WORLD'S LARGEST INDEPENDENT HAM MAGAZINE

# AMATEUR RADIO 73

May 1969

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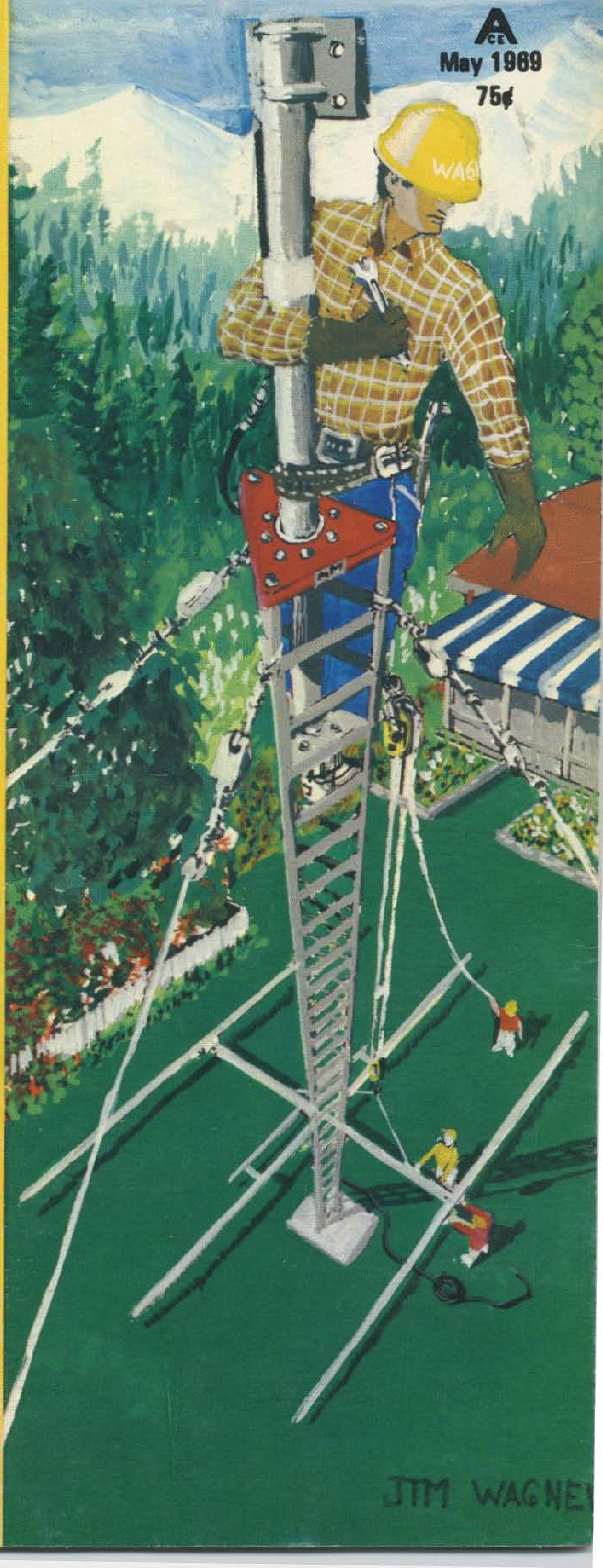

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# 73 MAGAZINE

## 73 Magazine #104, May 1969 Contents



**Features**






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# ...de W2NSD/1

Wayne Green

Just where does amateur radio stand today? And, where is it going? Obscenity on our bands...disenchantment with the ARRL... also with the FCC...worry about the ITU...the Miller 'effect' on DXing...home brew dying... movements to CB-ize our hobby...our empty Extra Class bands...growth of the hobby stopped...major manufacturers leaving or left for CB money...terrible QRM on a few bands ...wide open emptiness on others...clubs lanquishing...etc. Do we have more problems than we can solve? And, who is to solve them?

Let's briefly look at our background and then try to see where we are today.

The beginnings in any field of discovery are left to the amateur. The first radio amateurs were experimenters who built a good deal of their own equipment for the fun of it and got on the air with spark transmitters and fought QRN and, eventually QRM. Amateurs, naturally, were responsible for a lot of the important developments. As radio communications became a bigger and bigger business the ham bands shrank accordingly and more of the developments were made by larger companies who could afford the research engineers and expensive equipment required for the work.

By the late 20's commercial receivers were becoming popular and fewer and fewer amateurs took the trouble to build their own. Most of the amateurs built their own transmitters right up until WWII. This was because there were not enough amateurs to make commercial production of transmitters profitable at the time.

After the war there were so many surplus transmitters available that there was little incentive to go out and buy parts for building a new rig. With Command Sets selling for $5 which, with a little conversion, would give 100 watts of very stable VFO power on most ham bands, one would have to be crazy to spend $100 or so on parts to build the same rig. I remember buying a 100 watt Jefferson Travis surplus transceiver which covered 160-80-40 meters, AM phone and CW, a bunch of the Command Sets, SCR-522's galore, ARC-4's, a Meissner Signal Shifter, a BC-312 and an SX-28...all surplus and all of which I used for years. The Signal Shifter, with a little NBFM modulator I put in, connected to a pair of surplus 813's, let me work the world ...on all bands!

About the time surplus began to fade away our manufacturers saw that the ham market had grown big enough to make it worth while to add transmitters to their receiver lines. What ham in his right mind would go out and spend $200 for parts to build a rig that has no resale value worth mentioning when he could buy the same rig commercially for perhaps $250? A handful of amateurs continued to build their rigs, but they did it for the fun of building and had to recognize that economically they were in the hole.

Amateur construction did not die, by any means. Thousands of amateurs continued to build equipment...but now it was VHF gear which was not available commercially...RTTY terminal units...gadgets. Building projects in the ham magazines would often be duplicated by hundreds of readers. Probably only about 25% of the amateurs built equipment at this time, compared to the near 100% of the 30's.

Then came the transistor. Most of the older timers didn't even try to accommodate to the transistor. They went on for a year or two or even three building the tube circuits published in the magazines and ignored the transistors. As time went on fewer and fewer of those cartons of old tubes in the closet would fit into the new projects being published. Hardly anyone called for an old bathtub capacitor (condenser) anymore.

The percentage of home construction dropped. Most of the radio parts distributors went to selling complete equipment and CB rigs, leaving the parts jobbing to a handful of large mail-order houses. Gone was the day

(Continued on page 89)

# *Who's Who in Amateur Radio*

*Wells Chapin, W8GI*
*2775 Seminole Road*
*Ann Arbor, Michigan 48104*

We have celebrities in our ranks. There are many illustrious and glamorous names in the Call Book. Oddly enough, however, despite their status in their various fields of endeavor, these well-known persons do not constitute an aristocracy within our midst. Far from it! For Amateur Radio, unlike other forms of activity, exemplifies true Democracy. It cuts across class lines with complete disregard for wealth, social standing, nationality and creed.

Many of our colleagues possess names which are universally recognized, and it is high time that we acknowledged their presence among us. At a point in time when we hear constant warnings that our frequencies are in jeopardy, we may help to preserve our allocations by generating a program of better public relations. It is certain that we can use a more positive image. And surely, publicizing the names and achievements of our more eminent and distinguished hams will tend to enhance that image.

There are hams in medicine, law, show business, the clergy, the military, Big Business, Government, foreign royalty, and two of us have even run for the highest offices in our nation.

Not because of established protocol, but because it seems a likely place to begin, here are some hams with the "Blood Royal" in their veins. P. T. Namgyal, King of Sikkim, operates from the Palace at Gangtok as AC3PT. He has an American wife, who probably complains about the unsightly tower and beams which disfigure the looks of the house, just as ours do. OE3AH is Archduke Anton von Hapsburg, the Austrian pretender. Moulay Hassan, CN8MH, is King of Morocco. In Saudi Arabia, where Ibn Saud, who was probably the last of the absolute monarchs in the world, operated as HZ1TA, three of the Princes hold ham tickets. Crown Prince Abdullah is HZ1AF, Prince Talal uses the late King's call, HZ1TA, and Prince Saud ibn Saud was HZ1SS. So much for the blue bloods.

I wonder how many who have visited that famous landmark in New Orleans, Antoine's, realize that it is owned and operated by Roy Alciatore, W5RU. Roy loves to QSL, and he usually sends a commemorative Mardi Gras medallion along with his card.

Many DX'ers are familiar with the call, UA1LO. Sad to say, this ham is now a Silent Key. He was the Soviet Union's intrepid Cosmonaut, Yuri Gargarin. Incidentally, it is being rumored that one of our own Astronauts, who is a ham. may operate a rig on a forthcoming moon shot. It is said that the operation will be on the 144 MHz band.

Here are several hams who have achieved stature in the entertainment world:

| | | |
|---|---|---|
| Arthur Godfrey | K4LIB | Radio & TV personality |
| Tex Beneke | KØHWY | Band leader |
| Bill Leonard | W2SKE | Radio & TV announcer |
| Alvino Rey | W6UK | Band leader |
| Harry Gumm | K6MDD | Circus clown |
| Mel Shavelson | W6VLH | Screen writer, producer |
| Andy Devine | WB6RER | Famous character actor |
| Dave Mann | K2AGZ | Songwriter of many hits |
| Bob Mersey | W2TXI | Recording producer, conductor |
| Ernie Lehman | K6DXK | Film writer (Sound of Music) |
| Julius Baker | W2TDY | lst Flutist NY Philharmonic |
| Paul Weirick | K6AK | Arranger (Lawrence Welk) |
| Jean Shepherd | K2ORS | Humorist, Radio personality |
| Luz Zuluage | HK6LT | Miss Universe 1959 |
| Pee Wee Hunt | W1AYA | Famous jazz musician |
| Cliff Arquette | ex W6SGP | Charlie Weaver |
| Freeman Gosden | | Amos |
| Bobby Byrne | WB2JDG | Trombone, record exec |
| Wilmer Allison | W5VV | US Davis Cupper |

While we're on the subject of entertainment, 8XK, the ham station of Frank Conrad, later became known as KDKA. This station in Pittsburgh, was one of the pioneer stations in the crystal set days, and many's the hour spent manipulating the old cat's whisker, trying to pull in KDKA, back in the 20's. Really, the broadcasting industry owes its very existence to hams, for they laid the groundwork and experimented independently so that the principles of radio broadcasting could become a practicality. Prior to their work, radio was used solely for the communication of messages. The concept of broadcasting music, sporting events, Presidential Inaugurations, and such, was strictly the brainchild of hams.

Incidentally, there are many firms which make ham gear whose proprietors hold tickets. Art Collins, WØ CXX; Frank Gunther, W2ALS; Percy Spencer, W1GBE; Parker Gates, W9DZT, and many, many others. Bill Halligan, W9AC, founder of the Hallicrafter Corporation, was one of the founding fathers of our hobby, and deserves special mention.

Here are some outstanding business people who are amateurs:

| | | |
|---|---|---|
| Cyril Staud | K2DQ | Vice Pres., Eastman Kodak |
| Harry Vickers | W8HBY | Pres., Sperry Rand |
| Herb Scofield | W8DBH | Pres., TMC Systems |
| Buzz Reeves | K2GL | Reeves Sound Studios, etc. |
| George Davidson | K6EI | Exec., Standard Oil |
| E. Henderson (dec'd) | W1UDY | Exec., Sheraton Hotels |
| Harold Churchill | W2ZC | Exec., Time Publications |
| Bill Newcomb | K2CNX | Insurance Exec. |
| Harold Carlson | W2UNR | Exec., Associated Press |
| Findley Carter | K6GT | Director, Stanford Research |
| Bob Waters | W1PRI | Pres., Waters Mfg. Co. |
| Carl Lindemann | W1MLM | Vice Pres., NBC |
| Bob Ehrlich | W2NJR | Exec., AT&T |

General Electric has over 1000 hams, and there are hundreds at RCA, Westinghouse, Bell Telephone and others. Ford Motors has a ham club with over 100 active members. There are amateurs in all sorts of industrial and commercial institutions. Banks, department stores, railroads, shipping companies, utilities, airlines, mining and smelting companies, steel and copper firms, newspapers, book publishers, advertising agencies, drug firms, oil producers; these are just a few categories of business where hams may be found.

The clergy is well represented. Father Dan Linehan, S.J., of the Weston Observatory, W1HWK; Father Tom Aquinas Cox, W2CBX, of the International Radio Mission Association; Father Chuck Tardiff, 5H3 Jack

Rabbit, and Father Moran, 9N1 Mickey Mouse, are some of the more well known ones. And there are countless priests, nuns, ministers and rabbis, chaplains, and at least one Greek Orthodox priest, all yacking away, even as you and I.

Many of us remember the sinking ship, Flying Enterprise, whose skipper refused to leave, even after he had ordered his crew to abandon ship. His gallantry made headlines all over the world. This was Kurt Carlson, W2ZXM, who can often be heard on 20 meters, operating maritime mobile from the seven seas.

The president of Louisiana State University is John Hunter, W5DTL. W1DDB is the reknowned sculptor, Allison Macomber. And, Bill Juhre, the syndicated cartoonist is W9IMQ. Ray Blosser, W8DBK, is vice president of a bank in Cleveland. We've got 'em all over!

Politics and the Diplomatic Service are not without hams.Of course, we all have heard of K7UGA/K3UIG, Barry Goldwater. Some of the less publicized ones are:

| | | |
|---|---|---|
| William Porter | K1YPE/XV5 | Dep. Chf. of Missions in Viet Nam |
| Maurice Bienbaum | HC2KX | Ambassador to Ecuador |
| Armin Meyer | OD5XX | Ambassador to Lebanon |
| Dudley Mason | KW6CJ | Governor of Wake Island |
| Bert Delotto | W6FGY | California Legislator |
| James Homes | W6REK | California Legislator |
| John Doughten | W3LV | Pennsylvania Legislator |
| Carl Ruh | W4TZT | Kentucky Legislator |
| Frank Hazelbaker | W7FTP | Montana Legislator |
| John Thompson | W7OAZ | Montana Legislator |
| John McCarthy | K1EMO | Former Comm'r of Finance, Mass. |

There have always been many hams in the military. Since communications are a vital link in the successful maintenance of a proper military establishment, it would be difficult to envision a situation in which there were no reasonably close relationship between the Defense Department and Amateur Radio. In times of crisis, we are expected to furnish a pool of experienced communications personnel, upon which the military can depend. This calls for some degree of liaison.

Some of the high ranking officers who who hold licenses are:

| | |
|---|---|
| Rear Admiral H. Bruton | W4IH |
| Major Gen. Elmer (Bill) Littell | K3BNI |
| Gen. W. W. Watts | W4VI |
| Admiral McCarley | W6BSH |
| Admiral Weatherwax | W4PDW |
| Major Gen. Shuler | W4KN |
| Gen. J. Smith | W6RT |
| Adj. Gen. Windom | W8GZ |
| Gen. Joe Stillwell, Jr. | W4FPE |



The history of Amateur Radio, indeed, that of electronics in general, is star-studded with many great names, each of which would be entitled to an individual article; their contributions have been so significant. Men like DeForest, Colpitts, Hartley, Meissner, Armstrong and Hazeltine, all hams, have given the fruits of their genius for the betterment of all humanity. Without the work of these pioneers, many of the marvels which make life easy today would not even exist. It is fair to say that these men were giants.

Thanks to the devotion and dedication of thousands of radio amateurs, the art of electronics has contributed greatly to world peace and friendship. Nations, once widely separated from each other, have been enabled to maintain lines of communication and avenues of peaceful approach.

International aspects of ham radio may generate further interchange, resulting in an atmosphere of genuine amity and good will among the nations of the world. It may spread out to the general populations, and finally reach up to the ruling circles. In this way, ham radio has an opportunity to make its greatest contribution of all. Hams everywhere have a justifiable reason to be proud of their hobby. There are few hobbies which are so capable of contributing to society.

...W8GI


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# *A Stacked Gamma Matched Turnstile*

*Glenn H. Chamberlain, WA9LPC*
*4822 Prospect Avenue*
*Downers Grove, Illinois 60515*

Having just acquired the desire to operate on the higher frequencies, I purchased a conventional two-meter rig and an eight-element commercial yagi antenna. It was immediately apparent that the local groups were impossible to copy readily using the highly directional antenna.

In reviewing the material in the usual handbooks, the stacked turnstile appeared to be the most promising compromise. However, the need to insulate the elements from each other, and the matching, seemed overly complicated.

Why not a gamma match eliminating the need for insulators? The elements were cut from 3/8 inch aluminum tubing for the center of the band, 146 MHz. Their length from the formula for a half wave dipole is 38 inches.

With the gamma match the elements could be bolted directly together to a common boom. Using number 14 wire, the gammas were connected 4 inches from the center connection of the elements running horizontal ½" above each element towards the center.

To provide a 90 degree phase shift between the elements of each turnstile, use a quarter wave section of RG-58AU. The half wave sections for 146 MHz, using the 0.66 velocity factor, is 26.6 inches for each. The entire antenna is then fed at the center of the two half wave sections with RG-58AU.

The antenna was hung about four feet off the side of the tower at the forty foot level. The feedline at this location is about 75 feet long. A 15 watt AM transceiver was used for the test. The standing wave ratio was 1.3 at 144.4 MHz, 1.2 at 146.0 MHz, and 1.3 at 147.6 MHz.

The band was open when the antenna was connected. Reception of an Iowa station about 145 miles distant from Chicago dropped one S-unit when shifting from the commercial eight-element beam to the home brew turnstile. In comparing my signal with this station, my signal also fell one S-unit when changing from the commercial antenna. If the commercial beam lives up to its specifications of 15.5 dB gain, this means the stacked turnstile has about a 10 dB gain on a long haul.

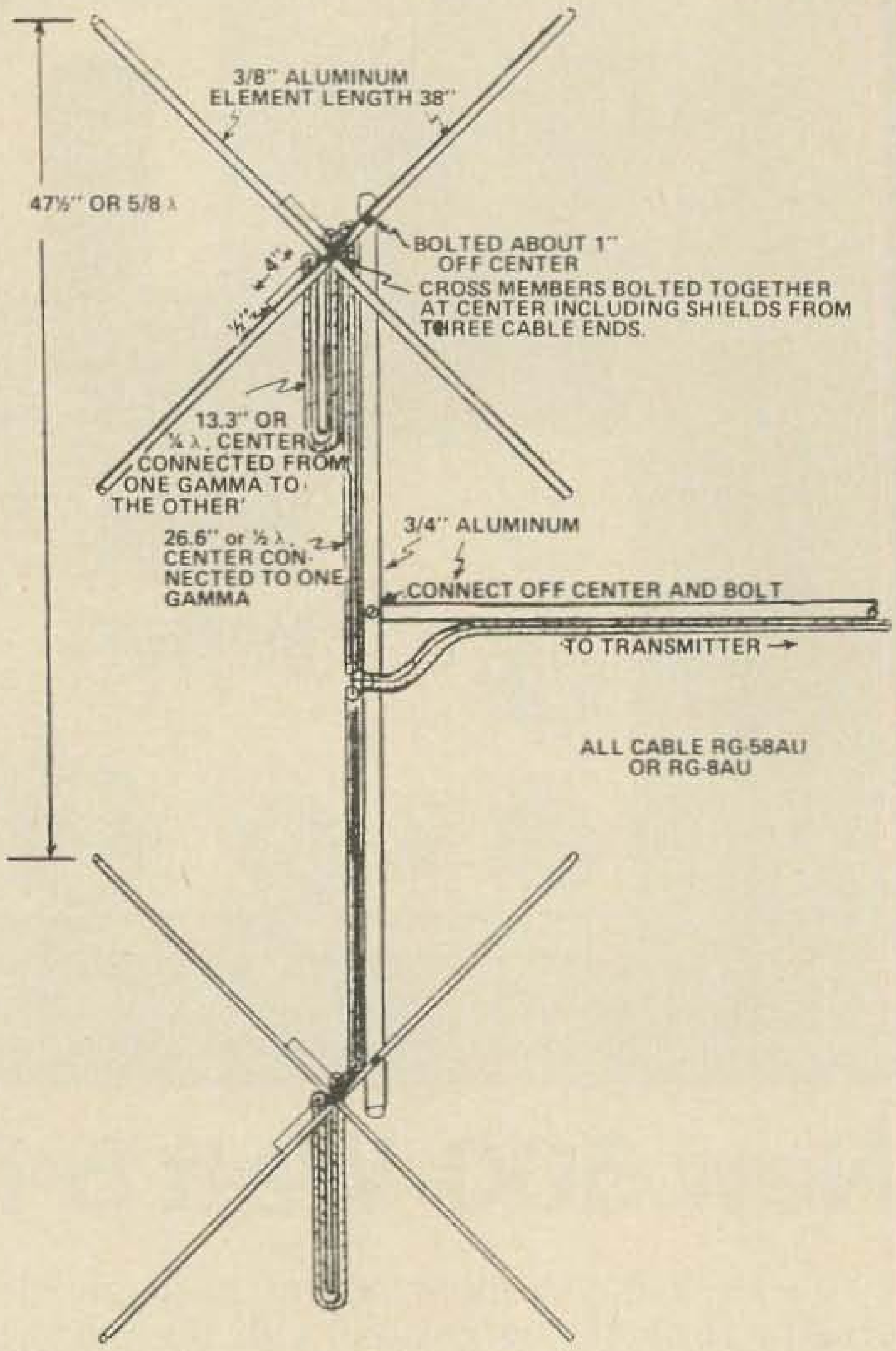


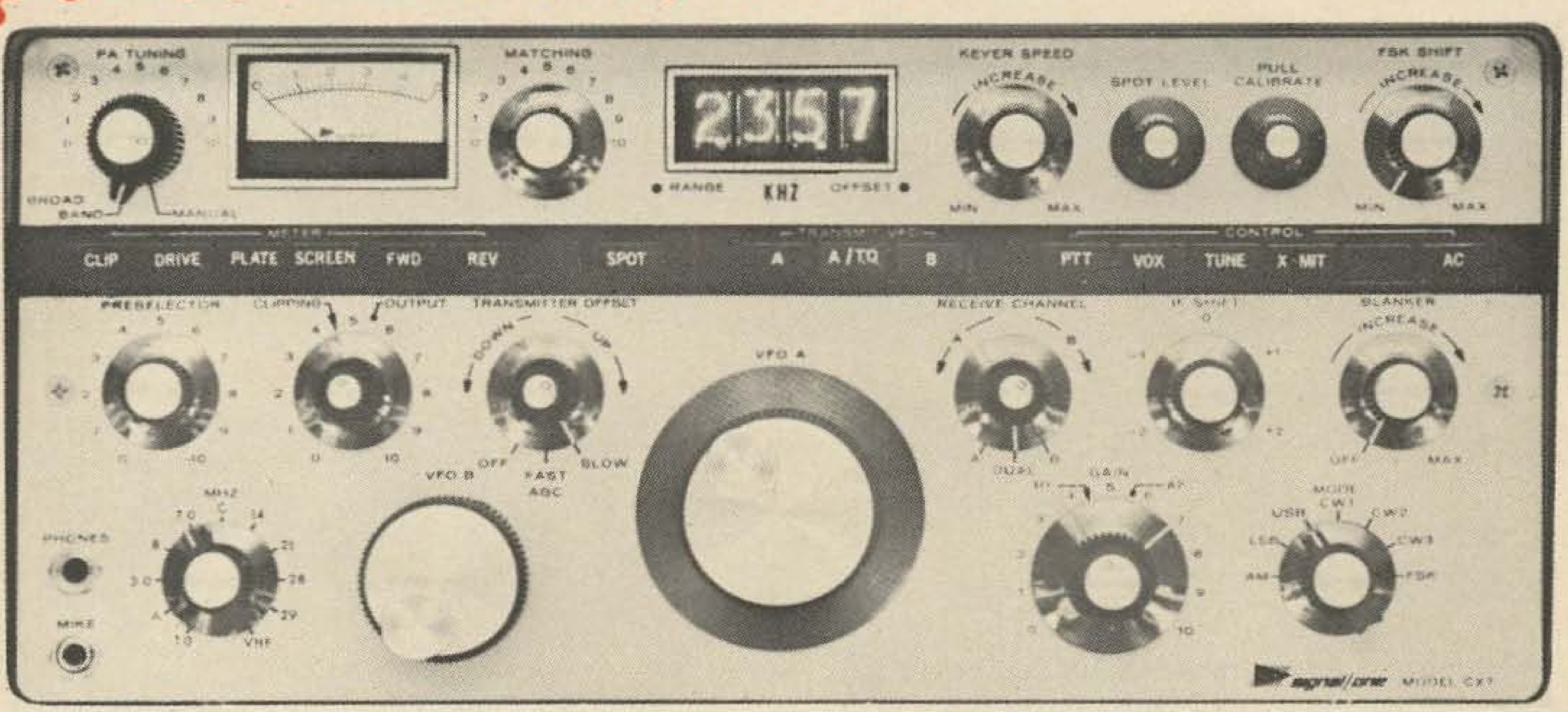

Fig. 1. The Stacked Gamma Matched Turnstile.

The antenna had excellent transmitting gain when using it in local group communication. Receiving was not quite as good. However, if more gain is desired, there is no reason two or three of these stacked turnstiles could not be hung around the perimeter of tower, each turnstile being fed with half wave sections of RG-58AU cable.

This antenna is simple to build, cheap, light, omni-directional and required no tuning after fabrication. At this QTH, we highly recommend it for those "local" schedules, and on the longer hauls you might be surprised.

...WA9LPC

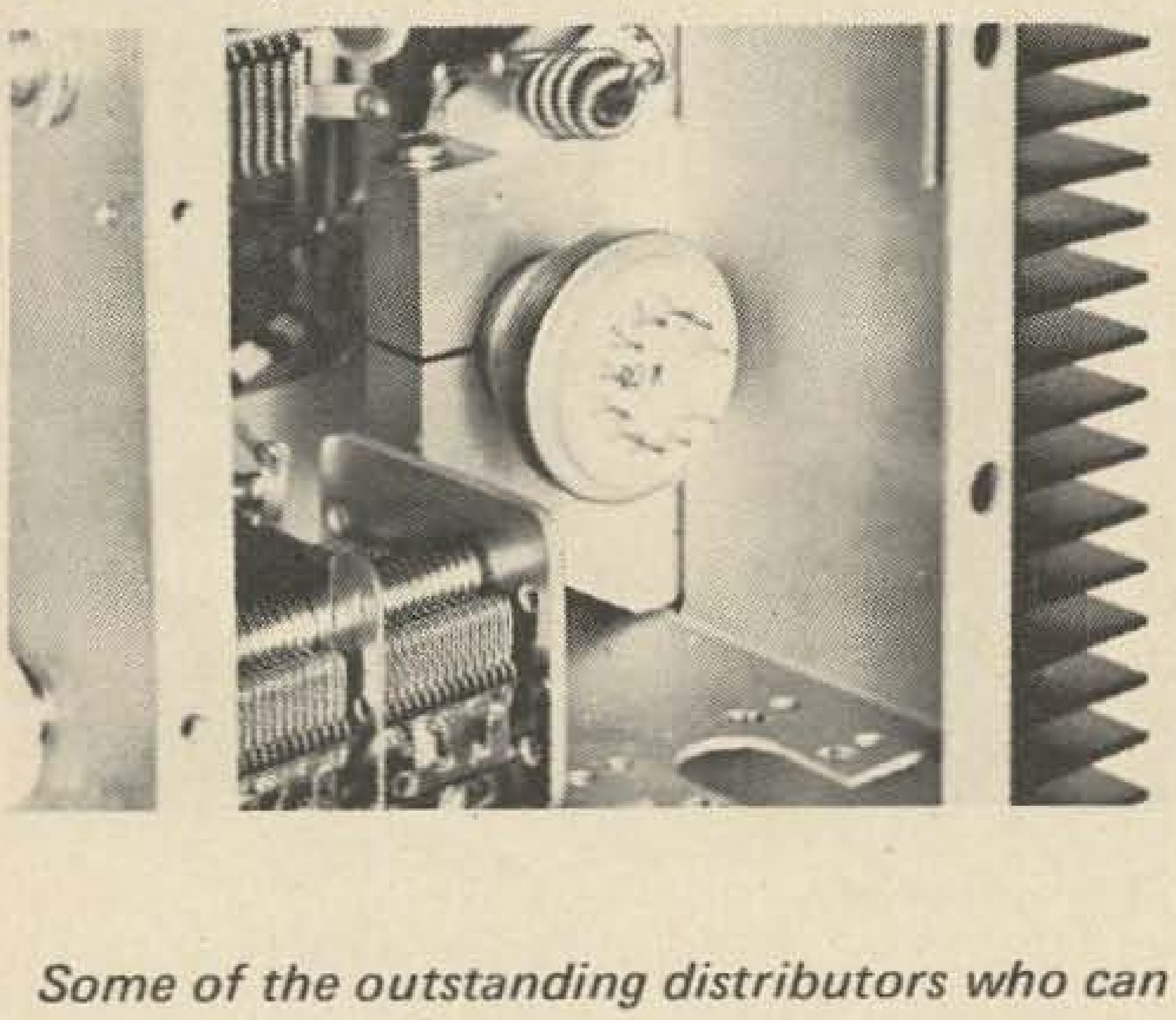
# performance . . .




**RF ENVELOPE CLIPPING** delivers clean, crisp SSB with the talk power that no other type of speech processing can match. None of that mushiness typical of audio clipping and compression . . . This signal **penetrates!**

**HIGH EFFECTIVE POWER OUTPUT . . .** 300 watts PEP input combined with the high **average** power content of RF-clipped SSB makes the CX7 sound more like a KW . . . or several, when it's followed by a linear.

**RUGGED CONDUCTION-COOLED FINAL AMPLIFIER** has ample reserve power dissipation capability to run all day at full rated input . . .



**DUAL-GATE MOSFET FRONT END** provides outstanding sensitivity plus exceptional resistance to overload. Toroidal preselector helps achieve superb cross-modulation and desensitization immunity. Steep-skirted bandpass first IF above 30 MHz yields excellent IF and image rejection while avoiding "forbidden bands" in frequency capability of the CX7.

**IF SHIFT*** control lets you move the received signal plus or minus 2kHz from nominal within the extremely steep-skirted IF filter passband to slice away QRM . . . attenuate a heterodyne by 50 db without affecting a desired signal only 500 Hz away!

*Pat. Applied For

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*"It Speaks for Itself"*

signal/one

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# *The VHF Vacation Special*

*TSgt Robert H. Wilder, W2ZRX/4*
*Box 23, 693 Radar Sqdn*
*Dauphin Island AFSTA*
*Dauphin 15, Alabama 36528*

For years I have been associated with the theory of using a simple whip or wire antenna and pumping as much power into it as you can to work as far as needed. This, of course, is a necessity if high mobility required for military communications is to be achieved.

With this background I found that for amateur operations this usually didn't work if you want a highly portable, cheap but efficient vhf antenna system.

The whole idea was to build an antenna from materials at hand in the average home. Using this premise a covey of antennas ranging from ground planes, verticals and simple beams were constructed out of metal coat hangers; collinears from aluminum clothes line and even the TV log periodic when re-runs were the only thing available to watch.

The latest, which is discussed here, was built out of some aluminum foil I scrounged from the XYL. (She is WA2YXE and it sure helps when you start taping the foil to the walls).

The "slot" antenna in its basic configuration of a plane surface is not usually used in either amateur or commercial applications. Commercially the slot antenna has been in use for several years, but, as in the case of navigational systems such as TVOR, four cylindrical slots are rotated electrically to obtain an extremely accurate circular radiation pattern.

Some basic theory of the slot will be needed if a practical antenna is to be built.

The slot can be considered a length of shorted open transmission line one-half wavelength long, so the standard current, voltage and impedance curves apply as seen in **Fig. 1**.

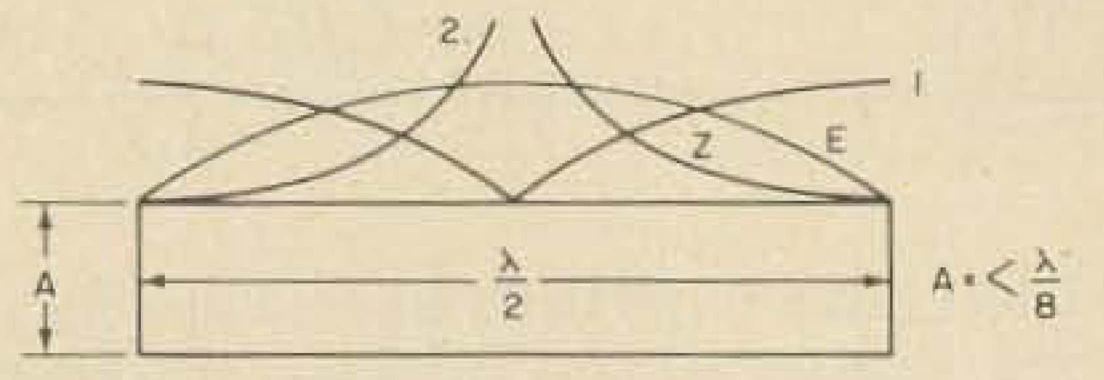



Fig. 1. Basic slot antenna.

The simple slot is nothing more than a ½ wavelength by .15 wavelength rectangular hole cut in a sheet of metal. The width of the slot is small at the higher frequencies, but with current flowing over the entire surface of the sheet (both faces) and not restricted to the slot edges, the capture area of the antenna is extremely large.

The interesting point is that if the slot is cut vertically to the ground reference (**Fig. 2**), the antenna will be horizontally polarized and conversely horizontal slots (**Fig. 3**) are vertically polarized due to the development of the "E" fields of the antenna.

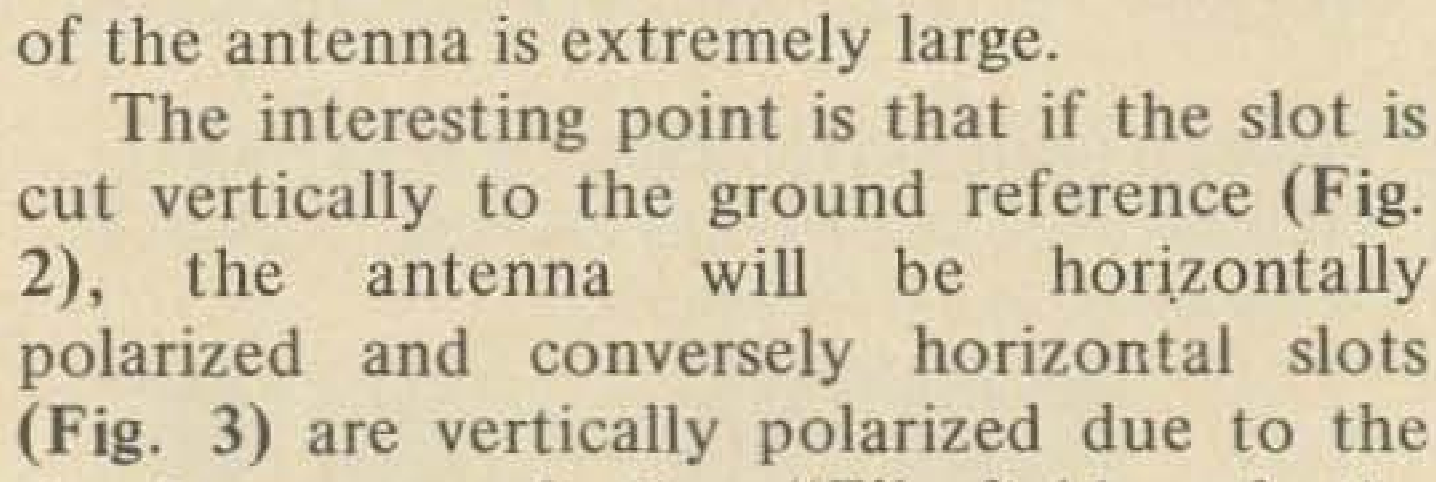



Fig. 2. Horizontal polarization.

Fig. 3. Vertical polarization.

RG-8 or RG-58 coaxial cable can be used to feed the plane surface "slot" antenna even though the nominal center terminal impedance of a resor: nt ½ wavelength slot in a large metal sheet is in the neighborhood of 500 ohms. Feeding the slot with the 50 ohm coaxial cable off center will offer a fairly close impedance match between the feedline and the slot. The theoretical distance from either end of the slot is 1/20 wavelength, but the exact point must be found experimentally for each installation as surrounding structures offer some change to the impedance characteristics. The "Rule-of-thumb" is to start at the 1/20 wavelength point and work both ways until an optimum match is achieved.

The aluminum foil "Slot" antenna is the ultimate of simplicity in construction as can to be seen from **Fig. 4**.

The figures in Columns A & B were computed from Length (Inches) = 5905/Freq (MHz) and will work as is, but the figure in Column C must be found thru trial and error. I found that the distance from the end computed for 1/20 wavelength worked better from the middle.

For the best operation some method of

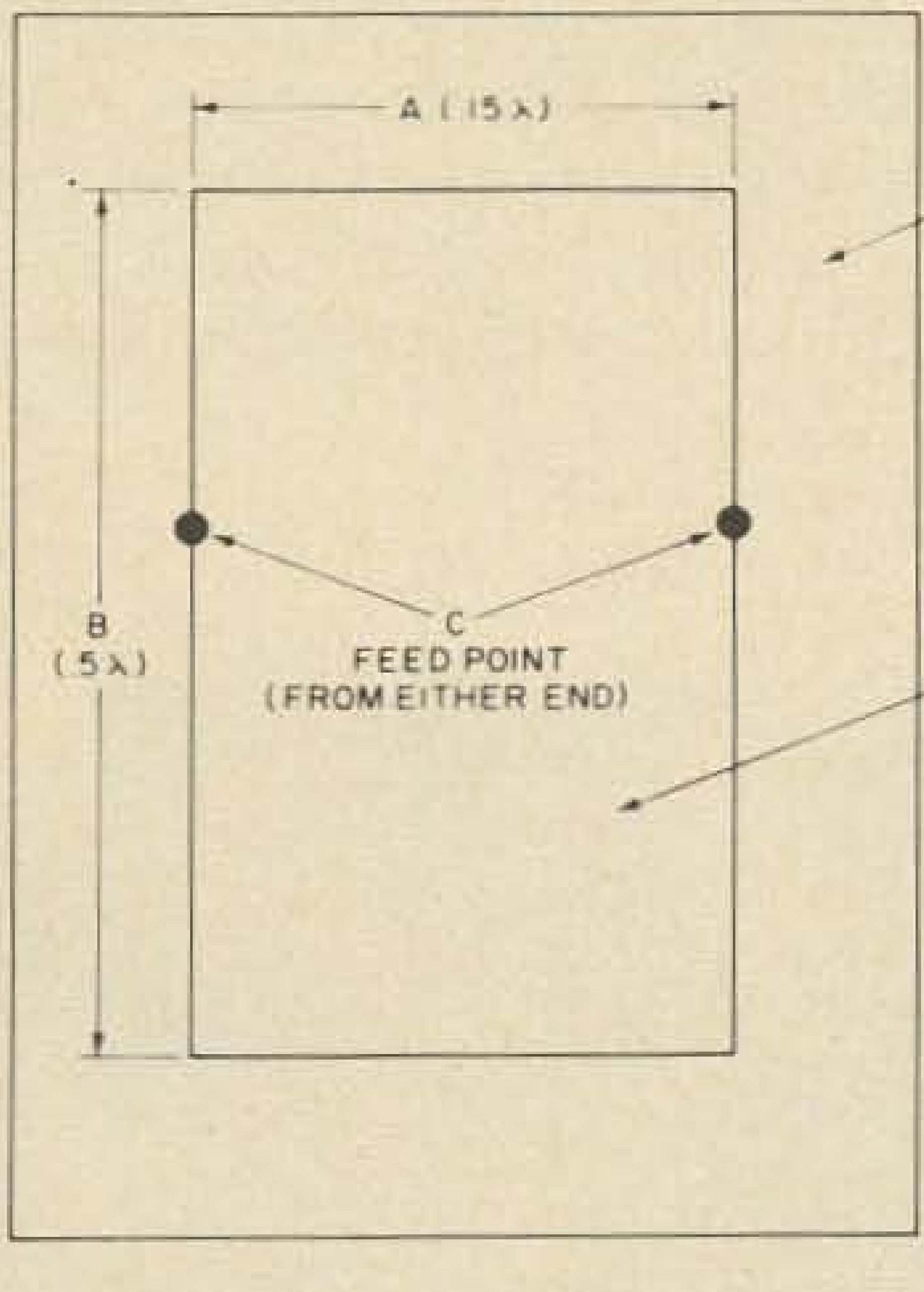



Fig. 4. The VHF Vacation Special. 65" sheet of 18" wide aluminum foil (a). (b) using chart 1 for measurements, and a single edge razor blade, cut out center piece and discard.

| Freq MHz | A Inches | B Inches | C Inches | Distance from end I used. |
|---|---|---|---|---|
| 144.0 | 12.30 | 41.00 | 4.10 | 17.40 |
| 144.5 | 12.26 | 40.88 | 4.09 | 17.41 |
| 145.0 | 12.23 | 40.75 | 4.08 | 17.42 |
| 145.5 | 12.18 | 40.60 | 4.06 | 17.43 |
| 146.0 | 12.14 | 40.45 | 4.05 | 17.45 |
| 147.5 | 12.08 | 40.29 | 4.03 | 17.47 |
| 147.0 | 12.04 | 40.13 | 4.01 | 17.49 |
| 147.5 | 11.99 | 39.98 | 3.99 | 17.51 |
| 148.0 | 11.95 | 39.83 | 3.98 | 17.52 |

bonding the coax to the sheet is necessary. I found that transparent tape can be used with little or no loss of power transfer if the tape is tight over the coax conductor and shield where it comes in contact with the sheet.

After construction of the slot antenna you should have something that looks like **(Fig. 5)**.

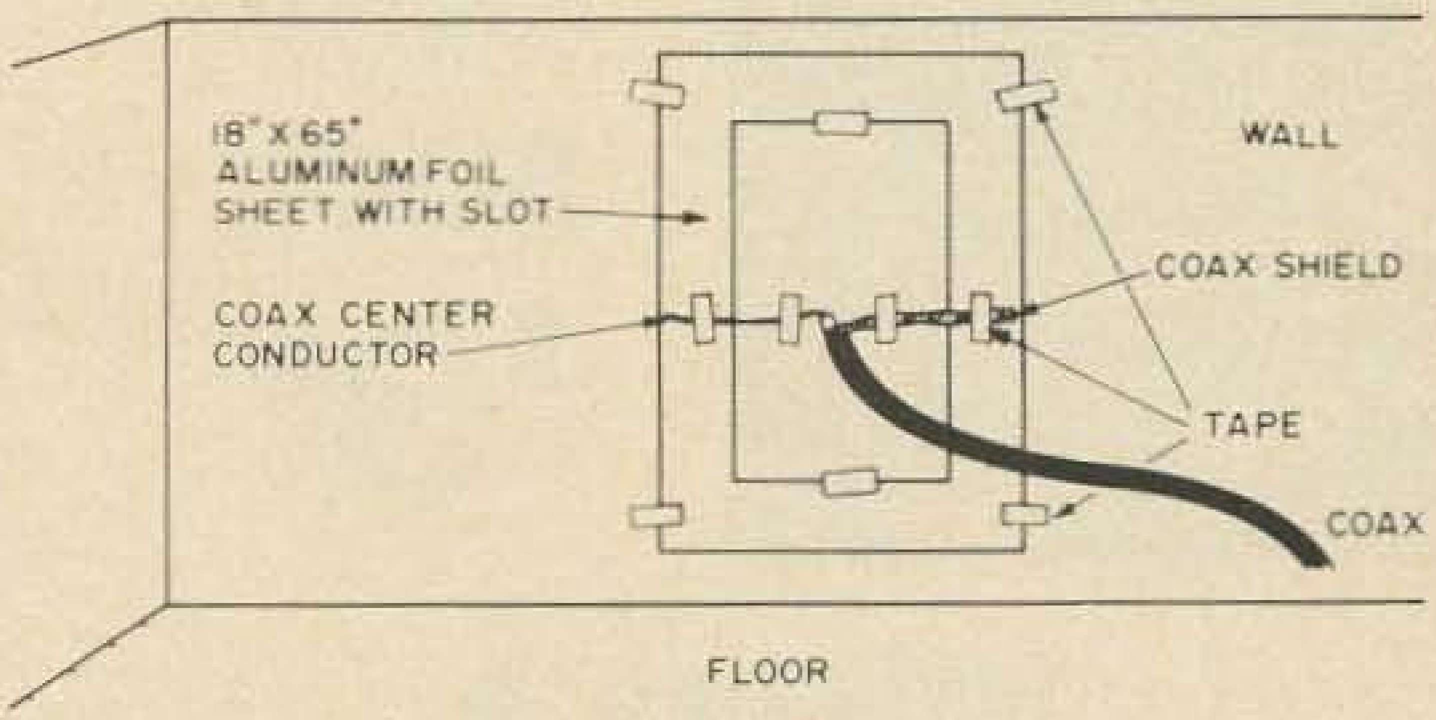
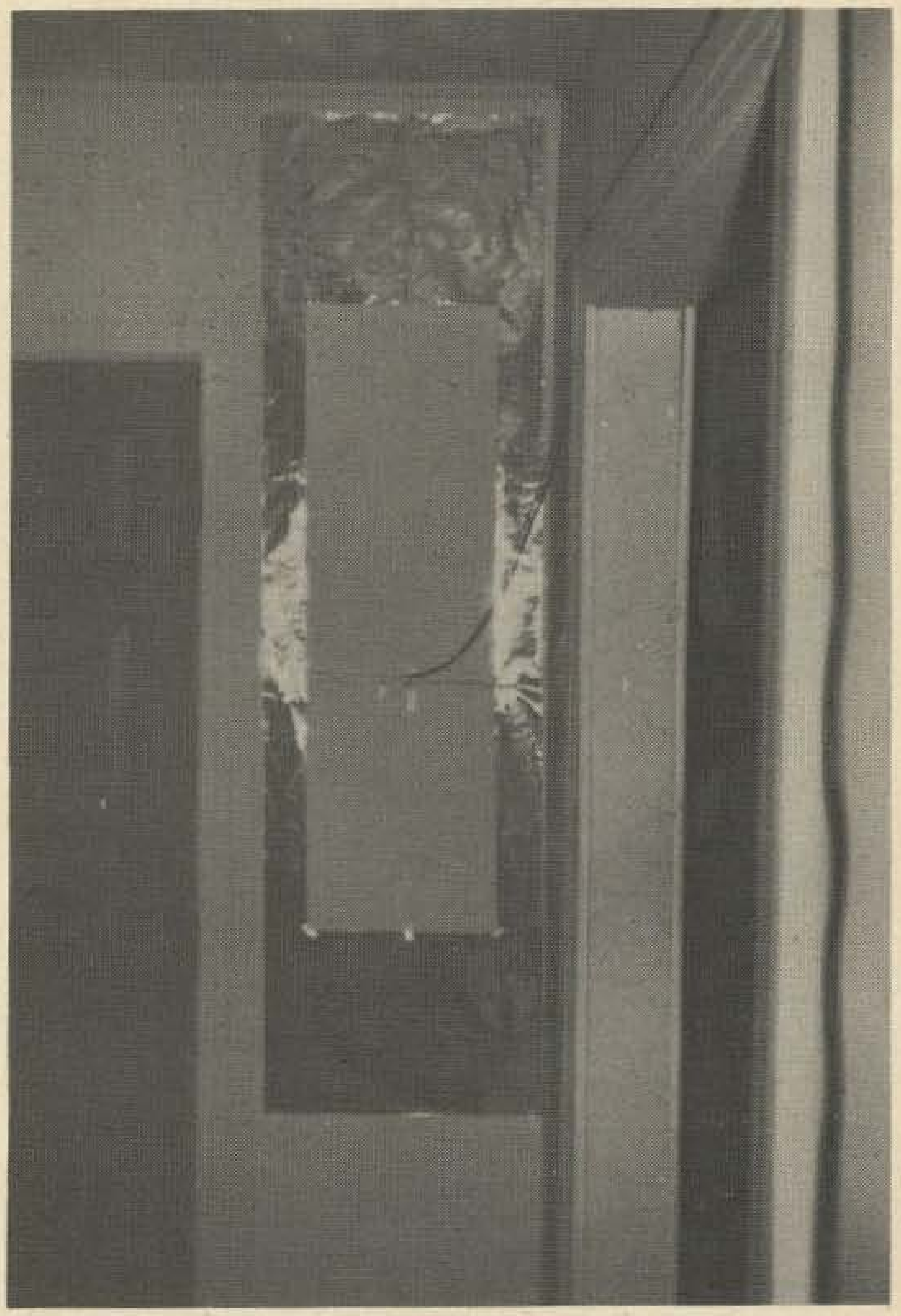



Fig. 5. Complete slot antenna. If mounted on a door it can be rotated to cover all directions.

The two major lobes of this antenna will be through the slot, perpendicular to the plane of the sheet. As seen from the top of the antenna (see arrow in **Fig. 5**) you can expect a pattern similar to that shown in **Fig. 6**.

If this antenna can be mounted on a door



144.OMC slot antenna, horizontal polarization.

near the transmitter, rotation of the pattern will be possible. It was found that by swinging the door 90 degrees signals that were a clean S-9 dropped sharply to below S-4.

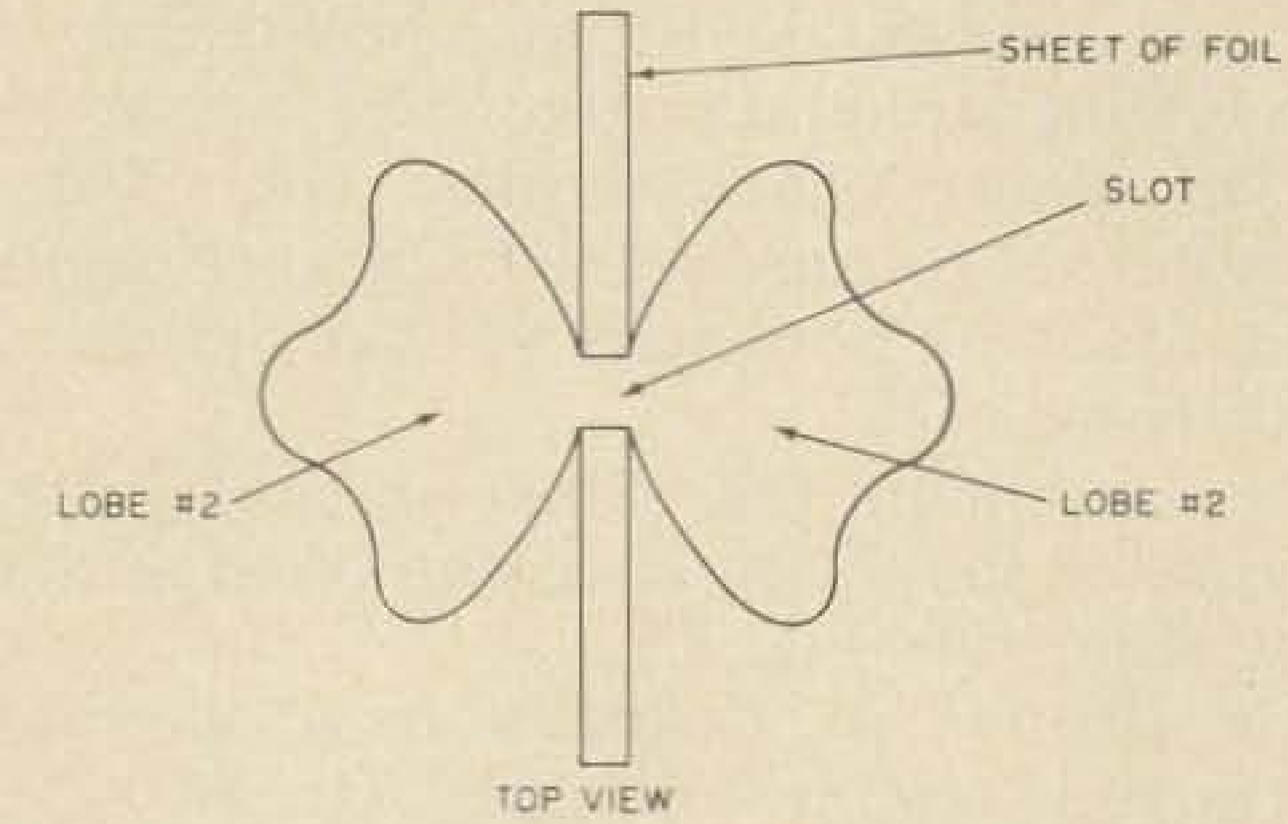



Fig. 6. Top view of radiation pattern of the slot antenna.

This antenna has out performed everything built to date including a ground plane at 25 feet above ground and the TV log periodic at 50 feet above ground. Reports have been exceptional up to 25 miles on the 143.950 MHz MARS frequency which is good on the Mississippi coast. Super regen receive such as the "Twoer" are completely quieted at 15 miles with less than 5 watts fed to the slot.

...W2ZRX

"Allow me to tune, Roggs—I need the exercise."

# *Now your transmitter can work...*

# 2 or 6 Meters

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# DRAKE TRANSMITTING CONVERTER


### Model TC-2
- Full coverage of 2 meter band
- 180 watts input

**$300.00**

Amateur Net

### Model TC-6
- Full coverage of 6 meter band
- 300 watts input

**$250.00**

Amateur Net

## FEATURES

- All switching between VHF and normal low-frequency operation of the exciter and receiver is accomplished by the function switch on the front panel.
- When used with any Drake exciter, no additional power supply is needed. However, the converters may be powered by an AC-3 or AC-4 power supply when used with other exciters.
- The low level drive required is obtainable from almost any exciter covering 20 meters or from the TR-6 (with TC-2).
- Oscillator injection may be obtained from the Drake VHF receiving converters.
- Transmitting AGC prevents flat-topping and increases talk power.
- Metering is provided for both final amplifier plate current and relative output power.
- Built-in antenna relay.
- Provision for controlling linear amplifier and/or external coax relay.
- Matches Drake 4-Line in appearance.

## TC-2 SPECIFICATIONS

**Frequency Coverage:** 143.9-148 MHz.

**Frequency Coverage** with TR-6 and SC-2: 143.9-144.5 MHz and 144.9-145.5 MHz.

**Modes of Operation:** SSB, CW, AM, RTTY; determined by exciter.

**Average Distortion Products:** The odd order are better than 25 dB below PEP.

**Input Power:** 180 watts on CW or RTTY. 180 watts PEP on SSB and AM.

**Output Impedance:** Nominal 52 ohms with adjustable output network (SWR less than 2:1).

**Injection Required:** 0.25 V. at 130 and 131 MHz (from SC-2).

**Excitation Required:** 0.25 V. at 13.9-18.0 MHz.

**4 Tubes, 4 Transistors, 5 Diodes.**

**Size:** 5½" high, 11⅝" deep, 7⅝" wide. **Weight**—9 lbs.

## TC-6 SPECIFICATIONS

**Frequency Coverage:** 49.5-54 MHz.

**Modes of Operation:** SSB, CW, AM, and RTTY; determined by exciter.

**Average Distortion Products:** The odd order are at least 35 dB below PEP.

**Input Power:** 300 watts on CW or RTTY. 300 watts PEP on SSB and AM.

**Output Impedance:** Nominal 52 ohms with adjustable Pi-L network (SWR less than 2:1).

**Injection Required:** 0.25 V. at 36.0 and 36.5 MHz (from SC-6).

**Excitation Required:** 0.25 V. at 13.5-17.5 MHz.

**6 Tubes, 1 Transistor, 4 Diodes.**

**Size:** 5½" high, 11⅝" deep, 7⅝" wide, **Weight:** 9 lbs.

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**R. L. DRAKE COMPANY** 540 Richard Street, Miamisburg, Ohio 45342

# "S" Unit Attenuator

*Edward A. Lawrence, WA5SWD/6*
*218 Haloid*
*Ridgecrest, Calif. 93555*

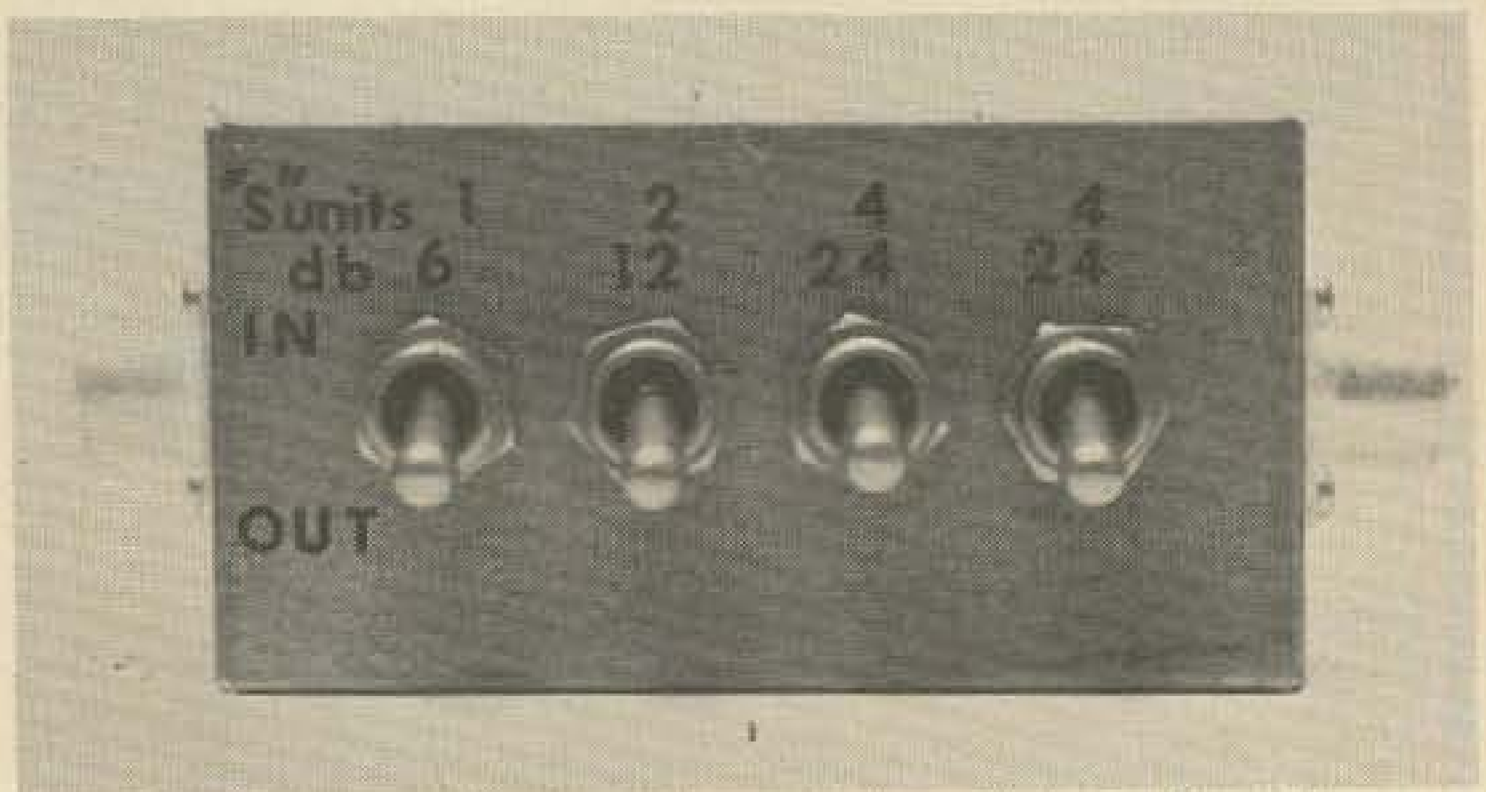
Since the topic of "S meters" is a popular one among radio amateurs, a lot of time is spent describing these devices, usually along the lines of how generous or "Scotch" the meters are at the QTH of the parties in the QSO. After a few such QSO's, I decided to build an attenuator, calibrated in "S" units. My aim was to attain an accuracy of 1 db or better, using 5% ½w resistors and simple construction so it would be easy to duplicate. What I wound up with is very similar to the attenuator described on page 40, January '67, 73.

As a sidelight, I started out by calculating both "tee" and "pi" pads, and used "pi" because all values of resistance are close to standard values, but (especially for high attenuation pads) the values for "tee" pads can get quite small; and expensive.

I figured the values required from the tables in the Allied's "Electronics Data Handbook", page 8, 5th edition. (Allied Radio, 75c, full of good info.)

Since "S" units are supposed to be 6 db, I figured data for steps of 1,2,4 and 8 times that amount, or 6,12,24 and 48 db. With these steps, any number from 0 to 15 "S" units of attenuation could be selected. However, 8 "S" units proved to be too much for one step, as shown by the lowered attenuation at 30 MHz, due to the inherent shunt capacitance of the resistor used in the series leg, plus the stray capacitance of the switch. So I removed the 8 "S" unit step and installed another 4 "S" unit step. This allows selected steps of attenuation from 0 to 11 "S" units.

Here are the values I calculated, and the actual values used, based on 51 ohms. The steps are switched in series, as required for the desired attenuation.




Front panel showing the switches for the various steps of attenuation.

Resistance Values for 51 Ohm Attenuator:

| "S" units | DB | R1 ideal | R1 actual | R2 ideal | R2 actual |
|---|---|---|---|---|---|
| 1 | 6 | 154 | 150 | 38 | 39 |
| 2 | 12 | 85 | 82 | 96 | 100 |
| 4 | 24 | 58 | 56 | 405 | 390 |
| 8 | 48 | 51.5 | 51 | 6400 | 6800 |

After the attenuator was completed, the attenuation was measured at 3 kHz and at 30 MHz. With the test equipment available it was possible to measure more accurately at 30 MHz than at 3 kHz. Below is the data from the tests.

| Atten Step "S" units | DB | Predicted atten DB | Measured at 3 kHz | Measured at 30 MHz |
|---|---|---|---|---|
| 1 | 6 | 6.2 | 6.0 | 6.02 |
| 2 | 12 | 12.3 | 12.2 | 12.16 |
| 4 | 24 | 23.3 | 24.2 | 24.05 |
| 8 | 48 | 48.5 | 47.5 | 39.11 |

Now if we want to make an educated guess as to how far up we can expect good results, say 1 db error out of 24 db, then we can use the measured error in the 48 db step to calculate the capacitance across the series leg, and from that calculate the frequency where the 1 db error will occur. Go through the math if that is how you get your kicks, or take my word for it. It comes out to about 2 pF. And this will cause a reduction of 1 db at about 220 MHz. And since the resistor is

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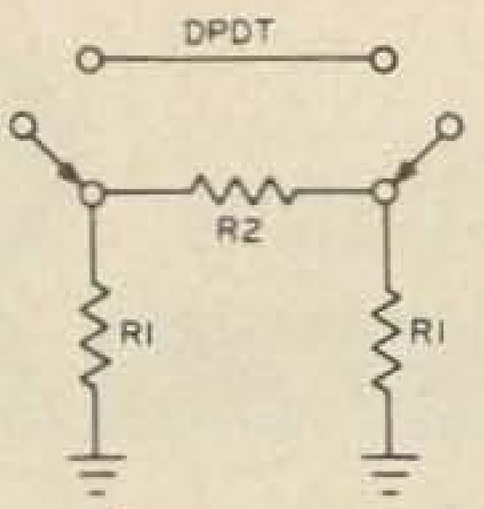
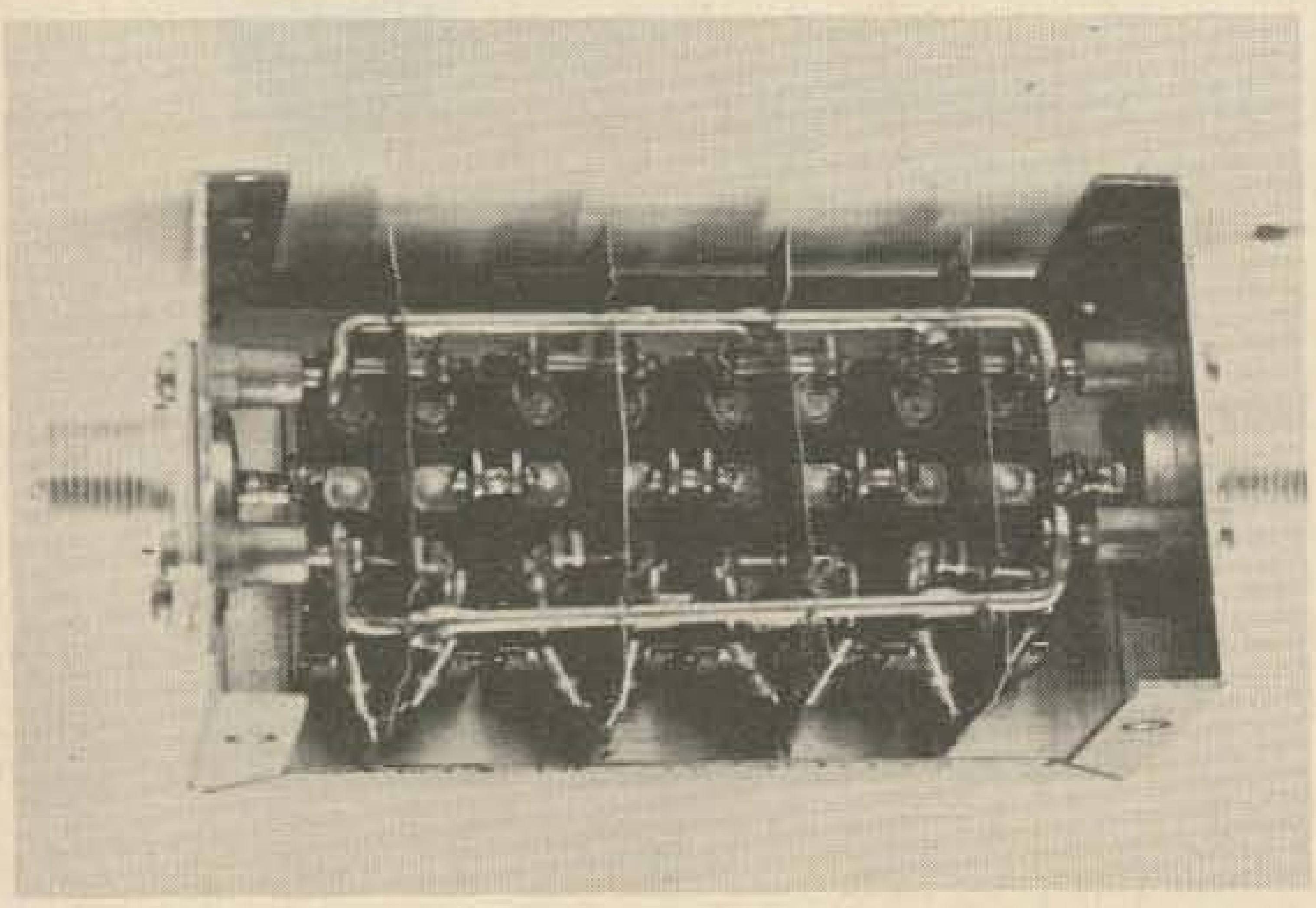



Fig. 1. Diagram for one step in the attenuator.

of a lower value for the smaller steps, they should hold their values to even higher frequencies, but I expect other factors would get into the act along the line somewhere. I will state that still works well at 2 meters.

If you want to get fancy, you can always figure the values for 1, 2 and 3 db steps and have from 0 to 72 db attenuation in 1 db steps.

Referring to the photos; you can see I built my attenuator in a Bud Minibox CU-2102-A, 4" X 2-1/8" X 1-5/8". Four steps is the maximum in this size box, unless different switches are used. Mine are Cutler-Hammer 7592K6. The shielding was made from transformer strap, but could be any soft copper available. Try a Hobby Shop and get the thin sheet that is used for embossing if all else fails.



Looking inside the attenuator.

Here are some of the uses an attenuator of this type is suited for:

Checking receiver "S" meter calibration.

Attenuating signals to aid in peaking receivers and converters.

Calibrating diode voltmeters for *rf* measurements.

Checking antenna gain. Or gain of that outboard *rf* stage.

P. S. My "S" meter lies, just as I thought!

. . . WA5SWD/6

## Armed Forces Day, May 17

Contacts may be made on CW with WAR (Washington) on 4001.5, listening 3.5-3.65; 4020, listening 3.65-3.8; 6992.5, listening 7.0-7.1; 7325, listening 7.1-7.2; 14405, listening 14.0-14.2. NSS (Washington will be on 3385, listening 3.5-3.65; 7301, listening 7.1-7.2; 14400, listening 14.0-14.2; 21500, listening 21-21.25. NPG (San Francisco) will be on 4005, listening 3.5-3.65; 7495, listening 7.1-7.2; 13975.5, listening 14.0-14.2; 20954.5, listening 21-21.25. AIR (Washington) will be on 3397.5, listening 3.5-3.8; 6997.5, listening 7.0-7.2; 13995, listening 14.0-14.2; 20994, listening 21-21.1. Times are 171400Z to 180245Z.

SSB contacts may be made with NSS on 4040, listening 3.8-4.0; 7336, listening 7.2-7.3; 14385, listening 14.2-14.35. NPG will be on 4001.5, listening 3.8-4.0; 7301.5, listening 7.2-7.3; 14356, listening 14.2-14.35; 21600, listening 21.25-21.45. AIR will be on 4025, listening 3.8-4.0; 7305, listening 7.2-7.3; 14397, listening 14.2-14.35.

RTTY contacts may be made with NSS on 4012.5/3.65-3.8; 7380/7.0-7.2; 13940/14-14.1. NPG will be on 4016.5/3.65-3.8; 7347.5/7.0-7.2; 13922.5/14-14.1. AIR will be on 3347/3.5-3.8; 7315/7.0-7.2

Watch for a plane flying between Washington and Boston on 143.82, listening 144.0-145.5 on AM and RTTY. Also one flying between Los Angeles and Seattle on 143.7, listening on 144-148 AM. Mt. Diablo will be on 148.41 on AM/FM/RTTY, tuning 144-148.

### CW Receiving Contest

At 180300Z (2300 EDT, 1900 PST) May 17th at 25 wpm, there will be a special Armed Forces Day message on WAR on 3347, 6992.5, 14405. On NSS on 3385, 7301, 14400, 21500. On NPG on 4005, 7495, 13975.5, 20954.5. On AIR on 3397.5, 7315, 13995. On A6USA on 6997.5.

### RTTY Receiving Contest

At 180335Z at 60 wpm WAR will transmit the message on 3347, 6992.5, 14405. NSS on 4012.5, 7380, 13940. NPG on 4016.5, 7347.5, 13922.5. AIR on 3397.5, 7315, 13995. A6USA on 6997.5. A5USA on 4025.

Send entries to Room 5A522, Pentagon, Washington, D.C. 20315, before 31 May.

# *In the Beginning. . .*

*Bob Manning, K1YSD*
*915 Washington Road*
*P. O. Box 66*
*West Rye, New Hampshire 03891*

Not long ago – 'twas October 3rd, 1968 to be exact, I was pouring L.S.D. into the air conditioner – I had taken an overdose of Midol barely 28 days previously and was morosely ruminating over the plight of the radio amateur. I remember the date very well. It was the fifth anniversary of ARRL's first Incentive Licensing proposal to the F.C.C.

Since we were about to 'gird our loins' and march valiantly back into yesteryear to the 'golden' or 'good old days' I had just ordered a 1936 Hudson Terraplane, dusted off all my old Rudy Valley records, bought up enormous quantities of lamp wick trimmers, pinned on my Alf Landon and Wilkie buttons and started building a two-holer replete with quarter moon, corn cobs and Sears Roebuck catalogs.

I was looking forward to going backward and seeing horse drawn carriages, apple carts, bread lines, WPA workmen and the return of spats, bustles and cholera.

Without warning, I was seized by *'holographitis'* which is similar to *'inspirational graphitee,'* but occurs outside water closet areas: 'tis an uncontrollable urge to write – something! – somewhere! I immediately seated myself and pounded out an article entitled, "Ipecac Works on Lids" (73 magazine, November 1968).

The response to this article was overwhelming! The fact that 'both' letters were written on foolscap with crayon and in block letters made little, if any, difference.

The Editor of 73, upon securing my release from the Intensive Care Unit of the local Domicile for Dememted Ding-a-Lings suggested I write more articles of similar ilk.

In the coming months and subsequent articles, I shall – by drawing on a seemingly bottomless pit of banality – endeavor to look at the foibles, follies and idiosyncrasies of amateur radio in such a way as to be humorous and satirical without being offensive.

If I am to be thusly foisted upon you, it is only fair that – like in *high class* books – you receive a resume' of my bona fides. 1. how had I become a ham and 2. what had put me on the path of *'holographitis'* besides a case of 'hoof and big mouth' disease and a diarrhetic typewriter?

How had I become a ham? Ah yes, I remember it well. Like most things I do, I did it backwards. Most hams become interested in amateur radio and then get their license. I got my license and only then did I become interested in amateur radio. This statement requires some explanatory background.

I spent 9 years in the U.S. Navy as a radioman and then, after a short stint with a British Thermal Unit (that's a hot one!), I transferred into the Air Force (ours). While I was in the Navy, I was considered an idiot by those whom I thought were of high intellect. In the Air Force, the exact opposite was true. To this day I haven't figured out whether 'tis better to be thought an idiot by genuis' or a genius by idiots . . .

This variance of feelings was not, in reality, without basis. For, when I entered the Navy, it was with the understanding that I would be schooled as a Hospital Corpsman and study under the famous Doctor Chicago, who was doing experimental research in 'acne' and 'hickey' transplants. Unfortunately, the 'powers that be' discovered that I was color blind and, in their infinite wisdom, transferred me into Radio/Electronics – have you ever seen a color blind person trying to decipher the color code on a resistor? The process, like the mating habits of the penguin, is strictly 'trial and error' *(Incidently, the trial and error mating habits of the Penguin is probably the reason for that creatures universal disease, 'pknobophobia' (fear of backing into cold door knobs) and the most likely reason for their Charlie Chaplin-like walk and accounts for the fact that you never see a Penguin in a crouched or bent over position.).* This deficiency on my part led my superiors to look askance at my attributes. Combine this with my chubby, pear shaped appearance – which gave me the unique distinction of being the only man in the history of the U.S. Navy to ever wear a Bell Bottomed *Shirt!* and their feelings become understandable.

