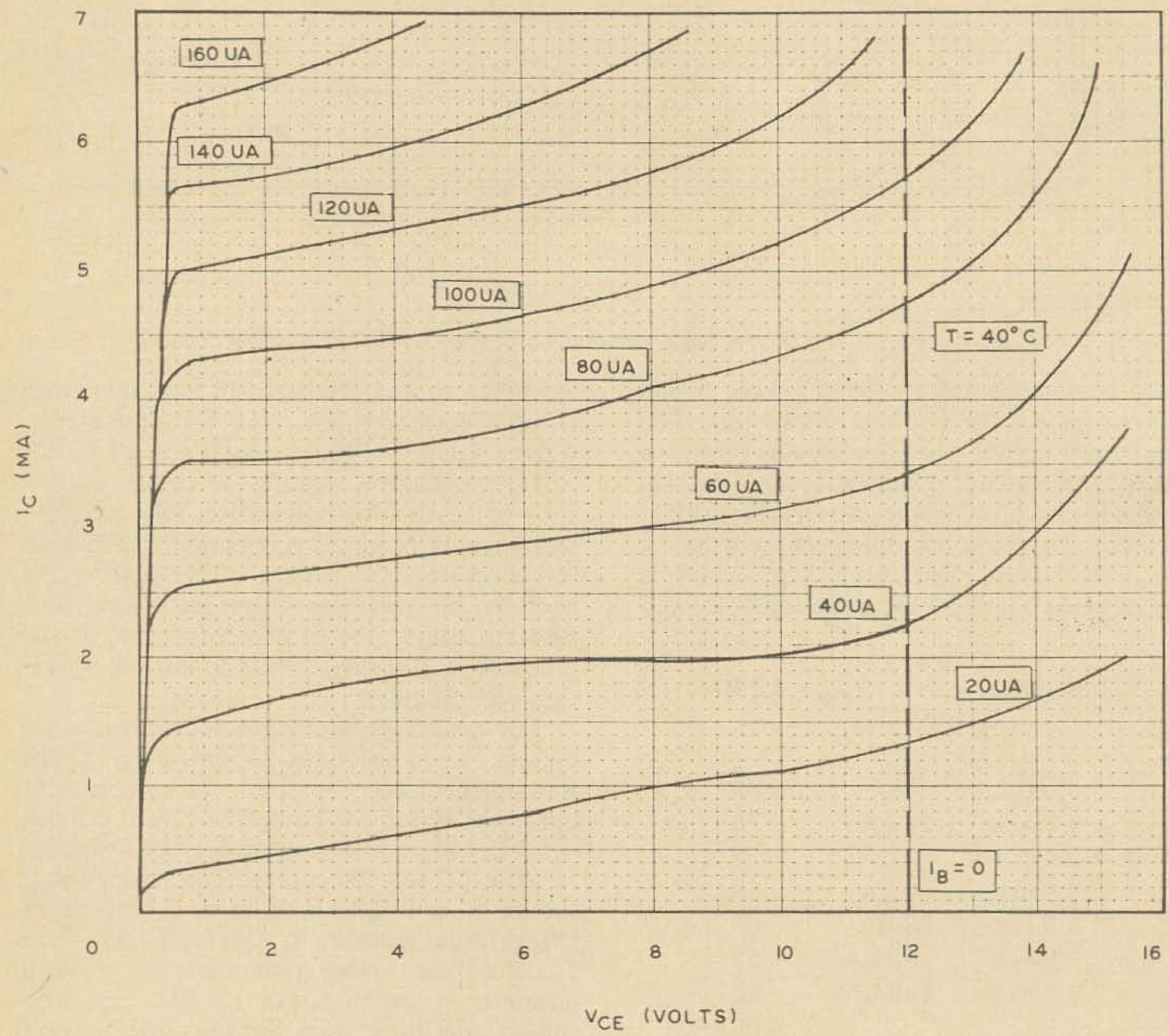
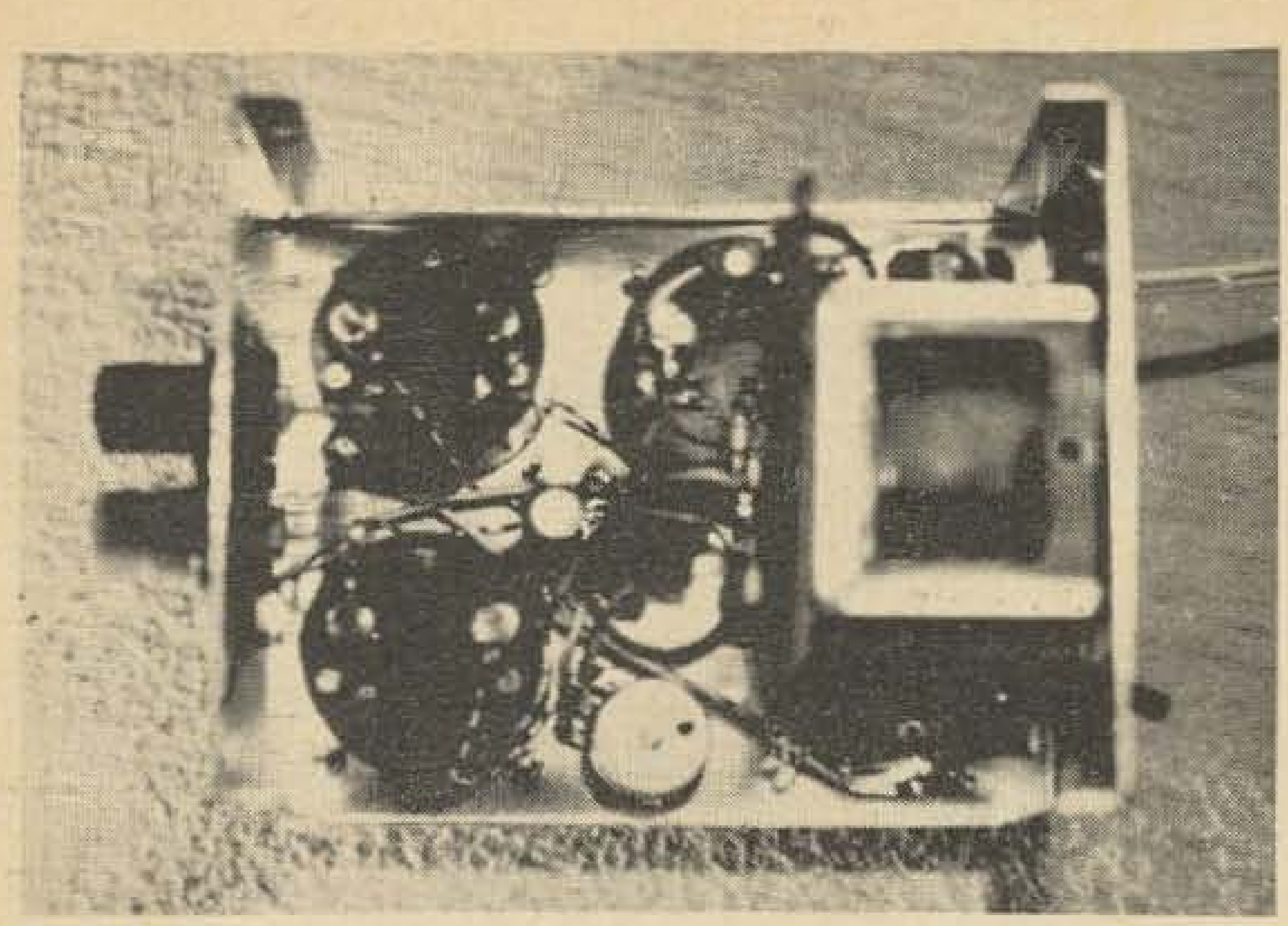


Fig. 2. DC curves of 2N918 transistor from manufacturer's specification sheet.



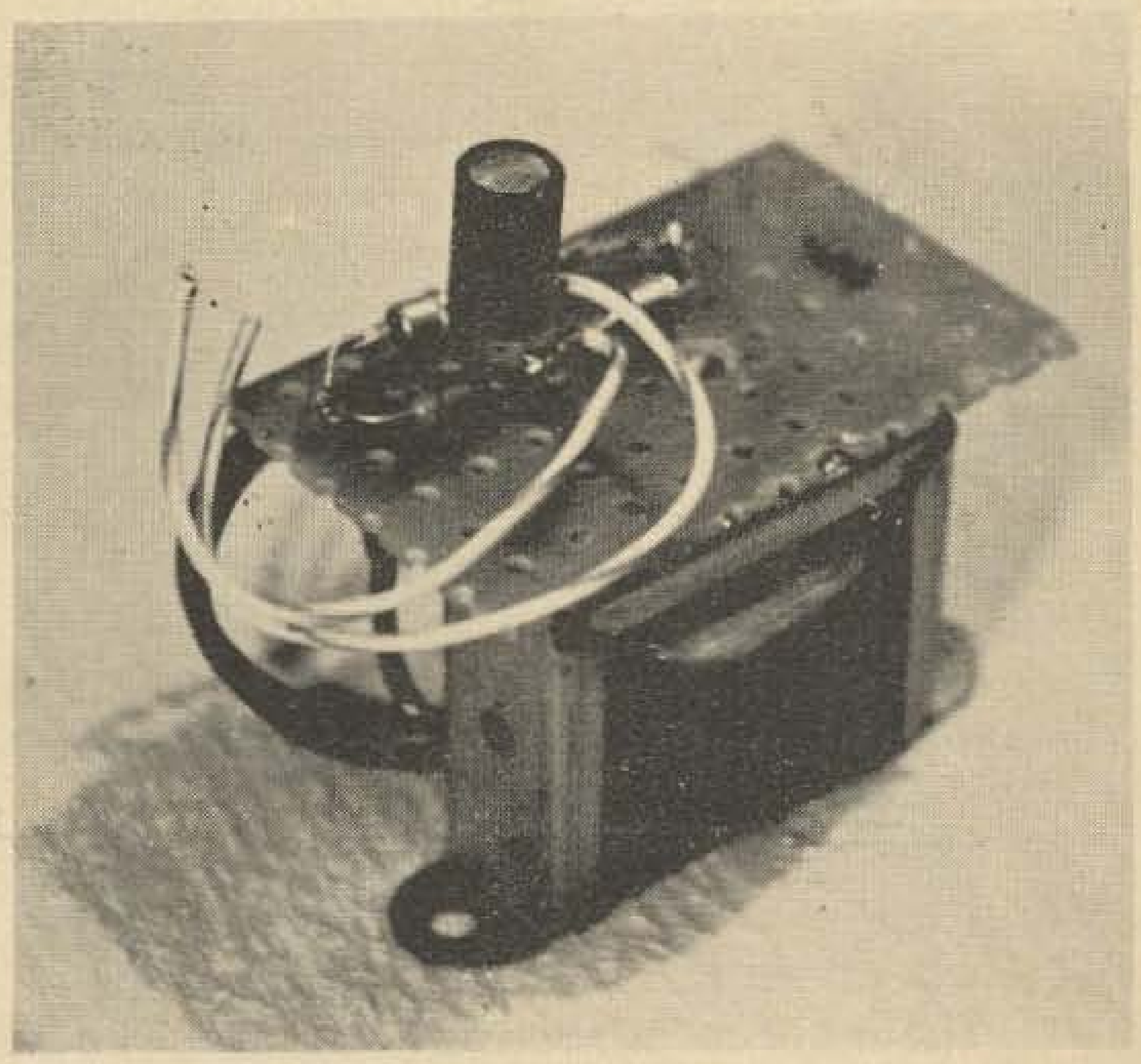
Inside view showing placement of components. (Output terminals and transformer should be switched to alleviate heating of test socket).

the wiper arm field to each terminal. The inside ends of the two outside terminals were bent up, as were the ends of the spring plate, and the cover replaced as tightly as possible to produce satisfactory operation.

The value of the bias control is not critical, with the exception that too low a value will draw unnecessary current, requiring a larger rheostat. Also, since no series meter resistor is used, the medium setting of this control should provide meter protection in the event that the transistor under test is shorted. In order to be able to monitor voltage and current when the Transistor Parameter Tracer is utilized as a power supply, the voltmeter is connected across the circuit at all times. When the function switch is in the 12 V/400 ma position, the 0-50 ma meter is shunted with constant resistance wire (R1) of a value which allows the meter to measure 0-500 ma, or ten times its normal scale. The value of this shunt resistance is determined by the formula R = Rm/n-1, where R is the necessary shunt resistance, Rm is the internal resistance of the meter, and n is the factor by which the original scale is to be multiplied. Thus, with a meter resistance of 2 ohms, the necessary shunt resistance is R = 2/10-1 = .22 ohms. If constant resistance wire having a resistance of 2 ohms/foot were used, 2/12 = .22/length = 2.64 inches of this wire would be needed for the shunt. It is best to cut the length slightly longer to allow for soldering, then adjust by cutting about 1/8 inch at a time from the length while monitoring the output with a variable 5-watt load connected in series with a reference milliamp meter. With a variable load between 24 and 120 ohms, the meter reading from 100 to 400 ma can be checked. An alternate method, not requiring a reference meter, is the use of composition resistors, arranged in series or parallel, to give a value of 30 ohms with a power dissipation of 5 watts. With this load connected across the output, a 12 V reading on the voltmeter should give a reading of 400 ma on the milliamp meter when the shunt is the correct length. Keep in mind that the power rating of the supply is 5 watts, limited by the 25 k ohm control, and any reading over 12 V at 400 ma will be close to exceeding this value, causing possible damage to the rheostat. All meters should be calibrated with the help of a reference meter and the zero-set screws made fast with a drop of clear nail polish or glue. The output terminals to which the Transistor Parameter Tracer supplies power when the function switch is in the 12 V/400 ma position, are H. H. Smith type 269RB.

Operation

A volt-ohm meter should be used to check out wiring and to assure that the function switch has been connected with the correct polarities (NPN, PNP) in reference to the transistor socket pins. To preclude applying too high a voltage to the transistor under test and to protect the meter in case of an inner transistor short, the VCE/IC control should be set to maximum resistance before applying power. Potentiometer IB should be set at mid-range for similar reasons. In addition, since transistor breakdown from possible transients can occur when inserting a transistor into the socket with the power on, the line switch should



Power supply components are mounted on small piece of Vectorboard glued to transformer.

