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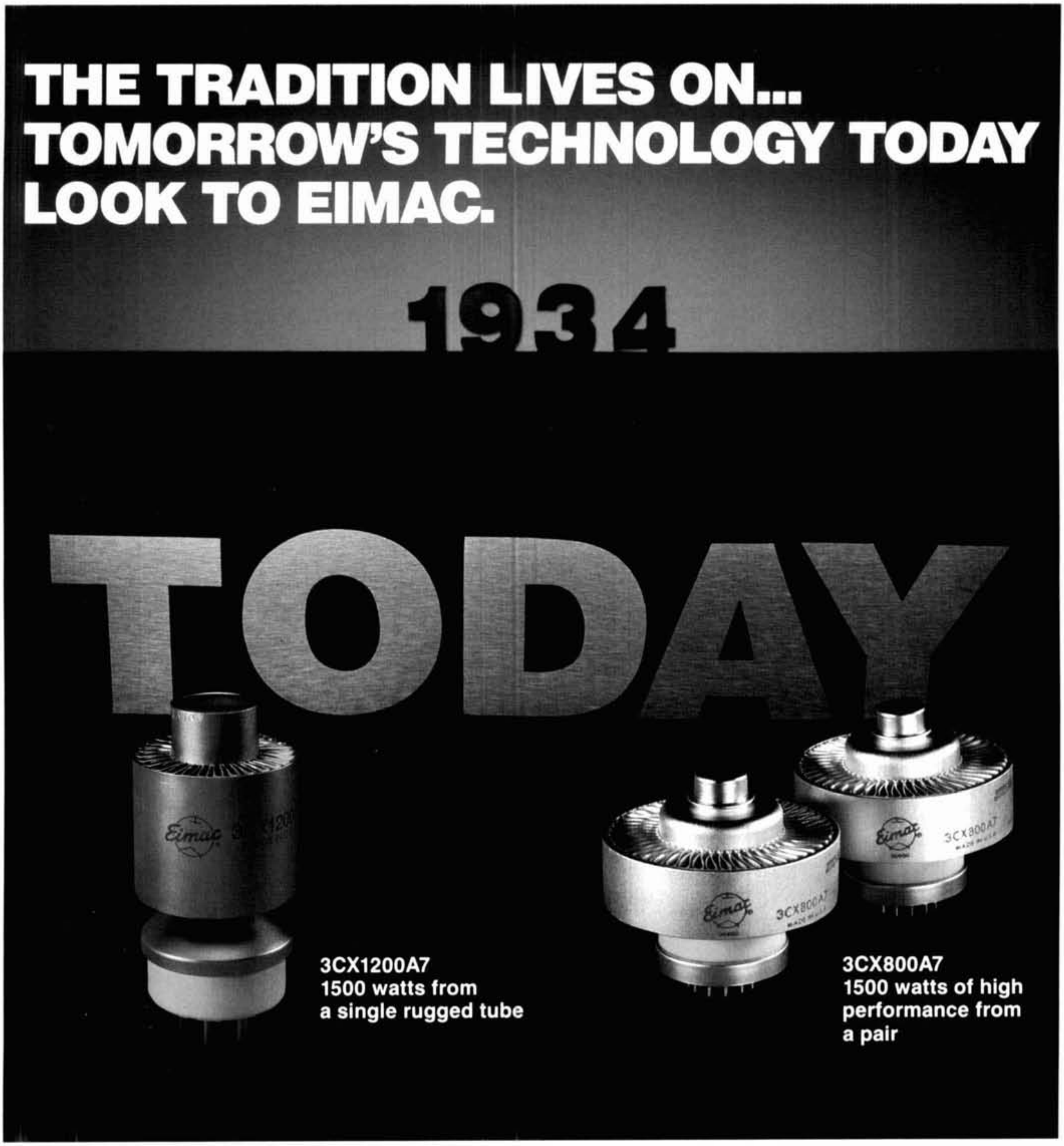

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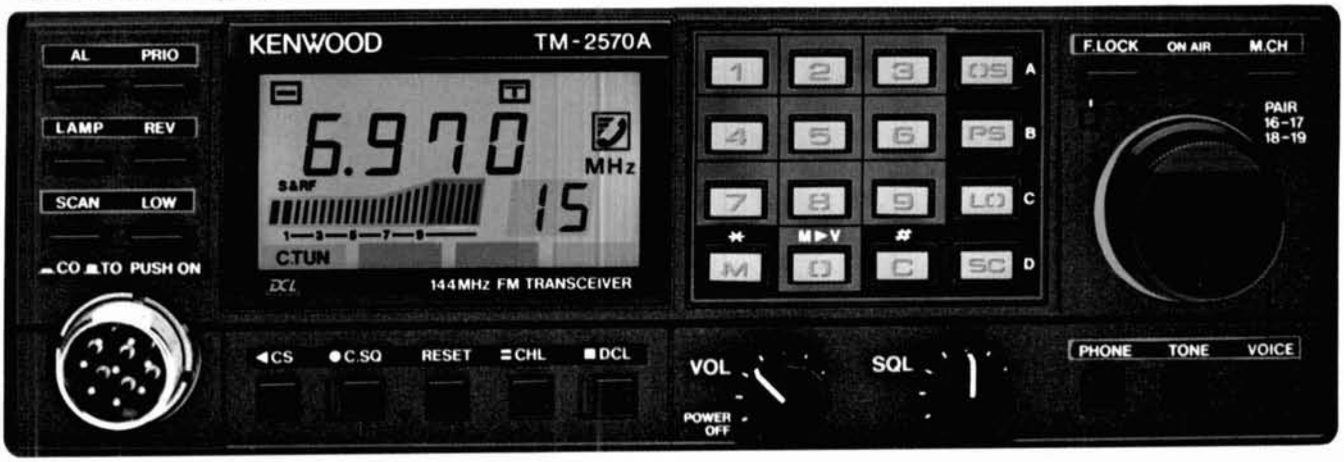

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- **PG-3B** DC line noise filter
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- **PS-430** DC power supply for TM-2550A/2530A/3530A
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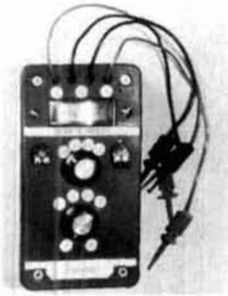
HAM RADIO

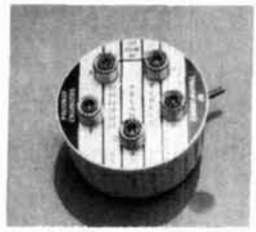
AUGUST 1989
Volume 22, Number 8

On the Cover: Cushcraft HF and VHF antennas set against a late September sky at the QTH of WA1QFY.

See page 79 for the *Ham Radio* Magazine 1988-89 Sweepstakes Winners List.



W5JQE, page 30



K4IPV, page 71

FEATURES

DEPARTMENTS

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Backscatter

Ode to the Death of PRB-3

When PRB-3, the bill to allow special callsigns, was first announced I was overjoyed at the prospect of being able to get a coveted 1x2 callsign. No longer would I be asked if I belonged in the Extra part of the band. I could rightfully join my Extra class brethren as ?1??! Or so I thought.

I have never been overly attached to any of the three calls I've had. As a Novice, WN1IGG wasn't bad, but the phonetics were horrible — Weston's Number 1, I Go Goofy. Gratefully, I never went on the General bands with that one. When I finally passed the General in 1972, the FCC gave me WA1QWW. Now there was a call you could be proud of — WA1 Quarter Wave Whip. There was a nice ring to it on CW too. However, I was still searching for the "perfect" call. In 1978, it was time to move on and get my Advanced. Did I want a new call? Surely, I didn't want KA1sumthinorother. Group C calls sounded good, so I ended up with N1ACH.

When I got to HR in 1979, I felt duty bound to upgrade to Extra in keeping with our high tech image. It wouldn't look good for me to have *just* the Advanced. Sooooo, I got my Extra. But for some reason, I didn't put in for a callsign change. Maybe the 2x1's at the time didn't have enough pizazz to me.

That all changed when PRB-3 was announced. Whoopee! Now I can get the call I want. What would I get? I really liked the W1X series of calls. So, I went through the list to see what was available. Jim Kearman had let W1XZ go. That had a nice CW ring to it. So did a few others. But I felt I'd be taking someone else's property.

Then it hit me.

What better call to ask for than W1HR, Jim Fisk's old call. Now this call has pizazz! I felt it would be a fitting tribute to Jim's memory to carry on his call here at *HR*. Contests and DX circles would ring again with the familiar W1HR call. Could I get it? Would someone else beat me to the punch?

Getting ready for the FCC to implement PRB-3, I figured I would either FAX, FedX, or maybe even hand carry an application to the authorized "giver of callsigns." This was an opportunity I wasn't going to miss. I wanted W1HR so bad I could almost taste it.

At the Dallas ARRL 75th Anniversary Convention in June, the FCC announced that they had killed PRB-3. This dashed my hopes of ever getting that super special callsign I've been waiting for, once and for all. It also means that, unless there is a major change in the FCC, expired calls will never again be reissued. There are plenty of us who would be happy to reactivate those calls — but 'tis never to be.

Well one cannot be disappointed forever. Now I'm playing the waiting game for the next best thing — NX1?. If I time it right, mebbe I'll get NX1H. It's a roll of the dice at best, but it's all I have left to get that "special" callsign.

de NX1? dba N1ACH

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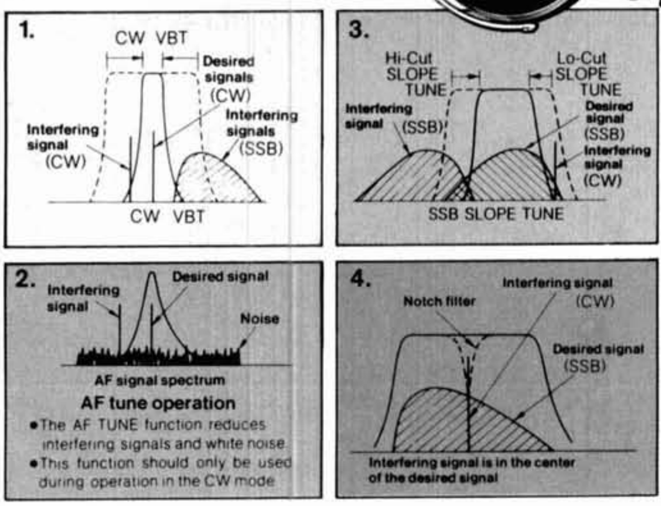

1) CW Variable Bandwidth Tuning. Vary the passband width continuously in the CW, FSK, and AM modes, without affecting the center frequency. This effectively minimizes QRM from nearby SSB and CW signals.

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Comments

Learning CW a "plus" for all hams

Dear HR

Concerning the no-code proposal: I feel that some opposition should be laid out to avoid dangers to the Amateur Radio service. Some of the problems created by having no code as an enticement into the Amateur Radio ranks are as follows:

Having a lack of CW knowledge in a state of emergency can prove disastrous. The no-code proposal, if passed, will let flocks of hams into the VHF and UHF ranks. This may be nice for a while, but then it will be proposed for the HF ranks. Pretty soon, CW itself will be the "obsolete language" of ham radio.

Eliminating the code test makes a mockery out of all the hams who have studied so hard to join the elite ranks of Amateur Radio in the first place. New young hams? Why is the code so hard for them to learn? It seems to me that the complaints stem from the older hams who just can't grasp the language. I was licensed all the way to Extra by the time I was 13 years old.

Pointing to CW as a learning block for all of the new hams is absolutely wrong. Come on! How about all of the new computer programmers who want to get onto radio? Anyone who can program those machines of splendor and strength should be able to pass a CW test.

The problem of slowing Amateur Radio growth stems from the older, experienced hams not getting the new ranks involved. Walking down a city street, probably only 5 in 20 people know what ham radio really is! Let's get on our feet and wave the Amateur Radio banner.

Instead of standing around arguing whether we should pass a CW test or not, let's pass out the code tapes and get rolling! I have five new friends who are getting their licenses soon, CW capable of course. See you on the bands, CW no doubt!

John Muhr, KT0F,
Littleton, Colorado

Preservation — our right

Dear HR

The late great Radio Amateur, Col. Clair Foster, W6HM (who personally paid for the first state-of-the-art ARRL headquarters station, W1MK), used to stress an argument that strongly calls for retention and expansion of our ham bands:

"They are like our national parks," he said. "They provide for the exercise of a valuable national talent (see Sec. 1 of the FCC rules). We don't log our national parks, do we? Taking ham frequencies for commercial use should not be permitted any more than the despoiling of our national parks for profit."

Louis R. Huber, W7UU,
Seattle, Washington

A tradeoff

Dear HR

I just read Bill Orr's "What is the correct radial length?" portion of April's Ham Radio Techniques. Bill surmised that radial length as compared to wavelength may not be critical in the HF spectrum. I have to agree, since I often wondered just exactly what people mean when they refer to "resonant radials." Are there things? I didn't think that radial's exhibit any reactive characteristics which are necessary to qualify as a tuned circuit. Isn't the primary objective to reduce ground resistance as much as possible in order to capture the greatest amount of displacement currents?

When reading many of the antenna books one might assume that if you're constructing a multiband vertical for HF you should cut radials at different lengths for the different bands. Not so, bury as many as you can and as long as your pocket book can afford. The impact on SWR should be dealt with *after* obtaining the highest efficiency possible. New hams would be well advised that a higher SWR due to an increase in length or number of radials is not indicative of a poor system. It simply means that since you have decreased ground resistance which results in increased efficiency, you must change *something* in the system that will "rematch" the transmission line and antenna.

Patrick Bouldin, KM5L,
Lancaster, Texas

Better management of HF bands needed

Dear HR

Enough is enough. I've been involved with ham radio for about 25 years. I spend all my radio time on the HF bands, especially 20 and 10. The atrocities that take place nowadays are demoralizing and the list is long: people tuning up on QSOs, running a carrier on DX, contacts on contacts as if 500 kc wasn't close enough, calling CQ without checking for a clear frequency first, deliberate malicious interference, not giving consideration to phone nets, RTTY on phone QSOs, etc. Even on CW some of the same problems exist.

It used to be the **first** time you did something wrong you received a letter from the FCC. Nowadays, nobody worries because they know that nothing is going to happen to them. After recent calls to my local FCC office and section manager I find this to be unfortunately true. I think it's time to admit that the Amateur community is not capable of handling the job of self-policing. If it comes down to the point where the FCC can't do the job because of money, then we're doomed to be no better off than the CBers.

Glenn Durant, KB0BHN,
Firestone, Colorado

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TH-55AT 1200 MHz Here Now!

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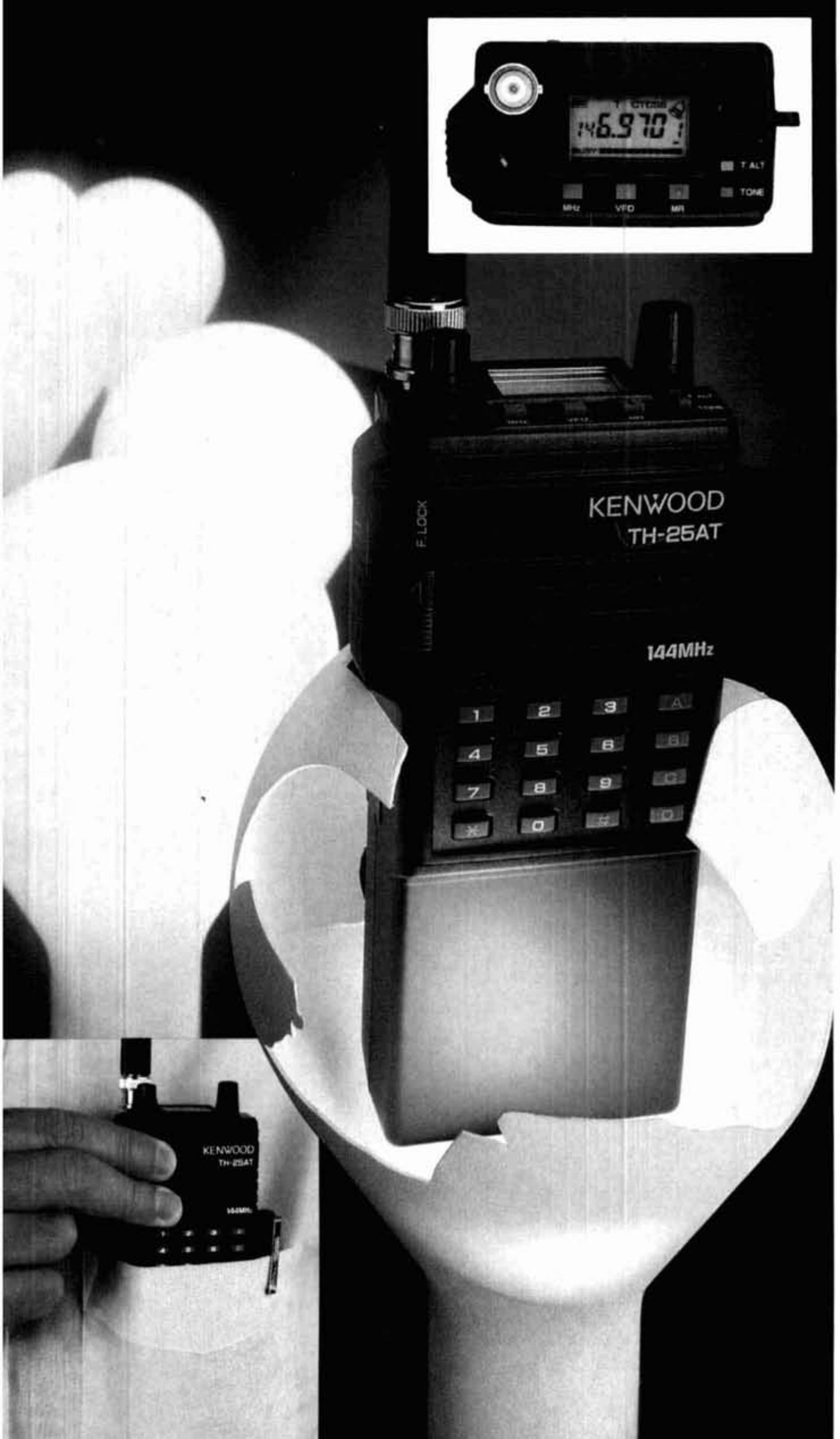

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- Frequency coverage: **TH-25AT:** 141-163 MHz (Rx); 144-148 MHz (Tx). (Modifiable for MARS/CAP. Permits required.) **TH-45AT:** 438-450 MHz.
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- Automatic offset selection (TH-25AT).
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- Large multi-function LCD display.
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- T-ALERT for quiet monitoring. Tone Alert beeps when squelch is opened.
- Band scan and memory scan.
- Automatic "power off" circuit.
- Water resistant.
- CTCSS encoder/decoder optional (TSU-6).
- **Supplied accessories:** StubbyDuk, PB-6 battery pack for 2.5 watts output, wall charger, belt hook, wrist strap, water resistant dust caps.

Optional accessories:

• **PB-5** 7.2 V, 200 mAh NiCd pack for 2.5 W output • **PB-6** 7.2 V, 600 mAh NiCd pack • **PB-7** 7.2 V, 1100 mAh NiCd pack • **PB-8** 12 V, 600 mAh NiCd for 5 W output • **PB-9** 7.2 V, 600 mAh NiCd with built-in charger • **BC-10** Compact charger • **BC-11** Rapid charger • **BT-6** AAA battery case • **DC-1/PG-2V** DC adapter • **HMC-2** Headset with VOX and PTT • **SC-14, 15, 16** Soft cases • **SMC-30/31** Speaker mics. • **TSU-6** CTCSS decode unit • **WR-1** Water resistant bag

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VIBRATION INDUCED YAGI FATIGUE FAILURES

By Dick Weber, K5IU, Box 44, Prosper, Texas 75078

Yagi element failure can be attributed to two basic causes. The first type of failure occurs when an element isn't strong enough to hold up when forces are applied. These forces may be caused by a thick layer of ice, high winds, or a combination of the two. Under the stress of these forces, the element either bends or breaks off, with signs of bending in the area of the break.

The second type of failure takes place after an element has been fluttering, or vibrating, in a relatively low wind stream. The break caused by this kind of failure is quite different. There's no sign of bending in the area of the break; it's a jagged line through the element. In addition to element fluttering, boom fluttering (although not as common) can lead to the same failure.

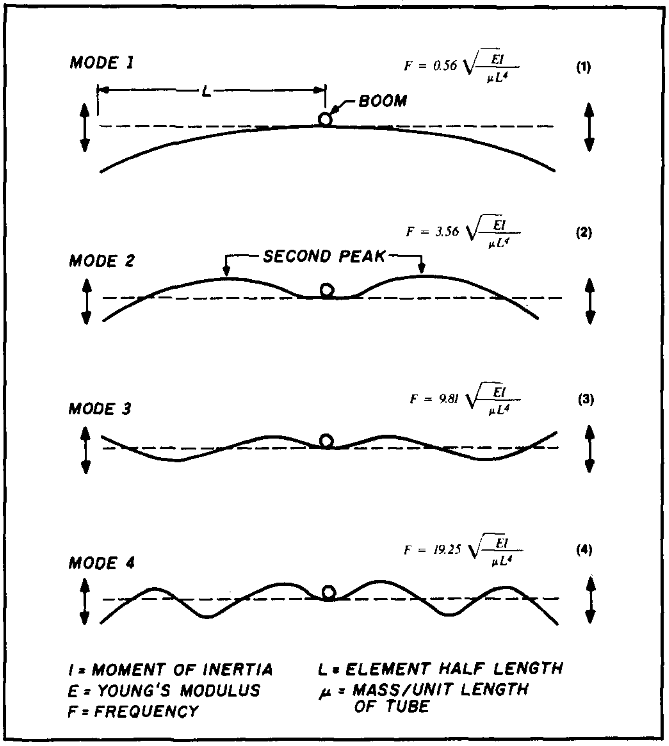
Because there's no sign of bending you'll know that the stress levels in the material are relatively low, yet failure occurs. What causes an element to flutter in the wind? What causes a break although the stress levels are well below those required to bend the tube? And what methods will minimize or eliminate this type of failure?

Understanding flutter

Two key areas that must be explored to understand flutter are the vibratory aspects of the element and the forces that set it in motion.

An element has mechanical resonant frequencies which can be excited. **Figure 1** shows four modes of element vibration and the shape the element takes during oscillation in each mode. These resonant modes happen at discrete, not harmonically related, resonant frequencies. The element has stiffness and mass — the necessary ingredients for resonance. The modes are different situations where the ingredients blend properly to yield resonance. There's a separate resonant frequency with each mode. This means the element can have several resonant frequencies. Use the equations shown with each mode in **Figure 1** to calculate the resonant frequency for that mode. **Equations 1** through **4** are for an element made of one tubing size.[1] Finding resonant frequencies for elements constructed of telescoped sections is best handled by computer finite element structural analysis programs. You can make approximations with the equations shown by selecting a tube diameter the same as the second or third smallest in the element. **Table 1** shows the resonant frequencies for various lengths and sizes of tubing for the first four modes. (Telescoped elements will have resonant frequencies in the ranges shown in **Table 1**.)

FIGURE 1



The four possible modes of element oscillation.

The mechanical resonances are lightly damped. Their behavior is exactly like high Q resonant electrical circuits. As a result, small exciting forces cause large displacement oscillations. For this to happen, and for flutter to be established, there has to be an exciting force at or very near one of the mode resonant frequencies. In addition, the excitation must be maintained to sustain the element oscillation. Where does this excitation come from? How can a mild wind stream provide a vibratory input to initiate and maintain an element oscillation?

Wind excitation

Several things can occur when air flows over a round tube. At low wind speeds nothing happens. The air flows around the tube creating no disturbances of any kind. At higher wind speeds, the air can't cling to the back side of the tube. This creates vortices, or swirls of air. At first the vortices form in pairs coming from both edges of the tube.

TABLE 1

Resonant frequencies of the first four modes for various element configurations.

Element Tube Diameter (inches)	Half Length (inches)	Wall Thickness (inches)	Mode 1 (Hz)	Mode 2 (Hz)	Mode 3 (Hz)	Mode 4 (Hz)
0.500	100	0.058	1.2	7.9	21.8	42.6
0.625	100	0.058	1.6	10.0	27.8	54.5
0.750	100	0.058	1.9	12.3	33.8	66.4
0.875	100	0.058	2.3	14.5	39.9	78.3
0.500	135	0.058	0.7	4.3	11.9	23.4
0.625	135	0.058	0.9	5.5	15.2	29.3
0.750	135	0.058	1.1	6.7	18.6	36.4
0.875	135	0.058	1.2	7.9	21.9	42.9
1.000	135	0.058	1.4	9.2	25.3	49.5
0.625	200	0.058	0.4	2.5	6.9	13.6
0.625	200	0.116	0.36	2.3	6.4	12.5
0.750	200	0.058	0.5	3.1	8.5	16.6
0.750	200	0.116	0.45	2.9	7.9	15.4
0.875	200	0.058	0.6	3.6	10.0	19.6
0.875	200	0.116	0.5	3.4	9.4	18.3
1.000	200	0.058	0.7	4.2	11.5	22.5
1.000	200	0.116	0.6	3.9	10.6	21.3
1.125	200	0.058	0.75	4.7	13.0	25.5
1.125	200	0.116	0.7	4.5	12.4	24.3
1.250	200	0.058	0.83	5.3	14.5	28.2
1.250	200	0.116	0.79	5.0	13.9	27.2

FIGURE 2

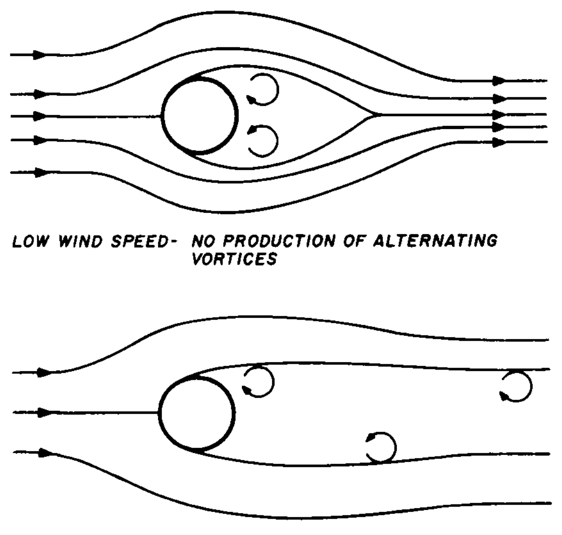


Diagram showing the cause of oscillation due to the creation of alternating vortices.

As the wind speed increases, the vortices leave first one edge of the tube and then the other. The formation of the vortices alternates back and forth between the two edges. The result is an oscillatory pressure loading on the tube. When the frequency of vortex formation is the same as the resonant frequency of one of the element vibratory modes, the element begins to flutter. **Figure 2** shows the various stages of vortex shedding.

As the wind stream velocity increases, the frequency of vortex formation accelerates. When the frequency of the vortex shedding builds up sufficiently, the element stops vibrating because the excitation is not at, or near, a mode resonant frequency. Similarly, as the wind speed decreases, either vortices cannot be shed or the frequency of shedding drops below a mode resonant frequency. The result is the same: the element stops vibrating.

As the wind speed continues to increase, vortices continue to be produced, but with greatly diminished amplitude. No effective excitation is produced above a certain air velocity. The result is a range of possible frequencies that can excite an element. The element will flutter only if the wind sheds vortices from the tube at or near an element mode resonant frequency.

Use **Equation 5** to find the shedding frequency.[2] The term Nr is an important parameter; it determines the interplay of the tube size, air velocity, air density, and air viscosity. Shedding occurs when Nr is in the range of 60 to 10,000.[3] Although shedding can occur over this wide range of Nr, other conditions may not be suitable for the initiation of element flutter.

$$f = 3.52 \cdot \frac{V}{D} \cdot \left[1 - \frac{20}{Nr}\right] \qquad \textbf{(5)}$$

$$Nr = 774 \bullet V \bullet D \qquad \textbf{(6)}$$

f = frequency of vortex shedding (Hz)
V = wind velocity (mile/hour)
D = tube diameter (inches)
Nr = Reynolds number (dimensionless) (air parameters factored into coefficient)

TABLE 2

Wind and frequency ranges for vortex shedding

Tube size (inches)	Wind speed range (mph)	Frequency range (Hz)
0.250	0.30—52	2.8—730
0.375	0.20—34	1.4—318
0.500	0.16—26	0.8—182
0.625	0.13—21	0.5—118
0.750	0.10—17	0.3—80
0.875	0.09—15	0.2—60
1.000	0.08—13	<0.2—46
1.125	0.07—11	<0.1—34
1.250	0.06—10	<1.1—28

Table 2 shows the wind speed ranges for tube sizes having the correct Nr range. There's no reason to consider wind speeds out of these ranges for a particular tube size when using **Equation 5**. This means that for the tubing sizes used in a Yagi element there's an upper and lower boundary to the frequencies which may start fluttering. If an element is made of several diameters of tubing, the upper and lower shedding frequencies are determined by the smallest and largest diameter tubes, respectively. **Table 2** also lists the range of shedding frequencies for each tube size. The possible frequency range is, theoretically, extremely wide.

The extremely low wind velocities within the range of Nr offer little danger. There's generally insufficient energy in the wind stream to cause pressure loadings of any appreciable magnitude on the tube. In addition, at higher wind speeds the flow is so turbulent that the vortices don't all shed from one side of the tube and then the other. They come off the tube at about the same frequency, but not in an orderly fashion.[3]

What then is the proper range of wind speeds which can cause fluttering? My own experience and observations have been of wind speeds less than 35 mph. This still leaves a wide range of frequencies that can be generated by vortex shedding. I've seen many elements vibrate in mode 2 and several vibrate in mode 3. I've also seen elements vibrate at a fixed frequency even though the wind speed wasn't constant. This indicates that a broad band of frequencies can be generated by vortex shedding from the same element, not only because of multiple element diameters, but also because the shedding frequency isn't inherently stable. I have never seen mode 1. Either there's insufficient energy in the wind stream at these wind speeds, or the vortices detach themselves when the element begins to vibrate, and the element shuts itself down.

The possible range of exciting frequencies in **Table 2** shows that these frequencies are in the range of the resonant frequencies of the various tube configurations in **Table 1**. Don't consider the lower frequencies in **Table 2** too seriously; there's a very small level of energy in the corresponding wind streams. It also appears that elements should begin vibrating in any wind stream. In reality, this doesn't happen. Even in view of the anomalies, you can gain insight into the vibratory behavior of a fluttering element.

Element fatigue failure

An element that breaks as a result of sustained fluttering fails by a different mechanism than if it bends due to a very high force. When an element bends or breaks off because of a very high wind or ice load, the yield stress of the material has been exceeded. An element can be deformed by a force below the yield stress, but when the force is removed the element will return to its original starting point. For example, if you pull a Yagi element with your hand, it will deflect several inches. When you let go, the element will return to its original shape. If you pull on the element enough to give it a permanent bend, you have stressed the material above its yield stress. Therefore, exceeding the yield stress results in a permanent bend. If the yield stress is greatly exceeded, the element will first bend and then break. An element which fails due to fluttering breaks for a different reason.

When aluminum is flexed at levels below the yield stress, no permanent bend results but damage accumulates. If the flexing is repeated enough times, the accumulated damage in the material results in a fatigue failure. The higher the load, the less load applications are needed to give a fatigue failure. The lower the load, the more cycles of application are needed to create the same accumulated damage. When an element flutters long enough, the accumulated damage in the material gets to the level where the element suffers fatigue failure.[4] However, there's no sign of a bend or evidence indicating the material has exceeded its yield stress near the break.

Minimizing element failure

There are several things that can be done if an element flutters. You can attempt a modification to the element to limit the amplitude of the stress during fluttering. Try increasing damping in the element to extend its life. This will lower the Q of the mechanical resonance, which means that the tube will take many more load cycles to generate a failure. I've heard of people filling the inside of elements with foam intended for sealing and insulating cracks and holes in buildings. This method may work. But if you attempt this, take two identical elements and foam only one. After the foam has cured, shake both of them in your hand to see if there is an appreciable difference in how the element vibrates when excited. Shake the element to set up a mode 2 oscillation (see **Figure 1**). Once you have oscillation, stop moving your hand and see how long it takes for the element to stop shaking. If the foamed one damps out sooner, you may have a working solution.