Of course, the fact that I once suggested replacing the old libido controlling saltpeter practice with a *'dry ice'* treatment did little to change their opinion. Instead of surreptitiously inserting saltpeter into the food fare, I proposed swallowing small dry ice capsules to freeze the prostate gland – thus arriving at the desired result without altering the taste of the food. Unfortunately, although the process did work, the side effects were nothing short of spectacular! It not only accomplished its original purpose, but also froze the larynx and the colon. The latter action created some extremely embarrassing situations for the user and the former action precluded him from calling for assistance.

Despite these obvious drawbacks – and the fact that I suffered from chronic seasickness, I became an excellent radioman. My last official test CW paper was accredited with 40 wpm. I must confess, however, that the officials simply took my word for my own test results. The tests had been given during heavy seas and the judges – to a man – exhibited a strange reluctance to either handle or even look at my paper.

Possessing the ability to send and receive CW at 25 and 35 wpm respectively and having trained on a great variety of electronic equipment, it was only natural that, when I transferred into the Air Force, that they would put me to work in a Teletype tape delivery center – where the only electronic mechanisms were a moldy coffee urn, a Tucker built coke machine and the ever present 'panic button'.

Eventually, however, I did end up in communications at a USAF MARS station where I made my first contact with the amateur radio fraternity. The Sergeant I worked for – call him Sam – held a 'Conditional' class license. Now, at that time, I knew nothing about the licensing structure and mistook the disdain shown towards Sam to be an aspersion on the type of license instead of the man. Whenever we held MARS meetings, the members flicked ashes in Sam's lap, lobbed candy wrappers at his Metrecal, accused him of having rubber pockets to steal soup and stated that, "if he had a brain, he'd be arrested for smuggling trash!"

Having no special love for Sam and being blessed – or cursed – with a caustic tongue – and knowing the disdain in which he was held, it was inevitable that we should eventually tangle.

It happened! - - - - One day, with Sam driving our 5 ton truck and with a burly airman seated between us, Sam managed to manually manipulate the controls of the truck in such a fashion so as to knock down two light standards, remove all the warning lights from the rear of the vehicle, open a new entry way into the MARS station, scare hell out of two pregnant dependents and caused the airman to slide, in a kneeling position, downward and forward under the dashboard where he straddled the drive wheel lever with considerable force – leaving him with a strange falsetto voice that may well have given rise to the eventual popularity of Tiny Tim.

Recognizing an opportunity to insert a verbal barb, I leaned across the agonized airman and asked, "Hey Sam – you got a 'conditional' drivers license too?"

There is no ire quite like that of an aggravated NCO and Sam was no exception. He immediately turned apoplectic vermillion, let out a 15 minute non repetative string of expletives and jammed on the brakes – once again doing injury to the already anguished airman on the floor who, looking up at us with ƆMƆ blazoned across his forehead and, in a voice pitched somewhere between Jeannette MacDonald and Yma Sumac said, "fer cripesakes! ya dummy! you do that one more time . . . my navel's gonna look like a chin cleft and I'm gonna be wearing my truss for love beads!"

The final outcome of this incident was that Sam and I made a hot headed $5 bet that we'd both have General Class tickets within 30 days. Even though I managed to obtain mine in 28 days, I was unable to collect. The Air Force, learning of Sam's unique ability as a truck driver, had transferred him as an instructor to a heavy equipment school. There I was–I had a ham license and didn't know what to do with it.

Since that time, I guess I've progressed normally through the various stages of 'being a ham'–I began thinking up witty 11 meter type phonetics for my call sign, designed and scrapped hundreds of provocative QSL cards, progressed into the short purposeless QSO "hi there–I'm Bob– – broken old bottles – ur five nine – opps chow call – c u l" then gravitated into the public service field where I was prepared to battle my way through wind, rain, snow, sleet, hurricanes, typhoons, hippie uprisings, draft card burnings and other similar disasters to deliver *the* vital message thereby saving countless lives and millions of dollars and be awarded the 'purple clavicle' with 'oatmeal clusters.' I then took up the contest type operation– – "yeah, let's see – if I multiply my input power by the number of stations, add 5,000 for delivering a confirmation to the SCM, divide by the temperature, subtract 10% for being an appliance operator, add 127 points for having read the CD bulletin, figure the logarithmic value of pi R square (pie are square???? NO! pi are round–fig newtons are square) ah...ta hell with it– – – I'll cheat. I then settled down to appreciating and happily indulging in all areas and, to paraphrase Will Rogers, "I never met a ham I didn't like!" – Eventually, I reached the epitome of all hams.... writing sarcastic letters to ARRL.

This covers HOW I became a ham.... now, how had I sunk to the depths of satirical writings??

*(International Business and newly formed countries want our frequencies, zoning laws restrict antenna heights, neighbors ogle us uneasily with awe – or fear – as if they expected us to mumble some voodoo chant, do two back flips and an arabesque, snip a lock of hair, sprinkle them with dried octupi eyes or dandruff and transform either them or ourselves into a 'fried egg sandwich'. TV viewers assail us for supposedly screwing up their twenty-one year old $37 Japanese TV set with the bamboo antenna and, on at least one occasion, hams became the topic of controversy in – of all places – an advice to the lovelorn column, our Mothers think we're gonna blow up the world – or at the very least – the house and our wives wish we'd forsake amateur radio for more sensible practices like 'bulb snatching' or 'skydiving' or become peeping toms, or winos or study the abnormal sex life of the African Anteater.)*

Being a student of Zen, Extratenialism and intensely adroit at deep analytical introspective soul searching – which, literally translated, means "I goof off a lot!" – I have given considerable thought to this status. I have concluded that objective humor – satirical, distorted or prismatic is about the only thing that keeps me from running, stark naked, out of the house attacking the first AT&T truck I see and grabbing my neighbor by the throat, standing him on tippy toe and driving him into the ground with the motor end of a sump pump.

There are, of course, other alternatives that a ham may use as a relief valve. Among them is the process (which is becoming more and more popular) of submitting random proposals to the F.C.C.

I know of one radio amateur whose demented half brother, Alf, submitted a proposal within the past week. Alf, being the offspring of a neurotic and psychotic (those mixed marriages never seem to work out) and as an impartial outsider has rather an objective view. He submitted what, in the light of some of the more recent events, seems to be a palatable system for future Incentive Licensing.

Alf's suggestion is that all amateurs be immediately reduced to Novice class and issued new licenses combined with a fixed amount of marbles secreted in a cummerbund. (choice of colors – marbles and cummerbund – is optional). As the operator operates, he must assume anatomically impossible positions – like standing on his head with one foot stuck out the nearest window – a G.I. can may be fastened 6'6" above the floor as an effective substitute –

(Sometimes, when I make like an SWL, I'm not absolutely sure that this procedure is not already in effect)–In this way, the operator must manage to loosen the marbles from the cummerbund. His operating privileges will be inversely proportional to his supply of marbles. This will continue until he reaches the pinnacle; i.e., the highest grade of license and the 'loss of all his marbles'! Note...Alf submitted an addenda suggesting new classes of license– –I don't know them all, but they run something like this: (a) the Dummy class (b) Novice (c) Apprentice (d) Mediocre (e) Mundane (f) Technician (g) Adequate (h) Advanced (i) Improving (j) Extra (k) $\pi\Sigma$≈ ±÷_¯∘π+=32 and the (l) Whoopee class...

One item I feel I should inject to round out my resume' is the fact that I am quite vain. Besides being large of girth and tired of fun being poked at my expanse, I was once totally bald.

Because of that hairless state I paid a thousand dollars for a complete 'Follicle Graft'. (The operation, for the uninformed, is the transplanting of hair and roots from a volunteer donor to the top of the head of the recipient).

Regretably, in this case, the grafter used the hair from the hind leg of a German Shepard and, since the operation, I've fallen in love with a State Trooper, have a constant craving for ALPO, my backyard is pockmarked from my inept attempts at burying bones, I can't stop chasing cars and every time I pass a fire hydrant, the whole head of hair snaps straight up!

I hope you will find some enjoyment in the articles. Even though I once thought 'verbiage' was verbal garbage and 'sagacity' implied some physical malformation, writing is not a new thing with me. I am the author of one article entitled, "Where Are The Men?" it dealt with the poignant question 'where is MR. PAUL, UNCLE JEMIMA and WHISTLERS FATHER?? – I then wrote a ditty titled, "             on the Range" and, finally, I am putting together an amateur radio study book to be called, "I'VE UPPED MY OPERATING PRIVILEGES ......... NOW ..........UP YOURS!!!!!"

Friendliness and Courtesy are contagious . . . start an epidemic (K1YSD)

# *Don't Kill Your Generator!*

*Jim Ashe, W1EZT*

Going to filter out that noise from your car generator so that you can better enjoy your mobile rig? Careful, or you may kill your generator, too. It's been known to happen.

Since generators put out dc, it seems reasonable that a little old capacitor (or a little new one) across the output shouldn't hurt anything. But it's a fact the output is something more than pure dc, or you would not be thinking about filter capacitors. Now, when you put a capacitor across the output you are shorting all that hash, noise, and ac that the generator makes, straight through to ground. Are you sure you want to do that? See **Fig. 1**.

All dc generators are really ac generators. You don't see the ac because it's rectified at the commutator. But the commutator doesn't do a perfect job, and there is some sparking there too, so that there is a lot of noise power available at the generator terminals.

In normal generator operation most of this power is dissipated in the car's electrical circuit, which has a fairly high resistance compared to the generator resistance. But when you put that capacitor across the generator's output, while the dc is not affected, all that noise power is now dissipated inside the generator – right in the armature, as illustrated in **Fig. 2**. If the generator is working hard anyway, perhaps during mobile operation, the increased dissipation may be enough to push it over the edge. Result: you buy a new generator armature.

But it's not hard to avoid that trouble, if a filter capacitor is needed. What if you add a small resistor in series with the capacitor? See **Fig. 3**. Now the ac is still provided with the relatively easy route across the generator terminals, but less power is dissipated since circuit resistance in increased, and most of the power goes into the outside resistor where it does no harm. You get your filtering, and the generator survives. Try it this way, next time!

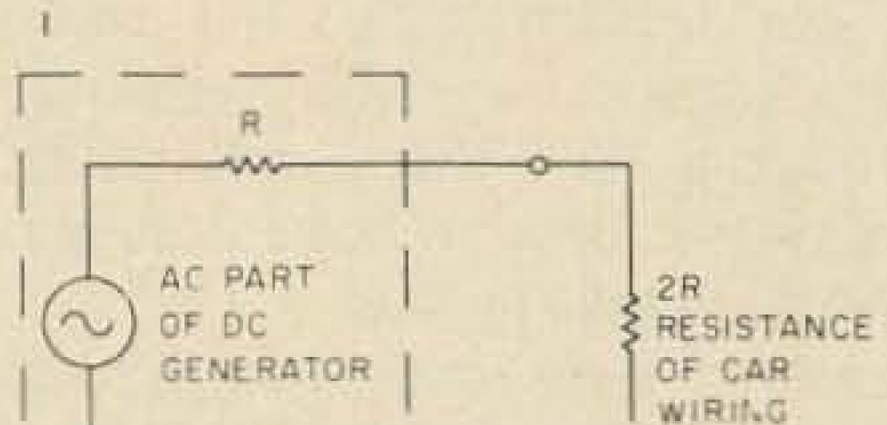



**Fig. 1.** Equivalent circuit at ac of an automobile generator installation. Resistance of car wiring is probably larger than that of generator by a factor of 2 to 5.

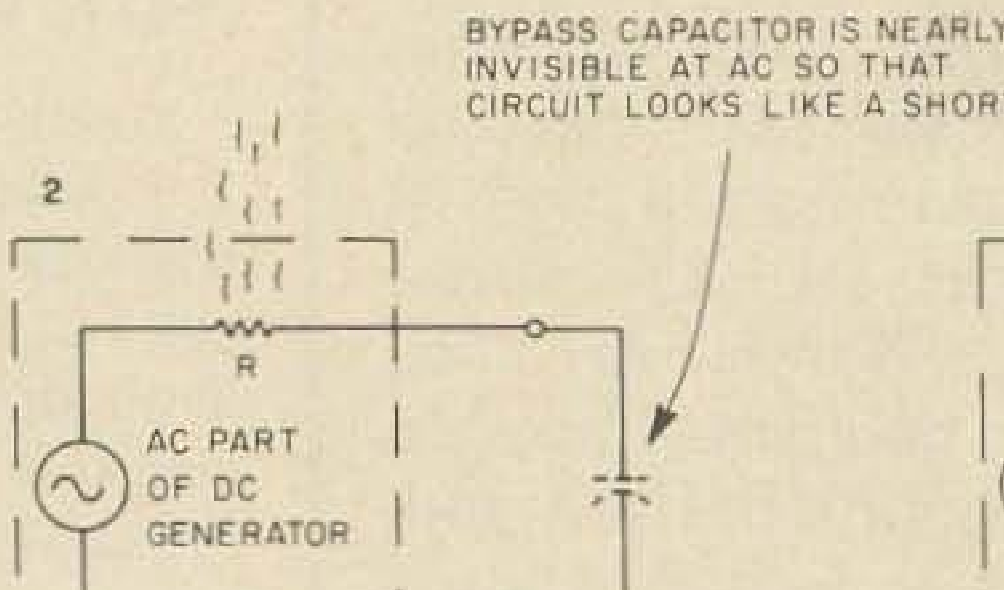



**Fig. 2.** If the car generator terminals are bypassed with a good capacitor, they are shorted so far as ac frequencies and noise are concerned. With reduced resistance greater currents flow, and the ac energy dissipated in the armature is several times greater than under normal conditions. At heavy generator loads the armature may deteriorate rapidly, or be destroyed.

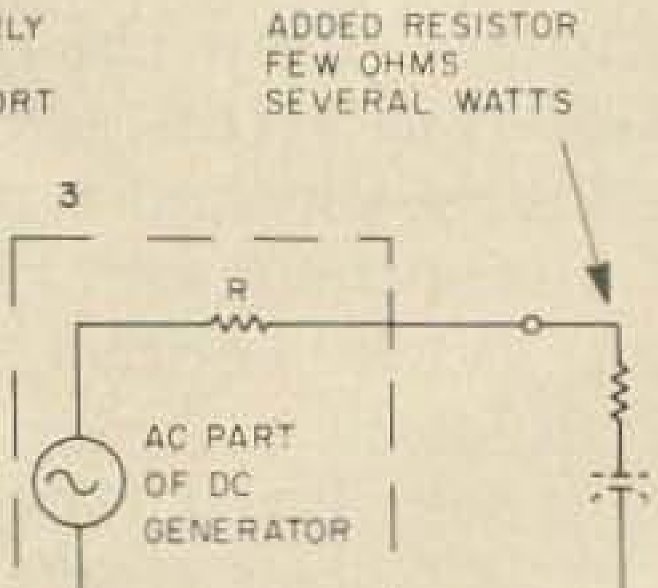



**Fig. 3.** The simple solution. A small resistor added in series with the capacitor reduces currents and carries much of the ac dissipation outside the armature. A few ohms should be appropriate, and checks may be made by temperature observation or direct measurement of armature noise and ac currents.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# *Working DX Without Six Elements*

*Joseph E. Taylor, K5PAC*
*6 Evergreen Court*
*Little Rock, Arkansas 72207*

Obviously, you won't work as much as often as the fellow on top of Crow Mountain with six elements, wide space, on a 100-foot tower and a 2 KW rig.

But you and I have already learned to adjust to that fact of life in our every day competition with the "big sigs".

The point is – you can work a surprising amount of DX of all sorts with Q5 QSO's if you go at it right.

Many American hams do not venture into the DX portions of the bands because they feel that they are not well enough equipped to work any DX. It ain't necessarily so!

So you have only 90 watts and no beam and very little chance of improving either – you can still work DX and enjoy it.

Maybe we ought to ask, "what we mean by DX", since not everyone means the same thing.

Old Charlie on the mountain has nearly 300 countries confirmed now. To him DX is another new country. "So what's another MP4 if you already have cards from each one that counts?"

But to most of us DX is that unique satisfaction that is associated with calling a fellow ham in another country, whether 3,000 miles away or 10,000 miles around the globe, and hearing him come back with that sweet sound that is our own personal private call! And the thrill is apt to be all the greater if we are operating with what we know to be less than the ultimate in equipment. A VQ9 on a beam or a quad is satisfying to be sure, but on a dipole there is an added dimension to the enjoyment.

By this I am not advocating that you use anything less than the best combination of equipment and antenna you can muster. The six element beam is wonderful if you can swing it, but my point is, you aren't out of the running if you can't.

A word needs to be said about what is meant by "working" DX too. For some fellows it is an exchange of RST, QTH and 73's. For others it involves a greater degree of getting acquainted as person with person. Where you will want to find your own maximum satsifaction is up to you alone.

Admittedly, it is harder to maintain a DX contact than it is to get one. So your percentages go down as your time in QSO goes up. In effect each of us works out his own pattern here.

CW or fone? Again we have to look at plain facts. Your chances with lower power and/or simpler antenna systems are better on CW than on fone. A good receiver can dig out and render copyable an extremely weak CW signal that would be hopelessly buried on SSB, let alone AM.

So, if you can do so enjoyably, you will have improved chances of success in CW operating. Don't be overly worried if your CW isn't perfect and your speed is down. DX operators are among the world's best at matching speeds. You will find fast ones and slow ones and very nearly all of them are patient, so don't chicken out on this score.

O. K., so you are ready to try – now for some concrete suggestions which will improve your chances of success.

1. Check your rig thoroughly. The fact that your power is limited doesn't mean your efficiency needs to be.

   A weak driver tube may not make much difference in rag-chewing in the 75 meter net. It may lose you many contacts in DX operation. Try to make sure your transmitter is at 100% peak of efficiency. Make sure your signal is clean and well keyed. Whatever your final power rating, you don't need to lose any unnecessarily.

2. Go over your receiver with the same kind of thoroughness. Any tubes that even leave you in doubt about their condition should be replaced. More contacts are lost because of inadequacy in receivers than in transmitters.

   If your receiver could profit by the added gain and the improved signal-to-noise ratio of one of the newer preselectors, it is a fine investment.

If your major problem is lack of selectivity, you may receive a good deal of help from a Q multiplier.

If your receiver is not stable it can be fatal in DX work. The inclusion of VR circuits or some approach to maintaining a fairly constant temperature in the receiver may help. Separate switching which leaves the heaters on at all times is a simple approach to this.

3. Give your antenna system a chance to do its best. Make sure it is the best you can arrange for a given DX band.

   If the system is not rotatable, try to orient it toward your favored direction (s). For example, in the central United States a dipole oriented NW/SE will favor both Europe and Australia. The direction of a dipole won't matter tremendously, but take whatever advantage you can get.

   Remember that the longer your wire, assuming it and the line are tuned, the better.

   Make sure your feed line is the best you can get. Coax may be your easiest approach, but compared to open wire line it is not as efficient.

   A tuner is not a necessity, especially if you use coax, but it will more than repay you for your effort and cost in building or securing one.

4. Listen – Listen – Listen. Spend hours on the bands you are interested in just listening. See what bands are open when, and to what parts of the world. Find out what parts of the DX bands will likely be best for you.

   For instance, you may find less crowding around 14,075 than around 14,010. For a signal which has its limitations you may do better there even though you hear more DX on the lower frequency.

5. When you are going to call a DX station who is calling CQ, be ready to call the instant he signs. If you drag your foot and hear another station calling him you probably won't call at all. Assume that the same will bé true of others. Get in fast.

   Don't call too long. After repeating his call twice and your own twice, break and see if he heard you. If he isn't answering, try two more of each. This is much better than four repetitions to begin with.

6. Calling CQDX. Don't be afraid to do it but don't overdo it. Remember your signal needs an opening more than repetition. Try to find a little gap between signals. Call QRZ once and sign your call. If there is no response call CQDX twice and your call twice and K. No more.

   No fancy stuff – no "AR-K" – no "DX pse KKK". In general the DX boys are good operators and they will respond to good practice on your part.

7. Answering. When you get a response keep your first transmission very short. . . . perhaps . . . .

   XY9AA De K5PAC – R – GM OM ES TKS CALL UR RST 559 – 559 QTH LITTLE ROCK ARK – NAME JOE – HW – XY9AA DE K5PAC – K

   There is little point in repeating what he got the first time, so unless his signal is very weak, keep your repetitions to a minimum. He will want his report, your QTH and your name. The rest can come in later transmissions. Get your first round completed, then get acquainted, if conditions permit, and your friend wants to. If he wants a short QSO, fine, keep it short. Your last transmission can be friendly without wishing "73's, 88's, gud luck, best DX, and gud health" to each member of his family individually.

8. QSL'ing – If either of you really wants a QSL then be prompt about it. If not, "pse QSL" is not an essential part of a QSO. He won't have his feelings hurt if you don't ask him for one. If you actually want it, O. K. If not, why put him to the trouble and expense?

This article is written to convince the ham – maybe *you,* if you've read this far – that fun can be had in the DX aspect of our hobby even without kilowatts and beams.

This is not speculation nor theory. In the past we have had quads and beams and I thoroughly believe in them. But in our present QTH the very best I could come up with was a 100 foot long dipole fed with open line into a home brew tuner. The rig runs about 180 watts CW.

Frankly, I've had a ball working DX on 15 and 20 meter CW. Why not crank up your rig, oil up the key and join me some day soon?

. . . K5PAC

# The Short-Vee Antenna

*Edward M. Noll, W3FQJ*
*3510 Limekiln Pike*
*Chulfont, Pennsylvania 18914*

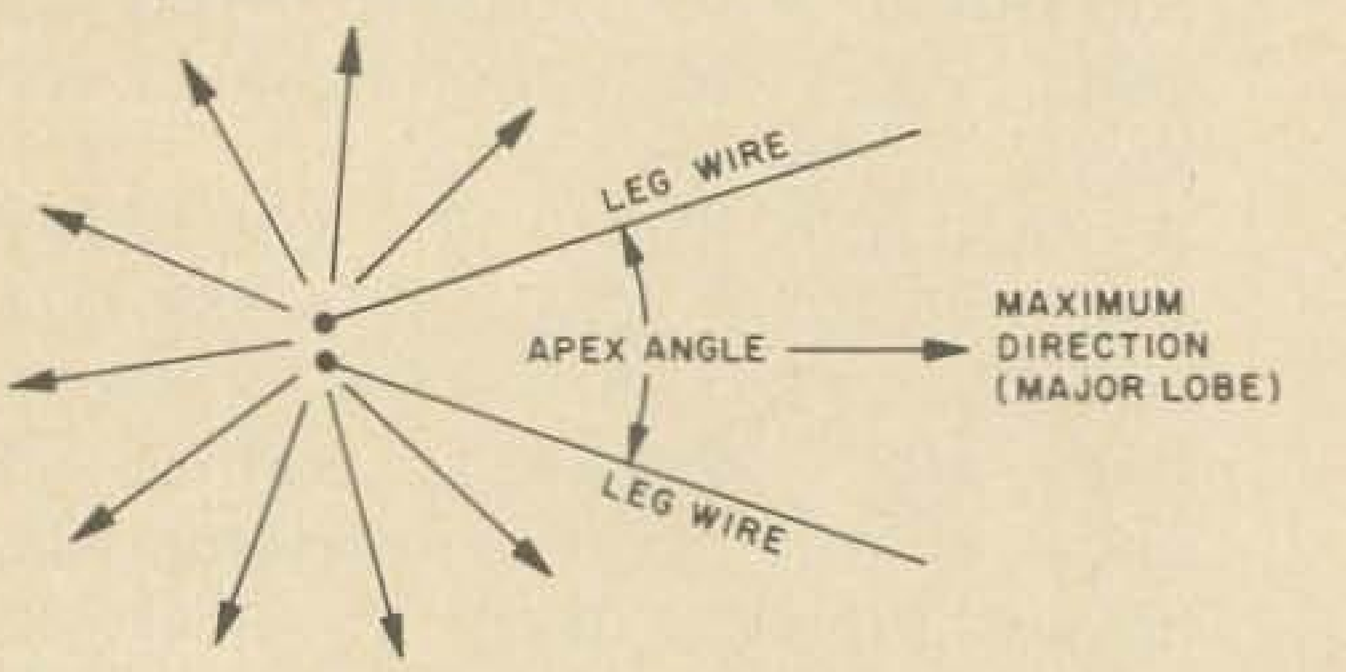



Fig. 1. The Short-Vee Antenna.

The short-vee antenna is an effective fixed-position antenna because of its reasonably omnidirectional pattern plus a broad directional characteristic in one direction. A simple definition for a short-vee antenna would be a vee antenna with a leg length of no greater than 100 feet or no greater than 2½ wavelengths, whichever is the shorter. Angle between the two leg wires would fall between 60 and 100 degrees, **Fig. 1**. If the legs are dimensioned and trimmed carefully, such an antenna requires no tuner and permits direct feed to the coaxial line between antenna and transmitter.

The short horizontal vee antenna should be made resonant on the desired bands. Do so by making certain the legs are an *odd multiple of an electrical quarter wavelength.* Equations for determining odd quarter wavelengths are:

$$1/4 \text{ Wavelength} = 246/f_{mc}$$

$$3/4 \text{ Wavelength} = 738/f_{mc}$$

$$5/4 \text{ Wavelength} = 1230/f_{mc}$$

$$7/4 \text{ Wavelength} = 1722/f_{mc}$$

$$9/4 \text{ Wavelength} = 2214/f_{mc}$$

The practical electrical quarter wavelength of the leg is somewhat shorter than the above formula values. In most instances for a short horizontal vee mounted at least 30 feet above ground, the shortening is approximately 6%. It is advisable to cut the legs long and then cut back slowly to the desired frequency using an antenna noise bridge or swr meter. When using an swr meter it is essential that the meter be placed a *whole multiple of an electrical half wavelength* from the point where the transmission line is connected to the antenna.

**Multi-Band Relations**

An interesting relationship exists among the odd quarter-wavelength dimensions for various amateur bands. For example the leg length for 5/4 wavelength operation on 15 and 7/4 wavelength operation on 10 is approximately the same. Thus a compromise leg length can be determined that permits optimum operation on both bands, **Fig. 2.** Furthermore an additional leg can be added in conical fashion to obtain an odd quarter wavelength operation on still another band.

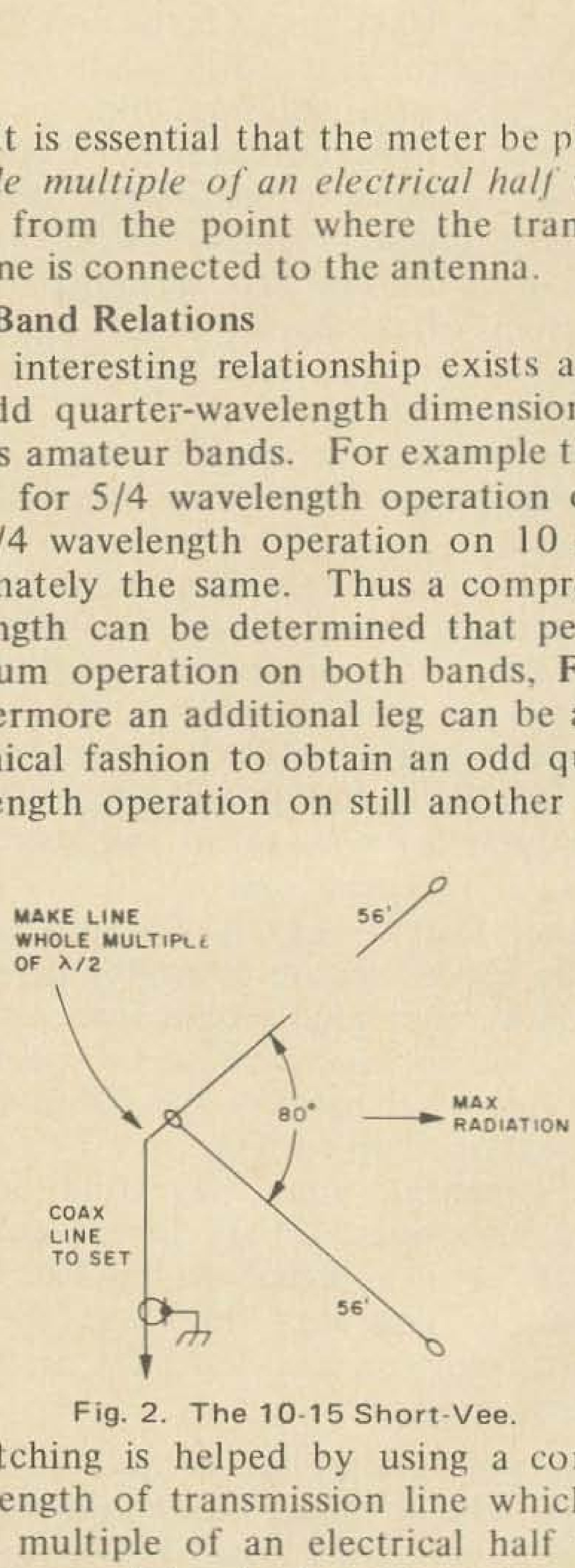



Fig. 2. The 10-15 Short-Vee.

Matching is helped by using a compromise length of transmission line which is a whole multiple of an electrical half wavelength on each band. In so doing the antenna resistance is reflected to the transmitter with little or no reactance. Thus the SWR ratio can be kept below 1.8 to 1 without any tuner at antenna or transmitter. This expedient permits fast band changes.

**10-15-20 Short Horizontal Vee**

Still another advantage of the short vee antenna is its limited space requirement. A practical version of this antenna style is

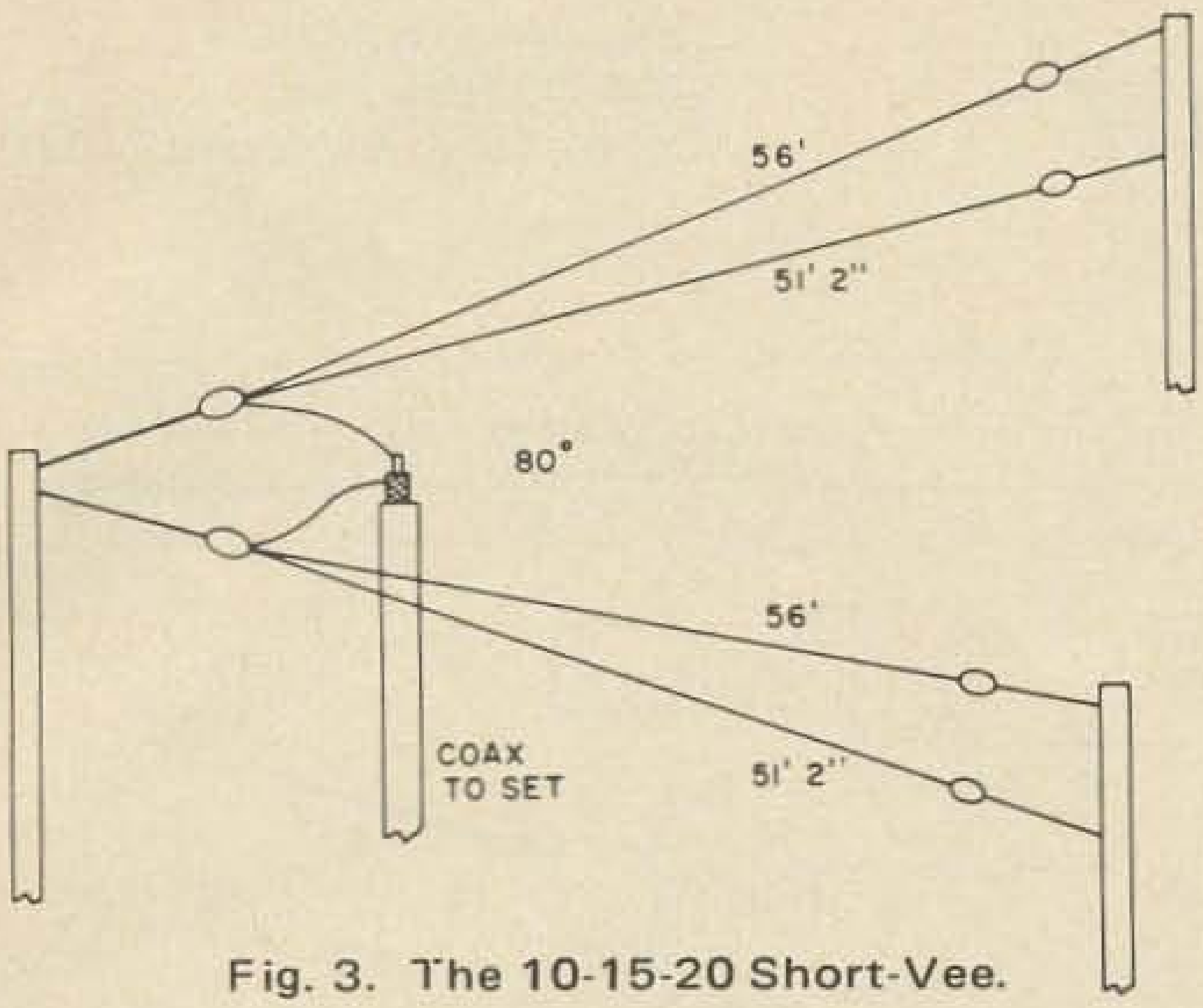


Fig. 3. The 10-15-20 Short-Vee.

given in Fig. 3. It serves as a fine antenna on 10-15-20 meter sideband. One pair of legs is cut to 56'. In so doing resonance is established on both the 10 and 15 meter bands. The second pair of legs is cut somewhat shorter to 51'2", operating as a 3/4 wavelength resonant leg on 20 meters.

The two pairs of legs are brought together at the apex and connect to the coaxial transmission line. The legs fan out from this point in conical fashion, Fig. 3, and have a separation of approximately 10 feet at the far end.

The apex angle was made 80$^{o}$. The total length of transmission line from antenna to transmitter can be made any whole multiple of 45 feet. (The 45-foot figure takes into consideration optimum operation on the three bands and the velocity factor of 0.66.)

A line that bisects the small angle of the vee is the direction of maximum radiation. For the short vee antenna it is quite a broad beam. At the same time there are additional lobes that provide omnidirectional radiation as well. Thus the antenna support positions can be selected to obtain maximum radiation in some preferred direction at the same time you can obtain acceptable all-direction radiation as well. It is not a high gain antenna but does give you that extra boost in some preferred direction.

Along the east coast such an antenna could be erected with its maximum direction south toward South America. At the same time it would provide good omnidirectional stateside coverage. If you have a WAS need, the maximum direction can be toward the west. At the same time you would have good north and south coverage. You may wish to beam it toward Europe, always ready for good openings. At the same time you have good stateside coverage.

. . . W3FQJ

# *The Little Wonder*

*Eddy Shell, W5ZBC*
*1209 Holiday Place*
*Bossier City, Louisiana 71010*

Every new QTH for the typical ham brings its own antenna problems. Returning to college to pursue additional graduate studies brought the age-old problem of how could I affix an antenna to a college dorm and not come under the watchful eye of the college authorities? The "Little Wonder" and an antenna tuner was the answer to my problem.

The basic idea came from an AFMARS antenna presently being used by some of the Texas members. This antenna is a normal 40-meter dipole with a coil at each end. The coil consists of 197 turns of No. 12 nyclad wire, close wound on a one-inch stock. It is tuned with a 48-inch pigtail which tunes 3311 kHz with a 1:1 SWR, with the ability to have a full-size 40-meter dipole for 7305 and the amateur use as well. (1 inch equals 50 kHz on the pigtail.)

The "Little Wonder" gets its name from the fact that it is a little wonder that the "Little Wonder" works. My first contact on 40 meters was a W3 in Pennsylvania, with a barefoot KWM2 at ten o'clock on a Saturday night and with the "Little Wonder" leaning against a wall in the kitchen location of my "ham shack."

Construction is simple and all parts can be purchased locally:

1 3/4" hard drawn copper tubing 31½" (junk yard, Sears, etc.)

1 3/4" hard drawn copper tubing 43 3/4" (junk yard, etc.)

4 6/32 1" brass bolts and nuts

1 36" oak dowel rod (fir will work, but oak is stronger)

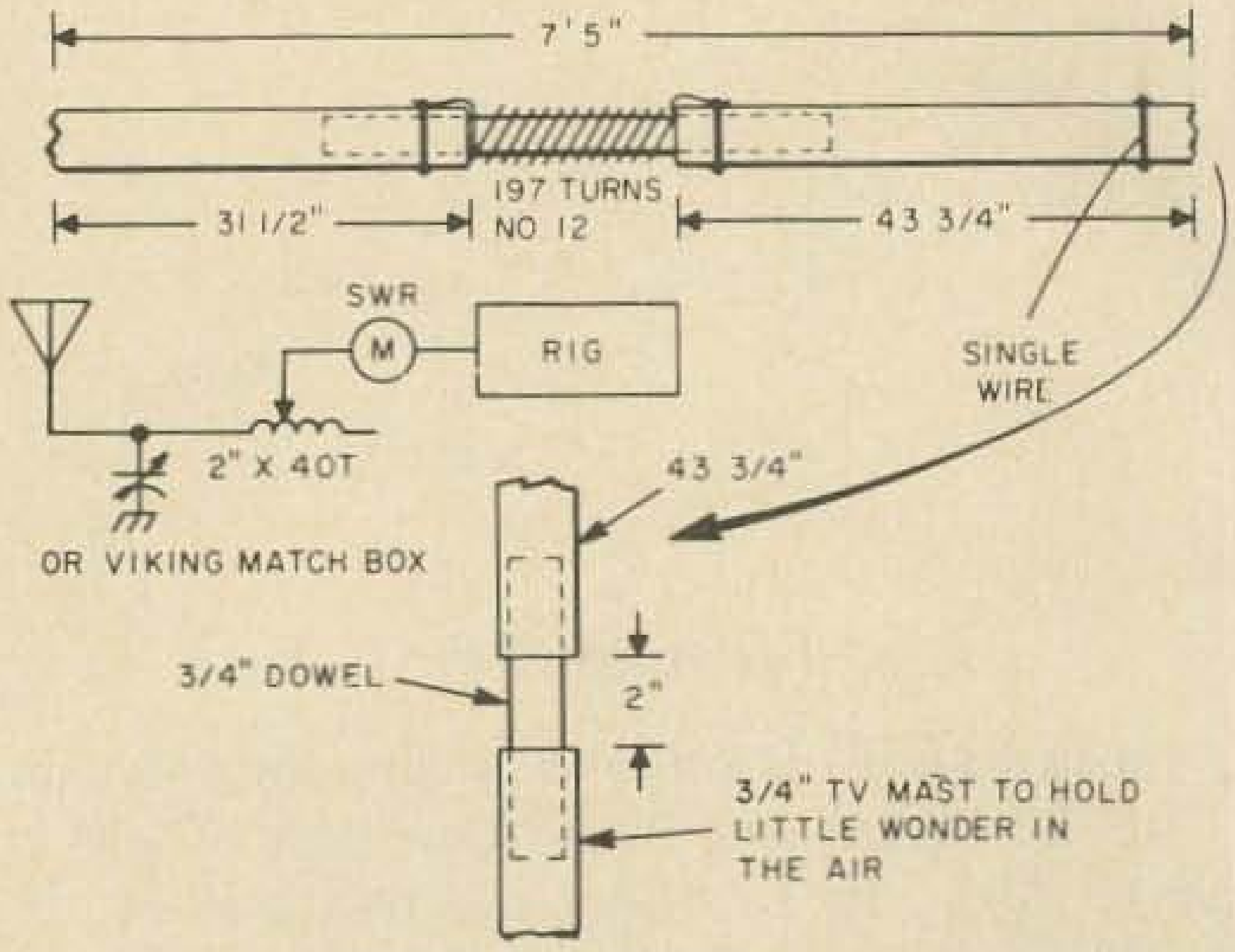
1 roll of plastic tape

1 55 feet of No. 12 nyclad wire (motor rewinding shop)

1 single-wire feedline to run from Little Wonder to antenna tuner...I used 8', 33', and 59' (when it comes into the room it could be hot with *rf*, so use a rubber or plastic coating on this section). I have found the 59' to work best with the Little Wonder about 35' up on top of a TV mast; however, at school the Little Wonder sat on the window ledge–so who knows?

2 3/4" bar stool rubber feet

1 24"x1" plastic water pipe to cover coil after assembly




The Little Wonder

How to construct: Drill a small hole in the wooden dowel 8" from one end. Twelve inches of No. 12 nyclad wire is pushed through the small hole. One person holds the 55 feet of No. 12 tight, and the second person starts turning the dowel rod until 197 turns have been made. A second hole is then drilled, and the other end of the No. 12 wire is put in this hole. Friction and the bend of the wire holds the coil in place. The dowel-coil assembly is pushed into one end of the 43 3/4" tubing, and the other end of the coil is pushed into one end of the 31 3/4" tubing. A 6/32 hole is drilled through the tubing and dowel and a 6/32 bolt makes a mechanical connection of the tubing to the pigtail of the coil. A third hole is drilled opposite the coil in the end of the long tubing, one inch from the end. A 6/32 bolt is placed in this hole for the single-wire feeder to be attached. The over-all length of the Little Wonder is 7'5". Rubber bar-stool feet are then placed over each end of the Little Wonder to keep out the weather, and the coil section is taped for the same reason. Attach your feedline and work the world.

How to tune the "Little Wonder": The best method of tuning the rig is to tune the unit into a 50-ohm load and then connect the antenna tuner. (Do not tune the rig.) The antenna tuner is tuned for 1:1 SWR. (A Viking Match Box will work fine; or make your own.)

How does it work? I am on the air with a lone KWM2 from 3311 kHz to 28 MHz, and without it I'd be QRT for the nine-month period. Trust you will be on the air soon with your own "Little Wonder." ...W5ZBC

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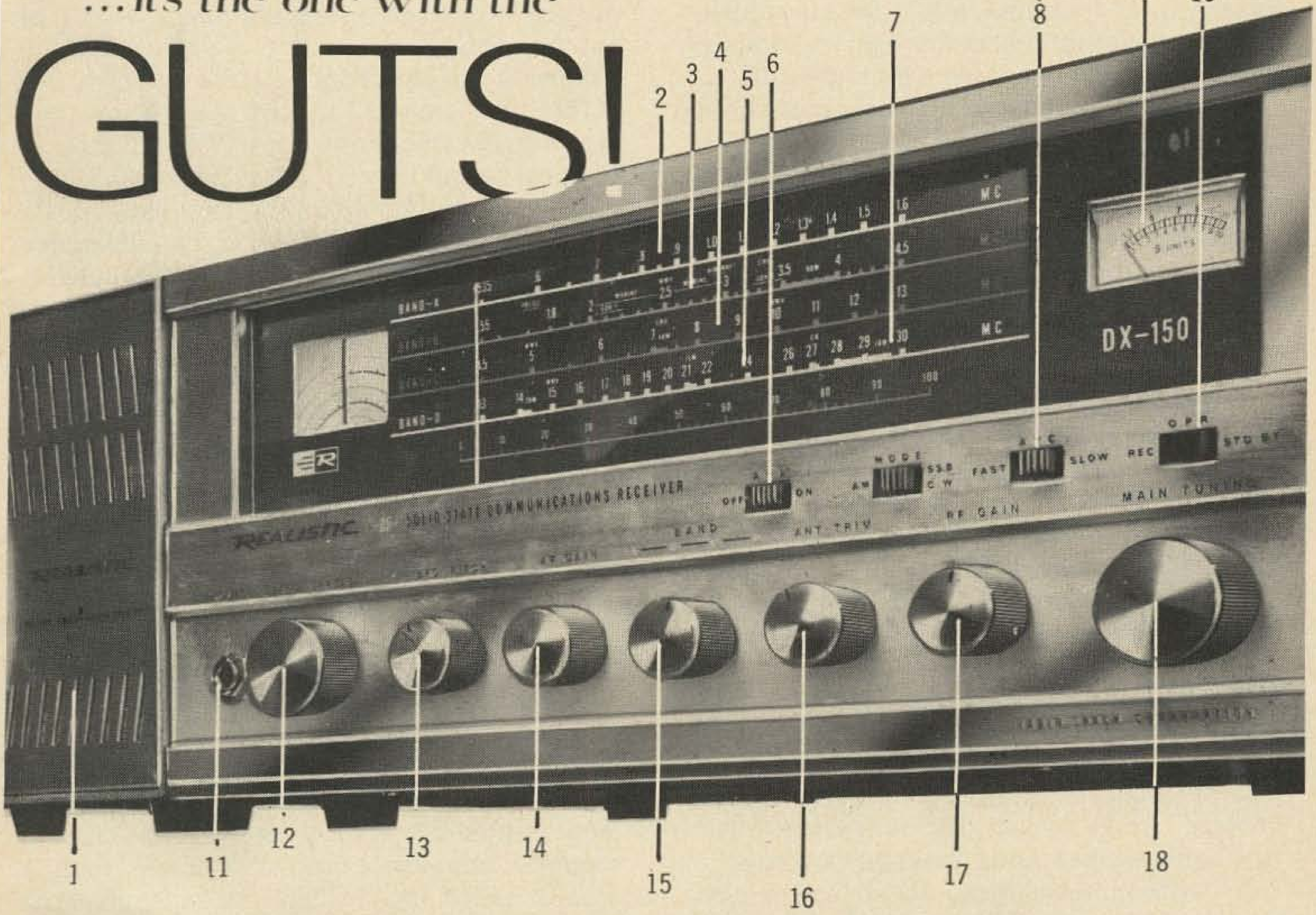


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# *Easy Tuning of the Multi-Element Quad Antenna*

David S. Traer, W4AZK
625 8th Street, South
Naples, Florida 33940

Perhaps the most perplexing and one of the most controversial problems facing the builder of the multi-element quad is element length or tuning. There are many various articles on quads each having an individual formula for element lengths or method of tuning and matching transmission line to driven element. Basically, there appears to be two methods of approach. Compromise tuning for broad banding or "on the button" tuning for maximum efficiency over a smaller bandwidth.

Since 1958, when I first erected a four element quad, many, many man-hours have been spent making measurements with receivers several miles away, field strength meters, vswr meters, impedance bridges, and grid dip meters. At that time, there were no fiberglass poles, mounting hardware, or any other information available on multi-element quads. It became necessary to find a more or less foolproof method of tuning and matching for maximum energy transfer, with a minimum of effort and with equipment available to the average ham. With these points in mind, I set out to find that method.

Several methods were tried over a period of time. In each case, the vswr over the entire band looked good from the transmitter end—with one exception—the driven element was always reactive. It should be well known that the reactive component of *any* antenna, whether inductive or capacitive, does *not radiate*, in addition, the standing waves along the transmission line are not at the same point as they would be with a pure resistive load mismatched to the transmission line in the same degree although reactance is also measured in ohms. The proximity to surrounding objects does not affect the closed loop of the quad as much as it would a yagi type antenna. Work may be done on the quad much closer to ground level (15-20 feet) if allowance is made for a frequency rise of approximately 25 to 50 kHz at 14 MHz when the antenna is put back to forty feet or higher. Therefore, the quad should be tuned to a lower frequency to eventually come out at the design frequency unless all tuning is done at the final antenna height.

One factor that may be difficult for some, is that all elements must be made accessible. If not accessible from your tower or pole, a temporary 2x4 may be set in the ground high enough to put the boom of the quad at least fifteen feet above ground level. An allowance of 50 kHz should be made at this height. Should the diamond configuration be used, a slightly higher temporary pole would be necessary. From my tests there has been no noticeable difference between the diamond or the square configuration. Some may argue that the two high current points in the diamond configuration, being farther apart, would tend to increase the gain. Theoretically, this may be true, but no measurable difference has been noted here.

Let's take an example of a twenty meter four element quad in the square configuration to be tuned to a design frequency of 14250 kHz. Tuning to be done at a minimum height above ground. First, one must buy, beg, borrow, or build the following equipment: grid dip meter, vswr meter, antenna scope or impedance bridge, and one friend a mile or more away. The station receiver, of course, is also a must. You may use any of the convenient formulas as a beginning because in this case we are not interested in the length of wire as measured in feet and inches, but the results as measured by our equipment. It is always better to have more wire than needed as it is quite easy to cut off any excess. Some use number 10, 12 or 14 solid copper wire, some aluminum clothes line wire, or seven strands of number 20 or 22 plain old antenna wire; which is available at most all wholesale houses. There are now many construction articles on multi-element quads so we will not delve any further into that region.

String the wire and place all elements on the boom, shorting all loops so that you have completely closed loops. No transmission line is attached as yet. Grid dip the driven element to approximately 14200 kHz. You need not try to be too accurate at this point. Attach your 52 ohm coax to the driven element and to your receiver. Now have your friend transmit a weak signal at 14200 kHz. Adjust the reflector element for a minimum signal from your friend's transmitter. You will note a definite null on the S meter of your receiver as you tune the reflector. A small stub of six to eight inches may be left for final adjustments. Cut off all excess wire, leaving the stub shorted. An electricians "bug" does a fine job as a shorting "bar."

Now let's insert a 52 ohm vswr bridge at the feed point of the driven element. Turn on your exciter at the lowest power possible to get a full-scale reading on your vswr meter. Adjust the driven element length for minimum reflected power. This reading will probably not go to zero reflected power due to the inductive reactance introduced by the reflector. Leaving the vswr meter "as is" at its minimum reading, adjust the first director (the one nearest the driven element) to further reduce the reflected power reading. This may or may not go to 1:1. If not, tune the second director in the same manner. The second director will have less effect than the first director on the reflected power. Proper tuning of the two directors with their capacitive reactance affect on the driven element will cancel the inductive reactance of the reflector leaving as near as possible a pure resistive load at the driven element. Remove the swr bridge and, using the antenna scope or impedance bridge, measure the feed point impedance. Should the swr meter have indicated zero reflected power upon completion of the tuning of all elements, the impedance measurement should have indicated 52 ohms nonreactive on the impedance bridge. In other words, the impedance bridge should null completely at 52 ohms indicating a nonreactive load. In the case of .1 wave length element spacing the impedance should measure about 50 ohms or lower. With .125 to .25 wave length element spacing between 50 to 75 ohms; .2 up to .3 about 75 to 100 ohms. Assuming that your impedance measurement came out around 52 ohms continue with the following. If the impedance is either higher or lower than 52 ohms, it is necessary to now use whatever matching method you prefer. Again an example: assume the driven element swr would not zero after all adjustments, and the measured impedance was in the neighborhood of 100 ohms. A simple quarter wave section of RG11U (75 ohm coax) may be attached to the driven element and all further adjustments made with the swr meter inserted at the junction of the 75 ohm quarter wave matching section and the 52 ohm coaxial line to the transmitter. Repeat the previous adjustments, starting with the reflector and the help of your friend, making only slight adjustments to the reflector as needed. All other adjustments should require only a "touch up." The above procedure is true regardless of element spacing as the phasing of parasitic elements is governed by the length of the elements for a given spacing.

Should the impedance be lower than the transmission line a Gamma or hairpin (Beta) match may easily be used. Refer to such articles or the handbook for adjustments, etc. Should the antenna impedance be larger than the transmission line use a quarter wave matching stub. The quarter wave matching section is preferred because of ease of construction. The Gamma or Beta match may also be used with the driven loop closed, but more time would be required for proper adjustment. The matching section is simply an electrical quarter wave transformer made from coax cable of a different characteristic impedance following as near as possible the result of the formula: The square root of the load impedance times the characteristic impedance of the transmission line. $Z_T = \sqrt{Z_L \times Z_S}$ where $Z_T$ = characteristic impedance of the coax for the quarter wave transformer, $Z_L$ = antenna or load impedance and $Z_S$ = source impedance or the characteristic impedance of your transmission line. Should the load impedance be within a few ohms of 50, the transmission line may be connected directly to the driven element or through a one to one balun.

While the antenna is still lowered, make a bandwidth test with the swr meter at the feed point of the driven element or at the transmission line end of the matching section with low power fed to your transmission line from your exciter. Make swr measurements every 50 kHz and plot the curve on graph paper. Do not become alarmed if the swr rises very sharply at the low end of the 14 MHz band. The CW portion may still be used with the antenna tuned for the phone portion, although the efficiency does diminish. This is "on the button" tuning so the reactance will be negligable over the phone portion of the band. If you use both phone and CW, it might be well to make the design frequency near center of the band. Likewise, the design frequency may be made in the CW segment if you desire. Getting back to the swr measurements, you will note that *at the antenna*, or the base of the matching section, if one is used, the reflected power is nil across the greater portion of the design frequency, making the *true* swr unit. Next remove the swr meter from the driven element and reconnect the transmission line. There is no need to cut the transmission line to any particular length—just use random length to suit your purpose. Insert the swr meter at the transmitter end next and again make the full swr meter measurements across the band every 50 kHz as previously done with the swr meter at the antenna. Again, plot the curve on graph paper and note the similarity of the curves. Due to a multitude of factors, the transmitter end of the transmission line swr readings will tend to be somewhat lower at the band end extremes.

A dummy load may be substituted for the antenna. Heath's "Cantenna" is a good and inexpensive one. The Waters dummy load power meter is excellent, but more expensive. An *rf* (thermo-couple) ammeter in the transmission line at the transmitter is worth its weight in gold and much more preferable to an in-line swr meter at the same point. Good Western Electric and G.E. *rf* ammeters may be purchased on the surplus market for less than five dollars. After tuning and loading the transmitter to either the dummy load or the antenna there will be no change in transmission line current when switched from one to the other and no retuning of the transmitter should be necessary. This indicates as nearly as possible with available equipment whether your antenna is nonreactive or near pure resistive. If a Bird Model 43 in-line wattmeter or equivalent is available, some interesting overall efficiency measurements may be made. Insert the wattmeter at the antenna feed point and adjust the transmitter to a given plate power input. On all further measurements keep the transmitter adjusted to the same power input. At frequencies near the design frequency the antenna is nonreactive and there is no reflected power and the overall efficiency is indicated. For instance, we adjust the transmitter to 500 watts dc input, the wattmeter indicates no reflected power and forward power reads 300 watts (with grounded grid amplifiers and 100 watts of power output from the exciter, the final amplifier should be adjusted to 360 watts input as the output from the 100 watts from the exciter should appear in the output to the transmission line). The overall efficiency from plate power input to actual power output to the antenna would be 60%. This includes normal transmission line losses, impedance transfer from final amplifier, etc. This percentage may seem high, but is quite attainable with good linear amplifier design and proper matching of transmission line to a resonant antenna. Now tune the transmitter to the same power, but to frequencies at which the antenna is nonresonant. Note the difference in forward power and reflected power. Subtract the reflected power from the forward power and figure the efficiency percentage. Make these same percentage measurements every 50 kHz over the band as was done with the swr curve. That does it! There lies the reason why it is still preferred to have an antenna with less frequency excursion and higher efficiency than one of a compromise nature.

The preceeding procedures are not intended to be the "ultimate" but will afford the "working ham" a less expensive and time-consuming method of getting the most from his multi-element quad antenna. Although the reference is to a four element quad on a thirty foot boom, the same approach may be used with a two or six element quad. The forward gain and F/B ration will be as good if not better than the average when tuned in this method.

Work has been going on for more than three years to broad-band a multi-element quad and yet retain a minimum reactive load over the entire band. Success seems just around the corner, but the last ten years working with the multi-element quad has taken its toll.

W4AZK

# The Antennascope — An Effective Tool

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There are two types of antennas, commercial and amateur. A commercial antenna is generally designed for one frequency, has many acres of ground around it, no obstructions and miles of heavy copper cable buried underground to provide an "effective" ground. These antennas work as designed – very well. The amateur antenna, on the other hand, is just that – an amateur design and construction.

This antenna is subject to all ills, roof tops, buildings, trees, TV masts, house electric wiring, telephone wires and what not. It's a wonder they work at all! But they can be made to work and thousands of amateurs make them work. They make them work by pruning or lengthening the feeder cable and by using an antenna coupler. These are always empirical steps, the "let's cut and try and see what happens" method. How much better it would be, and a time saver too, if we tested our antenna systems electrically and *knew* what was happening and then could take intelligent action to put the whole antenna system into resonance.

This fact is well known – an antenna can only accept power and radiate properly when it is operating at its resonant frequency. This is no problem for the commercial people who operate at one frequency. The amateur, however, wants to "roam the band" and may wish to operate over frequencies hundreds of thousands of cycles wide, even megacycles wide. How can he do this with a fixed antenna system? The answer is, he can't! But he can construct an antenna system for a certain frequency and take the penalty of reduced radiation when he moves far away from it. However this actually works very well, because each amateur has his own particular part of a band in which he likes to operate – and his friends tend to stay there too. On this particular spot, the amateur works diligently to "put out a good signal."

The question arises – how can we make sure our antenna system is radiating well at the particular frequency we wish to use? One answer is to use electrical test equipment to show us what is happening on the whole antenna system, which includes the antenna and the feed line.

One of the most useful devices for this purpose is the *rf* bridge, generally called the Antennascope. Basic circuitry and values were described by WA1CCH in the January 1968 issue of 73 Magazine, page 21A. It is a simple device, inexpensive to construct and very effective in results. It is usually powered by a grid dip oscillator. Such bridges should be used at the junction of the feed line and the antenna and will show the resonant frequency of the antenna itself and the radiation resistance at the feed point.

Making such measurement up in the air is a difficult thing for the average amateur and impossible for those whose antennas are supported at the ends. If we are willing, however, to accept a small degradation in results, we can use the *rf* bridge at the station end if we have a half wave, or multiple of a half wave, feed cable. At every half wave point on a feeder cable the voltage and current vectors are in phase, which simply means that the electrical condition seen at the end of the cable is repeated every half wavelength in the cable. We can use the *rf* bridge then, at the station end of the feed line, if we are willing to agree that the results will not be 100% but reasonably close to it. The results will be affected by all the various factors that affect amateur antenna resonance and these effects may give us some peculiar results, but they can be overcome and the final results may be quite valuable to us.

Let me give you an example to illustrate what I'm talking about and to show you how effective the use of the *rf* bridge can be: –

A friend of mine constructed a 40 meter inverted V antenna, held at the feed point 40' up on his beam tower, 66' legs down to supports which held the ends about 8' off the ground. Feed line was 100' of Twin Amphenol cable, velocity factor .68. The antenna was difficult to feed, swr was high, radiation was poor. He asked me to have a look (electrical) at it. I took my grid dip meter, *rf* bridge and vtvm.

The first thing done was to check the feed line length. 1/2 wave length at 7.1 MHz was 492 x .68/7.1 or 47.1 feet. Two 1/2 wave lengths (to get into the station) would be 94.2 feet.

The first conclusion was that the feed line was 5.8 feet too long.

Next Test No. 1 was made using the *rf* bridge with results as shown in **Fig. 1**, the results being shown in table form and also plotted in graphical form.

| F MC | R OHMS |
|---|---|
| 7.0 | 55 |
| 7.1 | 80 |
| 7.2 | 110 |
| 7.3 | 115 |

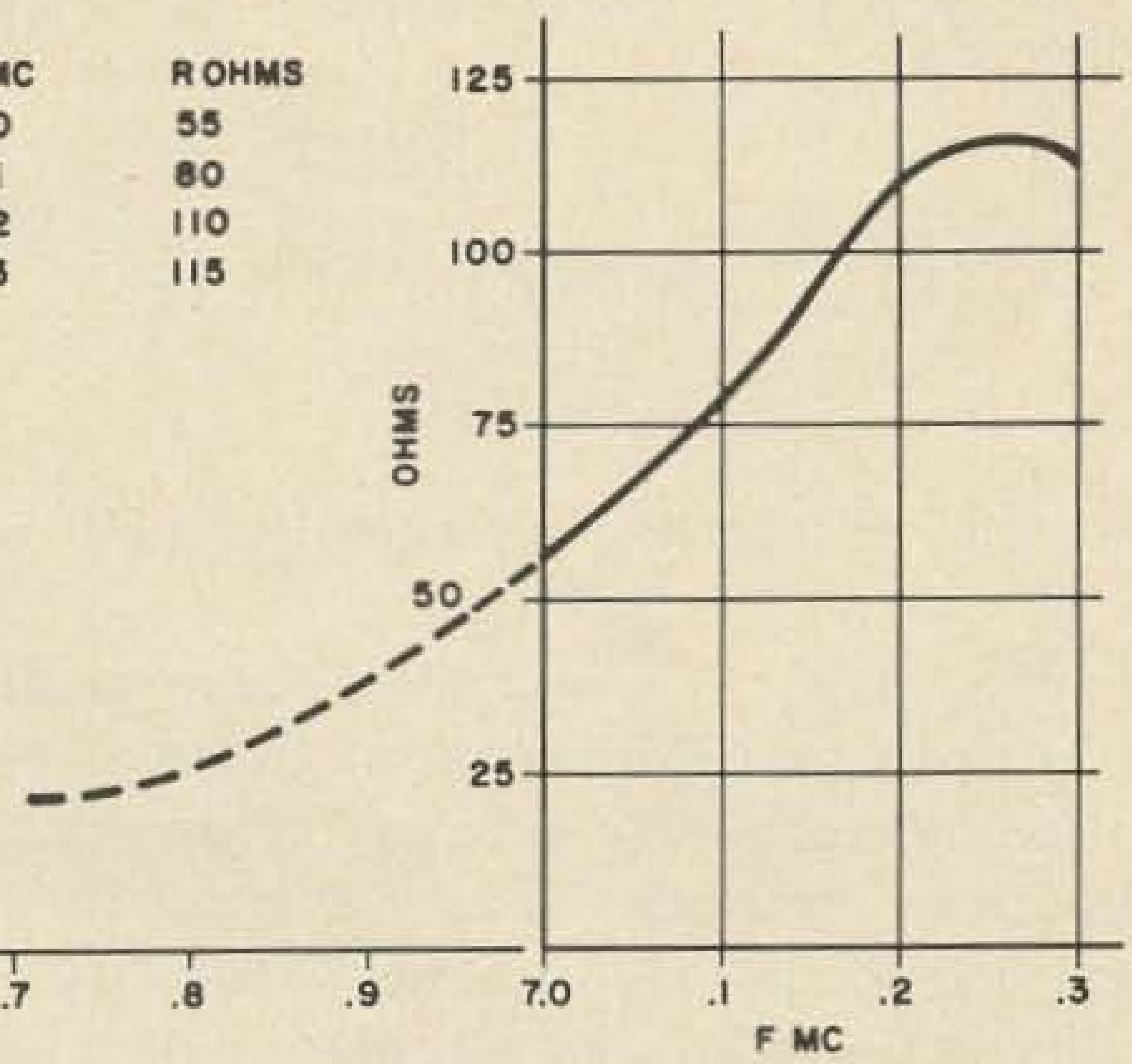



Fig. 1. 100' Feedline Test No. 1.

It was obvious from this graph that the antenna system was resonating outside the band as shown by the dotted lines. This test was repeated and the results were taken down to 6.4 MHz. They showed the system to be resonant at 6.6 MHz.

Test No. 2 was made next using the feed line cut to 94.2 feet. **Fig. 2** shows the results.

| F MC | R OHMS |
|---|---|
| 7.0 | 48 |
| 7.05 | 51 |
| 7.1 | 69 |
| 7.2 | 80 |
| 7.3 | 115 |

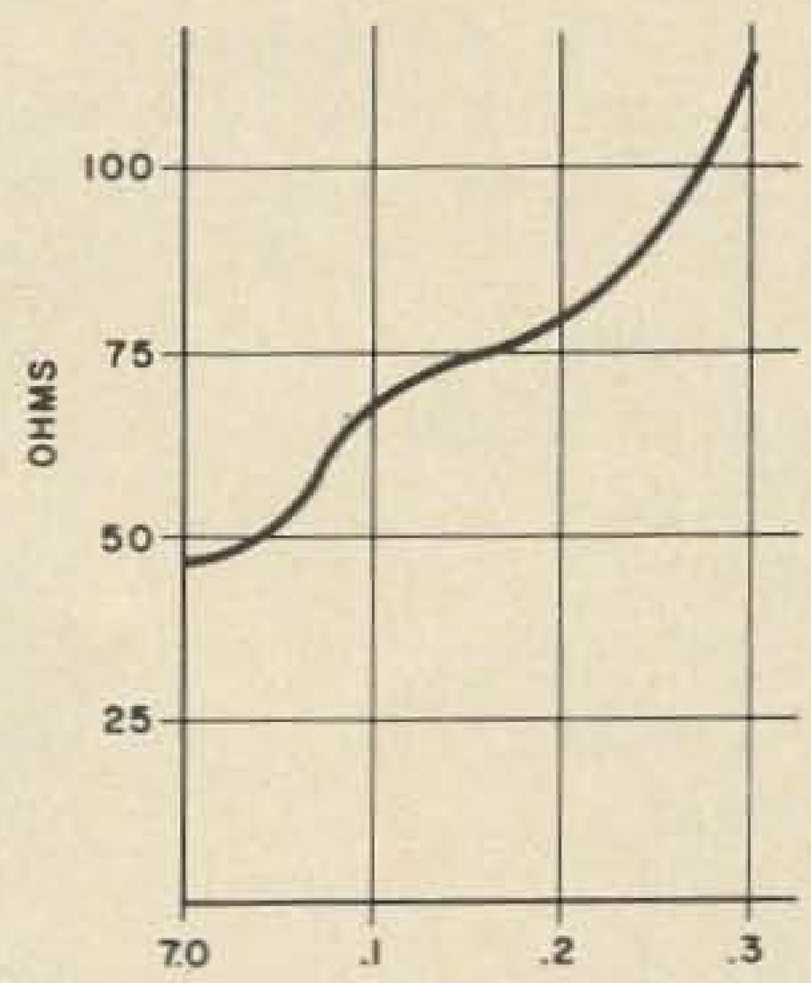



Fig. 2. 94.2' Feedline Test No. 2.

It was obvious the resonant point of the system was rising.

Test No. 3 was made next, cutting the feed line to 91.2 feet long. **Fig. 3** shows the results.

| F MC | R OHMS |
|---|---|
| 7.0 | 43 |
| 7.1 | 46 |
| 7.2 | 76 |
| 7.3 | 81 |

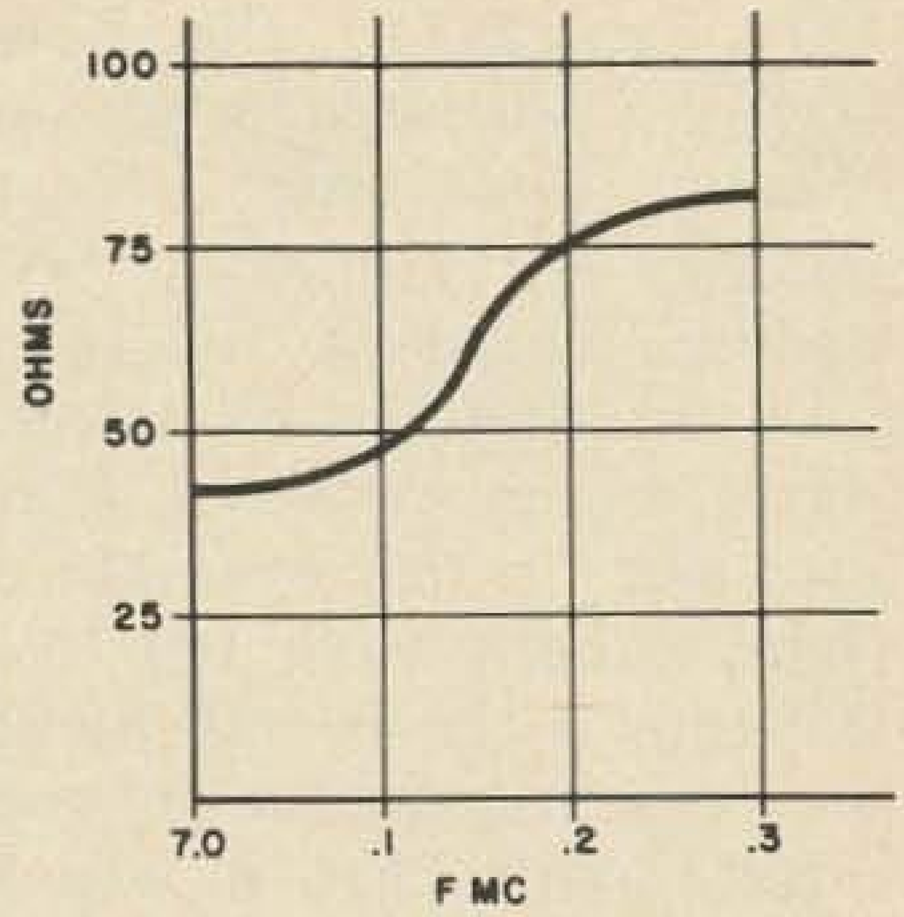



Fig. 3. 91.2' Feedline Test No. 3.

The resonant point was rising, but not far enough yet.

Test No. 4 was made using the feed line cut to 88.2 feet long. **Fig. 4** shows the results. It was obvious that we were very close to the resonant frequency of 7.1 MHz which my friend wished to use.

| F MC | R OHMS |
|---|---|
| 7.0 | 45 |
| 7.05 | 47 |
| 7.1 | 51 |
| 7.2 | 60 |
| 7.3 | 75 |

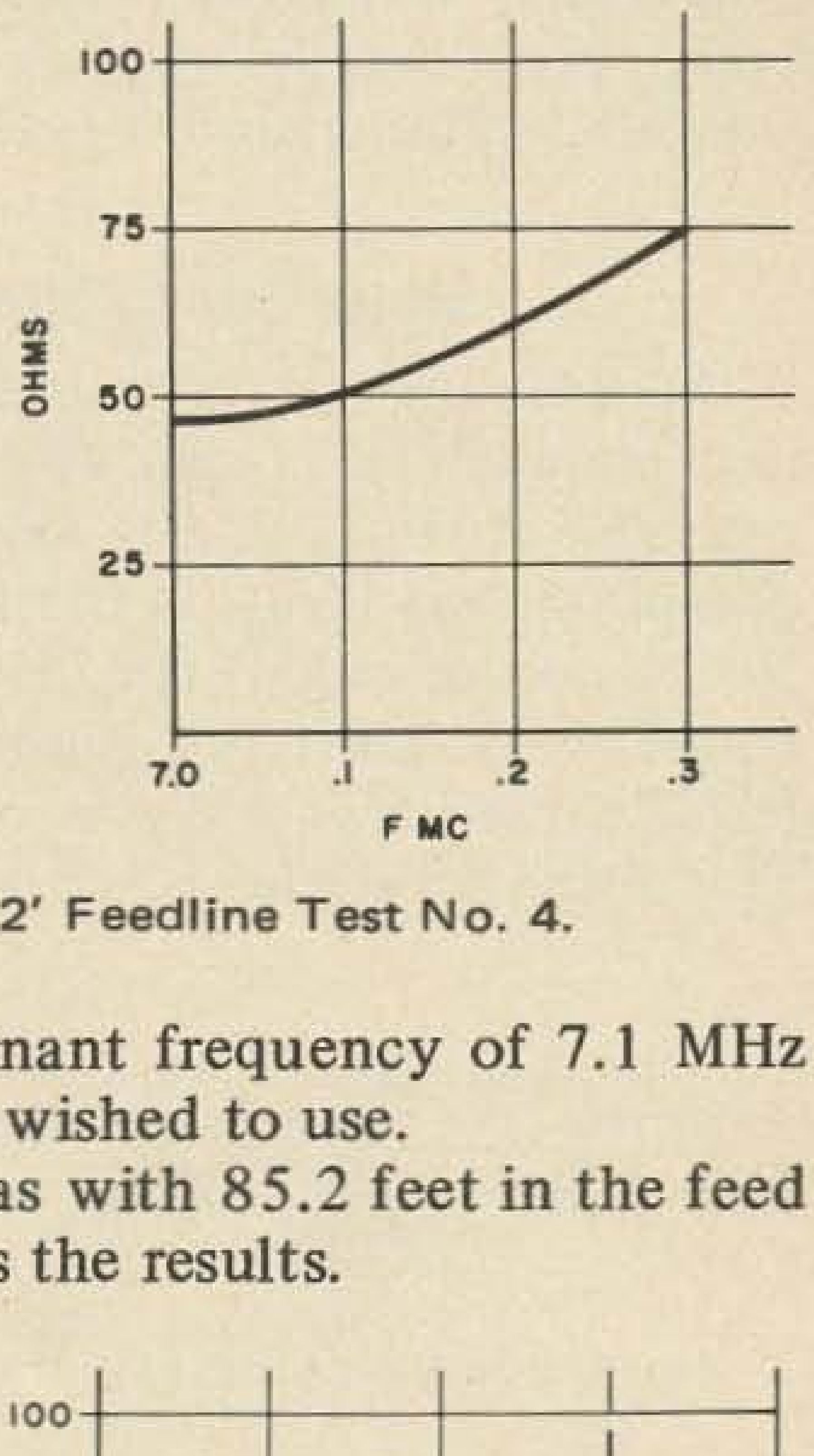



Fig. 4. 88.2' Feedline Test No. 4.

Test No. 5 was with 85.2 feet in the feed line. **Fig. 5** shows the results.

| F MC | R OHMS |
|---|---|
| 7.0 | 78 |
| 7.1 | 61 |
| 7.2 | 60 |
| 7.3 | 66 |

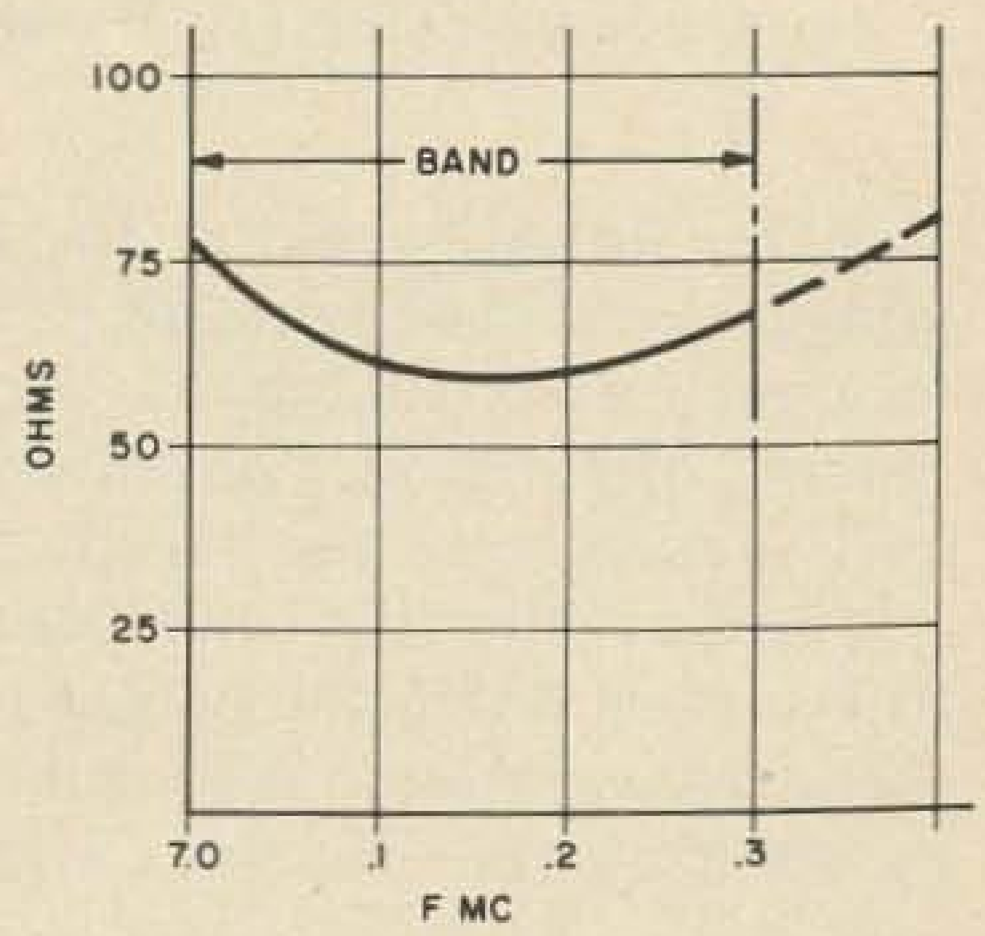



Fig. 5. 85.2' Feedline Test No. 5.