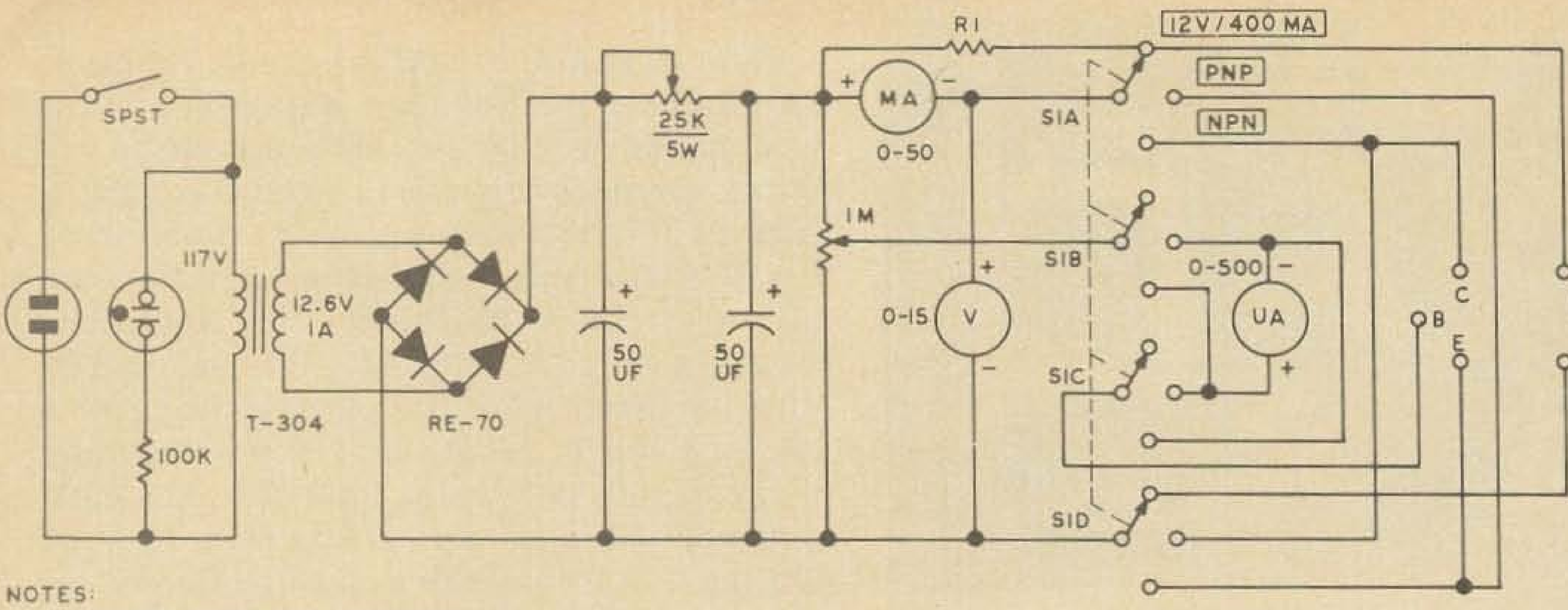


Fig. 3. Schematic of the Transistor Parameter Tracer. See text for component description.

remain off until the transistor to be tested is inserted and the controls are set as above.

After setting the function switch on the polarity of the transistor to be tested, inserting the transistor into the test socket, and adjusting the controls as outlined above, power may be applied. The VCE/IC and IB controls are interactive; that is, changing the setting of one will affect the meter reading controlled by the other. Therefore, it is possible to obtain a dc curve within the limits of the meters and the transistor under test. By advancing the VCE/IC control until a reading is shown on the milliamp meter, the first set of values is obtained. Varying the IB control will show whether the base is drawing current or if it is cut off. Continual advancing of the VCE/IC control in convenient steps will give additional sets of values, as advancing the IB control will give different levels of base current. By readjusting both controls for each set of values, a constant base current curve at difference values of VCE and IC can be noted.

These values of VCE, IC, and IB for each setting can be transformed into a dc curve for the transistor under test by utilizing linear graph paper. **Fig. 1** shows such a dc curve for a 2N918 transistor, plotted from values obtained with the Transistor Parameter Tracer. **Fig. 2.** shows the dc curves included on the manufacturer's spec sheet for this transistor. The value of beta, or the gain which can be expected from the transistor under test, can be computed at any point along the dc curves. Since beta = IC(ua)/IB(ua) for any constant value of VCE, beta may be determined for any corresponding values of IC, IB along the chosen vertical VCE axis. **Table 1** shows the computed values of beta taken along the VCE = 12 V axis for the 2N918 transistor. The values of beta obtained with this Transistor Parameter Tracer are valid only for the common emitter configuration. Naturally, the available gain will not be as great when the transistor is used in the common base configuration, and cannot be expected to provide any gain when utilized in the common collector configuration.

. . . K3PUR

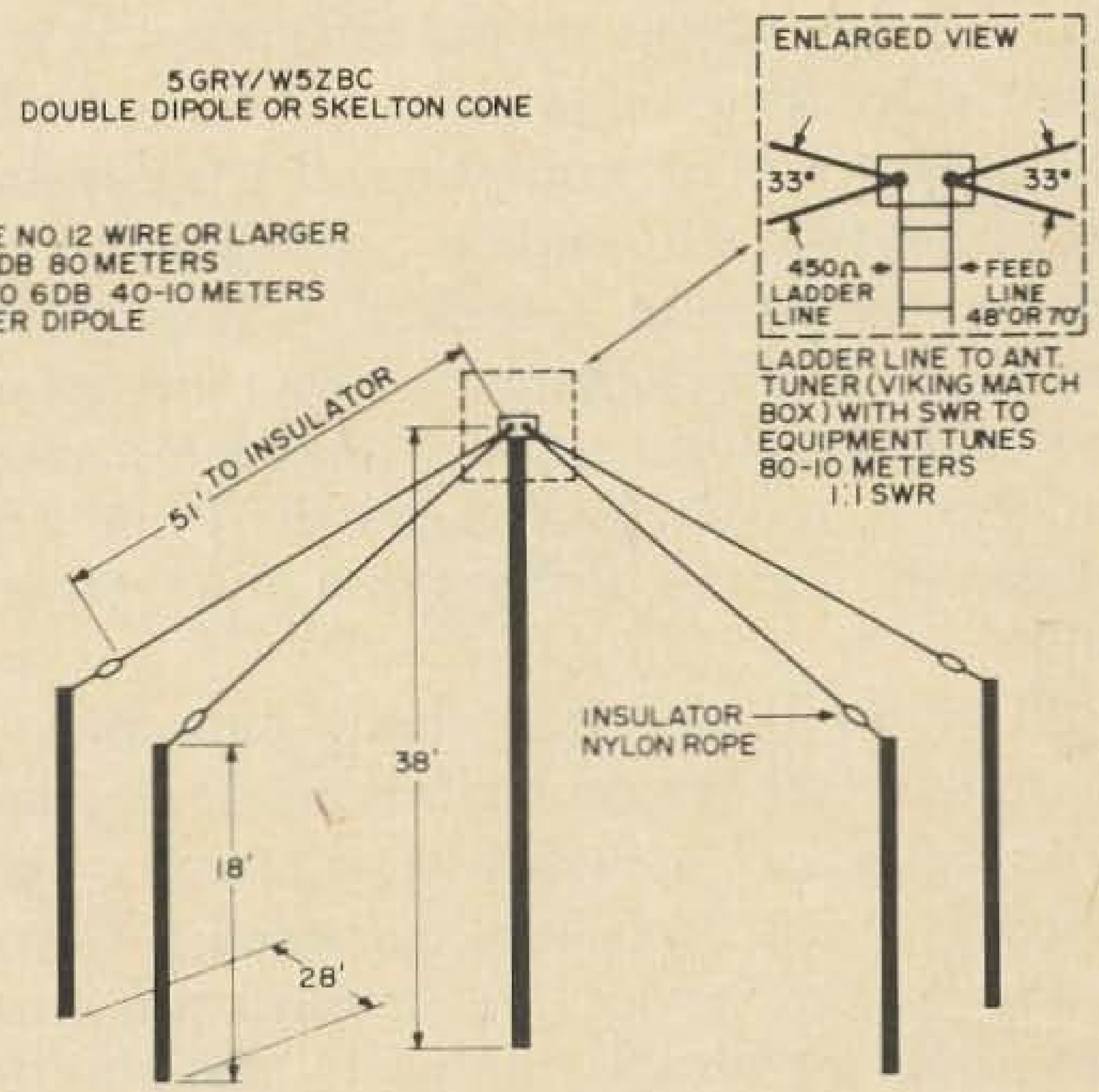
"I'd suggest you take up a nice hobby like amateur radio . . . and I just happen to have a great deal of extra equipment I can sell you cheap."

The Skelton Cone Antenna

In building, testing, trying all types of antennas for a number of years, I firmly believe the antenna to be the most important piece of equipment in the whole amateur station. In fact, by doubling power to your final you will most probably raise most ham receivers a half "s" unit. But having an antenna that will require the transmitter to be bolted down to the table, less it be drawn up into the antenna with all the other *rf*, will undoubtedly raise the "s" meter to 6db. This is exactly what The Skelton Cone Antenna will do: (1) require that your equipment be bolted down and (2) an increase of 6db on four amateur bands and 2.4db on 75 and 80 meters. If you are interested read on.

The basic idea of the Skelton Cone comes from the *RSGB Handbook* (3rd Edition, pp. 387-88) and the trial and error method of antenna construction. The Skelton Cone at this location as compared to a dipole at the same height and the same plane on the compass has provided the following:

1. 5.2 to 7 db gain on 40, 20, 15, and 10 meters over a dipole.
2. 2.1 to 4 db gain over a 75 and 80 meter dipole.
3. 1.1 SWR over 80 through 10 meters (phone and cw).
4. Provides for a double angle of radiation to provide less qsb.
5. Seems to have a pattern of 360 degrees with no reduction or increase of single in any one direction.
6. Provides for the e.m.f. of the antenna to be from 250 to 300 feet vs. 33 feet on a dipole, say on 40 meters.
7. Employs an antenna tuner to curb harmonics.
8. 3 db over a vertical in Europe or the South Pacific.



9. Creates something to talk about on the ham bands (Ref. *73* de W2NSD/ 1 Jan. 1969, p. 4)

The skelton cone also works on 3.311 kcs and 4.590 kcs, 2 different AF MARS frequency.

This antenna is well worth the low cost and will match some of the "so-called" amplifiers one hears on the air today. Whether it will provide you the gain claimed, I don't know, but there is one way to find out. Put it up and burn up the front end of your best friend's receiver. If you have questions, please forward SASE.

Eddy Shell, W5ZBC

Robert H. Grenell, ex-W8RHR
3926 Beech Street
Cincinnati, Ohio 45227

What Are We Here For?

No government has ever granted any privilege which was not demanded by the majority of the governed unless it felt that it had something to gain from so doing. Regardless of idealistic, democratic concepts, rights and privileges are not inherent, but are granted by those in power . . . or taken from them by force of revolution. If the government believes that certain privileges are no longer necessary or beneficial, it is quick to withdraw or usurp them. To those interested in the philosphical aspects of governmental power, I recommend readings from the works of Thomas Hobbes and John Stuart Mill.

How do these rather basic concepts of governmental behavior affect amateur radio? For better or for worse, they affect it very directly. The privileges accorded the Amateur Radio Service are no different from any other privileges granted by the government. The government believes that it and the country as a whole have something substantial to gain by the existence of amateur radio, and with good reason. To this self-seeking end, and no other, the government suffers the Amateur Radio Service to exist. Remember that.

Certain things are expected of us in return for our privileges, and it has now begun to look as though the time isn't far off when the government will examine the performance and contributions of the Amateur Radio Service to see if we're holding up our end of the deal. The result of that examination is entirely up to us. Whether the Amateur Radio Service will continue in its present form, be extensively curtailed, or even eliminated depends wholly upon whether the government feels it's getting what it wants and needs from our efforts.

With a TV-watching public convinced that radio amateurs constitute a marginal, if not detrimental, lunatic fringe of society, and a government which daily gobbles up more and more individual rights, where do we stand? In a world clamoring for more and more space in every dimension including the *rf* spectrum, can we justify the niche we occupy?

The trouble has already begun. Hams all over the world are aware of the plight of Ansel Gridley, W4GJO, who is being sued for $1,000,000 because of TVI which the FCC investigators stated was not his responsibility! Despite this statement exonerating Grid, a court of law entertains this absurd suit on the grounds of "electronic invasion of privacy." In all probability, Grid will win his case . . . but only at great expense in time as well as money. However, if there ever was a danger signal, this is it.

It's time to take a good look at ourselves and act on what we see. It looks like about 25% of the active amateurs are carrying the other 75% around on their backs. The moon-bouncers, the phone-patchers, the traffic nets (the ones that do something besides originating their own messages), and the emergency nets are doing most of the work of justifying our licenses!

There are those who will say that amateur radio is a hobby, not a job, and should be participated in as a hobby. But just remember that the very existence of this hobby depends on the patronage of a government which in recent years has become very acquisitive of rights and privileges. Sure, amateur radio is a hobby, but it seems that it's going to take a lot of work to guarantee its continued availability!

There are three basic jobs which must be undertaken soon if Amateur Radio's survival is to be assured: (1) We must fully exploit our public service capabilities. (2) We must fully exploit our technological ability, and advance the "state of the art" as we have in the past. (3) We must achieve maximum exploitation of our activities in terms of public relations.

Wayne Green, W2NSD, editor and glorious leader, has thoroughly hammered home the point that what is needed for openers is an intensive public relations campaign. There simply are not enough of us to form a meaningful pressure group, and we must, therefore, rely on the public, which knows little or nothing about us except that we occasionally interfere with their TV reception. To get the public on our side and out of neutral and/or hostile corners, we must acquaint them with the things we're doing and have done in the past which have bettered the lot of the people as a whole. But most important, we've got to be sure we have plenty to tell them about . . . things we're doing now, things we've done in the past that are affecting their lives now, and how they benefit now from our activities.

They should know that without amateur pioneering in the vhf spectrum, many things taken for granted would not be possible – things like the dependable microwave links that cover the entire country with television network programming, and the similar microwave links that have made possible the continually decreasing costs of long distance telephoning; and the highly reliable communications between earth and our astronauts in space. They should know that amateurs around the world are communicating via moon-bounce, perhaps paving the way for a truly global television system, and perhaps opening still another door in the communication/cost barrier. Perhaps they should be told that the most efficient method of voice communication yet developed, single sideband, is the result of amateur development and experimentation – but that sort of thing doesn't really mean much to the public as a whole.

They should be told that in time of emergency, a trained group of communicators stands ready to render invaluable assistance. Public officials and charitable organizations should be made aware that hams stand ready to aid them in any worthwhile project or endeavor requiring rapid and sure communications. We're in the unique position of having to "sell" the services we want to give away, because too few people are aware of our potential . . . and sometimes I wonder if even we are fully aware of it. Every parade, boat race, sports car rally, door-to-door charitable solicitation, every three-day week-end, provides another opportunity for hams to demonstrate their public service potential – and get it publicized.

How about a rush-hour traffic watch? In a given city or town, every ham with a rig in his car could call in traffic and accident alerts to police and to a *cooperating radio station.* The radio station is the kicker, because every time a traffic bulletin comes through, Radio Amateurs will get a plug if the project is properly set up to begin with. Receivers could be given to the station and to the police to receive the alerts. Probably all it would take is for an organized group of hams to contact a well-rated radio station and co-ordinate the project with police. Radio stations are constantly looking for new gimmicks, and this is just as good as the overworked "copter cop" routine.

Those who enjoy home-brewing can intensify their efforts and truly advance the "state of the art." I don't care what anyone tells you about technology having outstripped amateur techniques; we're the ones who let it happen while we complacently fell asleep at the switch. You *can* make a breakthrough; you *can* develop new techniques and applications. Every month new solid state devices become available to amateurs. Use them. Experiment. Build. Do something.

We are truly responsible for our futures as radio amateurs. Sure, amateur radio is a hobby, but it's a responsibility too – at least under the present scheme of things. We can make amateur radio such a powerful tool that the entire country will be convinced of our usefulness and seek out our services. Sure, amateur radio is a hobby, but compare it with other hobbies as, for example, pleasure boating on the Ohio river. How long do you suppose that would last if it were determined that it was interfering with shipping?