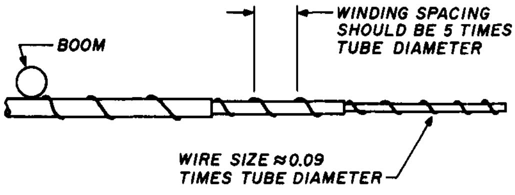
You might also modify the shape of the element so that orderly vortices can't be shed. To do so, wrap a wire in a helix around the element.[5] The wire diameter should be

TABLE 3

Resonant frequencies of the first four modes with 1/2" rope for various element configurations

Tube diameter (inches)	Element half length (inches)	Wall thickness (inches)	Mode 1 (Hz)	Mode 2 (Hz)	Mode 3 (Hz)	Mode 4 (Hz)
0.500	100	0.058	1.15	7.3	20.1	39.5
0.625	100	0.058	1.5	9.5	26.1	51.3
0.750	100	0.058	1.8	11.7	32.2	63.1
0.875	100	0.058	2.2	13.9	38.2	74.9
0.500	135	0.058	0.6	4.0	11.0	21.6
0.625	135	0.058	0.8	5.2	14.3	28.1
0.750	135	0.058	1.0	6.4	17.6	34.6
0.875	135	0.058	1.19	7.6	20.9	41.1
1.000	135	0.058	1.38	8.8	24.3	47.7
0.625	200	0.058	0.37	2.4	6.5	12.8
0.625	200	0.116	0.35	2.2	6.1	12.0
0.750	200	0.058	0.45	2.9	8.0	15.7
0.750	200	0.116	0.43	2.8	7.6	14.9
0.875	200	0.058	0.5	3.5	9.6	18.7
0.875	200	0.116	0.5	3.3	9.1	17.9
1.000	200	0.058	0.63	4.0	11.0	21.7
1.000	200	0.116	0.59	3.86	10.58	20.8
1.125	200	0.058	0.71	4.6	12.6	24.7
1.125	200	0.116	0.69	4.4	12.2	23.8
1.250	200	0.058	0.80	5.1	14.1	27.7
1.250	200	0.116	0.77	4.9	13.7	26.8

FIGURE 3



Experimental method for eliminating the creation of vortices by wrapping the elements with wire.

about 0.09 times the diameter of the element with the turns of the helix spaced about 5 times the diameter. (See **Figure 3**.) I don't know if anyone has tried this approach. I plan to experiment with it and I hope others will too. It offers the possibility of being the best solution. Rather than trying to accommodate the production of vortices, this approach may eliminate their generation. I know this idea has been applied successfully to various types of structures, like suspended pipelines and smoke stacks, but I'm not aware of its use with Yagi elements.

You can attempt to retune the mechanical resonances of the element out of the range of vortex shedding frequencies in two ways. One traditional method is to use damping ropes inside the elements. Actually, damping ropes provide both a slight mechanical retuning of the element and the addition of some amount of damping to lower the Q of the mechanical resonance. My experience with damping ropes has shown them to be of little value. I had four fatigue failures on a 20-meter Yagi and three on a 10-meter Yagi in one year. All had ropes. After the first break on each, I changed the ropes to the largest possible size, with no success.

The amount of mechanical retuning that results from placing a rope inside an element is shown in **Table 3**. I've calculated the resonant frequencies with a 1/2-inch rope inside the entire element length. A comparison of **Table 1** and **Table 3** shows the resonant frequencies haven't been substantially altered. If anyone has had success with ropes, it probably has been due to a lowering of the Q of the mechanical resonance by providing some damping. This was probably a marginal case. Evaluate this method the same way you did the foamed elements. Perhaps you can enhance the damping provided by the rope by gluing its entire length to the inside of the element. You'll probably have to soak the rope in an adhesive and coat the inside of the element before pulling the rope through.

A weight fastened to the tip of an element can alter the resonant frequency appreciably. **Table 4** shows the same element configurations, with a 3-ounce weight at the element tip. This table compares the first mode with and without the weight. There has been about a 40-percent reduction in resonant frequency. The second mode resonant frequency will be reduced further, while the higher modes' resonant frequencies will increase. I tested this on a 20-meter Yagi element and found that adding a 3-ounce weight cut the second mode frequency in half. The degree of retuning depends on element configuration and weight size.

Several years ago Dennis Peters, N5UA (now deceased), had a 10-meter beam which was losing an element about every two months even though he had ropes in the elements. After some discussion and much frustration on his part, he added weights to each element tip. Dennis used large washers secured with hose clamps; they did the trick.

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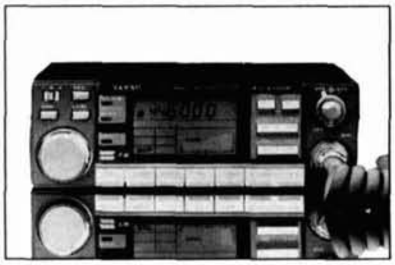

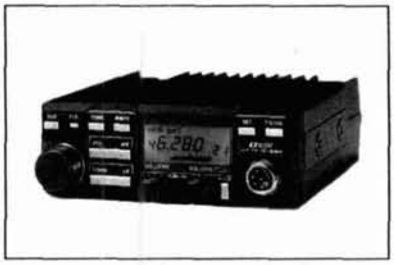

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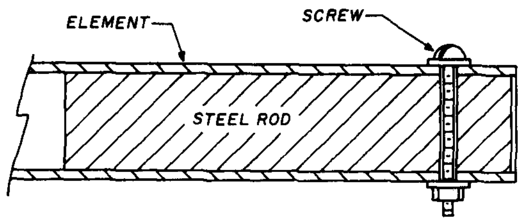
TABLE 4

Resonant frequencies of mode 1 without and with a 3-ounce tip weight.

Tube diameter (inches)	Element half length (inches)	Wall thickness (inches)	Mode 1, no tip weight (Hz)	Mode 1, with tip weight (Hz)
0.500	100	0.058	1.2	0.7
0.625	100	0.058	1.6	1.0
0.750	100	0.058	1.9	1.27
0.875	100	0.058	2.3	1.51
0.500	135	0.058	0.7	0.44
0.625	135	0.058	0.9	0.57
0.750	135	0.058	1.1	0.70
0.875	135	0.058	1.2	0.84
1.000	135	0.058	1.4	0.97
0.625	200	0.058	0.4	0.27
0.625	200	0.116	0.36	0.25
0.750	200	0.058	0.5	0.33
0.750	200	0.116	0.45	0.31
0.875	200	0.058	0.6	0.39
0.875	200	0.116	0.5	0.37
1.000	200	0.058	0.7	0.45
1.000	200	0.116	0.6	0.43
1.125	200	0.058	0.75	0.51
1.125	200	0.116	0.7	0.49
1.250	200	0.058	0.83	0.57
1.250	200	0.116	0.79	0.55

FIGURE 4



Adding weight to reduce the mechanical resonant frequency.

The antenna suffered no failures in the year before his station was dismantled.

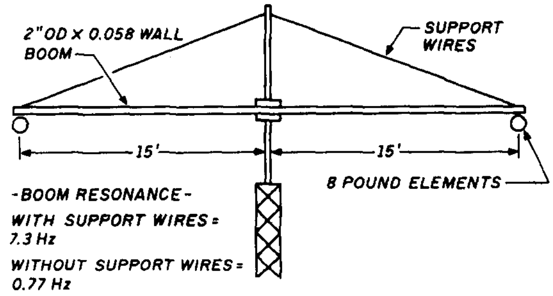
Add weights by clamping them to the outside of the element or securing them to the inside. You can slip lengths of steel rod into the tip of an element and secure them with screws. (**Figure 4** shows this method of attachment.) If you add weights, they can't be taped to the element. They must be hard mounted.

There are two preferred locations for adding weights. The first is at the tip. Another spot is about one-fifth of the way from the tip to the boom. The tip moves the most in modes 1 and 2; the second location moves substantially in mode 2. Adding weights loads these locations for the most dramatic retuning. Observe the shape the element takes when it's fluttering in order to determine weight placement. You'll see a displacement peak at the tip, and another part way to the boom. Put the second weight at the second peak. In **Figure 1**, the second peak is labeled for mode 2.

Boom flutter

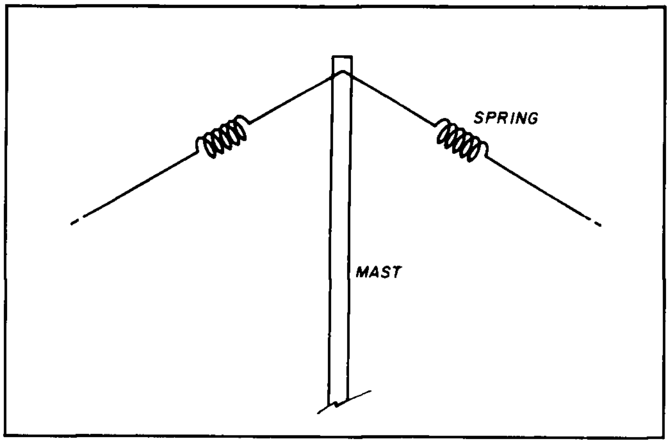
I've seen booms fluttering on several occasions. One boom eventually failed at the mast end. This failure isn't as common as element flutter, but it does happen. The cases I've observed have all had boom support wires strung from the mast to the boom. For the boom in **Figure 5**, the resonant frequency with the support wires is 7.3 Hz. Without the support wires, the resonant frequency is 0.77 Hz. Getting rid of the wire drops the resonant frequency substantially, but a lack of support wires may not be acceptable. Fortunately, there's an easy solution to the problem. The key is to provide the support needed, but not the stiffness of the support wire. Install a spring in the support wire as shown in **Figure 6**. The softer the spring the better. Pick a spring, or series of springs, that won't be stretched excessively by the tension needed to support the boom. This will

FIGURE 5



Case where boom with support is more prone to flutter.

FIGURE 6



Installing stiff springs in the boom support lines to damp the resonant frequency.

decouple the stiffness of the support wire and still provide the needed tension. The shift in resonant frequency will most likely put the boom into an area where either the energy in the wind stream isn't sufficient to start flutter, or the boom resonant frequency is below the vortex shedding minimum.

Element design variations

I've had Yagis with severe fluttering problems. I've also had Yagis with no problems at all. Those having failures were very stiff when compared with their mass, while those that had no damage weren't as stiff when compared with their mass. In **Equations 1** through **4**, the term $\frac{EI}{u}$ appears. EI is a stiffness term, and u is a mass term. The lower the "stiffness to mass" ratio, the lower the mode resonances. Based on the Yagis I have owned, I've concluded that elements with the lower resonant frequencies have the best chance of not fluttering. This suggests that retuning the element is indeed a viable approach, a fact supported by the experiences of Dennis Peters. I'd be very interested in hearing from any readers who have experienced problems with fluttering elements, whether you've been successful at solving them or not.

Summary

Elements and booms have mechanical resonant frequencies which can be put into oscillation by vortices shedding from the tube edges. There are several ways to reduce the likelihood of a fatigue failure. Damping can be added to reduce the amplitude of the stress. This would lengthen the life of the element. Adding damping ropes may help in marginal cases. Other methods have been tried, and there is certainly room for innovation. You can test an idea on the ground to see if it will reduce the Q of the mechanical resonance by noting the time it takes for oscillatory motion to damp out.

The most promising approach for minimizing element fatigue failures is to eliminate the orderly generation of vortices. The orderly formation of vortices will be disrupted in an element which is helically wound with a wire. To the best of my knowledge, this approach hasn't been tried with Yagis. It may prove to be the most effective remedy for fluttering elements.

There's a successful approach that's been used to eliminate element fatigue failures. Retuning the resonant frequencies of an element offers a means to prevent fatigue failure by moving the element resonances out of the shedding frequency range. You can do this by adding small weights. At minimum, the weights should be added at the element tips. A second location is on the span of the element, at the point with the largest displacement during a mode 2 oscillation. In addition, when selecting or designing a Yagi, keep in mind that elements which aren't very stiff in relation to their mass are less prone to vibration-induced fatigue failures.

Yagi booms are also subject to vortex shedding and fatigue failures. Booms with support wires have been observed to be most prone to fluttering. You can retune a boom with support wires by the adding springs in line with the wires. This lowers the resonant frequency of the boom and prevents it from fluttering. hr

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THE BATTLE OF THE BEAMS
PART 2

By D. V. Pritchard, G4GVO, 55 Walker Dr., Leigh on Sea, Essex SS9 3QT, England

As early as 1934, when *Knickebein* was in its infancy, a German scientist began to have doubts about its efficiency if exposed to jamming. He was Staatsrat (Privy Councillor) Dr. H. Plendl of the Deutsche Versuchanstalt für Luftfahrt (German Aeronautical Research Establishment) and he began to produce designs for a new system for accurate blind bombing.

Under his leadership, a new department was formed at Rechlin (the German equivalent of Farnborough) which began research in June of that year. This was in cooperation with another department led by a Dr. W. Kühnold which was also engaged on beam techniques for blind landing. The beams of Kühnold's system, however, had an aperture angle of about 5°, corresponding to an 8-km beamwidth at a range of 100 km, and were clearly unsuitable for accurate pinpointing of targets. Obviously a beam width of not more than 0.1° was required and this (at that time) could be attained with reasonable antenna dimensions and suitable power only if a frequency between 66 and 77 MHz were employed. Accordingly, experiments were begun with an 80-watt transmitter designed by a Dr. Ochmann which was code named *Bertha 1*; as this was not powerful enough a second was designed, *Bertha 2*, which delivered 500 watts and was tunable over the required range.

Preliminary tests carried out over Lake Müritz near Mecklenburg in 1935 resulted in ranges of only 1500 meters. Stationary beam antennas which could be phased to swing through about 10° were used, and the airborne equipment consisted of two t.r.f. receivers developed at Rechlin and an analyzer for unlocking the 2000-Hz modulated dot/dash system of the adopted and improved Knickebein apparatus. Unfortunately, full details of both transmitter and receivers are no longer available.

Wotan 1

By 1938, the system had been greatly improved. Dr. Kühnold had developed ground installations capable of easy dismantling and removal, with an operating cabin and antenna array mounted on a platform which could rotate through 360°. The antennas were mounted on a gantry and spaced at 14.75 meters (3.5 wavelengths). Originally, simple half-wave dipoles were employed, but before long directors and reflectors were added for extra power and range; these were energized with pulses at 120 per minute via a vacuum switch (soon replaced by a capacitor, nicknamed a "mill switch," designed by Dr. K. H. Fischer). The schematic block diagram of this system is shown in **Figure 1**. A half-wave Lecher line is used in conjunction with the "capacity" switch and its associated inductances to pulse both dipoles with the required dot/dash sequence.

The array generated a fan of 14 beams each with a bandwidth of 0.05° (**Figure 2**), and eight of these installations were erected in Germany, followed by many more on the coasts of occupied Europe. By now the airborne equipment had also been drastically improved by Dr. H. Hanel and Dr. Rücklin Telefunken, who had designed and developed a superhet for 66 to 77 MHz (code named *Anna*), while an analyzing system designed by Dr. Plendl known as the AVP (Anzeige-Verfahran von Plendl) was being mass-produced by Siemens.

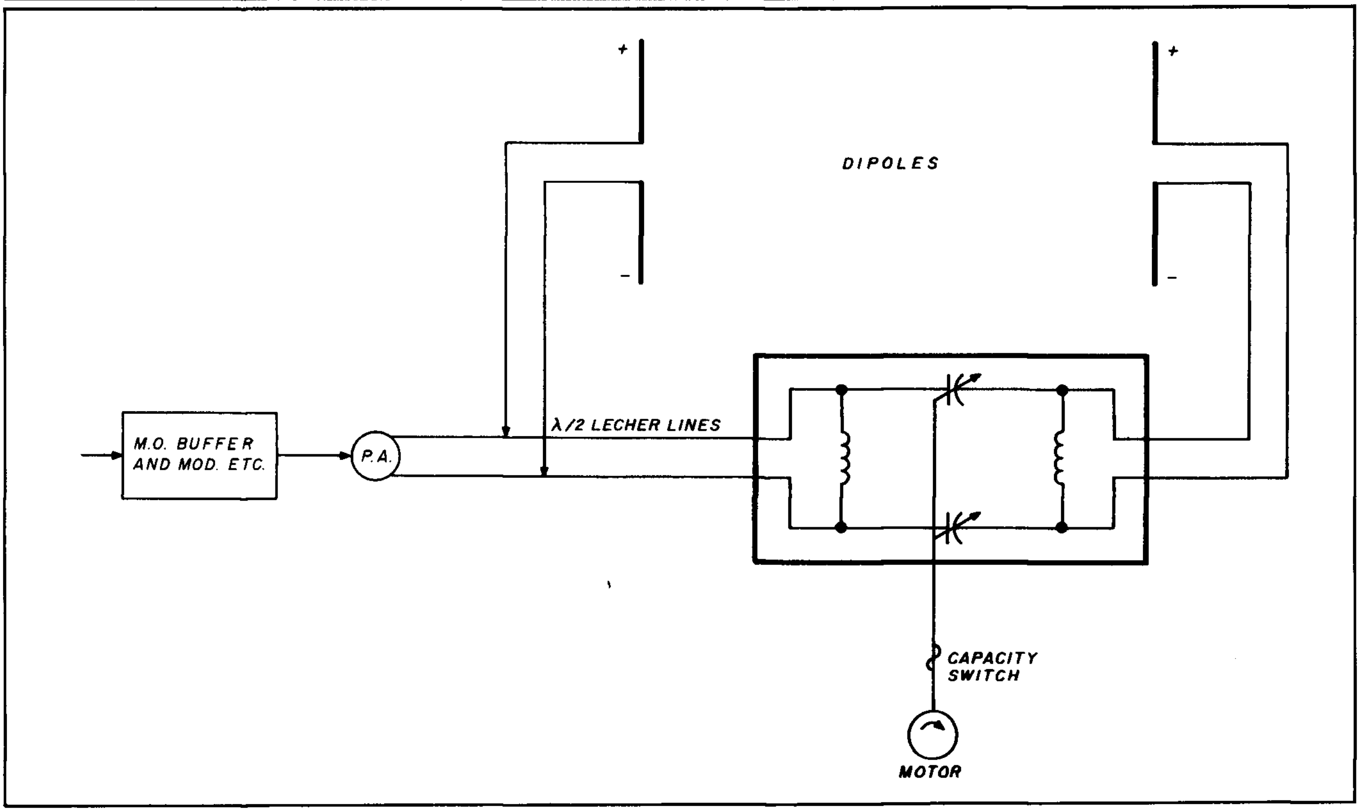
At the same time a Dr. K. Müller set up a Mobile Research Unit which produced some versatile mobile stations under the code name *Möbelwagen* or "furniture vans." He was also responsible for the clever camouflaging of their antenna — a feature which was later to prove troublesome for British counterattacks.

The complete system was known as *Wotan 1*.

Principle of operation

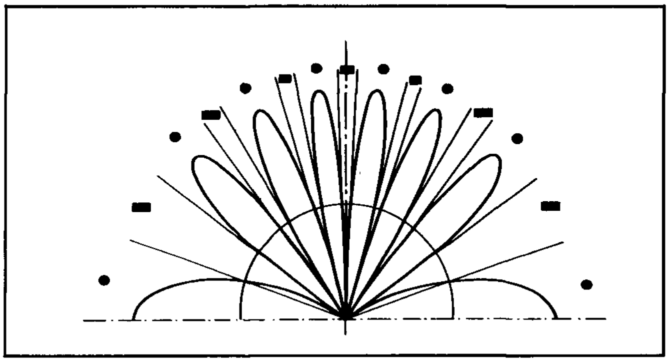
One of the 14 beams was selected to act as a director beam which, on being aimed towards the target, provided a flight path for the aircraft; this system was similar to Knickebein in that the pilot could plot his course according to a direction-indicating meter which told him if he was to the right or left of the beam. The official German layout of the beam-approach system and its associated cross-beams at points before the target is shown in **Figure 3**. **Figure 4** represents not only the director beam and reserve beam, but also the cross-beams and the associated fans of beams which enabled stray aircraft to plot their courses to the correct one. The main beams of the system used for the devastating raid on Coventry in 1940 are shown in **Figure 5**, and **Figure 6** is another official German layout showing

FIGURE 1



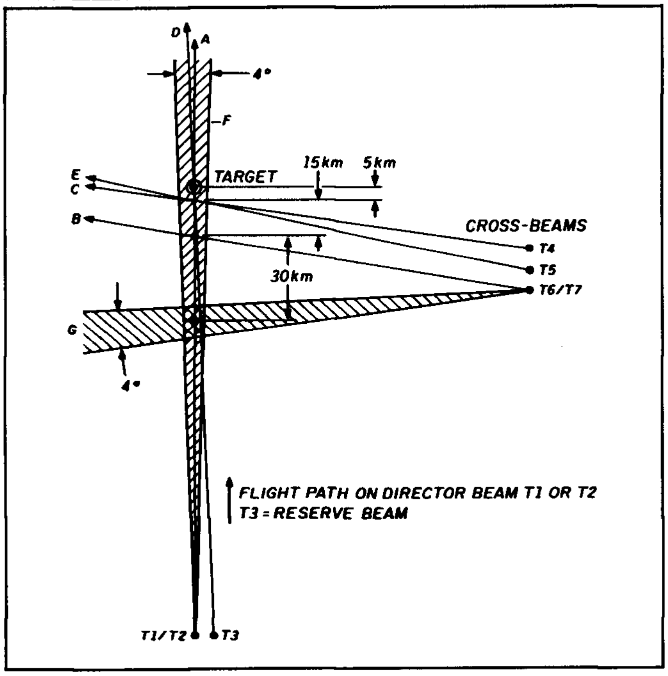
Block diagram of X-Gerät feed system and capacity switch for pulsing.

FIGURE 2



Antenna pattern of X-Gerät system.

FIGURE 3



Official German layout of the X-Gerät system.

the disposition of all beam systems in use at that time. (In this series the author has concentrated only on the more widely known systems.)

In practice the bombers did not fly along the director beam immediately after takeoff, but used either normal navigational methods or one of the fan beams, in order to present a smaller target for British radar and to try to cause confusion. The director beam was usually joined sometime after crossing the English coast.

At approximately 30 km before the target, the aircraft would encounter the coarse advanced cross-beam which, like the other beams, was similarly pulsed with dots and dashes — but on a different frequency. Before reaching this point, the bomber's radio operator would have consulted a table giving the characteristics of his particular type of

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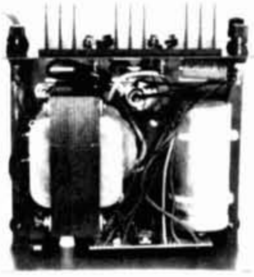

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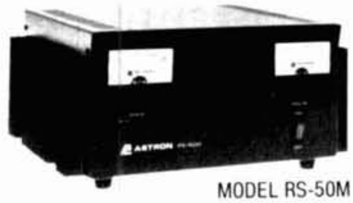

MODEL RS-50M

MODEL VS-50M

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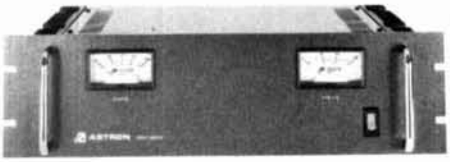

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RS-7B	5	7	4 × 7½ × 10¾	10
RS-10A	7.5	10	4 × 7½ × 10¾	11
RS-12A	9	12	4½ × 8 × 9	13
RS-12B	9	12	4 × 7½ × 10¾	13
RS-20A	16	20	5 × 9 × 10½	18
RS-35A	25	35	5 × 11 × 11	27
RS-50A	37	50	6 × 13¾ × 11	46

RS-M SERIES

MODEL RS-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
• Switchable volt and Amp meter				
RS-12M	9	12	4½ × 8 × 9	13
• Separate volt and Amp meters				
RS-20M	16	20	5 × 9 × 10½	18
RS-35M	25	35	5 × 11 × 11	27
RS-50M	37	50	6 × 13¾ × 11	46

VS-M AND VRM-M SERIES

MODEL VS-35M

• Separate Volt and Amp Meters • Output Voltage adjustable from 2-15 volts • Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H × W × D	Shipping Wt. (lbs.)
VS-12M	9	5	2	12	4½ × 8 × 9	13
VS-20M	16	9	4	20	5 × 9 × 10½	20
VS-35M	25	15	7	35	5 × 11 × 11	29
VS-50M	37	22	10	50	6 × 13¾ × 11	46
• Variable rack mount power supplies						
VRM-35M	25	15	7	35	5¼ × 19 × 12½	38
VRM-50M	37	22	10	50	5¼ × 19 × 12½	50

RS-S SERIES

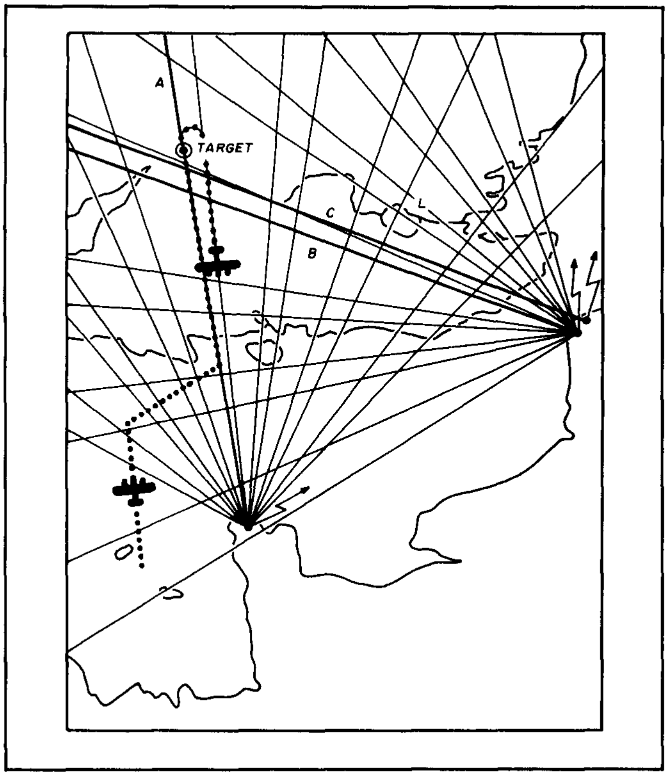
MODEL RS-12S

• Built in speaker

MODEL	Continuous Duty (Amps)	ICS* Amps	Size (IN) H × W × D	Shipping Wt. (lbs.)
RS-7S	5	7	4 × 7½ × 10¾	10
RS-10S	7.5	10	4 × 7½ × 10¾	12
RS-12S	9	12	4½ × 8 × 9	13
RS-20S	16	20	5 × 9 × 10½	18

*ICS—Intermittent Communication Service (50% Duty Cycle 5min. on 5 min. off)

FIGURE 4



German layout of beams showing main beams and associated fans.

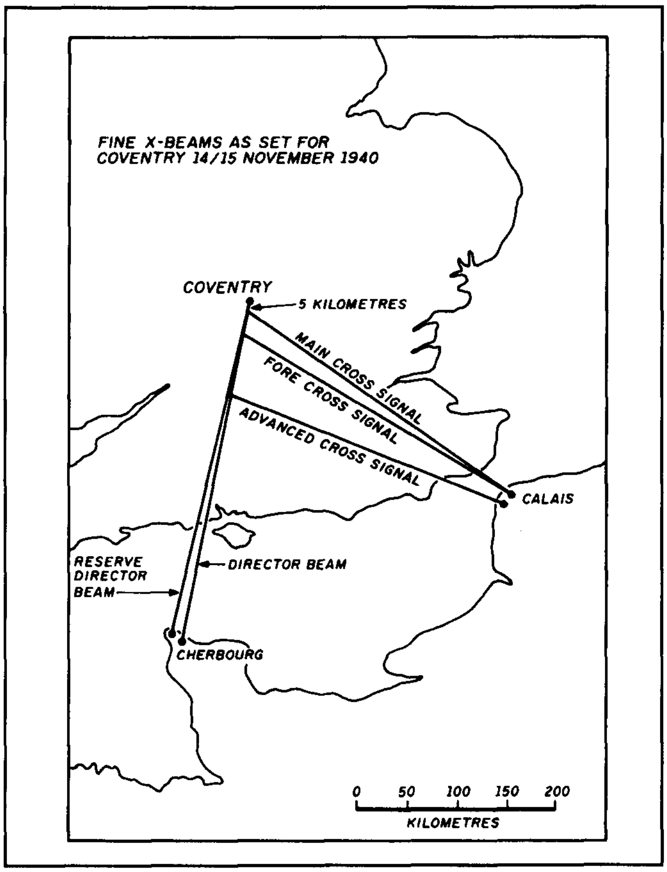
machine and fed them into a combined calculator and stop-watch called the *X-Uhr*, or "X-Clock." This was an incredibly accurate mechanism designed at Rechlin by a Dr. Hepper. A small upper dial on the left-hand side showed how long the instrument had been running, while the lower dial was used for calculating the "flight-path ratios." Information about the aircraft's type, height, and speed was inserted to give a flight-path ratio of, say, 2.78:1 for 18 km or 3:1 for 6 km, according to circumstances.

On arriving in the dash zone of the advanced cross-beam, the operator would listen for the (very brief) continuous note produced by the merging of dots and dashes, and press the clock's top button. This started the green "minute" hand and the black sweep hand simultaneously and, according to the inserted data, the time taken for the bombs to drop was now fed in.

At the "fore-cross signal" a button on the left was pressed, whereupon the green and black hands stopped and the red "hour" hand started. When the third button at the main cross-beam was pressed, the red hand would stop at the same point as the previous ones and, if the correct data had been given, the bombs would be automatically released.

After tests by a research squadron, the system was finally installed in Ju 52s and He 111s of *Kampf-Gruppe 100* — a group led by an outstanding Luftwaffe officer, Major Viktor von Lossberg. Quarter-wave whips were mounted on top of the fuselage behind the cockpit and these, in conjunction with the whip antenna for RT operation which was situated farther back, gave rise to the nickname "Three-master."

FIGURE 5



The X-Gerät system for Kampf-Gruppe 100.

The airborne equipment was installed in the radio operator's position, and repeaters for the course meters were fitted in the cockpit for the pilot's benefit. A motor generator fed from the aircraft's batteries (rotary converter) was placed at the bottom of the installation. Immediately above it were two audio units, to the left of which was the power distribution panel. The twin receivers for the director and cross-beams were above that and the Anna receiver was on the right.

Intelligence breakthrough

The phone shatterd Dr. R. V. Jones's sleep in the early hours of a morning during the first week of September 1940.

"We've got something new here! God knows what it is, but I'm sure it's something for you!"

The excited voice of Professor Frederick "Bimbo" Norman, a cryptographer at Bletchley Park, shook Jones into consciousness. They had broken some new Enigma traffic in which radio beams were mentioned, including the information that the beam width was 8 to 10 seconds of arc, or an angle of 1:20,000, suggesting that *the beam was no wider than about 20 meters at 320 km!*

Then came the electrifying word X-Gerät! Whatever X-Gerät was, it was being installed in aircraft of Kampf-Gruppe 100, one of the Luftwaffe's crack squadrons.