Test No. 6 was with the transmitter (300 watts CW) and antenna coupler connected. There was no trouble in loading and no trouble in balancing the coupler to obtain an swr of 1 to 1 ratio.

The results on the air were interesting, 5/9+ reports to the Eastern half of the U. S. A., 5/8 reports to Germany etc. *Conclusion:* The results shown above are not precise, nor can they be expected to be precise. There are too many unknown factors entering the electrical picture, such as those which required a shortening of the feed line, in this example, to somewhat less than a half wave length. But the bridge showed us the overall picture and suggested what was required to be done. The on-the-air results show that it was giving us a good picture and a result that was very satisfactory for my friend's needs.

Why not construct an *rf* bridge and check you own antenna system? I suggest it will pay off and be very informative to you, showing you what your antenna system looks like electrically and what to do to bring your whole system to the resonant frequency you wish to obtain. . . . VE3CEA

## Short Cut to Matching

In building an inexpensive, short space, two element beam for twenty meters, considerable difficulty was met in obtaining an acceptable match from the feed line (RG-58) to the center coil of the driven element (link coupling method...ref. Radio Amateur Handbook, three element beam for twenty meters). The initial set-up is shown in **Fig. 1**.

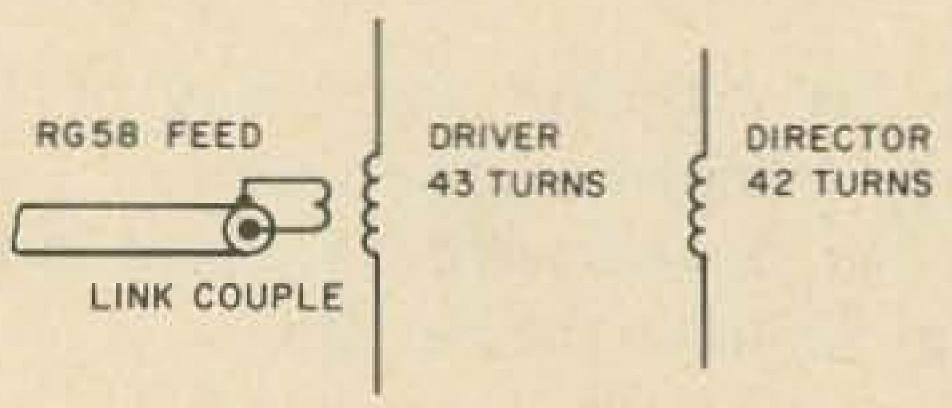



Fig. 1. Link coupling as in the original set up.

After initial tweaking, the best VSWR obtained was a disappointing 3:1. Varying factors such as changing the number of turns, spacing of turns and antenna height resulted only in *increasing* the VSWR.

Further thought and many aggravating trips up and down the ladder resulted in a decision to use an old approach to the problem by going to the "Gamma Match" method in Fig. 2.

The Gamma match was accomplished by:
1. Tying the shield of the RG-58 coax to the center turn #21 of the 43 turn center coil of the driven element and,
2. Connecting the coax center conductor to the 31st turn on the coil. This gave a starting point of 5:1 VSWR.

With a little hint from the handbook, a

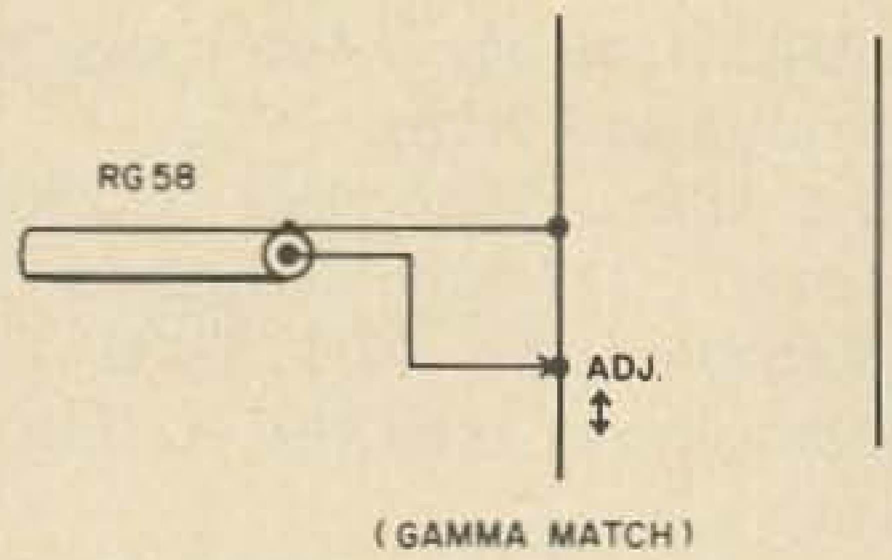



Fig. 2. Using the ever popular "Gamma Match."

140 picofarad capacitor was dug out of the "junk box" and inserted in the coax center conductor line...going to the tap on the coil as in **Fig. 3**.

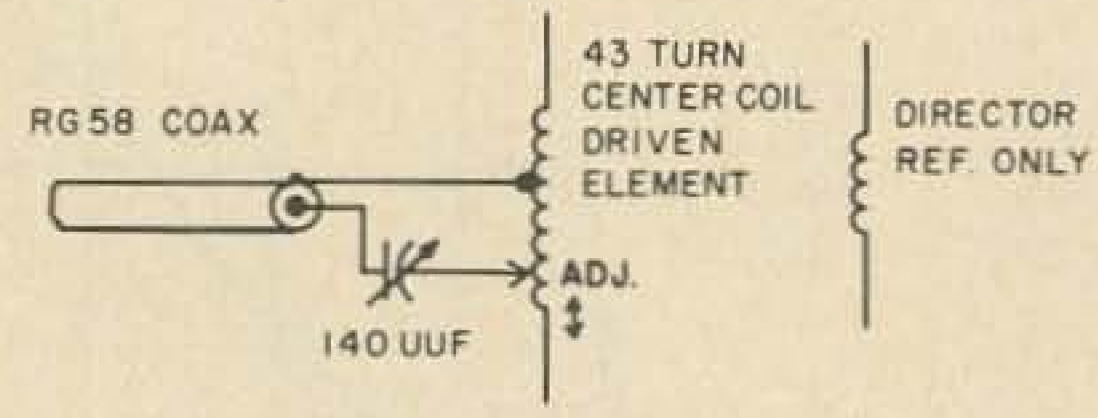



Fig. 3. Adding capacitor for best match.

The capacitor was set at several different positions and minimum of 3:1 was obtained at a max capacity setting. This appeared to be little headway for all the trouble, but past experience pointed to the possibility that the antenna height was a remaining variable not yet changed. A little experimentation with antenna height (more trips to roof) showed best results with it raised just five feet.

A check of the VSWR bridge showed a rewarding 1.5:1 for all our efforts to obtain a match.

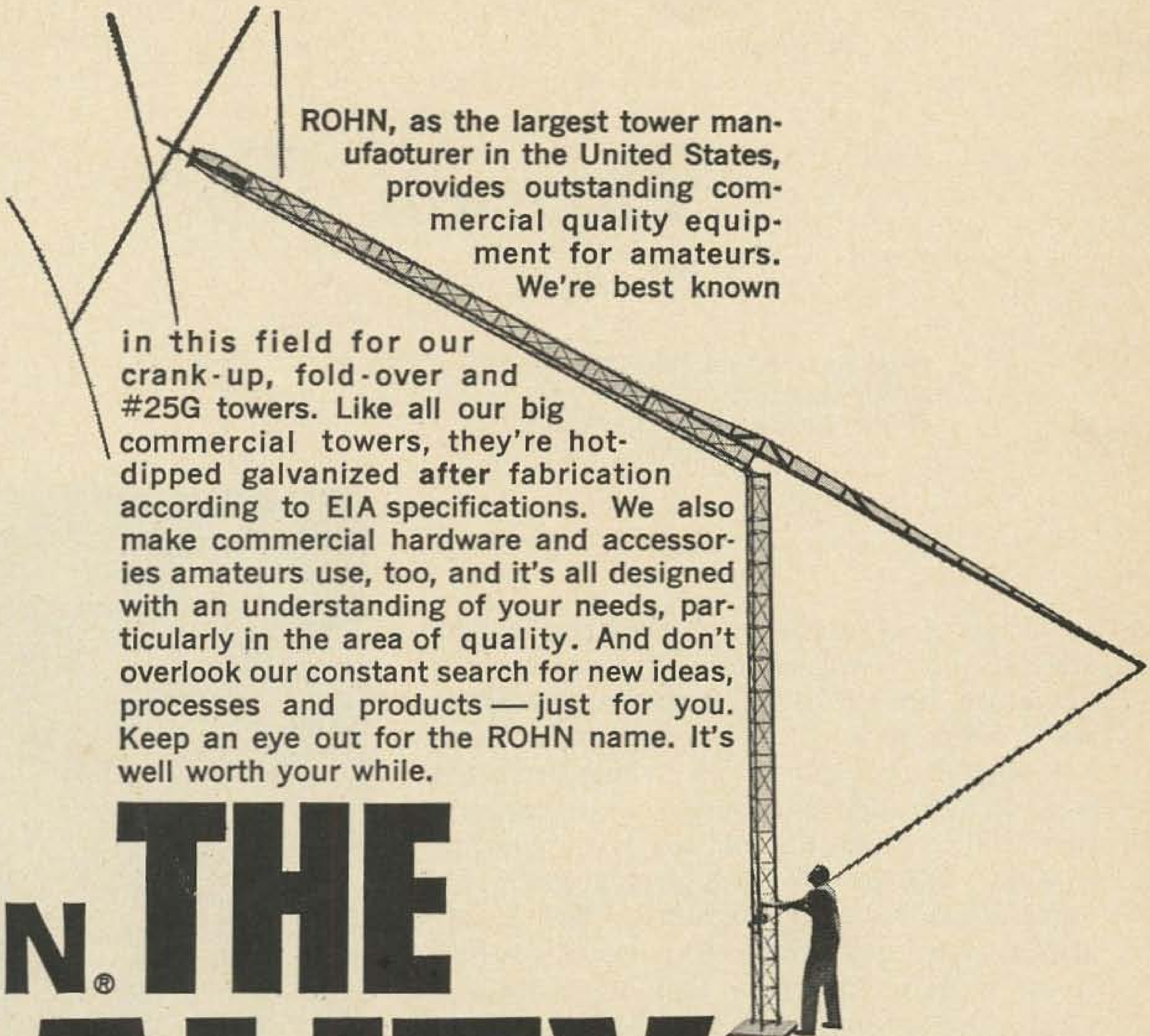
**Bernard Oliver, K6CZJ**

## DX QUIZ

OK, you DX'ers, how are you on prefixes? Score five points for each correct prefix. We are in Africa this trip.

| | | | |
|---|---|---|---|
| Congo Republic | ........ | Republic of Guinea | ........ |
| Republic of the Congo | ........ | Uganda | ........ |
| Mali | ........ | Rwanda | ........ |
| Central African Republic | ........ | Niger | ........ |
| Senegal | ........ | Tanzania | ........ |
| Cabindi | ........ | Gabon | ........ |
| Fernando Poo | ........ | Spanish Guinea | ........ |
| Zanzibar | ........ | Mauritania | ........ |
| Chad | ........ | Lesotho | ........ |
| | | Mozambique | ........ |
| | | Botswana | ........ |

You'll find the answers on page 50 No fair peeking until you've committed yourself to good guesses.



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# *Two on Top*

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Those of us restricted to using top-loaded verticals on 75-80 meters for fixed station operation, are apt to regret the narrow bandwidth inherent in this type of antenna. So it was with my Hustler 4-BTV, which performs fine over as much as 150 kHz in any selected part of the band, but limited my operation to either SSB or CW for a given adjustment. Since I like to work 80 meter CW DX and also ragchew on 75 meter SSB, there just had to be a better solution than lowering and raising the antenna each time I got a yen for the alternate mode of operation.

There was, and it was as simple as installing two top-loading coils—in my case the Hustler type RM-75.

This was accomplished by fabricating a suitable mounting bracket out of 1"x¼" aluminum stock, as shown in the figure. The two "ears," 45 degrees to the center mounting surface, permit the two coils to be mounted physically 90 degrees to each other, minimizing intercoupling. The bracket is mounted by the center hole to the 3/8"-24 stud atop the 4-BTV, on which a single RM-75 loading coil is normally attached. The stud

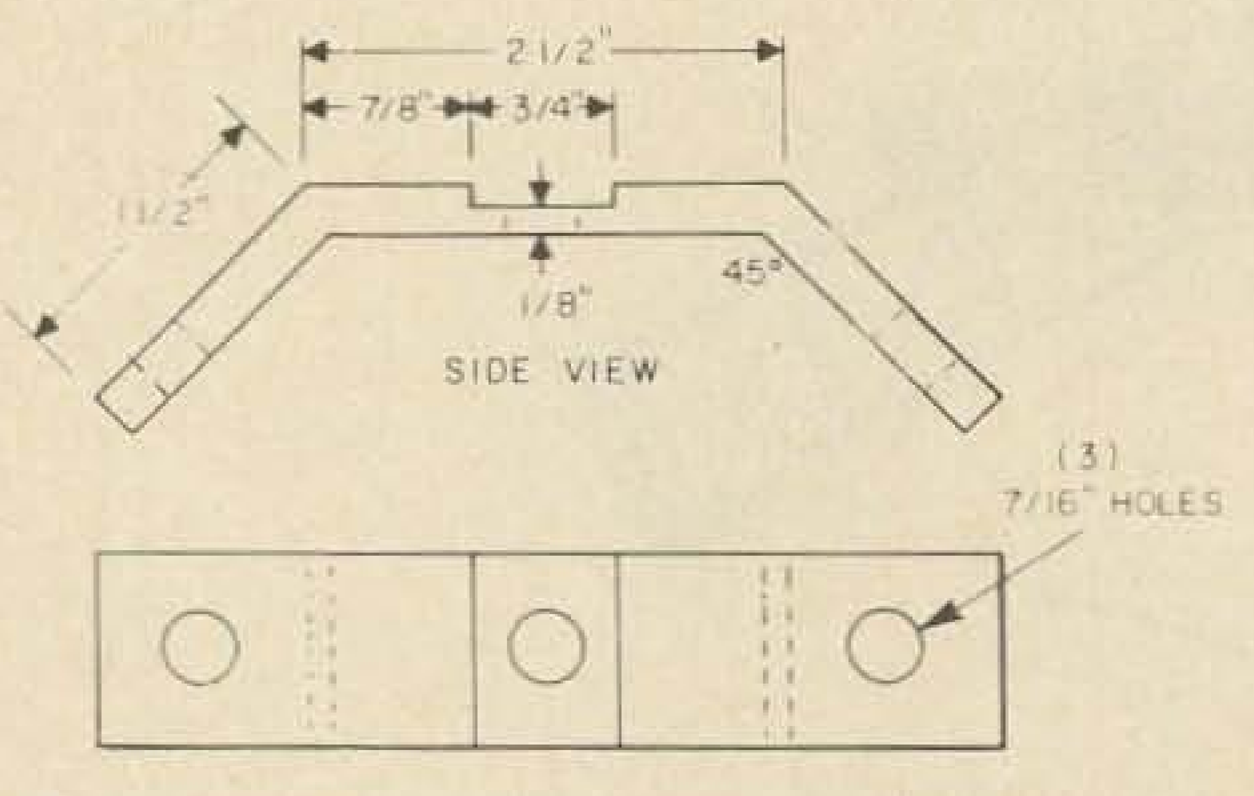
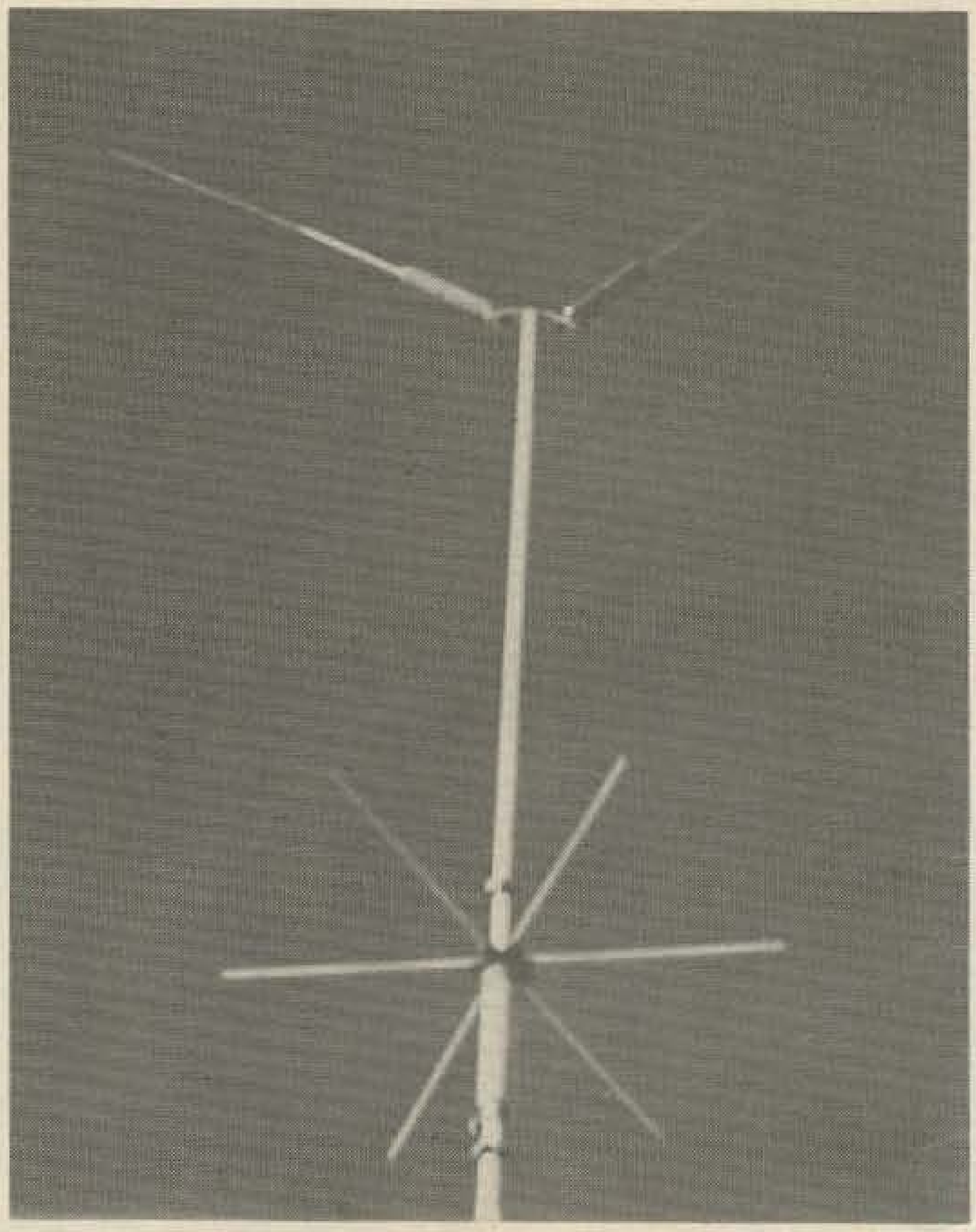


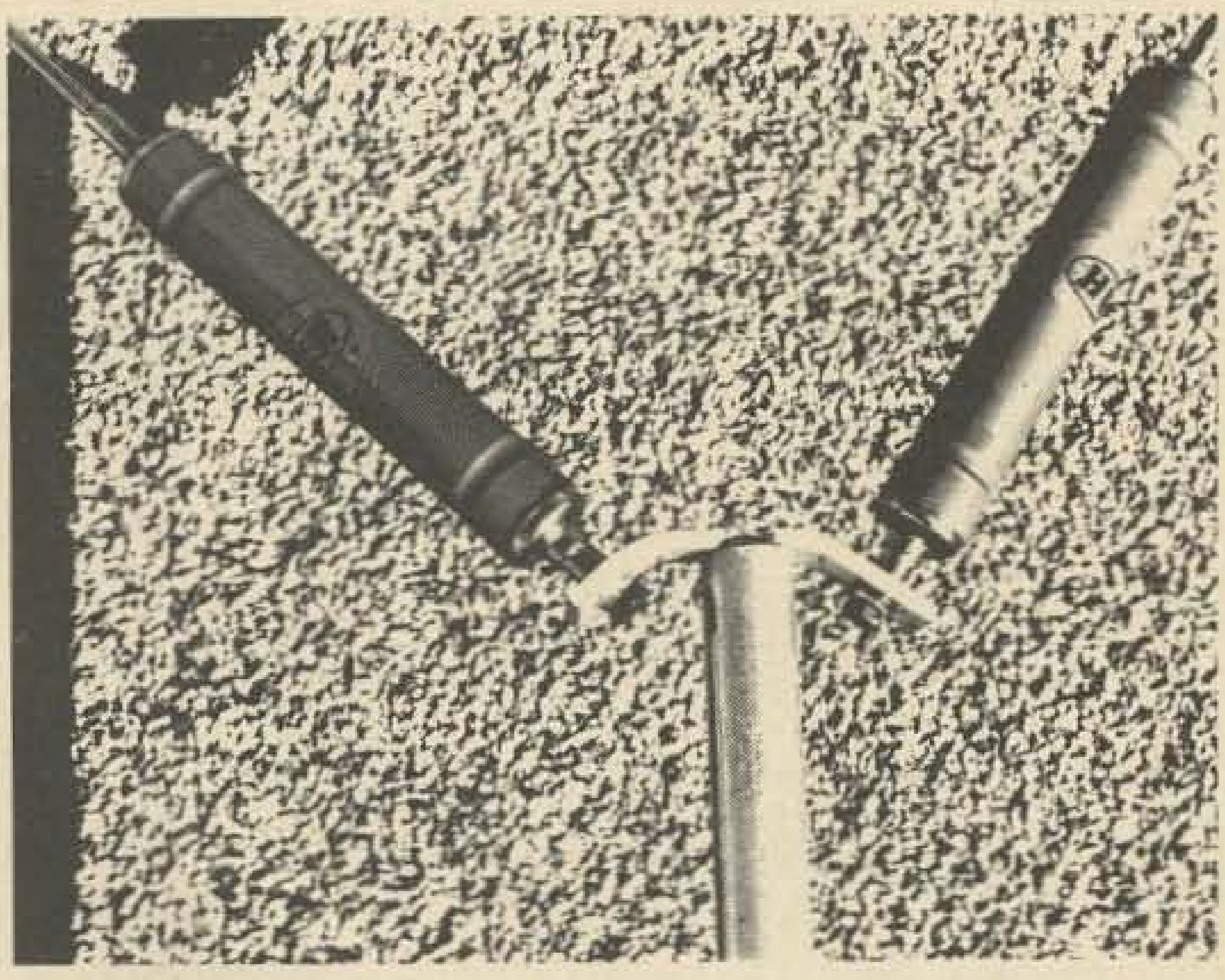

**Fig. 1. The mounting bracket for two RM-75 loading coils.**



View of the antenna in use.

being only about ¼" long required filing down the bracket thickness to 1/8" at the mounting point, in order to secure the bracket with a 3/8-24 nut. 1"x1/8" stock is also available, but it was felt this would be a bit flimsy, causing the "ears" to flap in a stiff breeze, with detrimental affects on resonance and loading. Anyway, both kinds of stock are to be found in the "Do It Yourself" aluminum rack in well equipped hardware stores. The coils are attached with 3/8-24x½" bolts using washers, plus a split lock-washer to take up the extra bolt length and ensure that the coils won't come loose.

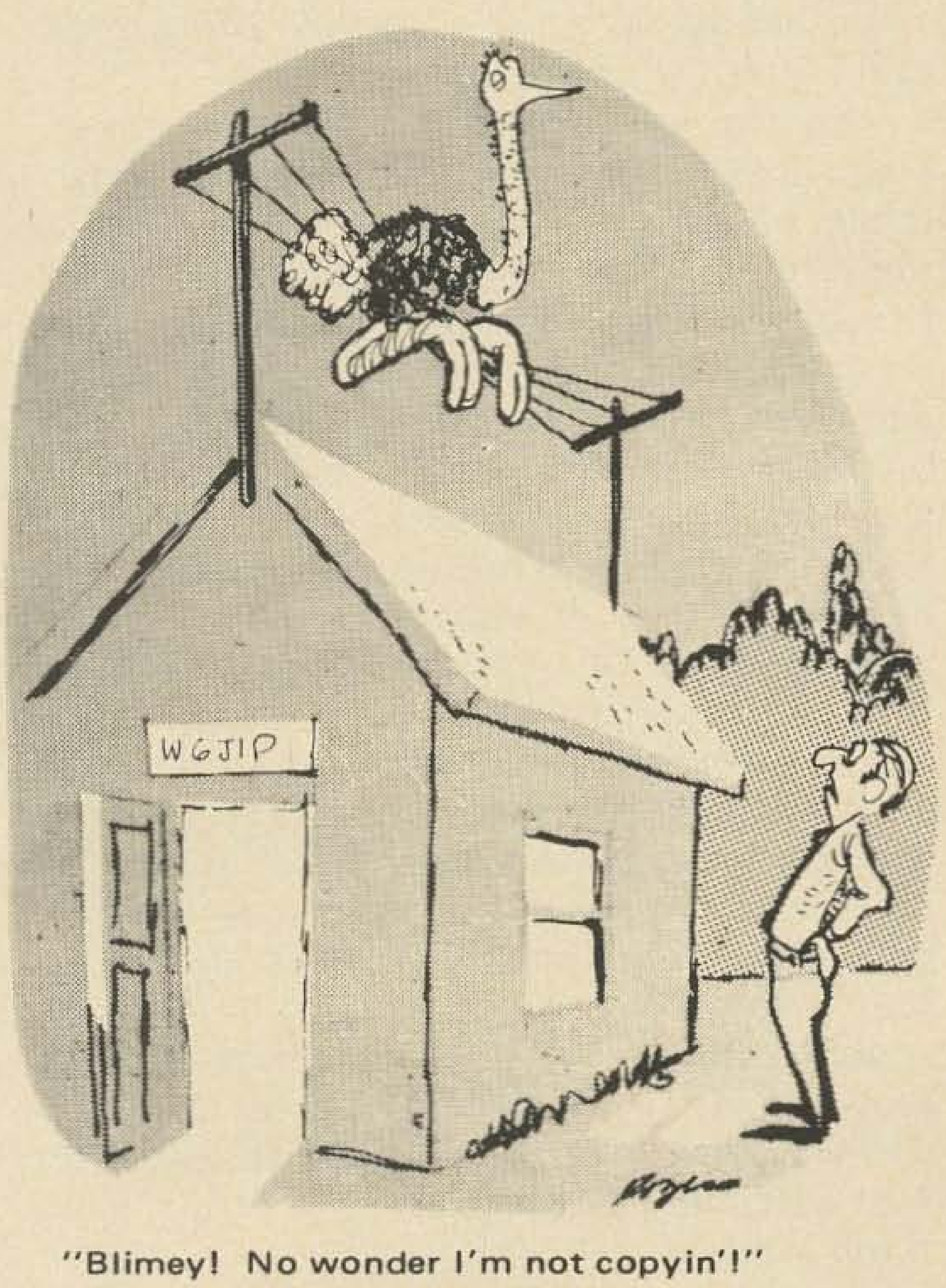
The pictures show the finished product. One coil is resonated by it's whiplet to 3900 kHz and the other to 3550 kHz. The antenna resonates and loads with low SWR at both frequencies with no interaction between the coils, and I can now enjoy operation on my



Mounting details showing the two "ears."

two favorite sections of the band without roof-climbing. The assembly easily withstood recent 55 mph wind gusts.

Of course, this principle can be applied to any similarly top loaded vertical, with a suitably made bracket. Hmmm! If I made a bracket with ears parallel to the mast, I could mount more than two coils, horizontally, and 90 degrees to each other, giving me additional band coverage. Who is going to be first on their block to have "four on top?" or even five? ...W6AJZ




"Blimey! No wonder I'm not copyin'!"

# *Measuring Antenna Gain*

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*Mystic, Conn. 06355*

Some basic methods are described for measuring antenna gain using a reference gain antenna as well as methods that can be used when a reference antenna is not available. Even for those who do not plan to use the methods described, reading and understanding them will provide a better insight into the meaning of an antenna gain figure. If one likes to experiment with antennas, either building arrays or experimenting with new forms, a continuing problem is how to measure the gain of an antenna. Of course, the proof of any antenna will always remain in how it performs in actual operation. Also, gain is just a number and by itself doesn't convey any information about the overall radiation pattern(except to say that it is formed in some directive manner). Nonetheless, it is often handy to be able to talk about some gain figure for an antenna.

One can estimate gain by using a new antenna in the same mounting position as an antenna of known gain and comparing many signal reports, switching back and forth between the two antennas, to obtain some reasonably meaningful gain figure for the new antenna. The procedure can be rather tedious, however. This article describes various ways by which the gain of an antenna can be more accurately measured, whether one has an antenna of known gain available or not. Because of physical restraints and the interference produced by atmospheric noise, the described methods work best with VHF antennas. However, with care, the methods can be used with well elevated high-frequency antennas. Another way to check the gain capabilities of a proposed high-frequency antenna design would be to first construct a scaled VHF model of the antenna. Such a model is also very useful to study the impedance and matching conditions necessary for best antenna performance.

**Basic Method**

Fig. 1 illustrates the basic equipment setup which is necessary to measure antenna gain.

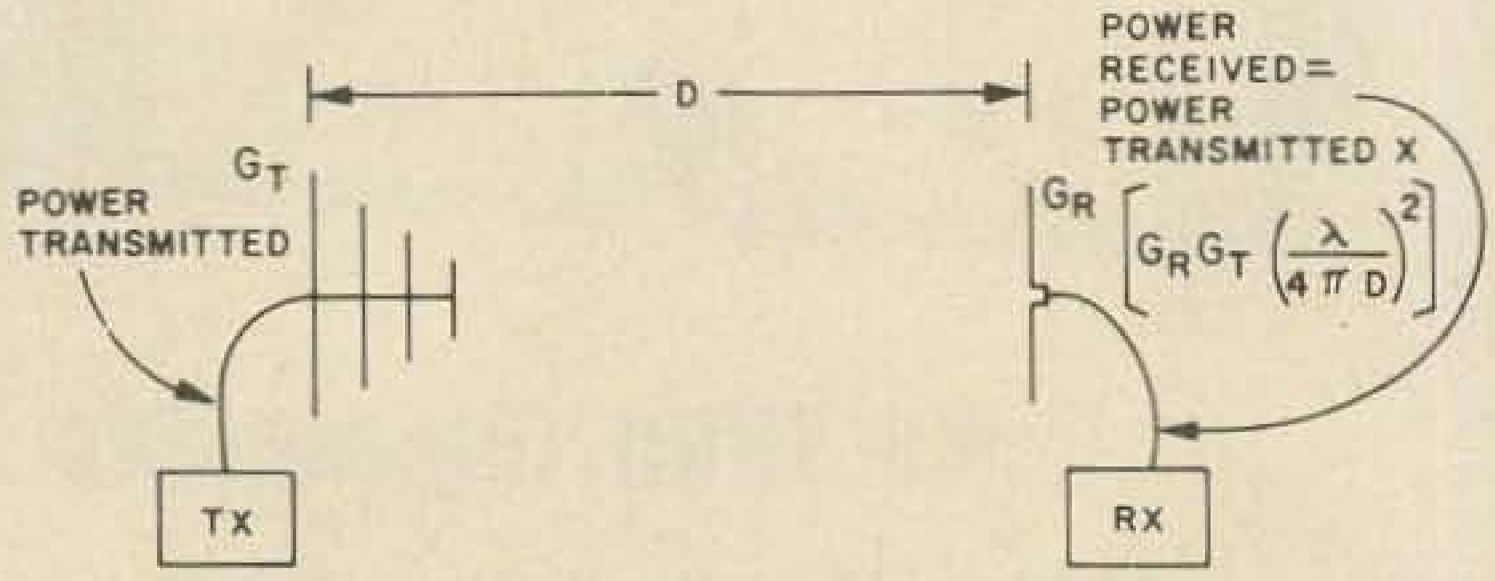


**Fig. 1.** Basic free-space transmission formula between antennas. Antennas are in the same plane and the transmission line between the equipments and antennas have negligible loss. Loss, if present, can be included as a scaling factor (i.e. a total line loss of 2.5 db will reduce the power received by a factor of .55).

The gain of the antennas and the power transmitted and received are related by the standard transmission equation:

$$P_{transmitted}/P_{received}=G_t G_r\ (\lambda/4\pi\ D)^2$$

$G_t$ and $G_r$ are the numerical values of the gain of the transmitting and receiving antenna, respectively. The term in parenthesis is simply a constant. $\lambda$ is the operating frequency expressed in meters and D is the distance between the antennas also expressed in meters.

The above equation is true so long as the antennas operate with essentially plane wavefronts. That is, if the antennas are too close there will be an appreciable phase difference between the signal which one antenna receives from the center and the edges of the other antenna. So, for good measurements, D in the above equation should at least be equal to about $2L^2/\lambda$. L is the longest lineal length of the antennas being used and $\lambda$ is the operating frequency. For instance, if an antenna were to be tested on 2 meters which had a maximum length of 3 meters, or about 10 feet, the test antennas would have to be separated by at least 9 meters, or about 30 feet. Generally, there is no difficulty in meeting the separation requirements unless one is dealing with very large antennas at very low frequencies.

The necessary power measurements can be accomplished in several ways. A wattmeter can be used in the transmitting antenna's transmission line or the *rf* voltage across the line measured and the power calculated. The line itself should be operating as close to a 1:1 swr ratio as possible. The receiving antenna power can be measured in essentially the same manner or if the gain of the receiver is accurately known, it can act as a power indicating device. Again, the impedances between the antenna, transmission line and receiver input must be correctly matched. Still another method is possible if only the power output of the transmitter can be measured. The transmitting power is adjusted for some convenient reference level on the receiver (receiver avc is off). The receiver "S" meter, if it is the type that functions with the avc disabled, or an audio output meter, if the transmitter is tone modulated, can be used. The transmitter is then connected to the receiver and its output level slowly increased (using an attenuator network or by varying an operating voltage which controls the output power) until the same reference level is obtained. The power level required will be the same as the received power.

If one operates only on a specific VHF band and wishes to construct a sort of "instant reading" gain meter, this can be done by using a dipole as the receiving antenna and placing an *rf* rectifier circuit and meter directly at its terminals. As long as the distance between the transmitting antenna and the receiving reference antenna is kept constant and as long as the input power to the transmitting antenna (of unknown gain) is always the same, the meter can be calibrated directly in terms of antenna gain. It is only necessary to use several antennas at the transmitting end of known gain first in order to establish the calibration of the receiving antenna "gain" meter. Such a device can be a great deal of fun and use during competitions at field days, etc. for the best antenna designs. Aside from the distance and power considerations mentioned, however, the only requirement for the FD "wonder" antennas tested is that they be capable of producing near unity swr in the transmission line to the transmitter. Unless this condition is met, the "gain" meter readings will not be valid in either an absolute or comparative sense. The basis for the calibration of such a meter should become clearer from the following test situations.

**Gain Using a Standard Reference Antenna**

If one has constructed an antenna of known directivity gain and wishes to determine the gain of an untried antenna design, the setup of **Fig. 1** can be used. The transmitter output power and received power are measured and the gain is calculated from the formula previously given, knowing the antenna separation and the operating frequency (using the untried antenna as either the transmitting or receiving antenna). For instance, if the reference antenna used is considered to have a gain of 1(0 db), the original formula can simply be restated as:

$$G=(4\pi\ D/\lambda)^2\ P_{received}/P_{transmitted}$$

Thus, if an antenna were tried on 2 meters at a distance of 10 meters and the power received were 1/10 of a watt for a 10 watt transmitter output, the gain would be:

$$G = (4\pi\ 10/2)^2\ \frac{1/10}{1/10} = 36 = 15.5\text{ db}$$

This gain is in reference to the gain of the reference antenna (a ½λ dipole, for instance).

In practice, however when one can move the antennas under test about easily, a much more simplified procedure is possible. The transmitter is connected to some available antenna. At a reasonable distance away, the standard or reference antenna is connected to a receiver. The transmitter power output and receiver gain are adjusted to produce some convenient reference level. The transmitter power output is noted. Then, the antenna under test is substituted for the reference antenna. The transmitter power output is readjusted to produce the same reference reading on the receiver. If the test antenna required only 1 watt of transmitter power to produce the same receiver reference level as when 10 watts were used with the reference antenna, the gain of the test antenna is simply 10 ÷ 1 or 10, which also happens to be 10 db. Remember that the numerical power ratio must be converted using a db power curve for db gain expression. Again, the antenna gains obtained by this method will all be referenced to the assumed unity gain (0 db) of the reference antenna.

**Gain of Two Identical Test Antennas**

Suppose that one had two identical antennas and did not know the gain of either nor had any reference antenna of known gain available. Surprisingly enough, the gain of the test antenna design can still be easily found. If the gain of both antennas in the test setup shown in **Fig. 1** is the same, the original gain formula is re-arranged in the form:

$$G=4\pi\ D/\lambda \qquad P_{received}/P_{transmitted}$$

The received power and transmitted power can be measured with some specific antenna separation and the formula will yield the gain of either antenna (as a numerical value, not in db). If the received power cannot be measured directly, the receiver can be used just to establish a reference level and the transmitter connected alternatively to one of the test antennas and then directly to the receiver to establish a power ratio that can be used in the formula.

The gain figure obtained from this procedure is mathematically related to a so-called isotropic antenna which radiates equally in all directions. A ½λ dipole antenna when used with this procedure should show a gain of slightly over 2 db—since it does concentrate its radiation broadside to the line of the antenna. Thus, if more complicated antennas are checked by this method the gain figure obtained must be reduced by 2 db if a comparison is desired with other antenna gain figures which use a ½λ dipole as a reference.

This procedure is frequently used to establish the gain of reference or standard antennas against which test antennas can be compared.

**Gain of Three Different Test Antennas**

Suppose that one had a group of three antennas none of which appear to have the same gain and no reference gain antenna is available to compare them against. By a variation of the previous procedure, the gain of all three antennas can still be established.

The antennas are arranged as shown in Fig. 2. The distances between them need not be equal but is assumed so to simplify this description. Using the basic transmission formula and when station 1 transmitts, the following formulas are obtained, each of which produces a simple number when the measured values are inserted.

$G_1 G_2 = (4\pi D/\lambda)^2 P_{rec. 2}/P_{trans. 1} = A$

$G_1 G_3 = (4\pi D/\lambda)^2 P_{rec. 3}/P_{trans. 1} = B$

Next station 2 transmits and the following relationship is determined:

$G_2 G_3 = (4\pi D/\lambda)^2 P_{rec. 3}/P_{trans. 2} = C$

Since three constants and three interrelated gains are concerned, the gain of each antenna can be found:

$G_1 = AB/C \quad G_2 = AC/B \quad G_3 = BC/A$

Again, the gains will be in numerical form and must be converted to db values. Also, the gains will be referenced to a theoretical isotropic antenna and must be reduced by 2 db for comparison to gains related to a ½λ dipole.

**Precautions**

The basic transmission formula used actually derives from optic equations, although it is the standard radio transmission formula. It

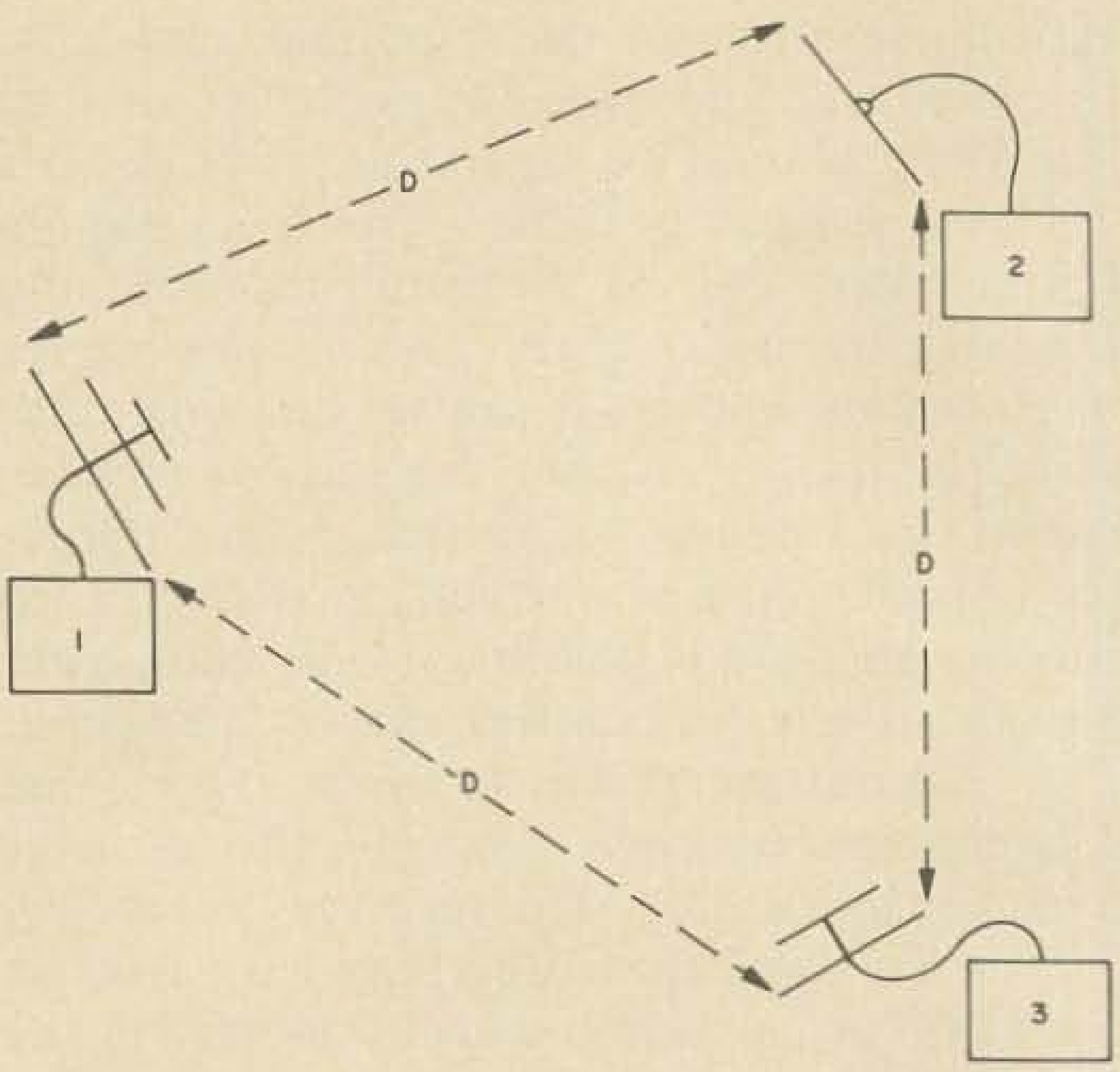


**Fig. 2.** As described in the text, the gain of three dissimilar antennas may each be found although the gain of none of the antennas is known. D, distance between antennas, need not be equal. The only requirement is that all the antennas have the same polarization.

does not take into account any other signals being present except the transmitted one in space. At high enough frequencies, this condition is reached with radio transmissions but at lower frequencies an antenna will receive noise signals as well as the desired signal. Therefore, allowance must be made, if possible, for the error caused by noise reception. If the received power levels are high compared to the received noise level, the noise effect may not be significant. At great distances and with low power levels meaningful results cannot be obtained.

Some other general precautions are:

1. Both antennas must be oriented for maximum signal before measurements are made. It can happen that maximum radiation does not coincide with the geometric center of an antenna.
2. The formula is based on line-of-sight transmission. Reflections, including those from inadequate antenna height, should be avoided.
3. The antennas must be separated sufficiently to produce a plane wave.
4. Correct impedance matches must exist throughout the transmitting and receiving terminals.
5. If the receiver is used as a power level indicating device, its gain must be reasonably stable or should be frequently checked. It must be operated in its linear range without overloading and with its avc off.

The use of a low power transmitter whose power output can be readily varied was assumed. A signal generator of sufficient output power can also be used. If one uses a method such that connection of the transmitter to the receiver for reference level setting is not necessary, a transmitter of fixed power output of any level can be used.

Summary

When commercial laboratories make gain measurements using some of the methods described they take elaborate precautions to avoid effects that will alter true gain readings. However, even with simple equipment—even the regular station transmitter and receiver in many cases—meaningful results can be obtained.

Even if one does not measure the gain of any antennas, the material in this article should give a better insight to many amateurs as to how the gain figure for an antenna is determined. Particularly, it should clarify how antenna gain is always related to some *reference*. Thus, unless one knows the reference, one can easily read good-sounding but not really useful gain figures for some antennas.

Finally, it should be appreciated that gain is *only* a numeric and not the only meaningful characteristic of an antenna, although too to gain figures. Other factors such as the vertical and horizontal radiation pattern forms, front-to-back ratio, impedance, bandwidth, etc. are just as important and, indeed, in some applications more significant for best communication than gain. ...W2EEY/1



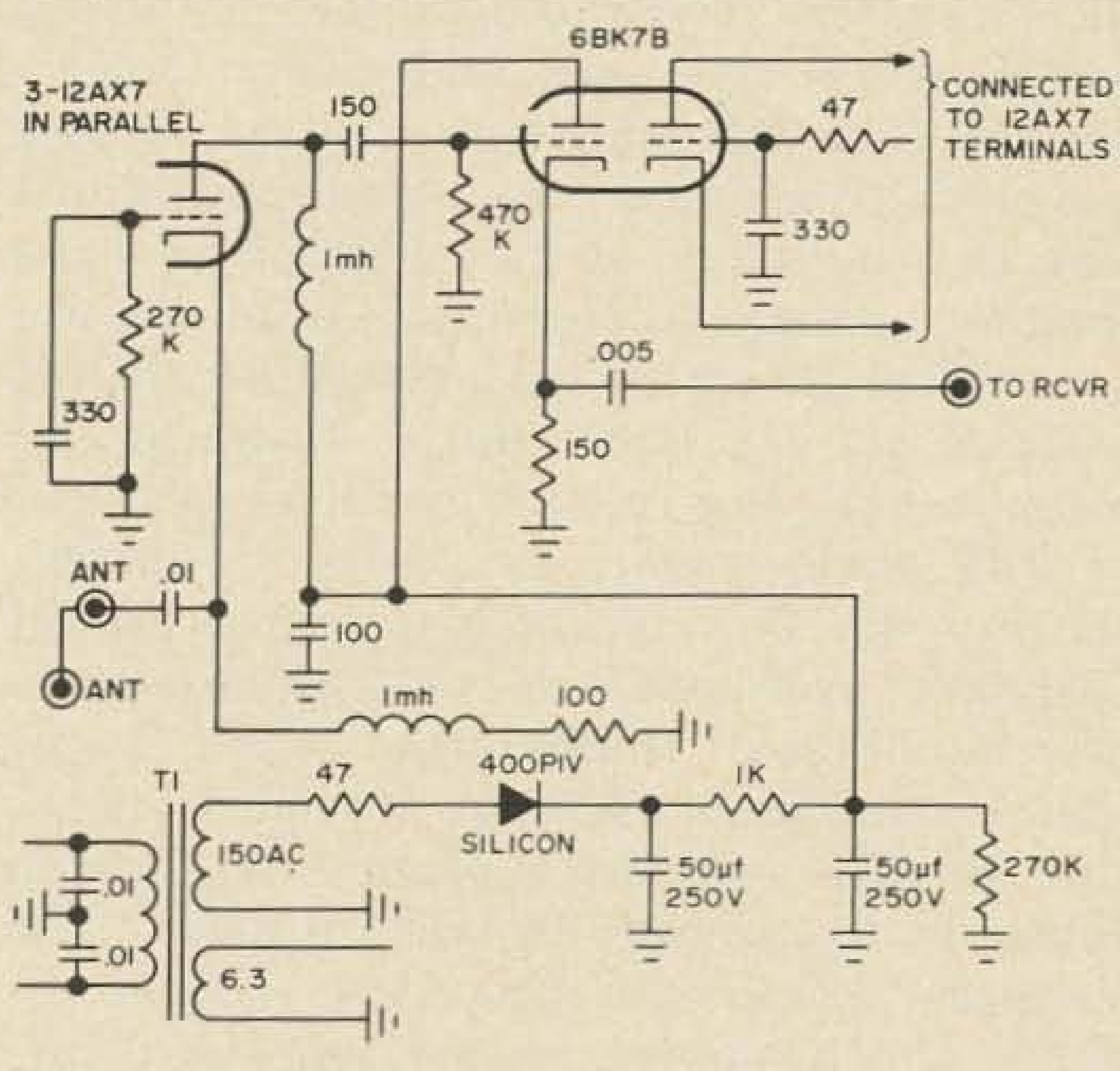


Fig. 1. A different TR Switch.

## A Different TR Switch

The TR Switch described in May 1963 *73 Magazine* on pages 12 and 14 has undergone a metamorphosis or change for the better. While in some areas of the country the grounded grid configuration will function well, it behooves the amateur in a metropolitan area, especially where there are several marine, coastal, point to point commercial stations operating, to use a different circuit. The *rf* chokes, especially the one in the cathode of the grounded grid tubes, have a self resonant frequency and lo and behold, commercial stations can be heard in the background. Weakly, but still there. No amount of decoupling will eliminate them. Different values of chokes can be used, but then a sacrifice in gain on the amateur frequencies results.

The most satisfactory circuitry tried to date uses a cascode *rf* stage lightly coupled to the transmission line, and a cathode follower output to match the receiver input impedance. A tube rectifier is used as an *rf* rectifier to provide dc voltage bias on transmit times. There is no time constant—it is instantaneous, for CW, in order for fast break-in. When using SSB, the bias holds long enough between syllables so that the receiver stays blocked as long as you keep talking. When receiving, the rectifier has no effect, unless a kw station next door fires up. In that case, he will create enough bias in the TR switch to prevent overload of the set. It will lower the gain of your receiver, but without this effect, you would have another kind of trouble. You would probably go to the other end of the band or change bands. It will be apparent to the experienced constructor that this unit can be used as a tuneable preselector merely by substituting the 1 mh $L_2$ *rf* choke with suitable tuned circuitry. M. C. Smith, W6GMC

# QRP - A New World to Conquer

*Arthur Child, W6TYP*
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Amateur radio has been getting more expensive and more complicated for those interested in building their own gear. It may come as a surprise to discover there are some hams who are finding ham radio simpler and more challenging. These unusual hams are the QRP operators, trying to use lower and lower powers to cover greater and greater ranges. For the QRP'ers a single transistor rates as a powerful transmitter, and communications may be maintained at power input levels so low they are hard to measure. Could you use your signal generator for a transmitter? If it is stable enough, yes! But it would be too complicated for a really convenient QRP rig.

QRP achievements are a real eye-opener. See **Fig. 1**. Powers much less than typical flashlight levels can achieve communication over hundreds or thousands of miles. Transmitter cost is small; there are no high voltages, and antenna systems typically range from Joysticks to carefully installed dipoles. The emphasis is on operating skill and on patience which gets you on the right frequency at the right time. At QRP levels you do not blast the opposition, you wait until he fades or quits. Or you learn to hear through him, and somewhere in there you become a real radio operator. In the QRP world the quality of the man is more important than the quality of the rig. The emphasis is on operating skill and patience. That is a refreshing change and this new perspective has proven reliably popular.

| QSO | Time | Freq. MHz | Mw Input | Range Miles | Mi./ W. eq. |
|---|---|---|---|---|---|
| W8UUJ/6, Cal. | 4 pm | 7.015 | 33 | 273 | 8,200 |
| WB2GFQ, N.J. | 12 pm | 7.142 | 50 | 2565 | 51,300 |
| W7OE, Wash. | 9 am | 7.015 | 100 | 680 | 6,800 |
| WA9DEU, Ill. | 7 pm | 7.015 | 500 | 1840 | 3,680 |
| WA8JXQ, Ohio | 8 pm | 7.142 | 500 | 2110 | 4,220 |

**All QSO's by calling CQ. None were arranged.**

**Fig. 1.** Log excerpts. Every one of these contacts is above the basic 1,000 miles per watt achievement that gets you going in QRP.

A world-wide organization of QRP'ers has developed. Membership is about 3,000 radio amateurs, living in 50 countries. It may be these people are the very best radio operators in the world, since they routinely try to achieve effective communication at power levels comparable to the *unwanted* emissions from much amateur gear and far below that from some commercial broadcast transmitters. And, they succeed, setting records of thousands of miles on milliwatts of power. For instance, you can talk from San Francisco, California to South River, New Jersey, on 50 milliwatts input. It's an established record.

Art Child, W6TYP, writes he has been trying to make contact with QRP'ers in Japan and ZL land. Some entries from his log appear in **Fig. 1**. Previous results indicate he'll succeed since he is using his big rig for this project. It runs 500 milliwatts. Some other of Art's achievements are a 2½ mile QSO on 12 microwatts for 200,000 miles per watt and a 354 mile QSO on 354 microwatts for one million miles per watt.

**QRP Recipe**

Interested? Find a good receiver, or make up something from scratch. A good possibility appears in the 3-tube superhet described in the October 1968 issue of 73 Magazine. Perhaps you could do something with the regenerative detector circuit appearing in the same issue. And while you're working over the receiver problem (which will probably cost more than anything else) get a letter off to the QRP Club's corresponding secretary for additional information on activities and memberships. That goes to F. Behrman, K7LNS, 3425 S.E. King Road, Milwaukee, Oregon.

Next step is a good antenna. There is plenty of information around about antenna design and construction, and QRP work simply makes quality more emphatically necessary. The difference from a normal antenna will appear in quality, rather than expense, and this is largely a matter of care and workmanship. Installing and tuning a really effective antenna will require some test gear, and recent issues of 73 Magazine can offer material to help you out. A simple antenna bridge may do more for you than an swr meter, since you may not have enough *rf* available to energize the meter. For many ideas see 73's special Antenna issue, May 1968.

As you get this set up you can think about your transmitter. Crystal control is preferred, so that once other QRP'ers know where your signal typically appears on their receiver dials, there will not be tuning questions with very weak signals. And you will appreciate the same reliability in their signals. On 40 meters the best frequencies are 7.015 or 7.142 MHz.

A typical circuit appears in **Fig. 2.** Few components could be pared out of this one. You will want to do some experimenting with this circuit, so start with a good high-frequency silicon or germanium transistor, use 1K ohms in the emitter circuit, and try 82K ohms in the base circuit. Place an mF as emitter by-pass, and a few picofarads in the base circuit to control feedback. C3 and L1 are tuned to the operating frequency and if L1 is a piece of Airdux, the antenna tap is easily moved up or down. Start with the tap close to ground, since antenna loading reduces *rf* available for feedback and at some point will cause poor keying. Listen to the signal on your receiver.

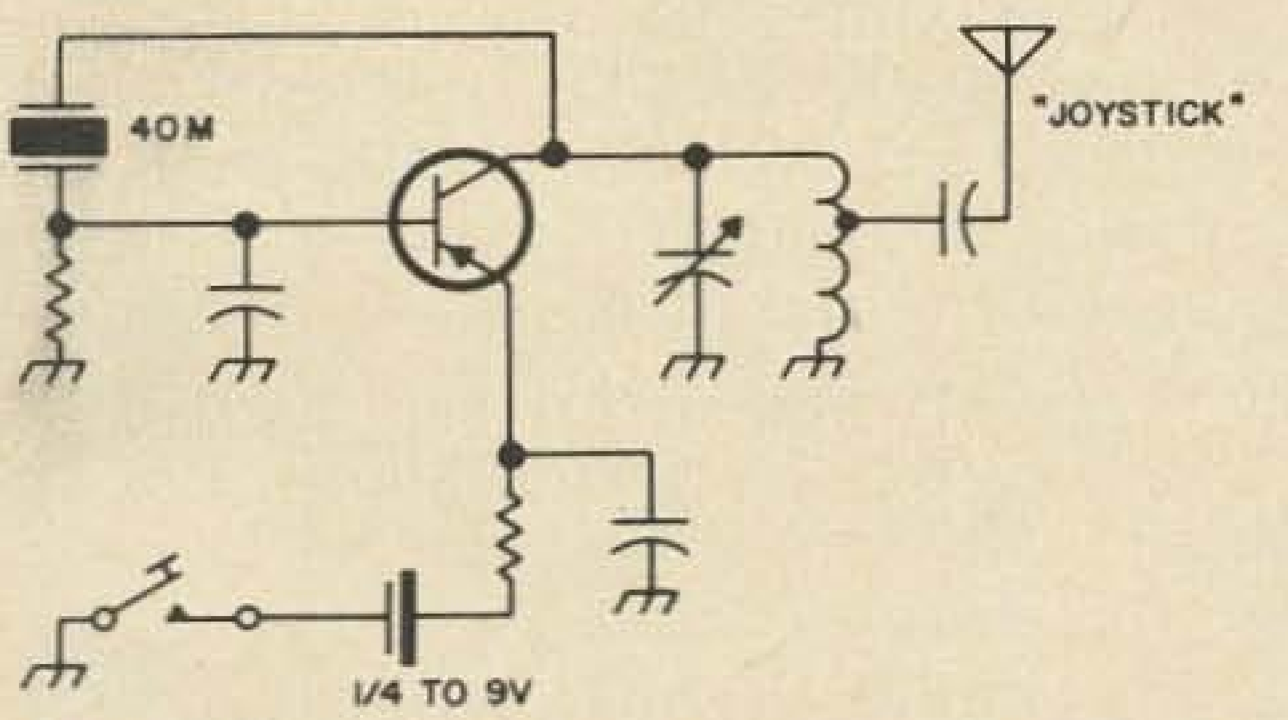


**Fig. 2.** This could be the simplest transmitter circuit ever published in 73 Magazine. Inexpensive, too. The "Joystick" antenna is in the same room, eliminating coupler, transmission line, etc., and tapping up the coil increases loading. When you can get out with this, you are learning to be a really good operator.

International's printed-circuit crystal oscillator can also do a nice job as a transmitter. The printed-circuit construction is very neat, and the kit sets you back $2.35 postpaid. See October issue of 73 again, page 5. The crystal runs another $3.75, specify the frequency. And another dollar should get the *rf* well started toward the antenna.

Finishing up the rig, you put a TR switch in the antenna system somewhere and you are in business. The transmitter frequency is located during tests by tuning the receiver to pick up the transmitter–you don't do this with a kilowatt! with key down. The receiver would probably not be harmed if you fed the transmitter's entire output into its front end and in some station setups you might have a little difficulty finding the transmitter signal, but a clip lead will help you out. Better be careful on principle, though, if your receiver has a solid-state front end.

Finally, start calling. It will take patience. After all, the air is full of high-power operators, some of whom tend to ignore signals under S9 or so. Yours will be one of these.

Soon you will learn to operate odd hours. Perhaps the honorable art of ragchewing will appeal to you, again. And you will wake up sometimes in the middle of the night thinking about a QSO, and why not? You are likely to become an early bird, early to bed and early to rise. This is said to offer valuable benefits unrelated to ham radio, and it also gives you a fantastically quiet band to operate in. The signals seem to sound different at this time of day, just before the sun is coming up. It is an experience you shouldn't miss.

**QRP Performance and Records**

Communications at QRP show a very strong dependence upon propagation conditions. On 40 meters, for instance, the best results are achieved late at night, as you might expect. But at QRP you cannot ignore the facts and vagaries of propagation conditions. They just jump right out at you, and you will soon become interested in the fluctuating conditions of the ham bands.

Once contact is made at, say, high power of 500 milliwatts then you can start ragchewing. QRP contacts, unlike DX contacts, may go on for extended periods as you and your contact crank down the power again and again, trying to achieve effective communication with the smallest transmitter power input.

When your log shows you can get a 1,000 miles per watt certificate from the QRP Club you are starting to achieve results. But the records are very much better than that, and recent work includes contacts on 40 meters ranging from 325 miles at noon to 2565 miles at 11:00 p.m., local time. On 50 milliwatts. That's better than 50,000 miles per watt. One million miles per watt is possible and has been achieved. Such records are unusual and definitely worth working for. Aside from the fact they offer an interesting challenge of the very best kind, you are sure to meet unusual and interesting people along the way. Don't miss the opportunity to enjoy QRP operation.

...W6TYP

# The Galaxy GT-550 Transceiver

Peter A. Lovelock, W6AJZ
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A decade or so ago transceivers came into being primarily for mobile application. Almost as an afterthought manufacturers made available AC power supplies for alternate fixed station use. Subsequent trends have caused transceivers to evolve in complexity (and size) to become complete, single package stations; some with an array of controls calculated to send a computer programmer into frenzied rapture. But have you ever tried to fit one of these integrated jobs under the dash of a Mustang? Or juggle a bank of knobs never designed for compatible freeway operation?

When Galaxy Electronics introduced their model III and V transceivers, it was obvious they had the mobile ham in mind as evidenced by functionally located controls, a tuning dial on the left side for optimum driver manipulation, and dimensions ideally suited to underdash installation. And a lot of fellows discovered that, with an outstanding receiver circuit and 300 watts PEP input, the Galaxys did an excellent job in the shack. Their feather weight and easy mobile mount made dual usage a snap.

The model V Mk 2, besides increasing input to 400 watts PEP, also added features for the CW operator such as sidetone, and plug-in options for semi-break in and a 300 Hz receiver filter. The V Mk 3 incorporated final tubes capable of 500 watts PEP.

Galaxy also developed a line of accessories for full fixed station flexibility with their transceivers, while retaining the inherent simplicity, desirable for mobiling, in the basic transceiver. This also permitted the buyer the choice of paying only for those features required for his particular mode of operation.

Having used a Galaxy V Mk 2, shared mobile and fixed, for a couple of years, I could testify to its performance, stability and rugged construction on the highway, while 108 countries and a lot of good CW work with an apartment trap vertical left little to be desired at home. With this experience, it was difficult to conceive that much room was left for improvement...that was, until at the recent SAROC convention, I witnessed the unveiling of the Galaxy GT-550.

Gone was the former, somewhat austere, front panel—to be replaced with contemporary styling guaranteed to gain living-room acceptance from the most discriminating XYL (mine). While keeping the same well-arranged controls, now with skirted knobs, a new single-scale, 500 kHz dial eliminates the second scale that formerly reversed frequency direction for tuning 20 meters. Now CW and phone segments have the same dial relationship on all bands—a pleasure for CW DX bandhoppers like me. The familiar two-speed tuning knob is supplanted by a massive, 2½" diameter, single speed knob with plastic insert finger spinner. The spinner permits traversing the entire 500 kHz range quicker, and more easily than the wrist switching action required with the old two speed control. The 72:1 ratio tuning is velvet smooth and the kingsize knob gives finger-tip precision with no discernable backlash, even when using my narrow bandwidth CW filter.

Black on white tuning and S-meter dials, indirectly lighted behind rectangular windows, make for easy reading and enhance the new styling.

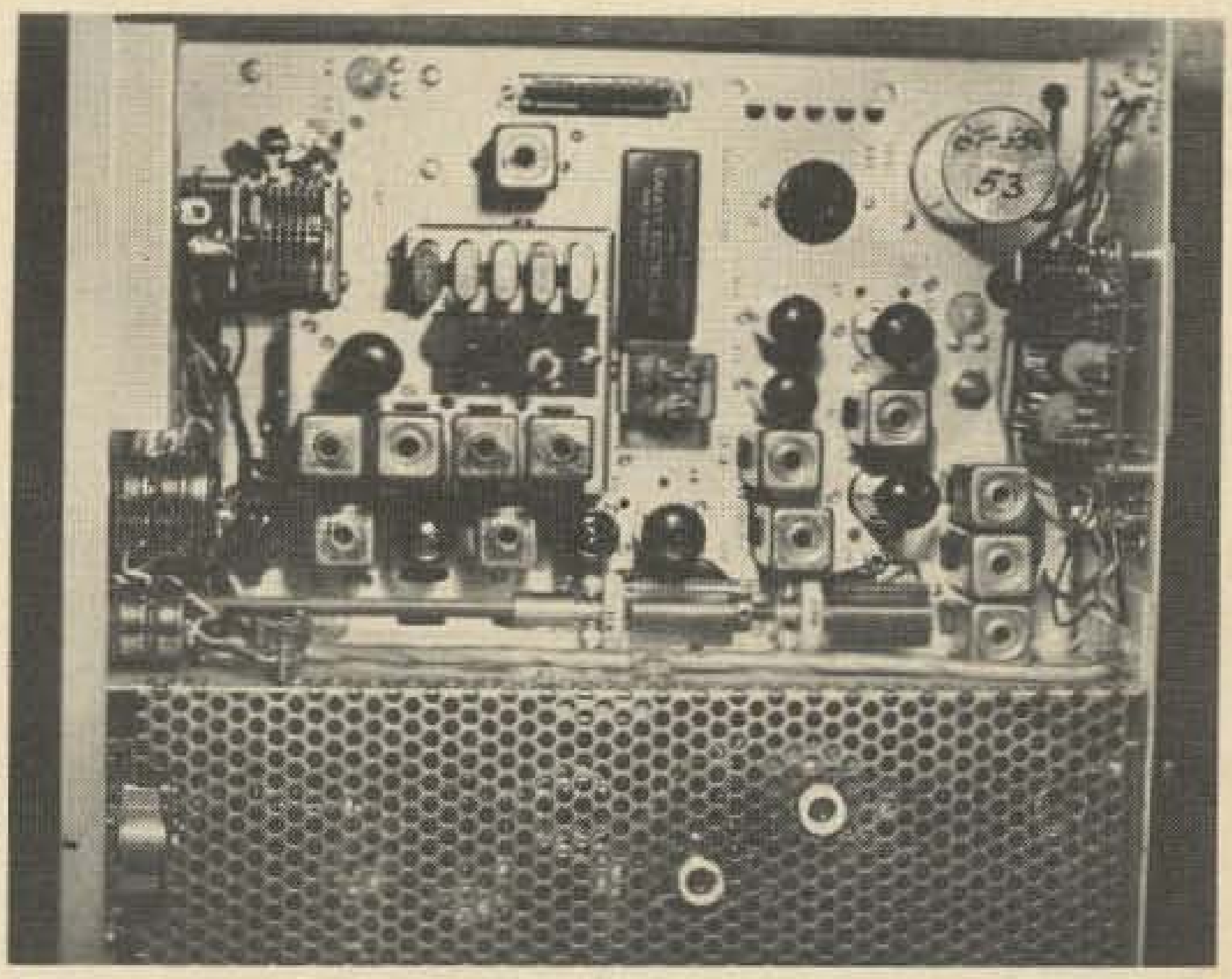
A study of the schematic proved that the GT-550 is based upon the tried and true circuitry developed through the earlier Galaxy series, with numerous significant improvements. The new parallel 6LB6 finals, together with a redesigned driver stage, provide improved linearity and ALC action for 550 watts PEP input. On CW the final operates at 360 watts input with reduced screen voltage for maximum tube life. As in previous Galaxys, the TUNE mode may also be used for CW operation, with input power continuously variable by the MIC/DRIVE control, from a fraction of 1 watt up to 250 watts.

Many circuit changes noted indicate continuing effort for peak performance in both receive and transmit modes. The already sensitive receiver circuit has been made even more so on the GT-550, as is particularly apparent on the ten meter band. This is where so many receivers show a drop-off in performance, but the GT-550 S+N/N ratio is extremely good. An added crystal for vfo hetrodyning has eliminated the need for that separate scale on 20 meters. Improved high and low voltage regulation includes provision for accurately adjusting the regulated 12 vdc used for the vfo, and also brought out to a rear panel jack for accessory operation. ALC control voltage is also brought to a rear jack for use with a linear amplifier, and is handy for plugging in a vtvm to observe where alc action begins relative to plate current peaks when setting the MIC gain control. Another added jack for the external vfo accessory, obviates running coax through a rear panel hole to a chassis jack, as in earlier Galaxy models.

Those operators who periodically check alignment to maintain top performance, will be glad to know that mechanical design of the GT-550 has made all alignment procedures possible from the chassis topside. No need to remove the bottom plate and balance the unit precariously on one side. In fact, the GT-550 can be completely aligned in its normal operating position by merely removing the top cover. Even RC 'swamp' circuits required for accurate adjustment of double tuned transformers, are built in. Just shorting a chassis test point to ground with a screwdriver swamps one winding while the other is being peaked. A vtvm chassis mounted test jack aids in alignment.

The bank of five band-hetrodyning crystals are mounted atop the chassis for accessibility—a convenience for operators wanting to substitute crystals for extended 10 meter or MARS frequencies.

The single piece top cover can be lifted



Interior view of the GT-550 Transceiver.

off, or slid back on the unit, for easy access by removing four screws. New design permits removing the final compartment shield without having to take off the bottom plate. The same basic dimensional configuration maintains the GT-550's adaptability to mobile or fixed installations, and the appearance is equally pleasing in both.

Like its predecessors, the GT-550 comes with an individual frequency drift calibration chart, as measured at the factory prior to shipment. Mine indicated a maximum warm-up drift of 140 Hz in the first 20 minutes, after which stability remained within a range of 10 Hz for the 40 minute balance of the test period. This degree of stability has been borne out in actual operation.

Checking the actual power output with a Waters Dummy Load Wattmeter Model 334, the following maximum readings were obtained when loaded according to instructions:

TUNE mode: 160 watts, CW mode: 280 watts.

SSB mode (1 kHz sinewave to MIC input): 400 watts.

The GT-550 can be powered either by the AC-400, a new heavy duty supply with switch selection for 115-230 vac, 50-60 Hz input, and solid state rectification; or the G1000DC supply for 12 vdc mobile installations.

All in all, the GT-550 offers a lot of transceiver at moderate price. Add plug-in options for the CW man, and a line of accessories including plug-in transistorized 25 kHz calibrator (for those new band limits); complimentary styled external VFO, 2 kw PEP Linear Amp., Hybrid Phone Patch with tape recorder facilities, speaker console that accommodates the AC-400 supply, and an RF Console that switch selects up to five antennas plus dummy load—with built-in forward/reflected wattmeter...and you have building blocks for a home station tailored to your needs, around a state-of-the-art transceiver ideally suited for mobiling.

**Technical Specifications**

**Frequency Coverage**—3.5-4.0; 7.0-7.5; 14.0-14.5; 21.0-21.5; 28.0-28.5; and 28.5-29.0 MHz with crystals supplied. Additional ten meter and MARS frequencies with accessory crystals.

**Dial Calibration**—5 kHz increments. 500 kHz range, with single linear scale—over 12 inches of bandspread. 72:1 ratio vernier tuning.

**Operation Modes**—Selectable USB-LSB, suppressed carrier. PTT or VOX (with optional accessory). Shifted carrier CW, manual or semi-break in (with vox accessory). Built in sidetone.

**Transmitter**—SSB input: 550 watts PEP. CW input: 360 watts. Carrier suppression -45 db. Unwanted sideband suppression, better than -55 db. Antenna load impedance, adjustable 40-100 ohms. Hi-Z microphone input for -50/60 db level.

**Receiver**—Sensitivity better than ½ μV for 10 db S+N/N ratio. Double action, fast attack delayed release, audio derived agc. Nominal 1 watt audio output to 8 ohm external speaker.

**General**—Crystal lattice filter on transmit and receive provides 2.1 kHz selectivity with 1.8:1 shape factor. Audio response 300-2, 400 Hz at -6 db points on receive and transmit. Dimensions approximately 7½" H x 11¼" W x 13-3/4" D. Weight approximately 13 lbs.

...W6AJZ

## DX QUIZ . . . Answers

Here are the answers to the quiz on page 38 Score five points for each correct answer. 75% is very good, 90% is unbelievable.

| | | | |
|---|---|---|---|
| Congo Republic | TN | Republic of Guinea | 7G1 |
| Republic of the Congo | 9Q5 | Uganda | 5X5 |
| Mali | TZ | Rwanda | 9X5 |
| Central African Republic | TL | Niger | 5U7 |
| Senegal | 6W8 | Tanzania | 5H3 |
| Cabindi | CR6 | Gabon | TR |
| Fernando Poo | EAØ | Spanish Guinea | EAØ |
| Zanzibar | VQ1 | Mauritania | 5T |
| Chad | TT | Lesotho | 7P8 |
| | | Mozambique | ZS9 |
| | | Botswana | CR7 |

## Novice Antenna

One of the problems the Novice has is the antenna. Many times it is a problem because of lack of knowledge, space or funds. Here is an 80 meter vertical which solves all the problems.

Most of the parts can be scrounged. You will need 17 feet 4 inches of ½" thin wall electrical conduit; a 5-foot piece of 2x2 inch lumber; a 4-foot length of tubing to use as a supporting mast; a coil, and some hardware.