We're luckier by far than most hobbyists. We have a great opportunity to justify our existence, and secure the continuation of our hobby just by performing. Let's do it.

. . . ex-W8RHR

A Thought

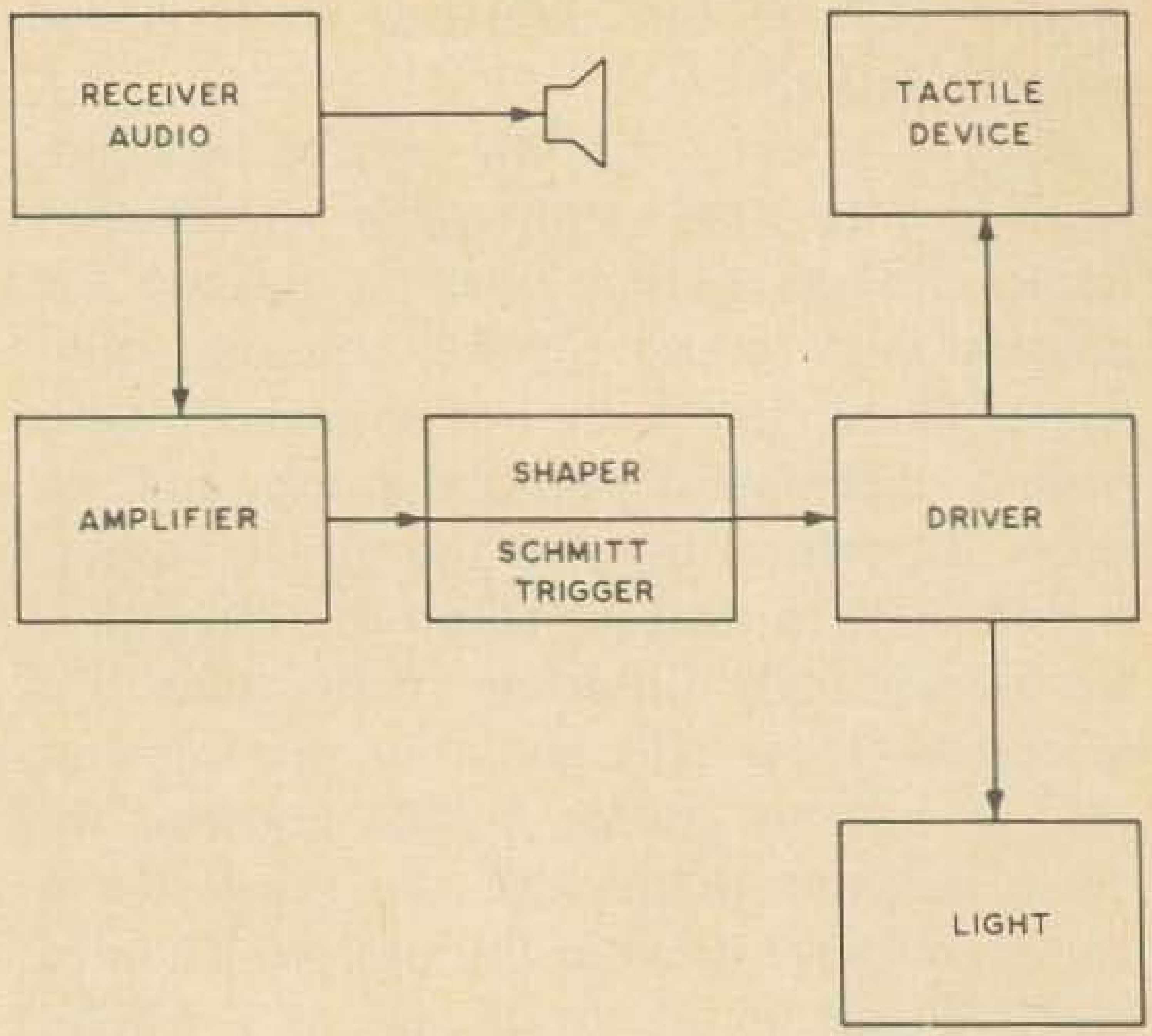
For a number of years now I have read on various occasions and in various ham magazines, articles on helps for the handicapped. A most admirable activity.

On most all occasions this took the form of apparatus, and hints and kinks for the sightless. And a few times articles for the handless and for people with mobility problems. But never have I seen materials, helps, or apparatus for the deaf or the deaf mute. I do not mean the hard of hearing (better amps, etc.), but those who have gone deaf, or those who have been deaf all of their life. I do not think this lack need exist. There are many thousands of deaf in this country. I am inclined to think that there are more deaf than blind! I'm sure that not all of them would be hams, but why not some? Wouldn't this make a fine hobby for a deaf child as well as a hearing child? And how many hams have lost their hearing and given up ham radio? I don't know, but I'm sure it need not be so.

One should consider the amount of use a ham makes of his eyes and compare this to the use he makes of his ears; what with scopes to visualize and the wave forms and meters to monitor the dc levels, what does one use ears for? Well, it's quite obvious that hearing is necessary for voice communication. But hearing is certainly not necessary for hams to communicate. There are other methods which could be used. T.V., FAX, RTTY, CW. FAX does not seem to be too popular at this time. TV is too complicated for most. But this does leave RTTY and CW. For the beginner, CW would seem the most logical, and for the advanced ham, RTTY would be a most interesting challenge.

The following circuit could be worked out and added to almost any receiver to convert the audio tones to either tactile or visual stimuli. I'm not sure how fast one could copy CW tactually or visually but, I'm sure 5 wpm would be copyable.

Suitable RTTY set ups are ubiquitous enough so that not much need be said on that matter. One must surely learn to use the eyes for all actions, but this does not seem to be an overwhelming problem. I'm not deaf, but I did try to simulate the problem by turning off all the sound in the



shack and working 6-meter RTTY. I did it with no great difficulty. I am least of all a CW type and find it hard to copy CW with all of my senses, so I could not simulate CW.

In closing let me say that I think it behooves all hams to consider all those who could enhance our hobby.

Robert D. Bailey, K3AQH

Scanning the Flyers

Radio Shack has put out a flyer in celebration of its 46th anniversary. They've made it worth your while to celebrate with them. Like, for instance, a simple receiver for the low-budget beginning amateur. Thirty-five years ago, he'd have started with a pair of UX-230 tubes in a regenerative detector plus one-stage audio. Then radio got complex and the beginner got left behind. Radio Shack has reached out a helping hand in the form of a kit, at $19.95, that is the modern solid-state version of the simple set that got many young chaps started in amateur radio. It's called Globe Patrol.

Parts, though, are the items bargain hunters search for, and Radio Shack has some at less than you'd expect to pay. A "build-it-box," perf board plus plastic cover, at 59c. Ten 14" jumper leads for 99c (most other places have gone up to $1.19). A slim 30-watt soldering iron at $1.49 which needs no stand. Two other items are not only handy things to have in the shack but can be, literally, life savers under certain circumstances. These are master controls for 117-V ac lines. One, at $3.19, controls three circuits, each with an independent switch and individual pilot light. The other, which sells for $3.99, is a master control for six circuits, all of which (including the pilot light) are controlled by a single switch. A master control like this can save your life if you should get tangled up in high voltage, and someone not too well acquainted with your shack has to locate a power switch in a matter of seconds. Having seen a friend get killed on a 117-volt line, I'm a bit touchy on this subject.

If you want to pursue the subject of multiple power outlets in greater depth, I suggest that you get Waber's 1969 catalog (Waber Electronics, Inc., 2000 North Second Street, Philadelphia, PA 10122). It shows a comprehensive line, offering such refinements as variable voltage, timed on, timed off, volt meters, circuit breakers, etc. These can make a neater as well as a safer shack.

It would seem that most wholesale houses buy their wares from the same source. It's not often you find an unusual item. . .or one at an unusual price. Olson Electronics catalog No. 369 appears to have departed from the pattern of universal similarity. I found a number of articles that were either below the customary price or different from the competive run.

For instance, there's a "wired wireless" extension speaker system that would seem to have almost limitless application possibilities.

Have you ever been tempted to use a rocker switch in place of a toggle. . .then had second thoughts because of the difficulty of cutting a rectangular hole in a panel? Olson gives you another choice; it offers a "see-saw" switch that looks and works much like a rocker, yet mounts in a round (3/4 inch) hole like a toggle. These cost 99¢ each.

There are many mini-multi meters. (How's that for alliteration?) on the market at very reasonable prices. Most of these, though, have voltage ranges that limit their use with amateur transmitters, where voltages above 1000 are often found. Here, again, Olson breaks the usual pattern. Their 20,000-ohms -per-volt multimeter, selling for only $7.99. has a top DC range of 2500 volts; on AC, it goes to 1000.

Tiny electrolytic capacitors compatible with small-sized transistorized circuits usually have prices inversely proportional to their size. At Olson's, you can buy 10 or 25 mfd 25-volt ¼" x ½" capacitors at five for 99¢.

From these examples, I've concluded it's worth the time to scan carefully every "flyer" that comes to hand. There are enough hidden bargains to make the practice profitable.

Carl C. Drumeller, W5JJ

LETTERS

Letters,

The article on "Adjusting FM Deviation" in the June 73 was interesting, but it does have some drawbacks. The author recommends monitoring the receiver with a scope while adjusting the transmitter deviation and watching for a flattening out of the CRT display. The trouble with this approach is that the flattening out is not necessarily an indication of the receiver band-pass limit; it could just as well be audio limiting of the deviated transmit signal.

A better approach: If the system contains both wide and narrowband units, use a narrowband receiver whose discriminator and low i-f stages are in good alignment. Position it some distance from the transmitter to be adjusted and have the transmitter operator gradually increase his deviation as he whistles loudly into the microphone. This insures that the transmitter limiter will be set to the maximum deviation level that can be copied. When the signal at the receiver just begins to break up (called "squelching out"), the deviation control of the transmitter should be backed off slightly. At this point, if the receiver doesn't squelch out on loud whistles, it will accept anything the adjusted transmitter will dish out in terms of audio level. For optimum system performance all transmitters should be similarly adjusted.

Reducing a wideband transmitter's deviation to make it compatible with a narrowband receiver is an unfortunate compromise. The performance of wideband receivers will be degraded substantially. Signal-to-noise ratios will fall off, reducing the sensitivity and the audio level, and increasing ignition interference and loud squelch tails. Remember to keep a limiting (loud as possible) audio signal modulating the transmitter throughout the adjustment procedure. Unless this is done the whole process is a waste of time.

Ken Sessions Jr K6MVH
Editor FM Journal
Ontario, CA 91762

Dear Curious,

Your letter on p.123 of June 73 is answered, yes. It was printed first in 73 (Nov 66), but my patent papers were filed 34 months earlier and the patent was issued in September 1966. The difference was that my write-up was not up to 73's standards and W4TDI's was. The question of angles and sunspots has never satisfied anybody. From October 1962 until February 1966 the sunspot numbers stayed below 30. The Bonadio antennas demonstrated their peculiarities during those years. Now, with the sunspot numbers a little over 100, they continue. None of these antennas have had any parts over 30 feet high, so the low angle of radiation is unresolved too.

George Bonadio W2WLR
373 East Avenue
Watertown, NY 13601

Dear Mr. Green,

Reference is made to the February 1969 QST editorial and to Mrs. Bloom's article in the April issue of 73. I think Mrs. Bloom got a little off base, so to speak, in her article. QST's editorial referred to those who become involved in conversations which do not pertain to amateur radio; also the use of obscene language and offensive topics of conversation.

Despite what Mr. Hindin ("One Technique To Avoid That Routine QSO") states in the April 73, the best way to conduct a QSO and not risk any offense is to give rst, QTH, name, rig, wx, QSL, es tnx fr QSO, 73, SK. Who, in this day and age, cares that I am a schoolteacher, an Episcopalian, a Mason and a Conservative? To many people these are all dirty words and would cause them offense. It appears that people nowadays want no conversation; just be around people and say nothing. From one end of the country to the other the rule seems to be: be busy and don't talk at all.

Jim Ingham WN5VFW
2636 Forest Park Blvd
Fort Worth, TX 76110

Dear Editor,

The enclosed picture was taken at a recent meeting of the Radio Society of Iran. Left to right are DL2WB, EP2JP, W4GUS, WA5AUA, EP2 BF, EP2BI, EP2HL, Ted Libershal (QSL manager), WA9EHZ, WB4BSF, EP2DA, HC5HC, with EP2BG, EP3AM, EP2BQ, EP2FD, EP2DW, EP2CH and several other active EP's not present. All amateurs visiting Tehran are most cordially invited to attend these meetings, which are held on the last Thursday, monthly. Contact Chuck Bowers EP2CB at the US Embassy for information. EP stations are active on all bands, with 20 meters being the favorite. Listen nightly around 14225-14235 between 1230-1830 GMT. QSL cards may be sent to the Radio Society of Iran, Armish MAAG, APO, NY 09205.

Dear Wayne,

I have located the following Wall Street Hams: Jay Nathan K2HVM, Bioren & Co., 120 Broadway. Joe Re K1ZUV, Bear, Stearns & Co., 1 Wall Street. Herb Gesell WB2ASA, Stone & Webster, 90 Broad. Rob Robitaille WB2OTF, Eastman, Dillon, 1 Chase How about a shout from other Wall Streeters?

George Gero WA2FEF
First Hannover Corp.
67 Broad Street, NYC

Dear Wayne,

First let me congratulate you on the last few issues. I realize that you don't like being editor, but be assured that nobody can do the job like you do it. I hope you'll stay this time.

Wayne, I went down last week and passed the Extra and have since done some very serious thinking on the whole business. Naturally I am proud of having passed, but I've discussed a few ideas with friends on the air and we have reached the conclusion that if phase II of the incentive licensing is implemented in November the future of our bands will be very seriously threatened.

The intrusion into our bands of the ever-hungry commercial is bound to become more pronounced. In my area we are plagued by meatgrinder CW signals on 80M from Central and South Americans, and of course Castro's sandbar. They are all over the band and really thick around 3750-3800, the DX phone frequencies.

Despite many of us giving them hell, their activities have increased noticably during the last two years and can't do anything but get worse since so many hams are apathetic about the loss of their frequencies. The rejection of the Extra and Advanced Class licenses rather prove this.

We would like to petition the FCC to (1) Restore the bands lost by the General, Conditional, Advanced and Technician licensees and revert back to the bands as they were before November 1968. (2) Create an incentive by opening a new phone subband in the 80 and 20M bands, at least, with 25 khz for Extra and 50 khz for Advanced as a reasonable, but minimal incentive.

Having passed the test, I think I'm in a good position to ask for a change back. I feel that it would be foolish to continue and that our prime concern should be to save our frequencies. I challenge anyone to prove that there has been any reduction of lids or profanity on our bands...or any other major improvement as a direct result of incentive licensing.

Robert Wheaton W5PKK
Route 2, Box 324D
San Antonio, TX 78228

Ed note: Well, Bob, I suggest you forget the petition signatures and spend your time putting the problems and the proposed solutions to them on paper. Sign it, have it notarized, make 14 copies and send the works to the FCC. Send me a copy for 73 too, please. The time for signatures is when the FCC releases your proposal with a docket number...then it is either supported or not. I think your idea is a good one and will be glad to pass along your letters in 73. For that matter, even if I disagree with your proposals I would probably pass them along in 73. Frankly, I wouldn't look for a lot of support from the ARRL, though I am always willing to be surprised.