Jones hustled the intelligence services into greater activity. Across the Channel the Resistance organizations

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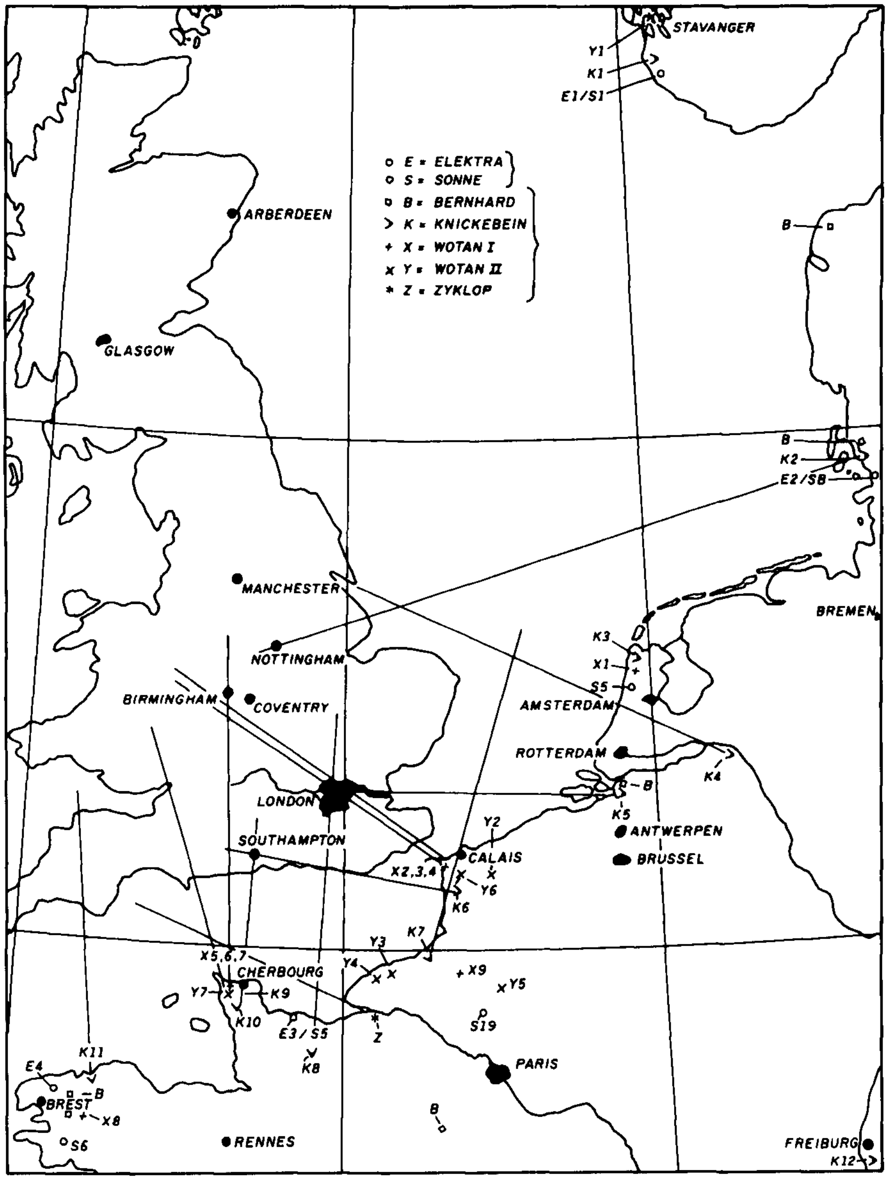
FIGURE 6



Official German layout showing the disposition of all beam systems in use at that time.

pulled out all the stops, and British Signals Intelligence (including Voluntary Interceptors — a body of dedicated Radio Amateurs) doubled their efforts. Their activities prompted Jones to record his appreciation: *"Our community of Radio Amateurs in Britain was to prove an invaluable reserve, both in Signals Intelligence and Signals proper, as well as furnishing many of the staff for our rapidly increasing number of radar stations."*

It was that well-known Amateur of his day, Rowley Scott-Farnie, G5GI, then an officer in RAF Signals Intelligence and a close friend of Jones, who reported beam signals from the Calais and Cherbourg areas around 70 MHz. By September 24, six beam stations were identified: two northwest of Cherbourg, three near Calais, and the last near Brest. The Germans had code named them *Weser, Spree, Rhein, Elbe, Isar,* and *Oder.* Evidently Kampf-Gruppe 100 was working through a book of numbered targets, and by the time the stations were identified Jones had the actual directions for the beams — and even that the Germans had specified them to the nearest 5 seconds of arc, *an accuracy of about 10 meters at 320 km!* (See **Figure 7**).

But how could such an accuracy be possible on 70 MHz?

The "Anna" numbers

Further decoded German transmissions revealed the existence of coarse and fine beams, including a mention of centimeters. This latter, however, referred to the precision with which a monitoring vehicle had to be positioned to orientate the director beam. Frequent mention of something called "Anna" was made, usually associated with a number between 10 and 85, and often a multiple of 5. By October 17, Jones had collected 10, 15, 25, 30, 35, 44, 47, 55, 60, 75, and 85. Another set of numbers gave crystal frequencies (typically 8750 kHz, since 8750 kHz × 8 = 70 MHz) and he suspected that Anna referred to the dial on the aircraft receiver, if not the aircraft itself. Since one set of numbers ended in 0 or 5, and the other in 0 or 0.5, simple deduction showed that the Anna reading had to be divided by 10 and either added to, or subtracted from, a constant number.

Learning from the Enigma traffic that a certain Feldwebel Schumann at a beam station at den Helder had signed a return for 3 crystals for 69.5, 70, and 71.1 MHz and that his station was ordered to transmit on Anna numbers 30 and 35, it was clear that the constant had to be 66.5 if one-tenth of the Anna number had to be added, or 73 if it had to be subtracted. As he knew that crystals for 75 MHz existed, the second possibility could be dismissed; when he obtained further confirmation from the two crystals whose frequencies were not exact or half integers, the problem was solved. Other information that emerged from the Anna numbers was that both the coarse and fine beams lay between 66.5 and 75 MHz.

Measurement inaccuracy

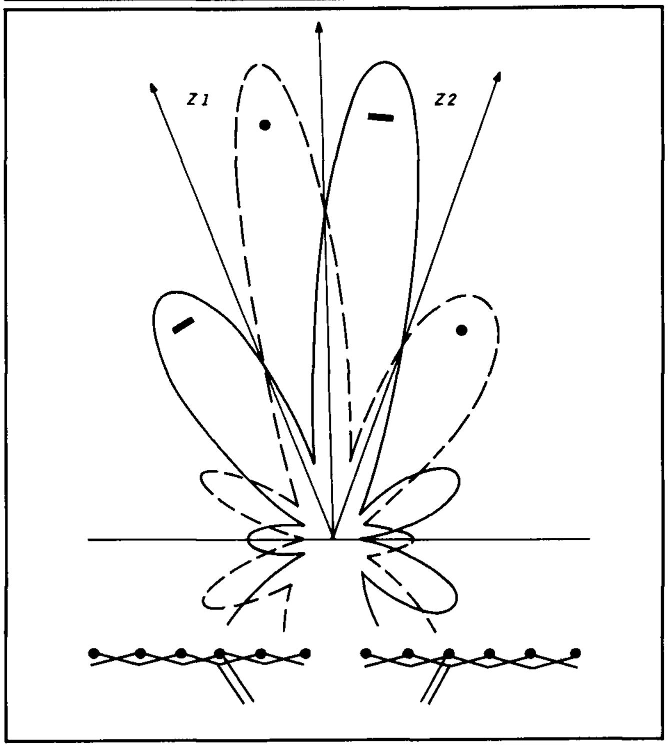
The immense value of Anna numbers was that if the transmitted orders to the beam stations could be decoded in time, he could then tell 80 Wing the frequencies to be jammed. Incredibly, his interpretation of the numbers was rejected because our monitoring services thought there were frequencies outside the range he had found. Dr. Jones's hackles rose — a posture they were seldom slow in assuming — and plain words were spoken. *"These, it transpired, were due to bad measurement of the frequencies of the German beams on the part of the countermeasures organization, a feature that was to plague us through the whole battle. The fault in this case probably lay not with the observers, but with the calibration of our receivers which were not up to the German standard of precision."* His findings were accepted.

Dr. Robert Cockburn of the Telecommunications Research Establishment, having successfully prescribed "Aspirins" for the Knickebein "Headaches," now developed "Bromides" for this new system which was code named "Ruffian." We now knew that the director beam was radiated from near Cherbourg and the cross-beams from the Calais area. As insurance against the failure of the main director beam (Weser), a reserve beam was provided by the adjacent station (Spree). The accuracy of the beams was so great that in calculating their paths it was necessary to take into account that the earth is not a sphere, but flattened towards the poles; this made a difference of 275 meters in where a beam from Cherbourg would cross London!

Countermeasures and counter arguments

Cockburn's jammers came into operation in October, but at this time Kampf-Gruppe 100 began to drop flares over its targets. This was hailed by some of Jones's antagonists as proof that the beams didn't work, or that the Germans were so unsure of them that they were using flares to find out where they were. However, Jones silenced these critics by pointing out that there was no evidence that Kampf-Gruppe 100 was upset by our countermeasures (which was true) and were not only using the system, but acting as pathfinders for other Luftwaffe groups.

FIGURE 7



Beam patterns of mobile X-Gerät.

Yet other problems had to be overcome.

If the Enigma transmissions to the beam stations (usually sent out in the afternoon preceding a raid) could be broken in time, we would know where and when Kampf-Gruppe 100 was going to attack, and our fighters could be ready for them. Our jammers, too, could be set on the correct frequencies. For this to be possible the cryptographers at Bletchley Park strained all their resources — and it was a *magnificent* effort, for they achieved this incredible feat late in October. Dr. Jones was then able to tell Fighter Command the exact place of the attack, the time of the first bomb to within 10 minutes, the exact speed of the bombers, their line of approach to within 90 meters, and their height to within two or three hundred meters!

Yet our night fighters repeatedly failed to find the enemy. Jones wrote: *"I almost began to wonder whether the only use the Duty Air Commodore made of my telephone calls was to take a bet with the rest of the Command as to where the target would be for that night."* On top of this was the growing suspicion that our jamming was not working. Why not?

The answer soon came, but not before tragedy struck.

Moonlight Sonata

On November 10 Jones received an Enigma decrypt of a transmission to the beam stations which told them to prepare operations against target numbers 51, 52, and 53, giv-

ing the beam settings at the same time. It took only a few minutes to work out that 51 was Wolverhampton, 52 was Birmingham, and 53 was Coventry. Then another signal was passed to him which contained orders for a major operation under the code name *Moonlight Sonata*. Four target areas were mentioned but there was no indication of the *order* of the attacks. Frantic guesses were made by the Air Staff and the best they could come up with was that Moonlight Sonata might mean a target in southern England. Strangely, no attack had been made on Wolverhampton, and on November 14 everyone braced themselves for the coming night and whatever Moonlight Sonata might mean.

Tragically, it was one of those afternoons when Bletchley Park failed to break the Enigma signals in time, and 80 Wing asked Jones which frequencies they should set their jammers on, giving a list of frequencies as determined by our monitoring aircraft. *"I could see at once that the measurements must be wrong, in that they did not match up with the figures I knew from the Anna code. I therefore made a mental correction of the measurements as far as I could. For example, 68.6 should have been 68.5, if our receivers had been properly calibrated, or 70.9 should have been 71.0. But deciding what, for example, 66.8 meant was more of a lottery. The only other clue that I spotted was that there seemed to be a convention that the director beams would generally be on frequencies between 66.5 and 71.5 and the cross-beams between 71.5 and 75 MHz — the division being presumably due to operational convenience. Remembering that we needed to knock out the main and reserve director beams and at least one of the cross-beams, I then made my mental gamble and suggested a set of frequencies to Addison which he said he would adopt. All this took no more than five minutes on the telephone, but I was well aware that in these snap decisions I was probably gambling with hundreds of lives. Sobering though this thought was, the fact remained that someone had to do it, and I was easily in the best position."*

Then on the night of November 14th Coventry was attacked, with heavy civilian casualties. What had gone wrong? The next day the decoded Enigma signals to the beams stations arrived and Jones's wretchedness turned to bewilderment. He had guessed the frequencies correctly — so where was the failure?

Incompetence and carelessness

The failure arose originally from a silly interservice squabble which led on to a ghastly mistake. On November 6 one of Kampf-Gruppe 100's Heinkels became lost over southern England and ditched on Chesil Beach. The Army took over, secured a rope around the fuselage and set about salvaging it, when a naval inshore vessel arrived and demanded to know what the Army thought it was doing. As the aircraft was in the water, salvage was a Navy matter, and taking the rope aboard they dragged the aircraft deeper into the sea, breaking the rope in the process. The X-Gerät equipment aboard, now heavy with silt and corrosion, was fortunately discovered and rushed to 80 Wing and then on to Farnborough for investigation.

On November 21 Jones, accompanied by Scott-Farnie and their assistants, went to see it for themsleves. They learned that Farnborough had examined the audio filter and found it set to 2000 Hz. But our jammers had been modulated at *1500 Hz*, which meant that while our carrier frequencies were correct the modulation tone had no effect on the beams.

"It was one of those instances, of which I have since found many, where enormous trouble is taken to get the difficult parts right and then a slip-up occurs because of lack of attention to a seemingly trivial detail. Of all the measurements in connection with the German beams, easily the simplest to determine was the modulation note, because this could be done at any time in comfort; and yet whoever had done it had either been tone deaf or completely careless, and no one had ever thought of checking his measurements. I was so indignant that I said whoever had made such a mistake ought to have been shot." It is hard to believe that the citizens of Coventry would have disagreed with this opinion.

Jones's anger was further increased by the fobbing-off he encountered. He was told that the modulation note was originally 1500 Hz but the Germans had changed their filters to avoid jamming. This ridiculous excuse was countered by Jones who pointed out that if that had been the case we would obviously have heard the change in note for ourselves. In any event he was able to prove that Kampf-Gruppe 100 had been using the same filters since the start of their operations.

On his insistence the jamming modulation frequency was changed and when the Germans later attacked Birmingham their bombs fell wide of the target, most of them outside the city. Gradually they came to realize we had broken X-Gerät and their confidence in the system diminished, and Britain which knew nothing about Dr. Jones and his scientific war went on with "business as usual."

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VERSATILE TRANSISTOR/DIODE TESTER

By Jim Owens, W5JQE, 20594 CR-150, Flint, Texas 75762 with G. D. Hanchett, W2YM

This simple and inexpensive transistor/diode tester shows shorts, opens, leakage, saturation and junction voltage, and relative gain or DC beta. It works on NPN and PNP bipolars, Darlington pairs, signal and power diodes, and FETs with junction or insulated gates in n- or p-channel, depletion or enhancement types. The tester also lets you solder and unsolder delicate FETs in chassis safely, using an ordinary ungrounded soldering iron. In the circuit diagram (shown in the off position) in **Figure 1** note that the RED (+), the RED (−), and the black base/gate (BG) leads are all connected together. You simply connect the micro clips to the transistor terminal wires in the following order: (−) to source, (+) to drain, and one or both of the (BG) clips to the gate terminal(s), and solder. Reverse the order when disconnecting the clip leads. Incidentally, all designators shown in parentheses — (+) and (−) and (BG), for example — conform to markings on the front panel and in the circuit diagram.

To understand how the tester works, set ganged switch S1-3 to the bipolar position (BP). Now trace the current path from the positive end of the AAA cells through CR1, CR2, R2, S1, R4, R5, the meter, R6, CR3, CR4, and S3 to the negative end of the AAA cells. The current drain of the R1 (BIAS) control on the batteries and the loading effect of the meter with its multipliers, along with R8 and R9, produce a voltage drop across the four diodes and the two 1000-ohm load resistors. This voltage drop lets you adjust R4 for 200 μA which registers full-scale deflection on the meter. The actual voltage between the RED (+) lead and the RED (−) lead will be approximately 2 volts. Note the (READ 2 VOLTS) label on the front panel of the tester.

The current drawn by the semiconductor device increases the voltage drop in the tester circuit, so the meter reads the voltage *across* the device instead of the current *through* it. This makes the tester versatile, easy to build, and reliable.

Testing procedures

Try testing an NPN bipolar transistor. Set the S1-3 switch to (BP) and the (BIAS) control to its (−) end. Connect the test clips as follows: RED (−) to the emitter, RED (+) to the collector, and one of the (BG) clips to the base. The meter should read full scale, 2 volts, because the transistor is biased beyond cutoff. Now advance the (BIAS) control toward its (+) end. At some point the transistor will start to conduct; this will increase the voltage drop across R2 and R6, and lower the meter reading. At or before full drive, the meter should read 0.1 or 0.2 volt. It will be drawing about 2 mA and reading the saturation voltage of the transistor under the test conditions. This reading indicates a good transistor. A shorted transistor will read zero; an open transistor will read full scale. The (BIAS) control has no effect on either reading.

The test for a Darlington NPN is the same as for the regular bipolar, but there will be a difference in the meter reading. The Darlington saturates at about 0.5 volt. Transistors are somewhat bidirectional. They conduct and amplify in both directions, but have much lower gain in the wrong direction. So test any unknown unit in both directions.

> How do you tell an NPN from a PNP? Picture a bipolar transistor as two diodes in series. An NPN has its diodes back-to-back, arrows pointing outward. If you connect the (+) clip to the base and the (−) clip to the emitter or collector, there will be conduction with a drop in the meter reading. Conversely, a PNP has its diodes connected face-to-face, arrows pointing inward. So when you connect the (−) to the base and the (+) to the emitter or collector, there will be conductivity and a drop in the meter reading. However, if you connect the test clips to a PNP as an NPN, or vice versa, there will be little or no conduction and the meter will remain at or near full scale.

The test for a PNP bipolar is the same as for an NPN, except that the RED (+) clip goes to the emitter and the RED (−) clip to the collector. The rotation of the (BIAS) control is reversed.

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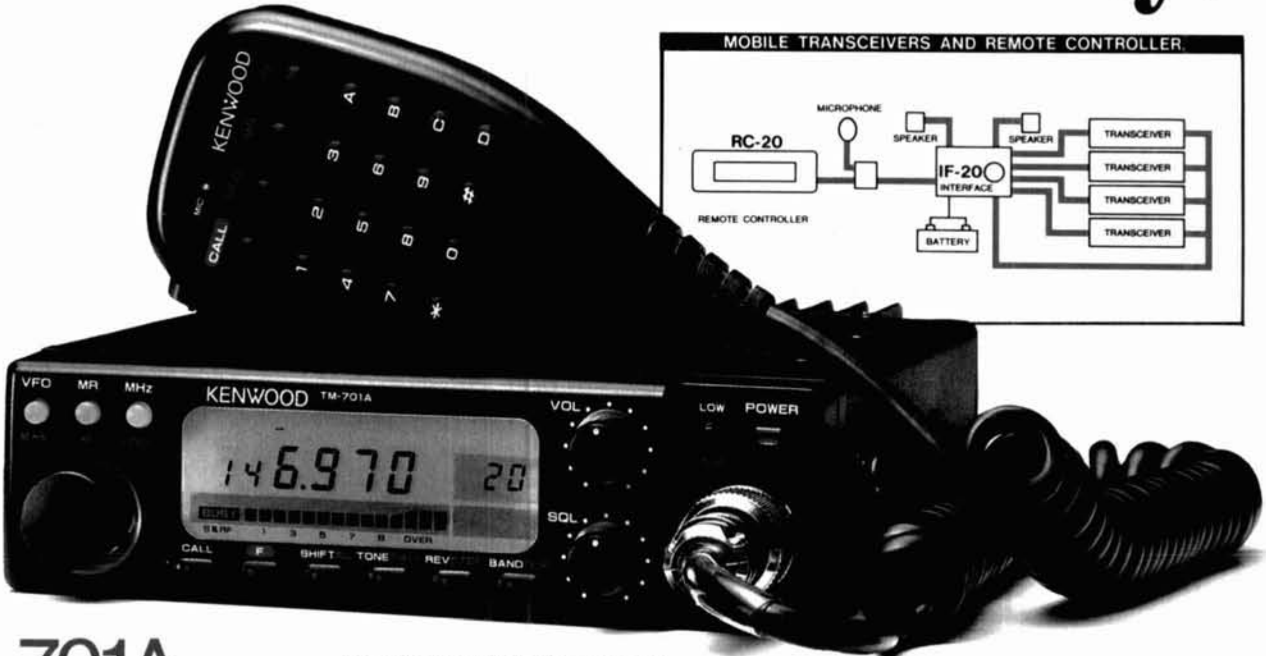

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- **25W on 2m and 70cm.**
- **Selectable full duplex-cross band (Telephone style) operation.**
- **Easy-to-operate front panel layout.**
- **Multi-function DTMF mic. supplied.** Controls are provided on the microphone for CALL (Call Channel), VFO, MR (Memory Call or to change the memory channel) and a programmable function key. The programmable key can be used to control one of the following functions on the radio: MHz, T. ALT, TONE, REV, BAND, or LOW power.
- **Easy-to-operate illuminated keys.** A functionally designed control panel with individually backlit keys increases the convenience and ease of operation during night-time use.
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- **Built-in dual digital VFO's.**
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  - **b) Programmable VFO** The user friendly programmable VFOs allow the operator to select and program variable tuning ranges in 1 MHz band increments.
- **Programmable call channel function.** The call channel key allows instant recall of your most commonly used frequency data.
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- **Easy-to-operate multi-mode scanning.**
  - **a) VFO scan** Band scan, Programmable band scan.
  - **b) Memory scan plus programmable memory channel lock-out**
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  - **d) Scan stop modes** Time operated scan (TO), Carrier operated scan (CO)
  - **e) Scan direction**
  - **f) Alert** When the AL switch is depressed memory channel 1 is scanned for activity at approximately 5 second intervals.
- **MHz switch.**
- **Lock function.**
- **Repeater reverse switch.**

Optional Accessories

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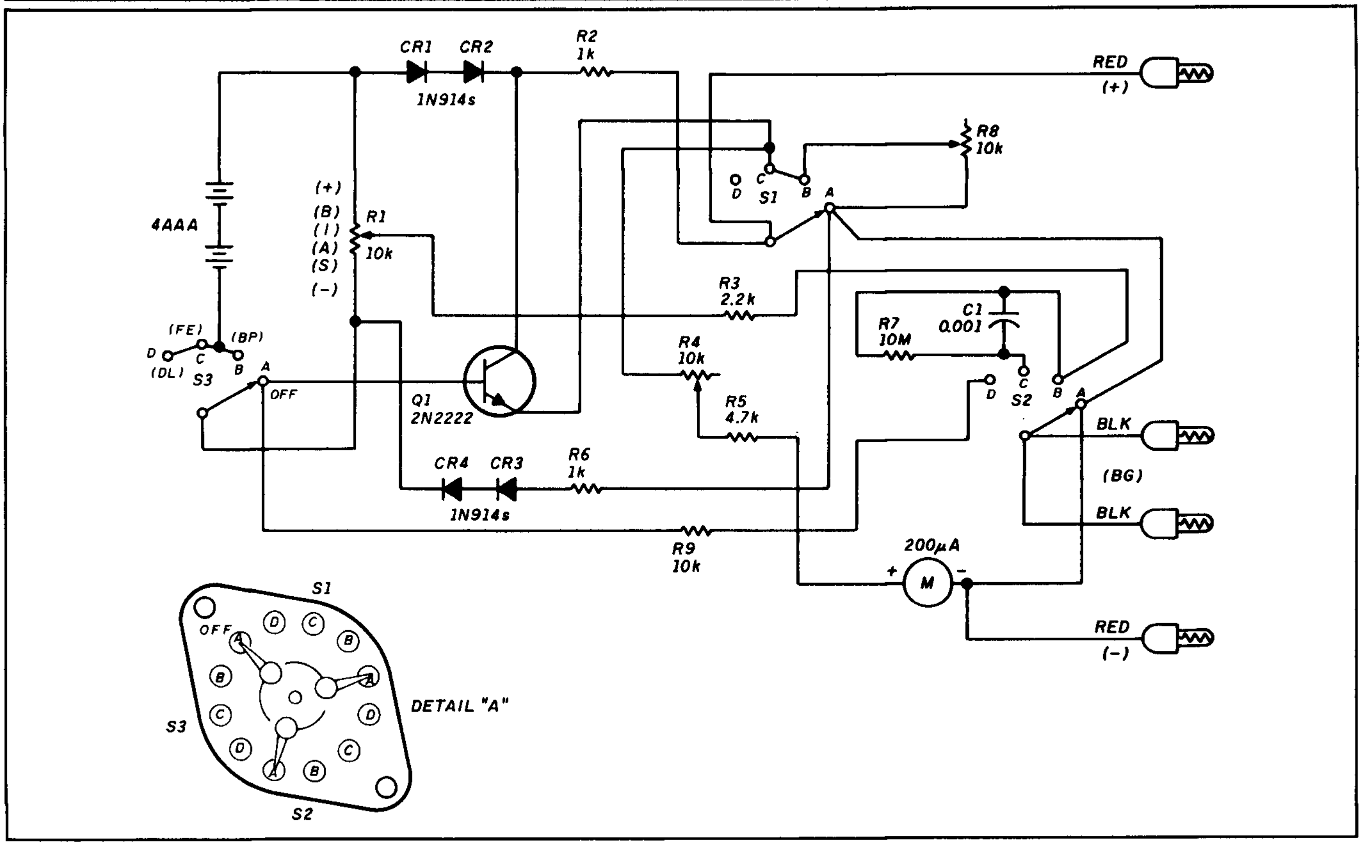
FIGURE 1



Schematic diagram of the diode/transistor tester.

PARTS LIST

CAPACITORS

C1	*0.001 ceramic*

RESISTORS

R4,R8	*10-k potentiometer (RS 271-335)*
R2,R6	*1 k*
R3	*2.2 k*
R5	*4.7 k*
R7	*10 meg*
R9	*10 k*
R1	*10-k potentiometer (RS 271-1715)*

SEMICONDUCTORS

CR1-4	*1N914*
Q1	*2N2222 (RS 276-2009)*

MISCELLANEOUS

Meter	*(no. 20-907 Circuit Specialists)*
Case	*(RS 270-222)*
Knobs	*(RS 274-403)*
Test leads	*(RS 278-016 cut in half to provide four leads)*
S1-3	*four-position triple-gang switch (10YX034 Circuit Specialists)*

Possible parts suppliers
Circuit Specialists, Box 3047, Scottsdale, Arizona 85257
Mouser Electronics, Box 699, Mansfield, Texas 76065
DC Electronics, Box 3202, Scottsdale, Arizona 85257
Madison Electronic Supply, 3621 Fannin, Houston, Texas 77004

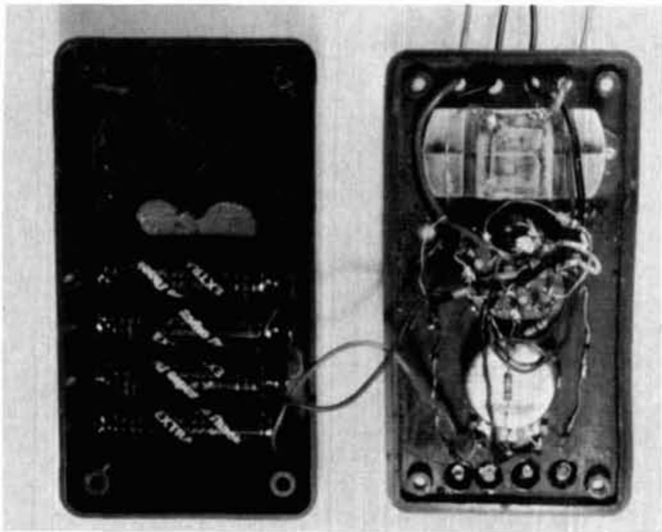
Test all bipolar transistors for leakage in the same manner. Remove the (BG) clip from the base following the saturation test, allowing the unit to self-bias beyond cutoff. If there's no collector-to-base leakage, the meter immediately rises to full scale. You can expect germanium units to show some leakage — the meter won't rise all the way to full scale. However, these units may still operate satisfactorily in circuits designed for them.

Selecting matched pairs is easy. Test the first one with the (BIAS) control set for a reading a little above the saturation voltage. Then try others; don't move the (BIAS) control. Choose the two with the nearest to identical readings.

Testing J-FETs and MOSFETs

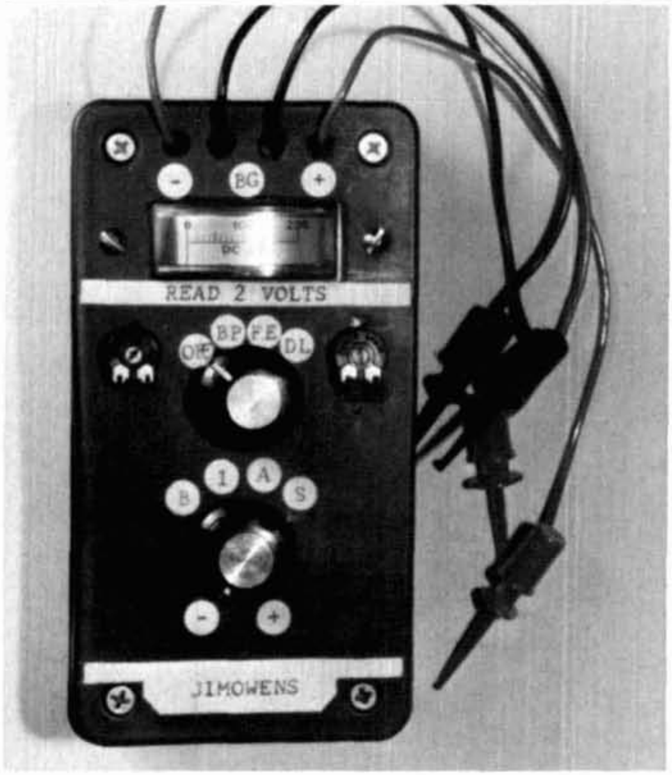
Test field-effect transistors as you would bipolars, but place the S1-3 switch in the (FE) position. This puts a 10-meg resistor in series with the gate. Try a junction gate for your first test. Connect the RED (−) to source, the RED (+) to drain, and one of the (BG) leads to the gate. Rotate the (BIAS) control from cutoff to saturation. As with a bipolar, this occurs at about 0.1 or 0.2 volt. However, if you drive the gate into conduction, the voltage at the source will drop to near zero. To test for leakage, readjust the (BIAS) control for a mid-scale reading and then switch from (FE) to (BP). There will be no change in the reading if there's no leakage. Next, test a dual gate FET like the 40673. Connect the RED (−) clip to the source substrate terminal, the RED (+) clip to the drain terminal, and the (BG) clips to the gate terminals. It will saturate at the same level as the junction FET. Use the same test for leakage. Follow the same procedure for testing a single gate, but expect the saturation voltage to be double that of the dual gate.

PHOTO A



Inside view of the tester.

PHOTO B



Completed tester, front panel view.

Diodes and rectifiers

Semiconductor manufacturers test diodes and rectifiers for forward bias voltage drop (a measure of junction voltage). In the shop or shack, junction voltage is the best indicator of the character of any diode. This measurement is easy to make. Put switch S1-3 in the (BP) position, then connect (+) to anode and (−) to cathode. A zero reading indicates a short; a full-

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scale reading indicates an open. Silicons read approximately 0.6 volt and germaniums read approximately 0.3 volt. Find matched pairs by selecting units with near identical junction voltage. Junction voltage is a more reliable figure of merit than the common ohmmeter resistance reading, in which one scale belies another.

Semiconductor manufacturers specify reverse bias diode leakage in microamperes. Hams talk about it in terms of kilohms or megohms, because we have only our ohmmeters to assess it. Actually, the resistance measurements correlate quite well if they are made above the voltage or current knee. To perform the test, set switch S1-3 in the (DL) position, connect the (+) clip to the cathode, and one of the (BG) leads to the anode. Germanium diodes have reverse bias leakage resistances ranging from thousands to millions of ohms. The usual range for rejection or acceptance lies between these extremes. This calls for a nonlinear meter scale, expanded on the high end and compressed on the low end, with a midpoint of about 500 kilohms. Exact readings aren't important; a point-to-point table will do. (You can glue it to one side of the instrument case.) The following is a tabulation of scale readings versus resistance values which I made for the model.

200 = zero ohms = full scale
150 = 180 k = 3/4 scale
100 = 560 k = 1/2 scale
50 = 1 meg = 1/4 scale
0.05 = 20 meg ≃ no movement

The high resistance point at half division is useful mostly for checking silicon diodes. Silicon diodes are rated at near-infinite resistance; any unit that barely moves the meter is technically a reject. Compare that with a germanium 1N34 which is acceptable with a leakage resistance as low as 100,000 ohms.