Bolt the conduit to the 2x2, overlapping about 2 feet. The top of the loading coil (in this case Illumitronics #2010—#16 wire, 2½" diameter, 10 turns per inch) is bolted to the conduit and the bottom of the coil is bolted to the wood. The supporting mast is then bolted to the other end of the 2x2 and sunk into the ground. 50 ohm coax is used to feed this antenna. The shield of the coax is connected to the mast, and the center conductor is temporarily fitted with an alligator clip for ease in tapping the coil.

Using an swr indicator, tap the coil at the point where the lowest swr is found. In my case, this was about 23 turns. The swr was still about 2:1. To bring it down, cut two radials ¼ wavelength long and connect to the point where the coax shield is connected to the mast. The radials can be buried. Pruning the coax length will also help bring down the swr at the transmitter.

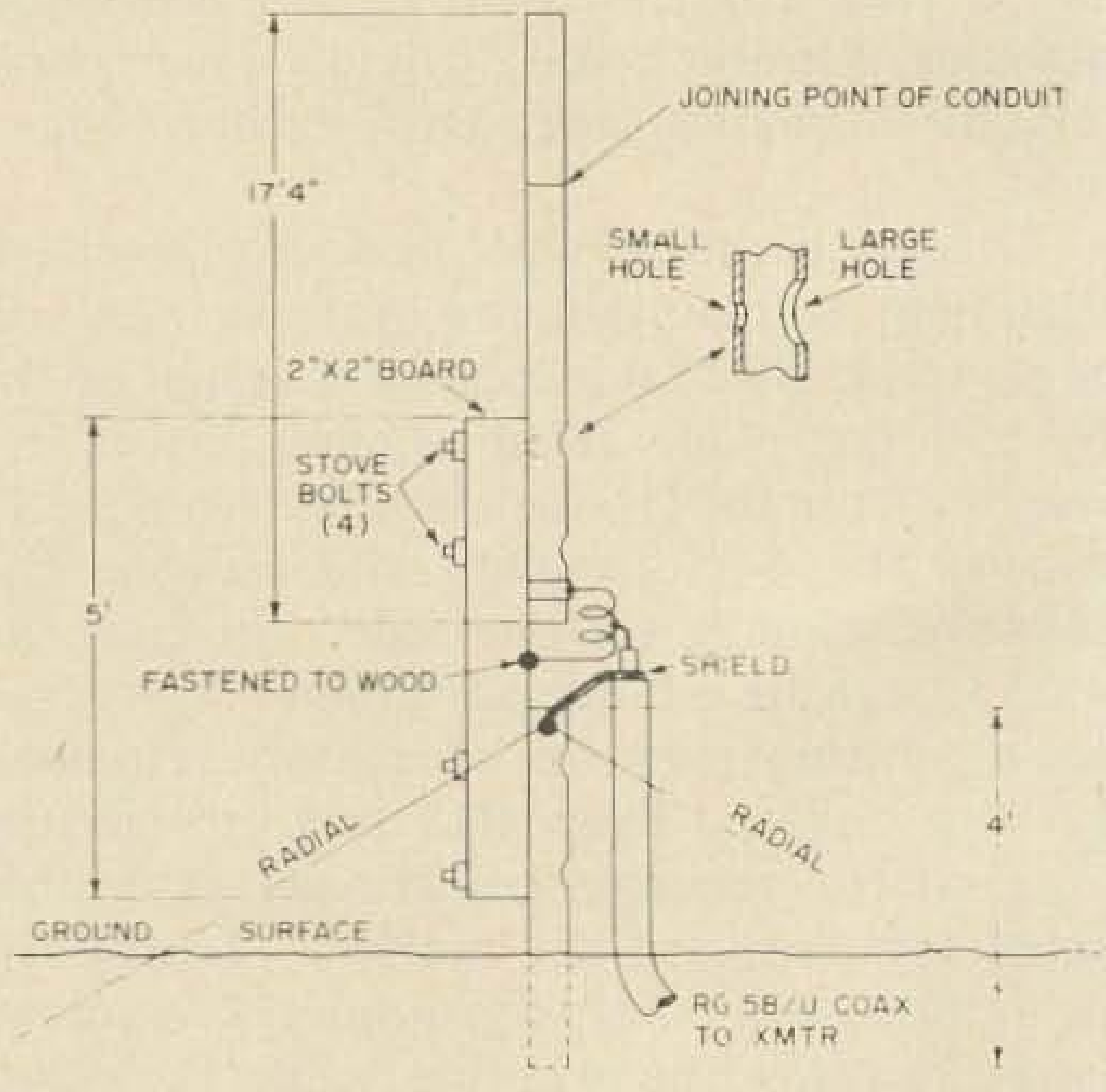



Fig. 1. Variable is mounted on the 1¼" TV mast.

Now that you are thoroughly confused, look at **Fig. 1** and you will see the arrangement.

**Wayne Jinske, WA9SSH**

# The Super SS

Clifford Klinert
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National City, Calif. 92050

*A Real Life True Adventure Story*

It is Saturday afternoon. I return home from work slightly tired, but refreshed in the thought of the weekend ahead. It doesn't happen often, and I really look forward to a little relaxation with my favorite hobby. I feel deep pride to be a member of the ARRL, the organization that arranges these contests. There is nothing I enjoy more than operating my station with the best of my speed and skill competing with others doing the same.

To the shack. Check it out. Twenty meter beam. Forty meter dipole. I turn on the transmitter. Oscillator. Drive. Plate tuning. 300 mils. Good. I turn on the receiver. Let's see who I clobbered. Nobody heard me. Good. Coffee. Pencils. Log. Paper. Clock. Check. Let's go.

I reach for the receiver dial, the hard black knob feels smooth in my fingers. Smoothly as velvet the pointer moves up the scale. The QRN ebbs and flows like waves on the beach, now softly sliding across the sand. Up through the noise pops a signal. I gently nudge the antenna trimmer until the rhythmic beat of a steady fist rings clear as a bell.

CQ SS. It's a VE. Must turn the rotor. Reach for the control. Click-click-click-uummmh. The lights dim. Pull the leads apart. No good. Pull the line cord.

Slightly despondent, I pace the few steps to the door and begin the painful ascent up the tower along the wall. With a mighty effort I pull myself to the roof. The sun is down now and a light mist hangs over the city softly filtering the strange glow from the mercury vapor lights on the street. Above arches the twenty meter beam like a parasol with its elements reaching into the darkness. Thin wisps of smoke curl from the bottom of the rotor, almost masked by the veil of the fog.

Up the tower. Good thing it's strong. Welded it myself. Know it's right. At the top. I wrap my legs around the tower and grip the boom. Pull. Harder. Gears frozen. Pull harder. Crack! Small piece of tower hits the roof. Hold tight to boom. Boom bending. Crack again. Here comes the rotator. Metal fatigue. Gotta work on that. Falling. Here comes a guy wire. Rotator catches. Hanging on. Snap! Cheap guy wire. Buy it new next time. Here comes top of tower.

Almost gently the top of the tower rotates downward, bending at the center and picking up speed. Now, nearing the roof, I hold tightly and watch its sickening descent. The top of the tower shears off the corner of the roof like a knife slicing butter. Now I carefully make my way down the remains of the tower, nothing but a grotesque tangle of twisted metal.

Wow! Splinters and roofing. Down to the ground. Forty meter dipole still OK. Shack OK inside. Only slight hole in roof. Bandswitch. I call CQ SS. Plate meter pins. Lights dim. Final's shorted. Power switch. Reach inside. Pull shielding off finals. It hit me. Wall falling away. Floor hits me. Everything black. Feel. Hard floor. Still alive. Reach for drawer. Flashlight.

The small sharp beam of the flashlight questioningly probes the darkness, tracing a cloud of thick grey smoke. I carefully sort through the tangle of wires and unplug the transmitter. Painfully, I limp outside and recycle the circuit breaker. I force myself back and view the damage. The power switch is welded on by the high current. The silicon diodes, now completely ruined, are blisteringly hot. Now the receiver once again warms up and returns to life.

QRN. On my frequency. Now calling me. A ZL. Pretty good signal. I grasp the receiver with both hands. Wires breaking off. Over my head. Heavy. Push hard. Across the room. Into the wall. Plaster and wood splinters. Wow! Tear up ARRL certificate. On the floor.

Once again I make the trip across the room. I move more slowly now with the seething forces inside me subsiding. I gently pull the light switch and close the door. I stroll toward the house carefully stepping over an object in the path. Some smoke still diffuses through the hole in the wall into the still purity of the night. The sky is now perfectly clear with the stars flashing like gold sequins on black velvet.

Quiet. To the house. Open the door. Wife. Still awake waiting. Arms around my neck. Soft. She speaks.

"Have a good contest?"

Yes. ...WB6BIH

# *A Novel Approach to Feeding and Tuning the Three-Band Boomless Quad*

*W. E. Rabenhorst, WA4VWY*
*1715 29th Avenue*
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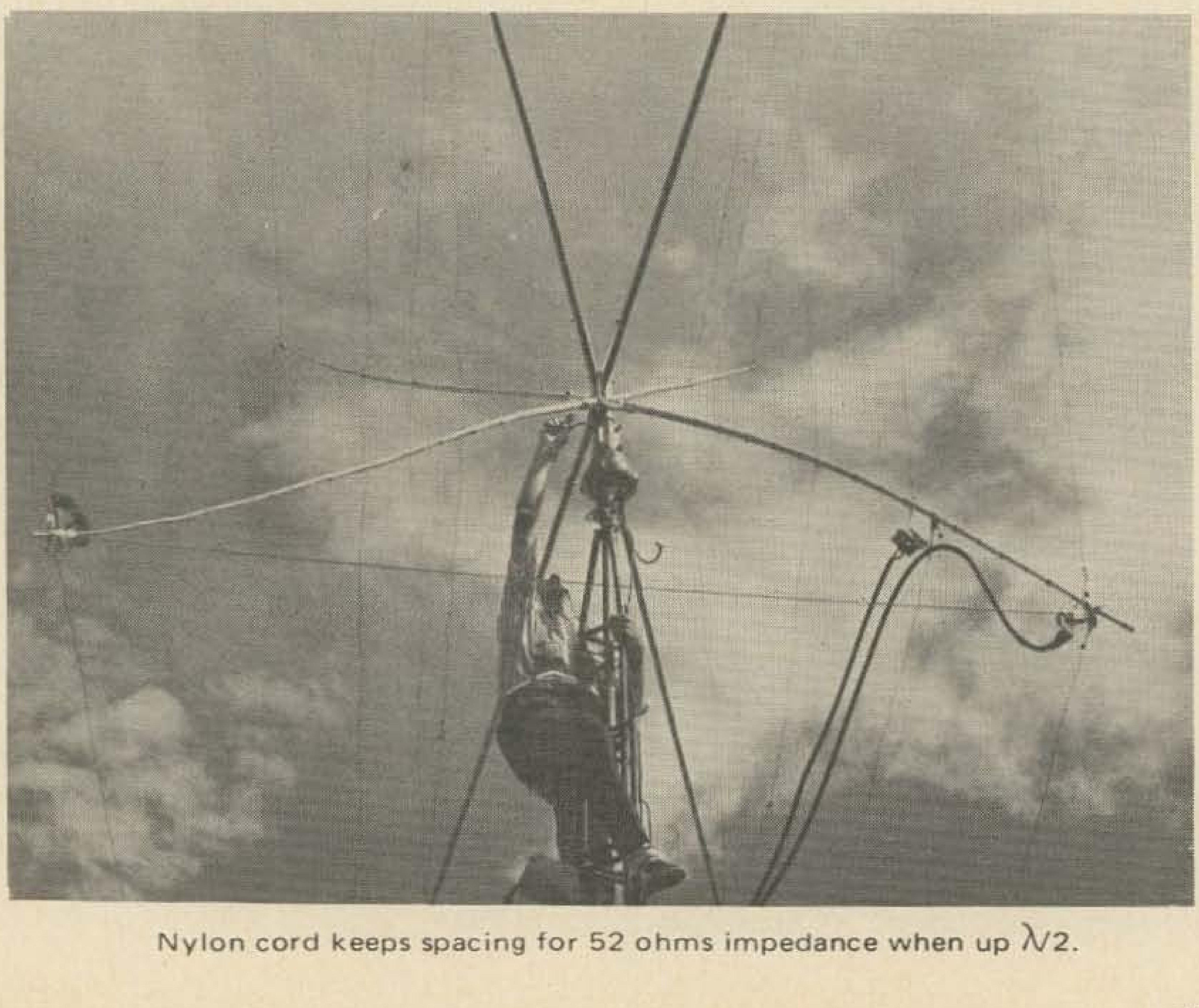
*Member of the Bar,*
*U.S. Supreme Court*

Although I learned two codes at age 13, one of 13 children on a farm in Wisconsin, and received my discharge from the Signal Corps in Washington, D. C., in November 1912, I did not obtain my General license until March 1948 and my Class A in March 1950.

One day I worked W3JXH in nearby Maryland and was invited to drive the few miles to see a quad antenna, my first. It turned out to be a 10-15 two-element all-metal job and only a few feet above ground, surrounded by buildings and overhanging trees, and enclosed inside a high steel fence. The owner claimed fine dx contacts.

I then went about building a 15-meter all-metal quad with both elements grounded on the upper boom. Although this quad had excellent F/B ratio, the band remained dead for several days, so the 15-meter job was taken down and a 20-meter quad of similar type built to take its place. It was initially fed at only four feet three inches from the ground. The first contact was with K3UIG, a "Government Employee" nine miles across town. The QSL which arrived two days later bore the name Barry Goldwater, with a beautiful color photo of the Nation's Capitol building. Other contacts were mostly beyond the Mississippi River and Central America and, when the band was either just opening or closing, generally quad-antenna stations answered. Diamond-shape quads are said to have a lower angle of radiation. Before leaving Washington, D. C., I gave this quad to W3YAE.

After arriving in Florida I decided to experiment with quads of the more conventional square, all wire type. Twelve different quads were built and torn down – boom, short boom and boomless. No. 13, the



Nylon cord keeps spacing for 52 ohms impedance when up $\lambda/2$.

present one, a boomless quad, was designed by W4TZ, across town, who had two composite aluminum spiders electrically welded, one of which was assembled and erected on the tower by me (age 76) without any help and without use of a safety belt. The decision not to use the safety belt loaned by W4TZ may sound a bit queer. Some 65 or 70 years ago a group at a Wisconsin family reunion witnessed a dog attempting to scale a picket gate, as he had done many times before. He caught the ring of his collar on a picket and hung there helplessly. Hanging by a safety belt, should my foot slip, might temporarily knock the breath out of an old man! However, I strongly recommend the use of safety belt, especially to you younger fellows with still many years ahead of you.

The accompanying photo shows the composite spider to have an aluminum plate at the center with eight short aluminum radials electrically welded thereto at an angle so that the spacing between the 20-meter driven element and its reflector is 6 feet 10 inches, with a corresponding lesser spacing for the 15- and 10-meter elements. This spacing, with the reflector properly tuned at a sufficient height above ground, resulted in a unity SWR when fed with RG/8-U or RG/58-U. The Quad handbook says that if the quad is below a certain height the impedance drops to one-half.

Square quads are normally fed at the center of the lower horizontal wire of the driven element. Since dipoles fed at the center are said to be a reasonably good match for 72-ohm feeders, and an inverted "V" having a 90-degree angle is said to be a good match for 52-ohm RG/8-U, I chose to feed my square, boomless quad at one lower corner for the following additional reasons: 1) the feeder may be fastened to the radial, thereby lessening sway in wind; 2) no need to pull the center of the driven element upward, out of shape and out of true with the reflector; and 3) it seemed to be more convenient to attach the SWR bridge at this point during tuning procedure. Believe it or not, it worked!

Fig. 1 shows construction of tuning coil at the corresponding (but opposite) corner of the reflector. Note the absence of long tuning "stubs" in the photo, which not only distort the plane at the current node, but also tend to affect the adjacent bands. The tuning coil was formed by winding antenna wire on a 7/8-inch dowel and, when released, forms approximately a one-inch diameter

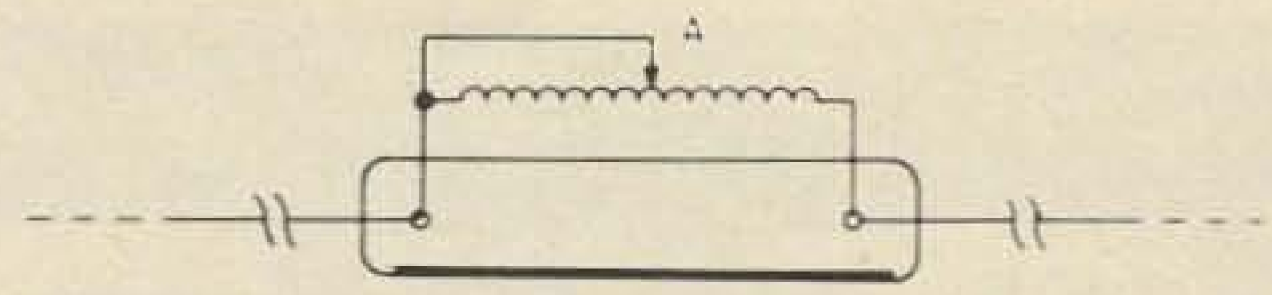



Fig. 1. Tuning Coil. When SWR bridge approaches unit, the clip A is removed and the short lead soldered to the turn. A change in capacity and configuration of coil might affect SWR if the shorted portion of coil were to be removed, more so, on 10 meters than on 20 and 15. Less turns are needed on 15 and 10 meters.

coil. This coil was then spread slightly and fastened to the ends of a somewhat shorter, thin insulator so that the outer edges of the turns are spread sufficiently to permit clipping a short piece of wire to a single turn without shorting an adjacent turn. Although less turns are needed for 20 meters, I started with a 26-turn coil because of the length of the insulator on hand and made the initial tap at the center turn, thereby shorting out one half of the coil.

Tuning was accomplished with a low power SWR bridge at the feed point where it could be clearly read at that short distance, and at a time when the band appeared to be dead or "out" so as to reduce chances of interference. Remember, I had no assistance and had to ascend and descend the ladder and tower (more than once!) to accomplish the tuning. A short piece of vinyl from the coax had previously been slipped over the clip to prevent *rf* burn when changing taps on coil. The coil being at the radial, it was easy to steady it during the tuning process by grasping the radial with the other hand. It was only necessary to go a turn or two either side of the original tap to arrive at the desired swr. The clip was then removed and the wire soldered in place, a 50-foot extension cord having furnished the required power for soldering gun. After removing the bridge and replacing it near the rig, it was only necessary to make a two-foot change in the feeder length to secure a like SWR reading of 1 to 1 at that location.

I used a 3-cent, home-made balun, following the general instructions for a 1 to 1 balun in August 1964 QST. The core is about 2 inches of ferrite obtained from a discarded BC loopstick, and wound with the necessary turns of No. 16 copper enamelled wire. It is not sealed, but merely taped. Weather? Reports from contacts do not materially differ, whether during dry weather or rain.

W4TZ uses a common feeder for the three bands, and a quarter-wave sleeve balun at each of the respective feed points, and the other ends of the quarter wave fastened to the common feeder. His watt-meter shows remarkably satisfactory swr.

Incidentally, either bamboo poles or fiber-glass radials may be slipped into the short, slotted aluminum arms of the spider and a non-skid hose clamp secures the radial.

The width of the tower shown in the photo was such that only one foot could be placed at a time on any cross-member. The other leg and one arm were draped around the tower during the erection of the quad, and the free hand was used to put the thing in place. The necessary tools had previously been placed in accessible pockets. The tower was not of the tilt type.

If an old man can assemble, erect and tune this boomless three-band quad without assistance, you younger fellers should be able to obtain similar satisfactory results.

Recently a station reported an S-8 signal off the back of the quad, but 20 over S-9 from the front. Not bad!

It is understood that fiber-glass radials now come in four-foot sections whose ends slip readily into each other, and are mailable by parcel post. At this point it may be of interest that I and my supervisor inaugurated the Parcel Post System in 1913 after trials at Chicago, St. Louis and New York to obtain size, weight and cost data.

If and when I can secure an aluminum welder (electric), I may be able to furnish this composite spider (and radials). That, however, was not the intended goal when this No. 13 boomless quad was designed.

Acknowledgement is hereby made to W4TZ for his assistance in designing the angle of the spider and having the first two prototypes made; also to C. D. Bently for photograph.

. . . WA4VWY

### Mosley 80M Dipole Kit

The DIV-80 Dipole antenna is a complete package designed as a regular or inverted vee dipole for 80–10M. It is rated at 2 KW PEP or 1 KW on AM or CW. The Kit includes 140' of Copperweld wire, a Mosley Dipole Connector (DPC-1) and two ceramic end insulators. The Kit includes simple instructions for pruning the antenna to the corect length for the part of the band in which operation is desired. It might be worth a mention that many stations using inverted vee antennas on 80 meters are working DX with ease.

# *To Patch or Not To Patch*

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For 20 years, hams have argued about phone patches. After a generation of discussion, the matter is about to be settled. The phone patch may become another "standard" appliance in the ham shack. But not without some trials and tribulations.

The idea of the phone patch is almost as old as the radio and the telephone. Military services have used "radio-wire integration," and the phone companies have long distance radio links. Telephones in private automobiles are obviously phone patches. Amateur equipment has included phone patches for years, too. A number of respected companies make them, and articles have appeared from time to time in CQ and 73 magazines. Why, then, is there so much confusion? The problems and arguments start with the "tariffs" filed by the telephone companies. For most practical purposes, a tariff can be considered as a law. Almost every telephone book prints a tariff which bothers the amateur with a phone patch—"No equipment, apparatus, circuit or device not furnished by the telephone company shall be attached to or connected with the facilities furnished by the telephone company...." The arguments caused by this tariff are shown by the attitudes of the amateur radio magazines and the ARRL. CQ magazine has continued to print phone patch articles. 73 magazine has been rejecting articles until a decision is made by FCC. And the ARRL has maintained the opinion that all phone patches are illegal. There is no mention of phone patches in "The Radio Amateur's Handbook," and the only mention of telephones warns the amateur to contact the telephone company if telephone interference occurs.

The official attitude of the telephone companies has been that phone patches were not legal. As a practical matter, though, "Mother Bell" has realized that amateur use of phone patches actually increases telephone traffic. Of course, there were objections if the amateur tried to connect his own extension phone in the shack and to install the wiring himself (thus avoiding extension phone charges). Poorly designed or operated patches have sometimes (though seldom) brought a knock on the door. But as a practical matter, the ham who asks the phone company to install an extension phone in the ham shack has usually found that the phone installer is quite willing to assist in hooking up the phone patch. At least, that way, it is done correctly. The fact is that hams have rarely (if ever) been prosecuted for operating a good phone patch.

The possibility has always existed, though, that the amateur might be doing something illegal. This possibility has resulted in a great reluctance to use phone patches. Some recent decisions of the FCC may change the tariffs, and could result in expanded use of the phone patch.

The FCC can, if it wishes, review telephone company tariffs and set aside those tariffs it does not approve. In 1956, the FCC's "Hush-A-Phone" decision caused a clarification of tariffs to allow use of devices which are not electrically connected to the phone. The legal wording of the decision caused many lawyers to feel that amateur phone patches would also be considered legal, although they are usually connected to the phone lines. After 12 years, in June, 1968, the FCC has clarified its position in a decision on the "Carterfone" case. The most significant portions of the FCC opinion are printed below.

> We hold that the tariff is unreasonable in that it prohibits the use of inter-connecting devices which do not adversely affect the telephone system....Our conclusion here is that a customer desiring to use an inter-connecting device to improve the utility to him of both the telephone system and a private radio system should be able to do so so long as the inter-connection does not adversely affect the telephone company's operations or the telephone system's utility for others. A Tariff which prevents this is unreasonable....We are not holding that the telephone companies may not prevent the use of devices which actually cause harm or that they may not set up reasonable standards to be met by inter-connection devices. These remedies are appropriate. We believe they are also adequate to fully protect the system.

The opinion set aside the tariffs preventing connections to the telephone system, and declared that they "are and have since their inception been unreasonable, unlawful, and unreasonably discriminatory..." The "Carterfone" decision, then, declares that phone patches are (and have always been) legal, if they do not harm the telephone equipment.

This decision, and tariffs effective January 1, 1969, (more on this later) have caused the ARRL to change its mind and allow phone patches as "legal" traffic. But, as might be expected, the telephone company does not appreciate the FCC decision. "Mother Bell" will lose a lot of money if customers go elsewhere for Teletype interface, facsimile, and data transmission equipment. The telephone company has appealed the decision–or at least a part of it–in a New York appeals court. This action is mostly intended to prevent suits by Carter and others, and doesn't appear to be intended to overturn the entire FCC decision.

It seems that AT&T intends to get the most mileage from the part of the FCC decision which says "We are not holding that the telephone companies may not prevent the use of devices which actually cause harm or...set up reasonable standards to be met..." Under this part of the decision, AT&T *could* file a tariff requiring inspection and approval of any connected device (including phone patches) by the local telephone company. This procedure has been in effect for some time to allow customer use of the customer's own telephone instrument as an extension. Inspection of the extra or "decorator" phones often costs $10 or more. Checking a phone patch would probably cost so much, or take so much paperwork, that the average ham wouldn't bother.

The move which prompted ARRL's acceptance of phone patches was the AT&T tariff (FCC) Number 263, which was effective January 1, 1969. This tariff has, in turn, been "reproduced" by the telephone operating companies and filed with state regulating agencies. The provisions quoted below are from Mountain States Telephone and Telegraph Co. General Exchange Tariff for New Mexico, Section 17, Part 12, effective January 6, 1969. The FCC tariff, and other local tariffs, are almost identical.

> Connection with customer-provided Equipment and Facilities....Certain customer-provided voice transmitting and/or receiving terminal equipment may be connected to the Exchange and Long Distance Message Telecommunications networks at the regulations, rates, and charges specified herein. ...May be connected through a Telephone Company network control signaling unit at the following rates and charges: Connecting arrangement, for connection of customer-provided voice transmitting and/or receiving equipment (including switchhook control key), each (QKT) $ .50 monthly. Maintenance service call resulting from customer-provided equipment, each $10.

This "QKT" connecting arrangement is rather simple. The "network control signaling unit" is a slightly-modified telephone instrument. A special switchhook key is provided. One of the buttons in the telephone cradle may be lifted and locked into place, which will cut out the telephone transmitter element and switch in a special set of coils hooked to the "QKT" jack.

The Electronic Industries Association has called the "network control signaling unit" provision of the tariff "common carrier featherbedding." The provision means that the customer cannot provide his own means of dialing, impedance matching, or answering of calls. While this provision will not bother most hams, some of us like to provide our own dialing arrangements. In addition, no matter how good your patch is technically, *even if it is better than telephone company equipment* (and many are), the company won't trust it.

The 50 cent monthly charge seems reasonable, although it does add up to $6 a year. Of course, a one-time installation charge is added (about $6.50), as well as the monthly cost for the extension phone if the one in the shack isn't the only one in the house.

The "maintenance service call" provision of the tariff means that any trouble caused by your phone patch will cost you $10. If you complain about your telephone service, and the cause is really your patch, it's your $10. If it's the fault of the telephone company, there is no charge. And, of course, if your patch causes problems which bring an unasked-for knock at the door, this will also cost you.

The "QKT" jack provides access to a 900-ohm matching coil within the telephone. For phone-patch purposes, you can treat this just like a telephone line, except that you cannot use it for dialing, and you cannot "answer" or "hang up" using this line. The 900-ohm figure probably comes as a surprise to you, as it did to me. For years, we have been thinking that line impedance was 600 ohms, and carefully designing our patches to work into that figure. The old, open-wire telephone lines *were* 600 ohms. It came as a great shock to me to learn that almost every subscriber line in the United States now has a nominal 900-ohm impedance. This fact will probably be a surprise to most phone patch manufacturers, also. However, the 600-ohm equipment has worked well in the past.

There are other restrictions on what you can feed to the jack supplied by the telephone company.

> ...Power of the signal at the central office (must) not exceed 12 db below 1 milliwatt averaged over any 3 second interval....The power of the signal which may be applied by the customer-provided equipment to the Telephone Company interface located on the customer's premises will be specified for each type of connecting arrangement but in no case shall it exceed one milliwatt.

In other words, you are not allowed to over-drive the telephone company lines. This is a reasonable provision, and should be the basis for providing a meter on your phone patch, although most patches don't have meters. It is not too likely that your patch will provide more than a legal signal. If it does, the "network control signaling unit" has *some* built-in compensation. Of course, the telephone company *could* specify an unreasonably low input level. Line loss can be as high as 10 db. Be suspicious in this area, but don't leave yourself open to that $10 charge.

> The power in the band 3995 to 4005 Hertz shall be at least 18 db below the limit (that is, 18 db below the 12 db below 1 milliwatt at the central office)....The power in the band 4,000 Hertz to 10,000 Hertz shall not exceed 16 db below 1 milliwatt....10,000 Hertz to 25,000 Hertz–24 db below... 25,000 Hertz to 40,000 Hertz–36 db below ...above 40,000 Hertz–50 db below...

These figures give the "low-pass" filter requirements which your phone patch must meet. They should not cause any difficulty.

> To prevent interruption...(the) signal (will) at no time have energy solely in the 2450 to 2750 Hertz band. If signal power is in (the) band, it must not exceed the power present at the same time in the 800 to 2450 Hertz band.

This rather simple restriction is the reason for the occasional unexplained disconnection of an apparently-good phone-patch circuit. The telephone companies use special signals in the 2450-2750 band which are the equivalent of a "hang up" command, and the call is cut off. An occasional hetrodyne at the wrong frequency can cause this problem, but there is not much you can do about it.

**Other Methods**

There is one other way to accomplish a phone patch, and it can be done at a saving. Section 20 of the tariff provides restrictions on "Inductive or Acoustic Coupline," which can be used *without charge.* I suspect that there will be quite a bit of amateur development effort toward developing inductive or acoustic phone patches. The restrictions are as follows: "...Network control signaling shall be performed by equipment furnished, installed, and maintained by the Telephone Company.

In other words, you have to have a telephone. No fair just inductively coupling the patch to the telephone company lines. "...Connection is made externally to a Telephone Company network control signaling unit."

You can't put part of the patch inside the telephone. The inductive coupler or acoustic arrangement must be outside the phone.

> ...Equipment must comply with the following minimum network protection criteria: ...The power of the signal which is applied by the customer-provided equipment to the network control signaling unit located on the customer's premises be limited so that the signal power at the output of the network control signaling unit (i.e. at the input to the telephone company line) does not exceed 9 db below 1 milliwatt when averaged over any three second interval....(and)....(frequency/power limits).

Notice that the signal power restriction is 9 db below 1 mw *at the line input,* rather than at the central office. If your line happens to be among the worst, your signal could be 19 db down at the central office, rather than the 12 db allowed for an electrically (QKT) connected system. This is rather restrictive, and again industry has objected. The frequency/power limits are the same as listed before, except that they are referred to the minus 9 db figure.

**Now What?**

With phone patches now legal, the amateur "fraternity" should take some positive action. Each of us with a phone patch must make sure that the patch is operated properly and that it is not harming the telephone equipment.

Since a tariff now exists for customer-provided equipment, the telephone companies can no longer turn a blind eye on phone patches. The cost is really very reasonable, and the peace of mind is worth it. Call the local company and get "legal" yourself.

Since the ARRL now recognizes phone patches, we should urge the ARRL and any other interested amateur groups to present the amateur views on this subject to the FCC and the state regulating agencies. I feel that a well-designed phone patch should not be subjected to the additional restrictions of a "network control signaling unit," and should be allowed to provide dialing, answering, and control functions if properly constructed. If you support this view, write the ARRL. The FCC sometimes listens to the voice of amateur radio. Possibly, a good quality phone patch could be used as a supporting exhibit. In any case, make your opinions known.

The phone patch is a useful piece of equipment, and now it's legal. Let's keep it that way.

...W5LHG

## Will Amateur Radio Win the Technology Race?

Ham radio is becoming extremely technical, what with SSB, VHF, UHF, SHF, Moonbounce, Pulse, Masers, Lasers, etc. Unless the convictions of most amateur radio operators change drastically, technology may destroy ham radio.

As an 18-year old electronics engineering student, I have been observing the more experienced operators above the age of thirty, most of whom have become content to possess their general license and just chew the rag. Few will admit their stagnation, but only a handful of "go-getters" are advancing ham radio technically. And even fewer are keeping up with the advancement. Many SSB operators really do not even understand the technique of SSB generation!

Just take a look at the bands above 50 MHz. Only on the frequencies where commercial equipment is available are there any large-scale operations. The majority of ham radio is not willing to explore the upper region, either due to lack of knowledge or lack of initiative.

Now I am not professing to be an electronics genius, but I am not content to pass the test and take a rest! After four to eight years of college, I plan extensive study of radio technology, far beyond what is expected of the average ham.

What I am advocating, however, is not for all amateurs to study college courses. This is too much to expect. But at least be able to understand your present rig. Try to keep pace with the moderate theory. Maybe, if you keep active, both on electronics theory and on the air, you'll be a better ham. Remember, amateur radio is not CB. We are supposed to lead in technology and experimentation, not follow.

Roy C. Pollitt, WA3IID

# *A Direct-Reading SWR Indicator*

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The direct reading swr indicator.

The device described here was conceived as a result of my somewhat frustrating experience in tuning an antenna matching circuit. The procedure usually recommended goes something like the following:

1. Tune up the transmitter into a dummy load of the proper impedance.

2. Remove the dummy load and connect the antenna matching unit to the transmitter through the SWR bridge.

3. With SWR bridge set to forward (FWD) position and transmitter energized, set the meter pointer to full scale.

4. Switch the SWR bridge to reflected (REF) position, and adjust antenna matching unit for minimum reading on the meter.

This sounds simple enough, but all too often the REF reading is decreasing because the transmitter output is decreasing as a result of mismatch. To guard against such a condition after an adjustment is made, the SWR bridge must be set to FWD, the meter adjusted to full scale, and the SWR bridge again switched to REF. Hopefully, the SWR has been decreased, but this is not always the case. What is involved, then, is a repetitive cycle of setting the meter to full scale in the FWD position, switching the bridge to REF, making an adjustment to decrease the reading, and then checking the result. This can get pretty frustrating after a while. There should be an easier way, and there is.

What is needed is a way to compare the forward and reflected readings continuously while making the adjustments to the matching unit. Of course this could be done by using two meters to show forward and reflected power simultaneously, and adjusting everything to maximize the reading on the forward meter while minimizing the reading on the reflected meter. I feel that the device described here is even simpler to use and it requires only one meter. Basically, it is a voltage comparator, as shown in Fig. 1. The meter should have a high impedance for best results. This circuit has some limitations.

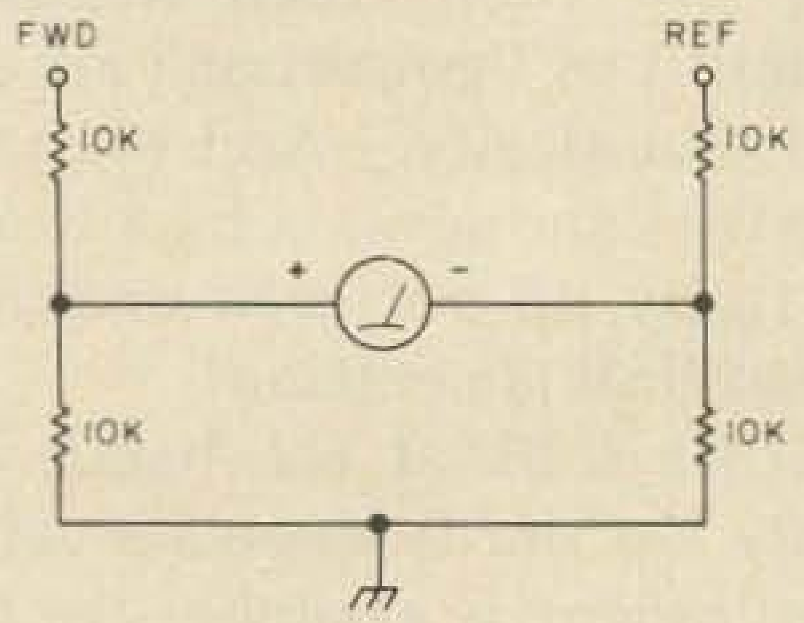



Fig. 1. A simple voltage comparator. This circuit has some limitations since a false swr reading may result depending on power.

For example, there is no way to determine what the SWR is; that is, high power with high SWR may give the same reading as lower power with low SWR. This limitation is removed in the circuit of Fig. 2. The SWR calibrations on the usual SWR indicator are computed from the following equation: SWR = (FWD + REF) / (FWD - REF). As an example, if we let 10 represent a full scale reading, and adjust to full scale with the bridge set to FWD, and switch to REF and get a half-scale reading (5) the SWR is (10 + 5) / (10 - 5) = 3.0. For the same case, using the circuit of Fig. 2, the voltage at point F will be twice that at point R. If we now set R1 to its midpoint, the meter will read zero. It now becomes obvious that R1

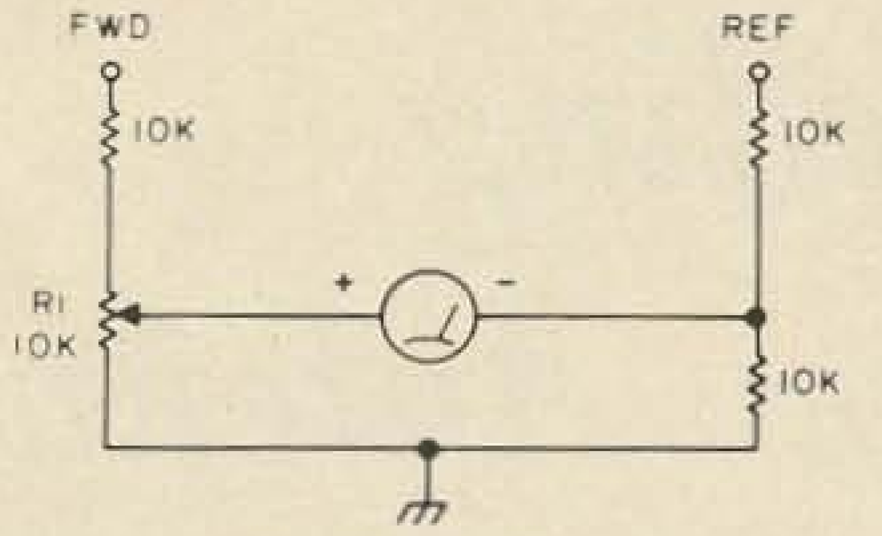



Fig. 2. The direct reading swr indicator which gives more accurate results.

can be equipped with a dial calibrated in SWR; i.e., the midpoint would correspond to SWR = 3.0. The dial can be calibrated by use of an ohmmeter as follows:

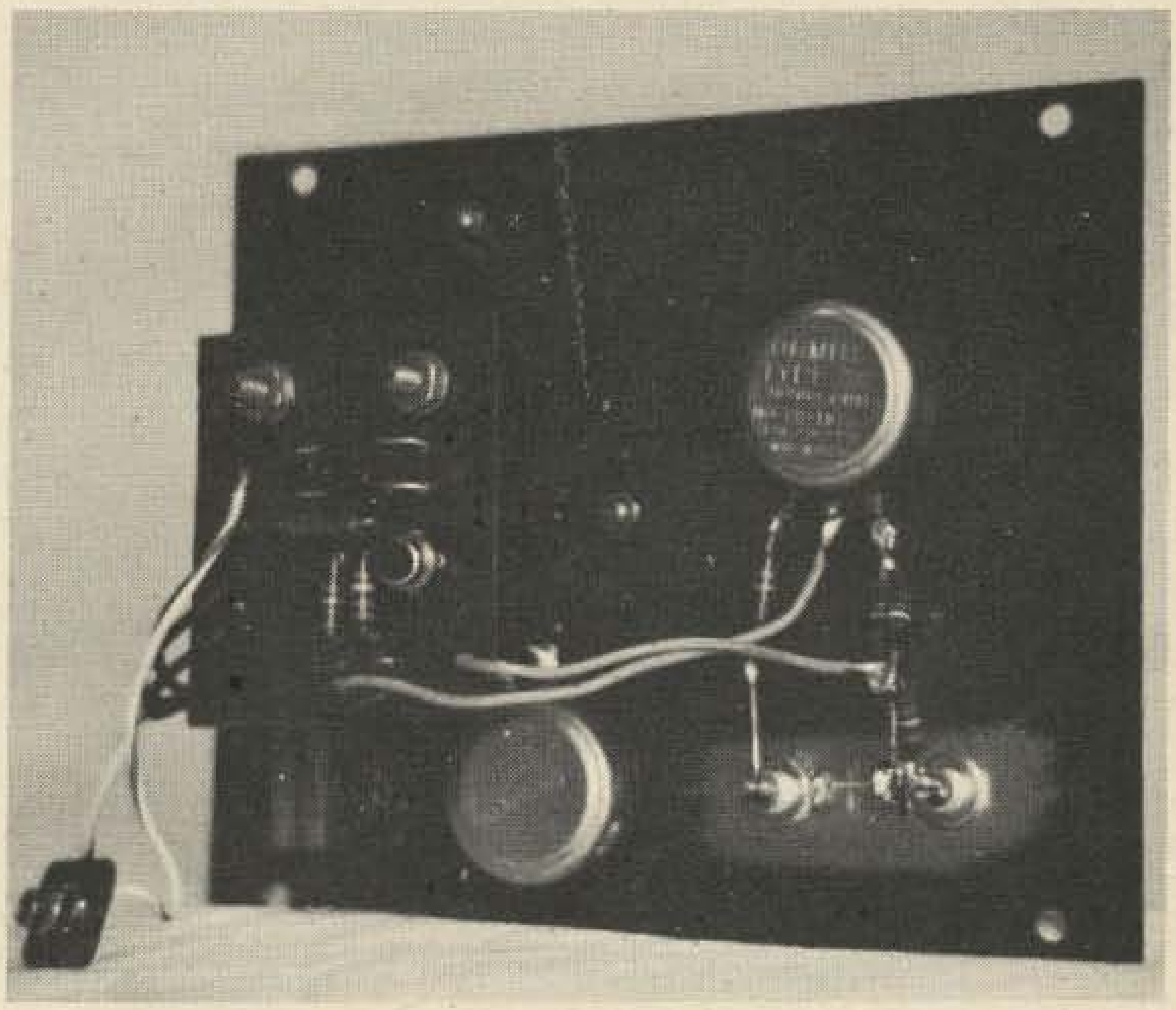
| SWR | Resistance (from ground end) |
|---|---|
| 1.0 | 0 |
| 1.2 | 909 |
| 1.5 | 2000 |
| 2.0 | 3333 |
| 3.0 | 5000 |
| 5.0 | 6667 |
| 10.0 | 8182 |
| 20.0 | 9048 |
| 00 | 10000 |

The meter used in my version is a 1 MA movement with a transistor amplifier similar to that described in January 1966 issue of 73. The meter amplifier was built on an etched circuit board for mounting directly to the meter terminals. The meter scale is arbitrarily calibrated with zero in the center. A resistor (82K) is used in series with the base lead to prevent changes in the zero-set when R1 is varied. My bridge has a positive output. If the one to be used has a negative output, the meter should, of course, be reversed.

The use of this device is extremely simple. The transmitter is first tuned up using the dummy load. The antenna matching unit is then connected to the transmitter through the SWR bridge. The meter is set to zero, and the transmitter is then energized. Adjusting R1 to bring the meter back to zero will then enable the SWR to be read from R1's dial. After this, any adjustment of the antenna matching unit which causes a more positive meter reading on the SWR indicator is in the right direction. The *amount* of increase in meter reading is a relative matter, depending not only on the SWR but also on the transmitter power. If the operator desires to determine the new (improved) SWR, he need only adjust R1 to bring the meter back to zero and read off the SWR from the calibrated dial.

Of course, the use of the direct-reading SWR indicator is not limited to tuning antenna matching networks. It can be used by anyone who would prefer its simplified SWR readout. If R1 is set to a higher SWR than that actually existing, a positive meter reading results, and the transmitter can be tuned for maximum output by maximizing the reading, just as in using the conventional indicator in the FWD position. ...K3WRW





A look at the interior. Obviously a simple device to build.

# *Asymmetrically Feeding Long-Wire Antennas*

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Changing the location of the feed-point on long-wire antennas can make major changes in the radiation pattern—changes that can be used advantageously when the antenna placement must remain fixed.

Illustrative patterns and methods to match and determine the feed point impedance are presented.

Many amateurs have room enough to erect an antenna that runs only in a specific direction. This situation may be due to points being available to support the antenna in only specific locations, or an antenna may have to be run in a specific direction because of obstacles, safety requirements, etc. When a wire antenna (doublet feed with a coaxial or a resonant line) is used on the lower frequency bands, the height in wavelengths is normally not very great, and the antenna radiation pattern is very broad—such that stations can almost be worked equally well whether situated "broadside" or "off the ends" of the antenna. On higher frequency bands, however, due to the increased electrical height and length of the antenna, the radiation pattern becomes quite sharp, both in the horizontal and vertical planes. On bands such as 20 meters and lower, one may have room enough to run an antenna that is several wavelengths long. But, if the line of the antenna must lie in a direction that coincides with the direction to a desired area, the signal radiated to that area will be many db below what it would be if a simple ½ λ dipole could be erected at right angles to the long antenna.

Assuming that one can only run a wire antenna in a fixed direction, one has to find some means of changing the radiation pattern to favor a desired area other than that of physically reorienting the antenna. One method that can be used is to asymmetrically feed the antenna. There is some change in radiation pattern when a wire antenna is either center or end fed, but the change is not extremely great (when end-fed, the radiation tends to be emphasized towards the unfed end). However, asymmetrically feeding a long antenna can produce a variety of tailored radiation patterns. One can't completely rotate the radiation pattern to any desired direction, but it is possible to at least develop useful radiation in directions that aren't covered by a symmetrically fed antenna or to produce a reduction in the response of the antenna towards a direction from which interference originates.

**Effect of Asymmetrical Feed**

The horizontal radiation pattern of a horizontally placed wire antenna is determined by the current/phase relationships in various sections of the antenna. When the antenna is symmetrically fed, a symmetrical horizontal radiation pattern results, such as is shown in **Fig. 1**. The cloverleaf-type pattern shown in **Fig. 1** results whenever the total antenna length is more than about 3/4 λ; otherwise, the main radiation is broadside to the line of the antenna. As the antenna is made longer in terms of wavelength, the lobes of the cloverleaf pattern become sharper and have a peak intensity at an angle closer to the line of the antenna. Sharp secondary responses also appear, some of which can have the radiated intensity of a dipole at its maximum orientation.

If one had a 3 λ long antenna which produced the horizontal radiation pattern shown by the solid line in **Fig. 1** and found that this pattern produced poor results in certain directions, **Fig. 2** shows some of the solutions

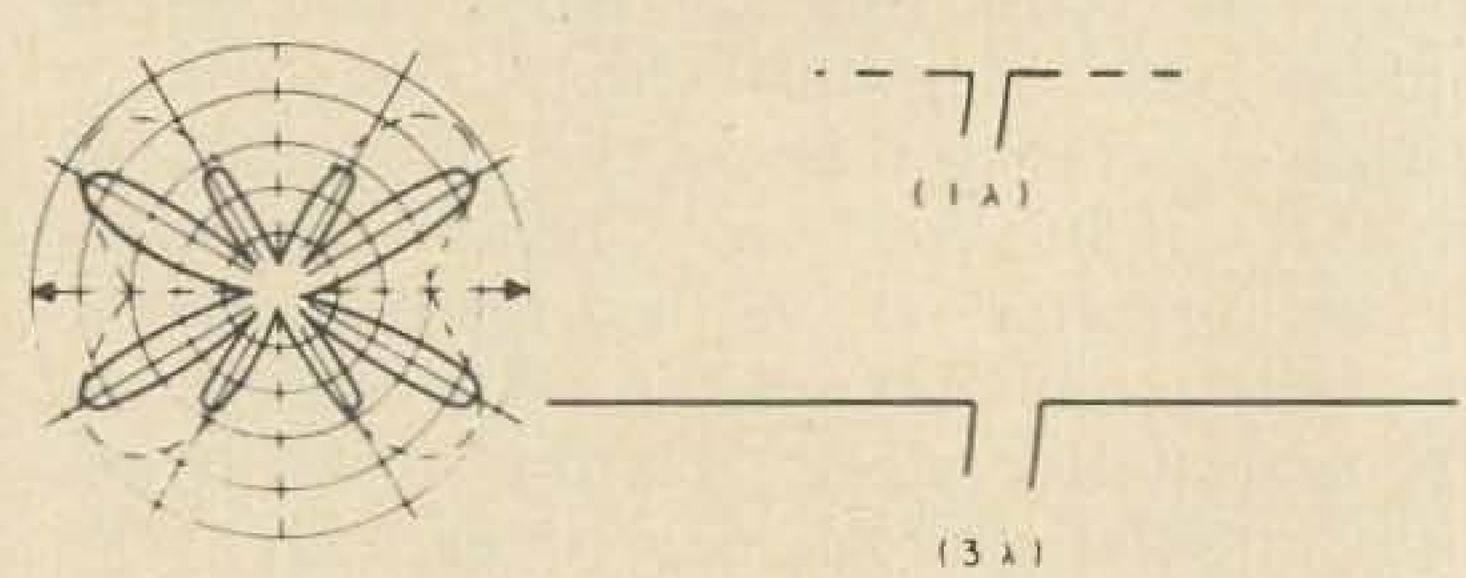



Fig. 1. The horizontal pattern of a 1λ long symmetrically fed antenna (dotted lines) and a 3λ long symmetrical antenna.

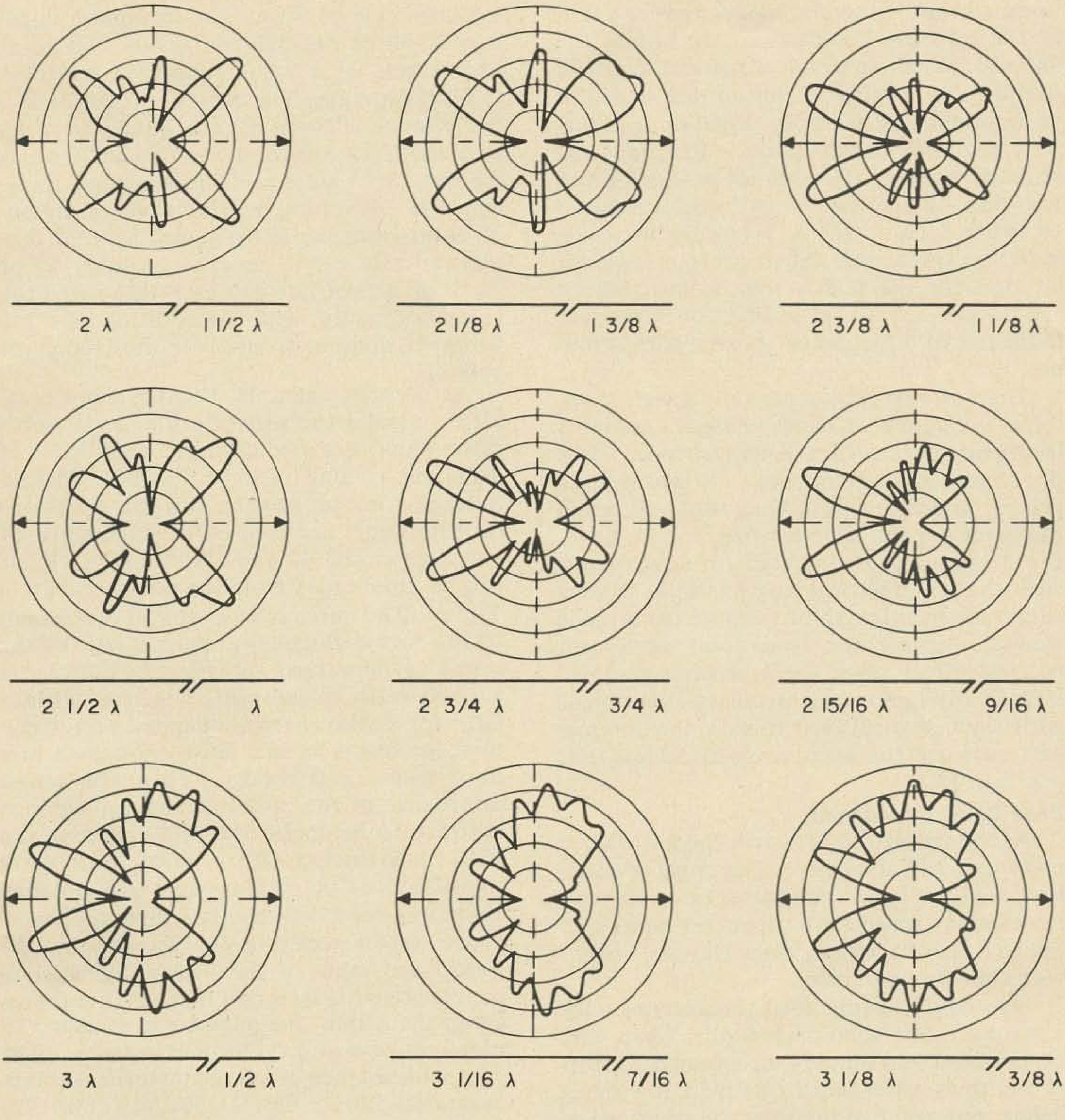



**Fig. 2. Changes in the horizontal pattern are illustrated as the total length of an antenna (3½λ) is held constant, but the feed-point is moved gradually toward the right.**

that asymmetrical feed can offer. Note that the horizontal patterns in **Fig. 2** are produced as the total antenna length remains constant and the feed point is moved towards the right. The same form patterns but with mirror responses would be produced if the feed point were moved toward the left.

Particular patterns deserve note, and it should be apparent as one studies the diagrams that in some cases very little change is required in antenna dimensions to produce significant changes in the pattern.

As the short side of the antenna is decreased slightly in length, some broadening of the main lobes occurs and the sharp second-responses are more filled in. The peak response of the main lobes changes from about 20 degrees to 45 degrees as measured from the line of the antenna. As the short side is reduced to 9/16 λ, an almost unidirectional type of pattern forms. A further slight reduction in the "short" side length to ½ λ produces a pattern that can be very useful in many circumstances. Two of the main lobes remain quite sharp and produce some gain while other main lobes have essentially disappeared from their usual location, thus leaving a deep null for about a 60 degrees arc in one direction. Other responses produce a fairly full response broadside to the line of the antenna. Such an antenna pattern might be useful if one wanted to concentrate radiation in an easterly or westerly direction (producing a good null in the opposite direction) and still have a reasonable amount of north-south response. When the "short" side is reduced to either 7/16 or 3/8 λ, primarily broadside radiation takes place. Such a response would be ideal for the fellow who moans that he can't work anyone in a direction broadside to the line of direction of his long-wire antenna.

The patterns shown are only exactly true for a frequency or band where the antenna lengths are the electrical lengths shown. They do change with frequency. However, as a general approximation, they still will retain the same general shapes when, for instance, the 3λ antenna is operated on a frequency such that its electrical length is 1½λ. As the total electrical length of the antenna is made shorter, varying the feed point placement has less effect upon the horizontal pattern. It probably is not worthwhile to experiment with asymmetrical feed to vary the antenna pattern when the antenna electrical length is less than 1λ.

**Feed Point Impedance**

As the feed point is varied, the impedance presented will also vary. The range of variation depends upon such factors as the antenna element/wavelength diameter ratio and can go from 50 ohms to a few thousand ohms with thin-wire antennas.

One could simply feed the antenna with a resonant line such as 450 ohm open wire or twinlead and employ an antenna coupler at the transmitter end to derive a low impedance, non-reactive load for the transmitter. A transmatch coupler will easily handle the range of impedances encountered, for instance, and provides a handy means for multiband coupling to the antenna.

For those interested in single band operation and/or using a non-resonant feedline, the antenna impedance that must be matched can be calculated without too much complication. To a close degree, the feed point impedance of an asymmetrically fed antenna is one-half the combined impedance of two symmetrically fed antennas whose half length is equal, respectively, to the length of each side of the asymmetrical antenna. Some examples should make this calculation clear.

Suppose that an asymmetrically fed antenna is used having a "short" side of ¼λ and a "long" side of 3¼λ. The feed point impedance will be one-half the added feed point impedances of a symmetrical ½λ and 6½λ (13/2λ) antenna. The center impedance of a ½λ antenna is about 70 ohms and that of an odd multiple ½λ is the same, or also 70 ohms for the 13/2λ antenna. The combined impedance is 140 ohms, half of which is simply 70 ohms—the same as for an ordinary ½λ dipole. In this special case, an ordinary 50 or 70 ohm coaxial line can be used to feed the antenna directly, with the addition of a 1:1 balun, if desired, to preserve the feed-point balance.

As another example, slightly more complex, consider the situation if an asymmetrical antenna were used having a "short" side of 3/8λ and a "long" side of 3 1/8λ. To find the feed-point impedance, it is first necessary to determine the feed-point impedance of a symmetrical 3/4λ and 6¼λ antenna. These can be determined from the graphs shown in Fig. 3. The curve is used which corresponds to the wire diameter/wavelength ratio of the actual asymmetrical antenna. In this case, a λ/1000 ratio is assumed, which is slightly large for a wire antenna operated on ten meters, for instance, but close enough to produce meaningful results. Then, the center impedance of the 3/4λ symmetrical antenna is found to be about 500 ohms resistive and +500 ohms reactive (500 + j500). The center impedance of the symmetrical 6¼λ antenna cannot be read directly, but since the impedance values repeat every wavelength, the impedance value of the 6¼λ antenna is approximately the same as a 1¼ or 2 ¼λ antenna. From the graphs, the impedance value is 150 ohms resistive and -500 ohms reactive. The center impedance of the asymmetrical antenna is: $Z=\frac{1}{2}(500+j500+150-j500)=\frac{1}{2}(650)=325$ ohms.

In this case, the reactive portions of the two symmetrical antennas are equal in magnitude but opposite in sign, so they simply cancel. The resultant resistive 325 ohm feed-point impedance would offer a good match to a 300 ohm twinlead feedline, or the antenna could be fed via a 4:1 balun with 75 ohm line, thus taking care of the impedance matching problem and preserving the feed-point balance simultaneously.

The choice of other "short" and "long" lengths for the asymmetrical antenna may not, of course, offer such simple feed-point impedances. In such a case, one can either build a matching network to allow coupling to the antenna by a non-resonant feedline or accept some slight change in the radiation

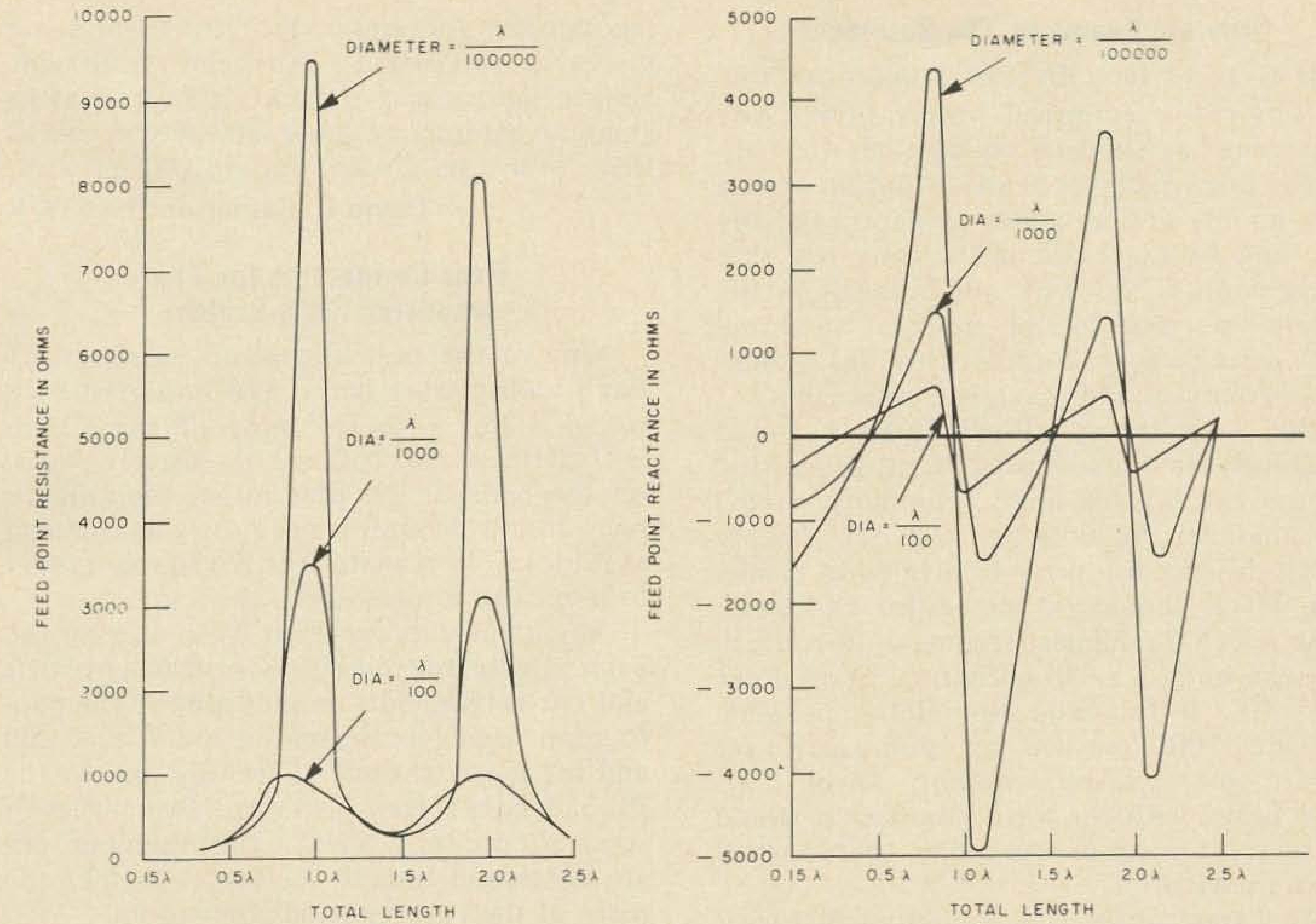



Fig. 3. Graphs of the feed-point resistive and reactive components of a symmetrical, center feed antenna. As explained in the text, these graphs can be used to calculate the feed-point impedance of an asymmetrical antenna.

pattern and use the closest "short" and "long" lengths which provide a convenient feed-point impedance.

### Summary

So many factors affect antenna directivity, both in the horizontal and vertical planes, in a given actual installation, that only using the antenna can disclose its true performance. If, however, a long-wire antenna does exhibit dead spots in a particular direction or if it is desired to reduce the level of interference from a certain direction, asymmetrical feeding of the antenna offers a possible solution with extremely little effort and cost.

For those who would like to experiment and know something of transmission line stub switching, it is possible to develop, using the principles presented, a dual feedline antenna with a selectable pattern. When not used as the power transmission line to the antenna, the alternate feedline would be shorted to reflect a direct continuity of the antenna flat-top. To accomplish this, of course, the feederline length would be a multiple of ½λ.

With some imagination, the long-wire antenna can be turned into a versatile radiator. The operator who has room enough to erect one or, indeed, can only erect such a radiator should not discount its possibilities too quickly.

...W2EEY/1

## Growing Beams In The Basement

It is a sad fact that most antenna "theory" is really empirical observation. Any ham who has tried to concoct his own antennas can vouch for the fact that no matter how good a design works on paper, the tinsnip and hacksaw test is the only one that really counts. So why not build them all? Before you start buying stock in an aluminum parts factory, consider this idea to minimize your cost and maximize your gain.

For years the aviation industry has used model planes to guess what might get off the ground and not fall apart. Similarly, model antennas can be used to find out cheaply which designs are likely to give good results and which should be slated for the trash. First select the highest frequency for which you can build a small oscillator. You don't need to get too wild, something between 500 and 1000 mc will give you a halfwave length that will be workably small. To keep peace with the local populace it would be a good idea to find one that doesn't interfere with TV.

The transmitter is a simple oscillator of whatever type is easiest to build. It is coupled to a simple halfwave folded dipole by a piece of 300 ohm TV ribbon. For greater effective power a shaped screen or dish can be placed behind it. The receiver is just a diode, a capacitor, a sensitive microammeter, and a variable resistor. At K9BDO we used a lab interferometer and obtained several promising designs for driven arrays.

Generally, this test system works well for determining the radiation patterns, front-to-back ratio, and gain of antenna designs. It can be used to find both the vertical and horizontal patterns, which is hard to do on full size antennas. It would be a good idea to make a dipole and a three element beam to serve as standards of measure. One thing that cannot be measured accurately is impedance, due to the effects of random capacitance and inductance. A lower frequency, such as six meters, must be used to make these measurements.

Materials for your donation to the world of invention can be almost anything, but I recommend aluminum clothesline and some pieces of soft wood. With this equipment almost anyone can embark on a career as an amateur antenna designer; and if you fail at that, you can always try writing articles.

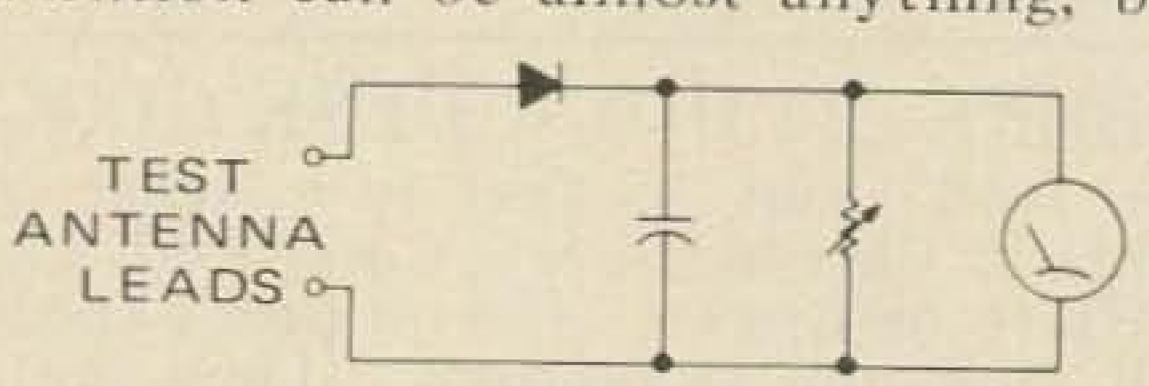


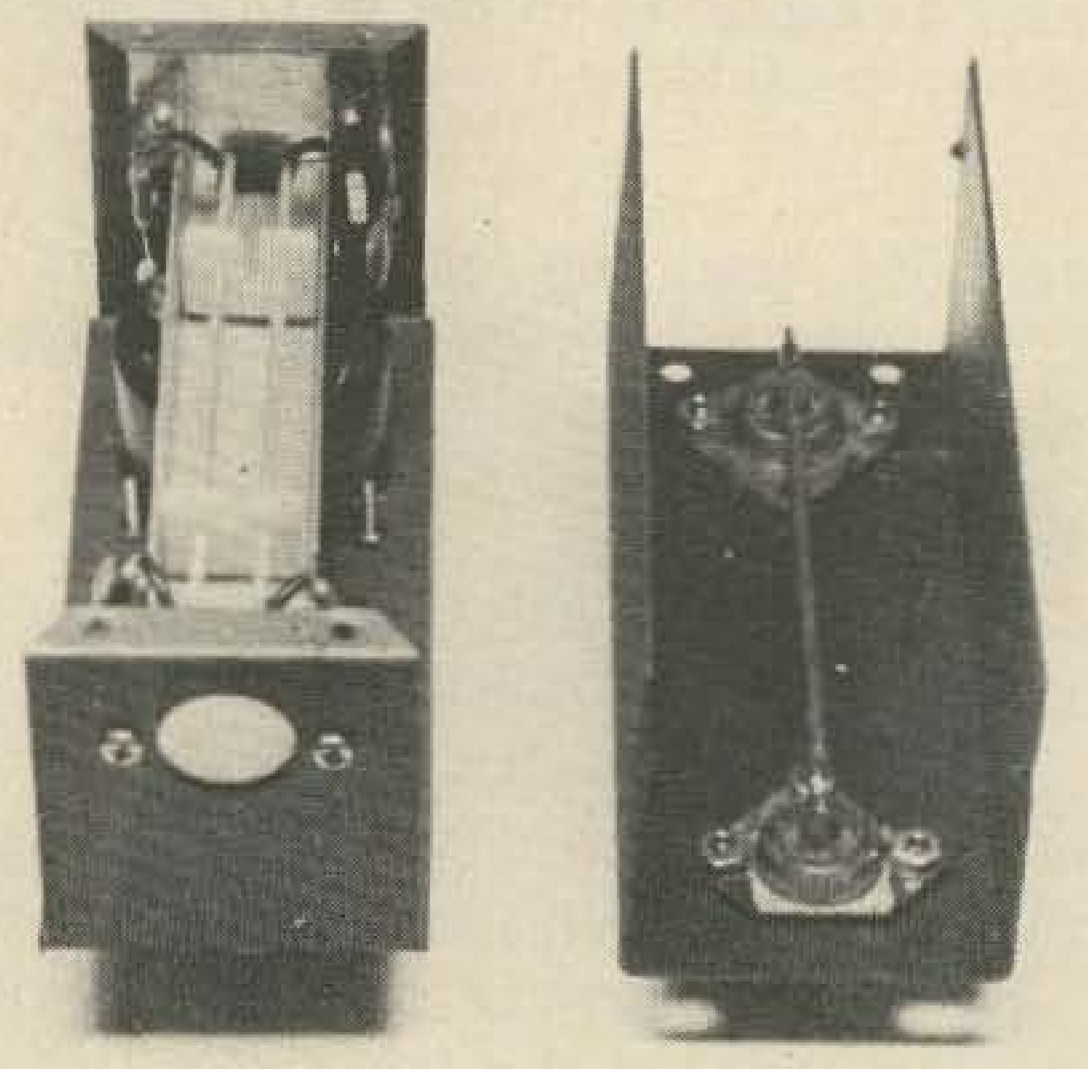

Fig. 1. The test system consists of a simple receiver with a diode, a capacitor, a microammeter, and a variable resistor.

**David B. Cameron, WA4VQR**

## Rear Connectors for That Imported SWR Bridge

One of the best all-around values on today's ham market is the $10 imported SWR bridge. But a shortcoming of these units is that the connectors are obtrusively placed on the ends of the unit rather than on the rear. In use the unit is not nearly as compact as it looks. Fortunately, it is a simple matter to move the connectors to the rear.

Begin the modification by removing the back. Note the pieces of insulating plastic and cut vertical slits as indicated in the photograph. Unsolder the middle rod at each end and lift it straight out. Carefully remove the PL-259 connectors. Now cut two pieces of scrap aluminum 1"x1½". Drill the appropriate holes and mount the pieces to take the place of the two removed connectors.



The modified SWR Bridge with connectors on the rear.

Mount the PL-259s on the rear cover, centering them 11/16" from the end. Place the center rod atop the terminals and solder. The center rod should now occupy the same position as before, but soldered to terminals on the rear. Replace the cover, and the modification is complete.

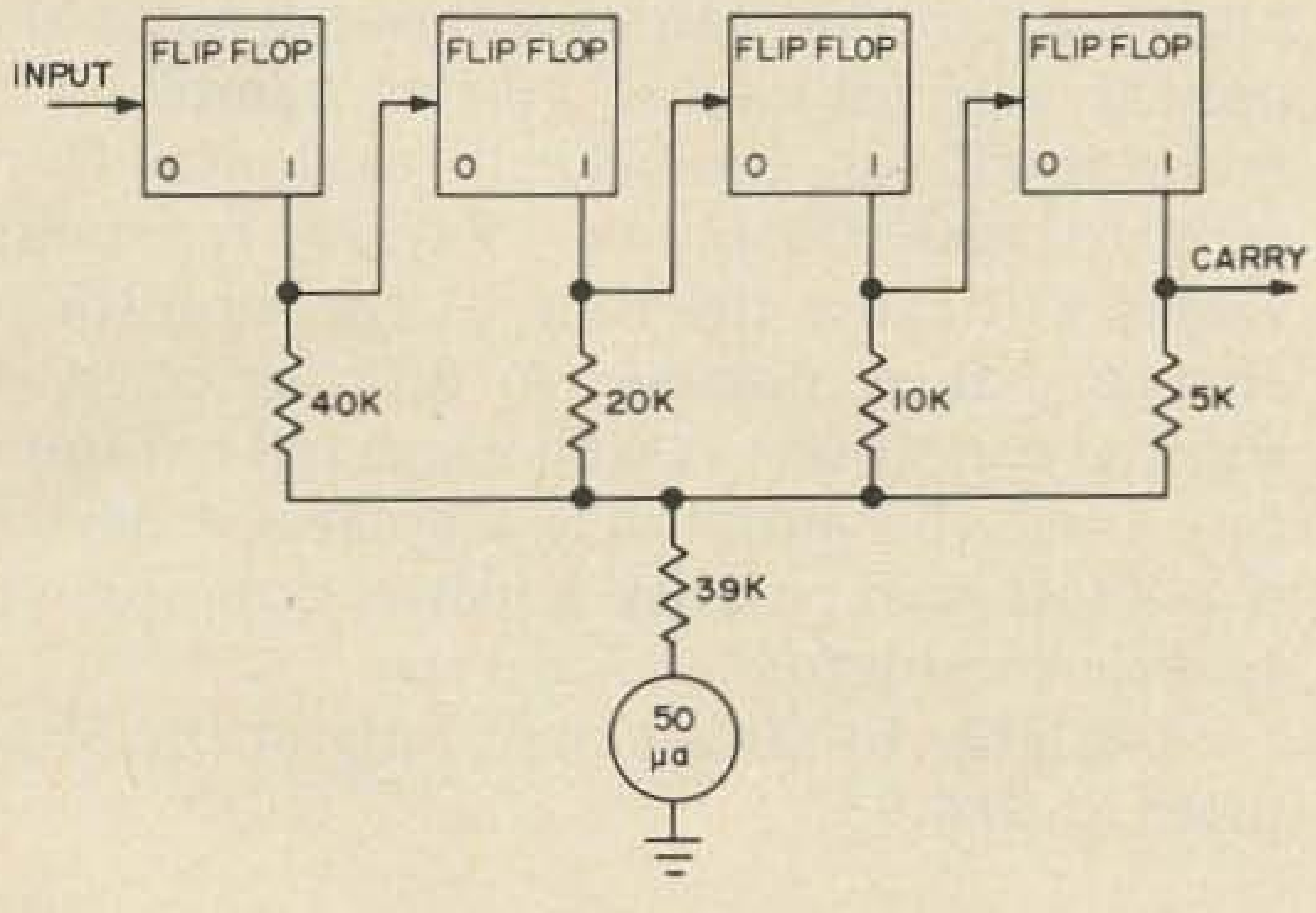
While accuracy on 6 and 2 meters and sensitivity in general may suffer slightly with the rear connector arrangement, few would deny the obvious advantages of the modification.