Dear Wayne,

You might be interested in some portable operating I intend to do during the first two weeks of August on a trip through Central America, HK, YV, Trinidad, the Leeward and Windward Islands, KP4, South Caicos and the Bahamas. I will probably concentrate on 75M to give more of the fellows new countries on that band. I always enjoy 73 and like your style very much. Keep up the good work.

Charles Crow WB4MKU
1211 27th Place South
Birmingham, AL 35205

Dear Wayne,

For some time you have been sounding off on the importance of getting new hams and I agree that the situation is serious. Our local club, the Twin City Hams, in cooperation with the local college, has just completed offering a course leading to a Novice license (no college credit). I must say that we were amazed at the number of people who were interested in becoming hams. We had over 100 people attend and expect over 30 new Novices in the near future.

Record my vote for the new system of indicating propagation conditions.

William Gulledge K5UAR
700A Plum Street
Monroe, LA 71201

Dear Editor,

Your May issue was so good I can't express it in words. There were 40 (count them 40) great articles. I especially liked "In The Beginning." It ought to win the Pulitzer Prize for comedy! If you have more articles like that I might become a Life Subscriber. Say, if you need a photo to fill some space you might use the enclosed. I expect to have an article on working DX ready for you soon.

Donald Rubin WA3JRA

Dear Wayne,

Yeah, I'm mad, but not at 73. I think that the ARRL is going to wipe out ham radio for all but the ham who works in electronics or the hobbyist who is willing to spend all of his time studying.

To build up their advertising the QST boys have plugged for licensing everyone. Now they want to void the investments in equipment of people like me. They want to cut off a lot of the use of the equipment they talked us into buying. Having been a ham since 1923 I have seen a lot of this hokus-pokus from the ARRL.

When is someone going to come out with an organization to replace the ARRL, which surely is now dead on the vine? I'll bet that the boys at headquarters haven't really been on the air twice in the last five years.

L.L.Bunning K6LOX
635 West 16th Street
Uplands, CA 91786

Ed note: Though the ARRL has seemed to many of us to have acted unwisely in the matter of incentive licensing and the net result has been, as you pointed out, a loss of investment for those amateurs who have as a result dropped out, I see no sign that the leaders of ARRL either planned things this way or even had a notion that their actions might bring this result. Incentive licensing was brought about, if I am to believe many consistent reports from deep inside HQ, by the intention of the League Mahager to use controversy as a means for calling attention to the League and thus getting more amateurs to become members. The plan backfired, of course, and the result has been a precipitous drop in membership. Once committed to supporting incentive licensing the League had to make it stick or else lose face. They made it stick.

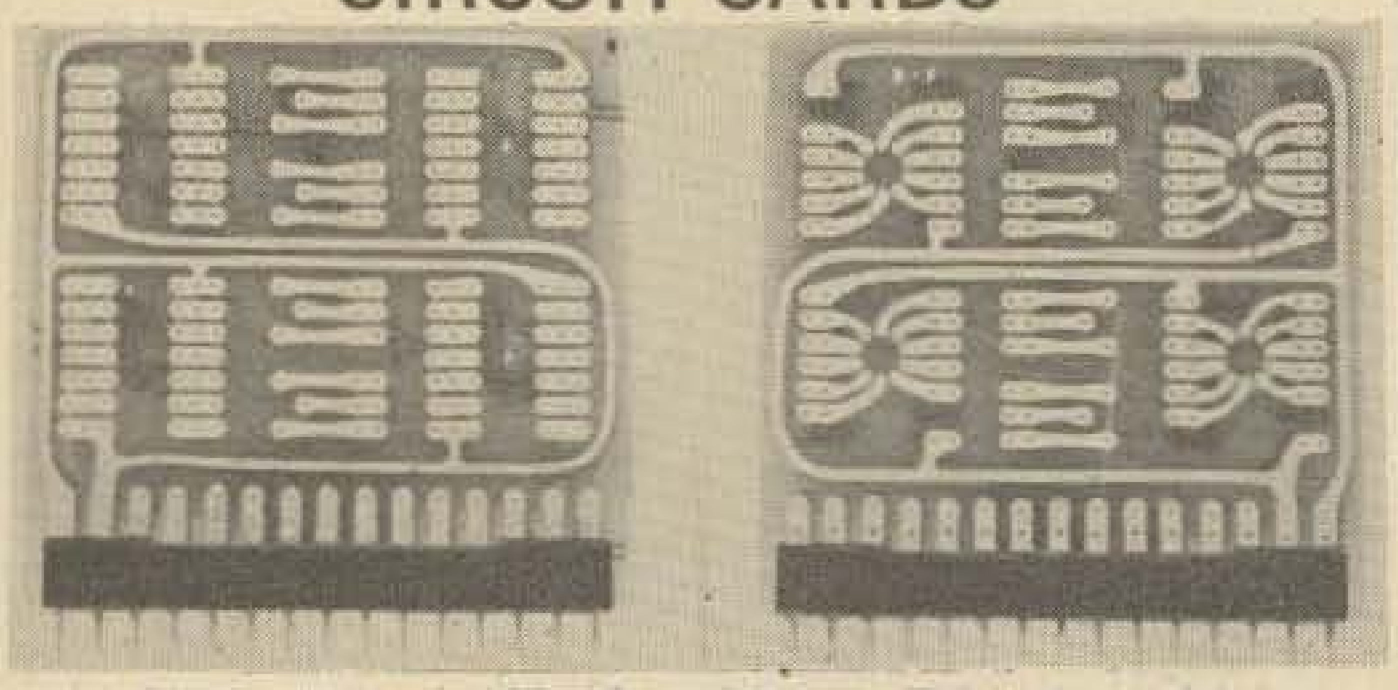
You ask when someone is going to come out with an organization to replace ARRL? I tried rather hard to come out with an organization that would just try and do the things that ARRL refuses to do...support amateurs in legal difficulties, like poor W4GJO and his million dollar TVI suit, who has yet to receive one nickle in help from the ARRL...and to support a lobby for amateur radio in Congress so amateur radio would not be the only major user of frequencies completely without any lobby whatsoever. The result? A mere handfull of amateurs joined the Institute of Amateur Radio and there was not enough money to pay for even a part time secretary. Far more money was spent killing off the IoAR than was ever sent in as dues. The Washington Amateur Radio Newsletter (warn, get it?), whose only observable function was to smear the Institute and everyone attached to it, was widely distributed to thousands of amateur radio clubs and every member of the Institute. The newsletter stopped when IoAR ceased to function.

A new club cannot grow without the support of a major magazine. And a magazine trying to support a new club finds that there is a tight group of the top manufacturers fighting with QST every inch of the way. This is nothing to be surprised at, if you stop and think about it. If you were running the ARRL/QST complex what would you do if you saw a competitor forming? You would do everything in your power to cut them off. You would ask advertisers not to support the magazine with their ads. You would pass word down through directors to club members that the new outfit is bad...maybe even crooked...is not needed...may even hurt ham radio seriously...etc. This would be preached at thousands of radio club meetings, along with snickers at anyone foolish enough to suggest that the new club might be of any value at all. Anyone remember anything like that happening?

It will be a while yet before anyone will be starting a new club.

(continued on page 146)

UNIVERSAL LOGIC CIRCUIT CARDS



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These boards are the most useful items we have ever offered for breadboarding with low cost integrated circuits. The cards are made from 1/16" G–10 Glass Epoxy, with pads for 14 lead dual in line mounting pads on one side and 10 lead TO–5 pads on the other. 8 lead TO–5 cans will mount in the 10 lead TO–5 pads also. Discrete Transistors and components can be mounted in the locations between the I.C.'s, power supply leads are already routed around the board. Our competitors charge $9.50 each for circuit card and mating connector.

We give you a surplus, unused p.c. board with components on it (that you can keep for your junk box), a connector and its mate, and our great circuit card. You drill out the desired hole pattern, unsolder the connector from the surplus card and install it on the new card, wire in the I.C.'s and compute. A few minutes of your time, and you save over 80% of the cost of comparable p.c. cards. Get enough for your breadboarding needs now because these are going to go fast.

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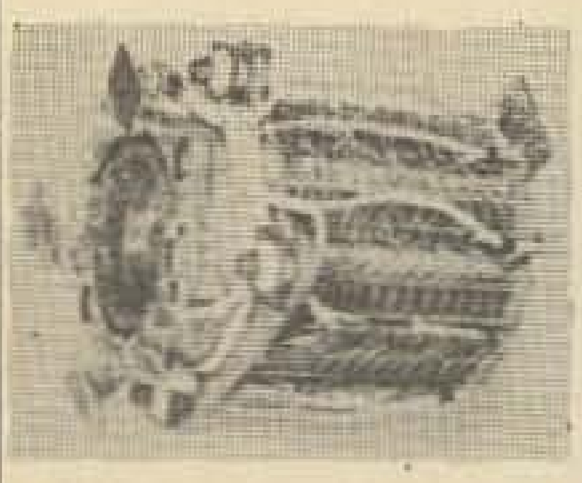
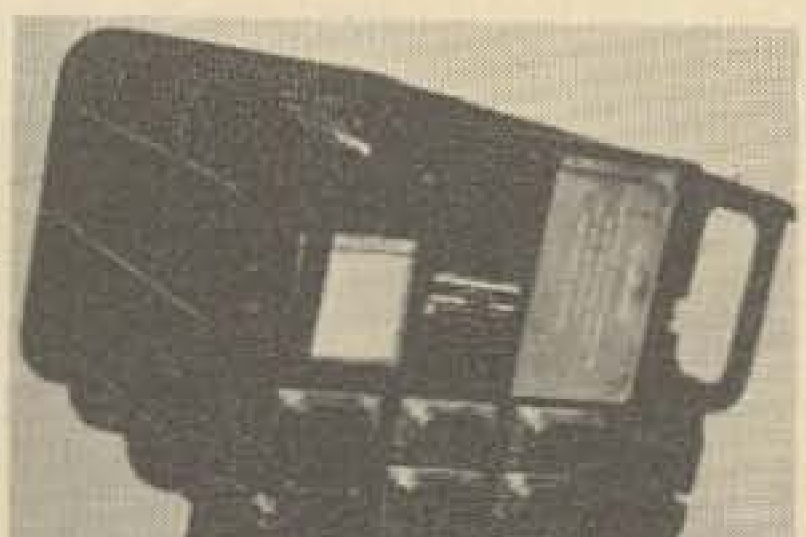
This memory drum originally cost the government over $6,400.00, and is a truly fantastic piece of equipment. It was made by Hughes Aircraft Co. as part of an aircraft computer. The unit is completely sealed and therefore the drum surface is in excellent condition. It has 146 heads mounted in 11 columns, 12 are phase adjustable timing heads, the drive motor requires 115 VAC 400 cycle (Hz) 150 VA, and has a speed of 800 RPM. SH. WT. 50 #. MMD–59. $100.00





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NEED A VARIABLE CAPACITOR for that homebrew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Rd., Worthington, Ohio 43085.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

SPECIAL CLOSE-OUT SALE. Rectifiers, Transistors, and many other Electronic Parts. Lowest prices. Send 15¢ for Catalog. Electronic Components Company, P.O.Box 2902 S., Baton Rouge, La.

FOURTH ANNUAL Mini-Hamfest, sponsored by the Rockford Amateur Radio Assn., August 17, 1969, at the Boone County Fairgrounds in Belvidere, Illinois. Lunch and refreshments.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 mhy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

"TOWER HEADQUARTERS!" 11 Brands! Heights aluminum 35% off! Strato Crank-ups-low cost! Rotors, antennas and gear discounts. Phone patch $11.95. Catalog-20¢ postage. Brownville Sales Co. Stanley, Wisconsin 54768.

SB-34 TRANSCEIVER and SB-2 mike $245. RCA Fleetone 12 volt, 60 watt FM mobile on 52.525 mhz, $110. Alan Rutz, RR2, LaPorte, IN 46350.

POLICE/FIRE Dispatcher Directories. Call signs, frequencies; most areas available. Exclusive official listings. Stamp brings catalog. Communications, Box 56-ST, Commack, NY 11725.

ELECTRONIC TEST and Communications Equipment – Bargains galore. Send 25 cents for catalog. Palen Electronics, Box 1536, San Mateo, CA 94401.

GO MOBILE 115V power inverter. Low cost boat, auto, camping. In reverse becomes a battery charger. Plans $1.50. Ken Electric, 922 S. Toledo, Tulsa, Oklahoma 74112.

WRL'S USED GEAR has trial-terms-guarantee! KWM-1 – $249.95; HW-12 – $89.95; Swan 250 – $249.95; Galaxy 5mk2 - $279.95; Galaxy 300 – $139.95; SBE34 – $299.95; R4A - $319.95; Invader 200 - $249.95; HQ180AC - $349.95; CE100V - $259.95; AF68 - $49.95. Many more. Free "bluebook' list. WRL, Box 919, Council Bluffs IA 51501

POWER SUPPLIES $3.98. Nixies $5. Counter $2. $1 packages: capacitors, thermistors, zeners. Popular miniature sizes. Catalog. Murphy, 204 Roslyn Ave., Carle Place, NY 11514.

THE ANNUAL HAMFEST for the Washington DC metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Maryland on Sunday September 21st, from 1000 until 1700.

THE FRRL SWAP N SHOP Hamfest will be held August 24 at Phillips Park, Aurora, Illinois. Free coffee and doughnuts from 9-10 AM. Fun for the whole family. Homing freq. 145.35 and 3.940 mc. For additional info contact Roger Louks, P.O. Box 93, Plano, IL 60545.

DANVILLE HAMFEST – August 31, Kickapoo Park, near Danville, Illinois. Advanced Registration $1. Tickets and information available from K9CDD, 508 W. Woodlawn, Danville, IL 61832.

THE SHAWNEE Amateur Radio Association will hold a hamfest Sunday, August 3rd at Herrin City Park in Herrin, Illinois. Trading, prizes. Tickets– Bill Johnson, 502 Kennicott, Carbondale, IL 62901

TELEPHONE DIALERS (2) Prestodial. Stores 36 telephone numbers and automatically dials any one at push of a button. New @ $119. Richard Jacobs WAØAIY, 4941 Tracy, K.C., MO 64110.

WARA 12th annual Hamfest, Sunday August 24th, Newton Falls Community Center, Newton Falls, Ohio. Take Ohio Turnpike to exit 14 and ask for map to Hamfest. Prizes, XYL activities, Swap and Shop. For further information write W8VTD, Box 809, Warren, Ohio 44481.

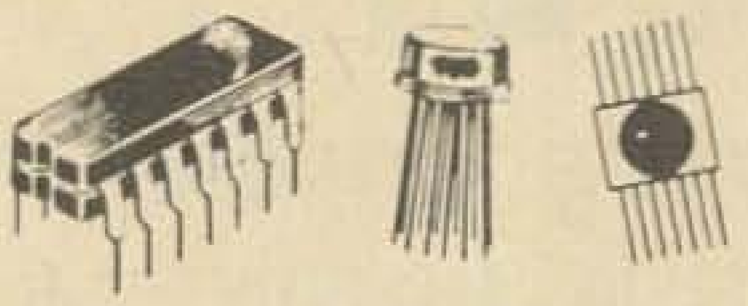
WANTED – a used Instructograph with tapes. K8UZG H Crawford, 302 Going, Pontiac MI 48058

THE EAST COAST VHF SOCIETY 11th annual free outdoor picnic-hamfest will be held Sunday, August 10, at Saddle Brook Park (NJ) starting at 10 AM. Write Box 1263, Paterson, NJ.