In-circuit testing

It is important that an in-circuit tester be nondestructive. With this in mind, I like to use out-of-circuit procedures in an orderly system as follows:

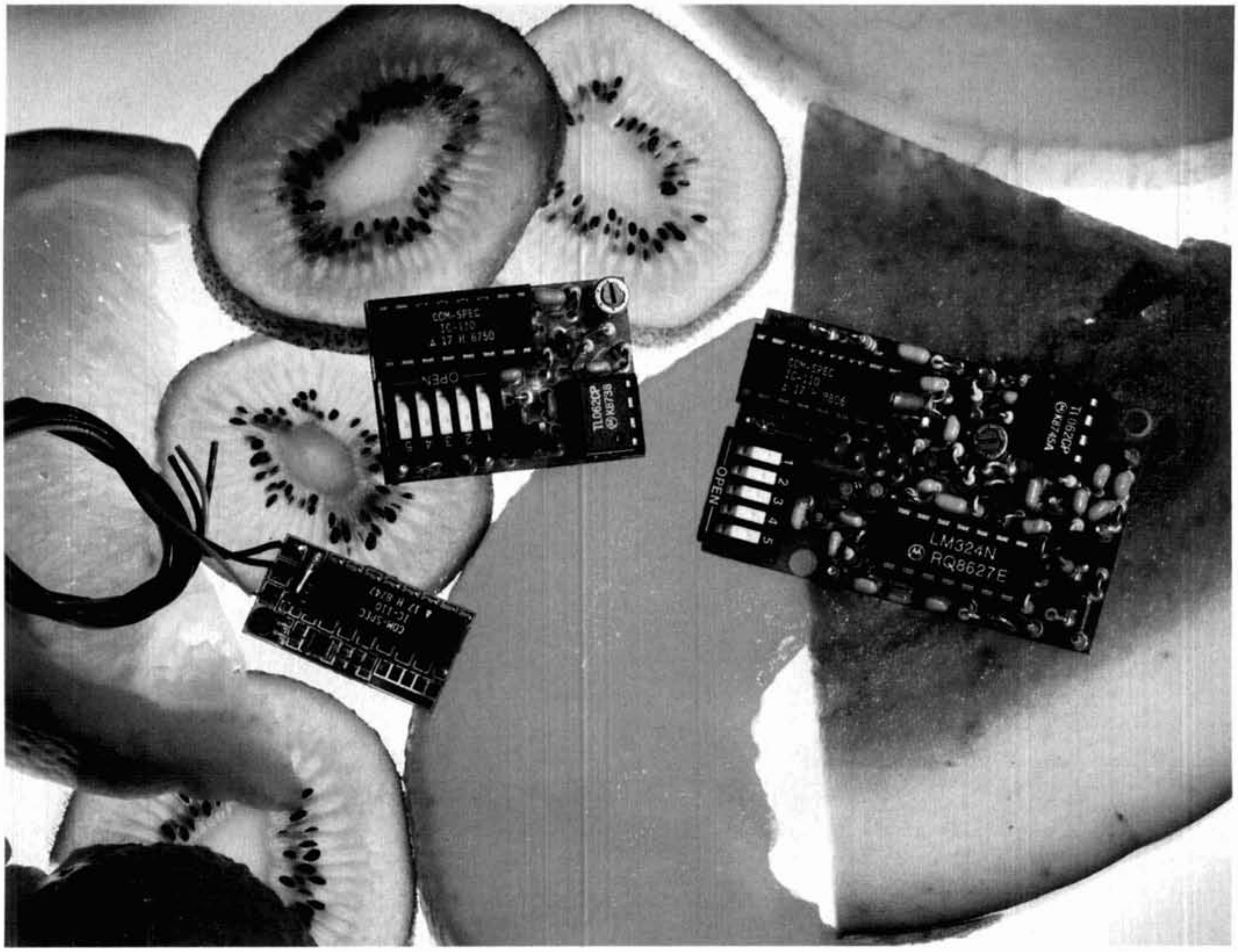
- Connect the transistor as you would out of circuit.
- If the transistor tests OK, move on.
- If the transistor tests NG, unsolder the base or gate and repeat the test.
- If the transistor tests OK now, move on. If not, unsolder the collector or drain, and make one final test. This one is conclusive.
- If you are testing an FET, use the soldering/desoldering technique described at the start of this article.

Construction

All wiring is point-to-point. **Figure 1** is drawn to be a mechanical as well as an electrical diagram. Note that the (OFF) post on S3 is a tie point for Q1's base and R9. Q1 is an emitter-follower current amplifier which drives the meter directly. R9 attenuates the drive to Q1 so that a short between RED (+) and (BG) makes the meter read full scale.

I made the round panel markers from a self-stick file folder label. You can also use ordinary typing paper with a speck of glue. Mark them with a typewriter or fine-tip pen. Use a 1/4-inch punch to extract the markers from the label. (Rub-on lettering is another possibility. Ed.)

R8 is used to load the supply to get 2 volts between (+) and (−). R4 sets the meter to read full scale. There is some interaction between them. **Figure 1** and Detail A show switches S1-3 going counter-clockwise from (OFF), as seen from the rear of the panel while you're doing the wiring. From the front of the panel, the rotation is clockwise. **Photos A** and **B** show an inside view and the completed tester. hr



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A HIGH PERFORMANCE DUOBAND YAGI FOR 15 AND 20 METERS

Two PV4s on a single boom

By David J. Rodman, M.D., KN2M, 368 Hedstrom Drive, Buffalo, New York 14226

Multiband antenna systems with traps, loading coils, or similar devices are common in Amateur Radio. These antennas have many distinct advantages — they can be purchased easily, are constructed simply with manufacturers' kits, are generally fed directly with a single coax line, and give modest performance. Monoband antennas aren't as popular — except within the realm of antenna afficionados, like contest enthusiasts. The superior gain and efficiency advantages of monoband antennas are often outweighed by the antennas' large size, cost, and complexity on a single tower.

I came up with this antenna project when the bands were in the doldrums of the sunspot cycle; that's why it doesn't address a triband system that would normally include the 10-meter band. I made an attempt at a compromise based on the needs of Amateurs who require multiband systems for the most popular HF bands, with the efficiency that approaches separate monoband antennas.

Theory

Wilson Electronics Corporation was the most recent manufacturer to address the idea of a duoband antenna system. Such antennas were adequate performers on the lower frequency; however, when used with the higher frequency, operators found not only that the gain was less than advertised, but the front-to-back ratio was dismal. While the use of two harmonically related or unrelated frequencies on the same boom has been addressed, don't assume that harmonically unrelated antennas in this configuration are devoid of element interaction.[1] In fact, just the opposite is true. Positioning harmonically related or unrelated elements in close proximity to any antenna tends to invite electrostatic shielding in some configurations. This shielding affects the higher frequency antenna more than its lower frequency counterpart because of the size of the elements. The effects of this interaction are most pronounced when antennas share the same boom. Electrostatic shielding also alters antenna performance when separate antennas are spaced inadequately.

Duoband antennas show degradation of front-to-back ratios on all frequencies, and forward gain reduction on the higher frequency antenna, as a result of electrostatic shielding. You'll need to anticipate this problem before you start to build if you want to improve your antenna's performance. Empirical estimations of element placement appear to be no better than chance in designing such antennas, and yield equally poor performance. To ease this burden for Yagi design, use computer modeling programs to simulate antenna performance before actual construction. These programs let you make accurate and precise iterations of design parameters in minutes.

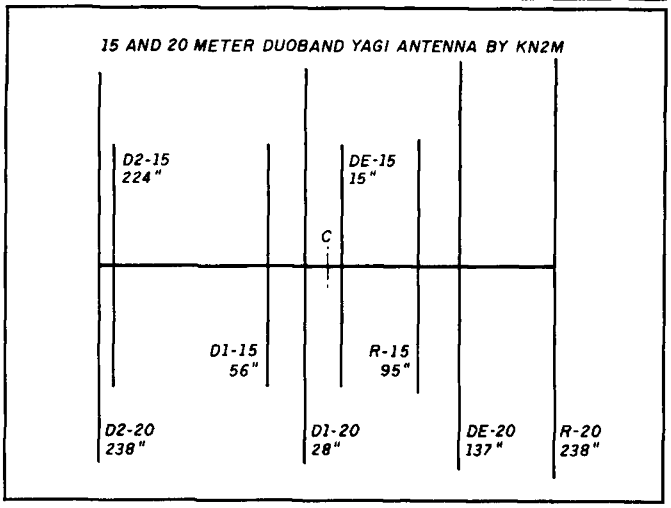
Design approach

I used MININEC to develop my antenna. MININEC lets you alter element size and spacing until both forward gain and front-to-back ratios are maximized at the desired operating frequency and height above ground. Actual antenna testing with distant observers showed that measured performance can even surpass computer predictions.

Before I discuss the optimization technique, I'd like to make several points concerning computer modeling. First, actual MININEC calculations are dependent upon the CPU type, clock speed, and the presence of a mathematical co-processor. Use the fastest system available to speed your calculations. Second, it's extremely difficult to model commercial multiband trap Yagi antenna designs. You need to specify all complex reactance values along with their locations in three-dimensional space precisely, before even attempting this. Don't expect to redesign trap antennas easily with such software. Finally, the calculations performed for my antenna required exhaustive changes in element position and length before I made my final design selection. Conceptually, it's similar to tuning a circuit with eight unknowns. The system performs as described for the dimensions and element taper specified. Small deviations from these specifications won't necessarily produce the same results. If you want to alter these values, I suggest you use computer modeling to make your changes.

The method required to maximize the performance of this

FIGURE 1



Element name code and distance from boom center.

or any similar project is as follows. First, start with a design showing element size, location, and diameter. Translate this data into a simple mock-up of the antenna (ignoring element taper) modeled in free space. With MININEC, calculations in free space are much faster than those performed over real ground. When you've produced a suitable design, model the antenna over real ground at the desired height. Once your design proves satisfactory, make a real model of the antenna with the actual taper schedule in free space. I used a BASIC program written by Bill Myers, K1GQ, called TAPER.[2] Finally, model the actual antenna over real ground. At any point in the analysis, you can vary element location to maximize the front-to-back ratio and minimize loss in forward gain. These values are generally inversely related, and give many opportunities for producing either a suitable design or one that becomes increasingly undesirable. Throughout your calculations, remember to accommodate maximum gain and front-to-back ratios at the design frequency.

Results

The antenna design is shown in **Figure 1**. This antenna system is based on the PV4 antenna designed originally by the late Jim Lawson, W2PV. The antenna was only recently introduced to the general Amateur population.[2] I read several sources before building the antenna that provided excellent background on construction.[1] The characteristics of this array are similar to previous descriptions in that gain is fairly constant over each band, but the front-to-back ratio peaks in a narrower frequency range.

Essentially, I've mounted two of these antennas on the same boom and redesigned them carefully to maximize antenna performance. Lawson was the first to note that gain is dependent on boom length. He also observed that front-to-back ratios are maximum at odd multiples of quarter-wave boom lengths.[3] Here, in contrast to those findings, gain and especially the front-to-back ratio of the higher frequency antenna are inevitably decreased by the electrostatic shielding of two antennas on the same long boom. The only way to maximize the front-to-back ratios of the two antennas is to perform repeated calculations with MININEC. Despite this technique, the gain on 15 meters is less than on 20 meters for the same electrical boom length. A rule of thumb when designing multiband antennas like the one described here is that the gain of the higher frequency antenna will approximate a three-element array of lesser boom length. A comparison of this data is shown in **Table 1**. If you can accept the fact that the 15-meter portion behaves more like a three-element antenna on a 0.3-wavelength boom, then this is by all accounts an excellent system. You now have a multiband Yagi without traps, but with maximum gain and front-to-back ratio at the design frequency. The system does require separate feedlines and matching devices for each band.

As you'll note in **Table 2**, the design uses relatively large element diameters. I selected aluminum sizes in an attempt to keep construction as rugged as possible. Moreover, with a large element diameter, the SWR bandwidth is increased by maintaining relatively low element Q. You can match your antenna with a gamma match or a beta device, whichever you like better. Note that the driven element length here has been shortened somewhat to produce the capacitive reactance necessary for the gamma match actually used in construction.

TABLE 1

Duoband antenna electrical characteristics for 14.175 and 21.2 MHz.

	Forward gain	Calculated F/B	Measured F/B	Input Z
20 meters	10.0 dB	25.4 dB	40 dB	19.4-j22.8
15 meters	7.9 dB	25.1 dB	35 dB	14.9-j20.1

TABLE 2

Duoband antenna element half-length data for 14.175 and 21.2 MHz.

Location	Length 15 inches	OD 15 inches	Length 20 inches	OD 20 inches	Material
Segment 1	72	1.125	72	1.125	6063-T6 0.049 wall
Segment 2	End piece varies	1.0	68	1.0	6063-T6 0.049 wall
Segment 3	none	none	End piece varies	0.875	6063-T6 0.049 wall

TABLE 3

Duoband antenna element end piece length data for 14.175 and 21.2 MHz.

Element	Length 15 inches	Length 20 inches	Distance to boom center inches	
Reflector	67.0	74.4	15-95	20-238
Driven element	59.0	58.2	15-15	20-137
Director no. 1	57.6	55.9	15-56	20-28
Director no. 2	55.0	49.9	15-224	20-238

Construction

Before assembling this antenna, remember to follow and reproduce exactly the dimensions specified by computer modeling (**Table 3**). If you don't you will get a less than optimal result, first noted in decreased front-to-back ratios.

There are advantages to using this particular configuration with a 40-foot boom. First, this is an excellent length for the 20-meter band, giving 10-dBi forward gain. Shortening the boom sacrifices gain on the most popular HF band. Second, the boom material (3-inch OD 0.065-inch wall aluminum tubing) is available in 20-foot lengths. The boom halves can be joined with a 3-foot piece of larger wall 2.875-inch OD tubing.

Be sure to place furniture foot caps on the ends of all elements during construction. This eliminates the risk of damage during ice storms. I also suggest using conductive grease at all element telescoping positions. Use simple hose clamps to secure each telescoping joint. To help retard weather corrosion, coat all hardware surfaces during construction with a clear aerosol varnish designed for outside use.

As I mentioned before, there are mechanical disadvantages when using the PV4 antenna. Because you use odd element spacing, the driven element location and matching device are at some distance from the mast. This antenna also needs a substantial boom brace because of the number and spacing of elements, and the fact that PV4 antennas tend to have a center of gravity away from the boom center. You'll note that the 15-meter portion of this antenna has been moved towards the director end of the boom. This makes it possible to adjust the matching device for that band while the antenna is on the tower. The array also has less tendency to be reflector heavy.

Many of you may shy away from any antenna project that requires construction and adjustment of a matching device. Because this antenna requires some reorientation during adjustment of the match for 20 meters, I'd like to make some points that should simplify these tasks. First, a calibrated noise bridge is invaluable for determining feedpoint resistance and reactance values. Second, if you use an odd multiple half-wavelength line for these measurements, you can even make them in the shack. Third, the actual feedpoint impedance may be measured more conveniently and with greater safety at a height lower on the tower, as it may be necessary to tilt the array upwards to reach and adjust the match.

Conclusion

The antenna design I've presented shows how current technology allows optimization of Yagi performance beyond previous methods. Computer analysis now replaces most antenna range testing. I've used my antenna at heights of up to 1.4 to 2 wavelengths above the ground. It performed well when contacting DX stations. The front-to-back ratios, both predicted and measured, are extremely favorable when compared with commercial antennas.

This antenna, like any multiband, has limitations. However, should you build one of these, you should notice definite improvements in band-centered gain and front-to-back ratios over multiband commercial antennas. Using a duoband antenna like this for the new 17 and 12-meter bands should give satisfying results with a single array. hr

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2. W. Myers, "The W2PV Four-Element Yagi," *QST*, October 1986, pages 15-19.
3. J.L. Lawson, W2PV, *Yagi Antenna Design*, American Radio Relay League, 1986.

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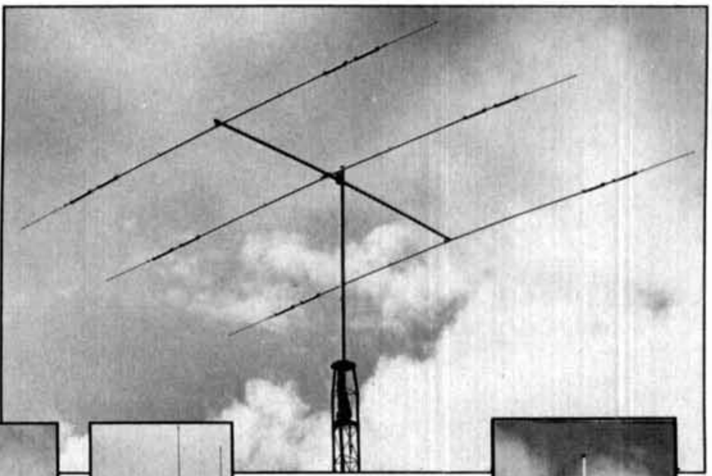

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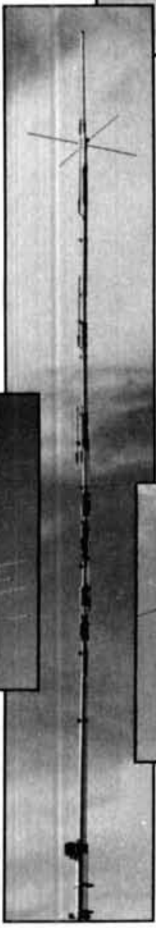

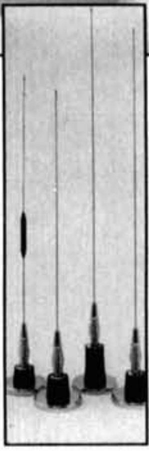

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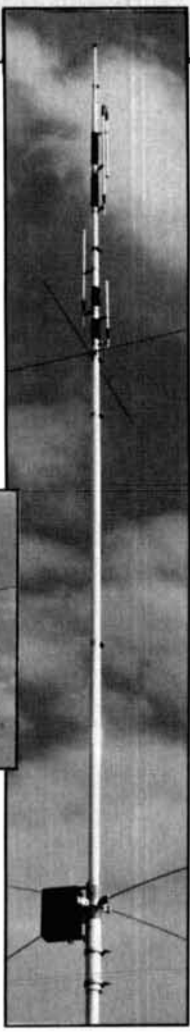

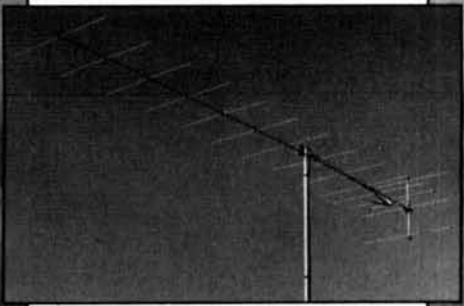

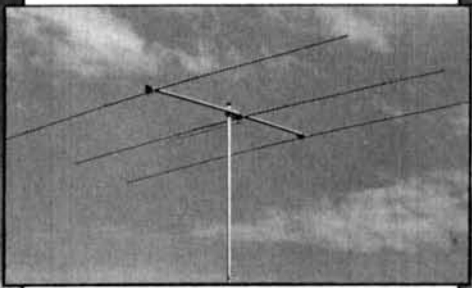

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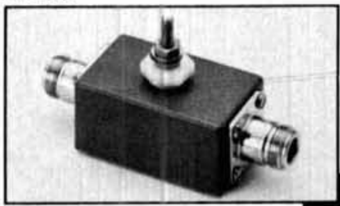

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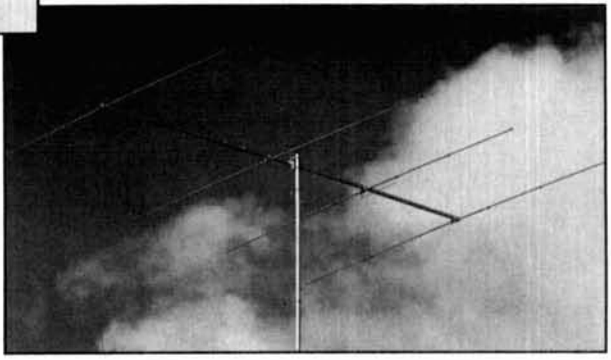

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PHONE CONTEST

The story of 1988's record-breaking effort

By Mark Allen, WJ7X, National Service Manager, Icom America, Inc.

I was taking a late night flight home from the Dayton Hamvention™ in 1988. As I settled into my seat, I saw the face of an old friend, Danny Eskenazi, K7SS, in a distant part of the sparsely occupied cabin. When I went over to say hello, I found Danny sitting with John Kiesel, KE7V.

The conversation drifted from topic to topic during the long flight, until the subject of a DXpedition came up. Danny's eyes beamed as he asked if I might be interested in lending technical support to a possible DXpedition to Aruba. Carl Cook, AI6V, had talked with Dan and several other operators about putting the DXpedition together in an attempt to win the 1988 CQ Worldwide DX Phone Contest.

The idea appealed to me greatly; however, my skills as a contest operator were minimal. I thought the DXpedition might be a good vehicle to get back into the contesting scene.

The remainder of the flight was occupied with talk about the most efficient way to beat our competition from both technical and operating standpoints. As I listened, I realized that I had fallen years behind the other operators in contesting.

About the time my enthusiam reached its peak, I was informed that Carl was going to run the operation on a "by invitation only" basis. Getting an invitation was going to be difficult, unless I had something specific to contribute. My contribution would definitely have to be my technical skills. As we left the plane in Seattle, Dan assured me that he would see what he could do.

Carl called a few days later. He said there was a rumor circulating that I was interested in getting involved in his planned Aruba DXpedition. Without the slightest hesitation, I told him "absolutely."

After a brief rundown of my technical background, Carl decided that it would be a good idea to have me along. Although I didn't realize it, my 20-year ham radio career was about to change dramatically.

Carl immediately put me to work on a series of challenging technical questions. He asked if I realized the range of the problems caused when six stations were operating simultaneously in a confined geographic area. I have had quite a bit of experience in this type of situation and an extensive career in the broadcast industry, so I was very familiar with the problems. However, I had never encountered anything of this magnitude. Carl decided that because I had experience in the Caribbean and Bahamas, I would also be a good person to coordinate our equipment shipments from the United States to Aruba.

Over the next several months, the scope of the project changed considerably. Carl recruited Evelyn Garrison, WS7A, to develop the concept of a ***TEAM ICOM***. ICOM would provide equipment for the effort and make transportation arrangements. In a meeting held shortly thereafter, Ron Rueter, NV6Z; Daniel Handa, W7WA; John Kiesel, KE7V; Dan Eskenazi, K7SS; and I had our first discussions about the exact types of equipment and station layouts we were going to use.

Although I didn't know it at the time, Murphy's Law was about to complicate our plans.

Our equipment list included: two IC-781s, three IC-761s, two IC-751As, seven IC-735s, four IC-12AT handi-talkies, power supplies, microphones, and various other accessories. We spent the next month drawing layout diagrams for each station, required antenna configurations, bandpass and band cutoff filters, and calculating the amount of coax cable and rope we'd need. Carl was a great help to us since he had coordinated such operations before and was familiar with the field problems involved in erecting massive numbers of antennas. At the last minute, Dick Ehrhorn, W4ETO, of ETO Alpha Amplifiers, offered a loan of Alpha 86 amplifiers. The group was very happy about this addition; it would add another couple of dB to our signal.

The logistics

By July 1, 1988, things were beginning to happen. Hundreds of hours had been invested in the project for planning, drawing, replanning, and computer analysis. It was at this time that I had my first contact with Tom Schiller, N6BT, whose area of expertise is antennas. His prowess at optimizing antennas absolutely amazed me! Tom and I had several discussions, and he ran a computer optimizing program to find the best antenna configurations.

Finally, the time came to find a place to collect all our equipment. We had amplifiers, radios, tower sections, cable, rope, and antennas. John Lopez of International Radio Systems in Miami graciously loaned us a warehouse facility. During July and August quite a bit of material arrived at John's warehouse.

In the meantime, the activity at ICOM continued at a frantic pace. All the equipment being sent to Aruba was new. First it was functionally checked for "infant" failure problems. ICOM's HF technician Russell Dudley, KW5O, coodinated this effort. Every conceivable parameter was checked on the 781s, 761s, 751As, and 735s. I began assembling spare parts kits, which included service manuals, owner's manuals, and parts that wouldn't be available in the field.

Although I didn't know it at the time, Murphy's Law was about to complicate our plans.

I had contacted a freight-forwarding service in Miami and had been assured that equipment transportation to and from Aruba would be no problem. Their planes, they said, flew to the island on a daily basis taking supplies to the hotels and casinos. It was here that I made my first mistake. Assuming that anyone who transported casino and hotel supplies should surely be well connected, I didn't do any serious checking. Boy, was I ever wrong!

Around the middle of August, I called Dick Ehrhorn, W4ETO. He informed me that all the amplifiers had been checked, rechecked, and shipped to our collection point in Miami. I also confirmed that all the tower materials, antennas, rope, and coax cable had also been shipped. ICOM shipped their equipment, and the whole project was in the hands of the trucking companies and UPS.

By September 1st, all the equipment had reached Miami and was being prepared for shipment to Aruba. There was not the slightest hint of trouble.

After extensive consultations with the Miami freight company, it was determined that the equipment needed to arrive by October 15th; the nominal shipping time to the island of Aruba was three or four days. We were told: "No problem." Murphy laughed at our ignorance.

A small setback

On Monday October 17th, I received a panicked call from Carl. He was in Aruba, but there was no equipment waiting.

The first call to the freight company indicated that the equipment had been picked up, shipped, and was in Aruba. Carl spent the remainder of the 17th and most of the 18th trying to locate it. Finally, after scouring customs, the air freight office, and the island, he determined that the equipment was just not there. Another call was made to the freight company. They were absolutely sure the equipment had been shipped and had flight and waybill numbers to prove it. Carl spent most of the 19th and 20th of October calling from Aruba, trying to locate the shipment.

Meanwhile, Hurricane Gilbert was lashing the islands of Bonnair and Curaco, and there were heavy rains and stray winds on Aruba. Time was rapidly running out. The entire crew was due on Monday the 24th to begin assembling the station and raising towers and antennas. Unfortunately, there was nothing for them to raise.

Late on Thursday October 20th, Carl determined that the freight had been shipped on the 19th. However, it had been sent to Curaco instead of Aruba. It seemed that the air-freight company was temporarily banned from landing in Aruba.

On Friday the 21st, we discovered that the freight agent in Curaco handling our shipment was an Amateur operator. Carl pleaded with him and explained the problems we were having. Magically, the brotherhood of Amateur Radio came

together. The shipment began arriving on the 22nd. The majority of it was in place by the 24th. Unfortunately, we discovered that we were still missing all of the antennas. We began working our way backwards and finally discovered that the antennas inadvertently had not been shipped from Miami. We made a hasty call to American Airlines air freight and they arrived on the 26th. We went to work building antennas the instant Carl drove in from the airport. Although we had built the towers on the 25th and 26th, we didn't actually get to put up the antennas until late Wednesday. Antenna erection continued throughout the day on Thursday and finished the morning of Friday the 28th, with the contest a mere twelve hours away! I left Seattle on the 24th, planning to land in Aruba later that night.

When I arrived, I found that the shipment had finally made it. Most of the equipment had been removed from its shipping containers and checked. Aside from a minor ding to an amplifier, the equipment had reached its destination in good condition — despite its detour!

The work proceeds

Meanwhile, all our technical plans were falling into place. There were two houses a short distance apart. We decided that the 10, 15, and 20-meter activities would be headquartered at one house. The Forty, 80, and 160 meters would be

at the other, which had a large open field that we would use for our Beverage antennas.

Two 781s were assigned to the 40 and 80-meter positions; the 160-meter position had one 751A, and three 761s covered 10, 15, and 20 meters. The 735s were used parallel to each position for spotting radios. They were connected via a relay network so the spotter operator could take control of the amplifier and antenna to grab a rare contact.

The antenna system generally consisted of four-over-four stacks on 10, 15, and 20 meters. The lower antennas were fixed and connected via a phasing harness to the upper, rotatable antenna. Stacked two-element beams were used in the same configuration on 40 meters. The antennas for 80 and 160 meters were pure magic! Wally Eckles, W8LRL, noted low-band DXer, appeared on Wednesday with the supplies to build the 80 and 160-meter antennas.

Wally proceeded to construct one of the largest low-band Beverage arrays I had ever seen! The transmitting antennas were an array of long wires, slopers, and a vertical made out of pipe borrowed from a local refinery. Stringing out the wires for the Beverage was an interesting experience. We traipsed through coral fields, slightly overgrown with underbrush and overrun with small iguanas. The ground around us moved continuously, as the lizards scurried about.

After all the antennas were up, everyone began making cables. There were hundreds of PL 259s to be installed on various types of coax cable. Our low-frequency antenna construction had fallen behind schedule. Consequently, the 160 station didn't get on the air until several hours into the contest. Station after station was falling together when, all of a sudden, Murphy struck again!

What we thought was going to be a simple licensing procedure for our operations became a total nightmare. Problems with the local telecommunications agency necessitated going all the way to the Minister of Telecommunications. The Minister, a most gracious gentleman, expedited our paperwork at an unbelievable pace. He assigned his assistant to take care of our needs, and though we had gotten off to a slightly rocky start with the local government, our P4Ø licenses came through at the last possible minute.

After all the months of planning, hundreds and hundreds of hours of work, and monumental expense, the contest was on!

We spent Friday the 28th cautiously tuning up amplifiers and radios. Amazingly enough, everything worked! The antennas performed as well as (and in some cases, better) than we expected. We keyed up transmitters at each location, to check our power requirements and to see if the AC wiring in the residences would stand the load. We found no problems with the AC power in either the HF or the LF house.

As Friday continued, everyone performed extensive equipment checks and rechecks. I found myself running from pro-

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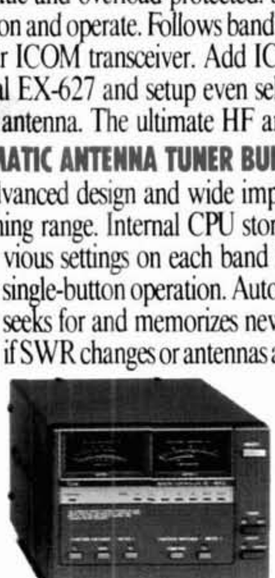

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ject to project, taking care of problems with flip switches, headset wiring, digital voice keyers, and every other aspect of the operation. Since this was a group of the world's finest operators, I was hardly about to question why each one of them needed a different kind of headset. There were as many different headsets, microphones, and keyer arrangements as there were operators. Contest time was now just six hours away. I was still frantically putting PL-259s on coax for short jumpers, rechecking the tuning on amplifiers and interfacing headsets.

We began our final on-the-air testing late in the afternoon of October 28th around 2200 Z. With one exception, all was operating well. Our 160 antenna was still under construction. W8LRL was hard at work building an antenna tuner to replace one that accidently got left behind.

The contest

By now, blood pressure readings for the first shift of operators were far above safe levels. Everyone and everything was ready to go. It was hard to believe the contest was finally beginning. After all the months of planning, hundreds and hundreds of hours of work, and monumental expense, the contest was on!

Approximately two hours into the contest, the 160-meter antenna problems were resolved, and the 160 station got on the air. Dick, W4ETO, and I continually monitored the heartbeat of the system. Dick kept an eye on the Ehrhorn amplifiers, and I watched all the ICOM equipment and peripheral devices.

Dick and I crossed paths when the contest was about six hours along. We discovered, to our excitement, that neither of us was having any equipment problems. We were amazed that everything was working; all the equipment was talking, but not to each other! We attributed the success to good equipment and excellent planning.

I finally closed my eyes around 3:00 a.m. Saturday morning, only to be awakened at 4:30 a.m. by Tom, N6BT, the on-the-air coordinating officer. He told me that the 15-meter station was down and nobody could figure out what was wrong with it. Ron Rueter, NV6Z, met me at the 15-meter position. It took two and a half minutes of troubleshooting to determine that a coax line was open. We replaced it quickly with a spare line, and 15 was back on the air. The total downtime was about six minutes. This was the only failure of any item during the contest.

By noon Sunday we hoped that the equipment would continue to operate without failure. Tom was passing out some promising information. Scores were stacking up impressively; they were even higher than we had expected. As each hour passed, the chances of Murphy striking again were reduced by several orders of magnitude. It was apparent that we were closing in on a new world's record. We had had a small rain shower and I nervously watched Bird watt meters for reflected power. I was sure that many of the outside connections were untaped — although we had tried to tape each of them.