**James C. Miller, III, WA4IQD**

## Add This Simple Decimal Readout to Your IC Counter

An integrated circuit counter is a pretty satisfying project and I can find no primrose paths in Wes Votipka's article in November '68 "73" magazine. One somewhat "un-American" (whatever *that* means) aspect of the counter described is that binary readout – you must sum the values of the lights on in each decade to translate. There is a fine excuse for this approach if illuminated readouts are required – in each decade four lamps and drivers do the job of ten lamps (nine, if zero is understood), drivers and a binary to decimal translator. If a diode matrix is used to translate, forty *good*, high back-resistance diodes are needed for each decade!

Now, my counter is not finished but perhaps my readout system will be of interest to others still in the building stage. This low cost approach gives a true decimal readout. I use a separate meter to indicate the output of each decade – 50 microampere meters function very well when connected directly to the outputs of 923 type flip flops. The trick is to properly weight the current passed to the meter by each flip flop of the decade. The circuit I've used is shown in the figure.




Note the binary relationships among the resistors – the least significant binary digit can only introduce one half the current supplied by the next more significant digit and so on. Logic levels of individual flip flops will be different, so equal increments of meter deflection will probably not be observed. However, the meter will assume very distinct positions for each count stored in the decade. Purists can trim resistance values to equalize deflection increments – I'm satisfied to let the chips fall where they will and mark the meter scales accordingly.

If there are some misgivings about cost – 50 microampere meters are seldom the cheapest on the list – imports go for about $3. Being pure Scotch I managed to cut that by picking up a batch of brand new photographic light meters from Olson Electronics in Akron, Ohio, at two for a dollar! These are 54 microampere movements and, though not cased, are beautifully made. I haven't tackled the mounting problem but it doesn't appear too difficult. **Earl Bryant WA7EYR**

## San Francisco, Here I Come!

In connection with the hearing on the Miller suit, I will be in San Francisco from May 26th through the 30th. If any clubs in the area are interested in having a guest speaker with a lot to say, please drop a note to me at 73 telling me which night you like. Questions answered on anything and everything, if you really want to know what's going on.

**Wayne, W2NSD/1**

## For Your Next Converter

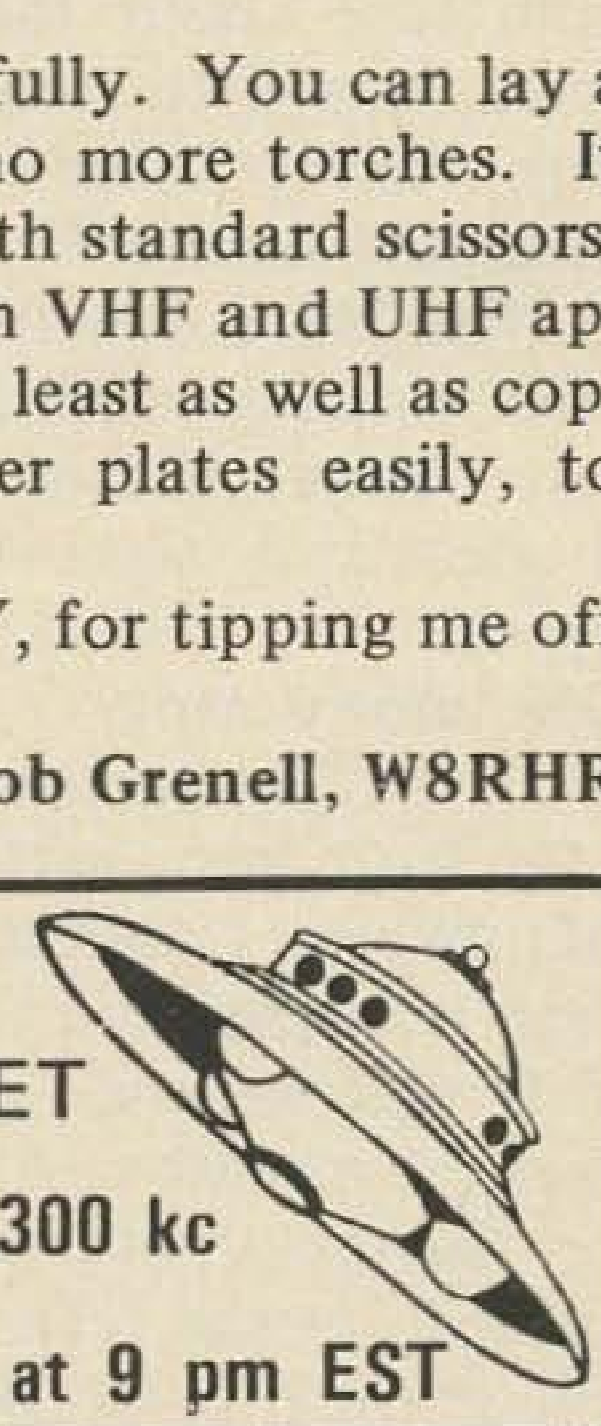
Good old Sears & Roebuck has done it again. How many times have you battled with copper flashing material—trying to get it to take solder, attempting to form it into some reasonable facsimile of a box or VHF cavity? If you're tired of burned fingers and torch-soldering, take heart. Rush down to your nearest Sears & Roebuck store and invest about $2.50 in a roll of their Zinc-Copper alloy flashing. It comes 1 foot wide, and the rolls are 10 feet long. That's a lot of converters!

It takes solder beautifully. You can lay a bead with only a gun—no more torches. It forms easily, and cuts with standard scissors, or with a paper-cutter. In VHF and UHF applications, it performs at least as well as copper flashing—and it silver plates easily, to boot.

Thanks to Jay, K8CJY, for tipping me off to this great stuff!

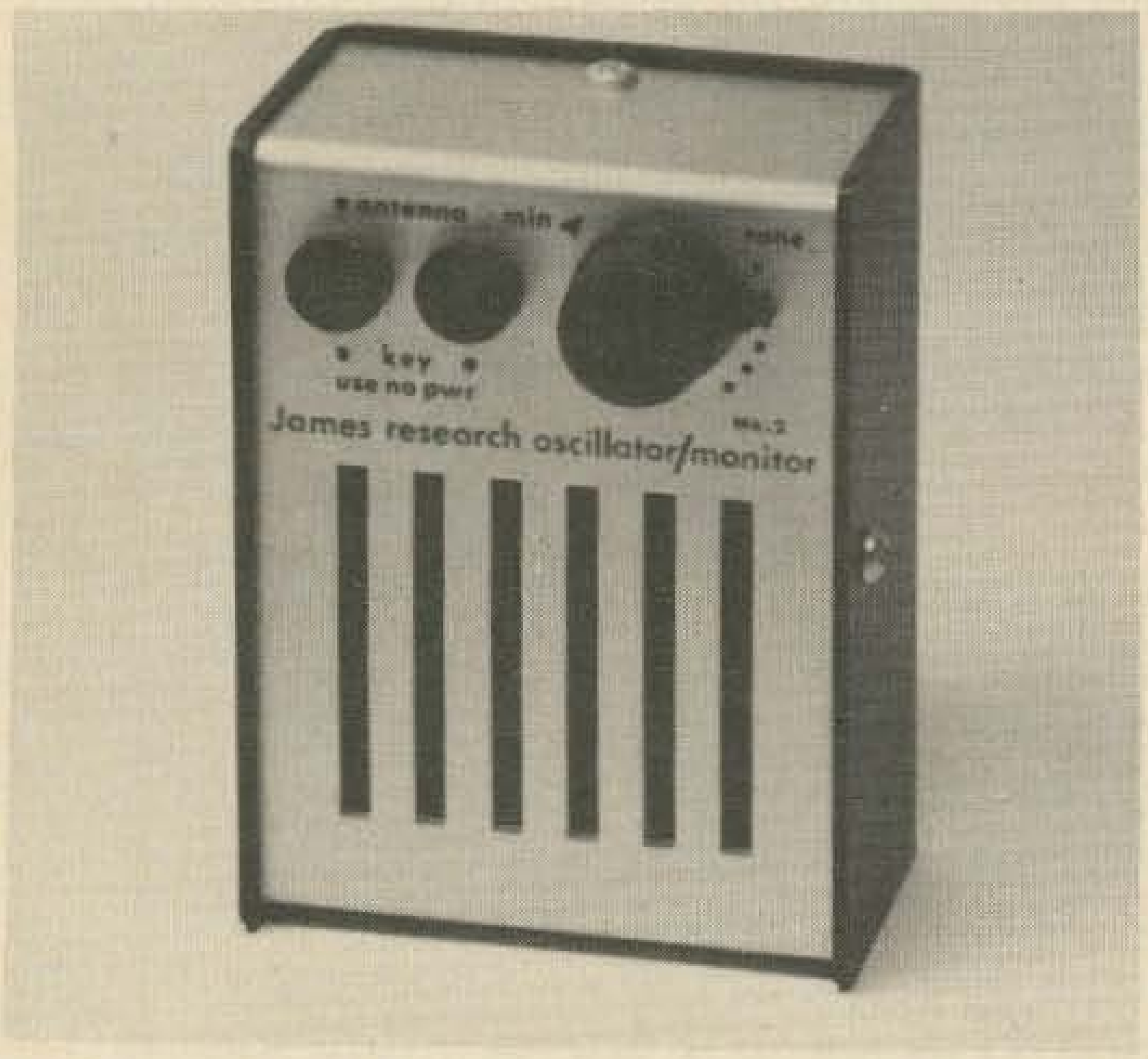
**Bob Grenell, W8RHR**





# 73 Tests

## The James Research Oscillator/Monitor, Mark 2 and Permaflex Key




Oscillator/Monitor is a very modest description of this extremely versatile piece of equipment. Housed in an anodized aluminum case about the size of a pack of cigarettes, this little unit does just about everything except stand up and sing "The Star Spangled Banner."

The Mark 2 will serve as a CW monitor, a code practice oscillator, an *rf* detector, an *rf* test device, and a test instrument to check diodes and semi-conductor devices of all types.

**CW monitoring**

The Mark 2 provides a reliable CW sidetone from any amateur transmitter regardless of power or frequency. It requires no connection to either the transmitter or key. An 8" stiff wire antenna picks up stray *rf* and triggers the monitor. A strong magnet is attached to the back of the case to allow it to be placed on the transmitter in the spot where the *rf* pickup will be best.

**Code practice**

The monitor can be connected to any keying device to produce a loud, click free audio tone. A tone control knob allows for adjustment to a comfortable listening tone.

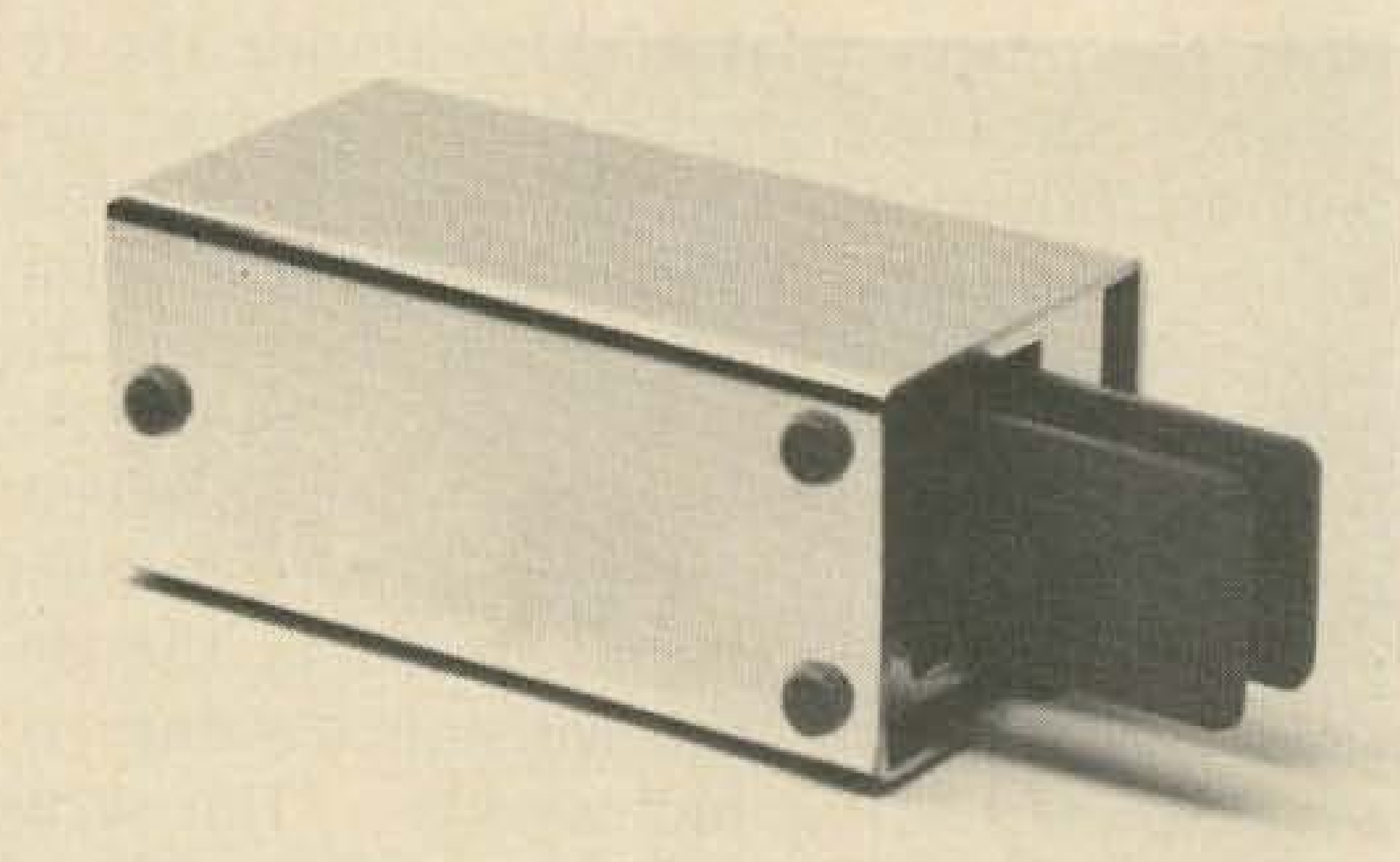
**RF detection and testing**

The high sensitivity and broadband characteristics of the monitor make it a valuable *rf* test instrument. It will detect the presence of *rf* by producing an audible tone and indicates relative power of the *rf* source by changing tone. No direct connection is required for *rf* in excess of 10 milliwatts. The monitor may be used as an effective tuning aid for transmitters or power oscillators. As the *rf* power increases, the tone becomes lower in pitch.

**Component continuity and semi-conductor testing**

For the testing of circuit or component continuity, the monitor has many advantages. Tests with the monitor are completely nondestructive since the power required can never exceed .0025 microwatts and the open circuit voltage is not over 1.5 volts. The maximum current that can pass through any component will not exceed 50 microamps. The monitor will test component resistances from zero to 100,000 ohms. Various resistance values will cause the tone of the monitor to change. It is possible to test for open or shorted conditions as well as partial continuity. Since the monitor is a polarized device, it will test such polarity sensitive components as semi-conductors and meters.

Available by direct mail only at the Miniprice of $14.95.



**Permaflex key**

The James Permaflex key is a manually operated single pole double throw switch mechanism. It has two independent insulated contact paddles mounted to a contacting center support arm. The key is operated by light finger pressure against either of the two paddles. The key can be used with any electronic keyer or may be connected directly to a transmitter. The contacts are rated 8 amps at 28V dc which is far in excess of most transmitter requirements and are the heart of the key design since they eliminate the usual corrosion and cleaning problem associated with traditional silver contacts.

The silver contacts have a gold diffused coating.

The key is housed in a polished chrome-plated steel cabinet 1 9/16" square by 3 3/4" long and total weight is 10 oz. There are two independent sets of rubber feet. When one set is used, the key operates as a side-swiper type of key. When turned to the other set of feet, it can be used as a straight hand key. Selling for $19.95, it is hard to find a more versatile key.

All James Research products are designed and manufactured in the USA and are available by direct mail order only. They carry a one-year guarantee. James Research Co., Dept. AR-M, 11 Schermerhorn Street, Brooklyn, N.Y. 11201.

# A "Compressed" Vertical for 160

*This antenna requires only half the height of a true quarter wave vertical.*

F. J. Bauer, Jr., W6FPO
P. O. Box 870
Felton, California 95018

It is not the purpose of this article to go into the relative merits of horizontal and vertical antennas for 160, but rather to present an interesting and practical design for those amateurs who would like to try a vertical without going to excessive heights or resorting to critical loading gimmicks. As is well known, a true quarter wave vertical for this band would require a height of at least 120 feet or so, which is usually out of the question for most amateurs. The antenna described here requires only half this height and as far as I can tell by experiment, the radiation efficiency is about as good as that of the full length antenna.

The basic design of the antenna is shown in Fig. 1. About the same conductor length is used as would be needed for a full length vertical. Also most of the horizontal radiation is cancelled by the adjacent horizontal sections of the radiator as shown in the figure. Complete cancellation will, of course, not be obtained since the antenna currents in the adjacent horizontal sections are not quite equal and opposite. However, on-the-air tests at night have consistently shown less QSB than that obtained from horizontal antennas, which seems to indicate that the antenna does behave like a true vertical.

The antenna is built most simply by stapling insulated wire to a wooden mast. Do not use a metal tower or mast. The antenna support I used is shown in Fig. 2. The mast is pivoted at the roof level with the lower third extending towards the ground as shown. Six bricks in a pail are used as a temporary counterweight whenever it is necessary to raise or lower the antenna. Two guy wires as shown were found adequate since no high winds are experienced at this QTH.

The first experimental antenna built used no. 12 weatherproof outdoor wire arranged

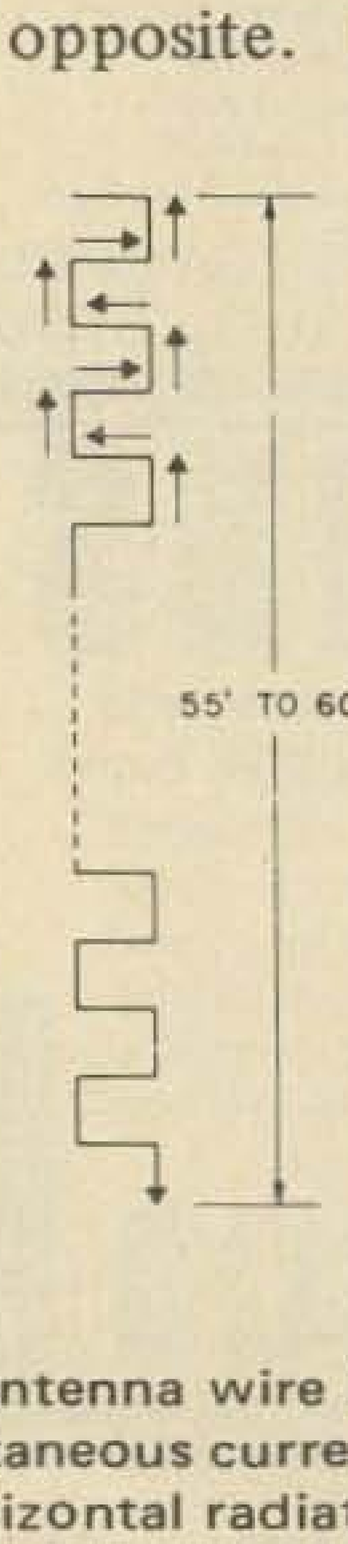



Fig. 1. Basic antenna wire layout. (Arrows indicate instantaneous current flow and cancellation of horizontal radiation.

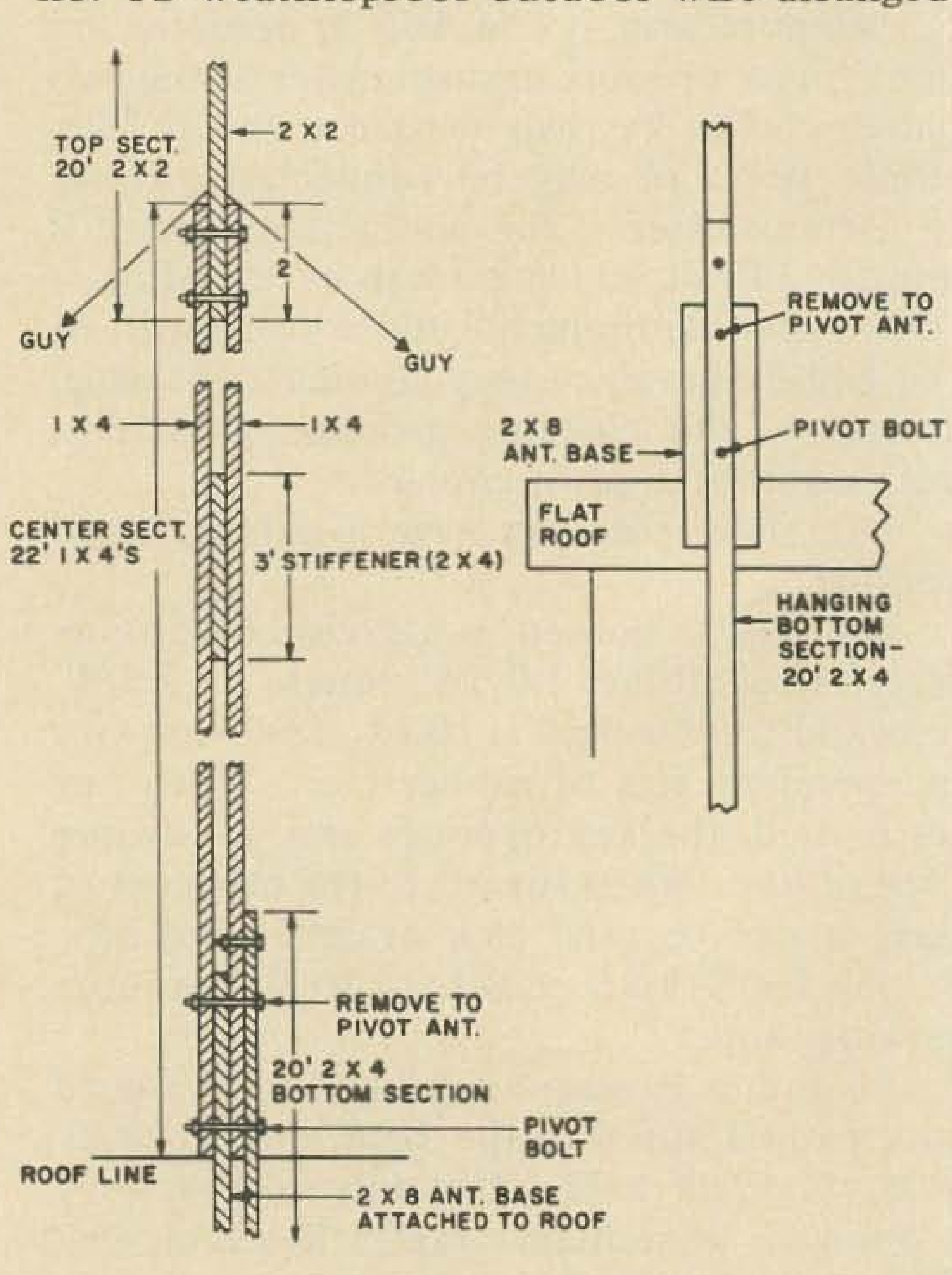



Fig. 2. Antenna support.

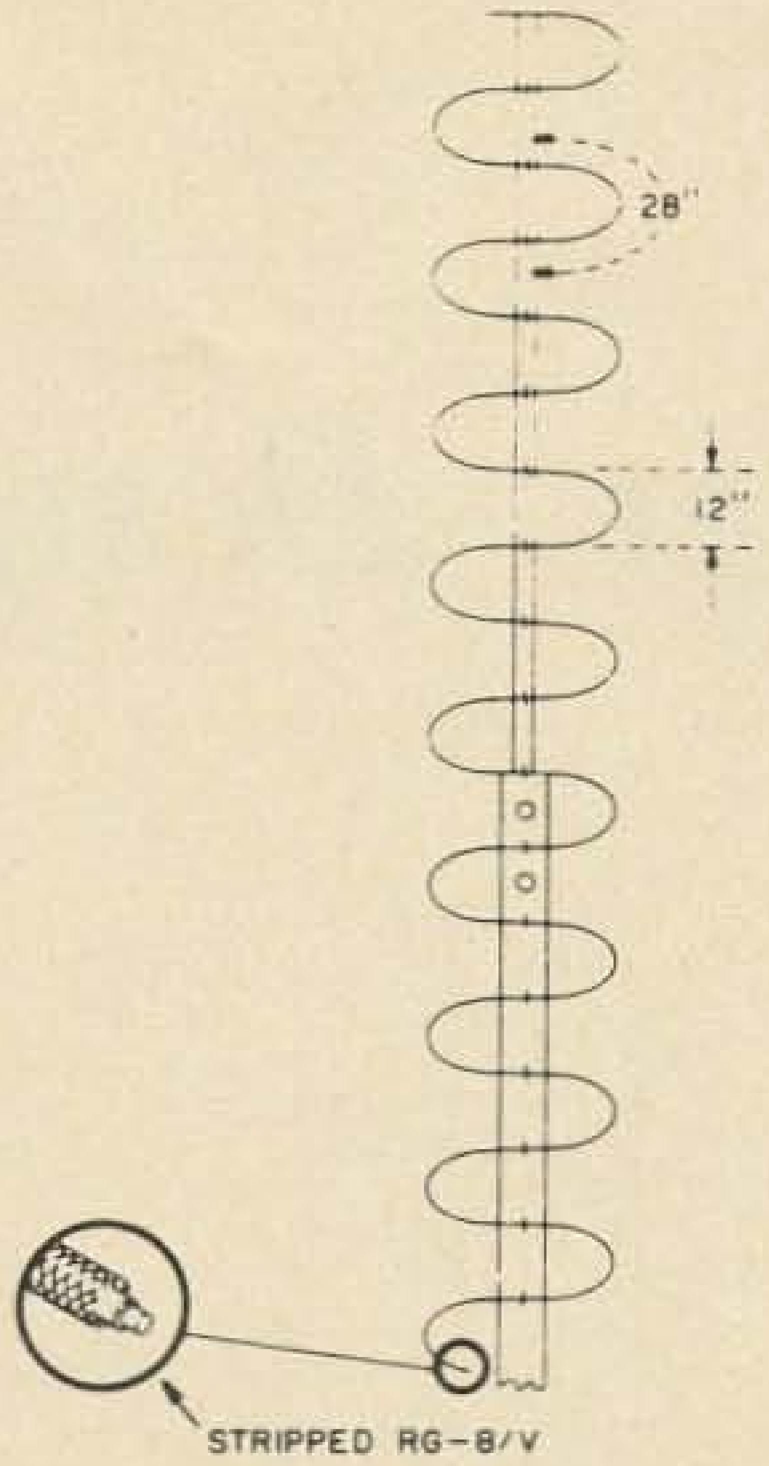



Fig. 3. Antenna configuration using stripped RG-8/U.

in 6-inch squares as shown in **Fig. 1**. It was about 32 feet high and proved quite effective on 75 when worked against ground as a quarter wave vertical. The second and final antenna was made from old RG8/U coaxial cable with the outer braid removed. Since the stripped RG-8/U did not lend itself to a square configuration, the antenna was made in a series of loops as shown in **Fig. 3**. With the dimensions shown, the antenna resonated at 2150 kHz against ground.

This was a little high for the frequency of interest (1990 kHz) and would have required making the antenna about four feet longer. Since I was out of lumber as well as energy, I decided to use a simple series tuned antenna coupler as shown in **Fig. 4**. The coupler was also satisfactory for tuning to the 1900-1925 kHz segment of the band. The simplest way to adjust the antenna system is to "grid dip" the tuner to the operating frequency and then use the transmitter pi network to load the transmitter in the normal manner.

I had no luck loading the transmitter "pi" network directly into the antenna because the antenna impedance was too low for the "pi" network–about 30 ohms as measured on an antennascope. No attempt was made to feed the antenna with a transmission line, since the antenna base and ground were both located right outside the shack window.

This antenna, like all quarter wave antennas requires a good ground system. Radials, of

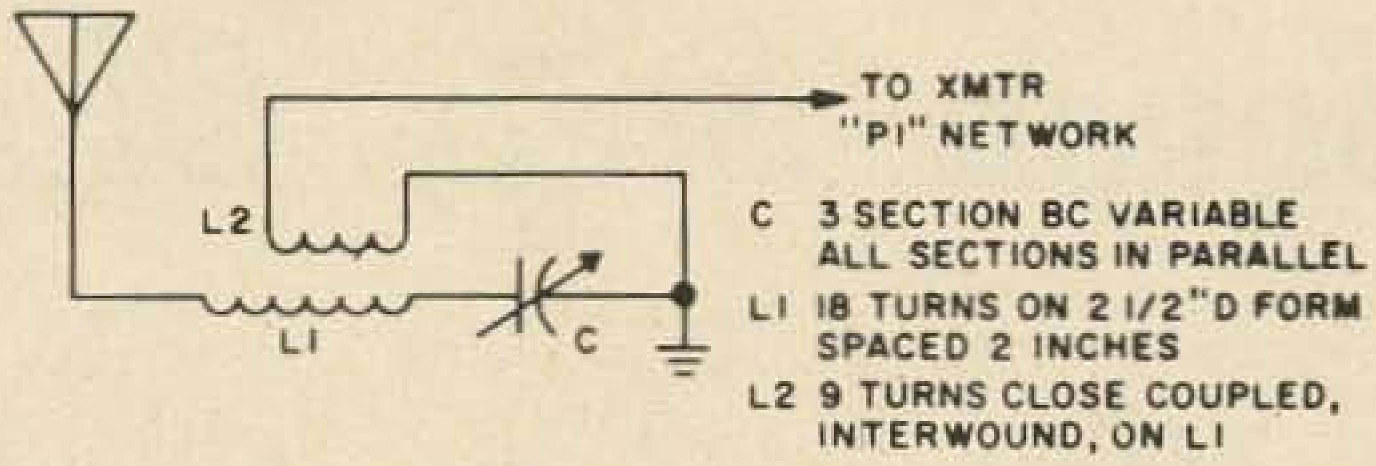



Fig. 4. Antenna Coupler.

course, would be best if you have the space and the energy to install them. I used three eight-foot ground rods in conjunction with three water pipe ground connections, all tied together. The antenna current was the same whether a half wave or quarter wave antenna was used, so I assumed that the ground system was fairly efficient.

As for results obtained with this antenna, I have had neither the desire nor the ambition to operate odd hours and check the antenna on some real DX. However, tests run with stations 250 miles or so out indicate a two S-unit gain at times over a low horizontal antenna. Strangely enough, stations closer in (40 miles or less) favor the horizontal

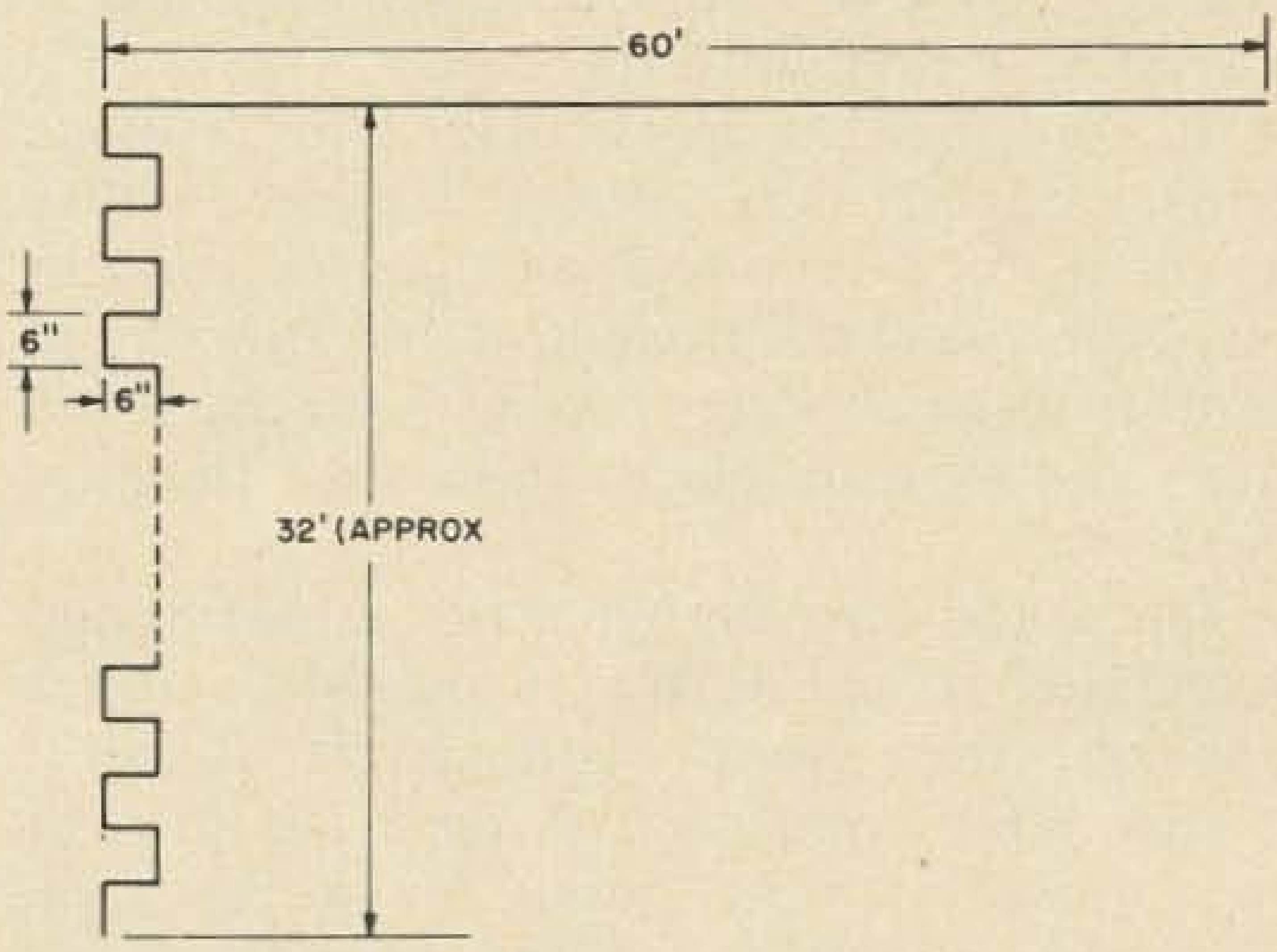



Fig. 5. Inverted "L" configuration.

antenna by two S-units or so. Excellent reports have also been received when working Idaho and Wyoming stations from this QTH with 50 watts input.

For those amateurs who think 60 feet or so is still too high for an antenna, I suggest an inverted "L" configuration as shown in **Fig. 5**. The antenna is, in effect, a 1/8 wave vertical with a 1/8 wave horizontal wire added. It has given a good account of itself as an all around 160 meter antenna both for DX and local work and is only 32 feet high.

No matter which antenna type you decide to build, you will be sure to have a conversation piece–on the roof, that is.

...W6FPO

# *Seven-Step Class A Transistor Amplifier Design*

*Edward A. Lawrence, WA5SWD/6*
*218 Haloid*
*Ridgecrest, California 93555*

Designing a Class A transistor amplifier is not so hard if you are willing to make a few reasonable assumptions. As a matter of fact, it is just an exercise in Ohm's Law. The biggest assumption is that the transistor has a reasonably high gain, and a reasonably low leakage. This procedure works for NPN, PNP, Silicon and Germanium. You don't care if it is Ge or Si until the 4th step, and if it is NPN or PNP until the last.

If you need a particular gain (voltage gain), you can determine the proper values to get it, or if you want all the gain you can get, take the same procedure, but bypass the emitter resistor. Refer to **Fig. 1** for the seven steps and an example to show how they are used.

Once you have designed the amplifier and assembled it, check Vc. It should be about one-half the supply voltage. If it isn't, change RB2. Increase it if Vc is too low, or vice versa. If you build for a set gain, remember to allow for the loading of the next stage by figuring the load in parallel with RL in step 2. If you decided to go all out for gain, pick CE to have a reactance of about one-tenth the value of RE at the lowest frequency you plan to pass through the amplifier.

This procedure will allow you to design a workable amplifier for almost all applications for Class A RC coupled amplifiers. You may come upon a special case, but I have developed this procedure while working in various Engineering Departments during the last three years, so I sincerely doubt it.

**Additional Remarks**

Step 1: To be able to get the maximum voltage swing out before clipping, the collector needs to be set one-half the effective supply voltage below supply voltage. To find effective supply voltage, subtract VE from VS. Then drop half of that across RL.

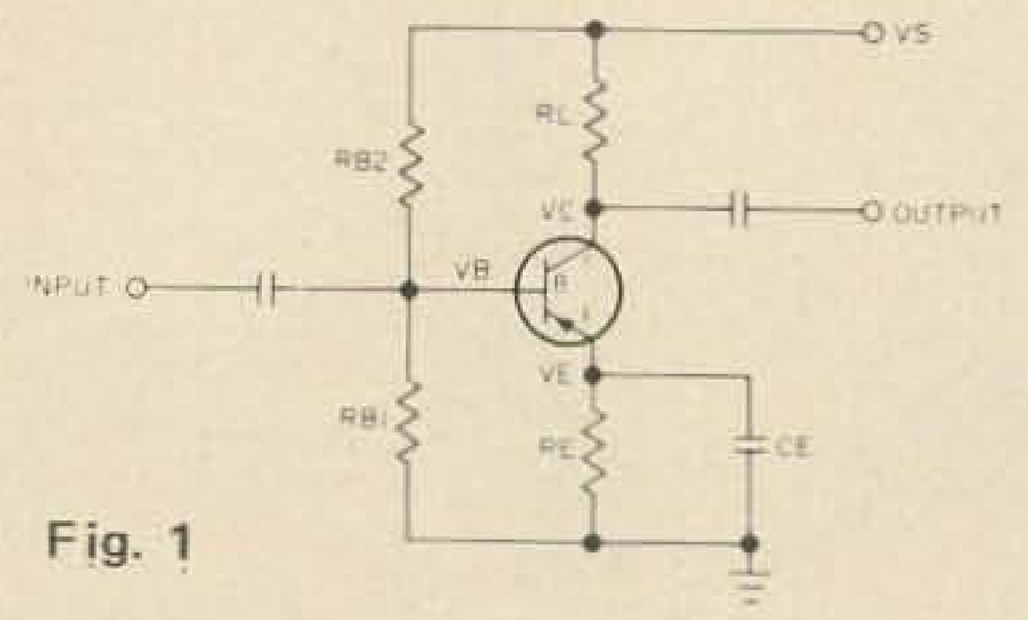



Fig. 1

1. Pick RL (.6-20K) IC=.5VS/RL
2. Calculate RE (Gain 1-25) RE=RL/Gain
3. Calculate VE (IE about equal to IC) VE=IC(RE)
4. Add VBE to VE to get VB. VBE=.3v for Ge, .6 for Si VB=VE + VBE
5. Pick RB1 (3.3-27K)
6. Calculate RB2 RB2=RB1(VS-VB/VB)
7. If NPN, VS is Positive
   If PNP, VS is Negative

Example: NPN Si, 12VDC, Gain of 10

1. RL=10K, IC=6/10K=.6 ma
2. RE=10K/10=1K
3. $VE=.6\times10^{-3}\times1\times10^{3}=.6VDC$
4. VB=.6+.6=1.2VDC
5. RB1=12K
6. RB2 in K ohms
   RB2=12(12-1.2/1.2)=12(9)=108, use 110 K
7. VS is Positive

Step 2: This step presumes that the gain of the transistor is higher than the gain the circuit asks for. Normally this will be the case. If you want all the gain you can get, bypass the emitter resistor. This will increase the distortion somewhat. Usually the distortion will still be low enough for amateur purposes, but not low enough for "Hi-Fi".

Step 3: Since the base current is small compared to the collector current, this is a good approximation. It is not advisable to ground the emitter directly, as this reduces the dc stability greatly. It also makes this procedure almost useless, since some of the assumptions no longer hold. And one resistor and a capacitor are a very small price to pay for the advantages gained. Also, as a rule, the more voltage you drop across the emitter resistor, the more stable the circuit will be with temperature changes.

Step 4: In actual practice, VBE will not be exactly .2 or .6 vdc, but these values will be very close. The emitter follows the base voltage, and not the reverse, as this procedure might seem to indicate. But this is the simpler way to design the amplifier.

Step 5: No correction has been made for base current, so VB may be slightly lower than this step indicates. The lower RB 1 and RB 2 are, the less base current will affect the result. But this also lowers the input impedance, which makes the amplifier harder to drive.

. . . WA5SWD/6

### Even Better Gamma

In the Sept. '66 *73*, the improved gamma match can be further improved by using the printed circuit board in one piece as in **Fig. 1.** This makes for a neater job and less chance of wire breakage. K6ZHO's idea is a fine one.

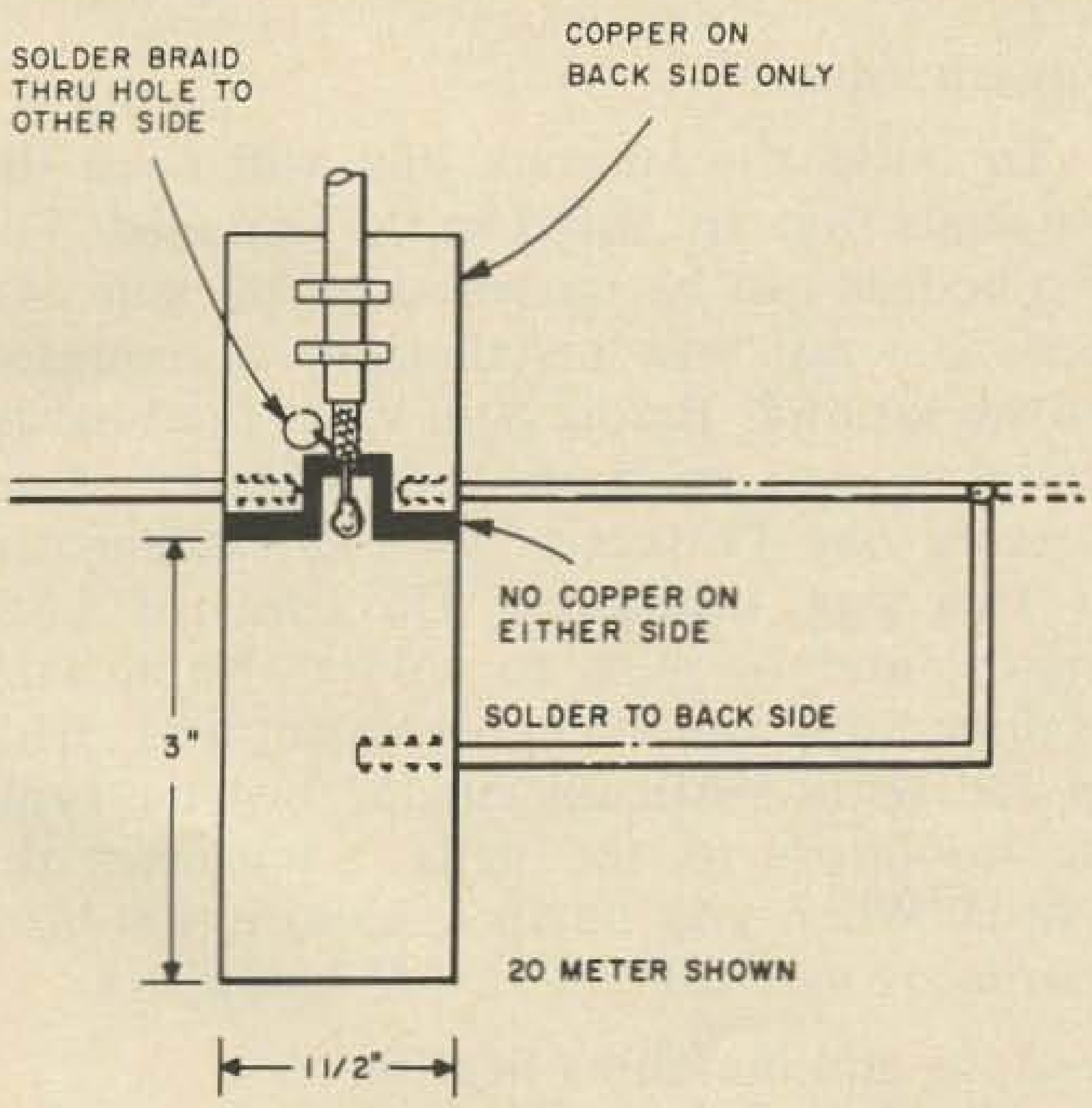



Fig. 1. Details of the improved gamma-match.

The boards should be of either epoxy or polyester. These will absorb less moisture and stand up better in the weather. Newark lists both of these items in their catalog. The epoxy 3x6 is $1.14, # 19F3213. The polyester 3x6 is $ .73, # 19F3228. Kepro is the vender.

Paul A. White, W6BKX

*A Cheap and Dirty 15-Meter Antenna for the Longhaul DX*

*Paul Cook III, WA7CSK*
*2943 N.E. 178th Street*
*Seattle, Washington 98155*

# *The $4.98 Novice Special*

Parts List:
200 ft. of wire
2–2x4 boards, about 12 ft. long
25 ft. of RG59/U coaxial cable
50 ft. of RG58/U coaxial cable
Electrical tape
Solder
4–egg type insulators

There's no doubt about it, with the sunspot cycle where it is now, 15 meters is the best band for the Novice who wants to work the world. Openings to all continents occur daily, and flea powered Novice stations are picking off the rare DX like shooting fish in a barrel. The word seems to be getting out, and now more and more WN callsigns are heard on 15. When the choice DX moves in on frequency, there are even a few pileups – an occurence formerly reserved for 20 meters. If you want to work *ALL* of the DX with good consistency, you're going to have to have a good signal.

Most Novices today run 75 watts into a simple dipole antenna, but if you want to be "top dog" in the pileups, you'll just have to do one better than the next guy. One way of doing this is to increase your transmitter power beyond the Novice limit of 75 watts. However, that just means big trouble with the FCC, so a better thing to do is to put in a better antenna. In this article I'm going to show you how to build a beam antenna that will beef up your signal so that you can really "sock-it-to-'em" on 15.

The antenna that I am going to describe is called a phased vertical array. It consists basically to two 1/4 wave vertical antennas with 1/4 wave radials placed 3/8 wavelength apart. The antenna is fed with appropriate matching and phasing sections and has a gain of about 6 db. This 6 db of signal improvement is the same as if you changed your transmitter power from 75 watts to 300 watts! The antenna is very cheap and easy to build, and you might have all of the parts, so then it may cost you nothing.

## Theory

Basically, the antenna consists of two vertical ground plane antennas placed in "phase" with each other. This means that the two ground planes are placed at a certain distance apart so that the signals from both antennas complement each other and produce higher radiation in one direction. This works the same for receiving. In this way we (1) reduce QRM to stations in other directions because they don't hear us, (2) reduce QRM from stations in other directions because we don't hear them, (3) increase our signal strength in the desired direction, and (4) increase the received signal strength from stations in the desired direction. This all adds up to higher station flexibility and efficiency.

## Construction

To build the antenna you will need the materials that are listed in the parts list. The two boards can be mounted on the side of a roof, like my own installation, or mounted on the ground. Before you erect the boards, pound a nail in each end of both. Then measure out 11 feet of wire and connect it to two egg insulators. Do this for both boards, and be sure to solder. Next, take fishline, rope, or what have you, and string up the wires vertically on the boards, tying the insulators to the nails. Then erect the boards. When you do this, be sure that both boards are vertical and 16-1/2 feet apart.

## Feedline and Matching Section

Now you have constructed the antenna, and it's time to piece together the matching section and feedline.

Take one 11 foot piece of RG59/U 75 ohm coax and splice it to an 11 foot piece of RG58/U 52 ohm coax, as shown in **Fig. 1a.** Do a neat, careful job and wrap the connection well with electrical tape. If you have some Krylon spray, use it on the connection to do a completely weatherproof job.

Get 11 feet of RG59/U and the RG58/U

Fig. 1A

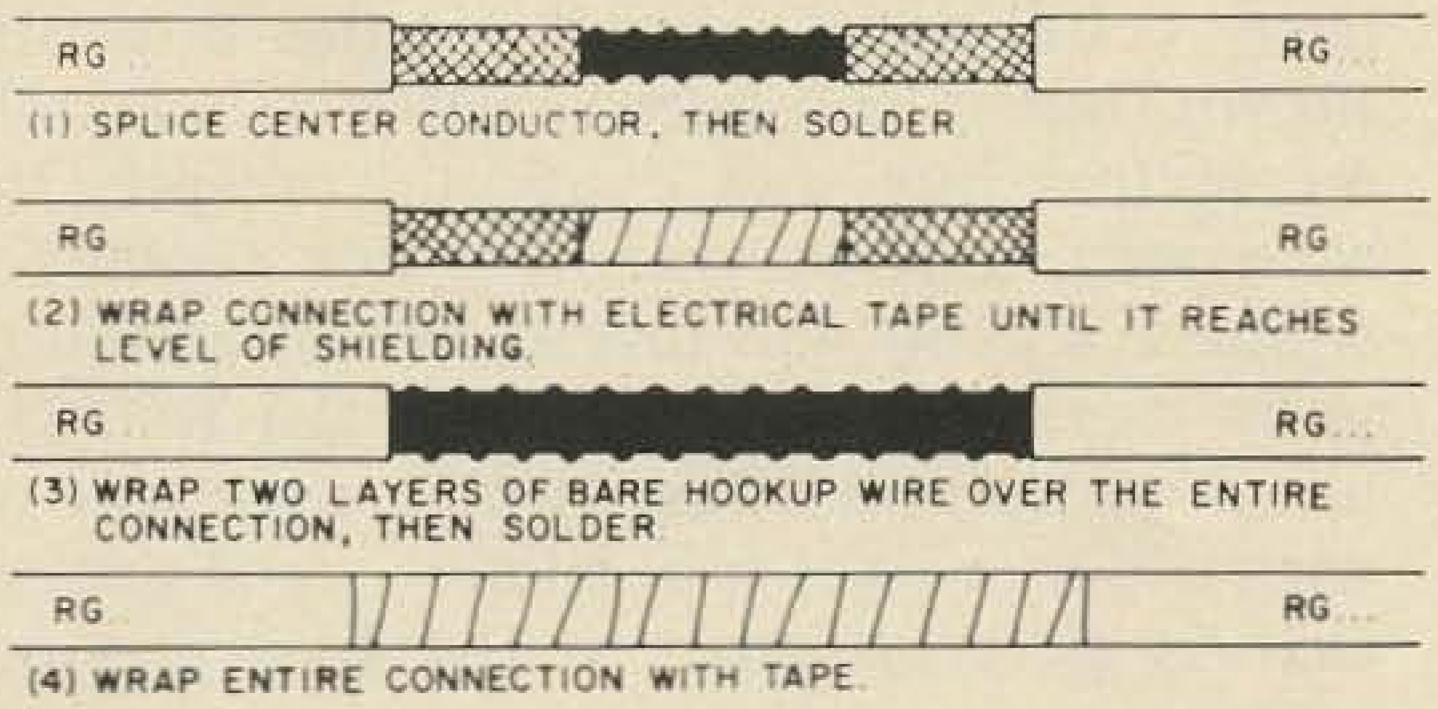
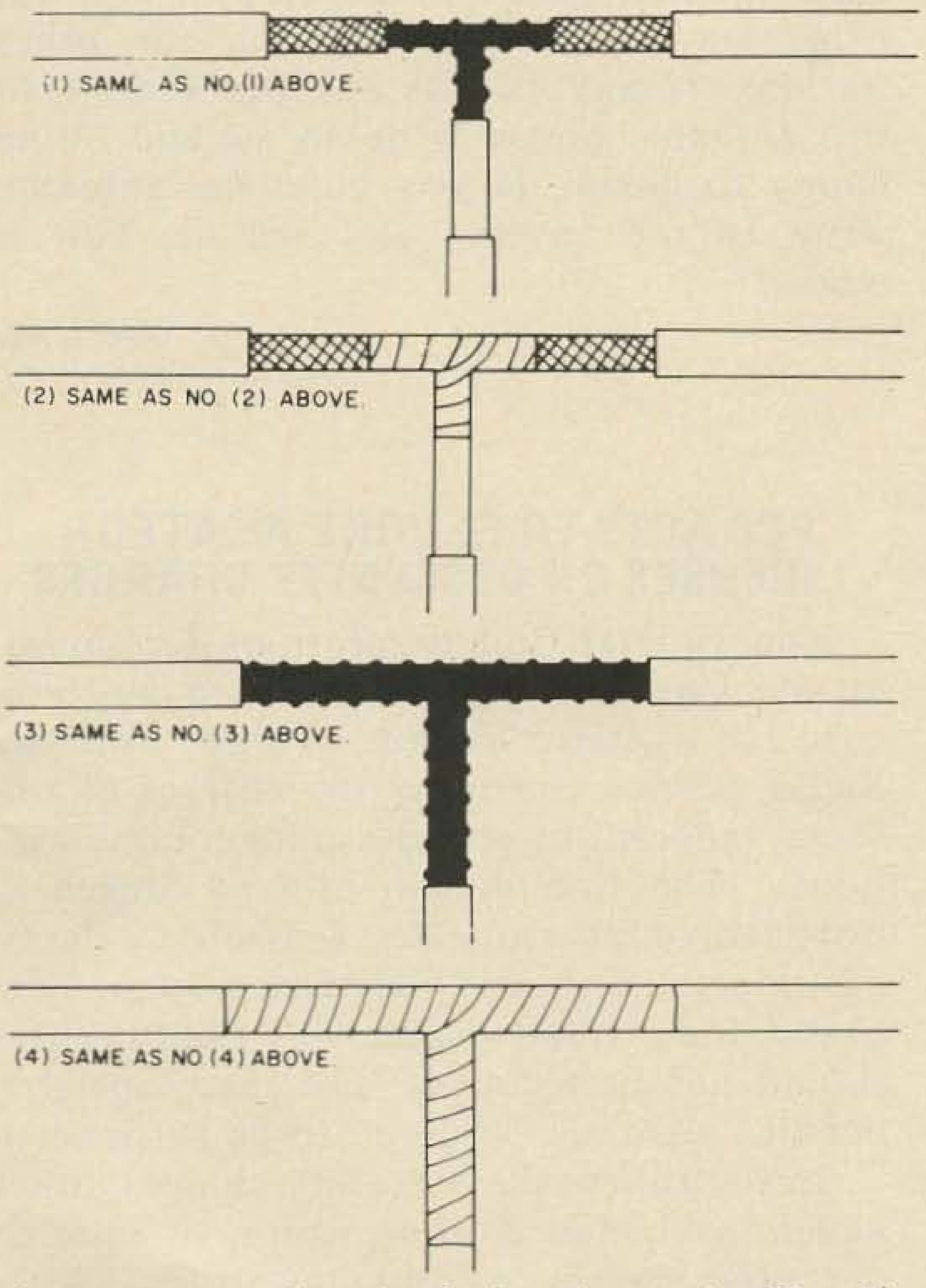



Fig. 1B




that goes to the shack (as shown in **Fig. 2**) and make the three way splice as shown in **Fig. 1b**. Here again, if you have Krylon, use it.

Now lay out the matching section on the ground or the roof. Don't coil up the coax or let any kinks get in it. Instead, lay it out so that it lies in a gentle curve with no sharp turns as shown in **Fig. 2**. Solder the center conductors from the two ends of the matching section to the antenna wires at the base of the boards as shown in **Fig. 3**. Then solder the outer conductor and eight or more 11 foot ground radials to the nail on each base. Run each radial out from the base fairly perpendicular to the vertical boards and lay

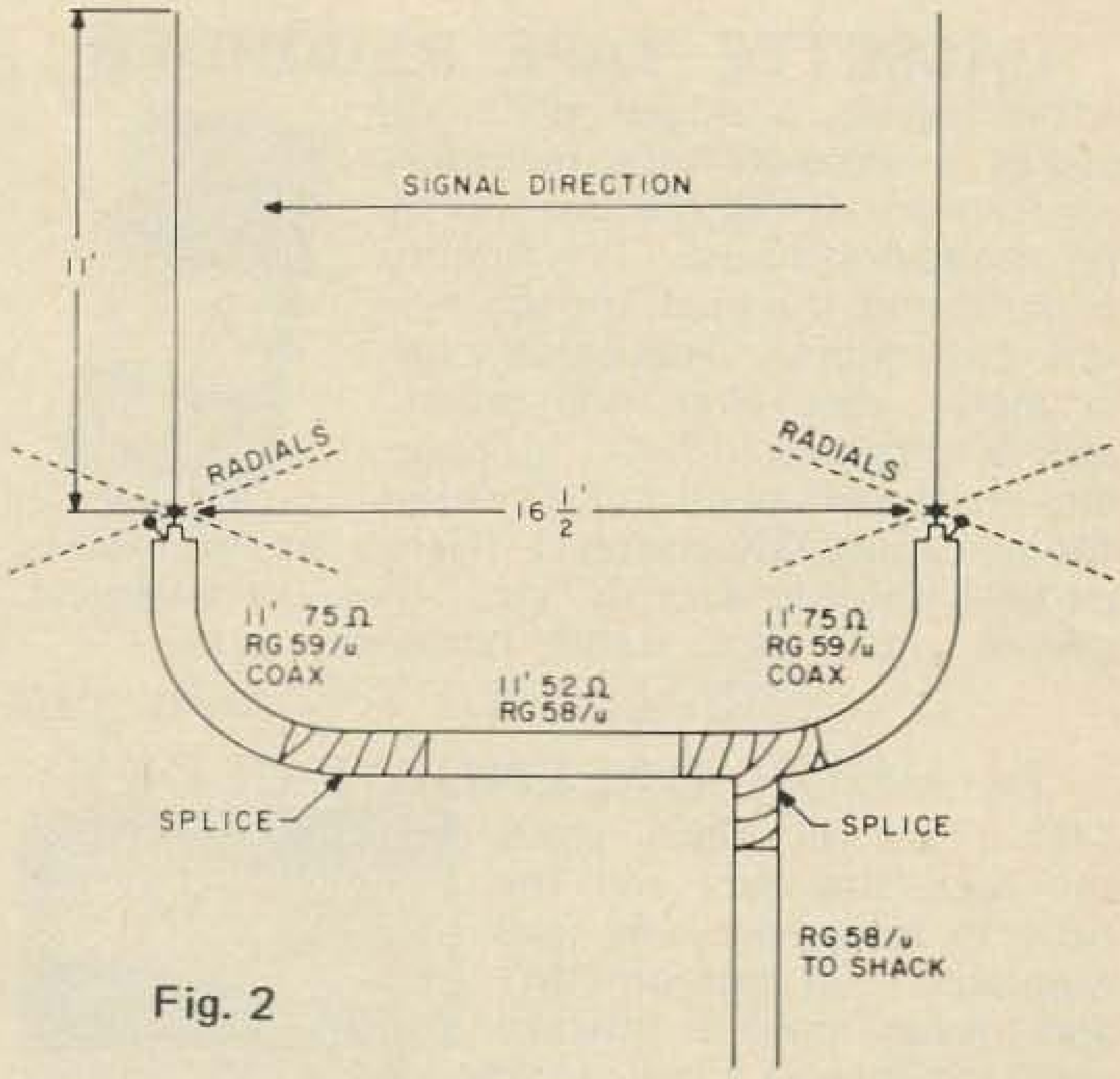



Fig. 2

them on the roof or ground in a fashion similar to the spokes of a wheel. The radials improve the low angle of radiation which brings in the long distance signals better.

**Operation**

Now that you have completed the antenna, try it out on the air! When I tried mine out with the antenna aimed toward Europe the first time on the air, I knocked off two SM's, a G3, and I1, and a DL with only 75 watts. This little antenna is a real bomb! If you wish to change the directivity of the antenna, then substitute PL-259

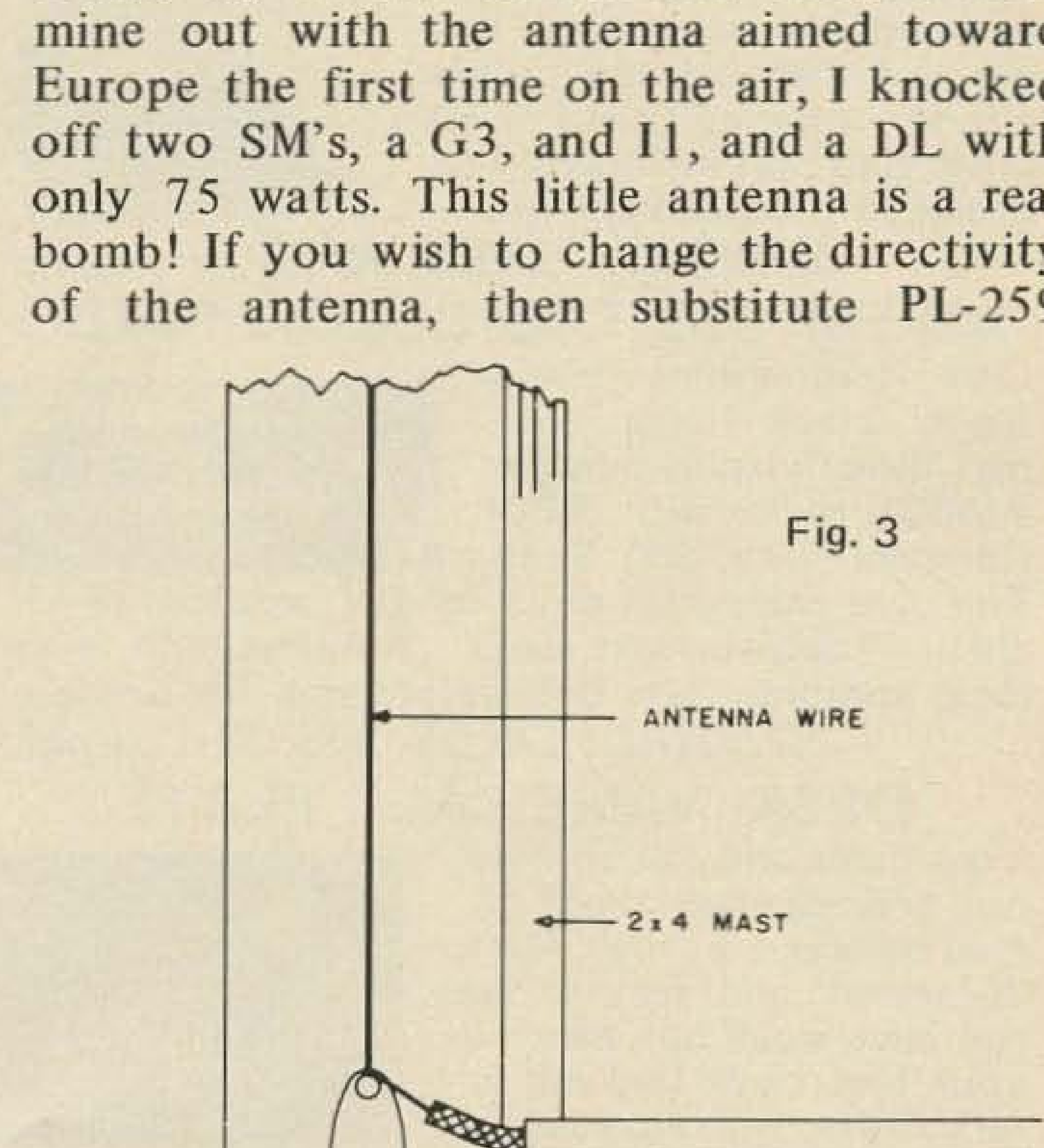



Fig. 3

coaxial plugs, a double female connector, and a Tee connector for the splices. If you connect these as shown in Fig. 2, you will have your signal aimed in the direction shown. But if you take the RG58/U matching section out, and connect it exactly the same way, only on the other side of the Tee connector, you will reverse the direction of your signal. If you leave out the RG58/U matching section altogether, you will end up with a figure eight type bidirectional pattern that is perpendicular to the two previous patterns.

In conclusion, if you try this antenna, I'm sure that you'll work a lot of DX. The antenna is efficient and works well, and will help you to get the edge on the other stations. If anyone has any problems with this antenna, please write to me and I'll be happy to advise. If you build this antenna, write to me anyway and tell me how it works!

. . . WA7CSK

## FCC ACTS TO REVOKE AMATEUR LICENSES ON OBSCENITY CHARGES

The Federal Communications Communications Commission took action today to revoke the operator licenses of three Amateur Radio Service operators on charges of obscene, indecent or profane radio communications. The Commission ordered Steven P. Bowman, of Sikeston, Mo.; Kenneth C. Henry of Anderson, Inc., and Gary Overman, of New Castle, Ind., to show cause why their licenses should not be revoked. The three operator licenses were also ordered to be suspended.

In addition to the obscenity charges, other violations included transmission of false or deceptive signals or communications, failure to identify stations properly, transmission of unidentified communications or signals and willful or malicious interference to radio communications of other amateur stations.

The Commission said that the three amateur licensees had repeatedly and willfully violated the Rules. The enforcement actions followed investigations carried out by the FCC Field Engineering Bureau and the FBI after complaints were received from other amateur radio operators.

Actions by the Commission March 14, 1969, by its Chief, Safety and Special Radio Services Bureau. By Orders, and Orders to Show Cause.

# *How to Fly Your Kite*

*M. B. Crowley, EI4R*
*78 Church Street*
*Listowel, Co., Kerry*
*Ireland*

*(Or a vertical long wire on last year's EIØRF Expedition)*

The location of the expedition "BEAR" island (rechristened "BEER" island) was good, but the shack QTH was surrounded on three sides by mountains. The problem was to put out sufficient wire for our 1.7 MHz bands; and 260 feet of wire can present quite a problem on such a location. A vertical aerial would be fine, but 260 feet of support pole was out of the question on an island expedition. Gas-filled balloons are not easily come by where we were located. The solution—yes—a kite.

Having in mind from my boyhood days the dimensions of a small kite without frills or tails that, once aloft, in a light breeze could be tied to a convenient peg and forgotten about, it seemed to me that this was the ideal solution.

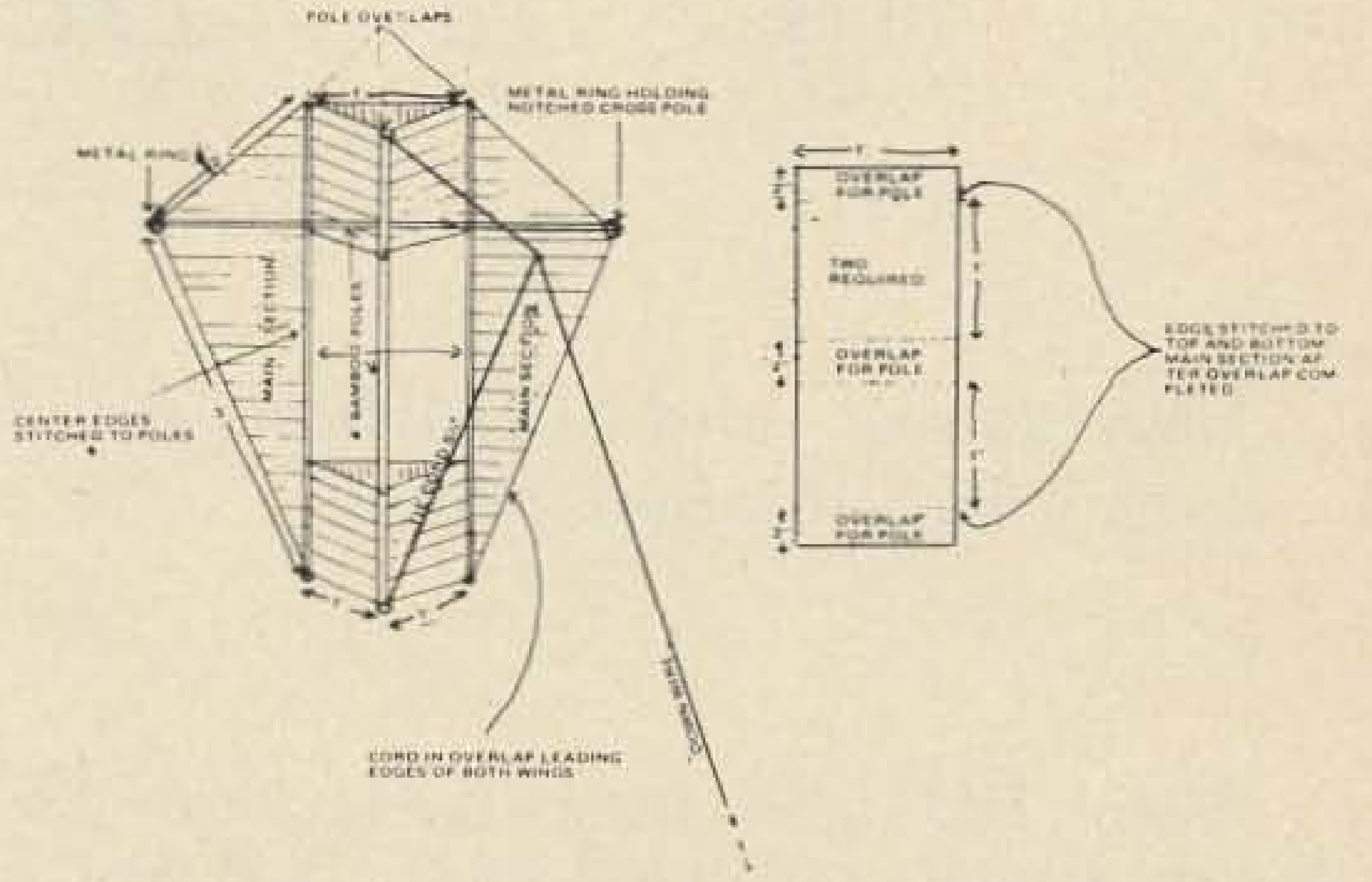
One of our boys gave me some 260 feet of braided copper wire from the old emergency TX "The Gibson Girl" used by aviators in the Second World War. This wire seemed ideal to fly the kite with and weighed only one pound.

Having some half-inch (average) diameter bamboo, garden variety poles on hand, and having persuaded the XYL to let me have some old bed sheets from her junk box, the next undertaking was to scale up the original version of the kiddie kite.

From the diagrams it can be seen that the dimensions and shape are straight forward and present no mathematical problems to scale up to the required size. In my case, this amounted to bamboo poles of 5 feet in length.

The materials required are four bamboo poles, one large section of sheeting and two smaller sections of sheeting. Three lengths of tough light cording are also required. The illustrations give the dimensions of these pieces. When cutting the cloth, do not forget to include that extra width of cloth on the leading edges of the wings, which, when folded back on itself and stitched, will hold the two pieces of cord that strengthen the wing edges.

It would at this stage be advisable to secure the services of the XYL or YL to machine stitch the edging. Go careful here, for this sort of favor could cost you later; why else




do I write this article for 73 Magazine?

The center pieces are stitched with a larger overlap to hold the bamboo poles, which should slip into place with a reasonably tight fit, the ends being then stitched over by hand needle to hold the poles permanently in place.

The overall weight of the kite and poles was 3 pounds. The down wire should be tied approximately a quarter way down the tie cord. Unwind about 50 feet of the downwire and have a helper push the kite up into the wind with the downwire held tight. In a modest steady breeze the kite will lift gently and the remainder of the wire can be paid out. If the kite pulls too hard and slips sideways, tie the downlead further up the tie cord until balance is achieved and the downwire is near vertical. In a light breeze and from the pull on the downwire, it seems to me that this size kite could support about 3 pounds of downwire.

One word of warning. If the breeze is strong, do not allow the junior operator to play around with this size kite. There are easier ways of flying nowadays. Once the kite is aloft, with the required length of wire, tie the downlead to a convenient tie point, through an insulator. A lead to the shack from the tie point will give you a vertical antenna without match, provided the wind remains. Force 9 winds should be avoided as your favorite rig may disappear out the shack window. Happy flying hours, fair winds and tight wires.

...EI4R

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# *In Search of a Better Angle*

*Observations and Suggestions Involving HF Radiation Angle Manipulation*

When HF DX-getting tactics are discussed, sooner or later the subject will center around antennas, for the antenna, coupled with its geographic positioning, will ultimately make or break a DXer. A status is eventually achieved, however, when the serious DXer has put up the largest and tallest antenna he cared or dared to, or a point of "signal strength stagnation" is reached. For most of us this is a frustrating level, for it probably still means an S-unit or three gap between us and the big guns. Even if you feel you're near the top, however, there were undoubtedly times when these extra db would have come in handy. This article is no magic panacea for combatting a W3CRA or W5VA in the pileups, but knowing a little about radiation angle manipulation may give you something to think about along those lines.

**Low angle advantages**

I think many of us have operated enough to realize the importance placed upon an antenna with a very long boom perched upon a very high tower. The fellows with the biggest combinations of these two, possibly coupled with an elegant location, constitute the big guns, or the big DXers and contest winners.

A major reason for their seeming invulnerability is the very low vertical radiation angles associated with such an antenna combination. For normal F2 propagation paths, the best situation is for your signal to reach a distant point in the least number of "hops" or reflections. Up to about 2500 miles or so, one hop propagation is possible, but after that, an earth reflection is necessary. Now the signal is being decreased by a number of losses; most pertinent here are distance losses due to spacial spreading, and ground losses at each earthly hop. Distance loss is of course a function of distance; a lower reflection angle means less distance travelled and therefore less loss than a higher angle, although the difference may only amount to a db or two. Much more important are the ground losses. While sea reflections are less critical of incident angle, ground reflections may result in four or five db differences per hop between low and high angles, depending upon frequency (1). Here is one place where the big guns clean up! One or two less of these lossy earth hops experienced by signals approaching from a high angle and we're talking about S-units of difference. Fortunately, all is not this rosy for the people with the low take-off angles.

**NBS observations – good news?**

The good news is that in most cases, these things I just talked about occur only for "storybook" propagation under ideal conditions. What about the real world? W. F. Utlaut presented an interesting report along those lines in our National Bureau of Standards research journal *Radio Propagation* where he made a detailed study of radiation angle importance. The results were slightly astounding (2).