3 INPUT DUAL AND GATE

Brand new factory marked and packaged PHILCO-FORD IC's. Flat pack, long leads, each nested in its own plastic protective snap-lid shipping pack. 3 input dual AND gate. We furnish circuit diagram and lead connections. A real bargain for factory first-line material.

#69-100 3 for $1.00; 12 for $3.00



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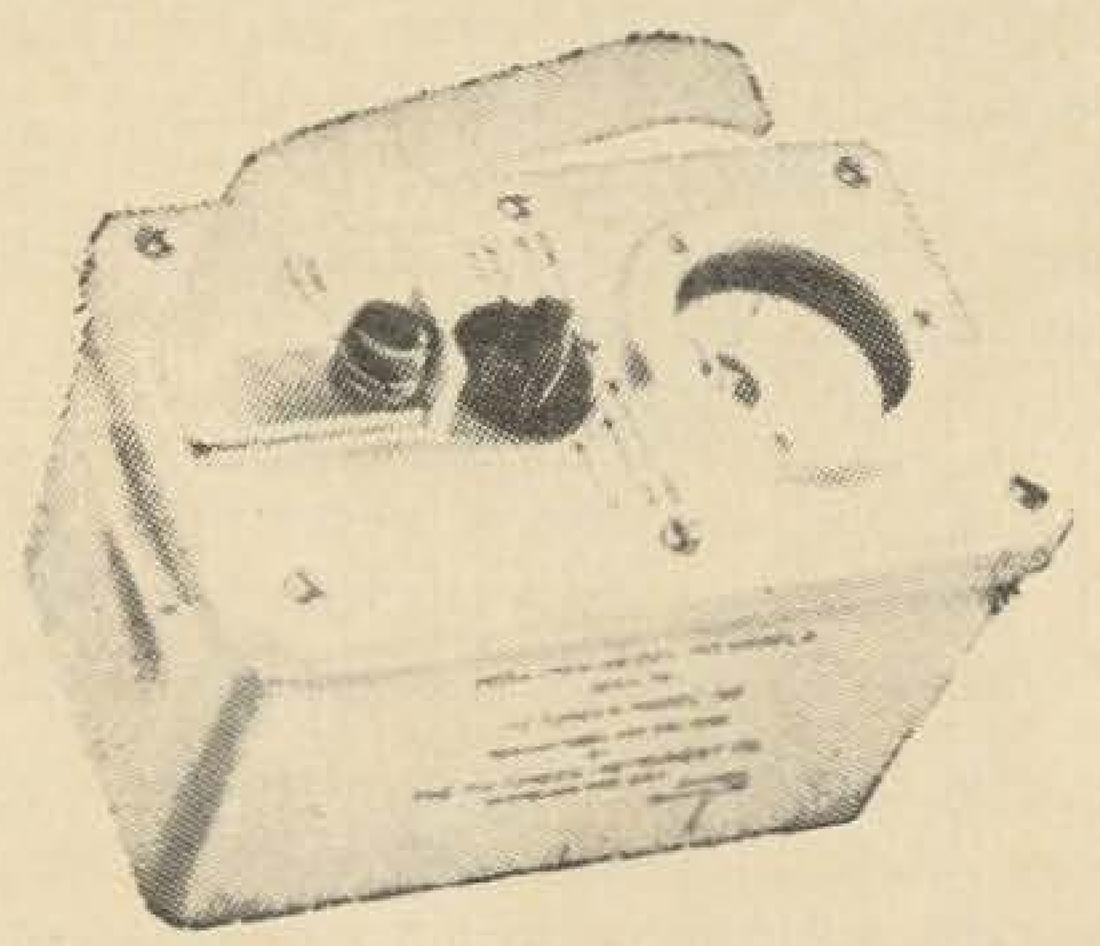

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TRADE or SELL Knight Kit V-107 VFO. Still in box. Use with TR-106 or 108. Want CB rig.. R. Hazel, Box 183, Stony Ridge, OH 43463.

SELL: HEATH RX-1 Mohawk, TX-1 Apache, SB-10 SSB adptr, spkr, relay, mike—complete station $225. PC62b 6&2 mtr xcvr, 12 & 110 pwr, vfo, $115. MC300 + 6&2 mtr xvrtrs, calib.,FB $170. 2 el 40 mtr beam + tribander + 30 ft self-standing twr $100. 4 el 6 mtr beam + rotator + 30 ft mast, $40. Carl WB6RXC, 213-283-5296.

W-I-M-U HAMFEST August 1-2-3, Mack's Inn, Idaho, 23 miles south of West Yellowstone, Montana. Calling all Wyoming, Idaho, Montana & Utah hams!

THE IOWA 75 METER phone picnic will be held in Anson Park at Marshalltown, Iowa, August 17th. All activities will begin around noon.

KNIGHT TR-108, factory aligned, mint, 2 crystals, $110 or ? Also SX-101 and Viking 500. Make offer. Jim McClure WA9BYR, 627 Dundee Ave., Barrington, IL 60010.

SX-111 HALLICRAFTERS receiver, used less than 100 hours, brand new condition, $135. Richard Kempfbeck, 203 Dix Hills rd, Huntington Station, NY 11746.

SWAN 500C, power supply, 508 VFO, VOX; Swan 250C, power supply, VOX, Manuals. Very new. Still under warranty. 25% off list. Will ship. Box 189. Advertiser:you sent no address. Please advise.

TECHNICAL WRITERS and editors needed. Freelance, various electronic topics. Send resume. Electronic Writers and Editors, Inc. P.O.Box 504, New Hyde Park, NY 11040.

JOB WANTED. Some engineering education. Marketing degree. Successful selling experience. Various abilities. Advanced, second phone licenses. 39. divorced, can relocate. Box 289, c/o 73, Peterboro, NH, 03458.

WANTED: Jan and Feb 1961 73 Magazine. I can swap with other copies or your price paid. Eskil Persson SM5CJP, Frotunagrand 1, 19400 Upplands Vasby, Sweden.

DALLAS AREA Ham-Swapfest—Texas Instrument Activity Center, Sunday, September 14, 1969, 9-5. Prizes: Swan 350C, TH-6, plus many more—Pre-registration prize - register now - $2/person - John Zagrodnick, 3823 Antique Drive, Dallas TX 75234.

73 Assistant Editor Position Open

Here is an opportunity to earn a modest living while working at your hobby. You'll be living in fabulously beautiful New Hampshire, well away from the rat race, and learning about publishing and printing. Please include details of your amateur radio background with your resume.

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Sign up for a three-year subscription for only $12. THIS GIVES YOU A FREE YEAR TO ENJOY. If you already have a sub, then give this page to a friend who doesn't have it. Tell him how much you enjoy 73.

(continued from page 141)

Dear Wayne,

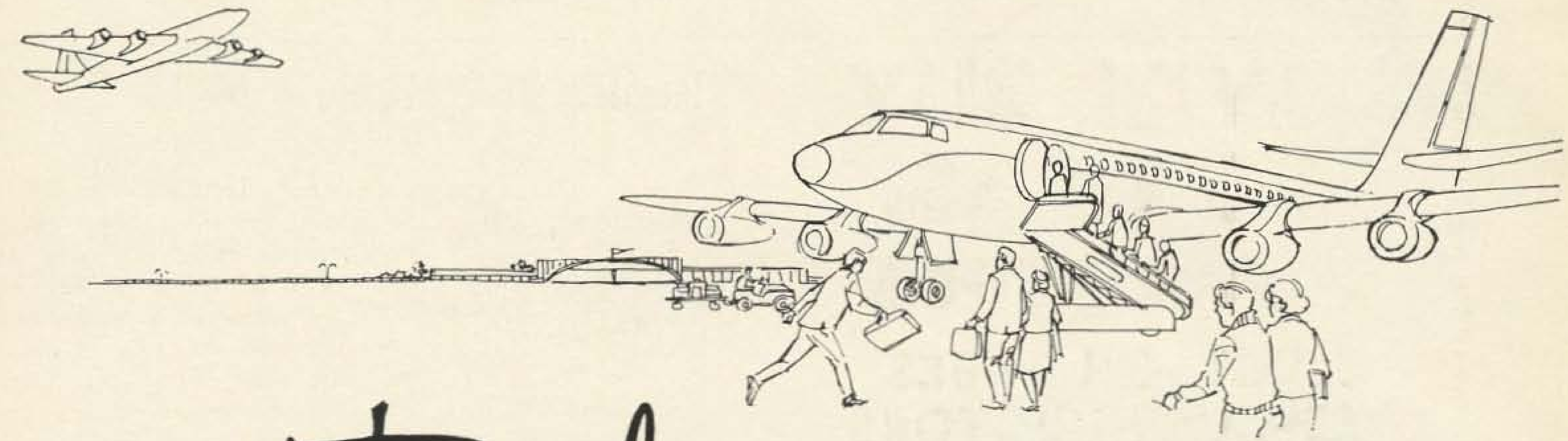
This is the last straw—my mailbox couldn't take it! I am indebted to someone for sending me down a stash of some 30 copies of 73 Magazine. Unfortunately they chose to arrive on Home Field Day when I had a shack full of hams, so I had to wait until those magazine-happy hams went home. I have since read them from cover-to-cover and all full of interesting news and circuits. I want to thank you folks for sending them down to me.

Our interest in Project Oscar is taking a severe knockback, with no reliable information available to us. I have been running our ZL-Oscar Net every Monday evening for 104 weeks now, and it sure takes some doing to hold a net together for that long without any information to pass out. The boys in VK quit answering mail about ten months back, and it was like finding gold in the streets to extract some information on what was going on. From all accounts things are at a real low ebb with Oscar. I have just received a letter from VK2APQ which indicates that yet another group is getting into the act and that Australis-A may yet be tossed aloft. Our shattered confidence makes us ultra-cautious about project "Moonray."

My 432 mhz converter is rough-looking, and evolved from that circuit you published. I had to use tubes in the oscillator chain. I have a home-made coaxial tank amplifier which I used on Oscars 3 and 4. I had several reception reports from VK and ZL, but no two-way contacts. Those were great times and our group had a fine time chasing Oscars.

Bruce Rowlings ZL1WB
New Zealand

INDEX TO ADVERTISERS



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The Swan Cygnet is the most versatile and portable transceiver on the market, and certainly the best possible value.

The lightweight compact design of the Cygnet makes it an ideal traveling companion. You can take it with you on vacation or business trip, and operate from your motel room, summer cabin, boat or car. All you do is connect to a power source, antenna, and you're on the air.

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Bill Deane, W6RET
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San Diego, California 92123

A unique rf choke.

At times it is difficult to obtain the exact *rf* plate choke that one may desire for a new final amplifer. In looking for a material to make a 2 ampere 5000 volt dc *rf* plate choke for non-ham use, I came across a material made by DuPont called Delrin. Delrin has high strength but can easily be cut and drilled. It has excellent electrical properties as an insulator with a high heat distortion temperature. These features make it an excellent form for *rf* plate chokes and other coils. Delrin is available in rods of 1/4 inch to 1 1/2 inch diameter and can be purchased in 12 inch lengths. The 3/4 inch diameter was selected for the choke and is available from Allied radio for $1.42 per foot (Allied part 60D9565CF).

The choke shown in the photograph is 5 1/4 inches long. The terminals of the coil are No. 8 brass cotter keys 5/8 inch long. The form is prepared by drilling the two terminal holes on a 4-inch spacing 5/8 inch deep, using a drill slightly smaller than the cotter key size. A 11/32 or 3/8 inch hole is drilled down the center of the rod to a depth of 3 3/4 inches. A 1/2 inch deep hole is drilled in the opposite end of the rod with a 29 drill. This hole is tapped for a 8/32 mounting screw. A 3-inch piece of .33 inch diameter ferrite rod (Lafayette 32C6102) is inserted into the hole and held in place with a few drops of epoxy. Next force the cotter keys into the form holes using a vise or by tapping lightly with a hammer. Sixty turns of No. 20 formvar wire is space wound (15 turns per inch) on the form with the coil ends soldered to the cotter key terminals. The space winding can be accomplished by a dual winding of No. 20 wire and then removing one winding. A light coating of coil dope will hold the turns in place.

The completed choke has an inductance of 90 uh, loafs along at 2 amps, has a Q of 225 at 3.6 mhz and has a series resonance well above the ham bands at 43 mhz.

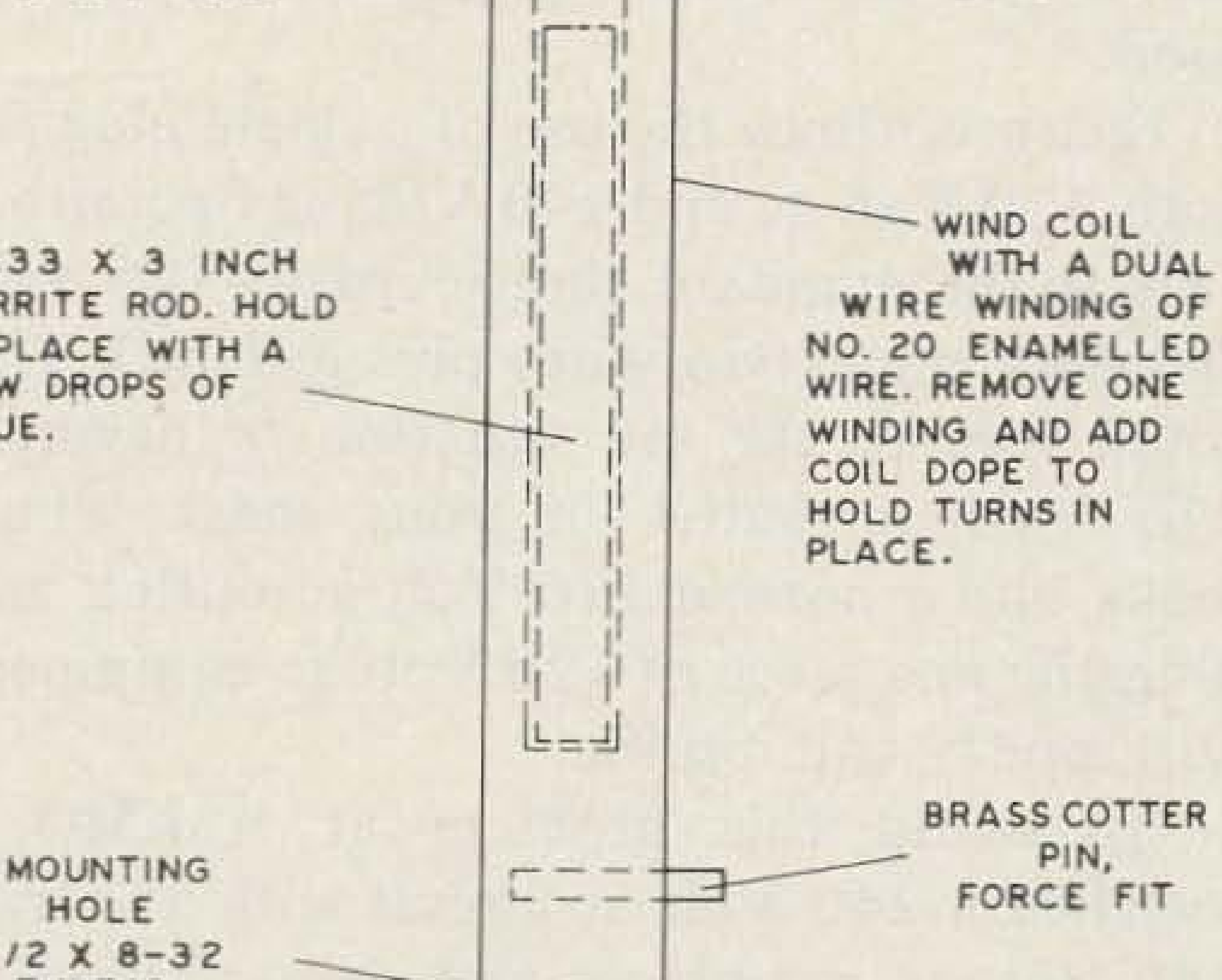

Fig. 1. Diagram of completed 2 amp 5000 volt rf choke using DuPont "Delrin."