I'd been so busy keeping an eye on all the equipment that I hadn't noticed that the support crew had put champagne on ice. This was a good indication they knew something that I didn't. I made a quick check with N6BT; our score was running well above what we expected.

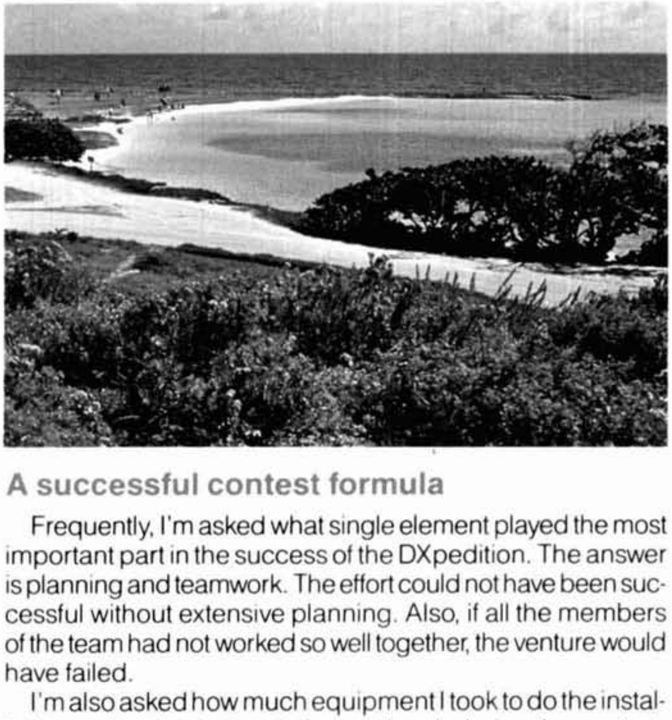
Finally, it was over; it was hard to believe. We had run the whole weekend without any equipment failure. There was much nervous talk about the exact status of our final score and our standing in the contest.

By Tuesday many of the operators had returned home; they had all been on tight vacation schedules. This left about five of us to disassemble and pack. Before we got started, we got word that ICOM was willing to sponsor the group for the CW contest that was coming in several weeks. With that news in mind, we took down the low-band station equipment and all but two operating stations of the high-band station and put them in storage.

All too soon it was time to leave and head back home. Eight months of planning and hundreds of hours of effort had paid off. As I stepped onto the plane to leave P4Ø land, I realized that I had been part of a world-champion DX team — a claim very few operators can make!

The final score, after all was checked and duped, was 54,864,040 points. This should surpass the old world's record by 12,906,796!

I realized that I had been part of a world-champion DX team — a claim very few operators can make!



A successful contest formula

Frequently, I'm asked what single element played the most important part in the success of the DXpedition. The answer is planning and teamwork. The effort could not have been successful without extensive planning. Also, if all the members of the team had not worked so well together, the venture would have failed.

I'm also asked how much equipment I took to do the installation and maintain the station on the air during the contest. I took my old faithful Bird watt meter with a full selection of elements, a set of hand tools, large and small soldering irons, a logic analyzer and a multimeter. I'd advise future DXpedition organizers to have operators submit itemized lists of the equipment they bring, in addition to marking each item with their name or callsign. Each of our operators was asked to bring such things as coax relays, keyers, headphones, and individual operating accessories. Consequently, we had quite a problem making sure everyone got back what they brought as we disassembled the station.

The attitude of our entire group during this DXpedition is best summed up by the saying on the license plates on the small, friendly island of Aruba. It says, "One happy island." We maintained our sense of humor and optimism during the long hours of planning, setup, and the contest itself. And the results paid off. hr

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Over 50 million points and 20,000 SSB contacts in 48 hours. That's what TEAM ICOM's operation from Aruba/P4ØV achieved during the 1988 CQ DX Contest setting a new all-time world record. Their incredible CW performance four weeks later was an overwhelming success... P4ØV's combined scores resulted in the highest SSB/CW contest score ever recorded!

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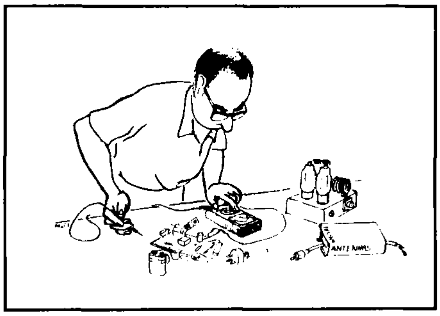


Bill Orr, W6SAI

THE GAMMA MATCH: AN UPDATE

When the 88 to 108-MHz FM broadcast band was authorized shortly after World War II, a VHF transmitting antenna using an off-center feed system was introduced. Adapted for Amateur use, the system was termed the "gamma match" and was featured in *QST*, September 1949. The builder, H. Washburn, W3MTE, remarked that the device worked well, permitting him to achieve an SWR value as low as 1.75:1. His arrangement is shown in **Figure 1**.

Several other antenna experimenters and I worked with the W3MTE gamma match. We soon determined that to lower the SWR appreciably below 2:1 a variable capacitor had to be placed in series with the gamma rod (see **Figure 2**).

Little information was available on optimum rod-to-antenna spacing, rod length, or rod diameter. It was strictly a cut-and-try situation. Some Amateurs had good luck with the device; others couldn't get it to work. The gamma match soon got the reputation as a tricky device that was hard to adjust. In time, it became apparent that the gamma rod had to be small in diameter compared with the driven element, and that the spacing of the gamma rod to the element had to be quite large compared with rod diameter, in order to make the system work properly.

Some attempts were made to analyze the gamma match using transmission line equations. But it wasn't until Harold Tolles, W7ITB, analyzed the device[1] that a computer program was derived that would predict gamma dimensions accurately for a particular antenna.[2]

The gamma match program

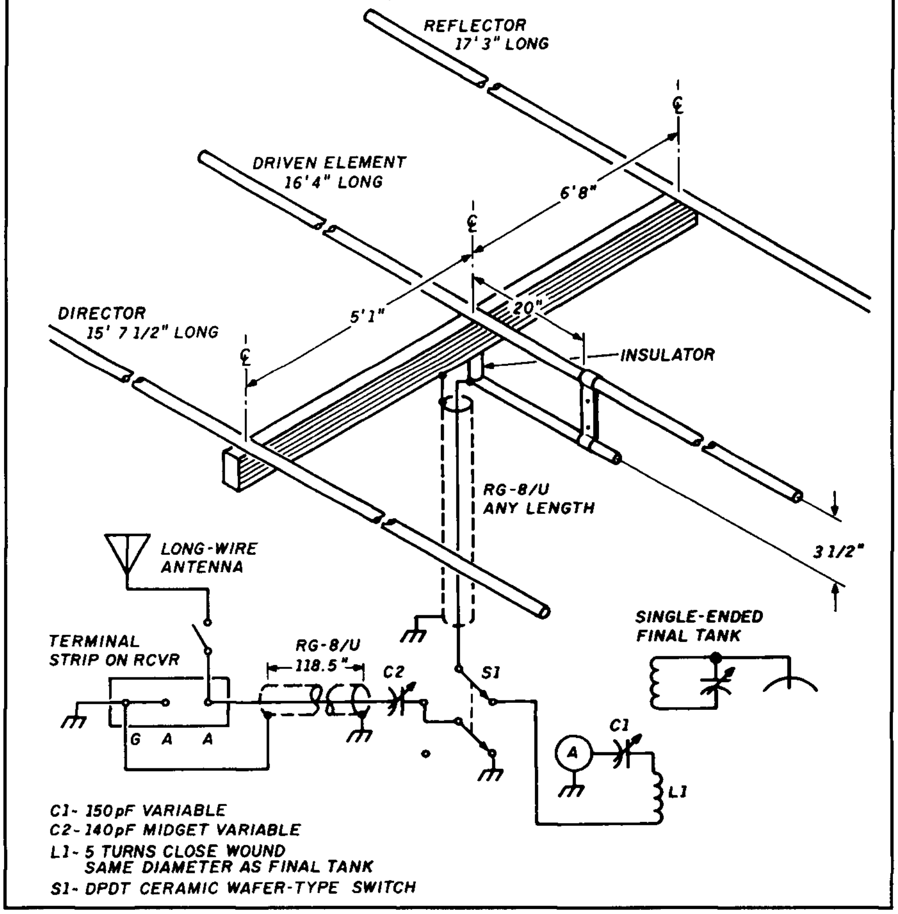
The gamma program, written in BASIC by Richard Nelson, WB0IKN, is based upon W7ITB's analysis and designed for the Apple II+. It can be modified to work equally well with many microcomputers.[3]

I put the program to use designing a gamma match for a three-element, 10-meter Yagi. I took beam dimensions from my *Beam Antenna Handbook*.[4] Design frequency was 28.5 MHz. I planned to use a 1-inch diameter element, a 1/4-inch diameter gamma rod, 3-inch center-to-center spacing, and a 100-pF series capacitor (refer to **Figure 3**). Feedpoint impedance was estimated to be 18 ohms and I wanted to match to a 50-ohm line. When I plugged these values into the computer program, it indicated a gamma rod length of 22 inches and a series capacitance of 180 pF.

These results immediately rang an alarm bell. Our experiments had indicated that the series gamma capacitor should be about six times the operating frequency in meters and the gamma rod

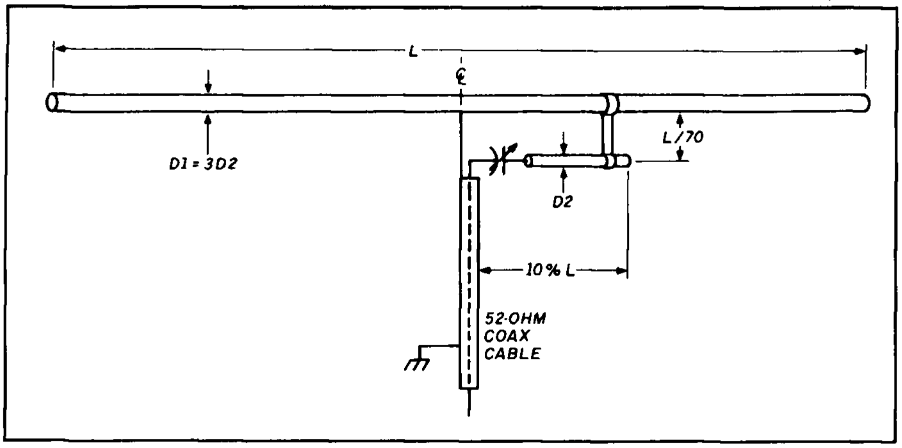
FIGURE 1

Dimensions of the gamma match beam at W3MTE.



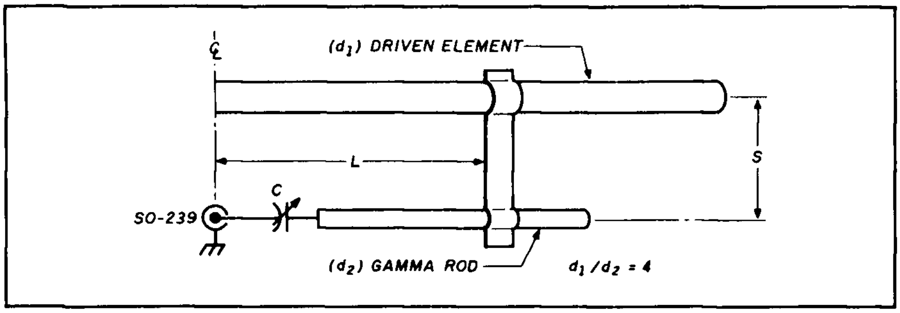
The early gamma match described by W3MTE (*QST*, September 1948).

FIGURE 2



Early *Radio Handbook* shows series gamma capacitor and approximate dimensions for gamma match.

FIGURE 3



W6SAI's 10-meter gamma match. Diameter d_1 = one inch, d_2 = 1/4 inch. Center-to-center spacing = 3 inches.

should be about 0.04 wavelength long. For the 10-meter band, this works out to a capacitor of 60 pF and a rod length of about 16 inches. To back up my assumption, I found a commercially produced 10-meter beam with substantially the same dimensions as my design, using a 19-inch gamma rod and a 45-pF capacitor. Not too close, but a lot closer than the answer ground out by the computer program!

Obviously, there was some factor I hadn't taken into account that influenced gamma dimensions. There was more to the gamma match than met the eye!

Gamma match computation

I found the answer to the puzzle in a short remark (almost an afterthought) in the text of the W7ITB computer program article.[1] Harold worked out gamma dimensions for a sample antenna and then mentioned that if the drive point impedance of the antenna had capacitive reactance, the value of the gamma capacitor would decrease, as would the length of the gamma rod. Armed with this morsel of information, I read the WB0IKN computer program again. At the end of the article the author mentioned that a smaller gamma capacitor may be used if radiator reactance is made capacitive (negative) by reducing its overall length.

Aha! Here was the missing clue. With a given value of drive point resistance, and a given gamma to driven element spacing, what would happen to the rod length and series capacitance values when different amounts of negative reactance were introduced into the driven element?

Varying the driven element reactance

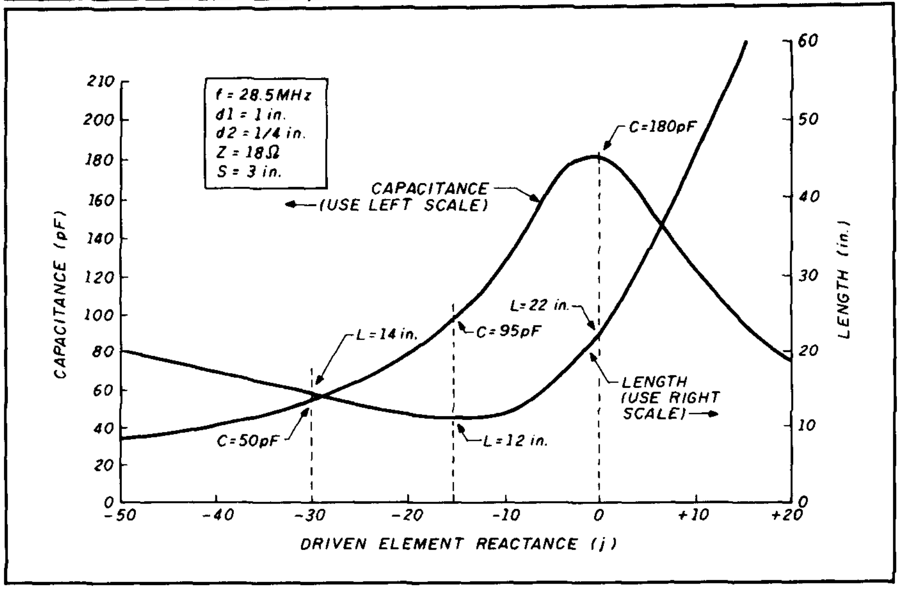
For a given frequency, an antenna element may exhibit either positive or negative reactance at its drive point when the antenna is simply made longer or shorter than the resonant length. Shortening the element produces negative reactance; that's what I was interested in! I reran the WB0IKN program, plugging in various values of negative reactance from j=0 to j=−50 (see **Figure 4**).

The plot shows that the series capacitance value peaks at the element resonant frequency (j=0) and decreases in value either side of resonance. The length of the gamma rod, however, follows a different curve. It exhibits the shortest length when the antenna exhibits negative reactance (−j15).

A practical gamma match system (one that can be built cheaply and adjusted easily) calls for the shortest gamma rod and the least amount of capacitance. It's no fun to hang from the top of a tower and try to adjust a gamma rod whose shorting bar isn't quite within reach!

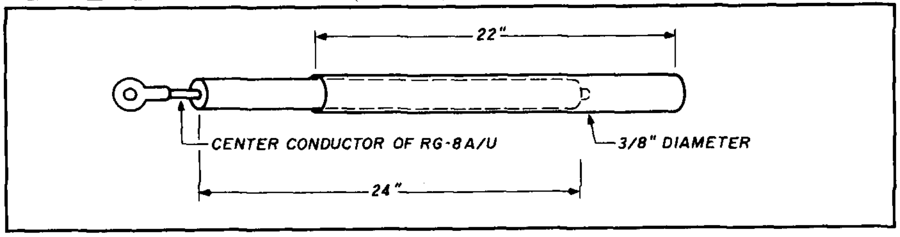
You can build a small gamma capacitor inexpensively with a coaxial gamma rod that has the inner conductor serving as one capacitance element as shown in **Figure 5**.

FIGURE 4



Graph for determining design lengths of the gamma match.

FIGURE 5



Coaxial gamma-rod capacitor for 10-meter beam. Maximum capacitance is about 55 pF.

In my case, a 22-inch adjustable gamma rod would work over a range of antenna reactance from j0 to −j50. However, as the antenna element approached resonance, the value of the gamma capacitance rose sharply, and the coaxial rod length didn't provide sufficient capacitance. From the plot, it was obvious that the designer of the manufactured antenna had cut his driven element shorter than resonance to provide a negative value of reactance (about −j30 ohms) in order to have reasonable gamma dimensions.

Gamma rod spacing

My next question was: what is the effect on gamma dimensions when element-to-rod spacing is varied? I used the computer program for the 10-meter beam element diameters; the results are summarized in **Table 1**. Rod length compared with spacing is given for four values of antenna reactance: j=0 (resonance), j=−15, j=−30 and j=−50 ohms.

TABLE 1

Various gamma and series capacitance values for different length driven elements.

j	Spacing inches	Rod Length inches	Capacitance pF
j0	1	39	83
	2	25	145
	3	23	180
	4	22	212
−j15	1	33.5	57
	2	15	80
	3	12	95
	4	11	105
−j30	1	36	24
	2	18	31
	3	13	52
	4	12	58
−j50	1	36	22
	2	22	31
	3	20.5	32
	4	17	35

Larger values of element-to-gamma spacing require a shorter rod length, but greater gamma capacitance. The shortest rod length is achieved when the driven element has a reactive value between −j15 and −j30, with an element-to-gamma spacing of 3 to 4 inches.

Gamma capacitance increases with element-to-gamma spacing, and decreases as the driven element exhibits greater values of negative reactance. Practical (small) values of capacitance are reached in the reactive region between −j30 and −j50.

Because shortening the driven element has minimal effect on beam performance, it would be helpful to choose a length providing a negative reactance of 30 to 50 ohms.

Element shortening

How much physical shortening is

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IC-2GAT, New 7w HT	429.95	Call $
IC-2SA New Micro Sized HT	419.00	Call $
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UHF		
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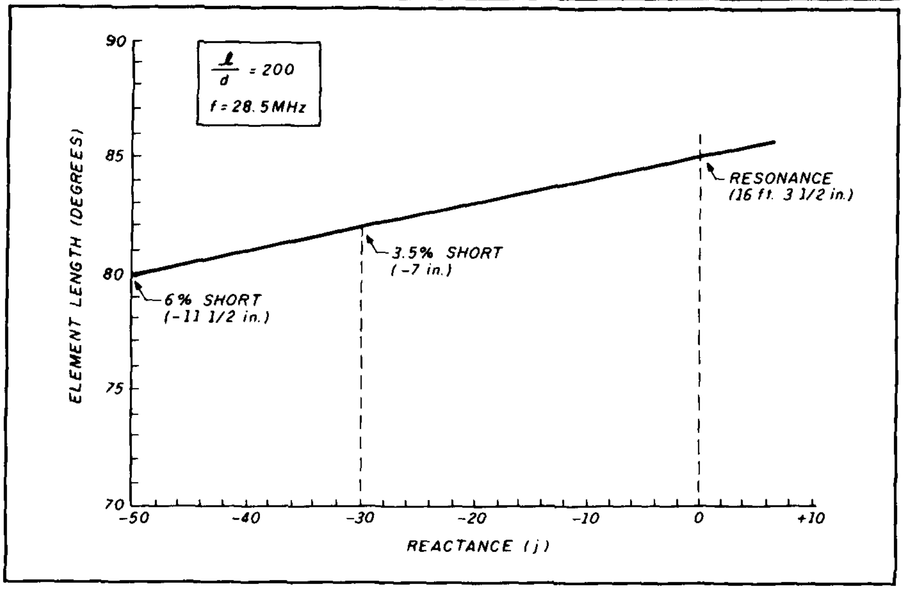
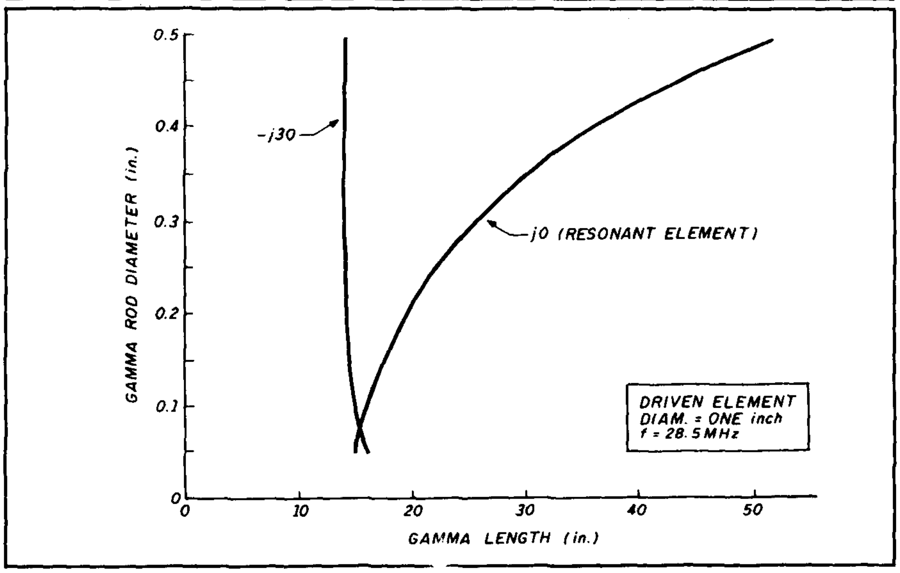
FIGURE 6



Tip-to-tip shortening required for various values of driven element reactance for 1-inch diameter element.

FIGURE 7



The length of the gamma rod with a shorter than resonant driven element (–j30) is nearly independent of gamma rod diameter.

required to provide a reactance of –30 to –50 ohms? It depends upon the ratio of element length to diameter. Such ratios have been computed and measured,[5] and a simplified plot for a length-to-diameter ratio of 200 is shown in **Figure 6**. This corresponds to a 1-inch diameter element at 28.5 MHz. To achieve a reactance value of –j30, you must shorten the driven element about 7 inches (tip to tip). For a reactance of –j50, you'll need a shortening of 11.5 inches.

Drive point impedance and element length

What happens to the 18-ohm figure if the driven element has a drive point value of 18 ohms at resonance and is shortened to provide a negative reactance? It decreases in value. The reduction depends upon the amount of shortening and the element diameter, as discussed previously. Assuming that the new resistance value is 15 ohms at a reactance value of –j50, a computer run shows that gamma rod length increases by an inch, and that the series capacitance decreases by 3 pF from the values determined for a feedpoint value of 18 ohms. This indicates that the actual feedpoint resistance isn't critical, and that the feedpoint values given in the literature for multi-element Yagi beams hold well for use in the gamma computer program.

Gamma rod diameter

The computer program provides interesting information about gamma rod diameters (see **Figures 7** and **8**). The curves show the importance of having a shorter than resonant driven element. With the –j30 element length, gamma rod length changes less than 2 inches as the rod diameter is varied from 0.05 to 0.5 inches. The gamma capacitor, given the same rod diameters, varies from 36 to 65 pF. When the driven element is resonant, the values of rod length and series capacitance vary largely. This gives further proof that adjustment of driven element length is of paramount importance in making the gamma match work.

Frequency scaling

If all the dimensions of a 28.5-MHz beam and gamma match system are doubled, the computed results will be identical at half the frequency — or 14.25 MHz. This scaling isn't practical for my 10-meter beam; it would result in a 20-meter driven element diameter of 2 inches. I prefer a diameter of about 1.25 inches, all else being equal. I would probably also build a tapered element. The gamma match computer program doesn't consider this element, but there are programs that compute an equivalent element length for a tapered element.[6] This equivalent element can then be used with the gamma program once its length is readjusted to provide a reactive termination. Someday the Yagi computer program will be modified for frequency scaling. It will also accommodate the gamma match, as well as other matching systems requiring adjustment of the driven element length.

Is there pattern distortion with the gamma match?

The gamma match feeds only half the driven element. What happens to voltages and currents in the other half? Does the unbalanced feed system upset the beam pattern? Tests run by

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The internal decoding program (SIAM^tm) feature can even identify different types of signals for you, including some simple types of RTTY encryption. The only software your computer needs is a terminal program.

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While you can use most modem or communications programs with the PK-232, AEA has two very special packages available exclusively for the PK-232....PC Pakratt with Fax for IBM PC and compatible computers, and Com Pakratt with Fax for the Commodore 64 and 128.

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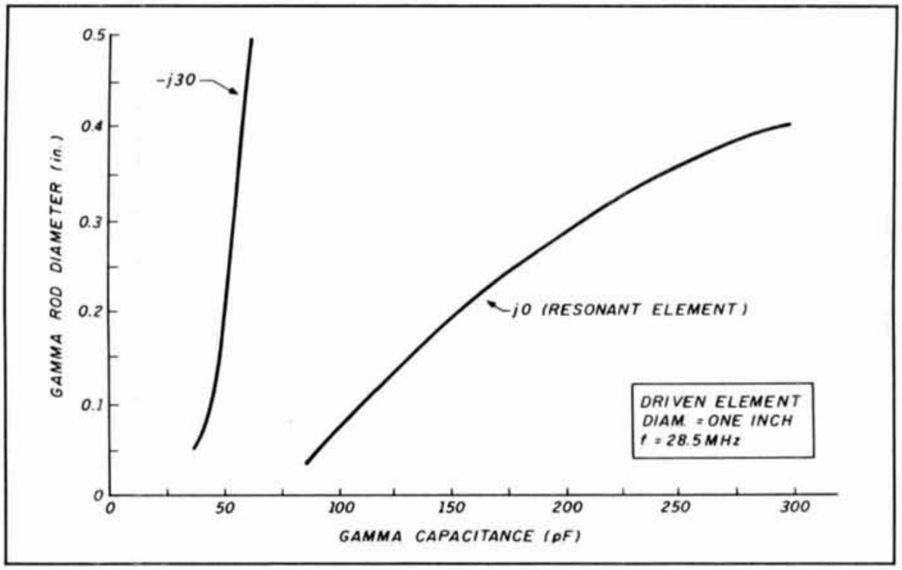
FIGURE 8



Gamma capacitance is nearly independent of gamma length when shorter than resonant driven element (−j30) is used.

Katashi Nose, KH6IJ, show that voltage at the driven element tips of a 20-meter Yagi isn't equal when a gamma match is used.[7] Even so, the azimuth pattern seemed balanced. Nose concluded that the voltage imbalance wasn't important.

Later tests run by Bob Sutherland, W6PO, a VHF "moonbounce" enthusiast, on a large array of 220-MHz gamma-fed Yagis showed that the array's pattern was normal with no noticeable "squint" or distortion that could be attributed to the gamma matches.

Gamma match summary

The gamma match provides a mechanically simple and easily adjusted network for matching a Yagi to a coaxial transmission line, provided the driven element of the array is somewhat shorter than the resonant length. This point has often been overlooked or not emphasized in the literature, leading to puzzling results.

For the best mechanical arrangement, make the capacitor part of the gamma rod, as shown in **Figure 5**. As they say in the world of computers, the gamma match is "user friendly." Information provided in this article, along with the gamma computer program, should make life easier for those contemplating using this interesting match system.

Electric stove RFI! (What next?)

My friend Wyn Wagener, W6VQD, called me the other evening to give me the latest news on the continuing RFI battle. He was concerned about the new electric ranges.

Old-style electric stoves have a multiple circuit heating element. The circuits are selected by a rotary switch that cuts the heating coils in and out, depending upon the cooking heat required. The newer electric ranges have dispensed with this common sense idea in favor of modern gimmicks and the results are questionable, to say the least.

The new brand of electric range has only one coil in the heating element and the circuit is cycled on and off by a continuously variable heat control, instead of a multicontact switch. The control mechanism consists of a small rheostat in series with a low wattage heating element and bimetallic strip heat sensor. As you advance the control, the heater warms up and the strip cycles on and off. The strip controls the main heating element which, in turn, cycles on and off. Wyn discovered that some ovens created copious RFI during the cycling process, which can run in a sequence of 3 to 20-second on/off bursts.

Before he bought a new range for his home, Wyn took a portable receiver to the appliance store and monitored several ovens. Although there seem to

Tell 'em you saw it in HAM RADIO!

be many makes, it seemed to Wyn that there were only two manufacturers of the devices, regardless of the name tag — General Electric and Frigidaire. Extensive monitoring showed the General Electric manufactured ranges to be relatively free of RFI, but the Frigidaire ranges completely wiped out the shortwave spectrum during operation!

The RFI battle is an uphill fight and it gets very discouraging. My radar range wiped out all HF reception, jammed the TV receiver, and made the kitchen radio unusable. A call to the manufacturer brought the news that I could buy a line filter for the range at a modest price. I asked the sales representative why they didn't install the filter on the oven before it was sold. He told me that it was installed on all export models, because most overseas countries demanded it. However, since there was no comparable law in the United States, they didn't feel it was their duty to protect the local customer in this regard! Alas. Perhaps it's time for the FCC to take a more active role in RFI regulation, a role they have been noticeably successful in avoiding to date.

The "Dead Band" quiz

I want to thank those of you who took the time to write me about these little brain teasers. I really appreciate your letters and comments. I want to acknowledge the following who provided correct answers to past quizzes.

Submitting correct answers in the "black box five-terminal network" quiz are: Albert Weller, Jr., WD8KBW; Martin Woll, N6VI; Tim Bratton, K5RA; Les Hannibal; Lawrence Roy, KA1ADF; Arthur Erdman, W8VNX; Mike Czuhajewski, WA8MCQ; Harold Muensterman, N9DEO; and Clayton Dunnihoo, K5ESV.

There are several configurations that satisfy the problem, the simplest being five 0.5-ohm resistors arranged in a five-pointed star with a common center.

Those who found the solution to the "resistors in a jar" quiz were: Martin Woll, N6VI; Tim Bratton, K5RA; Harold Muensterman, N9DEO; and Clayton Dunnihoo, K5ESV. (The minimum resistor count is 419.)

A new "Dead Band" quiz

If we have many more of the complete HF blackouts experienced last spring, you should have plenty of time to solve this puzzle, submitted by Andy Loomis, KE0UL.

"A snowplow begins to clear a roadway at noon on a day during a steady snowfall. The plow moves two miles during the first hour and one mile during the second. What time did the snow begin to fall?"

Andy says, "This is not a trick question, nor is it a problem with a quick but not obvious solution. The fascination of the problem lies in the apparent lack of enough information given in the question itself."

Good luck! I'll send the reader who produces the first complete, correct answer to this quiz an autographed copy of the *Beam Antenna Handbook*. Send your answers to me at Box 7508, Menlo Park, California 94025. The decision of the judges is final.

Note: The computer-produced curves shown in this article are in close agreement with earlier curves run with an RF bridge by John True, W4OQ, as shown in "How to Design Shunt-fed Systems for Grounded Vertical Radiators," *Ham Radio*, May 1975, page 34.

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Automatic Packet Beacon Tracker and Monitor

How often have you set your rig up on 20 or 10 meters to wait for the station you have traffic for, only to find the band isn't open to that area? You sit through countless hours of frustrating QRM, monitoring stations you're not interested in. PACTRACK.ASP, a script file I wrote for the Procomm Plus© terminal program (MS-DOS environment),* can help you overcome this trouble.

Written initially to monitor propagation conditions on the 10-meter band, PACTRACK.ASP will turn Procomm Plus into a powerful packet terminal program for the Kantronics KAM TNC™. It is easily modified for any of the other popular packet terminal units. To modify the script file for earlier versions of Procomm, change the carriage return character (^M) to an exclamation point (!). The program is written in the ASPECT script language, supported by Procomm.