Using a VOA transmitter in Munich, Germany, and receiving antennas in Boulder, Colorado (a receiver was also located in Slough, England, but results were consistent with those in Boulder), all with carefully calculated radiation patterns, Utlaut attempted to find out if low angles were that

| Boulder Antenna | Height *ft* | Radiation Angle *deg* |
| --- | --- | --- |
| 1B | 50 | 15.6 |
| 2B | 135 | 5.2 |
| 3B | 310 | 2.3 |
| 4B | 485 | 1.4 |
| 5B | 985 | 0.7 |

Table 1

good. From March to June, 1959, on 20 MHz, the Munich station transmitted while the receivers in Boulder carefully recorded daily signal variations. Five receiving antennas were used, varying in vertical radiation angle from .7 to 15.6 degrees. **Table 1** lists the various antennas, heights, and associated radiation angles, while **Figs. 1A, 1B, 1C,** and **1D** are graphs of hourly median signal strength for the Munich to Boulder path from March to June. Transmitting antennas at the Munich end were rhombics and vertical main lobes between 12 and 16 degrees (two antennas used).

While receiving data extended through times when the predicted MUF (Maximum Usable Frequencies) were below the operating frequencies, this may be slightly impractical from the amateur standpoint where relatively low power is usually employed. Close inspection of **Figs. 1 A-D** will bring out a number of interesting points:

1. No one radiation angle dominated for an entire average day during the time the band was open. (MUF greater than 20 MHz.)
2. Low angles seemed more of an asset during a summer month (June) than during a spring month (March). In addition, the spread of signal strength between one angle and another was greater during the summer months than during the spring.
3. Lower angles were characteristically "band openers" with dominance here noted in excess of three S-units over the highest angle.
4. Higher angles seemed valuable during the midday hours, with some advantages over the lowest angle in excess of two S-units at these times. (Remember, these were monthly averages; there were undoubtedly times when these differences were greater.)

The basic observation by Utlaut in this report was that statistically, and over an average 24-hour period, best results could be gained by using the lowest radiation angle possible. This involved times when the predicted MUF was much below 20 MHz; which

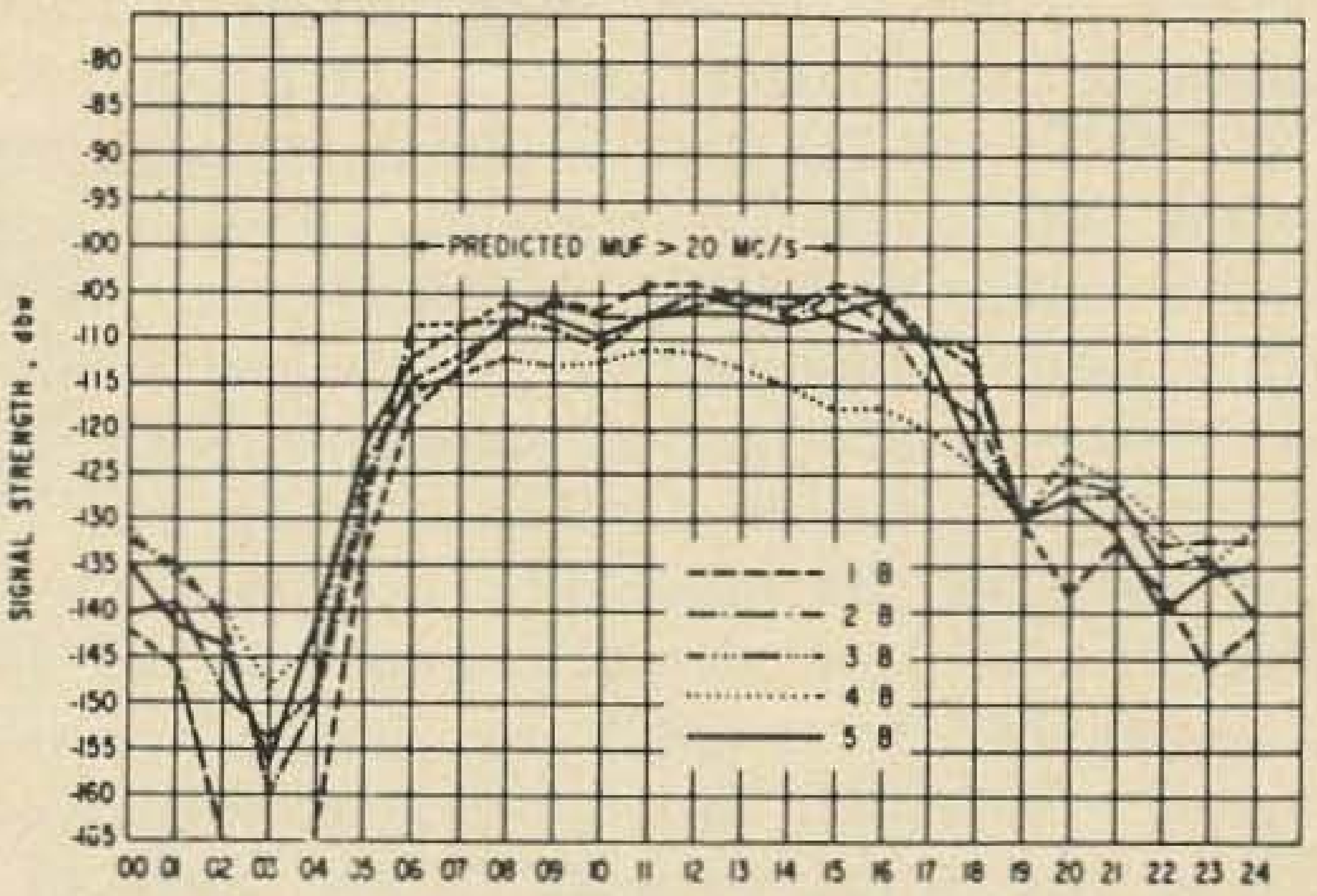

Fig. 1A. Hourly median signal strength for Munich to Boulder path, March, 1959.

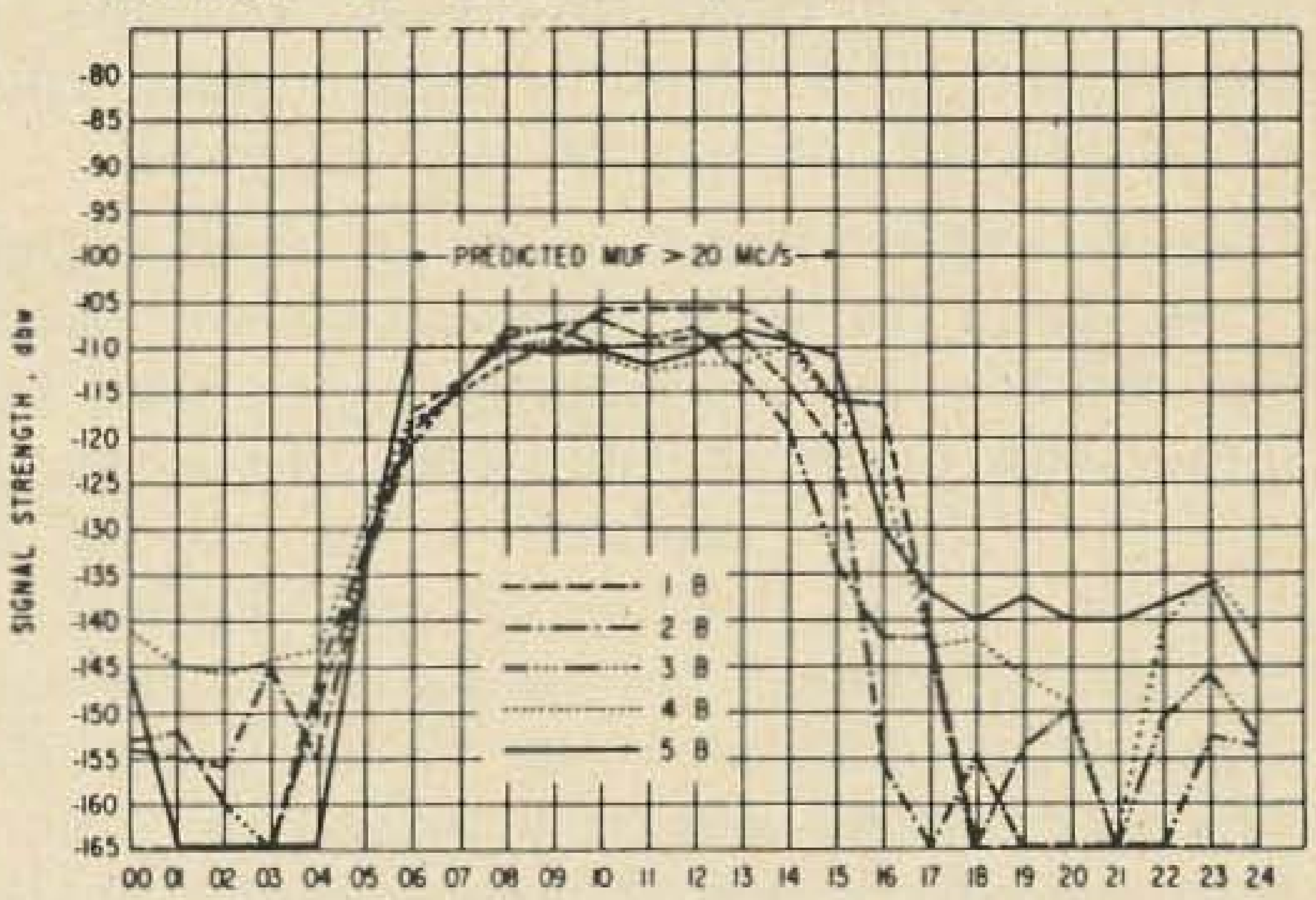

Fig. 1B. Hourly median signal strength for Munich to Boulder path, April 1959.

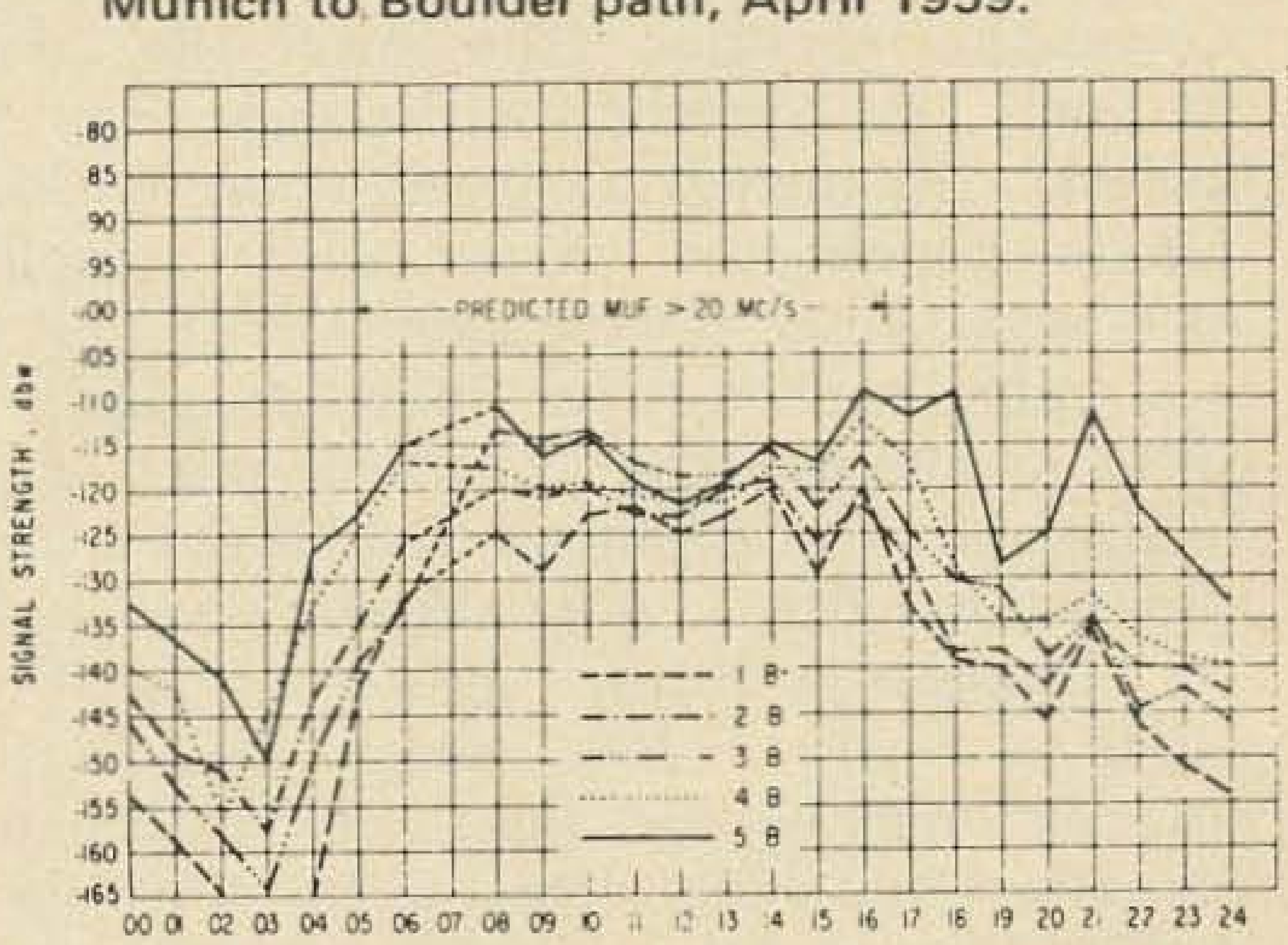

Fig. 1C. Hourly median signal strength for Munich to Boulder path, May 1959.

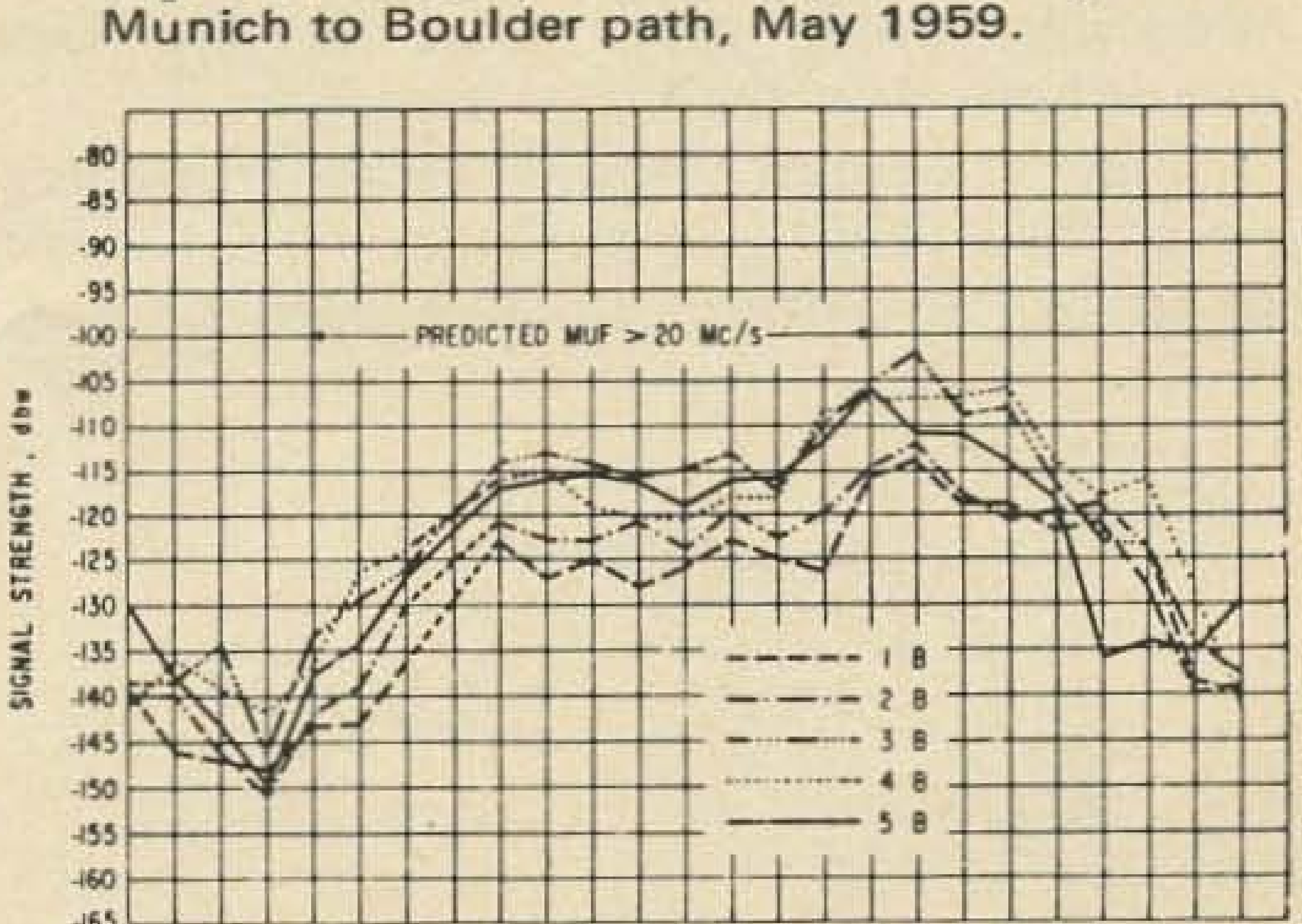

Fig. 1D. Hourly median signal strength for Munich to Boulder path, June, 1959. Transmitter in all cases was off the air from 0600 to 0800 MST. (1)

would probably mean communication below amateur capabilities. Looking at times when the MUF was 20 MHz or above, or when the band was open for possible amateur contacts, seems a slightly different story, with the "best" angle rapidly changing with time. The two most practical antennas, with realistically achievable angles, were 1B and 2B, representing the small time DXer (height 50 feet, angle 15.6 degrees) and the big gun (height 135 feet, angle 5.2 degrees) respectively. Although most differences between these two antennas were in the range of 5 db, special note should be taken of the April graph at about 1600 MST when antenna 1B (small time DXer) had the astronomical edge of 40 db over antenna 2B (the big gun)!

**Possible explanations – ray paths and angles**

Reasons for such phenomona are varied but usually of a complicated nature; the important point is that they do exist. A possible "easy" answer seems to lie in another recent finding by our Bureau of Standards; while a low radiation angle nets great skip distances, in most cases the absolute longest skip is achieved by a very high angled ray. **Fig.** 2 illustrates. Ray paths 1, 2, and 3 follow the generally accepted propagation theories – the lower the take-off angle, the greater the distance. Ray 5, however, the highest angled ray before ionospheric penetration takes place, actually out-distances the lowest angled ray! This is apparently the case for most propagation paths, as shown in another NBS graph, **Fig.** 3. This shows in a general case, that for any skip distance D, two ray paths are possible at any frequency below the exact MUF – either a high or low angled ray. Note, however, that the high angled ray is critically dependent upon the correct angle. Note also, in **Fig.** 2 again, that the high angle signal is spending much more time in the lossy ionosphere than the lower angles.

**Fig.** 4 depicts even a more frightening possibility. This is a government ionogram, or graphical picture showing path time ver-

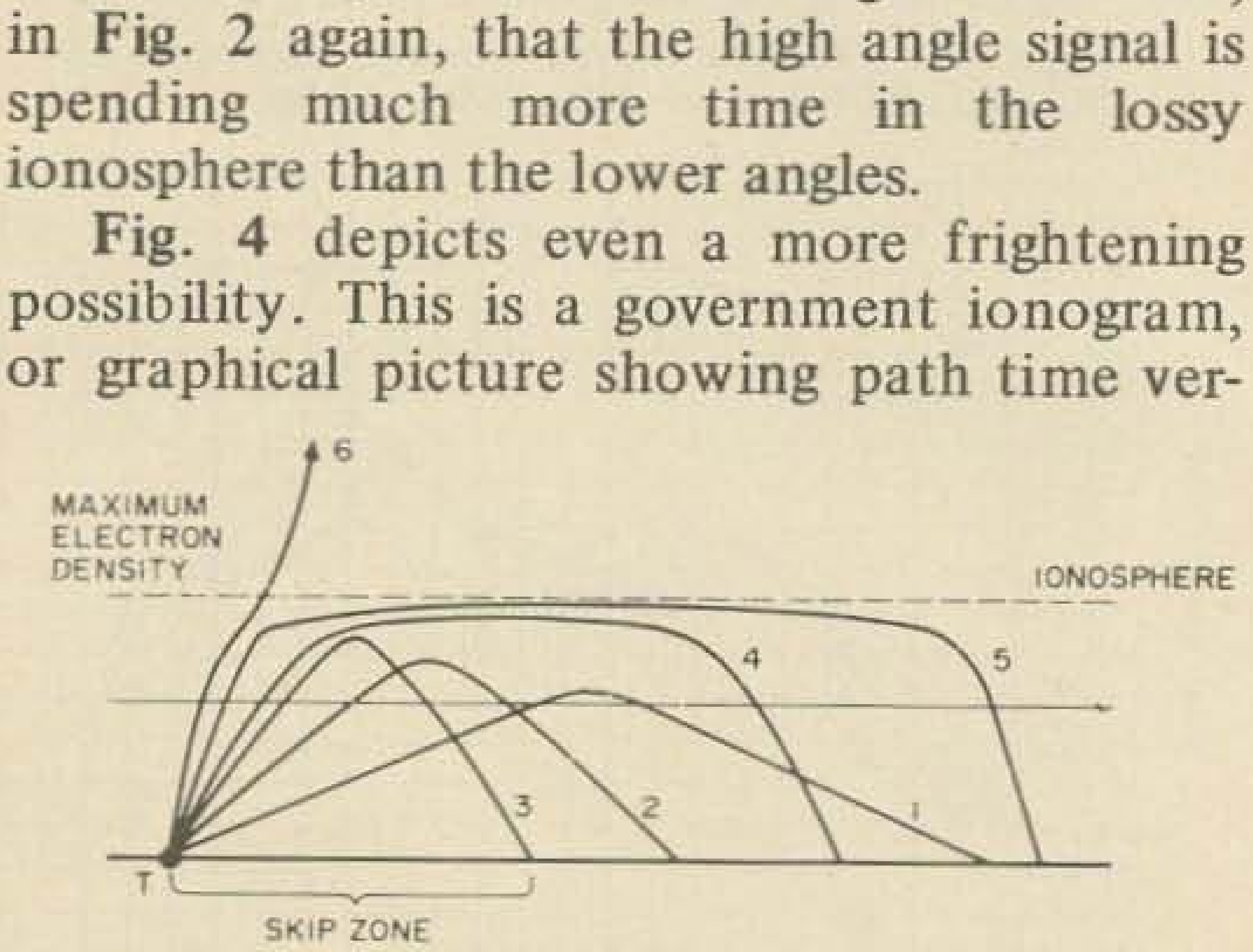


Fig. 2. Possible ray paths at a fixed frequency with varying vertical radiation angle. Note that the highest angled ray, #5, outdistances even the lowest angled ray, #3. (2)

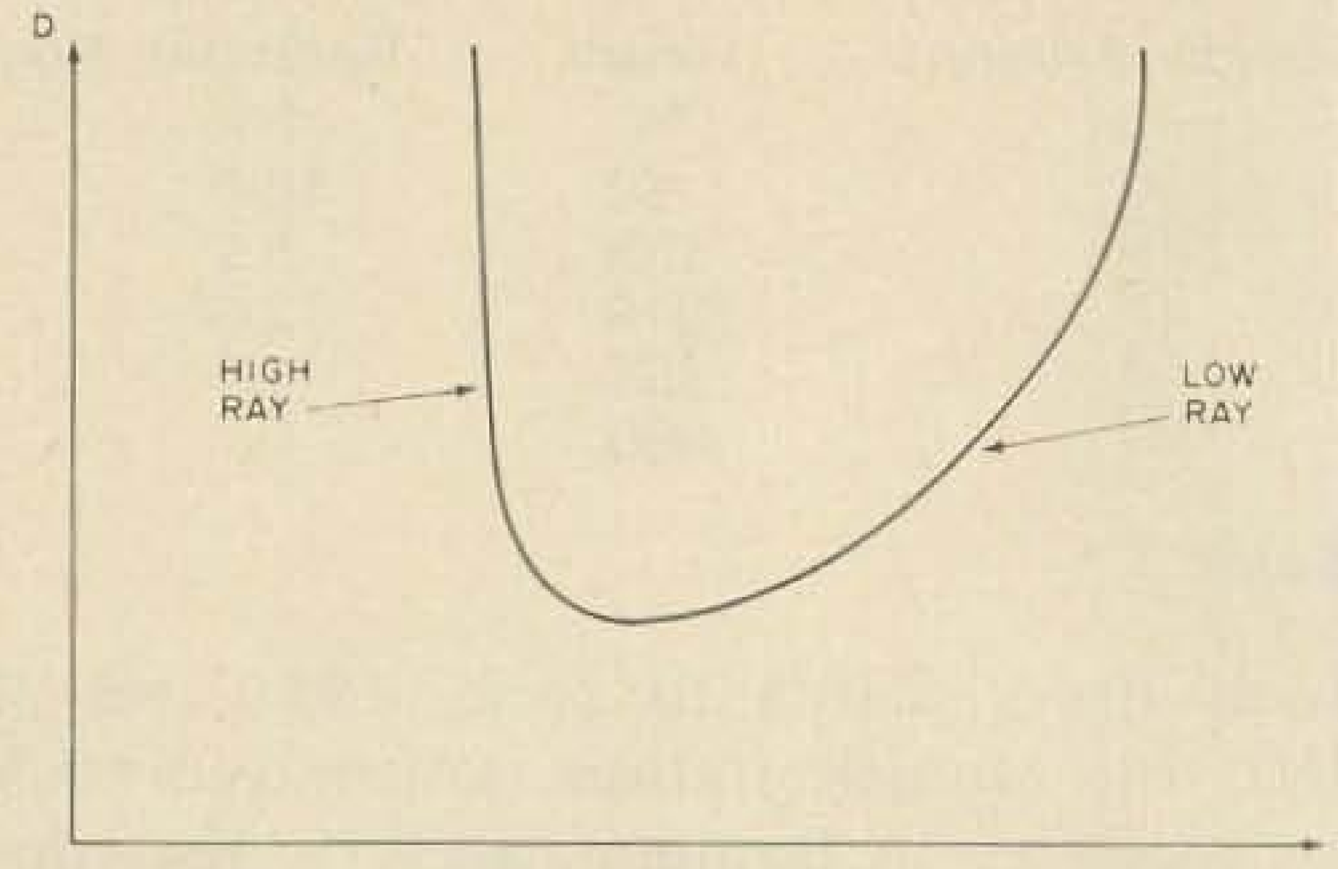


Fig. 3. Variation in skip distance D with vertical radiation angle Ø. Note how critically dependent the skip distance is upon small changes in angle for the high ray. (2)

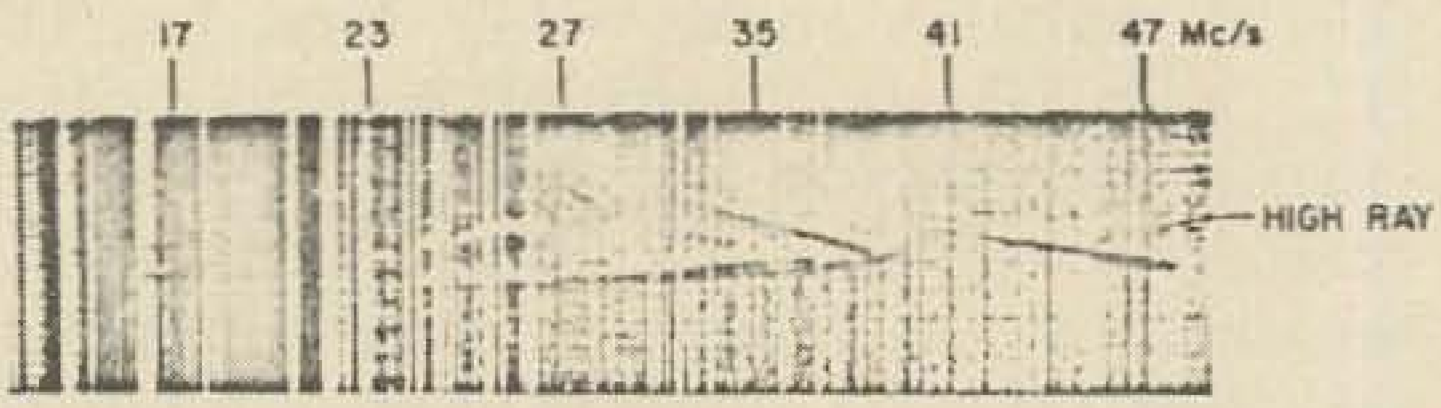


Fig. 4. Ottawa, Slough ionogram for November 14, 1957 at 1556 UT. Note that above 39 MHz only reflection of the high angle ray occurs. (2) (By permission of the Chief Superintendent DRTE.)

sus frequency, for, in this case, an Ottawa to Slough, England path. The horizontal lines show the high and low rays as reflected by a pulsed signal. The "omigosh" data here is that above 39 MHz, reflection occurred *only* with the high angle ray; low angle reflection was simply nonexistant!

A few more easily talked about reasons for the "best" angle to vary involve the great number of possible paths that a ray may "use" when skip distances are great. **Fig.** 5 illustrates two cases that could prevail along a DX path, although any combination of these hops are possible. Sporadic E clouds enjoy floating around, particularly during the summer months, and may enhance or belittle a band opening if one is hit. Since they are relatively small, a difference in take-off angle may result in a miss by one station, a hit by another, constituting different paths travelled, and ultimately differing signal strengths at the DX end. A similar situation may exist for the more stable E and F1 layers as well. Also, as suggested in **Fig.** 3, the number of possible paths decreases as the operating frequency approaches the MUF. The NBS tests were started in the spring, with the daytime MUF much above the operating frequency at that phase of the sunspot cycle, so many combinations of paths were possible. Many were apparently high angled paths. As summer approached, the daytime MUF was nearer 20

MHz, and consequently less paths available; the last path to go (at the exact MUF) apparently is characteristically low angled, hence the better results with low angles in the summer. Finally, the ionosphere is full of simple flaws, such as "thin" and "thick" spots, holes, and tilts, all of which play important roles in determining which path a signal may take, and all of which in some way are connected with the incident signal's vertical takeoff angle. What I'm trying to say is that there apparently is no year-round "best" angle, and for consistent results, it would be nice to be able to change the antenna's radiation angle quickly and accurately.

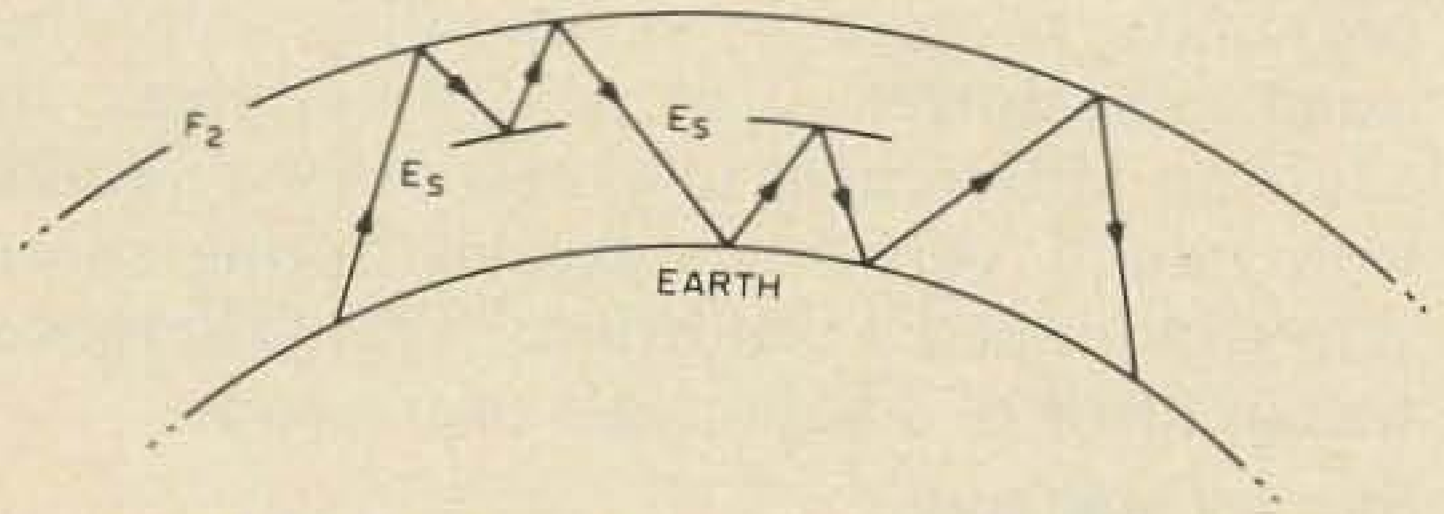


Fig. 5. Possible ray paths for typical $F_2$ propagation. Any combination of these F and E-layer bounces may occur.

### Three methods and results

Accomplishing this accurate radiation angle change is not as hard or expensive as might be guessed; many DXers have undoubtedly tried the suggestions I'm about to present and have, hopefully, met with some degree of success. I'll concern myself with horizontally polarized antennas only, since they are not as greatly subject to ground losses that vary from place to place, and since they are more highly regarded in DX circles.

The vertical radiation pattern of anyone's antenna is, of course, a point by point multiplication of antenna's free space pattern and the ground reflection pattern. The free space pattern is dependent upon the antenna's ability to focus the signal; the lobes or plots of transmitted intensity from such an antenna will lie at an angle of zero degrees with the horizontal. Ground reflection patterns of any horizontal antenna are basically a function of antenna height above a perfect ground. These two patterns, plus a small compensation factor for those of us without a perfect ground, as well as considerations for trees, buildings, wires, or other obstructions, make up the real radiation pattern. **Fig. 6** shows a simple example of this three step process.

### The Armstrong method

Antennas with parasitic elements are little

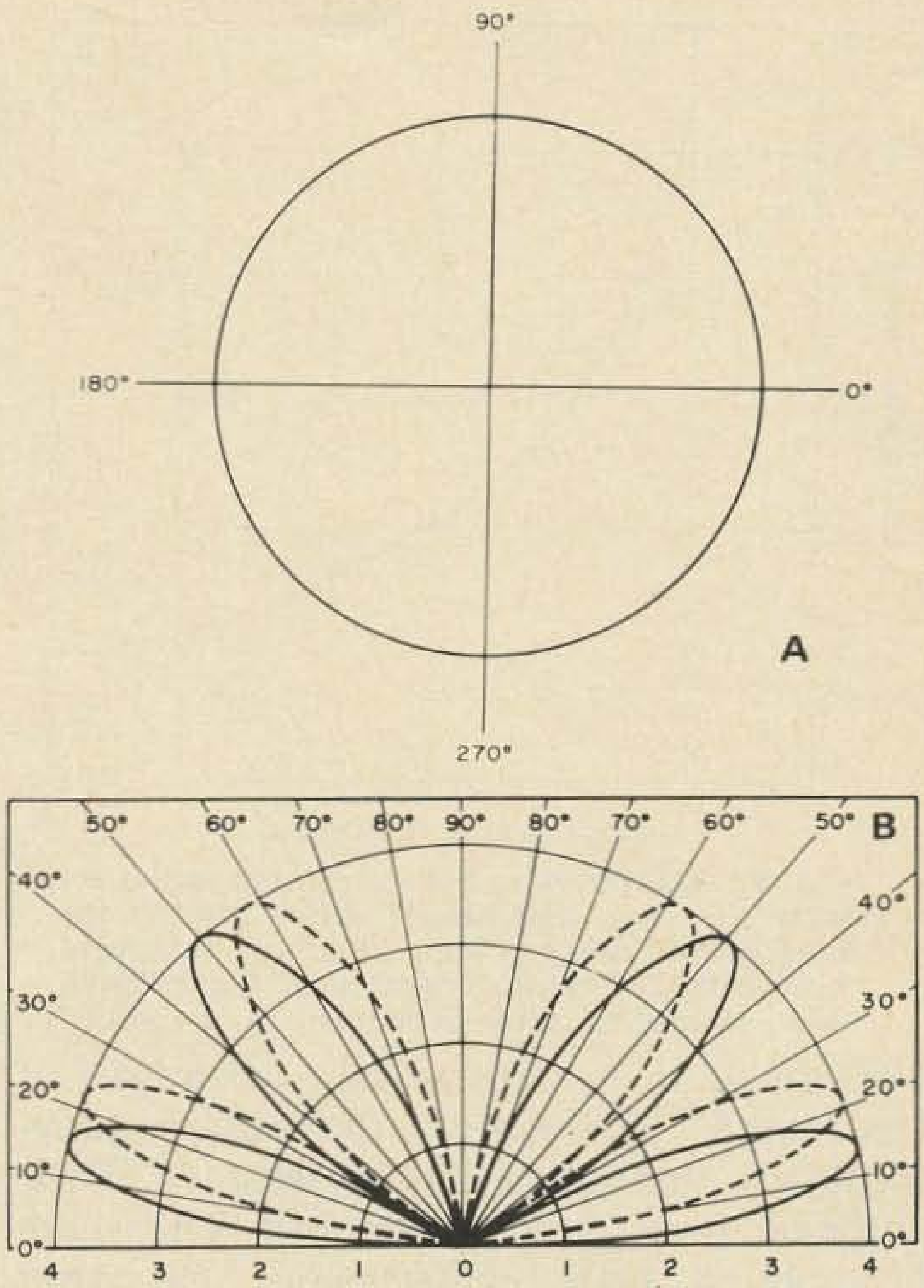


Fig. 6. Example of real radiation pattern determination. Fig. 6A is the vertical pattern of a half-wave dipole in free space for a plane perpendicular to the wire axis. Fig. 6B is the vertical ground reflection pattern in all directions for such an antenna at a height λ above a perfect ground. At the same time, 6B is the ideal resultant when A and the ground reflection pattern are multiplied together point by point for a plane perpendicular to the wire. The dotted line represents a possible final result taking into account obstructions and a less than perfect ground. (3)

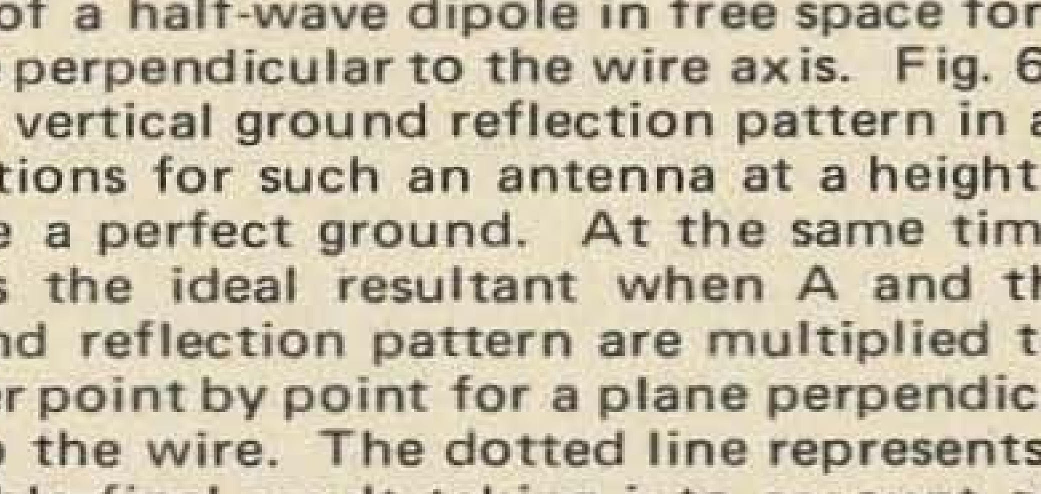


Fig. 7. Overlayed patterns of a reference dipole and a three element parasitic array, both at a height of one wavelength. Vertical lobes of both remain at same angle of elevation and depend only upon height above ground. (4)

different in these respects, as shown in **Fig. 7**. Probably the simplest method of radiation manipulation, then, would involve changing the multiplicative ground reflection pattern. Since for horizontally polarized antennas, the ground reflection pattern is a function only of height above ground, this is easily accomplished by varying the antenna's height. **Fig. 8** shows graphically this relationship for antennas over flat terrain. Note how

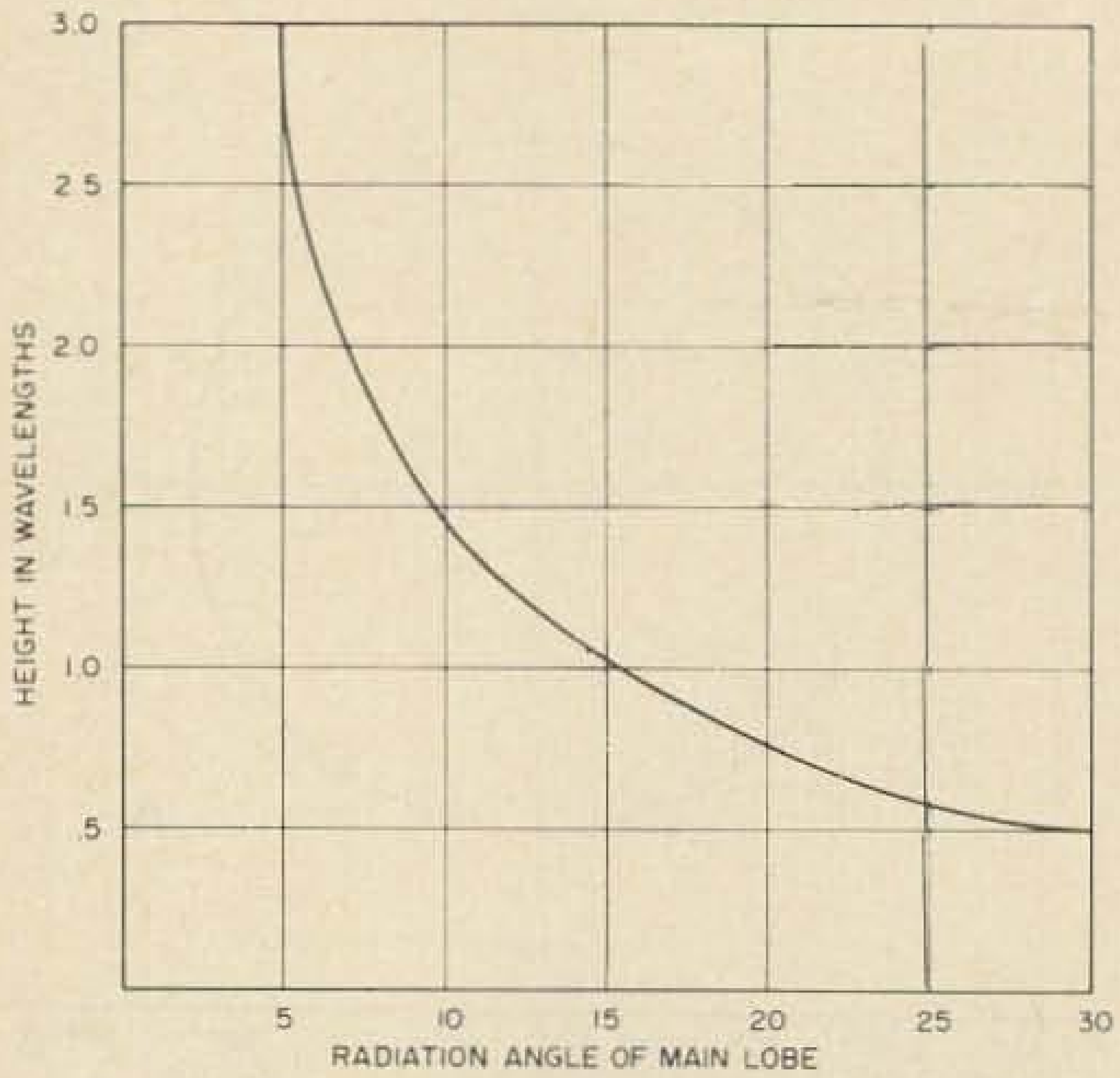


Fig. 8. Relationship between main radiation lobe elevation and height above ground for horizontal antennas above flat terrain. Note how difficult takeoff angles of less than 5 degrees are to achieve in such a situation.

difficult it is to achieve take-off angles of less than 5°. Fortunately, the severe requirements of this graph can be lessened if the antenna foreground is sloping. The math becomes a little embarrassing, but your actual radiation angle can be calculated in such a situation. A more complete analysis is given in "Radio Transmission in the Lower Atmosphere" by Bailey, Bateman, and Kirby, *PIRE,* October, 1955.

Lowering or raising the antenna is then a distinct possibility and although frequently practiced, it's usually agonizingly slow, and hard on arms and winches. It can be helpful, however, for short operating periods, such as contests or DXpedition chasing, when the lowering or raising need only be done once or twice per day.

**Stacking**

A much better method involves vertical stacking. While not going into the rigors of stacking dimensions, (A very good analysis can be found in "Optimum Stacking Spacings in Antenna Arrays" by H. W. Kasper, K2GAL, *QST,* April, 1958.) I will say that for best results, the antennas should be stacked for maximum gain, with the bottom bay at least λ/2 off the ground, more if there are numerous obstructions. For three element yagis, this involves spacing of at least 3/4 λ, a troublesome distance for 14 MHz, but a distinct possibility on 21 and 28 MHz. Aside from the three db maximum attainable gain if done correctly, this stacking sharpens the vertical lobes, although the antenna's actual height is now at the midpoint between antennas.

Interesting results can be achieved if an antenna switch is employed to change between any of the three possible antennas which are now present – top bay, bottom bay, and both bays, each with differing radiation angles. This type of arrangement is employed at a local station, K9CSW. Here two three element duoband quads are stacked vertically, with the top bay at 77 feet, and bottom bay at 37 feet, slightly less than optimum for 20 meters, but decent on fifteen. Results have been somewhat encouraging, and appear to bear out the critical dependency on radiation angle that was hoped for. The bottom bay has no doubt made such a poor showing due to its close proximity to ground, surrounding it by the usual city clutter of wires and buildings. In addition, differences in excess of two S-units were noted between antennas during short skip (Sporadic E) conditions. This difference was in favor of a high angle over a low.

**Sneaky stacking**

A final method involves feeding the stacked antennas slightly out of phase with each other, thus raising the main radiation lobe. The advantage here is that the 3 db that may have been gained by stacking is always present, as was not the case in switching the antennas themselves. Fig. 9 is a theoretical example. For two stacked arrays, A and B, 3/4 λ or 270 electrical degrees apart, best results are achieved when both antennas "look" electrically identical and are fed exactly in phase, with precisely cut equal feedlines. This gives a low main vertical lobe; for simplicity's sake, we'll call it zero degrees to the horizontal. To raise this main lobe, the signal must reach antenna B before antenna A. For a rise of 10°, as illustrated, this required the feedline to antenna A to be longer than that to B by a distance D. Using simple trigonometry, dis-

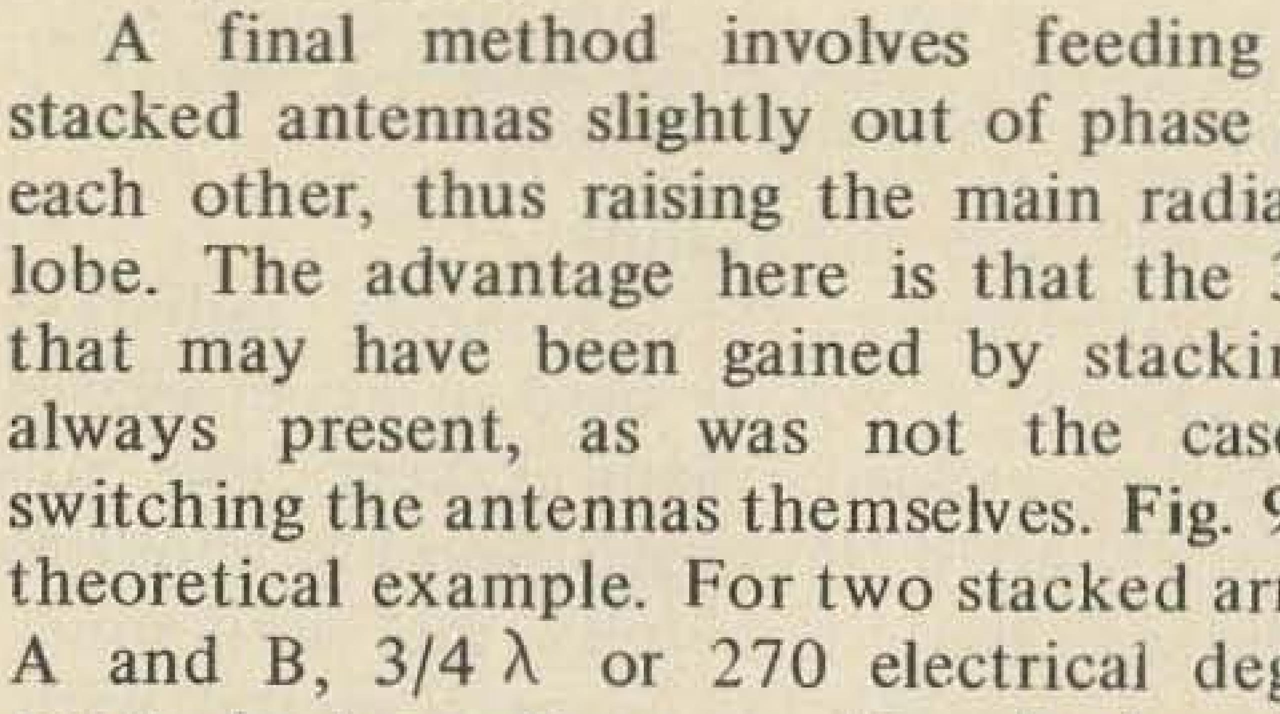


Fig. 9. To raise the main vertical radiation lobe in a vertical stacking situation, antenna A must differ in feedline from antenna B by a length D. Length D depends upon the desired angle x: here we used **10 degrees.** Angle y is also 10 degrees; therefore D is equal to tangent 10 degrees times the stacking spacing, or .132λ. (See Fig. 10)

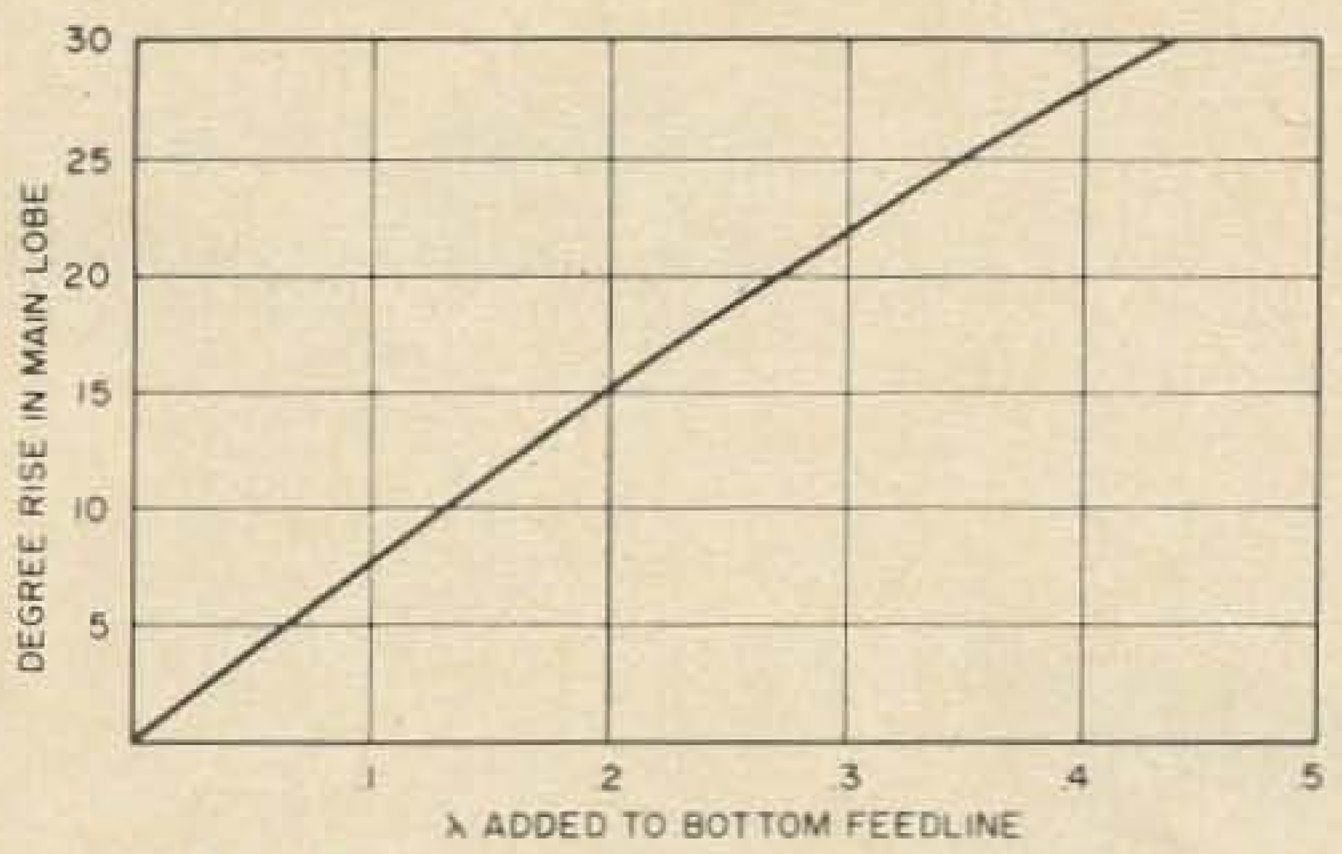


Fig. 10. Graph of wavelengths of feedline to be added to the top antenna in a stacking situation (Fig. 9) for raising the main vertical radiation lobe up to 30 degrees. This will only work for 3λ/4 stacking spacing.

tance D is found to be .132λ. To simplify things, this feedline difference has been plotted in **Fig. 10**. Note that this is only for a stacking spacing of 3/4λ.

A similar arrangement is being tried at K9CSW, with calculated switch positions of 10, 15, and 20 degrees, but results are a little hazy. Possibly the lobes are simply too broad to make a noticeable difference when shifted only a few degrees. Quads are partially stacked antennas themselves, so elevating the main vertical lobe any appreciable amount adds importance to usually insignificant side lobes. It's also quite difficult to keep two quads looking electrically identical for very long. One distinct advantage was noted here, however, over simply switching antennas. Some types of "city noise" apparently arrive at very distinct angles; manipulating the lobes in this manner often resulted in noise reduction on the order of two S-units. In some locations, this may be more valuable than any outgoing signal strength additions.

**Conclusion – suggestions and more problems**

The question I've still left partially unanswered is exactly what are the best angles? Bill Orr's *Beam Antenna Book* lists the range of optimum angle of radiation as in **Table III**. This is apparently inconsistent with those findings by Utlaut, (see **Fig. 1**) who found the very best angle to be the lowest tried, .7 degrees, much lower than the supposed 7 degree minimum. This was in light of the fact that the transmitting antennas in this case utilized realitively high angles (12 or 16 degrees) for main lobes. Although only listed for four months, Utlaut's signal strength versus time averages do show definite seasonal variations; low angles did seem valuable during a summer month (June or July) when the rule seemed the lower the better for the time the band was open. The spring months, however, pointed out the advantages in ability to vary the radiation angle, since higher angles dominated for much of the "band open" time. Results at K9CSW have varied, but seem to agree with this trend. Certainly an accurate yearly pattern could be worked out for a particular DX path, but the effects of other phenomena (sunspot number change, ionospheric storms, north-south tilts, etc.) that may be encountered along the variety of paths a DXer is interested in would make the game quite involved.

| Band | Range of Optimum Angle of Radiation | "Optimum" Antenna Height |
|---|---|---|
| 7 mc | 12° – 40° | Above 45' |
| 14 mc | 10° – 25° | Above 40' |
| 21 mc | 7° – 20° | Above 38' |
| 28 mc | 5° – 14° | Above 34' |

Table III. Geometrically determined "optimum" radiation angles for the ham bands. (4)

Another problem was encountered at K9CSW. Although signal strength differences were sometimes reported in excess of two S-units for one angle over another, it was rare when a same difference was noted on received signal strength. Apparently many DX paths are not completely reciprocal. This is a good thing or we might have to worry about accurately matching the DX station's vertical radiation pattern, but adds to the confusion when trying to decide which angle to use to be heard the best. Even in cases when signals received on both ends were enhanced, the difference was usually not detectible unless two-way key down S-meter tests were run. In contests or chasing a DXpedition, these key down tests are a little hard to come by; the need for some sort of system is apparent. Since accurate angle of arrival measurements are expensively complicated, perhaps only trial and error can devise such a system. It's hoped, however, that such a system actually exists, for it could pay off in great dividends for the serious operator, greatly adding to the effectiveness of even a modest antenna.

. . . K9YOE

**References:** 1. Davies, Kenneth. *Ionospheric Radio Propagation*, (Washington, D.C. U.S. Government Printing Office, 1965), Ch. 4. 2. Utlaut, W.F. "Effect of Antenna Radiation Angle Upon HF Radio Signals Propagated Over Long Distances," *Journal of Research of the NBS–Section D. Radio Propagation*, (Volume 65D, March-April 1961), 167-174. 3. The American Radio Relay League. *The ARRL Antenna Book*, (West Hartford, Connecticut: ARRL 1956) Ch. 2. 4. Orr, William I. *Beam Antenna Handbook*, (Wilton, Connecticut; Radio Publications, Inc., 1955) Ch's. 1 & 6.

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*Crystal Stability with VFO Convenience*

# FSK Exciter

A couple of years of chasing out of tolerance ARC-5's used as vfo's ruled out that approach. And anyone who has tried building a vfo in the 3 to 7 MHz range will testify that obtaining a stability of 20 to 50 Hz is not the easiest of chores.

Some thought was given to shifting a vfo off frequency during standby, and this approach is very workable.

A better idea, however, was to borrow the basic concept from the Northern FSK keyer, which uses a 200 kHz oscillator beating against a crystal in a balanced modulator.

One item (available on surplus) which seemed ideally suited to the job at hand was the sub-assembly O-17-ART-13A.

This is a low frequency pto covering the range of 200 kHz to 600 kHz in three bands and is used in the AN-ART-13. The unit uses a 1625 tube, has a very fine, slow tuning dial, and is extremely stable.

(Note: If this pto cannot be obtained, don't throw out the idea. A 400 to 600 kHz vfo is not difficult to construct around a standard 455 kHz bfo coil, and stability relatively easy to obtain at this frequency.)

Since the pto would be the "variable" portion of the frequency control it seemed desirable to use it without modification. This could be done by shifting the crystal. It would minimize the unwanted frequencies if the exciter output were one half the transmitter output frequency.

Actual construction is straightforward and nothing is critical. Most parts may be freely substituted within a reasonably wide tolerance. The work and testing may be divided into four stages.

1. The power supply may be any 200 – 400 v source. 12 v is necessary for the heater of the 1625. The other tubes may be either 6 or 12 v types, depending on the supply. A VR150 and a VR105 or equiva-

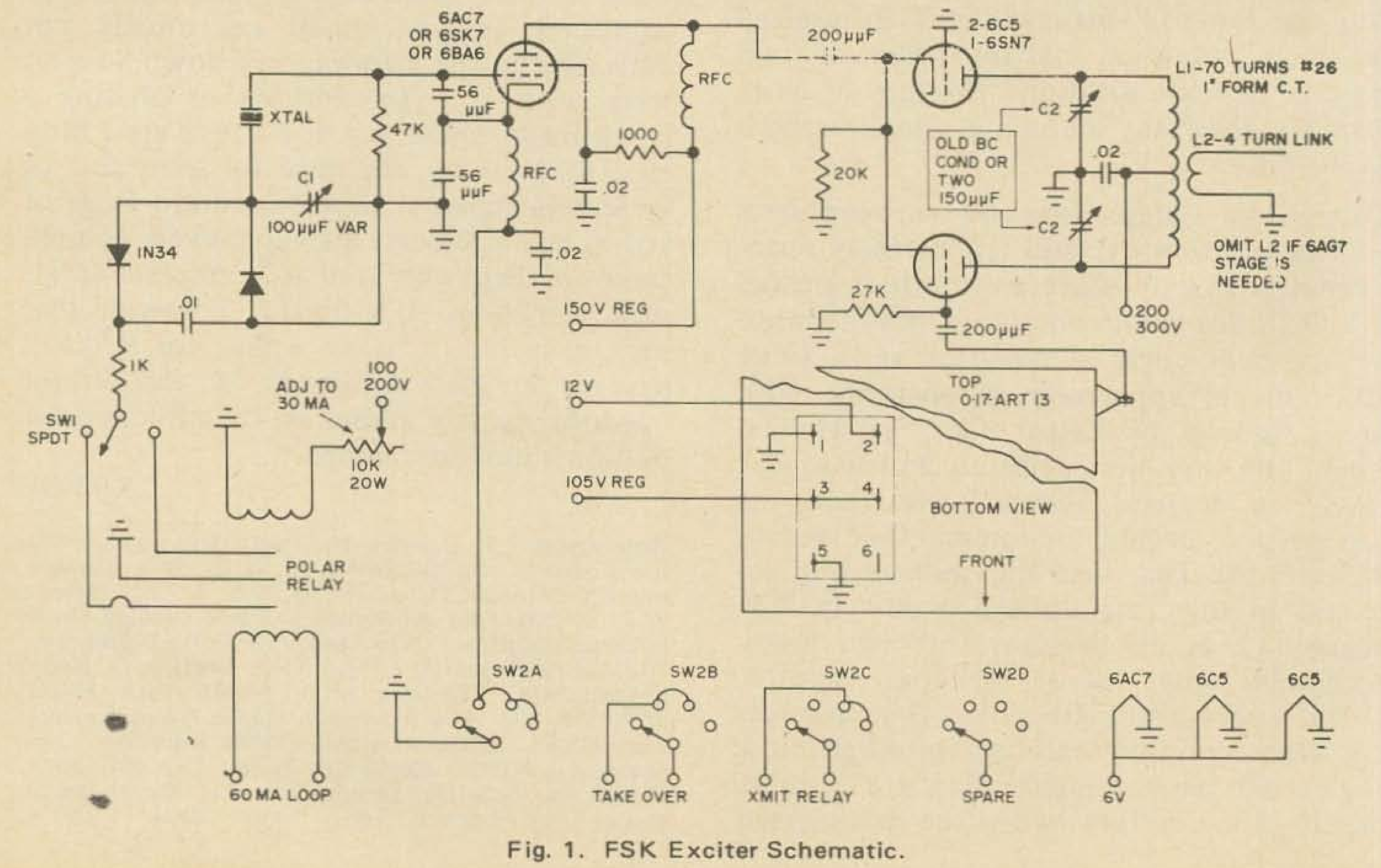



Fig. 1. FSK Exciter Schematic.

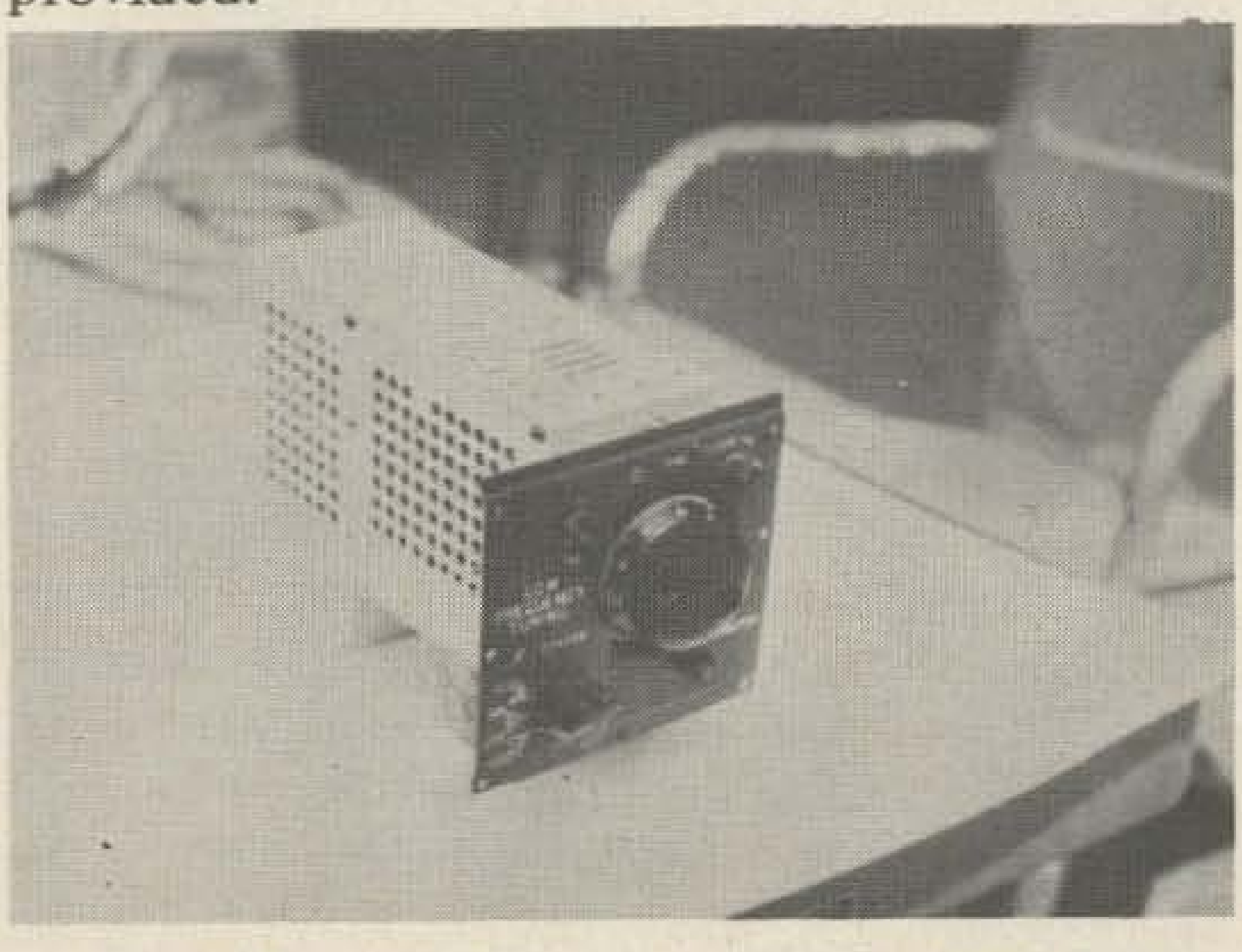
Complete exciter with pto.

lent regulator tubes should be used with the required dropping resistor (value depending on voltage). The O17-ART13 pto should not be used with more than 105 volts to minimize harmonic output. Once the power supply is assembled, the pto should be connected and checked by listening for its signal on the low end of the BC band.

2. Next the crystal oscillator should be completed. The only critical parts are the feed back capacitors from cathode to ground and from cathode to grid. The operation of the shift control may be checked by shorting across capacitor C1 with a screwdriver.

3. The two-triode balanced modulator requires no push pull input of any kind. The tuned circuit L1-C2 tunes the output range desired. Two separate condensers can be used for the sections of C2 if frequent frequency changes are not anticipated.

4. A polar relay is included in the keying circuit. With 30 mA bias current supplied from the exciter power supply, all that is necessary for operation is to plug into the local loop circuit. A turn over switch is provided.



The 0-17-ART-13 pto, available from Fair Radio for $4.00.

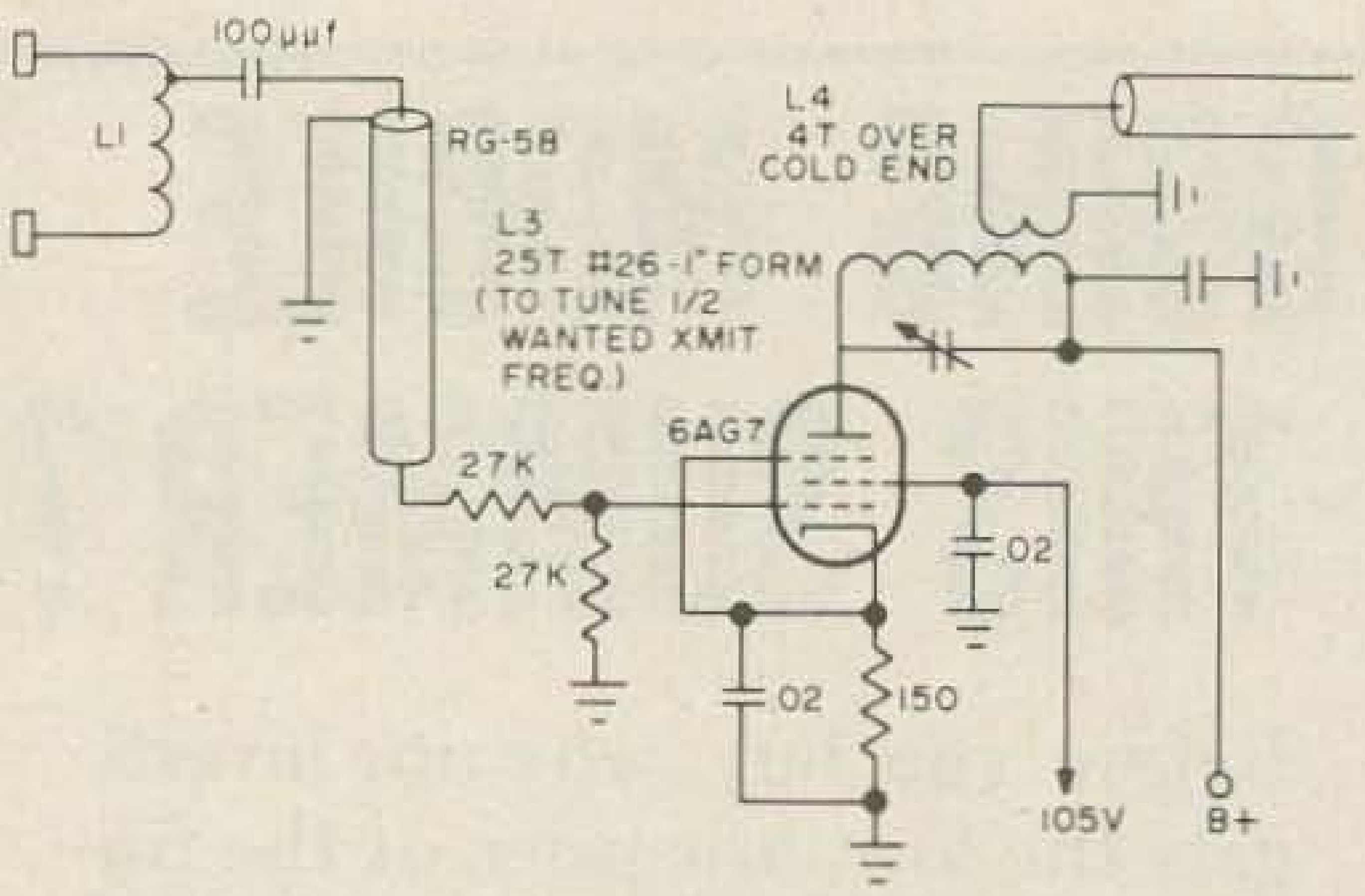


Fig. 2. 6AG7 Amplifier.

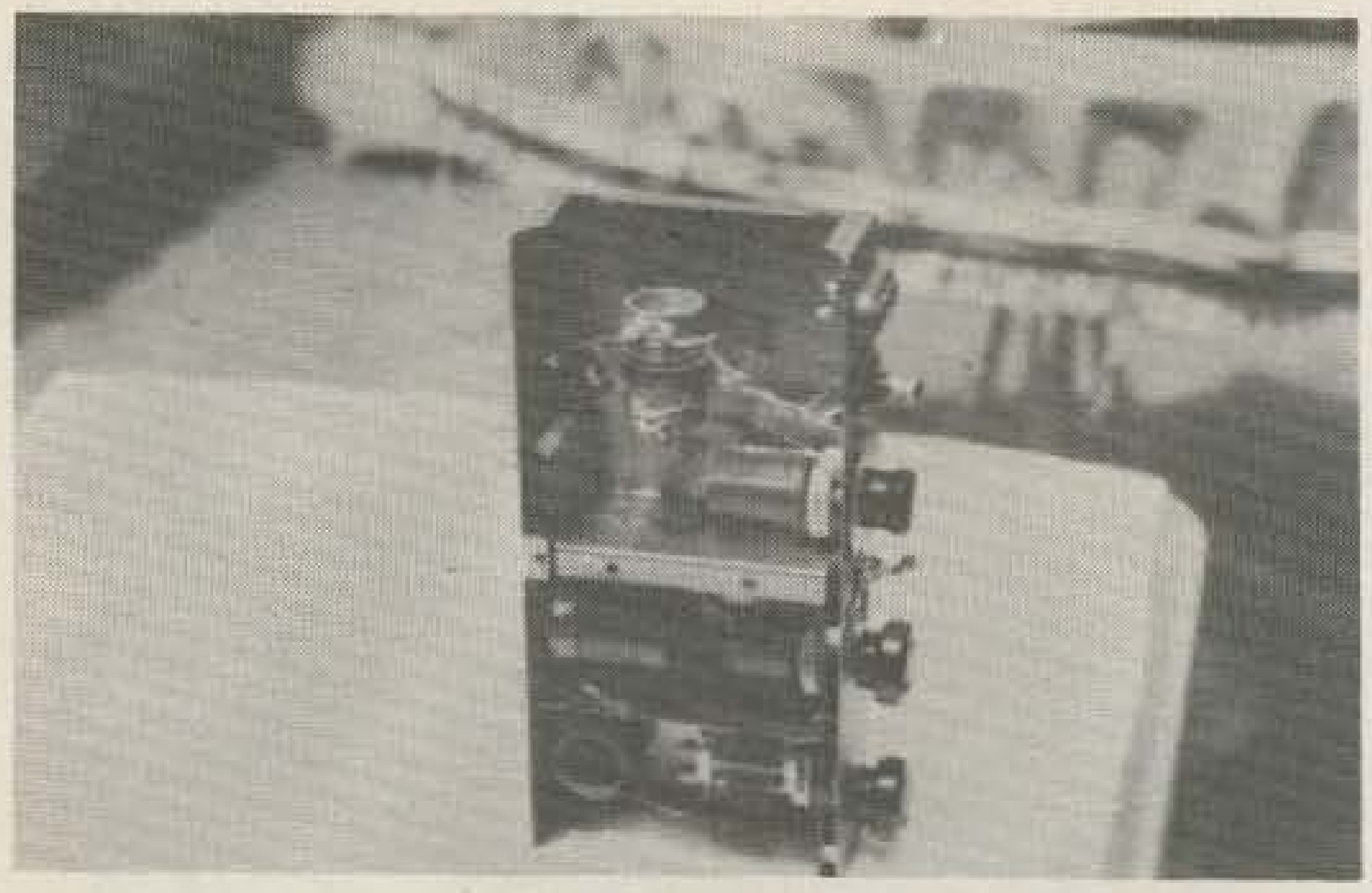


Fig. 2. 6AG7 Amplifier.