If you do not wish to build a choke with the ferrite rod and will be limiting your plate requirements to 800 ma at 2500 vdc, a choke can be wound on a 3/4 X 4 3/4 inch rod with No. 24 formvar wire closewound to occupy 3 1/2 inches. This choke has an inductance of 90 mh, a Q of 160 and a series resonance of 25 mhz. My thanks to Don Bidwell for his photograph of the choke.

. . . W6RET

Modification of the ac Input on the SB-200

Al Brogdon, K3KMO
RD 1 Box 390A
State College, PA 16801

The Heath SB-200 is a real gem, giving top performance per dollar in a linear amplifier. There are few ways it could be improved, but one feature which falls into the "needs improvement" category is the ac input arrangement.

In the original amplifier, terminal strip "S" has the wires from the power transformer's two primary windings connected to it. To change between 120 Volt ac and 240 Volt ac operation, it is necessary to change jumpers on this strip. This in itself isn't bad, but the ac line plug arrangement is not too good.

Heath outlines the use of a single plug for both 120 Volt ac and 240 Volt ac operation. This is the standard three-contact 120 Volt ac safety plug (two wires plus ground). This could lead to the sad situation of having a 240 Volt ac outlet in your shack which looks like a normal 120 Volt ac outlet, and plugging in a piece of 120 Volt ac equipment with pretty bad results.

To avoid this problem at K3KMO, I installed a 240 Volt ac circuit with a normal 240 Volt ac receptacle, and changed the line plug on the SB-200 to match the outlet. But then came the time I wanted to take the SB-200 to a friend's shack where only 120 Volt ac was available, and I was faced with the prospect of having to change line plugs, re-wire the jumpers on terminal strip "s" to make the change, and then do the same thing again when I brought the SB-200 home.

Rather than do this and be faced with the prospect of doing it other times, I decided to change the SB-200 to come up with an arrangement for simpler change-over. I placed an Amphenol 86PM8 male octal plug on the rear deck of the chassis, where the line cord had previously exited. Fortunately, there is just enough room on the chassis lip to accommodate this connector. I then wired the four leads from terminal strip "S" plus a ground wire to this plug as shown in **Fig. 1.**

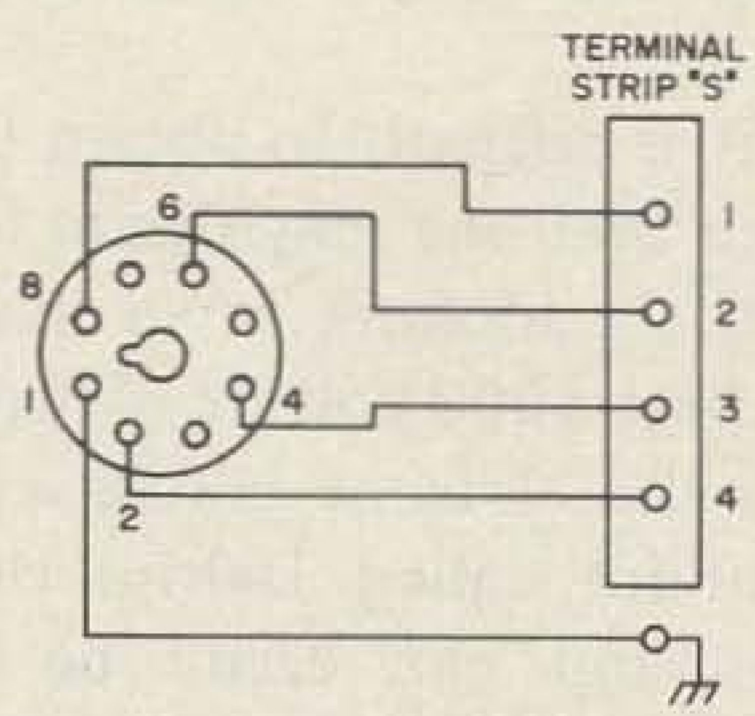

Fig. 1. Wiring changes in the SB-200, from terminal strip "S" to the new power connector (Amphenol 86PM8).

Then two line cords were prepared for the linear, one for 120 Volt ac operation, and the other for 240 Volt ac. The 120 Volt ac cord is the original SB-200 power cord with the plug supplied by the manufacturer. The other end of the cable is terminated in an Amphenol 78PF8 female octal cable connector, wired as shown in **Fig. 2a.** A second power cable was prepared using the 240 Volt ac plug on one end, and another octal connector on the other end, this time

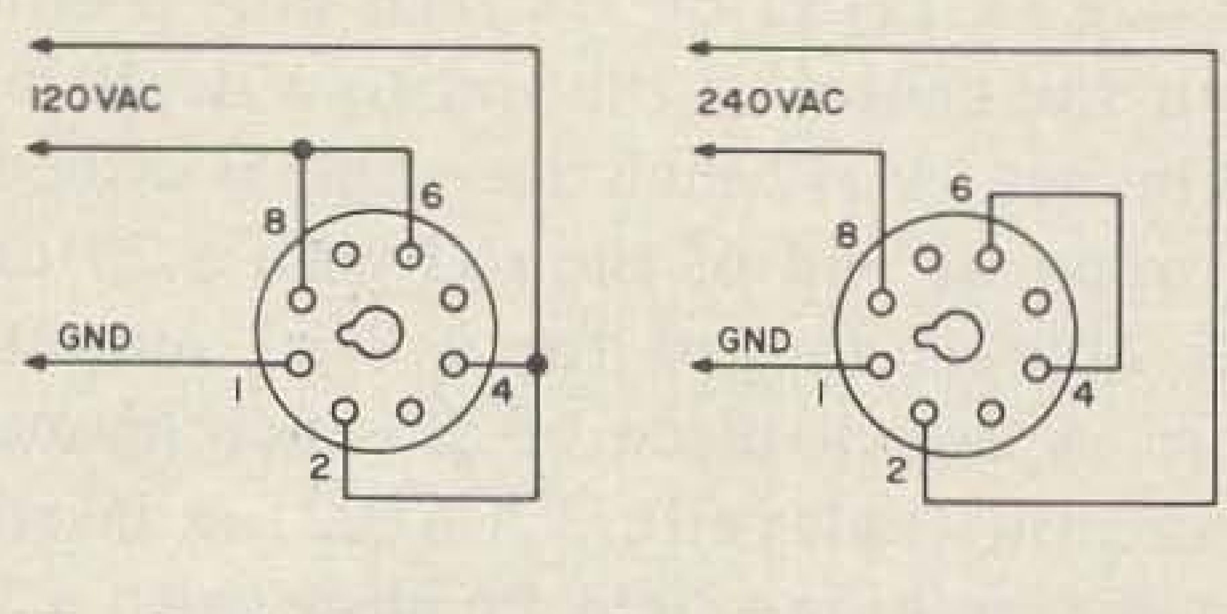

Fig. 2. Connections for the two line cables to mate with the new power connector.

wired as shown in **Fig. 2b.** Notice that with both power cables, the ac input is connected to the proper transformer leads, and the appropriate jumper connections are also made in the octal connector.

Therefore, the change from one input voltage to the other requires only that the appropriate ac input cable be connected. **Caution**: Be sure all jumpers are removed from terminal strip "S" when this modification is made.

If you are building an SB-200 from the kit, this change can be incorporated as the amplifier is being built, eliminating terminal strip "S" completely. The transformer primary leads and capacitors C1 and C2 can be wired directly to the octal plug. Be careful not to cut the transformer primary leads off too short by following the instructions for normal wiring. Just wait and cut them to length when you're ready to connect them.

This same approach can be used with any piece of equipment which has provisions for either 120 Volt ac or 240 Volt ac line input. And other types of connectors can be used according to your personal preference.

. . . K3KMO

LETTERS

Dear Wayne,

There were several omissions in the schematics of the "Six Meter KW Linear" in the July issue. The most important are as follows:

Page 21. 1. Coil data not given–should be 3 or 4 turns of 1/8" copper tubing, 1" diameter, spaced to resonate with the chosen capacitor.

2. There should be a connector in series with one lead of K1–this goes to the N. O. contacts of the exciter PTT relay.

3. R2 is 100K, ½watt.

4. Cathode pins 2 and 4 should be grounded in addition to pins 6 and 8.

Page 23. 1. Note 4 should read transient rather than equalizing.

Many thanks for the new tower and antennas, the cassette tape recorder, the trip through the Heath factory, and the other things 73 has bought for me in the year I have been sending in fillers. They are very much appreciated. I hope I will be able to supply similar material for "73 Junior."

Would 73 be interested in a short article on the subject of how semiconductor grade silicon is produced?

Bill Turner
Five Chestnut Court
Saint Peters, Missouri 63376

No . . .ed.

Dear Sir:

We thought it may be of interest that there is a new net on the air for emergencies and DX contacts. The world DX Round Table operating on 14270 KC Wednesday and Saturday from 0500-0800 GMT.

All QSL's for net contacts may be forwarded to (WA5UHR) net QSL manager.

Scott Freile
1510 Lynnview
Houston, Texas 77055

Dear OM Wayne,

I was given "DX-Handbook" first-edition from my good friend WA9NKG, "Paul" & find it a very nice book, especially I enjoyed the article about 80 meters DX. Here in JA, there are not so many DX's on 80 meters, only JA6AK is active. Hi. By the way I found some misunderstanding on page 90, "Call Areas." Please correct as follows:

JAPAN	Wrong		Right
JA1	Kanto, Shinetsu	JA1	Kanto
JA2	Tokai, Hokuriku	JA2	Tokai
JA9	Fukui, Toyama, Kanazawa, Ishikawa	JA9	Hokuriku
JAØ	Nagano, Suwa, Niigata	JAØ	Shinetsu

JA9 includes three prefectures; Fukui, Toyama, & Ishikawa, and Kanazawa is capital city of Ishikawa, like Phoenix in Ariz! JAØ has two prefectures; Nagano & Niigata, and Suwa is the name of one city in Nagano!

About 7 or 9 years ago in JA, there were only 8 areas from JA1 to JA8, and then JA1 & JA2 were divided into two till then JA1 had Kanto & Shinetsu, JA2 had Tokai & Hokuriku, but since then Shinetsu changed to JAØ & Hokuriku got JA9 calls, so you might use the old date! Hi! Anyway now you are all right!

Another info here, you wrote "for DX Watch for gigantic do-it-yourself coloring map," on 22 page. We can buy do-it-yourself map for DX from our JARL. About 55x80 cm ¥ 200 (about 60¢) with great circle map. This map is very nice for DX hound! You may get the map if you send about $1 to JARL, P. O. Box 377, Tokyo.

Oh, one more info, JA1 area got too many hams and they needed another call so they used JH1. It was two or three years ago. And now JH1 also going away the newest call right now (29 June '69) is JH1VZZ and JH1Y . . . JH1Z . . . is used for club stations so the rest is JH1WAA to JH1XZZ, when all of these calls used, they use JR1. First JR1 will go on the air in '69!

Narumi Kawai, JA9APS
1-10 Suwanokawara
Toyama-City 183, Japan

Dear Wayne,

I read with interest the article on facsimile and the radio amateur by Ralph Steinburg K6GKX in June, 1969. (I also had an article starting on page 130.)

You should know that facsimile and slow scan TV are exactly the same thing electrically if you add a horizontal sync pulse to the facsimile signal.

I have been running slow scan TV for the past 2½ years (one and a half years under the special slow scan TV license), using facsimile equipment. As far as I know, this is completely legal since I am conforming in every way to the various television kinds of signals that are being sent. Those who are receiving the slow scan TV signal using facsimile equipment can use the horizontal sync pulse if they wish. Those receiving the slow scan TV signals on a CRT presentation, generally require the sync pulse. Those that are receiving them on facsimile machines, do not need it.

Mr. Steinburg's statement, "with slow scan television legal on the low bands, facsimile may be the next mode of communications to follow in the near future. All it needs at the present time is enough interest by the radio amateurs to show the Federal Communications Commission, by petition, that facsimile will contribute to the state-of-the-art," really impedes matters by continuing the fiction that there is a difference between facsimile and slow scan TV.

J. R. Popkin-Clurman, W2BK
1623 Straight Path
Wyandanch, New York 11798

Dear Wayne,

Up until the past few months, very little effort had been made to attract youngsters into our ranks and it is indeed regretful that we have been so tardy in promoting amateur radio to this particular age group. Editorials in some of the amateur magazines have at last recognized the severe lack of youth-intake in amateur radio and soberly suggest that we make strong efforts to try and introduce these young people to ham radio.

Some may ask, "Why is youth so important to amateur radio?"

There are a multitude of good reasons why amateur radio needs new blood and certainly each reason has its own merits. To mention but two, we might start with what amateur radio as a hobby can provide for a youngster just getting started in ham radio. It offers a youngster the chance to convert his spare time from roaming the streets, lying idle on the couch, etc., to something constructive, educating, challenging and rewarding. For some, amateur radio can lead to a very successful career in electronics later in life. Amateur radio in the years to come, will need new amateurs to improve the state of the art and in general to man the helm. Todays youthful prospective amateurs will be the people to assume this task. This is why it is of cardinal importance that all amateurs do their utmost to familiarize the youth of today with ham radio.

Today's youth are basically a good group of people and they have a tremendous amount of potential and energy which if could be directed to the area of amateur radio, would lead to an eventual license and a genuine feeling of accomplishment and satisfaction.

Boy Scout Explorer posts, high school radio clubs, camps and other outlets have time after time graduated the prospective young amateur from training in code and theory, to an amateur license. However, these organizations lack the ability to make the initial contact with a youngster and this is where the individual amateur must help out.

One may ask at this point, "Well, what can I do?"

Get in touch with the youngster down the street and invite him or her over to the shack. Fire up the rig and explain how it works. Show them your collection of qsl's—let them have a try at the mike—show them what an amateur license looks like—be patient and encourage them, and most of all, let them know that you sincerely want to help them. You might then direct them to a local radio club or some other group that teaches code and theory classes for future hams. If there isn't any such group in the area, then you, yourself, could certainly help these young people. Five wpm and elementary theory and regulatory material certainly isn't difficult to teach to eager students, is it? They will always admire you for your guidance and assistance, believe me.