Program features

Once you've loaded Procomm Plus, activate PACTRACK.ASP by entering ALT F5. The program will ask you for the name of the script file. (The .ASP extension isn't required.) A title screen appears, listing the stations the program has been modified to monitor. You'll be asked to turn on your printer. Disable this feature if you don't want to print the beacon stations heard. PACTRACK will now perform the following functions for you:

- Monitor for beacon or ID packets from the stations you have included in the program.
- Print out the time and date of reception when a station has been received, and give an indication that your UNPROTO CQ path has been changed to transmit through the station. (See **Figure 1**.)
- Turn on the beacon at the interval you have selected, if you have included the beacon option in the program.
- Print out the time, date, and call of the station with a notice that the station received was not listed, if you receive a beacon or ID packet from a station other than those included in the program.
- Allow modification of the program to send a connect request to a specific station once it has been received, rather than automatically change your UNPROTO path.

*Procomm Plus is a registered trademark of Datastorm Technologies, Inc., PO Box 1471 Columbia, Missouri 65205.

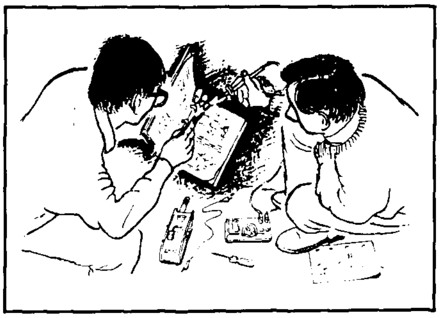

FIGURE 1

```
¥DA
DAYTIME  01/28/89  13:51:37
cmd:WJ5V:VE2GOF/R VE2GOF-2/G VE2GOF-1/B VE2GOF-7/N
md:####UNPROTO IS NOW CQ V VE2GOF-7####TURN BEACON ON

VE2GOF<<<< TARGET STATION FOR BEACON #######

      ######CAUTION...BEACON IS NOW ON########


¥DA
DAYTIME  01/28/89  14:00:28
cmd:WB4HFQ>ID:WB4HFQ WB4HFQ-2/G WB4HFQ-1/B WB4HFQ-7/N
md:###UNPROTO IS NOW CQ V WB4HFQ-7####TURN BEACON ON

WB4HFQ...QTH KY<<<< TARGET STATION FOR BEACON #######

      ######CAUTION...BEACON IS NOW ON########


¥DA
DAYTIME  01/28/89  14:10:15
cmd:COUNTY, LI, NY
        ######THE BEACON RECEIVED IS NOT LISTED######
```

Examples of printout using PACTRACK.ASP.

FIGURE 2

```
Alt-0  ID^M
Alt-1  $A^M
Alt-2  %A^M
Alt-3  ^C
Alt-4  CONV^M
Alt-5  D^MD^M
Alt-6  CMS ON^M
Alt-7  CMS OFF^M
Alt-8  GATE ON^M DIGI ON^M HID ON^M
Alt-9  GATE OFF^M DIGI OFF^M HID OFF^M
```

Procomm Plus keyboard macro screen with settings for packet radio.

Other Procomm features

Included in the Procomm Plus program is a keyboard macro screen which lets you set up the ALT 0-9 keys for your particular application. My keys are set up as shown in **Figure 2**. My keyboard macro, called KAM.KEY, is loaded automatically when the PACTRACK script file is called up.

Procomm also includes a "chat" mode. This is a split screen mode; the top three-quarters of the screen displays the received text, and the bottom quarter displays your transmitted text as entered from the keyboard. Entering ALT O activates the split screen option. I usually do this when I am communicating. You must activate full-duplex mode to use the split screen. You can accomplish this easily by entering ALT E; PACTRACK.ASP is loaded initially in the half-duplex mode and must be in half duplex to operate correctly. When you're finished with split screen mode, simply enter ESC to return to terminal mode and enter ALT E to return to half-duplex mode.

I'm looking forward to hearing from you experienced programmers regarding enhancements to PACTRACK. I'm not a programmer and this was my first attempt. However, the program runs very well and does what it was designed to do. For those who would prefer to send comments via packet radio, send them to W4GBB at WA4ONG in Richmond, Virginia.

If you don't want to type in the program, I'll send you the PACTRACK.ASP program and the keyboard macro file for $10. The Procomm Plus package is available from most local BBSs.* If you want to have the PACTRACK.ASP program customized for your particular application, include the following information:

- Call, QTH of the station(s) to be monitored

*Procomm is a user-supported product. It is not public domain, and is not free software. To become a registered user, send $25 for registration only, $35 for registration plus the latest version on disk, or $50 for registration plus the latest version and a printed, bound manual to the address listed. Procomm support BBS: (314)449-9401 24 hours a day, seven days a week.

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- Want beacon automatically turned on?
- Hard drive or floppy?
- Special beacon text
- Monitor for beacons or IDs?
- Information you want in your keyboard macro file

If you send me this information, I'll customize your program for the Kantronics KAM TNC. ■

Robert F. Cann, W4GBB

Editor's note: Send a no. 10 SASE to *Ham Radio* for a hard copy of the PACKTRACK. ASP program and macro file.

Mobile HT Audio — The Near Ultimate Solution

Many articles have been written describing schemes for improving the audio output from handheld transceivers, especially when operating mobile. The low output power leaves a lot to be desired when combined with vehicle and road noise. The usual fix involves building an external amplifier.

I've often wondered why I try listening to a 2-inch speaker driven by a few milliwatts of power while my car stereo system sits idle. Here's an easy, no modification required way, of using your car's audio system with your HT, for those of you with a built-in cassette player. I designed a cassette adapter that looks like a standard cassette tape with a cable that plugs into the HT's external speaker jack. You insert the adapter into the tape player as you would any standard cassette. I found out later from my son that my "creation" was already commercially available!

The device, marketed by Radio Shack as a "Compact Disc Cassette Adapter," is sold under catalog number 12-1951 for $19.95. It lets you play portable CD units through your cassette tape player. It comes equipped with a miniature stereo plug, the same size as the external speaker jack on my HT. When used in this manner, the HT will "play" through one channel of the stereo system.

There are three simple ways of converting the adapter to a mono system so you can use both stereo channels:

- Use a mono-to-stereo adapter plug, like Radio Shack no. 274-368. This is the preferred method, since the unmodified unit will be available for use with a stereo source like a CD player. However, the size of the adapter plug may interfere with the external microphone plug on some HTs.
- Replace the stereo plug with a mono plug, paralleling both inputs. This is the most difficult modification to make, because you need to connect both inputs to a single mini-plug.
- Add a short jumper wire at the cable terminations on the pc board inside the cassette. (The board contains an RC network.) This involves removing six screws (two on the top and four on the bottom of the cassette), adding a jumper between the red and white cable leads, and reassembling the cassette.

Now you can enjoy HT mobiling with the audio available from your car stereo system, without modifying the HT or the car stereo. Use the tone controls to reduce hiss and enhance weak signals. You'll be amazed at how good an HT can sound.

Frank H. Finney, W9PXP

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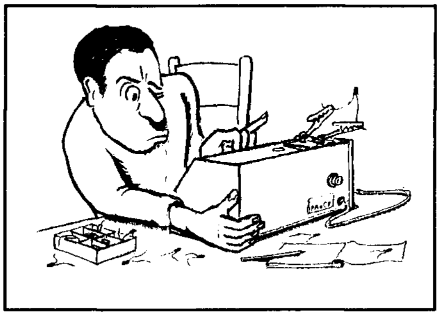


Joseph J. Carr, K4IPV

VERTICALLY POLARIZED HF ANTENNAS: PART 1

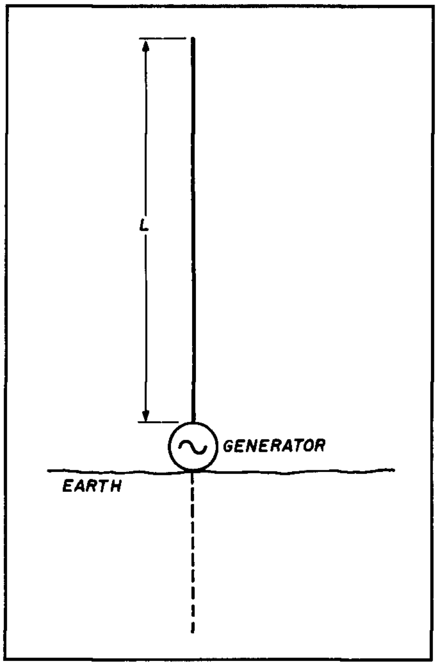
Antennas are a favorite topic for technical writers because our mailbags show that they're a very popular subject with readers. This month, and for the next two months, I'll discuss vertical antennas. Although the regard with which Amateurs view verticals varies from "tremendous" down to "little better radiator than a dummy load," the vertical remains popular. My own luck with verticals has been mostly good. The vertical is the antenna of choice for people living in cramped quarters that don't allow a beam antenna.

Will the vertical antenna work as well as a Yagi beam or quad up 100 feet? The answer is a qualified "maybe." The problem is context. For the DXer the beam is the hands-down favorite if money is no object. But in a situation where an omnidirectional horizontal pattern is needed, the beam suffers. So the correct answer to such a question is, "for what application?"

Because there are so many heated opinions regarding verticals, I take on this topic with some trepidation. Let's hope that a little more light than heat is generated. Keep in mind that it's possible your buddy's bad luck with a vertical might be due to not knowing how to design, build, and use one — or expecting something totally inappropriate from the antenna.

The polarity of an antenna is the direction of the electrical (E) field. Because the transmitted signal is an orthogonal electromagnetic wave, the magnetic field radiated from the antenna is at right angles to the electrical field. The direction of the electrical field, which sets the polarity of the antenna, is a function of the geometry of the radiator element. If the element is vertical, then the antenna polarity is also vertical. The signal propagates out from the radiator in all directions of azimuth, making this antenna an "omnidirectional" radiator.

FIGURE 1A



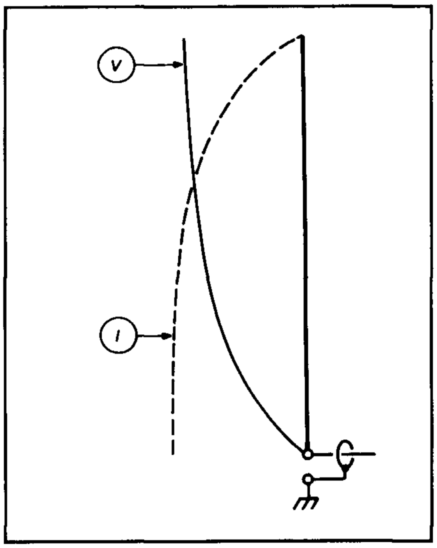
Basic concept of a vertical antenna.

Figure 1A shows the basic geometry of the vertical antenna: an RF generator (transmitter or transmission line from a transmitter) at the base of a radiator of length L. Although most commonly encountered verticals are quarter wavelength ($L = \lambda/4$), that length isn't the only permissible one. In fact, it may not even be the most desirable length. I'll talk about the standard quarter-wavelength vertical antenna here because it's so popular, and will also deal with other length verticals (both greater and less than quarter wavelength).

The quarter-wavelength vertical antenna can be modeled as half a dipole installed perpendicular to the ground, with the ground as the "other half" of the dipole. Because of this, some texts show the vertical with a dotted line "ghost radiator" in the earth beneath the main antenna element. **Figure 1B** shows the approximate current and voltage distribution for the quarter-wavelength vertical. Like the dipole, the quarter-wavelength vertical is fed at a current node, so the feedpoint impedance is at a minimum (typically 35 to 55 ohms, depending upon nearby objects). As a result, the current is maximum and the voltage is minimum at the feedpoint. As you'll see, however, not all vertical antennas are fed directly at the current node. As a result, some designs require antenna tuning units to make them match the antenna impedance to the transmitter output impedance.

Figures 2A and **2B** show the two basic configurations for the HF vertical antenna. **Figure 2A** shows the ground-mounted vertical antenna. The radia-

FIGURE 1B



Approximate current and voltage distributions on a quarter-wave vertical.

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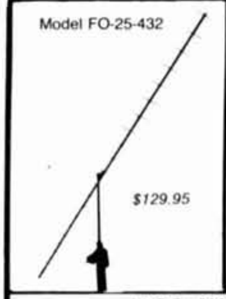

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1st H-Plane	-16 dB
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Impedance	50 ohm

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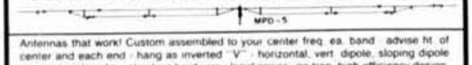

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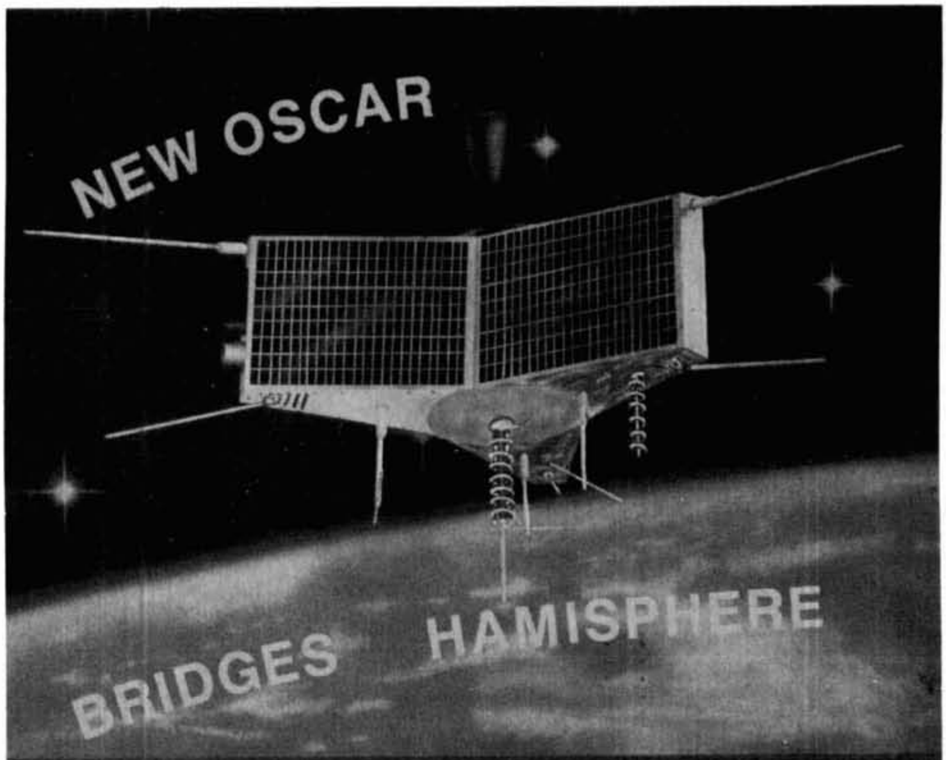

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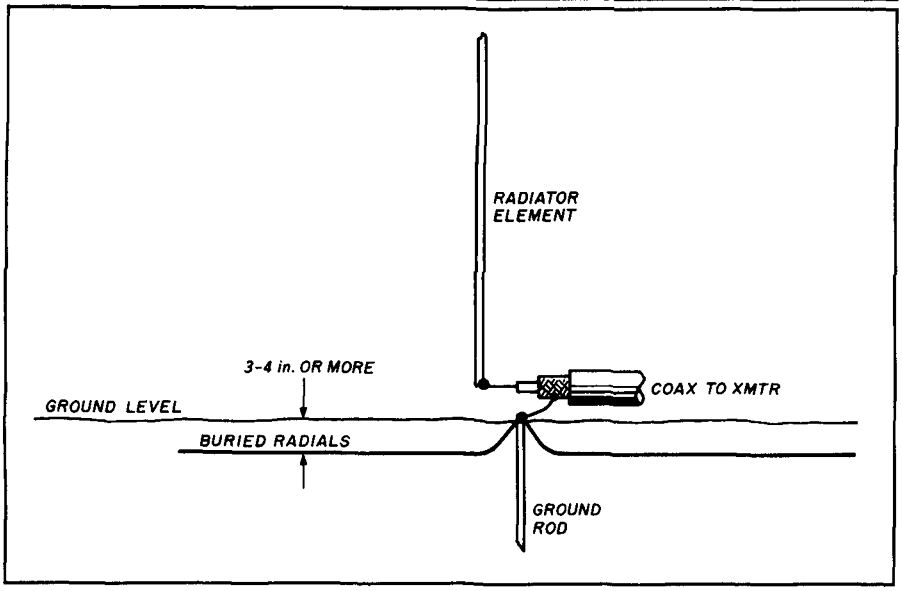
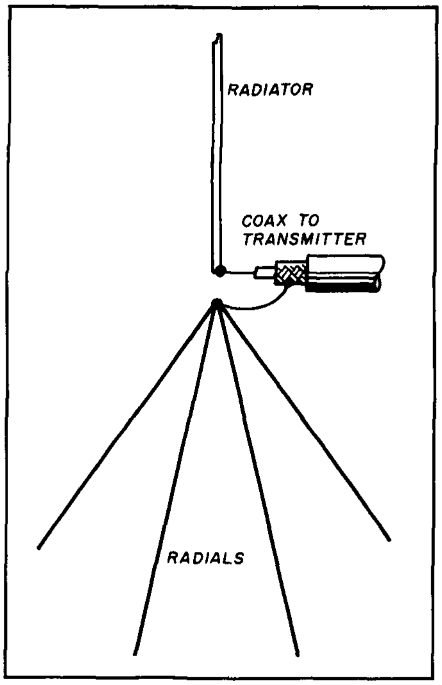
FIGURE 2A



Basic ground-mounted HF vertical.

FIGURE 2B



A vertical with elevated radials.

tor element is mounted at ground level, but is insulated from ground. Because the antenna shown is a quarter wavelength, it's fed at a current node with 52-ohm coaxial cable. The inner conductor of the coaxial cable is connected to the radiator element, while the coaxial cable shield is connected to the ground. As you will see later, the ground system for the vertical antenna is critical to its performance. Normally, the feedpoint impedance isn't exactly 52 ohms, but somewhat lower. As a result, without some matching there will be a slight VSWR. But in most cases the VSWR is a tolerable tradeoff for simplicity. If the antenna has a feedpoint impedance of 37 ohms, the value usually quoted, then the VSWR will be 52 ohms/37 ohms, or 1.41:1.

A vertical mounted above the ground level is shown in **Figure 2B**. This antenna is as popular as the ground mounted. Amateurs find it easy to construct this form of antenna because the lightweight vertical can be mounted at reasonable heights (15 to 50 feet) using fairly inexpensive television antenna slip-up telescoping masts. A problem with the nonground level vertical antenna is that there's no easy way to connect it to ground. The solution to the problem is to create an artificial counterpoise ground with a system of quarter-wavelength radials.

In general, at least two radials are required for each band — and even that number is marginal. The standard wisdom holds that the greater the number of radials, the better the performance. While that statement is true,

FIGURE 2C

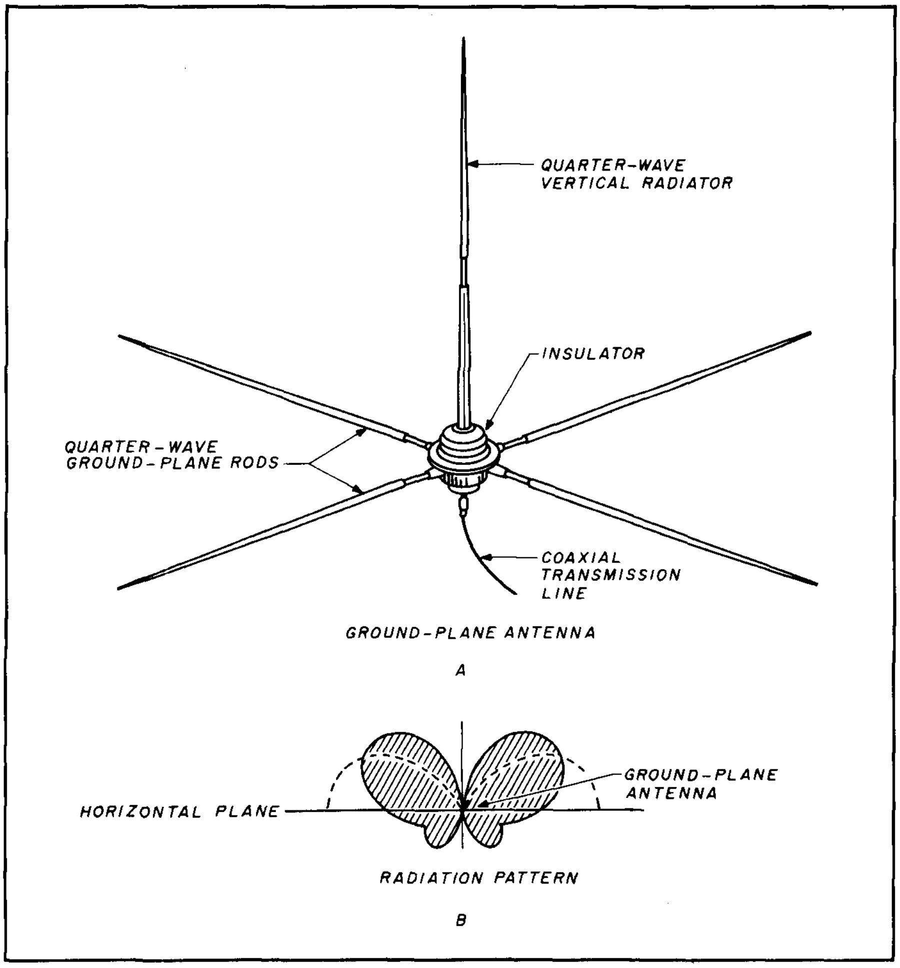


Diagram of a commercial ground plane with four radials mounted 90° apart.

there are both theoretical and practical limits to the number of radials. The theoretical limit is derived from the fact that more than 120 radials return practically no increase in operational effectiveness, and at more than 16 radials the returned added effectiveness per new radial is less than the case for fewer radials. That is, going from 16 to 32 radials (doubling the number) creates less of an increase in received field strength at a distant point than going from 8 to 16 radials (both represent doubling the density of the radial system).

The radials of the above-ground vertical antenna can be at any angle. In **Figure 2B** they are "drooping radials;" i.e., the angle is greater than 90 degrees relative to the vertical radiator element. Similarly, **Figure 2C** shows a vertical antenna equipped with radials at exactly 90 degrees. (No common antenna has radials of less than 90 degrees.) Both of these antennas are called ground-plane vertical antennas.

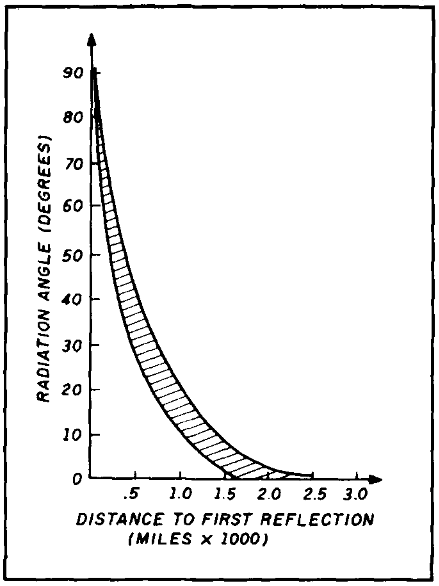
The angle of the radials is said to affect the feedpoint impedance and the angle of radiation of the vertical antenna. While those statements are undoubtedly true in some sense, there are other factors that also affect those parameters and are probably more important in most practical installations. Before digging further into the subject of vertical antennas, let's take a look at the subjects of angle of radiation and gain in vertical antennas.

Angle of radiation

Long distance propagation in the HF region depends upon the ionospheric phenomena called "skip." In this type of propagation, the signal leaves the transmitting antenna at angle a, called the angle of radiation, and enters the ionosphere where it is refracted back to earth at a distance from the transmitting station. The signal in the zone between the outer edge of the antenna's ground wave region and the distant skip point is weak or nonexistent.

The distance covered by the signal on each skip is a function of the angle of radiation. **Figure 3** shows a plot of the angle of radiation of the antenna, and the distance to the first skip zone. The angle referred to along the vertical axis is the angle of radiation away from the antenna relative to the horizon. For example, an angle of 10

FIGURE 3



Graph of skip zone versus angle of radiation.

degrees is elevated above the horizon 10 degrees. Shorter distances are found when the angle of radiation is increased. At an angle of about 30 degrees, for example, the distance per skip is only a few hundred miles.

Although you might expect to see a single line on the graph, there's actually a zone shown (shaded). This phenomenon exists because the ionosphere is found at different altitudes at different times of the day and different seasons of the year. Generally, however, in the absence of special event phenomena in the ionosphere, expect from 1500 to 2500 miles per bounce in the HF bands for low angles of radiation. Note, for example, that for a signal that's only a degree or two above the horizon, the skip distance is maximum.

At distances greater than those shown in **Figure 3**, the signal will make multiple hops. Given a situation where the skip distance is 2500 miles, covering a distance of 7500 miles requires three hops. Unfortunately, there's a signal strength loss of 3 to 6 dB on each hop, so you can expect the distant signal to be attenuated from making multiple hops between the earth's surface and the ionosphere. For maximizing distance, the angle of radiation needs to be minimized.

So what's the ideal angle of radiation? It's standard — but actually erroneous — wisdom among Amateur Radio operators (and even commercial operators, it turns out) that the lower the angle of radiation the better the antenna. This statement is only true if you're looking for long distance, so it reflects a strong bias toward the DX community. The correct answer to the question is: "It depends on where you want the signal to go." For example, I live in Virginia. If I want to work stations in the Carolinas or New England, it would behoove me to select a high angle of radiation for radio conditions represented in **Figure 3**, so that the signal will land in those regions. But if I want to work stations in Europe, Africa or South America, then a lower angle of radiation is required. Because of the difference between performance of high and low angles of radiation, some stations have two antennas for each band — one each for high and low angles of radiation.

Figure 4 shows a signal from a hypothetical antenna located at point O to show what angle is meant by angle of radiation. The beam from the

FIGURE 4

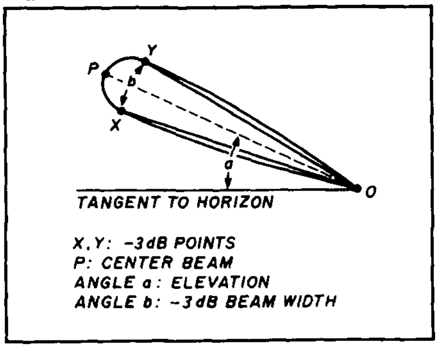


Diagram illustrating angle of radiation.

antenna is elevated above the horizon (represented by the horizontal "tangent to horizon" line). The angle of radiation, a, is the angle between the tangent line and the center of the beam. This angle is not to be confused with the beamwidth, which is also an angle. In the case of beamwidth, I'm talking about the thickness of the main lobe of the signal between points where the field strength is 3 dB down from the maximum signal (which occurs at point P); these points are represented by points x and y in **Figure 4**. Thus, angle b is the beamwidth, while angle a is the angle of radiation.

Gain in vertical antennas

Vertical antennas are known as omnidirectional because they radiate equally well in all directions. Gain in an

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FIGURE 5

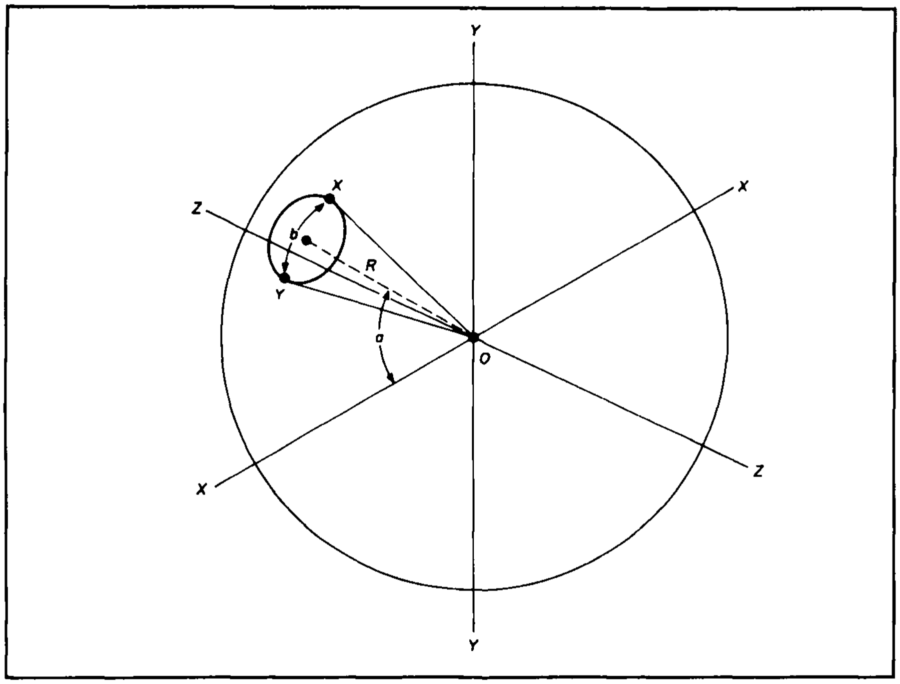
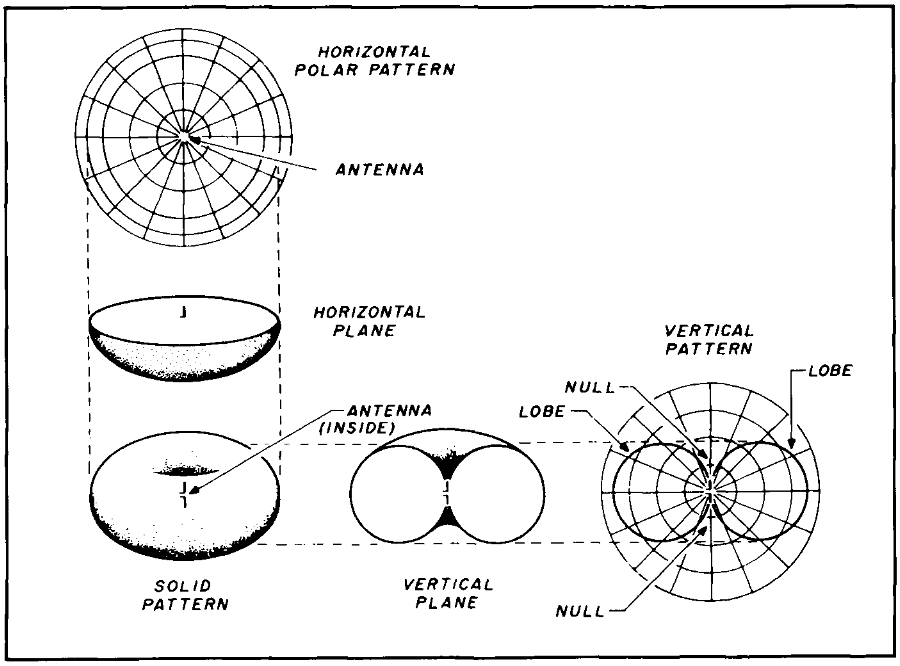


Diagram of a theoretical isotropic radiator.

FIGURE 6



E and H plane patterns of a typical vertical.

antenna is not the creation of power, but rather a simple refocusing of energy from all directions to a specific one. Therefore, gain implies directivity. According to the convention, then, the vertical antenna can't have any gain because it radiates in all directions equally, and gain implies directivity. Right? No, not really. Let's develop the theme more carefully.

Again consider the idea of an isotropic radiator (the word "isotropic" means equal power in all directions). Consider a spherical point source radiator located at point O in **Figure 5**. Whatever the level of power available from the transmitter, it will be spread equally well over the entire surface of the sphere as it radiates out into space away from point O. If you measure the power distributed over some area, A, at a distance, R, from the source, then the power available will be a fraction of the total power:

$$P_{avail} = \frac{\text{Total Available Power} \times \text{Area "A"}}{\text{Total Surface Area of Sphere}} \quad \textbf{(1)}$$

or, in math symbols, we can write the expression:

$$P_a = \frac{P_s}{4\pi r^2} \quad \textbf{(2)}$$

Where:

P_a is the power available per solid degree

P_s is the total radiated power in watts

R is the radius of the sphere, i.e., the distance from O to P.