The function switch allows complete station control with one knob. In standby position the cathode of the crystal oscillator is lifted from the ground. In the take-over, spot, position the exciter is switched on by SW2-A while SW2-B shorts out the loop across the TU output. This prevents the receiver from keying the transmitter (if printer and keyboard are in series), and also allows a quick return of the printer to lower case by flipping the take over switch and punching the letters key. In the third position the "C" section of SW2 is used to control a transmit relay. In position No. 4 the short across the converter output is removed and the transmitter may be keyed by an incoming signal.

As with any hetrodyne circuit, care must be exercised not to tune up on a harmonic or wrong beat. The unit should be set up initially with a grid dip meter or absorption wave meter. The crystal used must be chosen so that the fourth or fifth harmonic of the pto does not fall on or near the wanted frequency.

By doubling in the transmitter any unwanted is further removed from the tuned output of the transmitter.

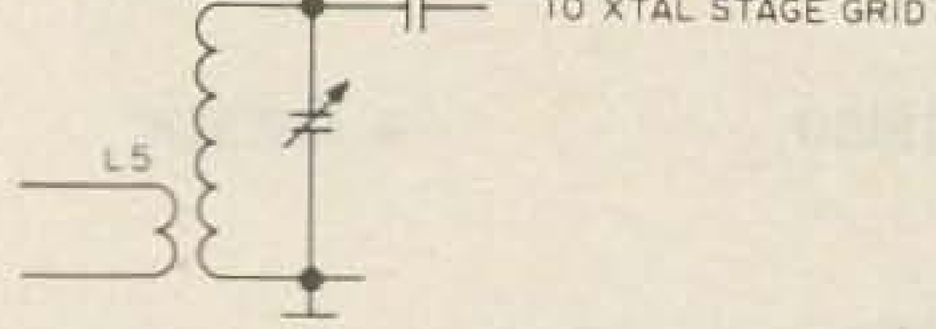


Fig. 3. Coupling coil to transmitter.

The average RTTY enthusist will devote long hours and careful planning to come up with the best possible TU. Then in a rush to get the rig on the air will, all too often, slap a diode shifter on any existing VFO – with less than the desired result.

Or, should he decide to shift a crystal he may spend hours grinding the rock to a net frequency only to find his shift shy of the 850 Hz. Not to mention the fact that the net frequency may change about the time he finally gets within tolerance.

In fact it was grinding my fifth crystal for Air Force Mars net operation in a little over one year that made me decide to do something, even if it were wrong.

Some Transmitters may require more drive than that obtainable from the balanced modulator. An amplifier stage becomes necessary. A 6AG7 is a logical choice. The grid of this tube is capacitively coupled to one side of coil L-1 through a short length of RG-58. Two or three turns should be removed from this side of L-1 to maintain balance. (If individual condensers are used for C-1, this may be maintained by tuning.)

The layout of the 6AG7 stage must be made with care. Some physical separation is desirable between the coil L-1, and the 6AG7 tube socket. The output coil, L-2, must be placed above chassis, (If L-1 is below) with the plate lead going directly topside from the tube pin. The 27,000 ohm resistor insures complete stability.

Low impedance output, either from the balanced modulator, or the 6AG7 stage, if necessary, allows the exciter to be located a convenient distance from the transmitter.

A tuned link coupled input coil should be used at the crystal stage of the transmitter.

Of the three FSK keyer units I have built, all have proved a pleasure to use. It has been found unnecessary to let the pto run all the time, as it will be well within tolerance from a cold start. And a five minute warm up will put you right on the button. The shifters have been used days at a time without touching the dial on Air Force Mars circuits.

So if you are having problems with drift, setting up and maintaining proper shift, or if you are simply tired of grinding rocks, the O-17-ART 13 pto shifter may be your answer. . . . W4LLR

### The First QSL

Probably it was reading the ARRL quotation, "A QSL is the final courtesy of a QSO," which prompted me to dig into several hundred old QSL's in order to find out when and who started the "bloody mess." Unlike the story of the "Chicken and the Egg," there is no doubt that ham radio came first and that the art of QSL'ing was not far behind.

Apparently it started around the middle or the end of 1921. I was operating 1IV at Bridgeport, Connecticut, at that time and my first card came from E. Laufer, 2AQP, who reports hearing my signals on October 9, 1921, using a one tube regenerative receiver. This was followed by a QSL from J. E. Hodge, 4BY, dated November 10, 1921, and a report from Gerald H. Edison, 1BMY, December 30, 1921, asks, "What is your radiation current?" These QSL's are all written on penny postcards with the call letters put on with a rubber stamp or crayon. The first professional print job came to me from 2BRB (now W2BRB) and included a picture of the station. It is dated December 28, 1921, and most certainly Ed should be considered to be among the first of the QSL'ers.

By 1922 and 1923 the QSL business was booming. Fancy printed cards were replacing the home-made ones with everyone trying to outdo the other in splendor.

1923 brought the first of the DX cards. My first is from W. R. Burne, British 2KW, who received my signals on two valves, September 5, 1923, at 04.10 GMT; so to the British go the credit for being the first to use GMT on their QSL's, but no doubt their geographical location had something to do with this.

Just in case you think the "big boys" of that era were too sophisticated to QSL, you are wrong. I have a QSL from 1AW, signed by Hiram Percy Maxim; one from S. Kruse, 10A and 9ZN, R.H.G. Mathews. Others include John Reinhartz, 1QP; Irving Vermilya, 1ZE; Dr. Cyriax, 2DI; and, Leon Deloy, French 8AB. Even the famous 1BCG confirmed a QSO with me on July 29, 1923. 2BO—still going strong as W2BO sent me a card dated May 10, 1923, and says he is running 20 watts and using a paragon receiver.

I suppose we will never know who sent the first QSL card but we can pin-point the year as 1921 and what a lot of QSL's have been exchanged in those forty-seven years.

C. Harold Campbell, W2IP

# *Telephone Beeper*

*Ed Marriner, W6BLZ*
*528 Colima Street*
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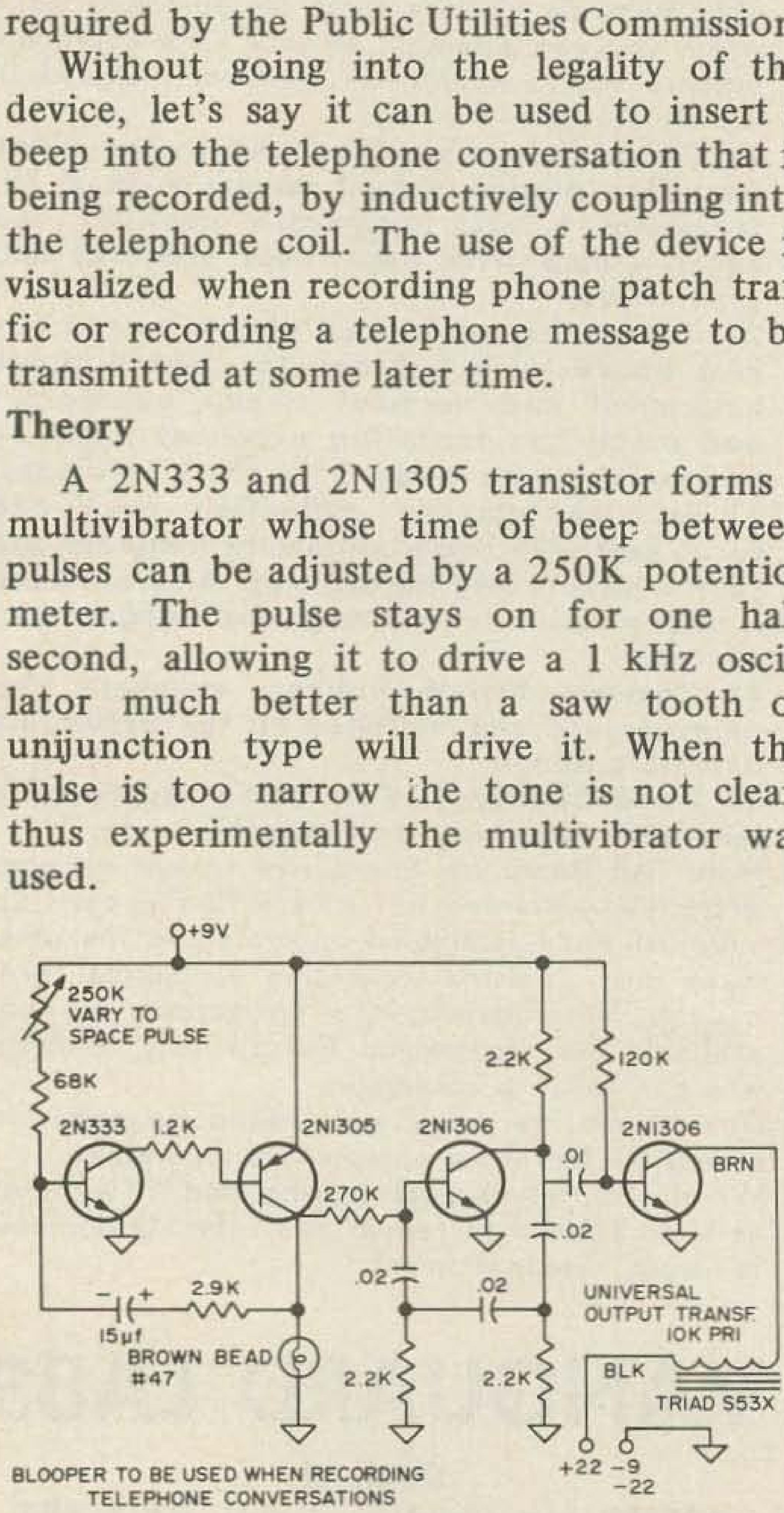
The following is a description of a telephone "beeper" to be used when recording telephone conversations. The "beep" can be adjusted to beep every nine seconds as required by the Public Utilities Commission.

Without going into the legality of the device, let's say it can be used to insert a beep into the telephone conversation that is being recorded, by inductively coupling into the telephone coil. The use of the device is visualized when recording phone patch traffic or recording a telephone message to be transmitted at some later time.

**Theory**

A 2N333 and 2N1305 transistor forms a multivibrator whose time of beep between pulses can be adjusted by a 250K potentiometer. The pulse stays on for one half second, allowing it to drive a 1 kHz oscillator much better than a saw tooth or unijunction type will drive it. When the pulse is too narrow the tone is not clear, thus experimentally the multivibrator was used.




**Beeper to be used when recording telephone conversations.**

A brown bead No. 47 lamp bulb acts as the pilot light and also as a non-linear element which helps to sustain reliable pulsing periods. The multivibrator drives a feedback type oscillator using a 2N1306 as the oscillator. This oscillator signal is amplified by a 2N1306 to create enough current through a coil to generate enough of a field to couple into the telephone instrument coil.

**Construction**

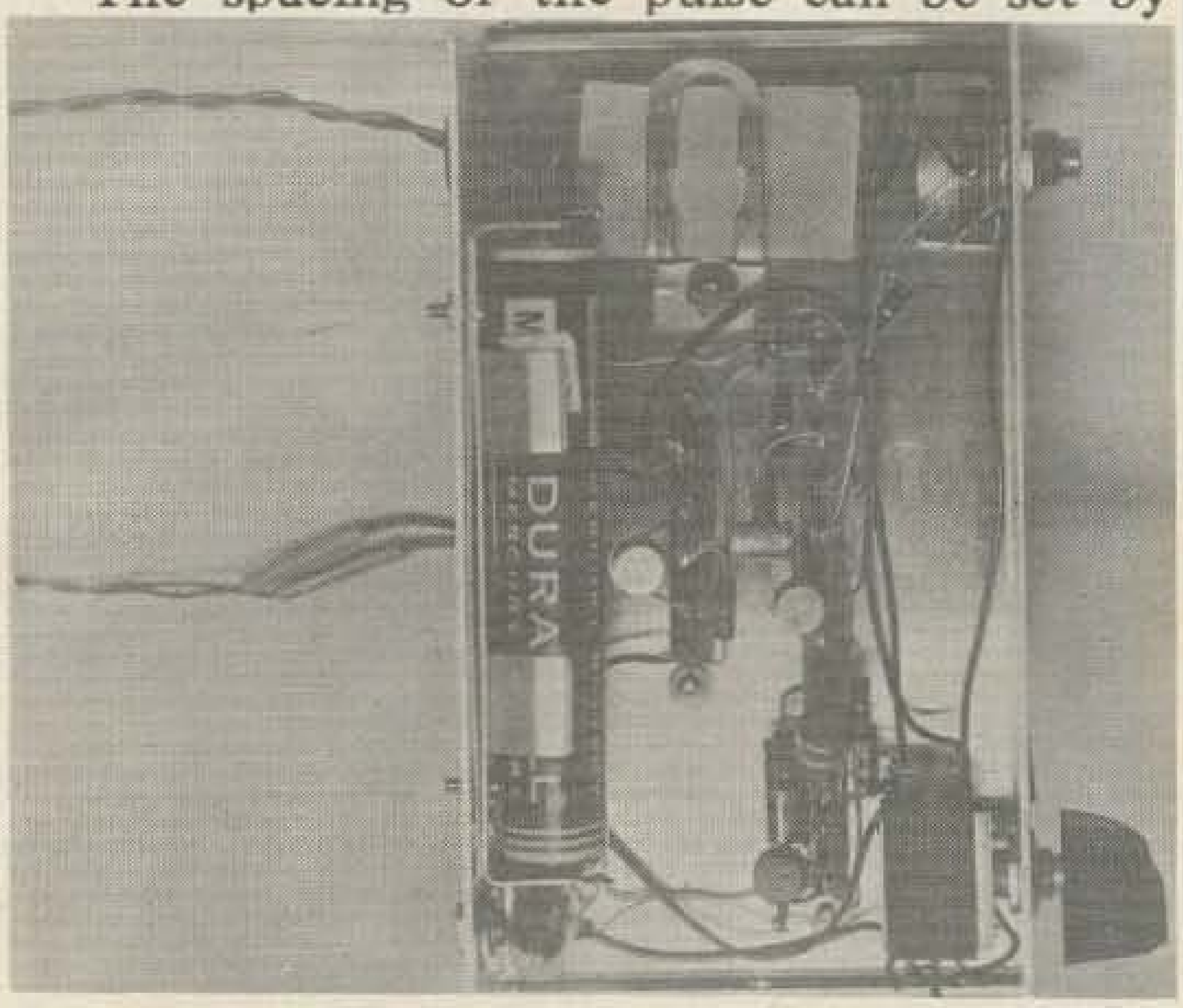
The "beeper" is built into an LMB type box, 3-1/2" wide, 2" high and 6" long. For simplicity the parts are mounted on terminal strips rather than on a printed circuit board.

Power is supplied from a 9 volt mercury type battery for long life, although, any 9 volt battery should last a very long time. The amplifier's source is 22 volts, which creates more current through the coupling coil.

Many types of coupling coils were tried, but an S53X output transformer seemed to work the best. The case was pried off and then the keeper or end of the core was driven off, using a hammer and screw driver. It was thought a stronger field could be obtained by sawing off one of the sides of the transformer to concentrate the field between the center and one outside core, but there was no difference in the coupled signal and it was not worth the effort.

There are no special precautions in wiring the unit except to get the polarity of the 15 mF condenser in the multivibrator circuit correct. If it is backwards, the oscillator will not work. An indication that the circuit is functioning can be determined by watching the lamp blink.

The spacing of the pulse can be set by



**Note the battery mounting and parts installed on terminals.**

turning the 250K poteniometer and timing it with a watch. A pair of crystal earphones can be clipped across the coil if it is desired to hear the tone, or the tone by induction into the telephone is another way to listen. The telephone coil is generally on the right side of the telephone as shown in the photograph. The transformer can be moved back and forth over the side of the phone until a maximum coupling is noticed and the transformer taped into place.

The circuit probably has other uses and comments might be suggested, but for our purpose it has served for inserting a beep into the telephone for recording. ...W6BLZ

*(Continued from page 2)*

of the bulging counters full of 19¢ pots, 5¢ tubes (guaranteed to light, play), and 29¢ tuning condensers.

Sideband came next and finished off the old surplus gear that was still working and most of the active amateurs made the move up to a transceiver...commercially made. Lordy, it would take a lab of test equipment to get one of those things working if you *could* build it. Even the servicing problems were getting beyond most of us by this time. How many fellows are going to go out and buy an oscilloscope and the other choice test gear needed to keep the modern transceiver working smoothly if they are going to use it only for an occasional service job? Virtually none, that's who.

This leaves us in the lousy position of not building our own equipment and not even being able to service it. Ham radio has come a long way. The old timers lament for the good old days, but no matter how loud their laments, they are buying just like the rest of us. Can anything be done about it? I don't know! Does anything have to be done? Has amateur radio changed so much that it is no longer worth keeping going?

What *are* the requirements for keeping amateur radio alive in our country? Let's take a look at the FCC regulations and see how we stack up these days as far as the purposes of the amateur radio "service" are concerned.

**SUBPART A–GENERAL**

**97.1 Basis and purpose.**

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary non-commercial communication service, particularly with respect to providing emergency communications.

(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international good will.

The first, and presumably most important, function is (a) to provide emergency communications. I think we can do this all okay. There's nothing about building there. For that matter, our commercial transceivers are vastly superior to home made equipment on several counts...easier to use...less down time ...anyone can use it...compact, etc. Old timers will tell you stories about the olden Field Days when fellows tried to tune and use someone else's rig and the troubles they had. My six-foot rack has been replaced by two small desk top boxes. And with about one amateur for every 800 people in the country we can provide emergency communications just about anywhere anytime. I think we should get a good high mark on (a).

Considering (b), it is difficult, of course, for even the above average amateur to try to compete with the well financed research laboratory for most development work. We can still compete with them when it comes to major break-throughs. Labs cannot possibly afford to spend a lot of money on something that does not have virtually a 100% chance of succeeding. We can. Fellows like Frank Jones, Bill Hoisington, Sam Harris, Bill Ashby and many others are doing work that is invaluable to our society...work that few labs would ever support. It is too bad that there are so few really outstanding men like this, but then, even in the past, there were only a small handful that made real contributions. I suspect that amateur radio is as valuable as it ever was in this respect.

(c) is very interesting. Verrry. Obviously, our incentive licensing rule changes reflect this aspect of the purposes of amateur radio. But have our rules really kept up with the technical end of things? Let us take another look back into our past at this time.

The first amateurs used the Morse Code for communications. It was considered difficult, at best, to modulate a spark transmitter, so code was the answer. Then came CW and the invention of the modulator, giving us AM. In the 20's and 30's the phone transmitters were considerably more expensive than CW rigs and a lot more difficult to tune, with the result that most amateur operation was via CW. But, as soon as phone was available the hams started using it and the percentage of phone ops grew steadily. Most operators preferred to talk rather than whistle and they changed to phone as soon as they could afford it.

Sideband completely broke the back of the CW holdouts. Their complaints that CW could get through better than phone or that a CW rig was much less expensive than a phone rig fell apart. Sideband, they found, could get through just about any time that CW could! And the Heath $99 SSB transceiver forever stilled complaints about cost.

There are still a sizable number of ops that use CW because they enjoy using it, but few, except Novices, use CW out of necessity. With the percentage of CW operation dropping year by year, many have wondered just why the FCC added the 20 wpm requirement to the Extra Class license.

Modern communications techniques would seem to put emphasis on things like RTTY, facsimile, slow scan television, narrow band television, time sharing of channels, and other developments rather than harking back to our early days and our most primative mode. The FCC, to the contrary, has been decidedly backwards in handing down favorable rules for RTTY, facsimile, television, etc. Amateur development of these modes has been harassed and impeded by the FCC rather than helped, as per (c).

Part (d) calls for trained operators, technicians and electronic experts. We are concentrating more on trained operators these days than technicians. But, with some 10,000 of us active on the VHF's and a similar number working with RTTY and other advanced modes of communications, we are not doing too badly in the expert department.

Good will? With phone contacts as simple as they are today tens of thousands of DX operators can talk and make friends with fellows all over the world. A few simpletons yelling break-break, or calling doggedly on a DX frequency can create ill will, but for the most part, ham radio is a friendly world community. A recent report of the Stanford Research organization showed that, dollar for dollar, radio amateurs achieve more good will than short wave broadcasting...by a large margin.

We might try to curb our penchant for donating money to DXpeditions too. These often bring terrible ill will for us from abroad. The big problem is this: since the DXer is doing the job for money, he is very apt to by-pass a lot of formalities and tread heavily on toes in order to get on the air. One DXer went into Jordan a few years back and went on the air without a proper license. The result was that ham radio was finished there from then on.

All in all, when you look over the FCC basis and purpose for amateur radio, we seem to still, in spite of all the changes that have come about, be well worth our salt. Perhaps those that are calling for a return to building should take a look at the balance sheet.

My own feeling is that building equipment is a lot of fun and I intend to run every construction project in 73 that I can get my hands on. Of course, I will tend towards pushing the newer modes such as TV, RTTY, SSTV, FAX, FM, and the like. We have a thousand or so hams that spend their hobby hours building equipment. Few of them ever get on the air for more than a short test of a new unit...then the parts go back into the junk box and the next project is underway. These are the fellows who provide us with most of the original constructions articles... this is why you keep seeing the same calls over and over in 73.

It is important for us to do everything we can to see that we constantly have new amateurs entering the hobby. A certain percentage of these newcomers will turn out to be builders...others will go for new modes...and a very few will get some sort of weird idea for a radical change and spend years working on it...and they just might succeed. I am reasonably sure that it won't be long until someone makes a gigantic breakthrough into another form of communications which will make radio obsolete. It could well be one of the Novices who will get his ticket this fall.

What do *you* think? ...Wayne

## Recent Visits

Sam Harris, W1FZJ/KP4 runs the receivers down at the world's largest dish in Arecibo. Sam is active on 75M in particular, working DX along the low end of the band. He is also working on a miniature Arecibo dish at home, a few miles from the Big One. His 75M and 40M antennas are hanging from the three "haystack" mountains that surround his QTH.

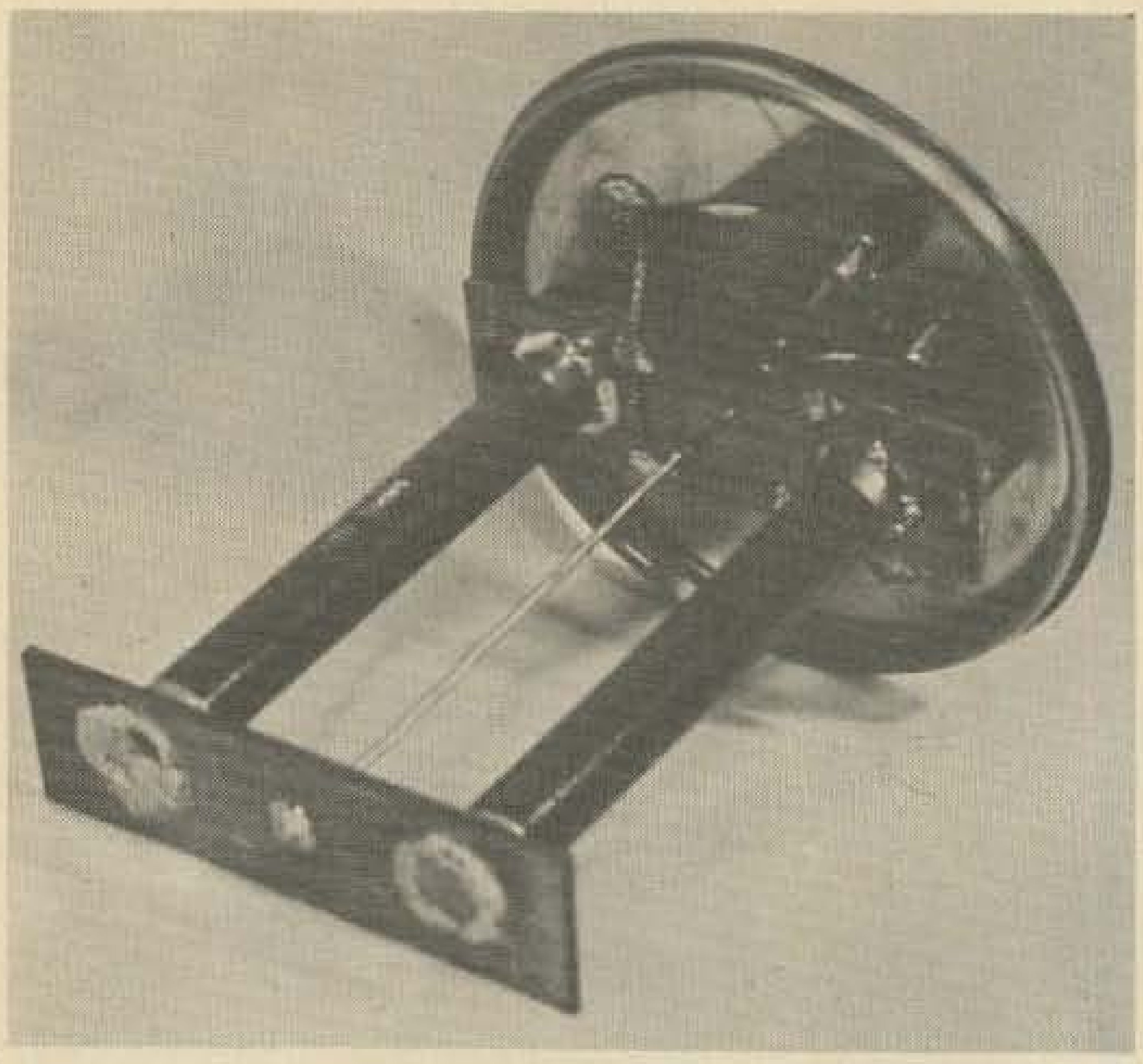
Helen Harris, W1HOY/KP4 keeps her ear fastened to the receiver on six meters all day every day. She doesn't miss an opening if she can help it. If you're on six you've probably worked her by now. Helen has an incredible card index file of the thousands of stations she has worked on six meters so far. Note the 50 or so notebooks over the operating position!

Dick Spenceley, KV4AA is alive and well on St. Thomas. Dick is another who got off the DXCC treadmill when crossed up by Miller. He still keeps at it, but for fun now instead of blood. Does Dick have the world's best fist? Many think so.

...Wayne

# A Kilowatt Dummy Antenna . . . Cheap!

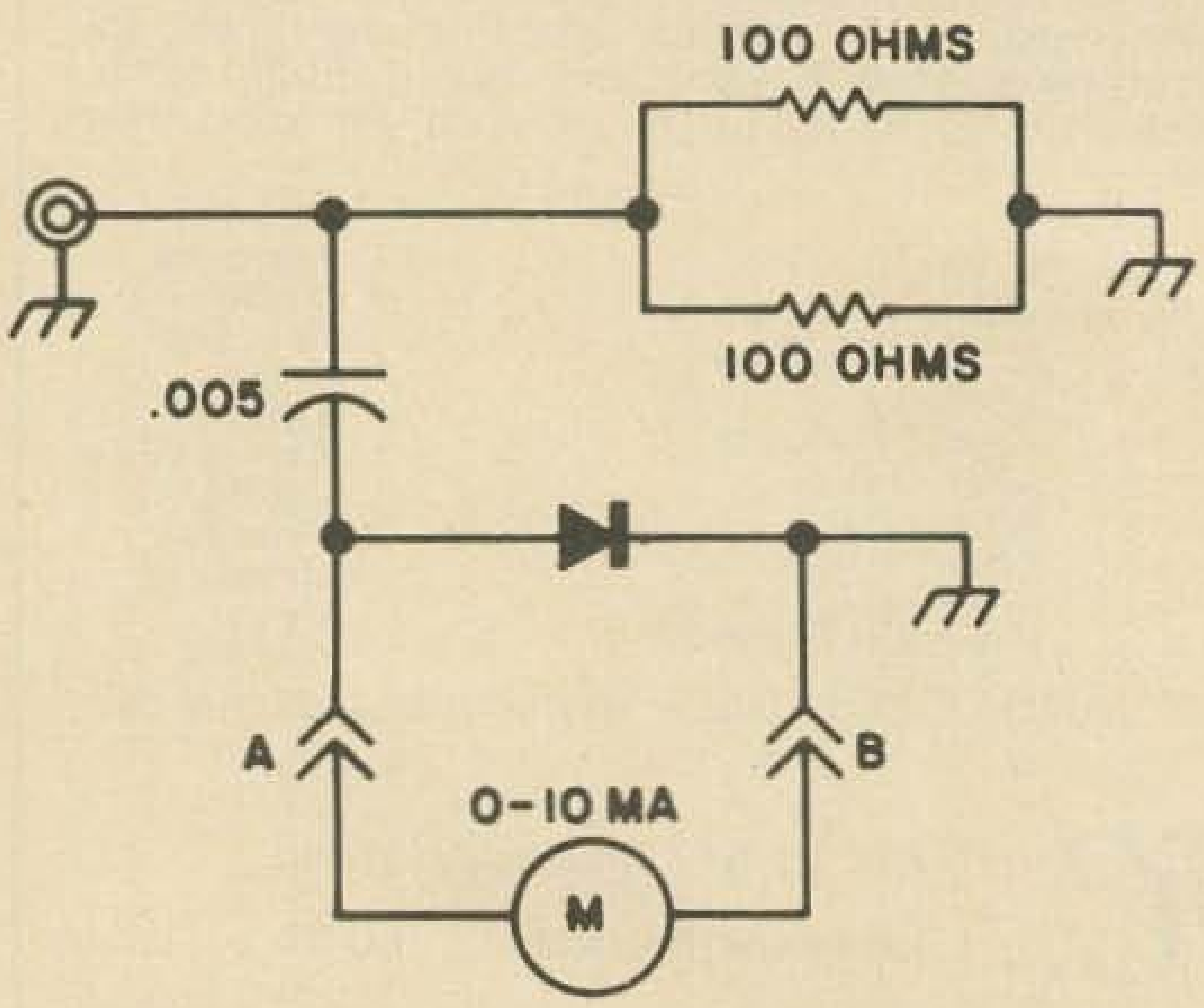
*Allan H. Matthews, WB2PTU*
*R. D. #1*
*Waverly, New York 14892*



This article describes a dummy antenna capable of handling one kilowatt, to be built at a cost of under \$4.00. In my case it cost \$1.53, but that was with a junkbox.

In a back issue of 73 (where else?), there were some 100 ohm, non-inductive resistors advertised by Mendelson Electronics, 516 Linden Ave., Dayton, Ohio. I ordered two of these at 50¢ each for my dummy load. When they arrived, they were 3/4 inch in diameter and 6 inches long, with both ends tin plated. I do not know the power rating of these resistors but they are more than adequate for our use. This unit will handle over 100 watts PEP with *no oil*.

The photograph tells the story. The top and bottom plates were cut to dimension, punched and drilled first. Next the resistors are fitted into the outside holes of these plates and soldered into place. I used 1/8th" double copper clad glass epoxy board and soldered the resistors to both sides of the board. Next run a heavy wire down through the center hole of the top plate and into the small hole of the bottom plate. Solder it on both sides of the plate. Center this wire in the top plates center 3/4" hole.




The next step involves a gallon paint can which can be purchased empty and clean at many paint stores for about 50¢. Punch the top of the can for a coax fitting, drill the holes to mount the unit inside the can and if you want a relative power output attachment, drill holes for the feed-thru terminals you will use. Also, drill 1 extra 1/16" hole in the top of the can.

Mount the top plate hanging down from the top of the can on 3/4" metal stand-offs. The resistors will clear the bottom of the can nicely at this height. Now mount your coax connector, your feed-through terminals and the other components in place and solder them. Run a couple of copper braids, (coax shield) from the top plate to the top of the can and solder them well on both ends. They will help to provide a low impedance ground path. The diode I used was of doubtful ancestry, but a 1N34A shoulu do the trick. This relative output meter circuit allows use of a fairly heavy meter, dependent upon the power of the transmitter and the frequency of operation. A variable resistor across the meter will be an aid.

Now go to the power company and scrounge a gallon of transformer oil or fill the can with mineral oil, leaving about 1 and 1/2" of space at the top of the can. *Do not use motor oil!!* The extra 1/16" hole? Oh, that is to relieve pressure as the oil heats up. When not in use, plug it with a match stick or small bolt. Well, there it is, a kilowatt dummy antenna at a price everybody can afford.

...WB2PTU

### One that Didn't Work Out

Don't misunderstand me. The home-brew :oax switch I'm about to describe works fine. t just cost more than it should have, and it loesn't do quite all that a commercial unit loes. If the purpose of home-brewing is to save money while producing gear equal or superior to commercial products, this project qualifies as a failure. Still, it may be of interest.

First, you take a cat food can–one of the little ones that contains the so-called "gourmet" cat foods. Open it and feed your cat the contents. (You *do* have a cat, don't you?) Then wash it–wash it *very* well. If you don't you'll have a very smelly coax switch!

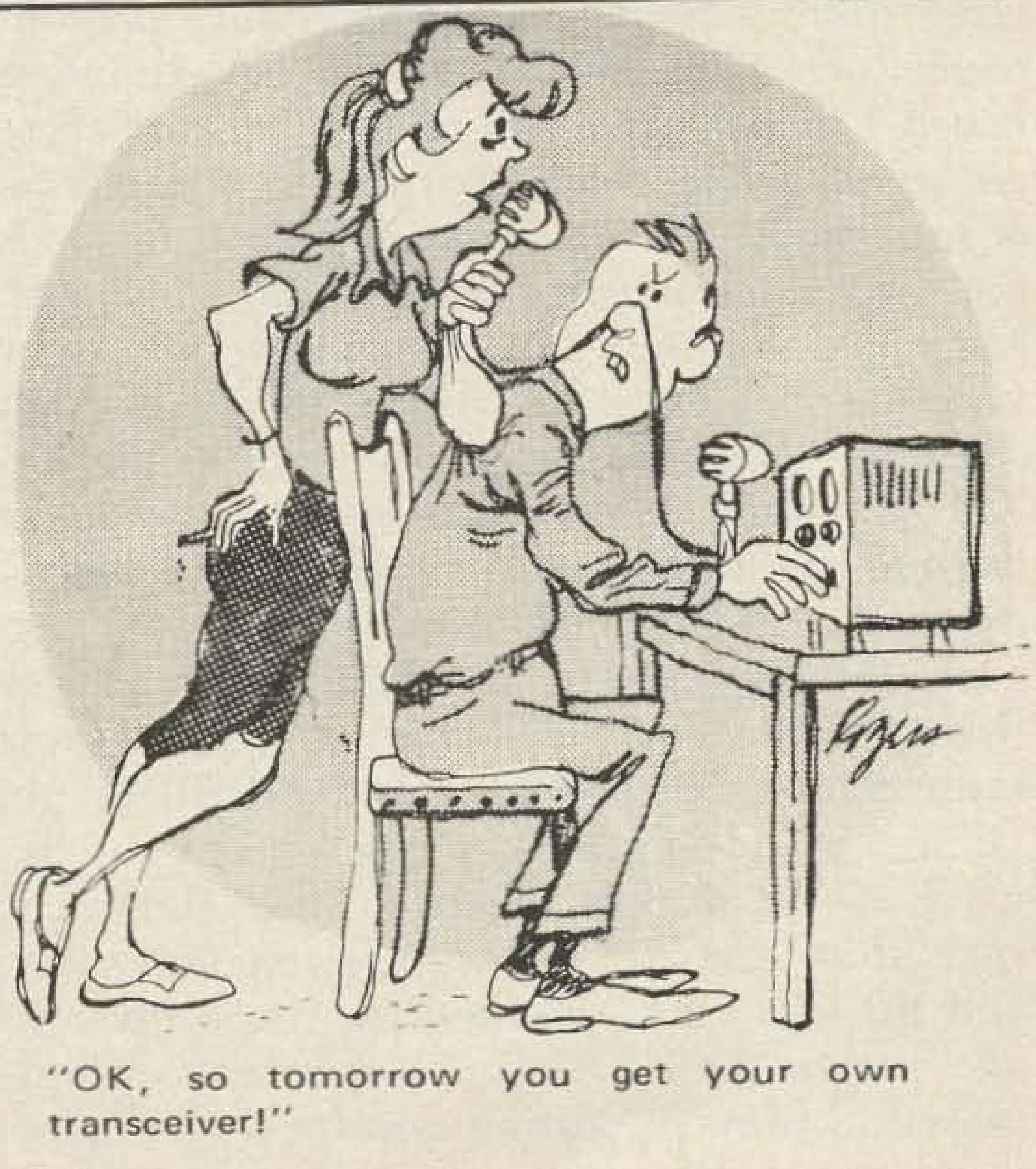
Now, mount six SO-239 connectors equally spaced around the outer wall of the can. (Use the single hóle mounting type if you can.) Drill a hole exactly in the center of the bottom, mount a six position ceramic switch with 60 degree indexing, and line up the contacts with the sockets. Note that in one position, there will be no connection, since one of the sockets serves as the input to the switch. Wire it up using short lengths of #12 wire. Cut a disc of flashing a little larger than the diameter of the can, and seal up the back by laying a bead of solder between the rim of the can and the flashing.

If you buy everything new, the switch will cost you five or six dollars. It doesn't ground the system in the "off" position, and it won't handle a kilowatt. For about five dollars more, you can buy a switch that does. However, crosstalk is low in the home-brew switch, and if you have enough coax connectors and a suitable switch in the junkbox, it may be up your alley. Works fine for switching between antennas, dummy loads, transverters, etc. If your junk box doesn't contain the necessary parts, take my advice–go buy a commercial unit.

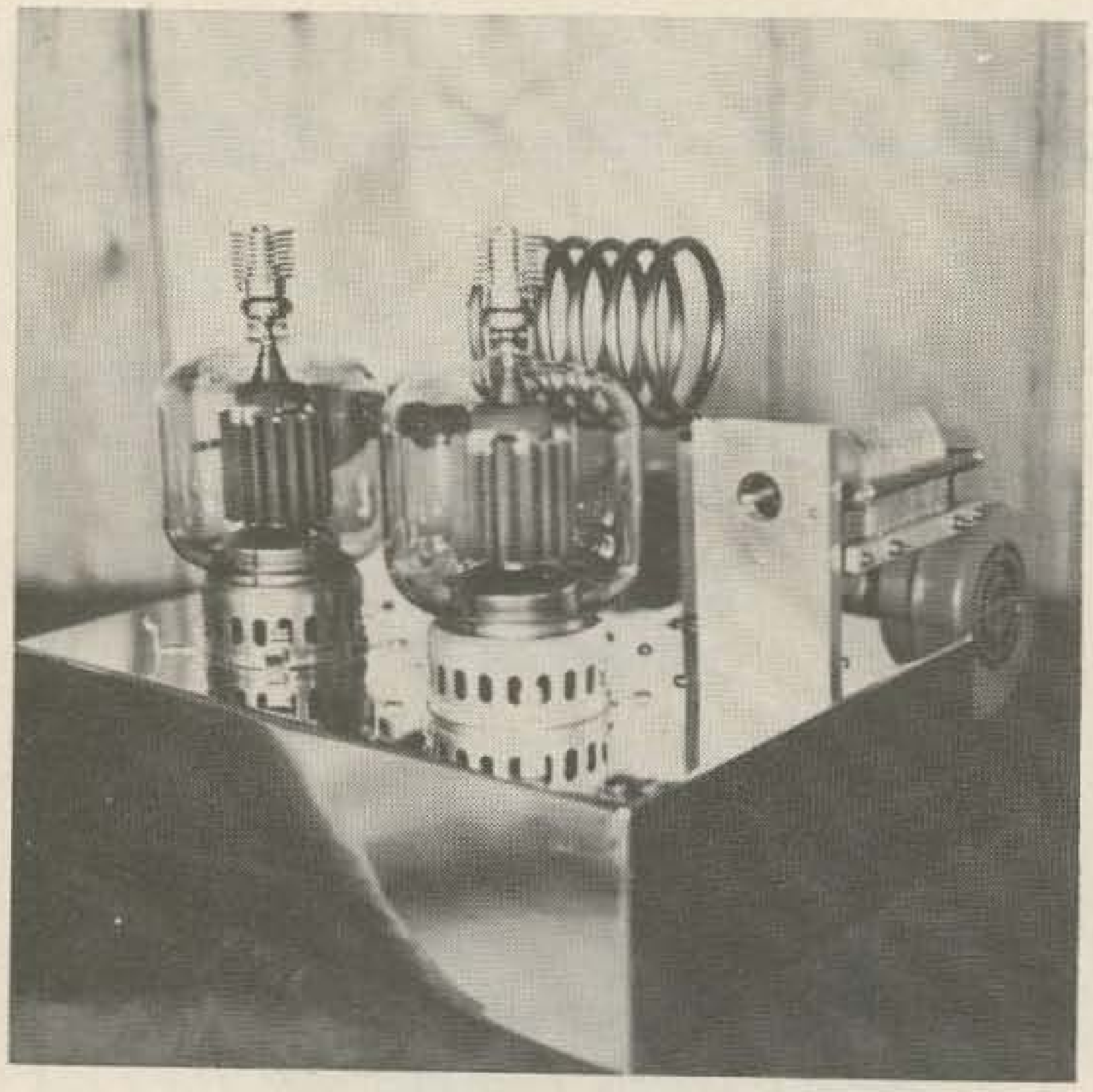
There's a moral in this somewhere...something about the point of diminishing returns?

**Bob Grenell, W8RHR**





"OK, so tomorrow you get your own transceiver!"

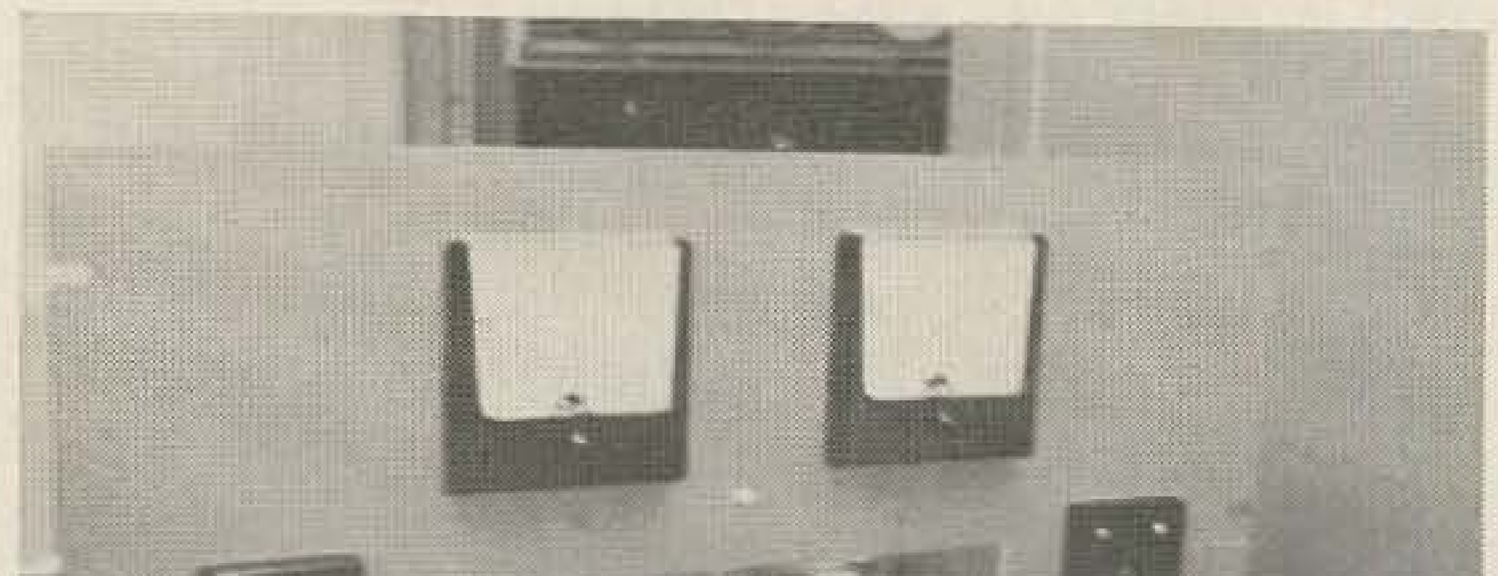


# *Mini–Bomb*

*Bill Brown WφSYK*
*28 Marine Lane*
*Hazelwood, Mo.*

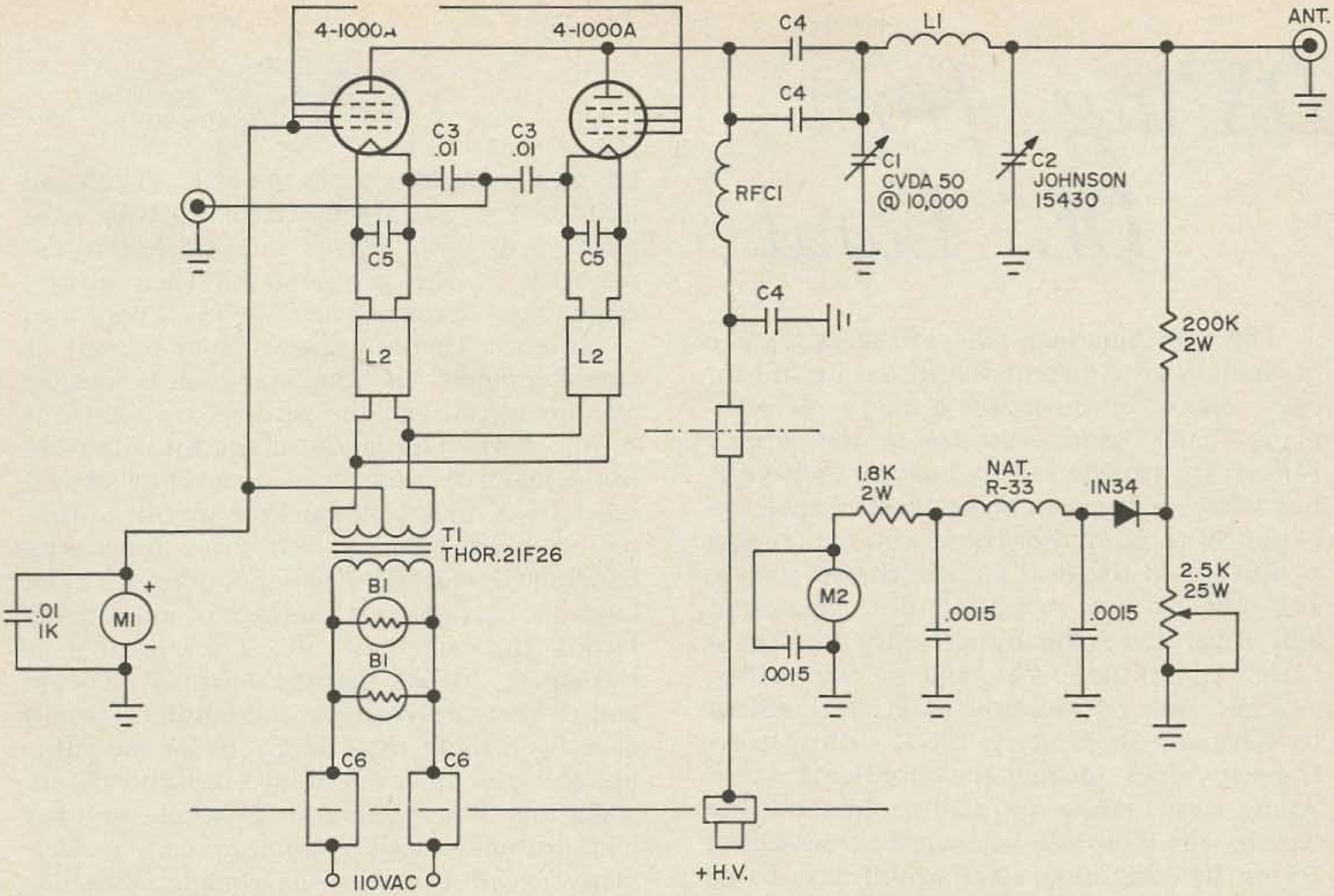
After many attempts to design a two tuber (4-1000A or 8166) on a standard chassis (13 x 17), I gave up in despair and went to a larger chassis which was 15" x 26" x 6" deep. An article was published in the May issue, 1965 called the "Big Bomb". I know of more than 30 Hams that are using this design.

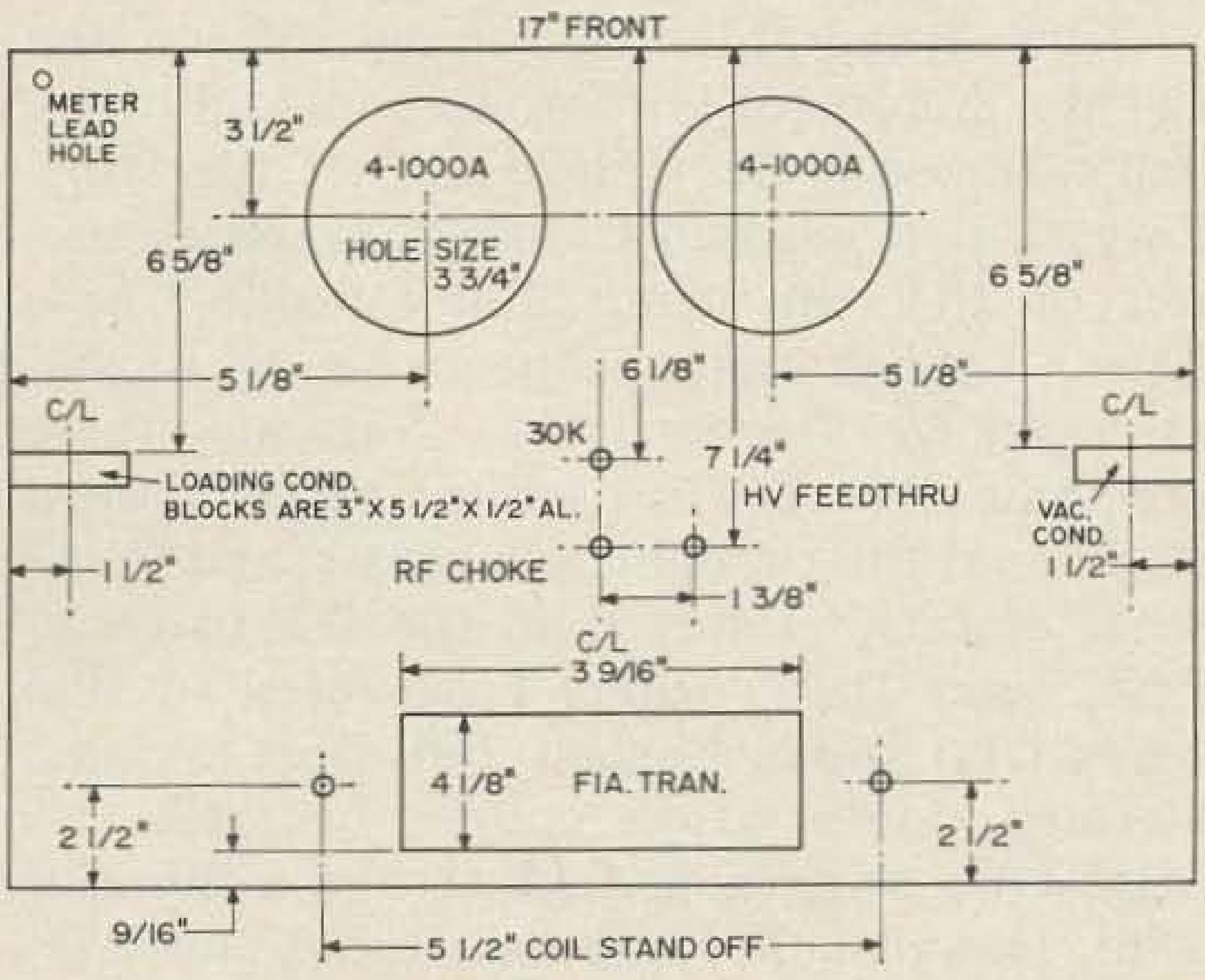
The smaller rig got started one afternoon after finding a very small ceramic vacuum capacitor. After two days on the drawing board I finally got all the parts laid out without overlapping. Some features that might be of interest are as follow: Both plate and loading capacitors were mounted on 3" x 5½" x ½" Machine aluminum blocks, which will prevent current losses and will add to the high efficiency. Checks proved efficiency as high as 72%. I would like to call your attention to the high voltage feed-thru. These are homemade out of 1" round teflon extending 1" on each side of chassis. Breakdown was better than 30 K. Plate coil for 20 meters was formed on quart bottle of TANQUERAY gin (dia. 3⅝"), length was 5½". (Tubing ⅜" used). The design of the "Mini Bomb" is such that parasitic chokes are not necessary, and this final was checked for this with voltage better than 7.5 K. Chassis was chrome plated to prevent rusting and for appearance.



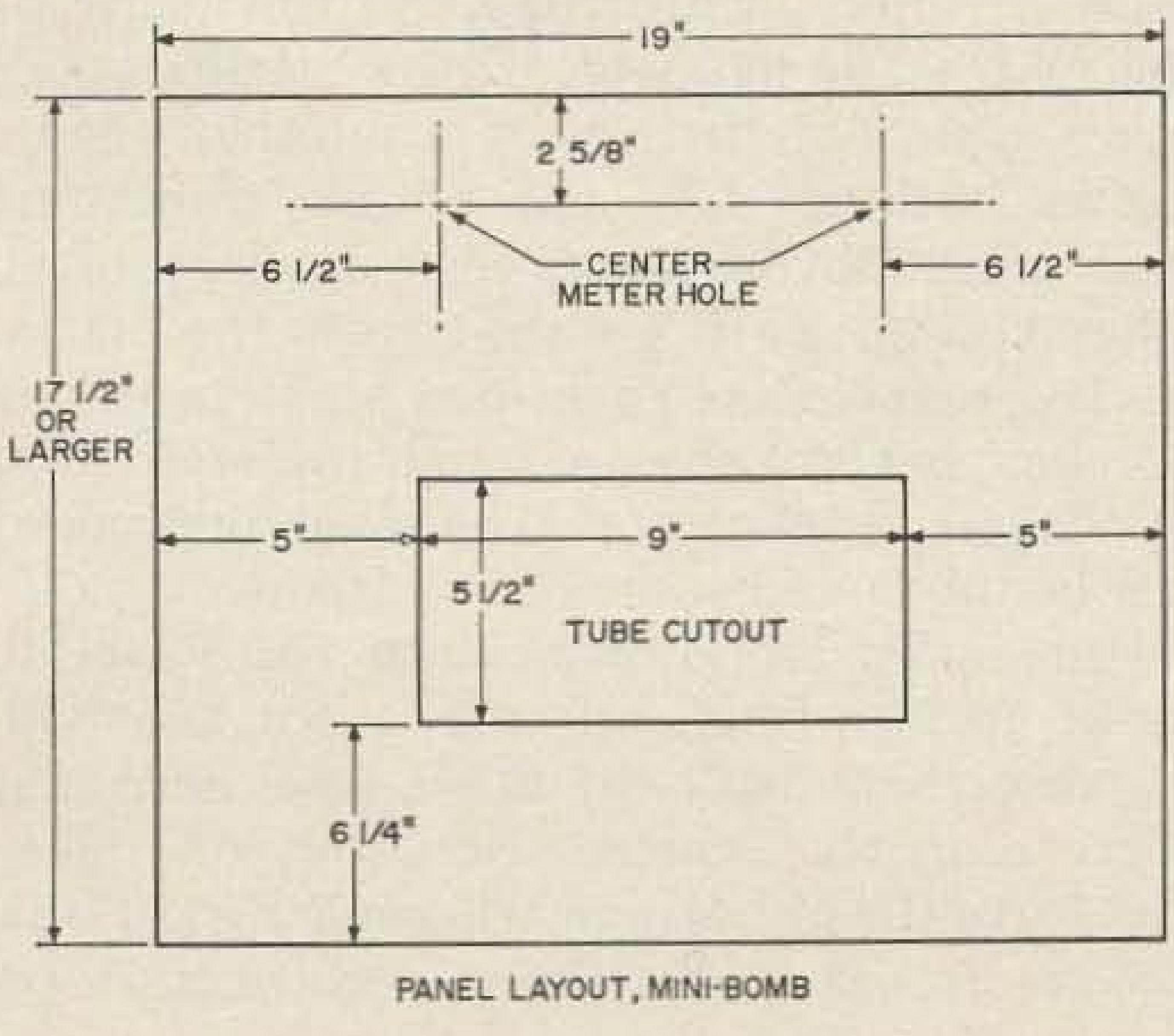
Since the tubes are in the front and centered on the chassis; a 6" x 9" cutout was made to view tubes. This cutout is 6½" from the bottom of the panel, which is steel, and 17½" high. Two meters (3½") were placed above the cutout. The plate meter is 0-1.5 amp. and the output meter is 0-1 mA with a 0-10 *rf* amp. scale being used. The large 3" Groth counter Dials rounds out the Panel.

This final is housed in a 61¼" cabinet with 24" depth, in order to make room for




MINI-BOMB CHASSIS LAYOUT




PANEL LAYOUT, MINI-BOMB

the blowers. The panel below is used for the "*wheel*" which is a Superior 28 amp. powerstat. The bottom panel is used for power supply, ac switches and pilot lights.

## Power Supply

A real heavy duty power supply can be built for less than one hundred dollars. The plate transformer was purchased from the local power company for less than 20.00. The rating is 5 KVA @ 7200 volts ac. This will give around 6500 volts dc under load for the highest voltage. I like to operate with a voltage of 3700 using 100 watts drive from a Collins 32S-1. Two 550 mA UTC chokes are used in the negative lead. These chokes are in series with the swinging choke, followed by the smoothing choke. Solid state silicon rectifier were built up by using 48 (1 amp @ 1 K. Diodes) Oil capacitors were purchased from the power company also, at the rating of 2500 AC @ 7.5 mfd. Four units are being used giving a total of 30 mfd better than 7000 VDC at a price $5.00 per unit. A bleeder consisting of seven 10 K @ 200 watts resistors in series finishes the power supply. In closing, I have been using this heavy type of construction for the past 11 years without a single break-down of any part in this rig, Good DX-ing.

. . . WØSYK

# DX'ing from DL Land

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This is an American's view of what it's like to operate an Amateur Radio station in Europe. This is by no means a unique achievement–many hams who are in the Armed Forces are transferred to Europe each year, but I have never seen an account of their experiences in print. For those who are coming to Europe in the near future, this may serve as a guide of what to expect. For others who will never have the opportunity to sign a "DX" call, I hope this will be interesting.

I received notification of my assignment to Germany in January 1967, with instructions to report during the month of April. Along with finding out all I could about the base to which I would be assigned, I set about trying to determine what would have to be done to set up a ham station. Since all I had read concerning reciprocal licensing stressed contacting the agency responsible for the issuing of licenses in the country to be visited prior to arrival, I wrote to the Bundesministerium in Bonn, requesting information and instructions. I received a reply very quickly (via Air Mail), and the gist of the letter was that I would have to go through the Military Affiliate Radio System, since they serve as a liaison with the German licensing officials (the Deutsche Bundespost). After I arrived in Germany, things were a bit hectic, as in any move, but I managed to get to the MARS station on the base and fill out the necessary forms, and then a helpful clerk made the necessary photocopy of my Stateside license (for proof of license class), and the paperwork was set in motion. Red tape being what it is, it was about a month before I got my license. This cost $9.75 for one year–we get off cheap in the States!

Now to get on the air. I had been busy with moving into an apartment and getting settled, and so far had not erected any antennas, so I strung a twenty meter dipole across the apartment. My first contact was with UW1AC, 5-7-9, both ways. Not too bad for my haywire set-up, but I definitely needed something a bit better. After examining the situation I decided that to keep on good terms with the landlord (who lived immediately below us) and still radiate a signal, I'd have to hang something up in the attic. There are quite a few people in Germany who have large yards with lots of nice trees, but the majority of the people build their houses close to the street and turn the back yard into a garden. The housewives spend a lot of time keeping their houses and yards spotless and beautiful, and the gardens are right out of a picture. Our landlord and his wife were of the majority, and I wasn't sure how they'd react to an ugly pole sticking up out of that picture-book garden, with wires and cables hanging all over the place. So, what with the language barrier and a shortage of apartments I took the easy way out. Looking at it in retrospect, I think that if I'd brought a beam and tower here with me the landlord would have been more than happy to let me put it up, and perhaps even helped me with the installation. I have yet to find anyone who has had problems with a landlord here in Germany, except those who have made a nuisance of themselves with loud parties, etc.

Now, I had antennas for ten, fifteen and twenty meters (or indoor, air-cooled dummy loads, if you prefer), and I started operating. I was a little worried about the language barrier on the ham bands, but I needn't have been. English seems to be an almost universal language among hams. Naturally there are some mistakes in pronunciation or word usage, but the thought gets across, and that's what counts. I stayed in the DX bands at first, since that's where I expected to find hams who spoke English, but after taking a German conversation course I braved 3.5 MHz CW, using a matchbox and a hunk of wire; lo and behold, the same old abbreviations were in use there, and I felt at home almost at once. Unfortunately, too many of the QSO's I've had were of the "Hello, goodbye" type, but there were a number of ragchews both on CW and phone–something you don't have a chance to do very often when you work a DX station from the States.

The regulations governing amateur operation here in Germany are much the same as in the States, except for a reduced maximum power input and some of the frequency allocations. We are allowed only 500 watts dc input to the final; but that's not too bad, because there isn't the QRM level here that there is in the States. However, on eighty and forty the popular Heath single band transceivers are useless without modification (as are some of the other transceivers). The DX bands are the same as in the States, but forty is only one hundred kilohertz wide, and eighty is three hundred kilohertz wide (7.0-7.1 MHz and 3.5-3.8 MHz). There is no official CW/phone separation of the ham bands here, but by gentlemen's agreement the lower one hundred kilohertz of each band is set aside for CW use; the exception being on forty, where the lower fifty kilohertz is usually CW only, but sometimes this varies with band occupancy.

TVI is not an overwhelming problem here as it occasionally is in the States. For one thing, the TV stations are controlled very closely, and have been set up for optimum coverage, thereby reducing or eliminating "fringe" areas. In my area the channels in use are 12, 14, and 40; and to get a harmonic into one of these, you'd really have to work at it. Fundamental overload is still a problem, but one that can be fairly easily corrected with a little cooperation. Even quiet hours are no great hardship, as the TV doesn't come on until early afternoon, and usually signs off before midnight.

Our AC power is 220 vac, 50 Hz, and it's fairly well regulated. There are transformers available commercially to step this down to 110 vac, and with few exceptions any gear designed for 60 Hz will work all right on 50 Hz without excessive transformer heating. Most of the better American manufacturers are providing export models of all their gear now, so if you're concerned about possible equipment damage this might be something to look into. I work in a test equipment repair and calibration facility, and to date the only problem we've had with transformer burn-out (due to line frequency) has been with some poor quality imitations of Tektronix equipment.

My pet peeve about my tour here has been (and is) QSL's, and the lack of them in my mailbox. I get a card out to each station worked, with one or two exceptions due to lack of address information, but to date, my return rate from W/K stations is just above fifty percent. I'm sorry to say that the return rate from DX stations is somewhat lower, but perhaps they have postal problems I'm not aware of.

This is not a complete picture of the American ham in Europe by any stretch of the imagination, but I hope you found it entertaining. If there are any questions, drop me an SASE, or look for me when the skip is good.

...DL4BR

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# *On the Use of Phonetics in Pileups*

If you are among these fortunate enough to have a call sign like W6AA, you won't be interested in the rest of this article, but if you have one like WD2BJB, you may be interested to know what the DX'er on the other end of a DX contest pileup thinks of you if you say "Whiskey, David, the number two, 'D' as in Denmark, 'J' as in Japan, and 'B' as in Boston."

Some time in the nostalgic past when all call signs began with a "W" or with no prefix at all, it was an easy matter to decipher call signs. Today, with so many prefixes to choose from, we seem to have gone overboard in our phonetic frenzy to get call signs across.

Phonetics are to clarify, not to confuse, yet frequently we are apt to accomplish the opposite by employing certain techniques. In a hot contest or pileup, the object is to get as much information across in a short time as possible. Frequently in a contest, the contact is over while a slow caller is blissfully repeating his phonetics.

There are two things wrong with "Whiskey David, the Number two, Denmark, Japan, Boston." For one thing there are too many bits of information to remember, and secondly, remembering the proper order puts one more burden on the DX station.

Let's put yourself on the receiving end of a pileup. The important part is "DJB," the rest can be filled in at leisure after the contact has been established. What would you do if you were a WB2 and you heard the DX station announce, "The WB2 what was your call?" Immediately all WB2's are compelled to answer. However, "The station with call like DJB" immediately identifies you unless there happens to be a BJD, BGD, BJB, or some other phonetically similar call, a rare coincidence. If you go back in the face of such positive identification, you would be ostracized.

The important thing is to get at least two letters of your suffix across. If the DX station has any savvy at all, he will pry the rest of the information from you at his leisure. When the DX asks for a fill, give him only the information he wants. He asks for a fill because of QRM and not much else.

How effective is "Denmark, Japan, Boston?" After about 3000 contacts, the DX'er is a pretty weary fellow. After hearing "Denmark, Japan, Boston" he is liable to mutter to himself, "Now was that Japan, Boston, Denmark or Boston, Denmark, Japan?" By using phonetics you give him the extra task of trying to remember which word came before which. The order may be trivial to you, since you have practiced it many times, but the DX operator has heard that combination for the first time and he has to remember the order.

Just plain "WD2BJD" is apt to be more effective because it is easier to remember for the DX'er. He might have gotten it as "WB2BGB" but what does it matter? You've nailed him and can now correct him at your leisure. Better still you should say "WD2BJD, Baker John Dog" and *not* the reverse order, WD2 Baker John, Dog, WD2BJD. The worst of course is "William Dog, the number two, Baker, John, Dog." The DX'er now has to remember a Baker, two dogs, a John, a William and a two floating around some place and must place them in proper sequence. No wonder he mutters to himself.

Stick to plain WD2BJD, no phonetics until asked for. If the DX'er goes back to only those who give phonetics, he probably won't be a winner for his country because he is taking too much time per contact.

Going to the other extreme, I have heard something like "DJB, DJB, DJB" given with no prefix – "no nothing." This is especially pathetic to hear when he is the only one left calling after everybody has gone to the listening cycle. Giving the phonetics of the DX station is downright insulting. It is tantamount to telling the DX he doesn't know his own call.

"What's your number again?" may not be correct grammatically, but it is more effective than "I would like to have you repeat your number." Note "what is" (he wants something so get set), "number" (it's my number he wants), "again," (he means repeat). The sequence is "get set" "for the query" "reinforce." This technique also works for copying high speed CW.* Note that in "I would like to have you repeat my number," the only part that carries information is "repeated number."

"William David Two Dog John and a Baker" is just as bad as "Kay Nine Dog and a King" (K9DK). The DX is apt to call you K9DNK. As my friend K4II says "If I send K4II "k" meaning "ar" on CW, I'm done for because they will insist on calling me K4IIK." This is just as bad as calling KH6IJ, K5BIJ, or KS6IJ on CW. I just can't shake them loose once the imprint is fixed, but on phone thanks to phonetics, corrections can be made.

Getting attention in a pileup calls for the skill of a seer. One must be able to place himself in the framework of the DX'er and be able to outguess the competition, and still not arouse the ire of the DX'er.

If you want to put these ideas to a test, come to Hawaii and operate in a DX contest. As for me, I don't care about fancy footwork, I just go back to the first caller I can make out who signs early.

# Getting Your Extra Class License

## Part IV — Radio Waves

The whole purpose of radio is to communicate, and to do so requires that information be transmitted from one place to be received elsewhere. The difference between radio and other forms of communication is that, in radio, we transmit this information over "radio waves" rather than by means of wires or the printed page.

To use radio for communication we must have some knowledge of the way in which radio waves work, and so the Extra Class license examination includes a number of questions to test your knowledge of radio wave propagation.

In fact, it includes too many such questions to cover adequately in a single installment of this series. This month we'll look at the general principles involved, and some of the more unusual aspects of VHF propagation. We'll handle the following questions from the FCC study list:

48. How do the directivity of an unterminated "V" antenna and a parasitic beam antenna compare?
58. What are aurora-reflected VHF signals? If such a signal is heard, what does it sound like?
67. What constitutes a parasitic antenna element?
71. List some different types of beam antennas.
76. What determines the skip distance of radio waves?

As usual, we'll extend the scope of these questions to cover the subjects more fully. For a start, we'll examine the whole problem by asking "What Is Radio Communication?" We will find, while exploring that subject, that signals are both radiated and reflected in the process of being used to communicate.

Our second and third questions will look in more detail at reflection, by asking first "How Does Signal Reflection Occur?" and then "How Does Reflection Affect the Signal?". The answers to these two questions will include the unusual VHF effects, and will also help us meet the final two questions.

Our final two questions will bring us into the area of signal radiation: "How Is a Signal Radiated?" will introduce the subject of antennas in general; "How Can a Signal Be Concentrated?" will focus our attention on directive antennas.

While we'll get no farther in this month's instalment, future discussions will extend our study of antennas in the same direction.

All set? Let's dive in.

*What Is Radio Communication?* It may seem an overstatement of the obvious to proclaim that the whole purpose of radio is to communicate – yet many of us are so involved with the purely technical aspects of radio and electronics that we tend to lose sight of this basic fact. For this reason it's worth while to stand back at this point and try to find out just what is involved in communication by radio – or "radio communication".

Let's try to find out what is involved by doing some "word substitution". What we want to know is simply "What Is Radio Communication?" If we can substitute other words or phrases for the words "radio" and "communication", we may have a meaningful answer.

We'll tackle the hard one first – what can we put in the place of "communication"?

This is hard because the question of what constitutes communication has been stumping the experts for years, and promises to continue doing so for some years to come. About all that they agree on is that communication involves a "transfer of information" – so let's try that on for size.

"Radio transfer of information" still seems to make sense although it doesn't tell us much more. Let's use that and try to keep going along this route. What can we put in the place of "information"?

Some 20 years ago, fortunately, Claude Shannon found a good answer for that one. He defined information as "a selection from a set of possible choices", and went on to define it more precisely as a reduction in the uncertainty of the selection. However when we plug in Shannon's definition of information the result looks more like a government directive than like any meaningful explanation. Let's try again, using Shannon's idea but not his words.

The simplest possible amount of information about anything is the mere fact that it exists, or does not exist. This is an all-or-nothing choice with no alternatives – and we make use of it any time we send a message using CW. The carrier is either there or it is not, and we interpret the pattern formed by its presence or absence over a period of time into characters of the alphabet which spell out the message.

Following this line of reasoning, the carrier is a radio wave and a radio wave is a form of energy. It's not unreasonable to say, then, that information *can* consist of a sequence of energy patterns. It's not even unreasonable to assume that it always consists of such a sequence of energy patterns, because an AM signal or even TV is also a sequence of energy patterns – just much more complex than the simple on-or-off of a CW signal.

And plugging this in gives us the phrase "radio transfer of a sequence of energy patterns", which doesn't seem to be too far out although it does tend to sound more like engineeringese than like English. Let's see what we can do about that.

The word "transfer" always implies a "from-to" relation; that is, it means a movement of something *from* a source or transmitter *to* a target or receiver. Let's use this fact to modify our phrase even more: "radio movement of a sequence of energy patterns from a transmitter to a receiver" is the result, and it sounds more like English if we turn words around a little to say "movement of a sequence of energy patterns from a transmitter to a receiver by means of radio".

What's more, this expansion of the simple phrase "radio communication" is beginning to look almost like a definition, which is what we set out to find!

About all we have left to do to it is to expand the word "radio" and we may have our answer.

The physicists tell us that any energy can be moved by two routes – conduction and radiation. Conducted energy moves along some physical "conductor"; direct current flowing in a copper wire is an example of conducted energy, and so is light flowing through a polished plastic rod. For that matter, the heat reaching the handle of a skillet gets there by conduction too.

Radiated energy, on the other hand, moves directly through space without benefit of a conductor. The light and heat from the sun are good examples of radiated energy. So is the *rf* output of any transmitter once it leaves the antenna. The word "radio" is, in fact, simply an abbreviation of the word "radiate"!

So we can define "radio communication" as being "movement of a sequence of energy patterns from a transmitter to a receiver by means of radiated energy". This gets us the answer to our first question, but there are a few points to clear up before we move on to the second.

For instance, the "transmitter" in the definition we have just developed is not what we generally mean when we use the word. In this definition, a "transmitter" includes the entire setup from operator and mike or key, through the transmitting equipment, to the antenna. Similarly, the word "receiver" in the definition includes the receiving antenna, receiving equipment, and finally the receiving operator. After all, communication is established only when something gets from one human brain to another – you can't do much communicating with a beacon or code wheel!

And the use of the words "radiated energy" in the definition doesn't mean that some conductors aren't involved too; the point here is that the major part of the transfer is done by radiation. We all know that any radio equipment is full of wires. The story is told of a British dowager in the early days who, upon being shown a "wireless" station, asked "Why do you call it wireless? I've never seen so many wires before in my life!

In fact, communication by radio involves the use of both conducted and radiated energy. The transmitting equipment originates the *rf* energy and puts the sequence of energy patterns into it, and all during this phase the energy is conducted by our wires and feedlines. If any of it *does* radiate at this stage of the game, it's a major problem! That's what shielding is all about.

The antenna is the bridge between conduction and radiation. At the transmitter, the energy is conducted to the antenna, and radiated from it. At the receiver, the antenna picks up the radiated energy, and the energy it receives is conducted into the receiving equipment.

So long as our *rf* energy is being conducted, it follows most of the normal rules which apply to dc and low-frequency *ac* (with a few exceptions such as skin effects). When it is radiated, the special rules which apply to radiated energy get into the act.