While amateur equipment becomes more and more sophisticated, and with DXpeditions and contests taking up a substantial amount of our hamming time amongst other facets of amateur radio, let us not neglect the youth around us for they certainly hold a share in ham radio's future.

The initiative is up to you. Ham radio is a very fascinating and rewarding hobby and has so very much to offer. Why not get in touch with the youngster down the road and lend the helping hand they need and at the same time, strike a blow for amateur radio.

Ralph J. Irace, Jr., WA1GEK

Dear Wayne,

Thanks for the articles by K1YSD. Many moons have passed since I laughed so hard. As a result of your fine articles on the Advanced Class License I passed my test.

Tom Shirley, K4HVV
410 Patton Road
Hinesville, GA 31313

Dear Editor,

Would any members of the American Cryptogram Association who are readers of "73" drop a line to the writer? The intent is to form a net to discuss crypto systems and solutions.

Thank you.

Herbert S. Dunkerley, WA3JIX
RFD 2
Jeannette, PA 15644

Dear Wayne,

I have finally rounded up a bunch of information on the recent beginners course in ham radio and a photograph of some of the instructors and graduates. Only 17 of the 28 who received a novice ticket are on the picture, but that was the best that I could do.

As for the course, here are the bare facts: Enrolled–109, Attended 6 or more lessons–48, Attended less than 6 lessons–61, Quit after attending 6 or more lessons–15, Earned Novice ticket–28, Attended whole course but not passing exam–5, Oldest earning ticket–69 years, Youngest earning ticket–13 years.

The course ran for 16 weeks. There was one hour of lecture on theory and one hour of code instruction each week. The first eight or nine lectures were on basic radio theory and regulations, and the last seven or eight were on specific topics: antennas, transmitters, power supplys, etc. Most of the basic theory was taught by Charlie DePoe, WA5VQR, a professor at the local college, who also kept the vital statistics throughout the course. The specific topics were taught by various members of The Twin City Hams radio club, some of whom are in the enclosed photo.

I taught the code portion of the course. It was designed for the beginner and started at zero wpm. At the end of the course the average speed of those finishing was about 7½ wpm, with a couple of the fast learners copying around 15. The code practice was recorded on magnetic tape prior to each

Recent FCC News

RM-886. The ARRL has requested that the CW-only band on two meters be moved from the high end of the band to the low end, 144.0 – 144.1 mhz. It has been the custom to use only CW in this lower 100 khz of the band, however, it may be worthwhile to make this into law if there are too many operators that refuse to honor the convention. It seems a shame that we have to make federal laws just to force a few inconsiderate operators to conform to custom.

RM-950. The ARRL has requested the opening of 28.0 – 28.5 mhz for F1 emission. This is RTTY which is now restricted to the CW portions of 80-40-20-15 meters. It should have been allocated that way in the first place. It is nice to see the ARRL behind this request . . . they were the principle opposers to the original requests for F1 on the low bands and managed to delay the FCC ruling on this for several years.

RM-981. A petition has been filed with the FCC to open all bands from two through 80 meters to maritime mobile while in Region 2 and to open 3.5 – 3.8 and 7.0 – 7.1 mhz for maritime outside of Region 2. At present maritime ops are permitted to use 40 thru 2 meters in Region 2 and 20-15-10 meters outside Region 2. Seems reasonable enough.

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

session to keep sending errors and resulting confusion to a minimum.

Everyone in the club agrees that the course was an unqualified success and that we all learned a great deal from it. It is still hard to believe that so many people are interested in amateur radio and are just looking for a chance to get into it. Any club can do itself a lot of good by encouraging people with a genuine interest.

Now, can anyone tell me how to keep 28 brand new Novices on the air?

Bill Gulledge, K5UAR
700A Plum Street
Monroe, LA 71201

Dear Wayne,

Since working as Chief Engineer of KALX (FM), my perspective on the Amateur license technical examination has changed. Many people will agree that it is a simple and uncomplicated task to pass the technical section. But in comparison with the First Phone exam, it is hardly a test at all.

You might note that the Amateur license is just that: for amateurs. But what has this done to the quality of the average ham? One can simply listen to the low bands any evening to provide the answer.

The degradation in quality has been brought about through the lack of respect in the ham license. Years ago it took real perseverance and intelligence to be a ham operator. There were no readily available stations, as today. Kits, if any, were almost the same as building from scratch. And when the ham was finished with a piece of gear, a receiver perhaps, he had a sense of pride, a sense of accomplishment. Today, the closest thing to that most hams experience is the sense of relief one feels when the last payment is made on a complete transceiver. Too, there was a feeling of fraternity. There was belonging, brought about because there was a great hurdle that everyonr had to pass to become a ham: the building of a transmitter and receiver, and the exam.

Today the exam is not difficult. And today the only comradeship most hams feel is in their mutual animosity towards CB'ers. Little wonder that the bands should be in such poor shape. When one loses respect in something, one is not apt to take good care of it.

One good way to make an Amateur license more valued is to require a stiff technical exam, one that would require actual studying, not memorization sessions with the License Manual. But the more difficult technical skills it engenders would prove greatly beneficial to the ham, and the country. It might even save the Amateur Radio Service.

I'd like to hear your comments on my letter.

Stephen L. Diamond, Radio KALX
500 Eshleman Hall
Berkeley, California 94720

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3 PLASTIC HOLDERS will frame and protect 60 cards, $1—or 10 holders $3. Prepaid & guaranteed. Patent 3309805. Tepabco, Box 198N, Gallatin, Tennessee 37066.

WANTED ANTIQUE RADIO and wireless equipment. Also radio magazines of teens and twenties. Also buying supply catalogs, Duck, Manhattan! etc. Farrell, 2252 Dixie Pontiac, Mich. 48055.

THE ANNUAL HAMFEST for the Washington DC metropolitan area, sponsored by the Foundation For Amateur Radio, will be held at the Gaithersburg Fairgrounds in nearby Gaithersburg, Maryland on Sunday September 21st, from 1000 until 1700.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 mhy torroids 5 for $2.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

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.5 mf 400 v. oil-filled capacitors, rectangular case, mil. spec. $1.00 per dozen.

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Color TV cartridge focus rectifier 6.5 kv. Used in every color TV. Cat: CFR-20, 79¢ each.

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2 Printed circuit I.F. transformers, 4 lug, 455 kc input and output, Cat: 1909P4, 99¢ each.

RCA UHF transistor type TV tuners, KRK-120 (long-shaft). Cat: UHF-20, KRK-120 (short-shaft). Cat: UHF-21, each $4.98.

RCA VHF transistor type TV tuners, KRK-146, Cat: VHF-74, $9.99 each.

Transistorized UHF tuners used in 1965 to 1967 TV sets made by Admiral, RCA, Motorola, etc. Removable gearing may vary from one make to another. Need only 12 volts DC to function. No filament voltage needed. Easy replacement units. Cat: UHF-567, $4.95.

UHF Tuner original units as used in TV sets such as RCA, Admiral, etc., covering channels 14 thru 82, as part no. 94D173-2. Complete with tube. Drive gearing is removable. Can be used in most sets. Cat: UHF-3, $4.95.

Color yokes. 70 degrees for all around color CRT's. Cat: XRC 70, $12.95. 90 degrees for all rectangular 19 to 25" color CRT's, Cat: XRC-90, $12.95.

Kit of 30 tested germanium diodes. Cat: 100. 99¢.

Silicon rectifier, octal based replacement for 5AS4-5AW4-5U4-5Y3-5T4-5V4-5Z4. With diagram. Cat: Rect-1, 99¢ each.

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FIND OUT about the New Greene Balun. Read all the details on page 59 of this issue. Greene Balun, Warfield, R.I. o2880

WANTED: TECHNICAL material. Corp model XFK freq. shift exciter for Tmc model GPT 750—also TMC single sideband exciter, model SBE for GPT 750 & manuals—plus 18 to 30 foot parabolic dish. What will you take for it in place of money—will swap brand new towers or test equipment. Write, wire or call: Eugene Leger, Hollis St., East Pepperell, Mass. 01437.

SELL: COLLINS KWS-1, Ser. 896, $640; 75A4, Ser. 5763, $420—or both for $1025. I will ship. Lew Hindert, Rt. 4, Box 290, New Braunfels, Texas 78130.

WANTED: CR tube for Tektronix 561 or 561A oscilloscope. Sell: Collins CC-2 Carrying Case, $50.00; TMC Commercial TTG-1 two-tone oscillator, $95.00; Kepco SC-18-4M transistorized power supply, 0-18 VDC, 0-4 amps, 0.1% regulation, metered, $110.00; Bird 6254 R-F watt meter, 0-2 watts, 30-500 mc, 50 ohms, $50.00; Bird 67 R-F watt meter, 0-25/100/500 watts, 30-500 mc, 50 ohms, $125.00. FOB, H. T. Cervantes, 34 Johnson Rd., Binghamton, N. Y. 13905 (607-724-5785).

CHRISTIAN Ham Fellowship now organized for Christian fellowship and gospel tract efforts among Christian licensed amateurs. Christian Ham Callbook, $1.00 donation. For details and sample copy of ham gospel tract, write to Christian Ham Fellowship, P. O. Box 218, Holland, Michigan 49423.

WANTED TEST EQUIPMENT: Bird watt meter, measurements of G. R. sig. gen. up to 450 mc; Tektronix scope. State price. W2EDN, 93 Gilmore Ave., Binghamton, N. Y. 13901.

WRL'S USED gear has trial-terms-guarantee! KWM1-$249.95; HW32-$89.95; Swan 250-$249.95; TR3-$369.95; NCX3-$169.95;SB34-$299.95; Galaxy V-$229.95; Galaxy Vmk2-$279.95; Ranger-$99.95; HT32A-$259.95; 100V-$259.95; Galaxy 2000 linear-$329.95. Many more. Free "blue-book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

WANTED: Turret Turner with coils or old chassis with Turner for Hammarlund SP400X receiver. Later model with 13 plate stator & 14 plate rotor. Ralph M. Williams, Box 372, Dixfield, ME 04224.

SELL HALLICRAFTERS HT-32 Transmitter, excellent condition inside & out, $210. Will deliver within 50 miles. Want Collins 32S1 or 32S3. Robert Kujawski, WA2VDX, 30 Rose St., Florida, N. Y. 914-651-7212.

GREENE . . center dipole insulator with . . or . . without balun . . see September 73 issue.

HAMS WHO LIKE audio, too, try new quarterly: Amplifiers by Williamson and Bailey, speaker by Baxandall. Details, Audion 307 Dickinson Ave., Swarthmore, PA 19081.

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Portable transistorized, wireless (no connections required). May be used on 2 or 4 cycle engines, 1-2-4-6 or 8 cylinder, outboards, marine, autos, trucks. 2 scales 6,000 & 12,000 rpm.

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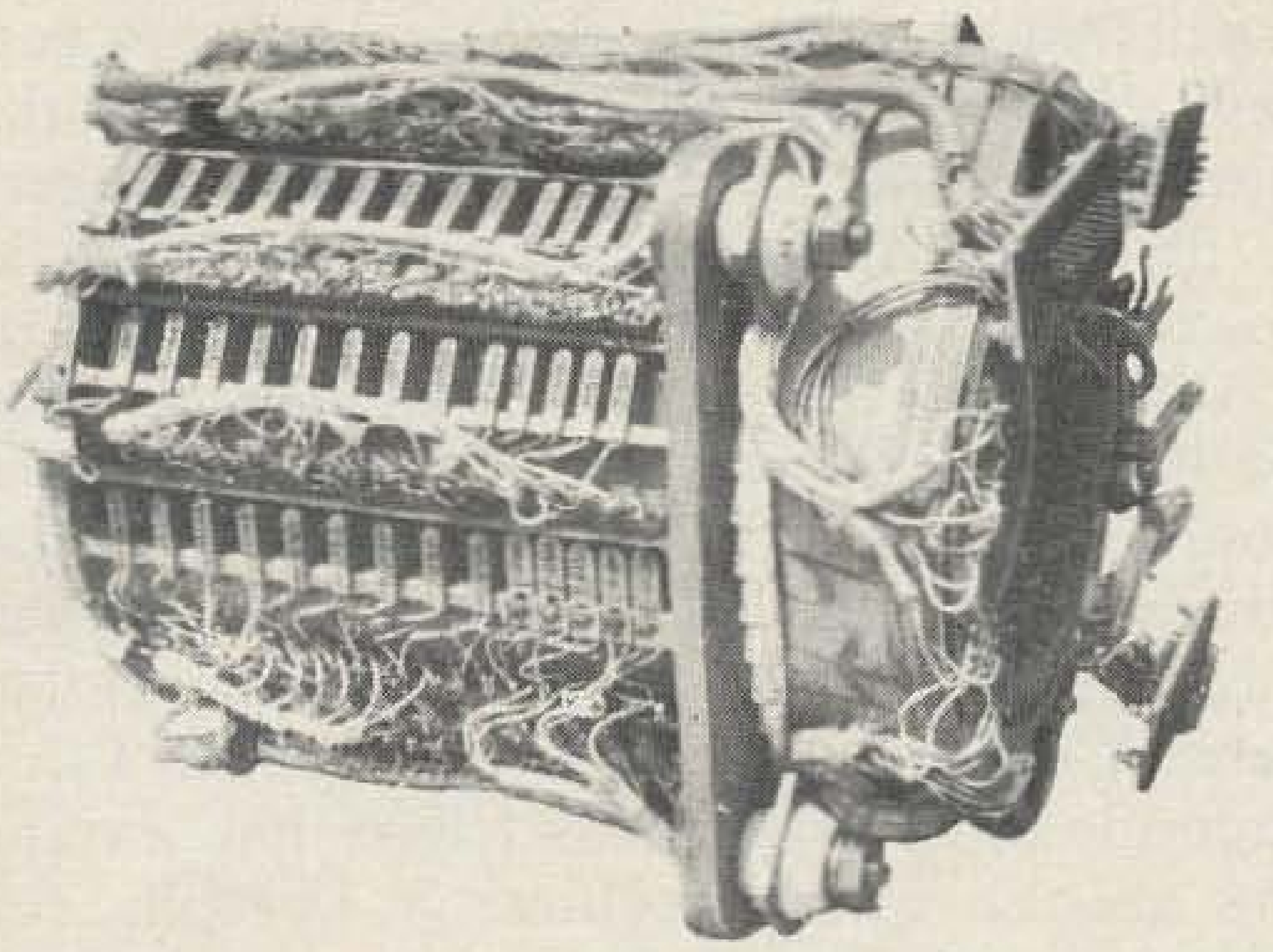
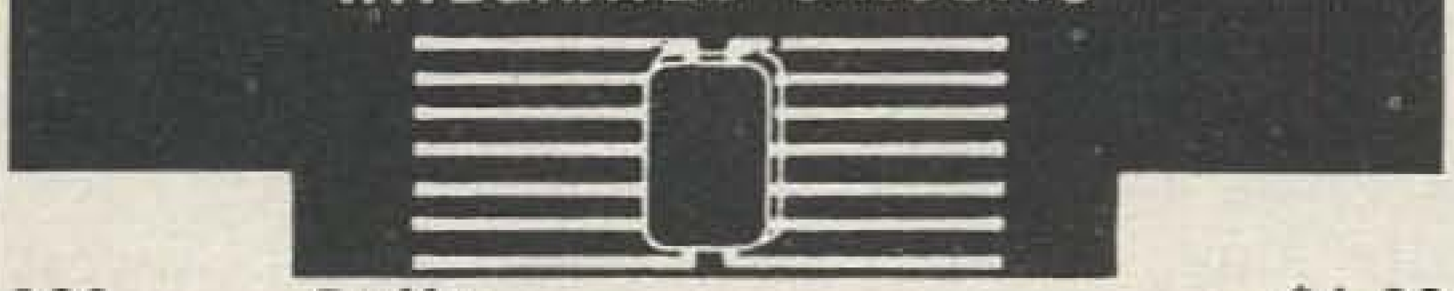
$6,400.00 MEMORY DRUM



Military surplus made by HUGHES for the AF. Condition appears excellent due to being enclosed in air tight case with terminations on plug connections. 134 read/write heads, 12 heads phase adjustable timing. Integral drive motor 115 volts 400 cycle.