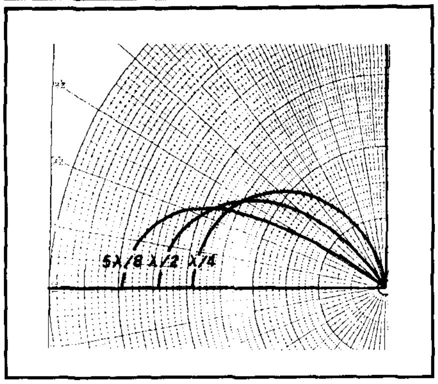
A practical rule of thumb for this problem is to calculate from the surface area of the sphere. If you perform the right calculations, you'll find that there are approximately 41,253 square degrees on the surface of a sphere. By calculating the surface area of the beam front (also in square degrees), you can find the power within that region.

Now for the matter of gain in a vertical antenna. The vertical isn't gainless because it doesn't radiate equally well in all directions. In fact, the vertical is quite directional except in the horizontal (azimuth) plane. **Figure 6** shows the radiation pattern of the typical vertical radiator. The pattern looks like a giant doughnut in free space (see solid pattern in **Figure 6**). When sliced like a bagel, the pattern is the familiar circular omnidirectional pattern. When examined in the vertical plane, however, the plane looks like a sliced figure eight. The gain comes from the fact that energy isn't spread over an entire sphere, but concentrated to the toroidal doughnut-shaped region shown. Therefore, the power per unit area is greater than for the isotropic (truly omnidirectional) case.

Non quarter-wavelength verticals

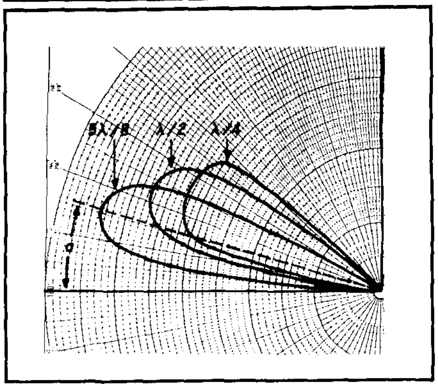
The angle of radiation for a vertical antenna, hence the shape of the hypothetical doughnut radiation pat-

FIGURE 7A



Approximate patterns for three different length verticals. Relative power gains are also visible.

FIGURE 7B



Effects of ground losses on the patterns of the same three antennas.

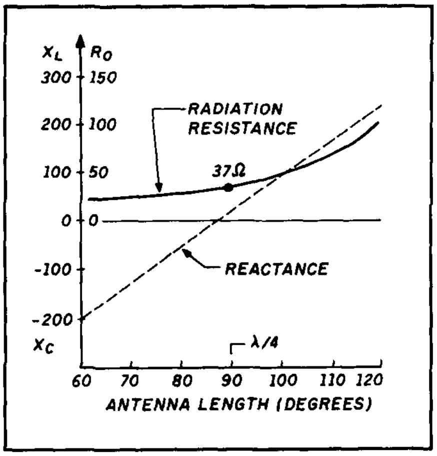
tern, is a function of the antenna length. (Note: "length" in terms of vertical antennas is the same as "height," and is sometimes expressed in degrees or wavelength, as well as feet and/or meters). **Figure 7A** shows the approximate patterns for three different length vertical antennas: quarter wavelength, half wavelength, and 5/8 wavelength. Note that the quarter-wavelength antenna has the highest angle of radiation, as well as the lowest gain of the three cases. The 5/8-wavelength antenna has both the lowest angle of radiation and the highest gain (compared with isotropic).

The patterns shown in **Figure 7A** assume a perfectly conducting ground underneath the antenna. However, that's not a possible situation for practical antennas — all real grounds are lossy. The effect of ground loss pulls the pattern in close to the ground (**Figure 7B**). Although all of the patterns are elevated from those of **Figure 7A**, the relationships still remain. The 5/8-wavelength radiator has the lowest angle of radiation and highest gain.

The feedpoint impedance of a vertical antenna is a function of the radiator length. For the standard quarter-wavelength antenna, the feedpoint radiation resistance is approximately 37 ohms, with only a very small reactance component. **Figures 8A** and **B** show the approximate feedpoint impedances for antennas from nearly zero effective length to 120 degrees of length.

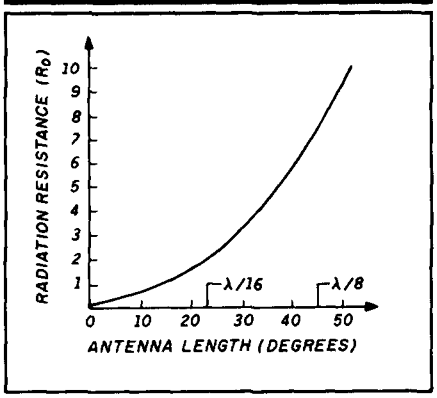
Antenna length as it is expressed in degrees derives from the fact that one wavelength equals 360 degrees. Thus, a quarter-wavelength antenna has a length of 360 degrees/4 = 90 degrees. To convert any specific length from degrees to wavelengths, divide the length in degrees by 360. Thus, for a 90-degree antenna: 90 degrees/360 degrees = 1/4 wavelength. The graph in **Figure 8A** shows the antenna feed-

FIGURE 8A



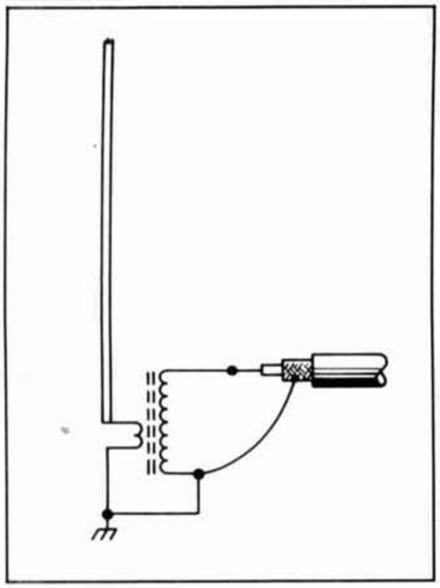
Approximate feedpoint impedances of antennas from 0° to 120° in electrical length.

FIGURE 8B



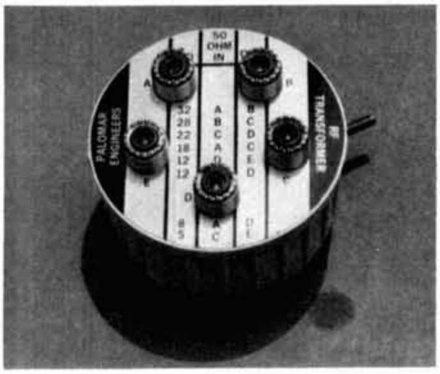
Radiation resistance of antennas from 0° to 60° in electrical length.

FIGURE 9



Basic connection of a toriodal transformer to a vertical antenna.

PHOTO A



Commercial impedance matching transformer.

point impedance, both reactance and radiation resistance, for antennas from 60 to 120 degrees; **Figure 8B** shows the radiation resistance for antennas from near zero to 60 degrees. Note that the radiation resistance for such short antennas is extremely small. For example, an antenna that is 30 degrees long (30/360 = 0.083 wavelength) has a resistance of approximately 3 ohms.

It's generally the practice on vertical antennas with an impedance-matching problem to use a broadband impedance-matching transformer to raise the impedance of these antennas to a higher value. **Figure 9** shows the basic connection of the toroidal transformer to the vertical antenna. You can wind a homebrew transformer following instructions given in *The ARRL Handbook*, other publications, or a past issue of this column. You can also use a manufactured impedance transformer like the Palomar Engineers' model shown in **Photo A**. This transformer is designed specifically for HF vertical antennas.

Next month...

In the second installment of this three-part series I'll look at two topics: the installation of vertical antennas, and vertical antenna construction and mounting techniques.

I can be reached at POB 1099, Falls Church, Virginia 22041; I'd like to have your comments and suggestions for this column. hr

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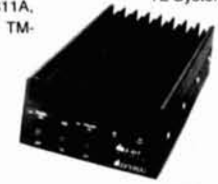

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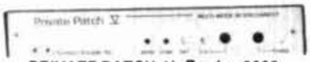

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Tom McMullen, W1SL

VISUAL AIDS — LIQUID CRYSTAL DISPLAYS

In this last article in my series on visual aids, I'll look at a type of display used in a multitude of products — including watches, volt/ohm/milliammeters, computer screens, automotive monitoring systems, and transceivers. (The list is far too long to complete here.) It's called a liquid crystal display, or LCD. The beauty of this type of display is that it can be manufactured to show characters in any language, or to provide a visual symbol in any shape. It also uses very little power.

What's in it?

The principle used in the LCD comes from a laboratory device for exploring methods of electronically controlling light transmission. This experimental device is called a Kerr cell (see **Figures 1A** and **1B**). It works as a result of polarization. The input and output sides of the Kerr cell have a polarized coating which allows light with the same polarization as the coating to pass through it. When the liquid in the cell is polarized the same as the coating material, the light passes through. When voltage is applied to the electrodes, the liquid changes its polarization, and the light doesn't pass through (refer to **Figure 1B**).

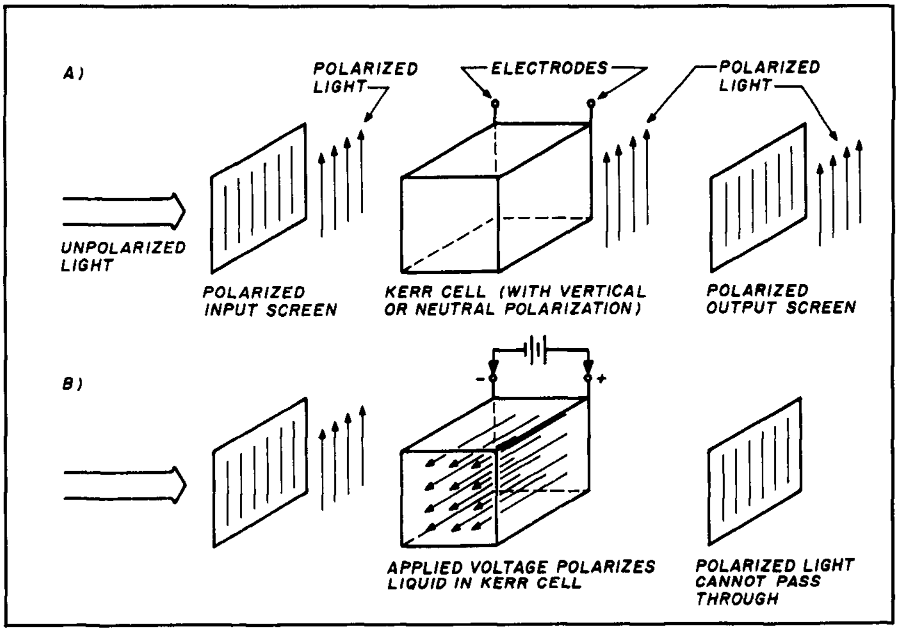
You can perform an experiment with polarized light using the lenses from a pair of sunglasses that have a polarized coating — plain tinted lenses won't work. Look at a light through both lenses, and rotate one lens as you do so. At some point, the light will decrease markedly or perhaps disappear. This is the point at which the lenses are polarized 90 degrees apart. A polarizing filter for photographic use works in a similar manner; glare and reflections are polarized to some extent, and when the filter is rotated, the glare can be reduced for improved photographs.

Putting theory to work

The Kerr cell is a bulky apparatus; it's most useful in laboratory and other experimental uses. The modern LCD is an adaptation of this principle that can be small enough to use in a wrist watch, or large enough to display many lines of text or graphics on a laptop computer.

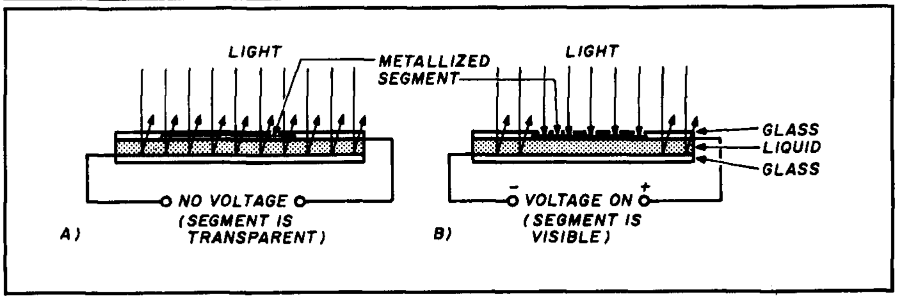
A basic LCD element is shown in **Figure 2**. It consists of two pieces of glass with a liquid sandwiched between. The inner surface of each piece of glass is coated with a very thin metallic layer which serves as an electrical contact, and will allow light to pass. In its normal, unexcited state the liquid isn't polarized (see **Figure 2A**).

FIGURE 1



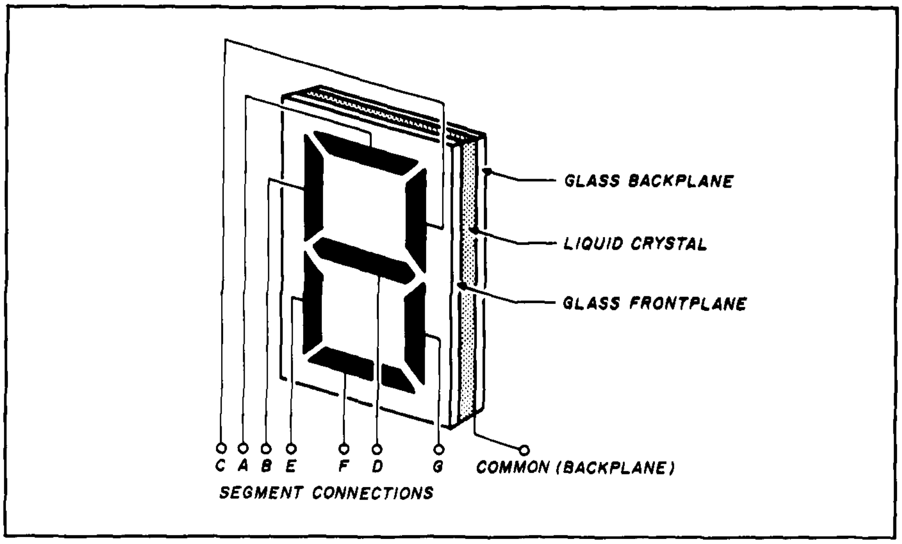
The predecessor for today's LCD was the Kerr Cell shown here in a simplified view. A liquid in the cell could be polarized by applying a voltage. When the polarization of the crystal-line structure in the liquid was different from the light entering the cell, output was decreased.

FIGURE 2



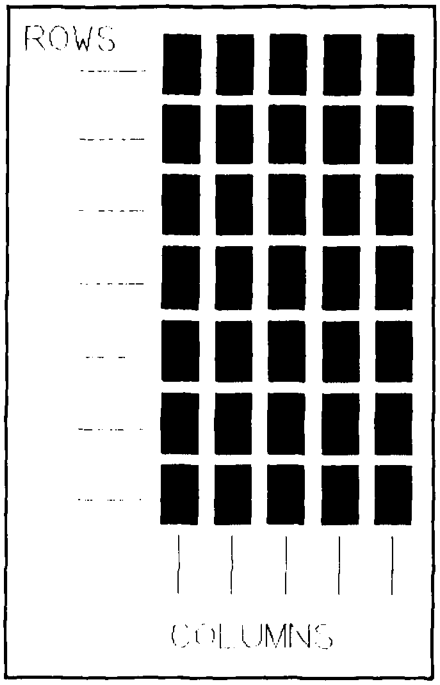
The LCD used on most devices today is a sandwich of glass with a liquid crystal material between. The glass has thin metallic layers for electrical contact.

FIGURE 3



A common seven-segment readout element as used in many numeric applications today. A simple, inexpensive driver IC activates the proper segments to form numbers.

FIGURE 4



An array of dots forms a matrix for complex characters. This array is five dots wide by seven dots high; many other combinations are possible.

When voltage is applied to the metallic layer, the crystalline structure in the liquid changes direction (polarization) and stops the light. Most LCDs depend upon reflected light; when you view the display from the front, you see the outline of whatever shape the metallic segment has as a silhouette against the reflective backplane **Figure 2B**.

In its simplest form (in clocks, watches, calculators, and other strictly numeric readout devices) each segment of a number is a conducting transparent layer connected to a contact — much the same as the LED seven-segment display I described last month. **Figure 3** shows a seven-segment LCD readout display. A simple decoder IC can drive the desired segments to form a number. Some LCDs have a large number of segments and can form letters as well as numbers, in what's called an alphanumeric display.

Complex characters

Even greater versatility is obtained by forming the characters with an array of dots that can be turned on or off individually. This type of readout is called a dot-matrix LCD. The dot pattern is often five or six dots wide and seven or eight dots high, but there are many other possibilities. **Figure 4** shows an example of a 5 × 7 matrix.

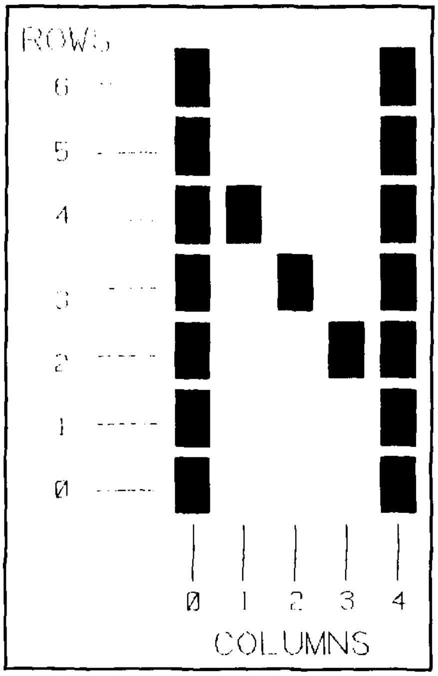
This type of display requires a more sophisticated driver. It operates by decoding the incoming data and deciding which rows or columns to energize for the pattern required. **Figure 5** shows the letter N. It's formed by first activating all the rows (0 through 6) along with column 0. The driver then activates row 4 and column 1, row 3 and column 2, row 2 and column 3, and finally rows 0 through 6 and column 4. The polarity of the liquid (actually, in many devices it's almost a jelly) behind each dot changes, shutting off the reflected light. What you see is the dark letter against a light background.

What keeps the first vertical column of the N from disappearing while the driver is working on the rest of the letter? Once you have "turned on" polarized liquid, it stays that way until another voltage application turns it off. This is where the low power consumption advantage comes in. You don't need to keep voltage on the segment all the time — just refresh it once in a while with another pulse of voltage to keep it from fading away. Without refreshing, LCDs fade after a while; some inexpensive ones disappear in a few minutes, but better ones last much longer. They change gradually from black, to grey, to clear.

Of course, the more dots you have the more metallic contacts you need, and the more complex the driver circuitry must be. Modern microprocessors and driver ICs can handle this with ease. Multiple digit readouts use a technique called "strobing." The driver turns on the correct dots or segments in the first character, then goes to the next one and activates it, and so on, until all characters are active.

If there are multiple lines (as there are on a computer screen), the driver can work on one line after the other. It moves down the screen so fast that

FIGURE 5



The letter "N" formed by activating the correct rows and columns of a dot-matrix display. See text.

your eye doesn't see any flicker, then returns to the top to either refresh the first line of characters or to make changes in it.

Of course all these metaled spots, rows, and columns require connections to the outside world so the driver circuits can apply voltage. There are a large number of connections at the edge of the glass readout device, and these are somewhat fragile. However, most LCD assemblies are packaged in such a way that you can't damage them if you take reasonable care. Flexible ribbon cable is often used to make connections between the LCD and the rest of the circuits. LCDs do have the slight disadvantage of being temperature sensitive. People traveling in cold climates are accustomed to seeing the wrong time on their automotive clocks until the heater has warmed the passenger compartment, and the liquid in the LCD has thawed enough to respond to voltage pulses. The electronics for the clock continue to work normally, so when the LCD thaws out it suddenly shows the correct time. Latest advances in LCD technology have produced displays in many colors; you'll see them in some of the newer Amateur transceivers, and some computer screens. An item that caught my eye just recently was a book-sized AM/FM/TV receiver with a flip-up screen. The screen was an LCD approximately 4 × 5 inches, showing a color TV program in amazing clarity. What an improvement compared to the first color TV set I saw. It took two people to move, and used three cathode-ray tubes and filters to produce a color image. The modern LCD version fits in a briefcase and has a better picture too!

Coming in my next column — what you can do with simple, inexpensive instrumentation.

PRODUCT REVIEW

Morse Code Tutor Program

"Morse: The Code Machine" by Laresco, a morse code tutor for Apple II series and C-64 computers, is designed to teach code recognition and build speed. It can be used by someone preparing for the Novice exam, anyone who wants to upgrade, or by the ham who simply wants to increase code speed. There are 12 different software packages available, from the basic Fundamental to the "all frills" Elite+. Each successive version of the program includes more modes and features. Purchasing a code oscillator lets you take advantage of the manual's code sending lessons.

The Fundamental package is a "bare bones" version of the program. It generates code sounds for characters in text memory. No characters are displayed on the screen. You practice writing the characters on paper for the code you hear. After completing the session, you can view the text in memory and compare it with what you wrote.

I worked with the Elite+ version. It has three learning modes: teach, drill, and practice. Each mode is broken down into sections which let you tailor your learning experience and concentrate on your weakest areas. The manual suggests you use all three modes in two daily sessions for the best possible code workout.

Teach mode concentrates on basic Morse code recognition. You can use any one of five different teaching modes. Each concentrates on getting you to connect the letter with its particular code sounds. Code can be self- or machine generated.

In *drill mode*, you work to increase your recognition of what you've learned in *teach mode*. Characters or code sounds are generated by the computer and stored in a buffer. You have the option of matching the character with the code, or the code with the character, by hitting the appropriate key on the keyboard. The computer corrects you when you make a mistake.

After you've worked with the teach and drill modes, you can improve your code recognition speed with practice mode. This mode allows you to practice what you've learned using self- or computer-generated text.

Depending on which package you purchase, text can be typed in or loaded from a DOS 3.3 disk file. You also have the option of saving text memory to disk or viewing text memory on the screen. All packages allow you to choose extended sound spacing (i.e., spacing between dots and dashes within a character) and transmission tone frequency; the "+" packages also have extended character and word spacing capabilities. The more complex packages include color graphics, but you don't need a color monitor to use the graphics modes. The Fundamental and Fundamental + versions come with an 18-page abbrievated manual. All other packages come with a 33-page detailed manual which describes all the modes and features, and includes basic lesson plans. For more information on the different packages and their capabilities contact: Laresco, POB 2018 1200 Ring Road, Calumet City, Illinois, 60409. Phone: (312)891-3279.

It took me a few hours of playing around with the program and its various options to realize all it could do for me. I'm not very "computer literate" so there were a few things that I had to learn by trial and error. My biggest mistake was in not *taking the time to sit down and read the manual thoroughly.*

On the whole, however, I think the "Code Machine" is a useful tool for learning the code. Depending on the package you choose, you have several different ways to learn. But you don't have to take my word for it! My eight-year-old son dropped by my office while I was playing with the program. Within 15 minutes of using "Morse: The Code Machine," he recognized many more letters than he had when he started...and it took some persuading so I could get in on the fun too!

de KA1STC

NEW PRODUCTS

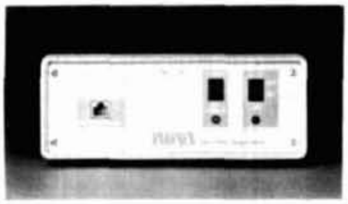
Packet Talker

Engineering Consulting announces the "Packet Talker" model PKTA for the Commodore 64 and compatible computers. The PKTA uses software to convert ASCII messages into speech. Messages can be stored in bulletin board format for up to 300 users; they can be retrieved by preassigned touchtone access commands. Each message is spoken over the air from the computer's voice synthesizer. Use the Packet Talker with repeater controllers to add a talking packet bulletin board, or hear messages from a personal mobile packet terminal.

The PKTA can link a packet TNC with any voice repeater. Hardware and software are provided for interfacing to the C-64. Audio from the TNC and PTT circuits of the transceiver combine with the computer's voice allowing conventional packet communications and voice retrieval of messages on request.

A similar option (PK8 and PK1) is available for Ultra ComShack 64 repeater controllers. When used with the Ultra, the Packet Talker allows complete repeater control, remote screen transfer of all active parameters, voice messages, and remote programming of all parameters from any off-site TNC terminal.

The model PKTA Packet Talker sells for $189.95 and is available from Engineering Consulting, 583 Candlewood Street, Brea, California 92621. Phone: (714)671-2009 or FAX (714)255-9984.



New Field Calibration Power Sensor

Bird Electronic Corporation has announced the model 4029 Power Sensor Calibrator for use with their 4420 series RF power meters. With a CRT terminal or a PC with a serial port, the 4029 provides in-field calibration of 4420 power meters to within ±3 percent of a known RF standard.

The 4029 supplies a menu-driven protocol to the terminal to aid in the calibration process. You drive a 4020 series RF power sensor connected to the calibrator with a known amount of RF power at a specific frequency, and enter the power level into the terminal keyboard. The calibrator calculates and stores a correction factor in the power sensor's memory for that frequency.

Bird also has the model 4024 Directional Power Sensor, the latest addition to the 4020 series of Thruline® design RF sensors. The frequency range of the unit is 1.5 to 32 MHz at up to 10 kW. Other sensors in the series cover ranges from 1.8 to 32 MHz and 25 to 1000 MHz at up to 1 kW. All 4020 models are unconditionally guaranteed for life.

NEW PRODUCTS

For further information contact Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139. Phone: (216)248-1200.

Circle #301 on Reader Service Card.

AVCOM's PSA-65A Portable Spectrum Analyzer

AVCOM introduces its portable spectrum analyzer, model PSA-65A. It covers frequencies through 1000 MHz in one sweep with a sensitivity greater than −90 dBm at narrow spans. The lightweight battery or line-operated spectrum analyzer is for two-way radio, cellular, cable, and other uses. Options include frequency extenders to enable the PSA-65A to be used at Satcom and higher frequencies, audio demod for monitoring, log periodic antennas, and carrying case. For brochure and spec sheet contact AVCOM of VA, Inc., 500 Southlake Boulevard, Richmond, Virginia 23236. Phone: (804)794-2500, FAX (804)794-8284, or TLX 70-1545 AVCOM.UD.

Circle #302 on Reader Service Card.

Antenna Specialists Company Catalog

The Antenna Specialists Company, has released a new Amateur Radio products catalog, no. HM-1001. It lists over 30 models of mobile antennas, base antennas, power dividers, and RF power amplifiers. Included are the patented DURA-FLEX® neoprene elastomer shock spring models, and On-Glass® window mount mobile antennas. A copy of the catalog is available from The Antenna Specialists Company, 30500 Bruce Industrial Parkway, Cleveland, Ohio 44139-3996. Phone: (216)349-8400 or FAX (216)349-8407.

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Phillips Drivers Tooled for Foreign Electronics

Jensen Tools offers a set of six Phillips screwdrivers tooled for Japanese, European, and other foreign equipment. These Telvac drivers are made of hardened steel with standard grip, acid-resistant plastic handles. The set, priced at $12.95, is featured in Jensen's free 1989/90 catalog.

For more information write or call Jensen Tools, Inc., 7815 S. 46th Street, Phoenix, Arizona 85044. Phone: (602)968-6231.

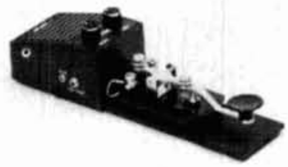
Circle #304 on Reader Service Card.

New Products

MFJ Offers Code Practice Oscillator

MFJ Enterprises, Inc., announces its new MFJ-557 deluxe code practice oscillator for $24.95. It features a straight Morse key and a code oscillator with a built-in speaker, mounted together on a non-skid heavy steel base. A volume control lets you adjust it from barely audible to full sound. A tone control gives you a wide tone adjustment. An earphone jack is included.

The oscillator runs on a 9-volt battery (not included) or 110 volts AC with an optional power supply ($9.95) that plugs into a jack on the side of the MFJ-557. The straight key features screw-adjustable contacts and can be hooked to your transmitter and used for sending code over the air. The measures 8-1/2 × 2-1/4 × 3-3/4 inches. It comes with MFJ's one-year unconditional guarantee.



For more information contact MFJ Enterprises, Inc., PO Box 494, Mississippi State, Mississippi 39762. Phone: (601)323-5869. To order, call toll free (800)647-1800.

Circle #305 on Reader Service Card.

New Software Logging Program

"Hamlog" is a new modular auto-logging software program by Ernest Sandoe, KA1AWH.

This stand-alone user friendly program has over 17 modules and can be supplied to run in Turbo BASIC or MS/PC BASIC for IBM compatibles. It works well on 64K.

"Hamlog" is also available for over 130 different computers using the CP/M operating system, and for Apple computers using Apple BASIC.

An optional QSL label writing program is available for $5 plus $2 shipping and handling.

Send $24.95 ($19.95 for Apple version) to Ernest Sandoe, KA1AWH, POB 2015, Peabody, Massachusetts 01960. (Massachusetts residents include 5-percent sales tax.)

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AUTOMATIC ROTOR BRAKE DELAY

Thomas V. Cefalo, Jr., WA1SPI, 29 Oak Street, Winchester, Massachusetts 01801

The immediate brake engagement that may occur when a rotation motor is de-energized is a problem common to some rotors. It doesn't usually present much trouble with a light antenna load, but with larger loads the additional stress applied to the rotor and the tower can be damaging. To avoid this possibility, manufacturers have incorporated a separate brake control into their rotor control units which lets the operator manually operate the brake. This solves the problem for the most part, unless the operator should accidentally engage the brake while the antenna is turning.

I've designed a circuit that automatically delays the rotor brake, giving the antenna time to stop turning. I'll describe its operation and construction here.

Theory of operation

The circuit shown in **Figure 1** is used with a Cornell-Dubilier HAM II/CD44 rotor system. The circuit is run by a separate power supply. Using the separate power supply cuts down on the number of modifications you need to make to the control unit, and leaves the original circuitry pretty much intact. I used CMOS integrated circuits to reduce the power requirements and provide a higher noise immunity.

Delay circuit operation is simple and straightforward. NAND gates and a multivibrator are the main components performing the delay function. The logic timing diagram is shown in **Figure 2**.

The brake switch is connected to a latch composed of two NAND gates (U2A and U2B) to debounce the switch contacts. U1 is a multivibrator configured for monostable operation and triggered from the rising edge of a pulse. One output of the latch (pin 3) is connected to the positive trigger input of the multivibrator. The gate inputs for U2C of brake relay RY1 are connected to pin 3 of the latch and the inverted output $\overline{Q}$ of the multivibrator. When the brake switch is depressed, pin 3 of the latch transitions to a low, which forces the output of U2C to a high state. This causes transistor Q1 to become forward biased, turning on brake relay RY1. The relay contacts are connected in series with the primary of the rotor control unit's power transformer, disengaging the brake when power is applied.

The other output of the latch (pin 4) is connected to the switching transistor Q2 of the second relay RY2. This relay guarantees that the rotor's motor is switched off when the brake switch is released. When the brake switch is depressed, pin 4 of the latch transitions from a low to a high. This forward biases the transistor turning on RY2, making power available to the rotation motor's direction switches. You can rotate the antenna with the brake disengaged by depressing the control unit direction switches.