Shipping wt. 39 lbs. . . . .#DRUM $100.00

INTEGRATED CIRCUITS



900	Buffer	$1.00
910	Dual 2-input NOR	1.00
2-903	Dual input gate	1.00
914	Dual 2-input gate	1.00
914-925	Dual 2-input gate dual expander	1.00
923	JK flip flop	1.00
925	Dual 2-input gate exp	1.00
946	DTL 4 2-input NAND/NOR gate	2/1.00
	DTL Clocked flip flop	2/1.00
1M5	Dual 4-input logic gate	2/1.00
7M6	6 NPN transistors in one package, gen use	3/1.00
12M2	Diff Amp	1.00
711	Dual Comp Amp	2.00

JOHN MESHNA JR.

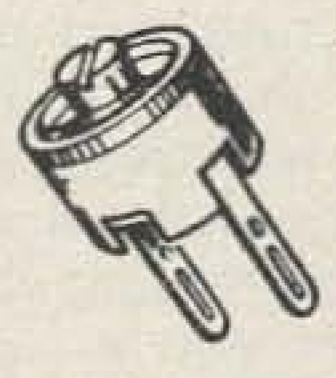
19 ALLERTON ST., LYNN, MASS. 01904
P. O. BOX 62, E. LYNN, MASS. 01904

COMPUTOR GRADE CAPACITORS

15 volt 110,000 mfd	$2.00 ea.	12/$20
18 volt 6,500 mfd	1.00	12/$10
50 volt 4,000 mfd	1.00	12/$10
450 volt 600 mfd	2.00	12/$20

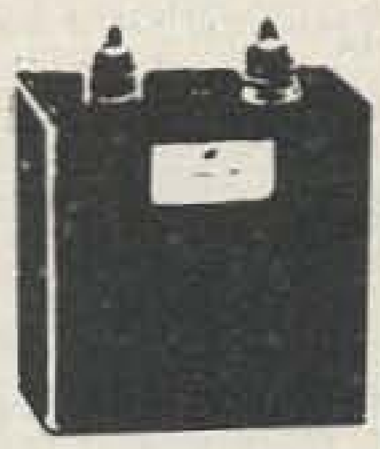
VARIABLE DISC TRIMMER

Miniature ceramic variable trimmer capacitor. Piston type tuning, size .375 diam, .275 deep. Printed circuit mount. Amateur net on this is $1.68 each. Our price only 25¢ each or 24 for $5.00. All are brand new. State size, may be assorted if you wish.



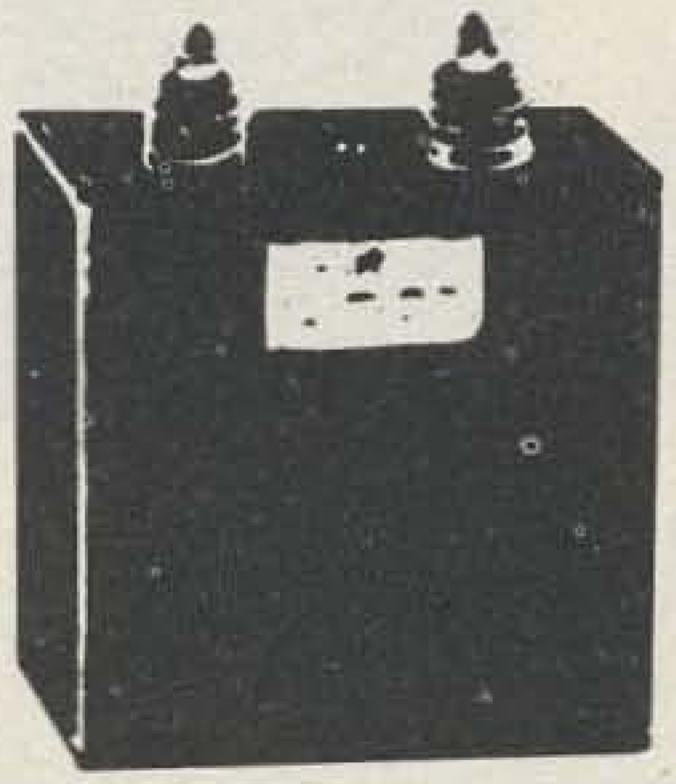
#N300	2.5-11 pf
#NPO	5.5-18 pf
#N650	9-35 pf

0.5 mfd 7,500 Volt



Brand new Military surplus oil filled transmitting cap. Ceramic standoffs.
5 lbs. . . . . #69-210 $5.00

H. V. CAPACITOR



GE oil filled capacitor, A real brute, rated 1 mfd at 15,000 volts. Terrific savings due to being Govt. surplus.
30 lbs. . . . .#69-63 $10.00

"IF" TRANSFORMERS

262.5 khz tube, Miller type 6572
262.5 khz transistor, Miller type 8008
10.7 mhz tube, Miller type 1463
10.7 mhz transistor, Miller type FM-IF

The above 6/$1.00 36/$5.00

CINCY STAG HAMFEST: The 32nd Annual Stag Hamfest will be held September 28, 1969 at Stricker's Grove, Compton Road, Mt. Healthy, Cincinnati, Ohio. Door prizes each hour, raffle, lots of food, flea market, model aircraft flying, and contests. Identify Mr. Hamfest and win prize. $5.00 cost covers everything. For further info., contact John Bruning, W8DSR, 6307 Fairhurst Ave., Cincinnati, Ohio 45213.

INTEGRATED CIRCUITS: new Fairchild Micrologic; epoxy TO-5 package. 900 buffer, 914 gates, 60¢ each; 923 J-K flip flop, 90¢ each. Guaranteed. Add 15¢ postage. HAL Devices, Box 365W, Urbana, Illinois 61801.

Increase Your Grid Dipper Range

There is general agreement that a grid dip meter is an invaluable piece of amateur test equipment. Why then confine its use to the usual frequency range of 2 or 3 mhz to perhaps 250 mhz when it is some easy to make additional coils to cover the lower ranges?

Browsing through the catalogs will quickly convince you that hardly anyone sees fit to supply low frequency coils and when they do it is at additional cost. Why not make your own? All that is necessary is a base which will fit the coil socket of your dipper, a coil form or two, and a little patience. My current dipper is a Heath GD-1 (which I find superior to several others I have had around the shack) which requires a two-pin coil base. In my case I had only to bend two lengths of copper tubing to the proper spacing for the coil terminals at one end and the socket spacing at the other. After the proper frequency range was established, the entire coil and about a half inch of the leads were potted in casting plastic, making a very sturdy assembly.

The low cost coils I used (5 cents each at a local hamfest) came equipped with a ferrite slug. I left the slug in for the lowest range – 250 khz to 1 mhz and took it out of the higher range – 1 mhz to 2 mhz. No exact data can be given due to the variation in dipper circuitry. This will be a case of pure "cut and try." The range of the new coils must be plotted on a graph against the original dial markings.

A general coverage receiver will allow calibration down to 550 khz and by feeding the signal into its *if* strip, an additional point at approximately 450 khz is obtained. Below that frequency things get a little tougher. If you happen to have a low frequency receiver, fine, if not, use harmonics in the BC band.

William P. Turner, WAØABI

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No.	Description	3 for $15
☐ 958	Decade Counter	
☐ 959	Buffer-Memory	$5.95
☐ 960	Decoder-Driver	

LOWEST PRICES ON LINEAR AMPLIFIERS

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☐ 709	Operational Amp
☐ 710	Differential Comparator
☐ 711	Sense Amplifier

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☐ 100	.07
☐ 200	.09
☐ 400	.12
☐ 600	.19
☐ 800	.24
☐ 1000	.29

400 mc NPN HIGH POWER UHF TRANSISTORS — 2.99 ea. ☐

☐ 2N3632 23W, 3A.

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PRV	7A	16A	25A
50	☐ .41	☐ .60	☐ .65
100	☐ .63	☐ .75	☐ .95
200	☐ .91	☐ 1.10	☐ 1.25
400	☐ 1.50	☐ 1.75	☐ 1.95
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EPOXY RECTIFIERS & *METAL CASED

1.5A - 2A - 3 AMPS

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100	☐ .07	☐ .07	☐ .19
200	☐ .09	☐ .09	☐ .22
400	☐ .12	☐ .12	☐ .31
600	☐ .16	☐ .16	☐ .43
800	☐ .21	☐ .21	☐ .49
1000	☐ .32	☐ .32	☐ .79

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5 for $1

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☐ 2N2368	5 for $1
☐ 2N3396	5 for $1
☐ 2N3565	5 for $1
☐ 2N3568	5 for $1
☐ 2N3638	5 for $1
☐ 2N3641-3	5 for $1
☐ 2N3645	5 for $1
☐ 2N3662	5 for $1
☐ 2N3683	5 for $1
☐ 2N3793	5 for $1
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PIV	SALE
☐ 2000*	1.00
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☐ 4000	1.65
☐ 5000	2.25
☐ 6000	2.96
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*1.5 Amp rating

1 AMP EPOXY MICRO MINI

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100	☐ .07
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400	☐ .12
600	☐ .16
800	☐ .21
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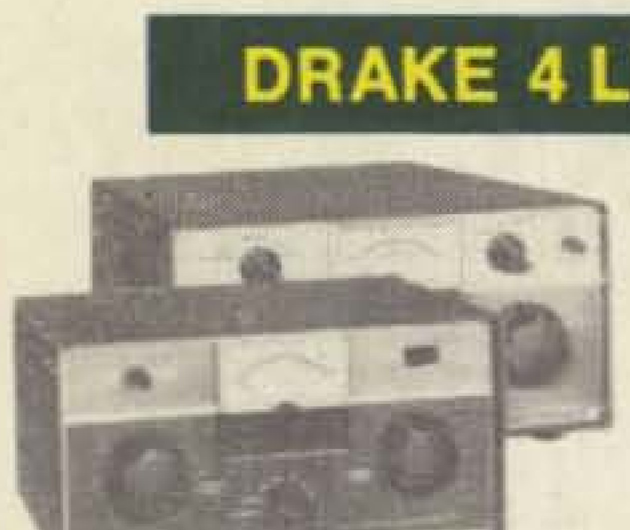

MN-4 MN-2000

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Integral Wattmeter: fwd pwr in watts and VSWR direct • Can read refl pwr • Matches xmtr to ant VSWR 5:1

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Fwd and refl pwr directly in watts • Two scales each direction • Calib Acc: ±(5% of reading + 1% of full scale)

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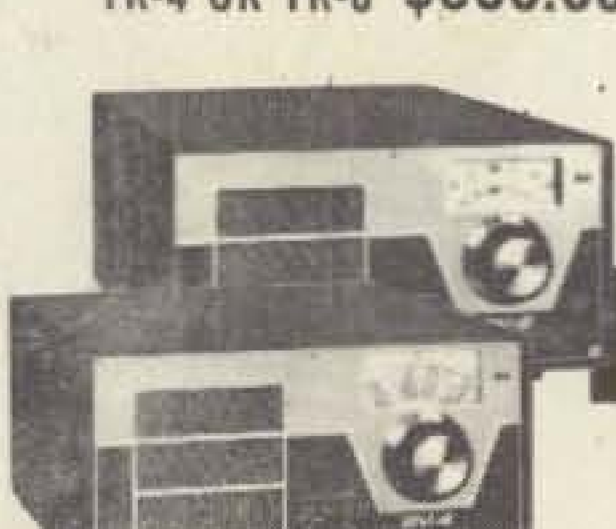
RV-4 & RV-6 REMOTE VFO's



Permit rcvg, xmtg or xcvg on separate freq in same range as transceiver. RV-4 OR RV-6 **$99.95**

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FF-1 Fixed Freq. Adapter $ 24.50
MC-4 Mobile Spkr/Wattmeter $ 69.00
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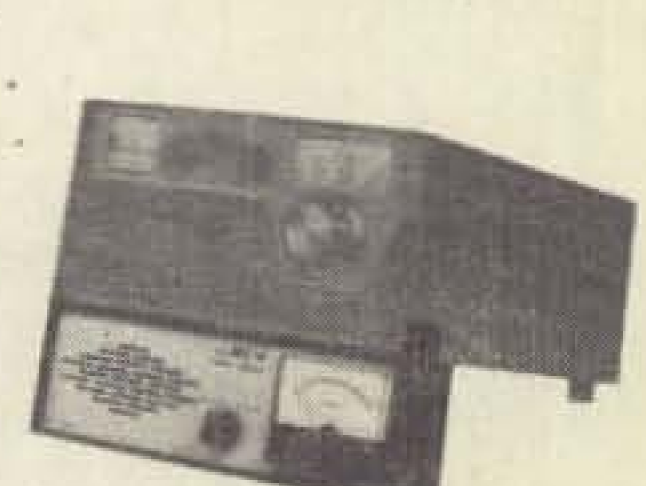

MC-4

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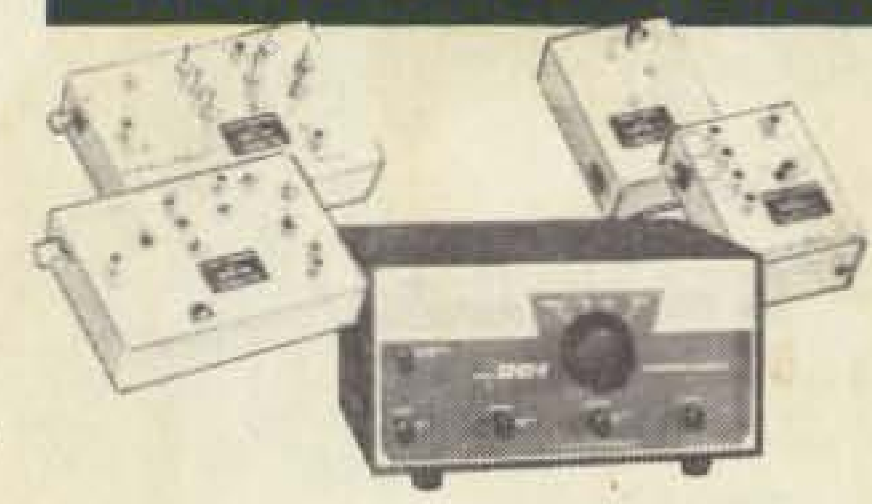

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