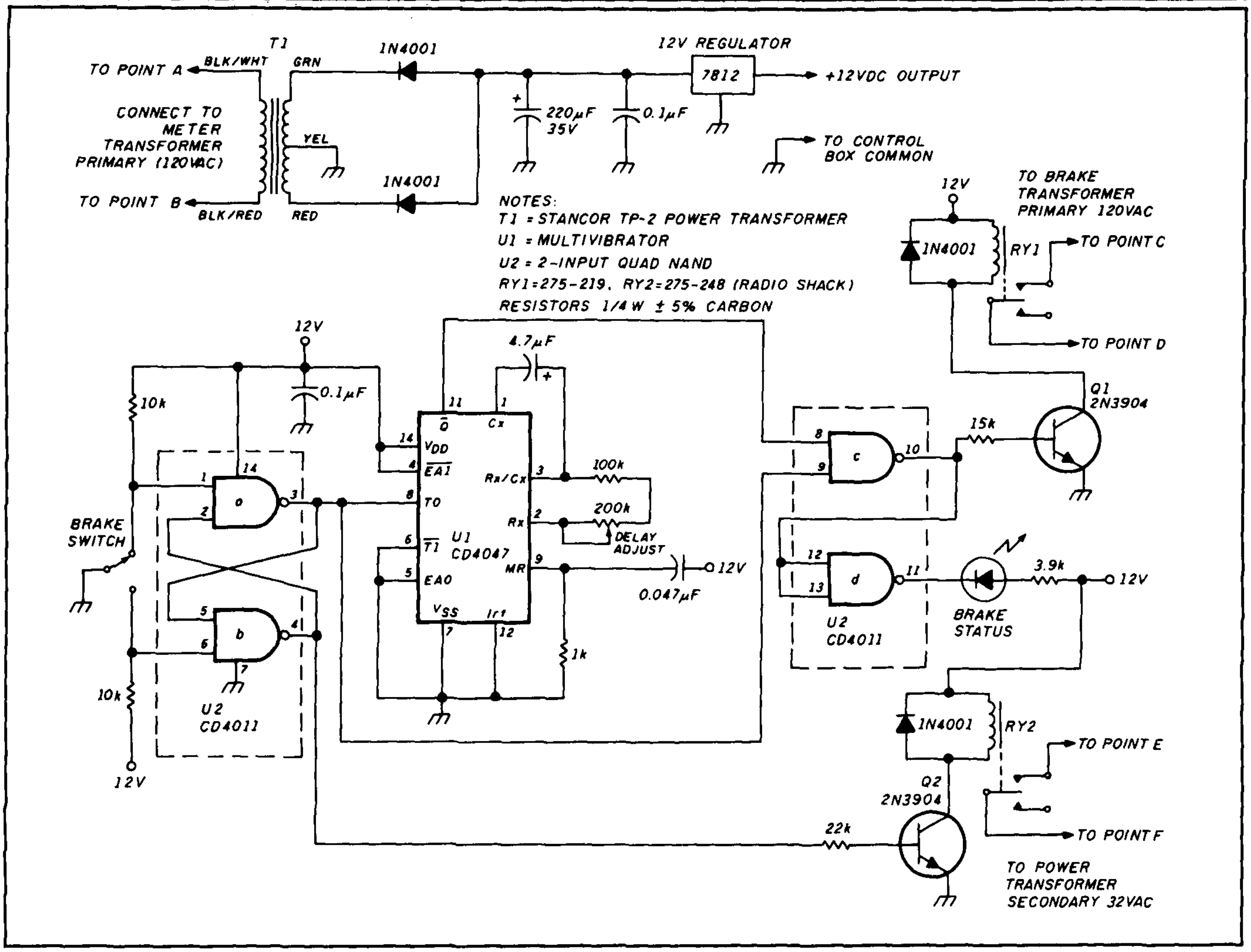
The direction and brake switch can be released simultaneously, just as the antenna reaches the location you've chosen. As you release the brake switch, pin 4 of the latch transitions to a low level; this switches RY2 off and disconnects the power to the motor. At the same time, pin 3 of the latch transitions to a high level. The multivibrator triggers from the rising edge, causing $\overline{Q}$ to pulse (see **Figure 2**). The external timing capacitor and resistor determine the width of the pulse and the brake remains disengaged for the duration. When the pulse-timing constant has elapsed, $\overline{Q}$ switches back to a high level and the output of U2C transitions to a low. This turns the brake relay off, and the brake engages.

The brake is delayed by the width of the multivibrator's pulse. Because the antenna has stopped turning in the meantime, no damage is caused when the brake engages. You can adjust the delay from approximately 1 to 3.5 seconds. Use the following guidelines: Cx > 1000 pF, and 10 k < Rx < 1 meg, to obtain other delay times from **Equation 1**.

$$Td = 2.48 \times Rx \times Cx \qquad (1)$$

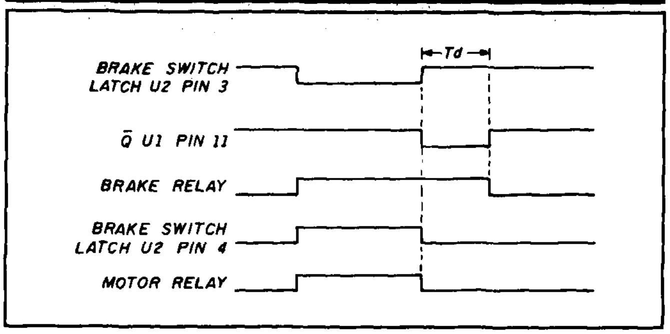
To prevent the brake from disengaging on power-up, I connected an RC network to the master reset input (pin 9 of U1). This network generates a pulse when power is first applied, causing the multivibrator to reset. This forces $\overline{Q}$ to remain high. I've also included an LED, which indicates the status of the brake.

FIGURE 1



Brake delay and power-supply schematic.

FIGURE 2



Logic timing diagram.

The power supply is a standard full-wave center-tapped rectifier with a secondary rating of 26-volts CT. It provides a maximum current of 150 mA. The delaying circuit draws a maximum current of 106 mA. Use any type of power supply that fits in the control box and supplies the current required by the delay circuit.

Construction

I built the circuit on a 3-1/2" × 2" vector pc board using point-to-point wiring. Both the delaying circuit and the power supply (except for transformer T1) reside on the vector board. I inserted push-in type solder lugs into the board to provide a point for external wire connections.

I mounted the transformer in the upper section of the control unit's chassis on two 1/4" standoffs. I placed it at the end of the switching levels next to the meter transformer. The pc board is attached to the bottom of the chassis under the meter transformer with four 1/4" standoffs.

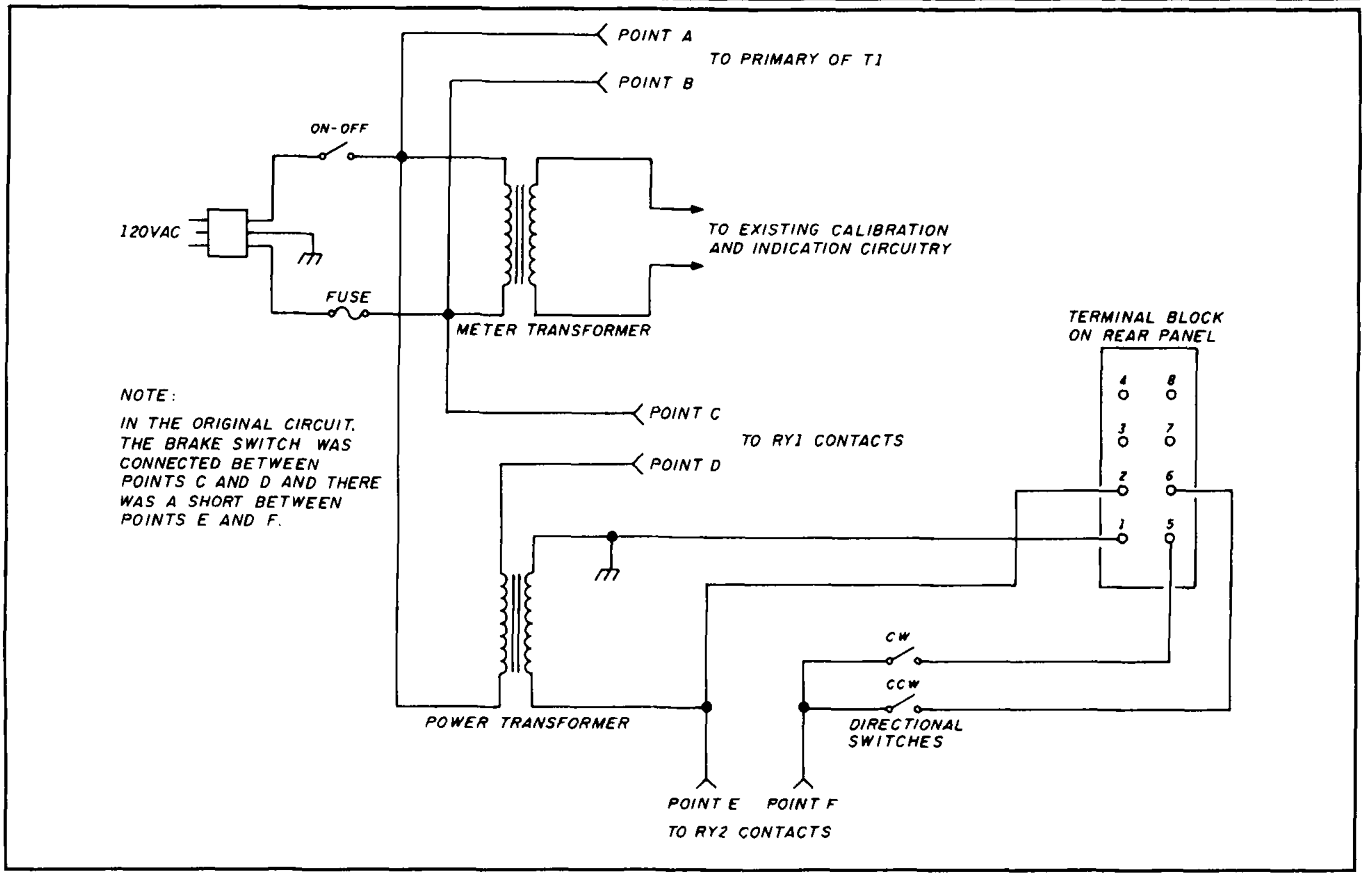
You can mount the brake status LED on the front panel. If you put it between the on/off and calibration switch it will be convenient and easy to see.

Wiring

Figure 3 shows the wiring details for installing the delaying circuit into the control unit. Remove the two wires from the brake switch and connect them to the RY1 contacts. Connect the common side of the brake switch to ground. Run a wire from the normally open terminal of the brake switch to pin 6 of U2B, and connect a wire from the normally closed terminal to pin 1 of U2A.

Locate the wire connected to the common terminal of both direction switches. Remove this wire from the direction switch and attach it to one of the switching contacts on RY2. Run a

FIGURE 3



Control unit wiring modifications.

wire between the other contact on RY2 and the common terminal of both direction switches.

Connect the primary leads of power transformer T1* in parallel with the primary of the meter transformer. Now connect the secondary leads of T1 and the leads for the LED to the pc board. Finally, mount the common ground of the delay circuit to the control unit's chassis ground and the system is ready to use.

Conclusion

The delay circuit provides a simple solution to a problem that could result in some costly damage to your antenna system. The circuit prolongs rotor life because it eliminates the stresses associated with sudden stops. From the operator's standpoint, the control unit operates just as it did originally; however, the brake can no longer be accidentally or incorrectly engaged.

The modifications have a minimal impact on the control unit and the circuit is easy to build and install. Although the system I described is used with the CD44, you can adapt the circuit for other rotor systems using controllable brakes.

*Radio Shack carries a transformer (P/N 273-1366) rated at 25.2 volts CT at 450 mA. Digi-Key carries a similar transformer (P/N T105-ND) rated at 28 volts CT at 160 mA. *Ed.*

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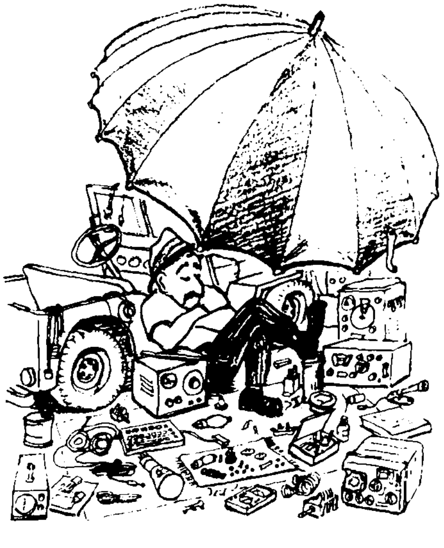

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CANCELLATION NOTICE. The BARC Packet Radio Symposium scheduled for September 16 at Georgian College, Barrie, Ontario has been cancelled.

IOWA: August 5-6. The Cedar Valley ARC's Summerfest '89, Teamsters Hall, 5000 J Street SW, Cedar Rapids. 8 AM to 5 PM, August 5 and 8 AM to 3 PM August 6. Admission $4. 12 and under free. For advance registration write Summerfest '89, Cliff Goldsberry, 2926 Shaffer Drive SW, Cedar Rapids, IA 52404. (319) 365-8849.

WISCONSIN: August 12. The tenth annual Rhinelander Swapfest sponsored by the Northwoods ARC, ARES, Tomahawk Rep. Assn and Rhinelander Rep. Assn., Rhinelander Ice Arena. Tickets $1.00. Auction 1:00 PM. For information contact Leonard Bauman, K9RMN, 804 Lincoln Street, Rhinelander, WI 54501. (715) 369-3296 or 369-5564.

LOUISIANA: August 12-13. The Shreveport Amateur Radio Association (SARA) is hosting their 10th annual ARK-LA-TEX Hamfest in Shreveport's air-condition Convention Hall.

MINNESOTA: August 13. St. Cloud ARC Hamfest, Whitney Senior Center, St. Cloud. Ticket donation $3. Extra ticket $2. Contact SCARC, Box 141, St. Cloud, MN 56302.

PENNSYLVANIA: August 13. Mid-Atlantic ARC Hamfest, Bucks County Rt 611 Drive-In Theater, Warrington. Buyers admitted 8 AM. Admission $3. For information call Al Maslin, W3DZI (215)446-4936 or write MARC, PO Box 352, Villanova, PA 19085.

INDIANA: August 13. The Porter County ARC's annual NW Indiana Hamfest and Computer Fair, Porter County Fairgrounds and Expo Center, Rt 49, east of Valparaiso. Admission $3.50/advance; $4/door. Kids under 12 free. For information/tickets contact Hamfest Committee, PCARC, PO Box 1782, Valparaiso, IN 46384.

NEW JERSEY: August 19. The 13th annual Ramapo Mountain ARC Hamfest and Computer Flea Market, American Legion Hall and Grounds, 65 Oak Street, Oakland. 8 AM to 1 PM. For more information contact Marc, WA2S, (201) 652-1318 or (201) 652-8493.

NEW YORK: August 19. The Finger Lakes Hamfest sponsored by the Tompkins County ARC, 4H-Acres, off Rt. 13, 7 miles north of Ithaca. Admission $3. Under 18 free. Handi parking. For more information contact Bob, KD2IM (607) 347-4444.

WASHINGTON: August 19-20. Northwestern Division Convention & Tacoma Hamfair sponsored by the Radio Club of Tacoma (W7DK), Pacific Lutheran University. Saturday 9 to 5. Sunday 9 to 1. Preregistration $5 to August 6; $7 at the door. $1 for non-hams. 12 and under free. For details write Radio Club of Tacoma, PO Box 11188, Tacoma, WA 98411 or phone RCT (206) 759-2040 or BillMorgan, W7GPR (206) 531-3821.

OHIO: August 20. W8VTD, the Warren Amateur Radio Association's Hamfest, Trumbull Branch Campus of Kent State University, Warren. Admission $2.50/advance; $3.00/door. Under 12 free. For information Warren ARA Hamfest, PO Box 809, Warren, OH 44482.

INDIANA: August 20. The Tippecanoe Amateur Radio Association's 18th annual Hamfest, Tippecanoe County Fairgrounds, Teal Road and 18th Street, Lafayette. Fairgrounds open 5 AM. For more information write D.C. Roberts, 5124 Jackson Highway, West Lafayette, IN 47906.

ILLINOIS: August 20. The Western Illinois ARC's Tri-State Swapfest '89, Eagles Alps Lodge, 3737 North 5th Street, Quincy. 8 AM to 3 PM. Admission $2/advance; $3/door. For information/reservations Michael Nowack, NA9Q, c/o WIARC, PO Box 3132, Quincy, IL 62301. (217)-224-8526.

ALASKA: August 26. The ARctic ARC's Hamfest/Swapmeet, 10th Avenue and Steese Highway, Fairbanks. Admission $1.00. For information Joan Soutar, N0AJW, PO Box 81389, Fairbanks, AK 99708.

MISSOURI: August 27. The St. Charles ARC will sponsor Hamfest '89, Blanchette Park in St. Charles. 6:30 AM to 2:30 PM. Free admission and parking. Handi parking available. Contact Mike Nolan, KA0UXQ, 16 Gateswood Drive, St. Peters, MO 63376.

TENNESSEE: August 27. The Lebanon Hamfest sponsored by the Short Mountain Repeater Club, Cedars of Lebanon State Park, US 231, 7 miles north of Lebanon. For information contact Mary Alice Fanning, KA4GSB, 4936 Danby Drive, Nashville, TN 37211. (615) 832-3215.

NEW MEXICO: September 2-3. The Alamogordo ARC's fifth annual Hamfest, Otero County Fairgrounds, Alamogordo. Free admission.

PENNSYLVANIA: September 9. Uniontown ARC (W3PIE) will hold its 40th annual Gabfest, Club grounds, Old Pittsburgh Road, Uniontown. Registration $3 or 2/$5. For more information write UARC Gabfest, c/o John T. Cermak, WB3DOD, PO Box 433, Republic, PA 15475. (412) 246-2870.

FLORIDA: September 9-10. The Platinum Coast Amateur Radio Society presents the 24th annual Melbourne Hamfest, Melbourne Auditorium. Registration $4 advance (SASE only), $5 at the door. Hamfest 708 Dartmouth Avenue, Melbourne, FL 32901.

NORTH CAROLINA: October 1: JARSFEST '89, Benson American Legion Complex, 301 N. Benson NC 27504. 8 AM to 4 PM. For flyer SASE to Johnston Amateur Radio Society, PO Box 1154, Smithfield, NC 27577. (919)934-0486, 894-5479.

OPERATING EVENTS

"Things to do . . ."

August 5-6: Titusville, PA. From the birthplace of the oil industry, special event station K3HWL will operate from 1400Z to 2300Z each day from the site of the historic Perry Street railroad station to commemorate the fourth year of operation of the Oil Creek & Titusville Railroad. Sponsored by the Oil Creek Valley Radio Society. CW 3.710, 3.675, 7.110. SSB 7.250, 14.275, 28.350 MHz. For QSL send QSL and No. 10 SASE to Robert E. Myers, K3HWL, RD 1, Box 143-G, Titusville, PA 16354.

August 7-12: All-American Soap Box Derby. The Cuyahoga Falls ARC will operate special event station W8VPV during the 52nd running of the Derby. Monday-Friday 2200Z-0300Z. Saturday 1100Z-2000Z. Freq. 3.860, 14.240, 28420. For certificate send large SASE by 9/20/89 to W8VPV, Box 614, Cuyahoga Falls, OH 44222.

August 12: The Arapahoe Radio Club's fifth annual ham radio expeditions to Colorado's 14,000-foot mountain peaks. CW frequency 14,050-14,060 with participants calling "CQ 14". Phone stations around 14,285 calling "CQ Fourteeners". Operation from 1600-1800Z. QSl direct of to K9AY, 7318 S. Birch Street, Littleton, CO 80122.

August 12-13: The Southcentral Conn. Amateur Radio Association will operate W1GB in the General portion of 80-15 and Novice 10m from Paul Newman's "Hole in the Wall Gang" camp for children with cancer and blood disorders. For a special QSL send QSL and SASE to K1PVT, Bill DeBenedetto, 55 Thompson St, 13E, East Haven, CT 06513.

August 16-18: Bridgewater, New Jersey. The Somerset County Office of Emergency Management will operate WC2ADK 1400-0100Z each day to promote Amateur Radio, R.A.C.E.S and Public Service at the annual 4-H Fair. Sugg. Freq. Lower 25 kHz of General 80-10m and 10m Novice. Visitors on 145.320 simplex. Send QSL and SASE to Somerset County OEM/4H, PO Box 3000, Somerville, NJ 08876.

August 19: Salisbury, New Hampshire. To commemorate Old Home Day, N1GCO will operate 1400Z to 2000Z on lower 25 kHz of General HF, 220/440 repeater and simplex and 145.07 packet. For special QSL send SASE to N1GCO, RFD 5, Box 42, Penacook, NH 03303.

August 19-Sept 3: The Jet Propulsion Laboratory ARC will operate W6VIO from 000Z August 19 through 2359Z Sept 3 to commemorate the Voyager 2 encounter with Neptune. This complete the Grand Tour. Primary SSB and SSTV frequency will be 14.235. Greatest activity will be weekday noons and evenings. For QSL, send QSL and SASE to W6VIO callbook address. DX stations QSL via bureau.

FREE 1989-90 Florida two meter repeater directories are currently being distributed by the Hernando County Amateur Radio Assn. of Brooksville, FL. Ask for one at any official Florida Welcome Center or SASE to Repeater Directory, Hernando County ARA, POB 1721, Brooksville, FL 34605-1721.

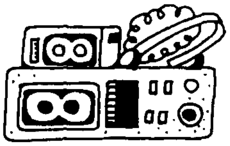
LAUREL ARC monthly (except December) Amateur exam sessions for all license classes. No fee is charged. Pre-registration is required. Call (301) 725-1212, Maryland Radio Center, 8576 Laureldale Drive, Laurel, MD 20707.

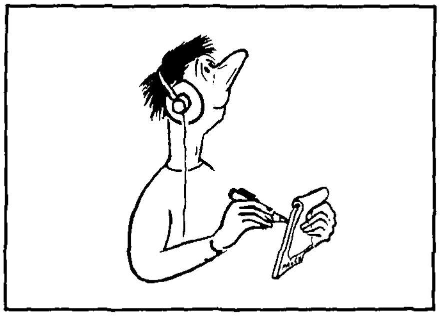
AMATEUR EXAMS in Wellesley, MA, Saturday, August 26, 10 AM. Please call Vern, ND1Z (508) 533-6822 by August 20 to book a spot. New and prospective Amateurs are most especially welcome.

NORTH COAST ARC 1989 LICENSE EXAMS. 12:30 PM, Saturdays February 11, April 15, June 10, August 12, October 14, December 9. N. Olmsted Community Cabin, S of Lorain on W. Park. Novice thru Extra. Walkins allowed. Talk in 145.29 repeater. For information Dan Sarama, KB8A, 15591 Rademaker Blvd, Brookpark, Ohio 44142. 267-5083 or Pauline Wells, KA8FOE, Rick Wells, K8SCI, 777-9460/779-8999.

AMATEUR RADIO CLASSES: For those people interested in obtaining a Novice (basic level) Ham license or upgrading to Tech/General, the Chelsea Civil Defense, in cooperation with QRA Radio Club, will sponsor Amateur Radio Communications classes evenings at Chelsea High School starting MARCH 7, 1989. For more information write Frank Masucci, K1BPN, 136 Grove Street, Chelsea, MA 02150. Please enclose your telephone number.

THE MIT UHF REPEATER ASSOCIATION and the MIT Radio Society offer monthly HAM EXAMS. All classes Novice to Extra. Wednesday, AUGUST 23, 7 PM, MIT Room 1-150, 77 Mass Avenue, Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann at (617) 484-2098. Exam fee $4.50. Bring a copy of your current license (if any), two forms of picture ID, and a completed form 610 available from the FCC in Quincy, MA (617) 770-4023.





Garth Stonehocker, KØRYW

DXING DURING THE SUMMER QRN SEASON

An estimated 3600 thunderstorms are in progress around the world at any given time. They occur mostly in the tropical regions. These thunderstorms can be classified as air mass, frontal, or combinations of the two, depending on how they form. The main source of summertime QRN is the air mass thunderstorm.

During the evening DXing hours, air mass thunderstorm QRN may limit the usefulness of low band signals for local ragchewing and, for the most part, will rule out weak signal DX. The QRN, propagated from equatorial land regions or closer, increases the overall average noise level on the 80 and 160-meter bands. This happens because the "tropical" regions get closer to those of us in the Northern Hemisphere as the sun comes up to 23°N in the summer. As a result, a hop or two is cut from the thunderstorm noise propagation distance, adding a few dB to the overall noise. Florida leads the top thunderstorm producers of the closer areas; the eastern side of the Rocky Mountains in Colorado and Nebraska is next, followed by the southeastern part of the United States.

The air mass thunderstorm forms when the sun heats the ground. As the heat from the ground rises, it warms the air above, causing it to rise. As this heated air meets the colder air above, its moisture content condenses, forming clouds. The clouds — some of which are seized by the winds and carried into the jet stream to form the characteristic anvil-shaped top of a thunderhead at 30,000 to 40,000 feet — continue to rise until their condensed moisture forms drops heavy enough to fall as rain. Some drops are carried further upward and freeze into hail. This fast up-and-down motion generates static electricity strong enough to cause the air (as an insulator) to break down between a cloud and the earth, or between one cloud and another. As the lightning stroke releases this energy, it produces electromagnetic pulses. Our receivers pick up the HF radio frequency pulses we call "noise." Most air mass storms form on afternoons when the humidity is above 50 percent, and last into the night before cooling off enough to dissipate. Air mass thunderstorms linger for several days until they release their moisture as rain, or slowly move on.

How can you communicate with DX stations on these lower bands? Directional antennas may help if the thunderstorm activity is in the opposite direction from the DX stations. If you can avoid pointing your beam at these areas, you can help minimize noise pickup. In fact, if you can get the back of the antenna pointed in that direction, you can use the front-to-back ratio (typically 15 dB) to further decrease noise pickup. This may mean working DX long path or over the Pole. If the ionosphere will support propagation in that direction, and no geomagnetic field disturbance is occurring, you may find this a solution to some of the summer noise problems. You may also want to change your operating hours. Since most air mass thunderstorms dissipate during the night and build to noise proportions with the heat that arrives after dawn each day, there's a minimum noise period from about 3 to 8 a.m. which offers good operating conditions.

Last-minute forecast

The higher frequency bands are expected to be best the third and fourth weeks of August, when the solar flux increases the MUF for long skip openings. Don't expect many trans-equatorial openings in the evenings during the summer months. Sporadic E (E_S) short skip openings at midday should give the highest E region MUF in many years. Lower frequency signal strengths will decrease during daylight hours when the flux is high. Higher noise will also lead to poor conditions. Look for the best signals the first two and last weeks of the month. Thunderstorm noise will still be a problem in the evenings. Sporadic E short skip openings around sunset should help signals get through the noise.

Band-by-band summary

Six-meter sporadic E short skip conditions on some days will last anywhere from 30 minutes to a couple of hours around local noon. Expect about 1000 miles per hop.

Ten, 12, 15, and 17 meters will have quite a few short skip Es openings and some long skip openings during the 27-day solar flux peak to southern areas of the world, in the daylight hours. Fifteen and 17 meters will be best for several hours as the MUF decreases for the evening.

Twenty, 30, and 40 meters will be useful for DX communications to most eastern, western, and northern areas of the world during daylight hours and into the evening most days, via long skip to 2000 miles per hop or short skip Es, with 1000-mile hops. The period of daylight is still relatively long, but will be noticeably shorter by the end of the month.

Thirty, 40, 80, and 160 meters are all good for nighttime DX, even though the background noise will be severe in the evenings. The direction of the openings will rotate from the east to the south and then westward in the morning. If you want to avoid thunderstorm QRN, you may find sporadic E propagation helpful in the early evening toward the east and south. Try the early morning hours for communication paths to the west, and monitor WWVH or WWV on 2.5 and 5 MHz as beacons.

UGUST

WESTERN USA

GMT	PDT	N (EAST)	NE (OPE)	E (RICA)	SE (IERICA)	S (ARCTICA)	SW (ZEALAND)	W (ANIA TRALIA)	NW (N)
0000	5:00	12	17	15	10	10	10	10	10
0100	6:00	10	20	15	10	10	10	10	10
0200	7:00	10	20	15	10	10	10	10	10
0300	8:00	12	17	17	10	12	10	10	10
0400	9:00	12	15	17	12	15	10	10	10
0500	10:00	15	17	15	12	20	10	10	12
0600	11:00	15	17	12	15	20	10	10	15
0700	12:00	17	20	12	15	20	10	10	15
0800	1:00	20	20	15	15	20	10	10	17
0900	2:00	20	20	15	17	20	10	10	17
1000	3:00	20	20	15	20	20	12	12	17
1100	4:00	30	15	15	15	20	15	15	20
1200	5:00	17	15	10	15	20	15	15	20
1300	6:00	15	12	10	12	20	15	15	30
1400	7:00	15	12	10	10	30	17	17	20
1500	8:00	15	10	10	10	30	17	17	20
1600	9:00	17	10	10	10	20	17	17	20
1700	10:00	20	10	10	10	15	15	17	30
1800	11:00	20	12	10	10	12	10	17	17
1900	12:00	20	12	10	10	10	10	12	15
2000	1:00	20	12	10	10	10	10	10	15
2100	2:00	17	15	10	10	10	10	10	12
2200	3:00	15	15	12	10	10	10	10	12
2300	4:00	15	15	12	10	10	10	10	10

MID USA

GMT	MDT	N (EAST)	NE (OPE)	E (RICA)	SE (IERICA)	S (ARCTICA)	SW (ZEALAND)	W (ANIA TRALIA)	NW (N)	CDT
0000	6:00	15	17	15	10	10	10	10	10	7:00
0100	7:00	12	20	15	10	10	10	10	10	8:00
0200	8:00	10	20	15	10	12	10	10	10	9:00
0300	9:00	12	20	17	10	12	10	10	10	10:00
0400	10:00	15	17	17	12	15	10	10	10	11:00
0500	11:00	17	17	17	12	20	10	10	12	12:00
0600	12:00	20	20	15	15	20	10	10	15	1:00
0700	1:00	20	20	15	15	20	10	10	17	2:00
0800	2:00	20	30	15	15	20	10	10	17	3:00
0900	3:00	20	20	15	17	20	12	12	17	4:00
1000	4:00	20	17	15	20	20	15	15	20	5:00
1100	5:00	17	15	10	17	20	15	15	20	6:00
1200	6:00	15	15	10	17	20	15	15	30	7:00
1300	7:00	15	12	10	15	30	17	15	15	8:00
1400	8:00	15	12	10	10	30	17	17	17	9:00
1500	9:00	15	10	10	10	30	17	17	17	10:00
1600	10:00	17	10	10	10	20	17	17	20	11:00
1700	11:00	20	10	10	10	15	15	17	20	12:00
1800	12:00	20	10	10	10	12	10	17	30	1:00
1900	1:00	20	10	10	10	10	10	12	15	2:00
2000	2:00	20	10	10	10	10	10	10	15	3:00
2100	3:00	17	10	10	10	10	10	10	12	4:00
2200	4:00	15	15	12	10	10	10	10	10	5:00
2300	5:00	15	15	12	10	10	10	10	10	6:00

EASTERN USA

GMT	EDT	N (EAST)	NE (OPE)	E (RICA)	SE (BBEAN ERICA)	S (ARCTICA)	SW (ZEALAND)	W (ANIA RALIA)	NW (N)
0000	8:00	15	17	15	10	10	10	10	10
0100	9:00	15	20	15	10	12	10	10	10
0200	10:00	17	20	15	10	12	10	10	10
0300	11:00	17	20	17	10	15	10	10	10
0400	12:00	20	30	17	12	20	10	10	10
0500	1:00	20	20	17	15	20	10	10	10
0600	2:00	20	20	15	15	20	10	10	20
0700	3:00	20	30	15	15	20	12	12	20
0800	4:00	15	17	17	15	20	15	15	20
0900	5:00	15	15	15	17	20	15	15	20
1000	6:00	15	15	10	17	20	15	15	15
1100	7:00	12	12	10	15	20	17	17	15
1200	8:00	10	12	10	10	30	15	15	17
1300	9:00	10	12	10	10	30	15	15	17
1400	10:00	12	10	10	10	30	15	17	20
1500	11:00	15	10	10	10	17	17	17	20
1600	12:00	15	10	10	10	15	17	17	20
1700	1:00	17	10	10	10	12	15	17	20
1800	2:00	20	12	10	10	12	10	17	20
1900	3:00	20	12	10	10	10	10	10	15
2000	4:00	20	12	10	10	10	10	10	15
2100	5:00	30	15	10	10	10	10	10	12
2200	6:00	17	15	12	10	10	10	10	10
2300	7:00	15	17	12	10	10	10	10	10

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