It might appear most logical to move from here directly into our examination of the bridge between conduction and radiation, the antenna. However, action of many types of antennas involves the rules of radiated energy rather than those of conduction, and so is easier to comprehend with a knowledge of these rules. For that reason we'll examine the rules of radiated energy next. Then we'll move on to look at the antenna situation.

*How Does Signal Reflection Occur?* Reflection of a signal is just one of two effects which occur when radiated energy meets anything. To find out how a signal is reflected, we must examine the way in which radiated energy interacts with anything it meets.

It's easiest to understand by keeping in mind that *light* is also radiated energy; any rule followed by an *rf* wave must also be followed by light, and any rule obeyed by a light beam must also be obeyed by *rf*.

It's also important to keep in mind that the rules which determine action of waves, while simple enough in themselves, are at the very heart of all modern physics. Most engineering textbooks make no effort to explain the rules – they merely state that the rules are followed.

One volume which does attempt to explain them in detail (Fields and Waves in Modern Radio, by Ramo and Whinnery) makes generous use of matrix algebra and differential equations derived from Maxwell's Equations to present the explanation.

But we're not afraid to take a chance on oversimplifying a complex subject in the interests of getting the main part of the idea across; we may make a few minor errors along the way but in general the following explanation is how it works.

And you won't find the slightest trace of mathematics in it, either.

A word of warning is in order, however. While the main idea is presented accurately, don't get into any arguments with physicists and cite this material as your reference. It may not be all that accurate; in case of conflict, believe the physicist!

If you're still with us, then, let's dive right into just how "wave mechanics" and "quantum theory" describe the interaction of radiated energy and matter.

While nobody yet knows exactly what a "wave" of radiated energy amounts to or just how it manages to get from here to there, a number of ideas and concepts (the big brains call the "models") have been developed – and most of them seem to fit at least parts of the needs pretty accurately.

One of these ideas, which is the basis of quantum theory, is that a wave consists of minute packets of energy called "photons" and that the amount of energy per packet is related to the frequency of the wave. The higher the frequency, the more energy per packet.

In this scheme of things, a light wave packs more punch than does a radio wave, and an X-ray has more punch than either.

The effects which we observe in waves, such as those of reflection, refraction, diffusion, or scattering, occur only at the boundaries where the wave moves from one substance to another. So long as a wave is travelling in a single medium, whether that medium is air, a sheet of plastic, glass, or the unknown substance today's scientists call merely "space" and the learned men of an earlier era knew as the "aether", it can produce no observable effect!

At the boundary which separates one medium from another, though, one major effect occurs. This effect shows up as two distinct phenomena – and it's only because of them that we can tell that waves exist.

The effect which occurs is an interaction between the wave's energy and the particles which make up the medium; normally these particles are atoms, but sometimes they are molecules and in a very special case they include electrons as well.

The particular type of interaction which occurs depends upon the relationship between the frequency of the wave and the self-resonant frequency of the particles involved. Each of the particles of atomic or molecular size *does* have a self-resonant frequency, and it's most convenient to think of them as being tiny tank circuits exposed to an excitation from the incoming wave.

If the incoming wave is at a frequency far below that of the particle's resonance, the particle will vibrate weakly in phase with the incoming wave.

If the incoming wave is at a frequency far *above* that of the particle's resonance, the particle will still vibrate weakly at the frequency of the incoming wave, but its vibration will be 180° out of phase with the incoming excitation.

If the incoming wave's frequency matches that at which the particle is resonant, the particle will vibrate strongly, 90° out of phase with the incoming wave.

In most materials the particle resonances are at frequencies higher than that of visible light; a few substances have resonances as low as the infrared region, but almost none have resonance in the common *rf* range.

For this reason, for most *rf* energy and almost all materials the first case will hold true. Each particle at the boundary of the material will vibrate weakly and in phase with the incoming wave.

There's a very special exception which we will meet a little later, in which both in-phase and out-of-phase vibrations occur. Before we look at that, though, let's stay with the first case and see what happens most of the time.

Now as it happens, a vibrating particle will itself emit new radiation just because it's vibrating. It's the same basic idea as that of the tuning fork, which you hit to make vibrate, and which then emits an audio wave because it is vibrating.

This means that when an *rf* wave hits the surface of any substance, each particle at the surface of that substance will re-radiate new waves which are in phase with the original *rf*.

Each of these new waves will, in turn, hit adjacent atoms or particles within the material and cause additional vibrations and more re-radiation.

If the particles are scattered about the substance more or less at random, as they are for instance in a gas, the total effect of all this secondary vibration will be a "scattering" or "diffusion" of the original wave. The higher-frequency waves in the original energy (if a mixture of frequencies were present at the start) will predominate in the scattered new radiation, because they had more energy per photon to begin with.

We see such an effect any time we look at a blue sky. The blue skylight is the scattered re-radiation produced by the molecules of the air when they are hit by sunlight; the red of the sunlight is dissipated in the scattering process.

If the particles are held in a reasonably rigid structure, though, as they are in most solids, the effect of the new radiations is rather different.

All of the individual re-radiations from the individual particles tend to cancel each other out, because the particles are regularly spaced. The only re-radiations that are not at least partially cancelled by this effect are those which happen to add up in "coherent phase" travelling in just one direction inside the material, and those from the surface layers of particles which have no other particles above them to produce cancelling re-radiation.

The new wave inside the substance is known as the "refracted" wave. It may move at a different speed than did the original, and in a different direction as well, depending entirely upon just how the particles of the substance are arranged in their rigid structure.

The particles at the surface (a layer about half a wavelength deep) are producing re-radiation in all directions. These re-radiations all interfere with each other, just as do the cancelling ones inside the substance, but just what happens when they interfere depends upon the structure at the surface.

If the surface of the material is smooth (using the wavelength of the incoming radiation as the yardstick to determine smoothness; anything with irregularities no more than 1/10 wavelength apart is considered "smooth"), then the radiations from the particles at the surface will interfere with each other just as do those inside the material to produce a single wave travelling in a single direction.

The interference is normally such that the new wave from the surface particles – known as the "reflected" wave – leaves the surface at the same angle with which the original wave arrived, but in the opposite direction. This is the classic law of optical reflection as shown in Fig. 1.

If the surface is rough (irregularities more than 1/10 wavelength apart), then the reflected waves from each surface particle will not add up to a single wave since each will have travelled a different distance at any given point away from the surface. Reflection still occurs, but it is diffuse rather than sharp. A white cloud offers an optical

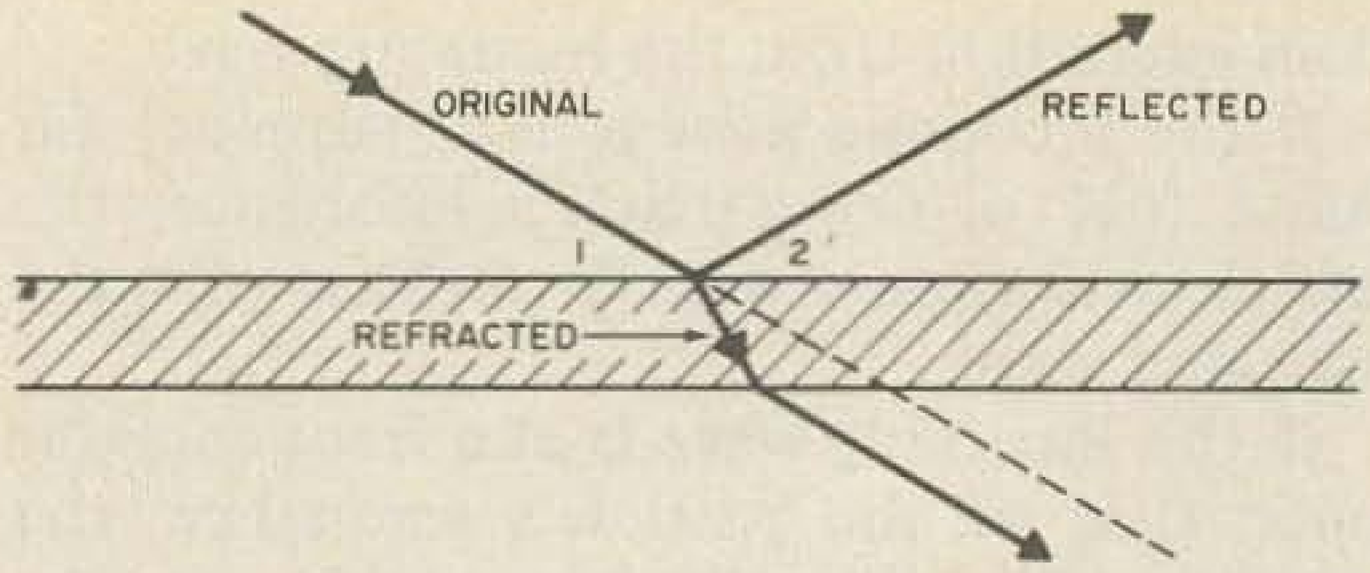



Fig. 1 – Classic optical example of reflection and refraction shows that reflected ray always leaves surface at same angle it arrives. Refracted ray changes direction at boundary. If refracted ray passes through another boundary, as shown here, its direction changes again; if two boundaries are parallel to each other final ray will be parallel to original ray (dotted) but offset from its path. If boundaries are not parallel, as in a lens, rays may be either spread apart or focussed to a point. Same effects are present in radio waves but because wavelength is much larger the effects show up somewhat differently.

example of this. So, for that matter, does the white surface of the paper on this page; the paper particles are much larger than the wavelength of light, and so the light falling on the page is reflected diffusely. Where the ink is heavy, it forms a coating with a surface structure smaller than 1/10 wavelength of light, and so appears glossy with sharp reflections.

Since both light and *rf* waves are the same type of electromagnetic radiation, differing only in frequency, *rf* acts just the same way light does. The apparent differences are due to the vast difference in frequency; a structure which is quite smooth to an *rf* wave may consist of such widely scattered particles that it appears totally transparent to light. A screen-wire reflector is a good example of what we mean here. Another example is the ionosphere, although its relative smoothness differs for *rf* of different frequency.

Because of this, when a radio wave hits almost anything both reflection and refraction will occur. The reflection is the basis for radar, and the refraction makes skip propagation possible (as well as possibly providing the mechanism for radio to exist in the first place, if you consider the "radiated" wave as being refracted through space).

But before we go any further we must examine the very special case of materials which are electrical conductors, because they behave rather differently than the ordinary solid substances we have been examining.

an insulator lies in the atomic makeup of the material. A conductor contains numbers of "free" electrons which are bound only loosely to their parent atoms and which are free to wander about the interior of the material under the influence of electric forces. A perfect insulator has no such electrons, and actual insulators have very few.

The free electrons in a conductor provide the means by which an electric current is conducted, and also make a large difference in the action of the material when a wave hits it, because both the free electrons *and* the particles which make up the substance's structure at the atomic level vibrate.

The particles vibrate weakly, in phase with the incoming wave, just as do those of insulators. The free electrons, on the other hand, vibrate *out* of phase with the incoming wave by $180^\circ$, also weakly.

The vibrations of the free electrons cancel out the vibrations of the particles, and make it impossible for the wave to penetrate the boundary of the substance. Refraction cannot occur, because the energy can't get inside the material.

But the energy is still striking the surface, and the surface layer of particles is still vibrating. This permits reflection to occur. What's more, the law of conservation of energy requires that all energy going into something must come out again – and since no refraction can occur, *all* the energy taken from the incoming wave is reflected from the surface.

Thus a conducting surface will reflect all the *rf* which hits it, while an insulating surface will reflect only a part and will refract the rest through itself.

Conducting reflectors play a large part in antenna design; the principles of reflection (particularly that of re-radiation) are also important in understanding action of parasitic antennas.

The effect normally known as "signal reflection", though, is more often actually due to refraction than to reflection. Such things as skip transmission, meteor trail communication, and aurora-reflected signals are actually effects of refraction. Moonbounce and scatter work, however, are true reflection phenomena.

The reason why refraction can masquerade as reflection is illustrated in **Fig. 2**, which shows refraction at work in one of the ionized layers responsible for skip transmission.

When a wave is refracted, both its speed and direction usually undergo change. Speed may either increase or decrease; the change of direction usually depends upon what happens to the speed.

If the refracting medium has characteristics which change gradually within the material, the speed and direction of the refracted wave will also change gradually as the wave proceeds in the material.

The ionized layer is such a medium; its makeup changes – both from minute to minute (and other periodic changes) and at various points within the layer at the same time.

Thus a wave transmitted from the earth will be bent or refracted only slightly as it enters the ionized layer, but the deeper it penetrates into the layer the more its direction is changed. When the original direction has been changed enough to turn it around a corner, the wave is moving out of the material rather than in, and then the change in direction becomes less the farther it travels.

Eventually the wave will come back out of the layer, provided that the refraction doesn't just happen to trap it completely within the layer and bend it only enough to keep it trapped. Even if this should happen at some spot, there are enough irregularities in the layers that the energy would escape elswhere – and such an action may be at least partially responsible for some types of fading.

As Fig. 2 shows, when the wave emerges from the layer there is no way at all you can

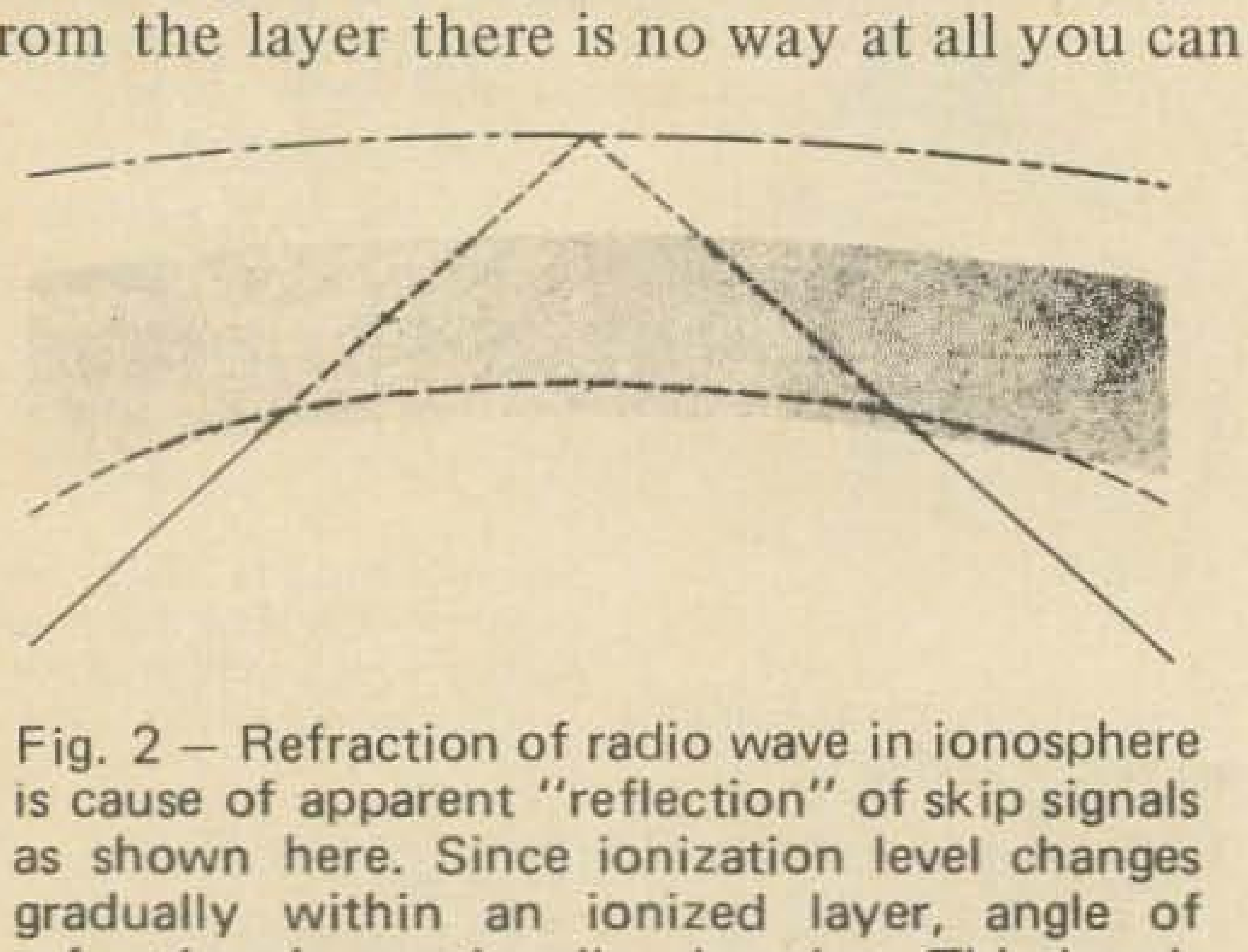


Fig. 2 – Refraction of radio wave in ionosphere is cause of apparent "reflection" of skip signals as shown here. Since ionization level changes gradually within an ionized layer, angle of refraction is continually changing. This bends wave back in new direction, making it appear to have been reflected from a surface at somewhat greater height (dashed line). Wave reaching layer at shallow angle (dotted) does not penetrate so deeply as one hitting at sharp angle (solid); therefore it is bent less and so returns to earth at greater range than difference of angles alone would indicate.

determine that it wasn't simply reflected from a sharp surface at a somewhat greater height. This fictional reflecting surface's height is what is referred to as the "virtual height" of the skip layers.

The reason we know it works by refraction rather than reflection is that the virtual height of a layer appears to change with the angle at which energy hits it. The shallower the angle, the lower the virtual height. You can see from the dotted-line example in Fig. 2 that this would be expected with refraction, but not with reflection.

This mechanism in the ionisphere indicates that the angle at which the signal will be "reflected" depends critically upon the angle at which the signal arrives, and also upon the condition of the ionized layer at that particular time. High-frequency signals packing more punch per photon, bore right on through much more readily than do those of lower frequency – so that as you keep going up in frequency, you find a point at which the signal simply doesn't come back down. Instead, it bores on out headed toward outer space.

The angle at which the signal hits the layer depends, in turn, upon the actual angle at which the wave leaves the transmitting antenna. This depends upon the antenna design, its height above electrical ground, and the nature of the ground surface within several wavelengths of the antenna site. The lower the angle at which the signal leaves, the more shallow will be the angle at which it hits the refracting layer, and the greater will be the distance covered before it returns to earth.

Any substance which is capable of refracting the wave can cause "reflection" by refraction in this same manner. In addition to the horizontal ionized layers which make up the ionisphere, *rf* signals are frequently "reflected" from the aurora borealis and from the trails of ionization left behind by meteors. At VHF, similar effects are caused at the boundary between different layers of air in the atmosphere.

*How Does Reflection Affect the Signal?* True reflection has virtually no effect upon the signal, except that its phase changes 180° during the process of reflection. "Reflection" by means of the refraction effect, though, can affect a signal in many ways.

Reflection of VHF signals from the shimmering veils of ionization which are known to science as the aurora and to the general public as "the Northern lights" offers several examples of such effects.

The aurora is a rapidly moving affair. Its exact cause and composition is still not accurately known, but it is believed to be especially intense ionization of the upper atmosphere under influence of solar radiation trapped by the earth's magnetic field. It is visible as curtains, columns, and sometimes horizontal sheets, and moves in both the horizontal and vertical planes at relatively high speeds.

Often, the aurora appears to shimmer with a to-and-fro motion.

Any radiation reflected (that is, refracted back toward the source) from these clouds has a frequency shift imposed upon it by the motion of the clouds, by Doppler effect.

This frequency shift is, effectively, FM of the original signal, in which the modulating signal is the oscillating movement of the aurora itself.

The frequency of the aurora's oscillation is often so great that the resulting FM completely wipes out any intelligibility of audio upon the signal, and makes a CW signal appear to occupy a wide band rather than the normal near-zero bandwidth.

If aurora-reflected signals are received by the normal CW method, using a product detector or BFO, the FM causes the received signal to appear to warble. But since the reflection is coming to the receiver from a wide source – the entire aurora cloud – and part of it is moving toward the receiver while other parts are moving away, it isn't just a

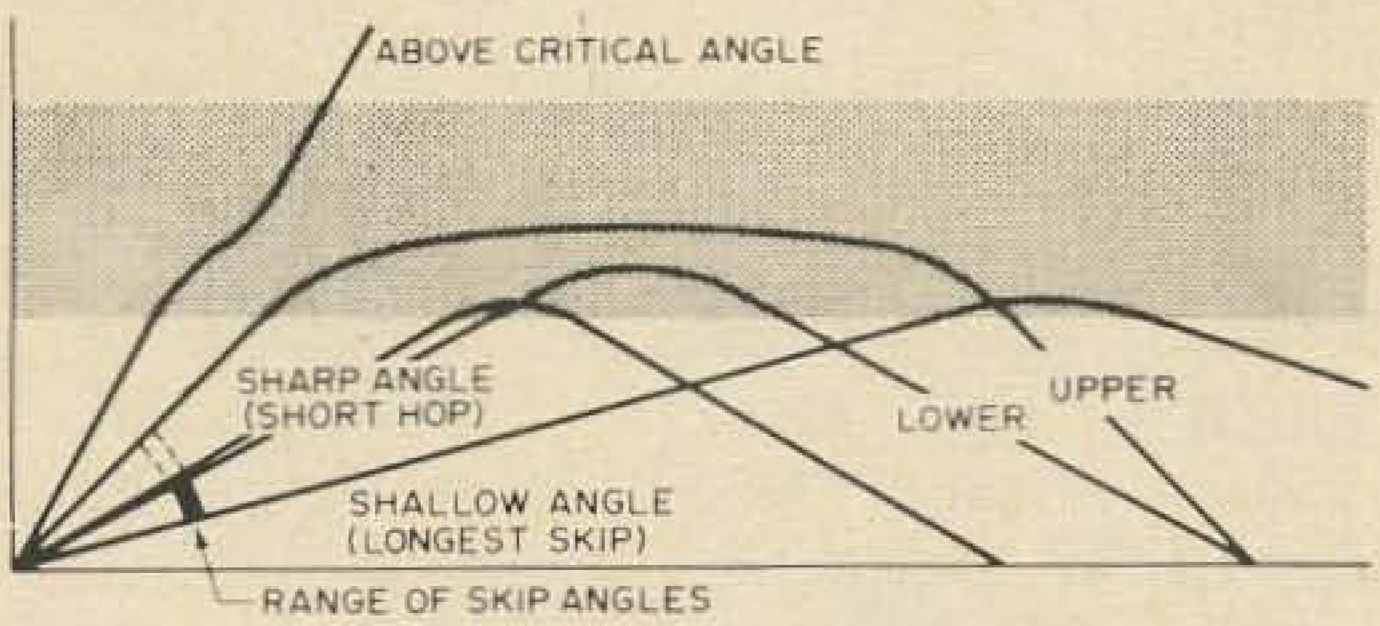
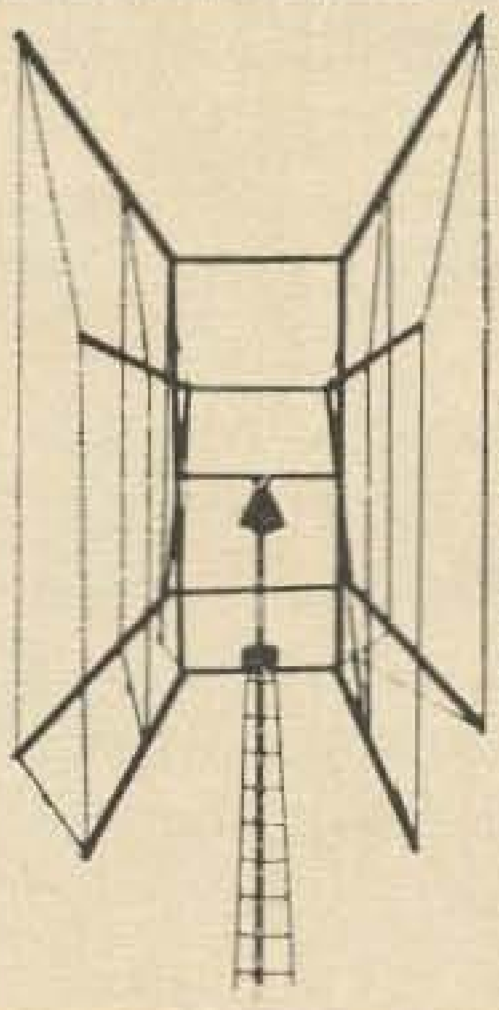


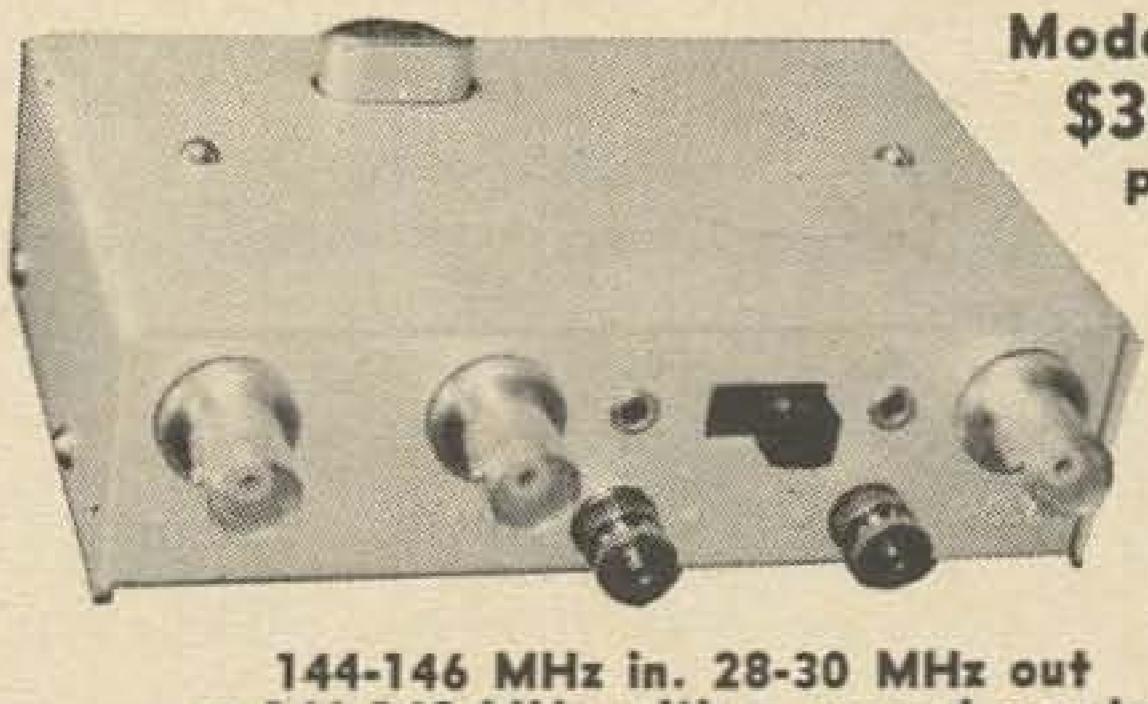

Fig. 3 – Various effects of transmission angle (angle at which wave leaves transmitter) are shown in this sketch. The longest skip distance is achieved by the wave with the lowest transmission angle, and the shortest by that with a moderately high angle. As angle increases, wave is held in ionized layer longer and skip distance increases again. Such waves are called "Pedersen waves" and may interfere with lower waves from same transmitter as shown. Still greater angles permit wave to pass on through ionized layers if ionization is sufficiently weak.

single warbling note. Instead, it's a mixture of frequencies covering the entire audio range. The resulting sound has been compared to the whine of a buzz saw going through a pine knot . . .









Just to complicate things, most aurora-reflected signals are very weak; very little of the original signal is reflected to any one receiver. The signal-to-noise ratio is often as low as zero db.

Somewhat the same situation prevails when the trail left by a falling meteor provides the refracting ionization. In this case, though, the warble is absent. Any Doppler shift is usually constant. Signal levels, however, are much lower because the refracting volume is much lower.

Scatter techniques depend more upon true reflection, of the same type that makes an oncoming automobile's headlights visible over the rim of a hill on a foggy night. The original signal is reflected in all directions by tiny discontinuities in the atmosphere (tropo scatter) and ionosphere (ionospheric scatter). Scatter transmission provides the most reliable and consistent form of long-distance *rf* communication, but requires power levels greater than those allowed the ham by law to attain reasonable distances with high reliability. At amateur power levels, distances are so short that most scatter signals are thought to be "ground wave" instead.

All of these effects are present with all radio frequencies, but their effectiveness varies with frequency. At moderate frequencies (15 meters and below) they are usually overpowered by "normal" skip transmission. In the VHF range they are most observable, and many VHF operators specialized in using one or more of these techniques. As the frequency goes on up, the amount of refraction becomes too small to return a usable signal level and the effect again appears to disappear.

*How Is A Signal Radiated?* The subject of just how an *rf* signal can be propagated is a most profound one, and virtually all the first installment of our previous Advanced class study course (March, 1968, issue) was devoted to it.

A few minor modifications to the propagation model we put together in answer to our question "How Does Signal Reflection Occur?" can, however, offer some additional insight into the subject.

As we explored reflection and refraction, we discovered that a conductor cannot refract a wave but must reflect it. At that point, we declared that the energy had no place else to go and so all the incident wave went back out as a reflection.

If, however, the conductor happens to be serving as an antenna, that statement was not fully correct. The energy *does* have some place else to go – down the feedline.

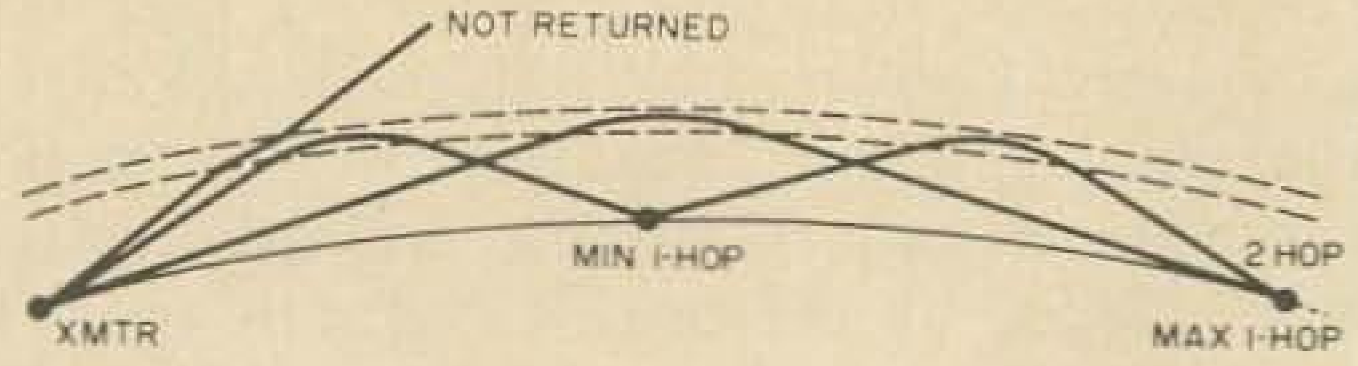



Fig. 4 – Both single and multiple-hop propagation are shown here. Wave launched at original angle for shortest skip range hits earth at moderately steep angle and is reflected back toward ionosphere. There it is refracted again and comes back down at double the original distance. "Skip distance" is distance from transmitter to the minimum 1-hop point; this region is sometimes called the "dead zone". Waves launched at higher angles fail to return (except for Pedersen waves, see Fig. 3). Those launched at intermediate angles fall between minimum and maximum 1-hop ranges.

In the case of a transmitting antenna, energy is coming up the feedline instead. In either case, the system is no longer in perfect balance.

When the frequency of the wave which is exciting the antenna is such that a standing wave can develop on the antenna structure itself, it does so. This standing wave can be thought of as the re-radiated wave from all the surface particles. However, since the standing wave maintains a perfect phase relationship with the radiated energy, it will couple with the radiation field and permit a much more efficient transfer of the energy itself.

What's more, the fields of the standing wave will induce a current *inside* the conductor – where the radiated wave itself cannot get because of reflection at the surface. This action is what moves the energy through the totally-reflecting boundary of the conductor.

If we're trying to radiate a signal rather than receive one, we begin by pumping energy into the antenna conductor at a frequency at which the antenna has electricl resonance. This produces a standing wave upon the antenna, and this standing wave is accompanied by a magnetic field which is directly associated with current flow in the conductor.

The variation in the magnetic field is accompanied by a variation in the electric field established between the ends of the antenna conductor, and the phase relationships between the magnetic and electric fields which result are such that the "wave" which they define is a travelling wave rather than a standing wave.

A travelling wave is, by definition, one which is being radiated through some medium – usually "space". A standing wave, on the other hand, is confined to a physical structure such as an antenna.

While most antennas radiate by means of a standing wave created upon their structure, this is *not* an absolute requirement. Any resonant antenna has a standing wave, and so do such "non-resonant" antenna types as the long wire.

The terminated V, the rhombic, and the Beverage antenna designs, however, all make use of travelling waves without requiring a standing wave as well.

Travelling-wave antennas are inherently less efficient in the transfer of energy for a given amount of wire; the absence of the standing wave to help couple energy from inside the conductor to the outside of it must be paid for in a much larger structure. Travelling-wave antennas are almost invariably several wavelengths long, while the most common standing-wave antenna is the half-wave dipole, and the quarter-wave whip is no rarity either.

The difference is brought about largely by the difference in current distribution in a travelling-wave antenna as compared to a standing-wave antenna. **Fig. 5A** shows the familiar standing wave of current upon a resonant antenna; **Fig. 5B** shows the current distribution on a travelling-wave antenna.

The difference is marked; in the resonant antenna, current is highest near the center and drops to virtually zero at each end, while in the travelling-wave antenna the current is essentially constant throughout the conductor, dropping only because of radiated energy.

Those portions of the conductor which carry the greatest current are simultaneously surrounded by the strongest magnetic field since the magnetic field and the current are closely associated.

As this magnetic field couples to its surroundings, each tiny portion of the antenna acts as if it were a separate source of radiation.

With the constant current in the travelling-wave antenna, all these separate sources are radiating in essentially the same phase (the only phase differences are those introduced by the physical length of the conductor) and at essentially the same strength. The result is an interference pattern which causes most of the individual fields to cancel each other out just as did the re-radiation of

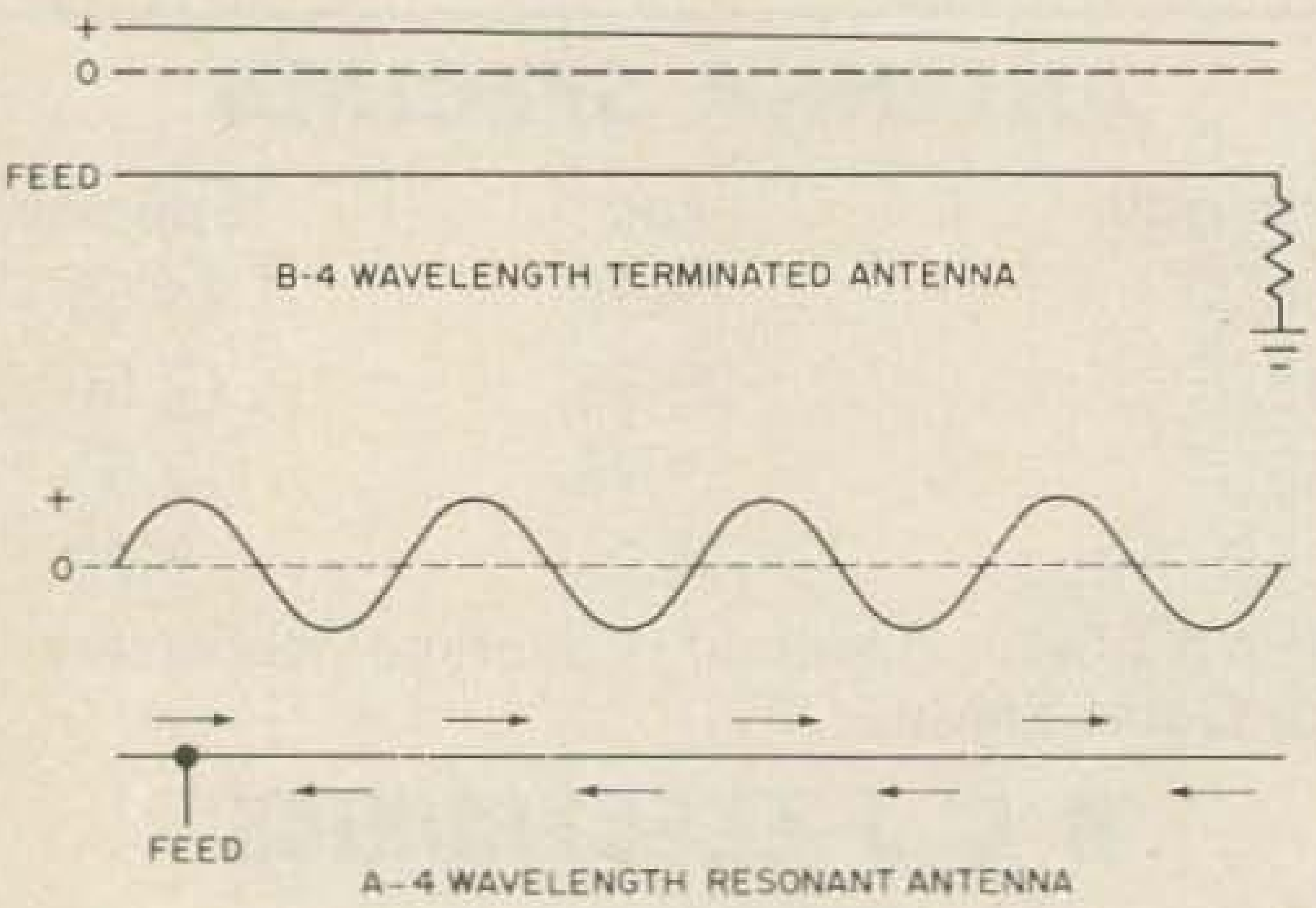



Fig. 5 – Difference in current distribution between resonant antenna (A) and terminated or travelling-wave antenna (B) creates differences in radiation patterns. On resonant antenna, current goes in different directions at different points to create standing wave. On terminated antenna, current flow is all one-way, from feedpoint to termination. Both antennas are shown as being "current-fed" at maximum current points.

individual particles in refraction. Those which add up instead of cancelling become travelling waves leaving the antenna.

In the resonant antenna, the separate portions of the conductor are not necessarily in phase with each other because the total reflection at the ends of the antenna introduces a 180° phase change, and they most certainly are not of equal strength as radiators since the current is not constant. Mutual interference still operates to cancel out most of the fields and leave a radiating travelling wave – but the pattern is different.

The most noticeable difference is that the travelling-wave antenna is unidirectional while the standing-wave antenna is not. This is because the current in the travelling-wave antenna is flowing only one way, while in the standing-wave antenna current is flowing in both directions (out and back) at the same time to create the standing wave.

**Fig. 6** compares the directional patterns for a terminated long-wire antenna (a travelling-wave type) and for a resonant long-wire of the same length.

A key point to keep in mind concerning signal radiation is that each individual small part of any radiating structure, such as an antenna, radiates with equal strength in all directions. Its radiation pattern is essentially a perfect sphere.

However, any radiating conductor which has any length at all must be composed of many such small parts, and each of them is radiating in slightly different phase from all the rest since the exciting energy takes at least a little time to get from one to another, and phasing *is* time delay.

The result is that any possible (as opposed to theoretical) antenna must have some type of radiation pattern, which is the result of the interference pattern created by the individual spherical patterns of its individual parts. That's why we looked at refraction and reflection first; the exact same principle is involved in the creation of the radiation pattern for any antenna, and as we shall discover shortly is also involved in our efforts to concentrate a signal in a desired direction.

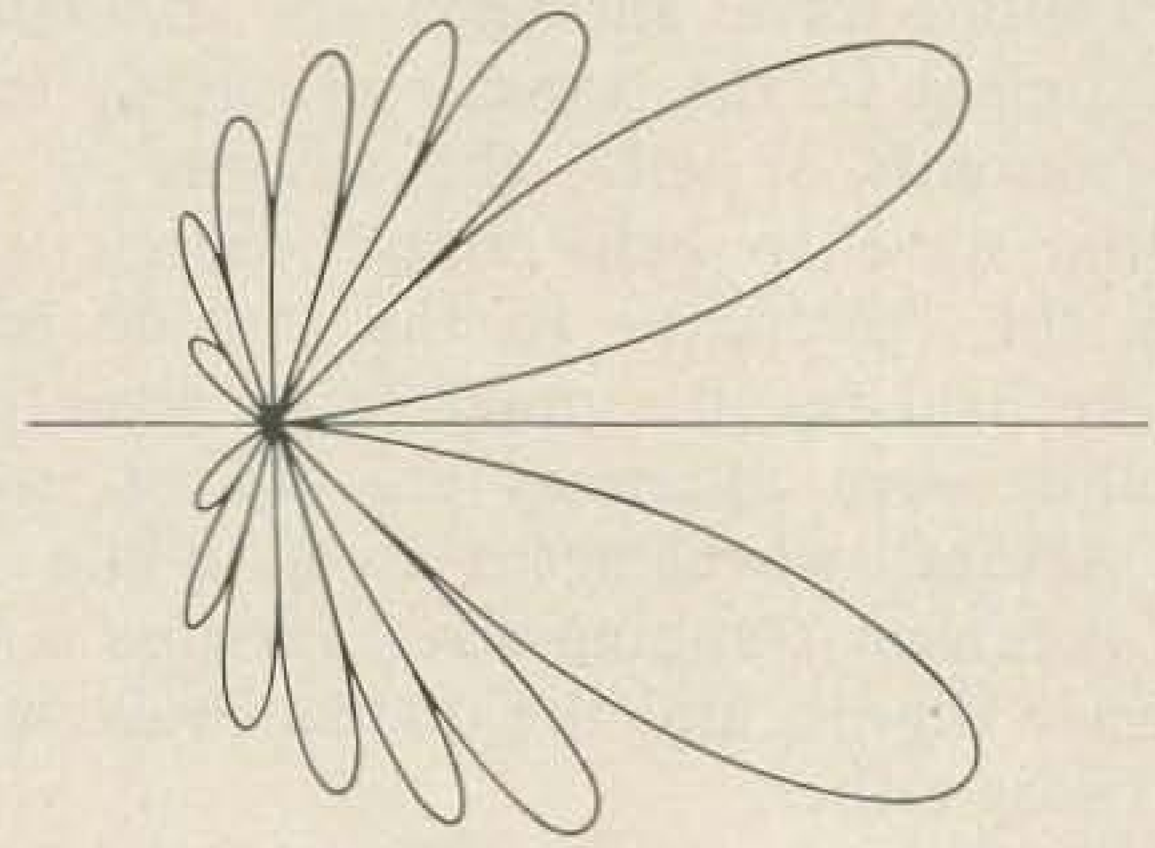


Fig. 6 – A – Radiation pattern of terminated antenna four wavelengths long is unidirectional in general direction of the wire, but has a null directly off the wire's end. The pattern's main lobes make 26° angle with wire. Pattern is symmetrical in three dimensions; consider this a cross-section view of it looking down from top.

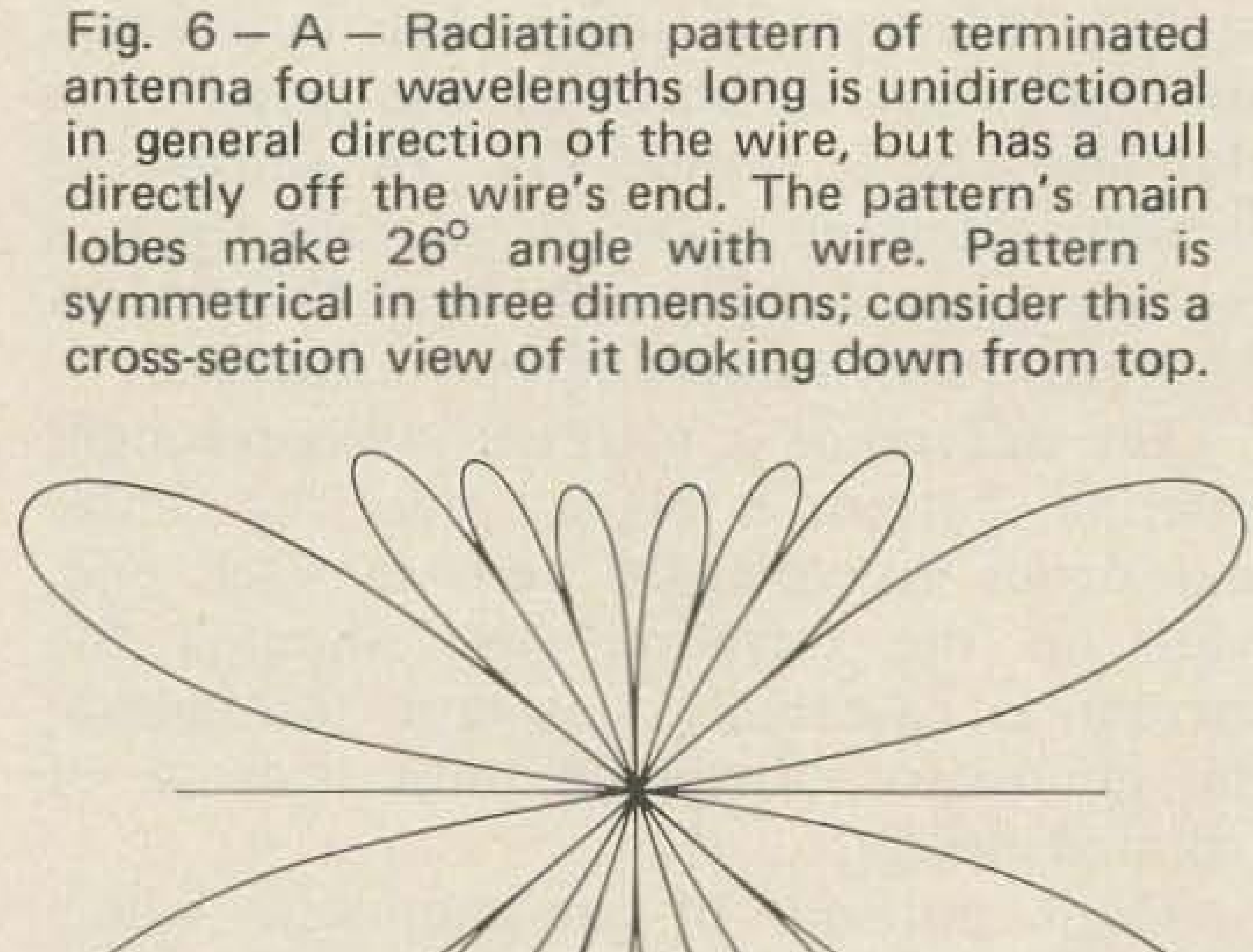


Fig. 6 – B – Resonant antenna of same 4-wavelength length has this type of pattern; it's like the terminated antenna's pattern with a mirror image superimposed on it. Result has main lobes in both directions, still with 26° angle and symmetrical shape. Bidirectional current flow (Fig. 5) is directly responsible for this bidirectional pattern.

*How Can a Signal Be Concentrated?* The "isotropic" antenna, which doesn't exist in practice but is the basis of antenna theory, radiates any power applied to it with equal strength in all directions. Its radiation pattern is a perfect sphere.

As we just saw, any possible physical antenna must be made up of several different atoms and so cannot be a perfect isotropic antenna – but even if we could get one, nobody would want it. *rf* power is too difficult to generate to waste by beaming as much signal straight up into space and straight back down into the ground as we send in the desired directions!

*Any* practical antenna performs at least some concentration of its signal, then, by putting it all into its radiation pattern. What we're really concerned with here is how we can concentrate the signal even more. It would be nice, for instance, to be able to put all our power in just the direction we wanted to transmit, without wasting any of it in undesired directions.

Such antenna designs exist, of course, and are known by the general name of "beam antennas" since their purpose is to concentrate as much of their power as possible into a single beam.

At least four major types of beam antennas have been developed, and many different designs within each type bear individual names. The types are (1) driven arrays, (2) parasitic arrays, (3) reflective systems, and (4) travelling-wave antennas.

Driven arrays include broadside arrays, endfire arrays, and combinations of the two. The Lazy H, ZL Special, 8JK beam, and Franlkin Collinear array are examples of driven arrays, as are most directive BC-station installations.

Almost all parasitic arrays are of the endfire type; the most common such design is the Yagi antenna.

Reflective systems are used primarily in the UHF and higher-frequency regions, and include the "big dishes" and the corner reflector.

Travelling-wave antennas include the terminated V, the rhombic, and their variations; these are most usually used only at low frequencies where the other types of beams are not practical. One type of travelling-wave antenna in wide commercial use at high frequencies is the helical beam.

Any single beam antenna installation may mix or match these types. Especially popular among VHF workers is a combination of driven and parasitic arrays in which several separate parasitic arrays are driven at the same time to form a driven array of parasitic arrays. **Fig. 7** shows the idea. At UHF, a corner reflector is sometimes incorporated into a parasitic array to increase the beam concentration and reduce unwanted back-lobes.

Since most beam antennas in ham use are either driven arrays, parasitic arrays, or combinations of the two types such as that shown in **Fig.** 7, we'll concentrate on only these two types for now.

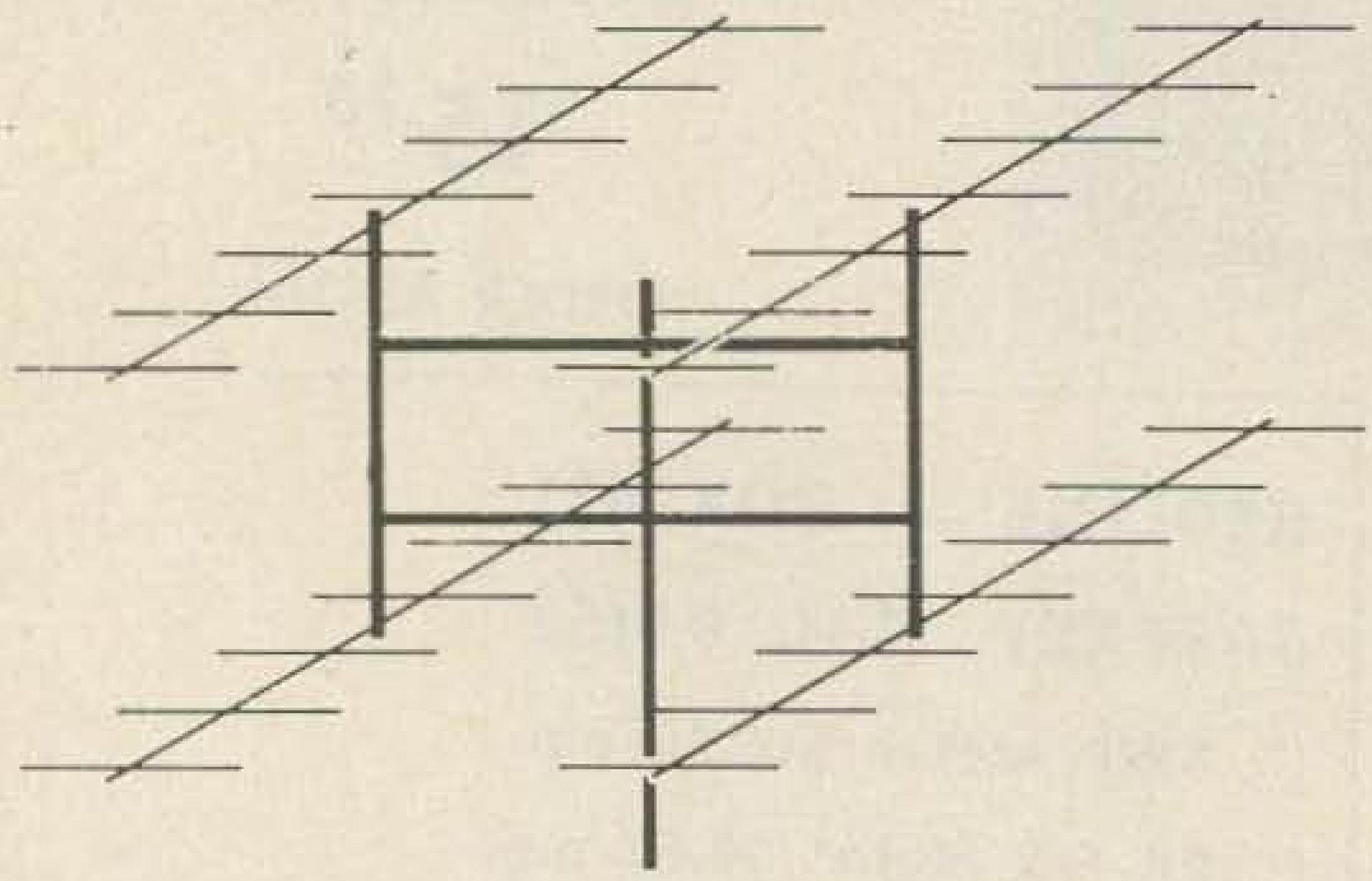


Fig. 7 – Quad Yagi antenna installation popular with serious VHF enthusiasts is typical example of an array of arrays. Each of the four Yagis is itself a parasitic array, and the four are arranged and fed as a two-by-two broadside driven array. Result is highly directional pattern and maximum gain; as much as 18 db power gain can be achieved in practical amount of space with careful design and adjustment.

The driven array consists of a number of individual antennas arranged in some regular pattern, all of which are driven at the same time from the same source. It's exactly the same principle as the radiation from separate atoms in refraction, except that it's at a much larger scale.

**Fig.** 8 shows the essential portions of any driven array; each individual antenna is shown here only as a dot rather than as a wire, because it's easiest to see what's happening if we think of each individual antenna as an "isotropic" one for the moment.

If each of the individual antennas is fed with current of exactly the same phase, then the array is a "broadside array" because it will concentrate the pattern to be strongest in the directions broadside to the line of the antennas. That is, the pattern shown in solid lines will result.

This is caused by interference between the patterns of the individual antennas. Only at point P (and other points along the line between P and the center of the array) will a receiver get equal amounts of in-phase energy from all the individual radiators. At other angles, the waves from one antenna must travel further (and so take longer en route) than those from another, and so will arrive out of phase. This causes a partial cancellation. The pattern is the result of all these partial cancellation effects.

If, however, the antennas are fed differently, the pattern will change. For instance, if the feedline is connected directly to the leftmost antenna and goes to the adjacent one through an additional length of cable which introduces a phase delay, and so forth down the line, and if that phase delay is chosen just right so that the energy *feeding* each array is in phase with the energy arriving from its neighbor to the left, then the only point at which all antennas contribute equally is that marked Q. The resulting radiation pattern is shown in dotted lines in **Fig.** 8, and the array is now an "endfire

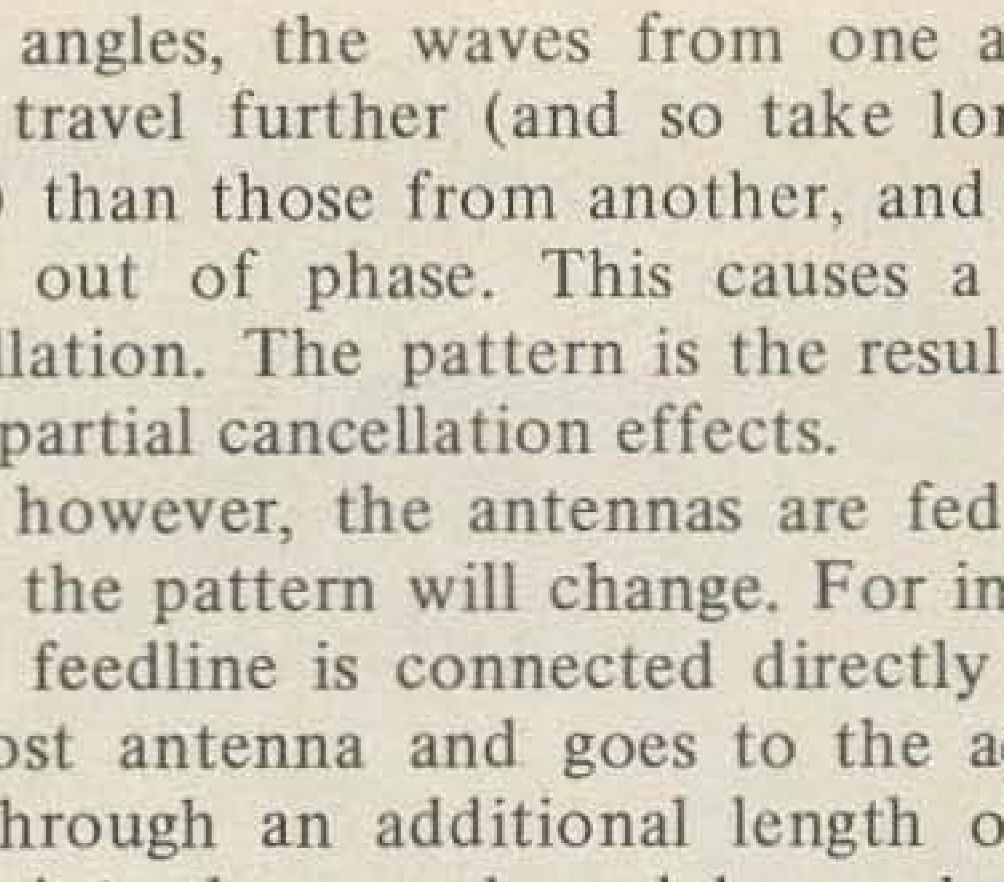



Fig. 8 – Basic patterns of driven arrays are broadside and endfire as shown here. For simplicity, each element of this array is shown as an isotropic (point-source) radiator and all minor lobes have been omitted. Both patterns repeat themselves in opposite direction; that is, they are bidirectional. Difference in direction between broadside and endfire patterns is due to feedline phasing within array; main lobes can be tilted to any in-between angle by proper phasing but this is not usually done with ham antennas.

array" since it fires its strongest beam off the end of the line of antennas. The only change necessary to obtain this 90-degree change in direction was to change the phasing of the feedlines.

By appropriate choice of phase relationships between the various antennas in a driven array, the beam can be tilted to any point between the broadside position and the endfire pattern. This is done in BC-station design, but in ham work it's much easier to simply rotate the array.

If, instead of the imaginary isotropic antennas we used in **Fig.** 8, the individual elements of the array are dipoles (as they usually are) then the radiation pattern of the dipole gets into the act. Broadside arrays made up of dipoles are usually set up either parallel to each other, or end to end, as in the "colinear" antenna. Endfire arrays of dipoles on the other hand usually have the antenna conductors arranged at right angles to the line of radiation, like the Yagi parasitic array (which has an endfire radiation pattern).

A parasitic array is essentially a driven array in which only one of the antennas is actually driven, and the rest pick up their energy by radiation from that one. Most parasitic arrays are endfire designs, since it's simple to get the necessary coupling and phase relationships from parallel dipoles.

The phase of the energy actually radiated from an antenna depends, in part, upon the relationship of the exciting energy's frequency to the frequency at which the antenna is self-resonant. The phasing adjustment which, in the endfire driven array, was made by adjusting feedline length, is made in a parasitic array by tuning the parastic (non-driven) elements to frequencies slightly different from that at which the antenna is to operate.

If an element is tuned to a frequency slightly lower than that at which operation is desired, the phase of its reflected or re-radiated energy will be such as to cut down the radiation pattern in its direction, and build it up in the opposite direction. Such an element is called a "reflector".

If an element is tuned to a frequency slightly higher than that at which the beam is to operate, it will build up the radiation pattern in its direction and cut it down in the opposite direction. Such an element, since it directs the pattern in its own direction, is called a "director".

The spacing between the driven element and the parasitic elements is just as critical, in a parasitic array, as is the tuning of the parasitic elements, since the array's performance is determined, by relative phase over the entiré structure. Distance determines phasing also. For any specific tuning of a parasitic element, there is a critical distance as well.

Before the principles of the parasitic array were understood as well as they now are, this led to many conflicting rules for design of parasitic beams and their tuning. About 10 years ago, however, it was discovered that the critical factor actually is the combination of tuning and spacing. It is now known that almost any spacing (within reason) can be used, or alternatively almost any tuning of element lengths. Once a spacing is chosen, then the tuning of the elements must be matched to it; if element tuning is chosen first, then the spacing must be adjusted to obtain maximum performance.

In comparison to the other three types of beam antennas, parasitic arrays offer the highest performance per unit size. On paper at least, you can get any desired gain from a physically small parasitic array if you just use enough elements and tune and space them properly. In practice, the gain really is limited – but you can get a 10-time increase in effective radiated power from an antenna only a half wavelength wide and a wavelength long, which is much more than any of the other types of beam can provide. For this reason many engineers call such designs "super-gain" antennas.

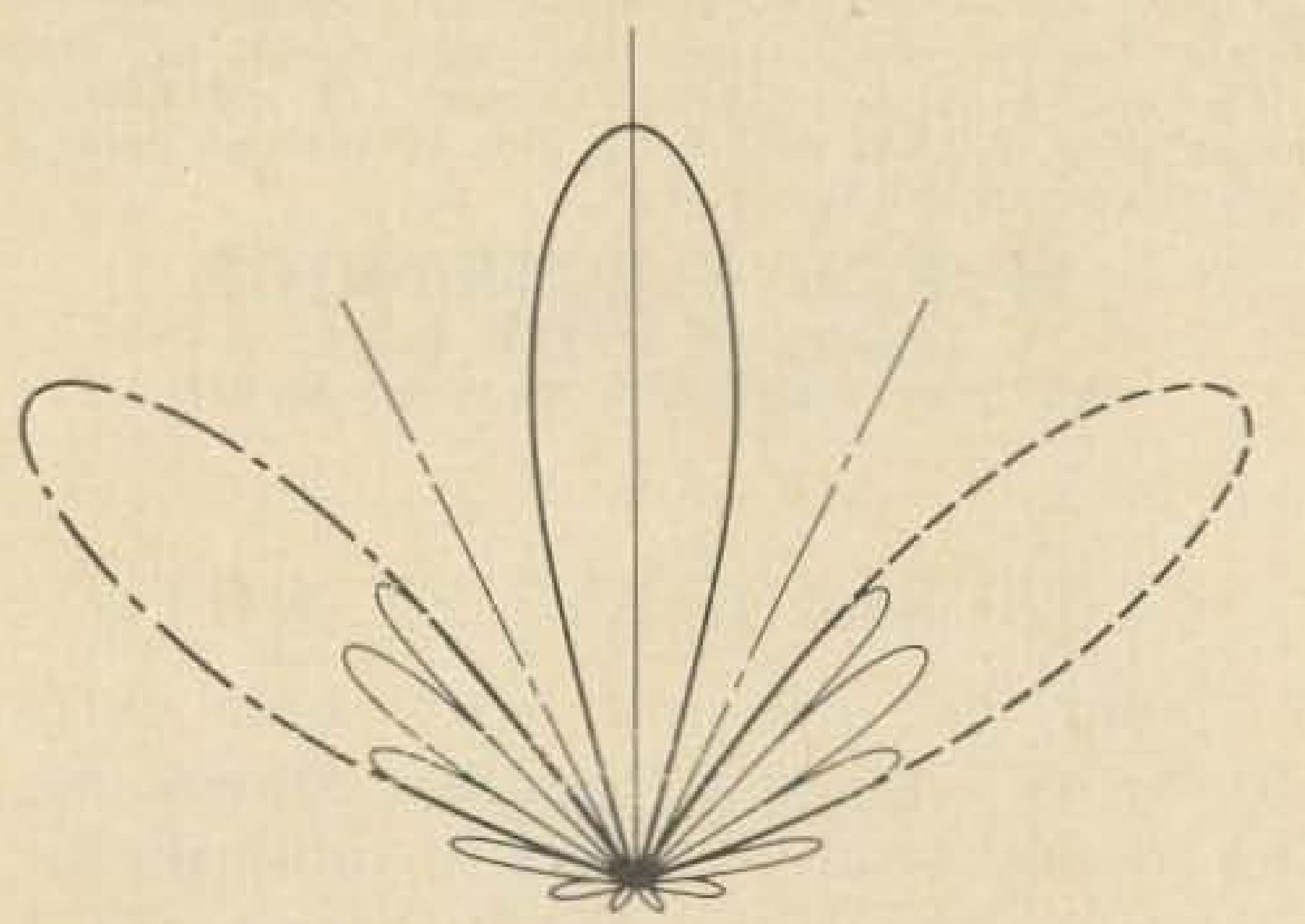


Fig. 9 – Buildup of radiation pattern for terminated V antenna with each leg 4 wavelengths long is shown. Each leg of V by itself has pattern of terminated long-wire (Fig. 6); legs are placed at proper angle to make main lobes coincide in one direction, and cancel out to at least some degree in all others.

The travelling-wave antenna, such as the rhombic or the terminated V, gets its gain by a cancellation effect also. As **Fig. 6** showed, a travelling-wave antenna is inherently unidirectional – but puts its power into a cone rather than a beam. If two such antennas are erected side by side to form a V as shown in **Fig. 9**, their patterns can be made to cancel each other out in most directions while they add together in just one and form a single beam of radiation. This is the terminated V. If the terminations at the wide end of the V are removed and another pair of antennas is put in their place, with terminations at the narrow end **(Fig. 10)**, you have the rhombic. Gain of such an antenna is moderately high,

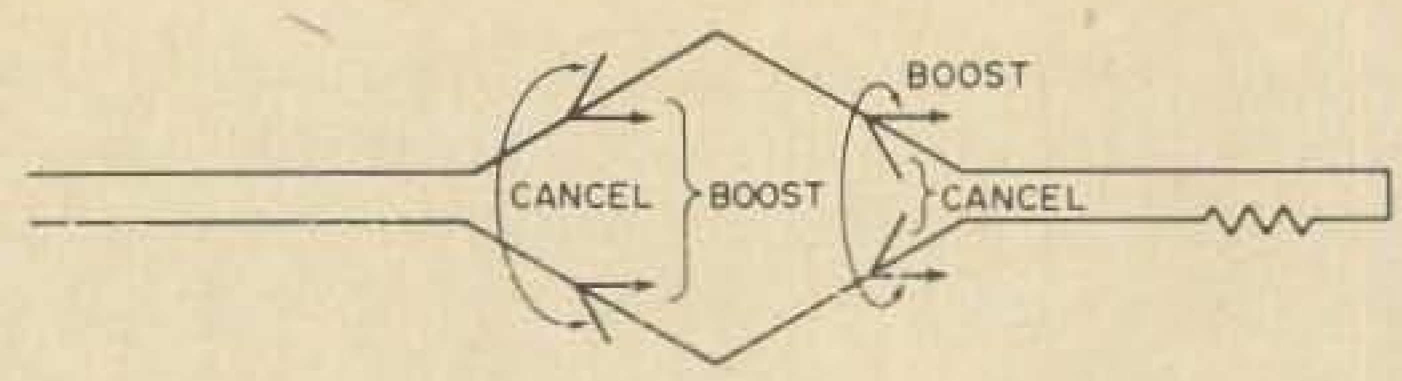



Fig. 10 – Simplified buildup of pattern for rhombic antenna is similar to that for terminated V; lobes aimed in same direction boost each other and all the rest cancel. Cancellation is more complete in rhombic.

but is nowhere near that to be expected from either a driven array or a parasitic of similar size – because each leg of the rhombic needs to be at least four wavelengths long to get the directive effect.

You can also get some directivity from an *un*terminated V. This is essentially two long-wires side by side. The cancellation effect still works to take out part of each long-wire's pattern, but the resulting beam is bidirectional with its major lobe splitting the V angle as shown in **Fig. 11**.

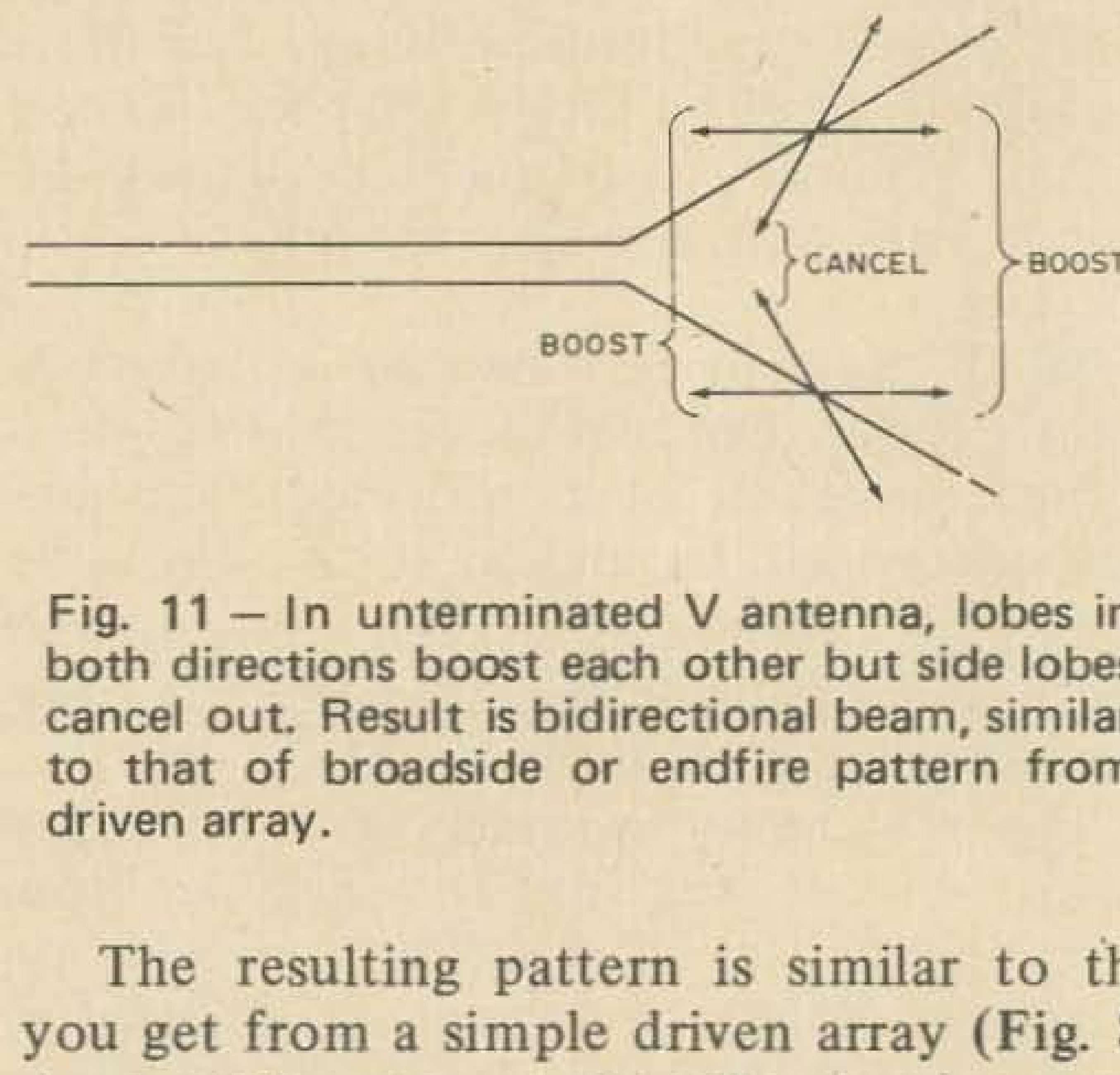



Fig. 11 – In unterminated V antenna, lobes in both directions boost each other but side lobes cancel out. Result is bidirectional beam, similar to that of broadside or endfire pattern from driven array.

The resulting pattern is similar to that you get from a simple driven array **(Fig. 8)**. A parasitic array, on the other hand, concentrates its power essentially in a single direction, as does the terminated V or the rhombic.

The subject of antennas and how they work is one of the most important in ham radio, because nowhere else can you get such an improvement in your station's performance for a comparable amount of effort. We'll be going into it more in our next few installments, but even then we will not be able to cover it completely – the subject is just too large.

A number of books are available at various levels of technical knowledge. The traditional authority on the subject is "Antennas", by John Kraus, W8JK, inventor of the 8JK beam, the corner reflector, and the helical beam. Terman's "Electronic and

Radio Engineering" contains much valuable data at a slightly less exotic level, being intended as an undergraduate text for engineering students at the college junior/senior level. "Fields and Waves in Modern Radio" by Ramo and Whinnery handles the basic principles of radiation excellently but requires at least an acquaintance with higher math (matrix algebra and partial differential equations) to read comfortably. Jasik's "Antenna Engineering Handbook" is intended for the antenna design engineer but avoids much of the deeper theory and concentrates on practical applications instead. Any or all of these are recommended for additional study, if you're really interested in adding to your knowledge of how and why antennas work as they do.

*Next Month.* We'll continue examining antennas, looking at such factors as harmonic rejection and feedline matching.

**RENEWAL CODE**

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

73 MAGAZINE

## Loosen Those Army Set Screws!

One of the big problems faced by every would be user of the Command Transmitters is the frustrating task of loosening those special set screws on the knobs and shafts of this series. Usually one ends by using brute force and damaging the part, or just laying the equipment aside.

One of the regular screwdriver blades in the SC-5 Screwdriver set which can be purchased from the radio houses, or any good screwdriver with a very small blade will just fit into this set screw and with a stout twist will loosen any of them very quickly. If this screwdriver set is not available, grind any stout screwdriver down to about 1/16th of an inch, and they will fit into these set screws cross-wise.

The knobs and shafts of this Command series suddenly become very valuable.

**Irvin Kanode, WA9CKP**


# NEW BOOKS

## Electronics for Technicians

Written by Abraham Marcus and published by Prentice-Hall, Electronics for Technicians is a sequel to Electricity for Technicians. It describes electronic phenomena in physical terms, rather than mathematical and is extremely well-written.

The book is divided into three sections. Section I deals with the electron tube. The various types of tubes are discussed in language which almost anyone with any electronic knowledge can easily understand. Section II discusses semiconductor theory and the various types of semiconductors are examined. Section III deals with how tubes and semiconductors are used in various circuits including power supplies, amplifiers, oscillators and various circuits used in the home, in industry and communications. Mr. Marcus gives an overall view of the subject and his book should serve as a basic foundation for further study in electronics.

The book is divided into 20 chapters within the three categories, and each chapter is followed by a series of questions for the student to test his comprehension of the material. Following the 20 chapters is a series of apendices showing pin identification for electron tubes, lead identification for various transistors, and a complete section on electronic symbols which is the most up-to-date I have seen so far.

In an attractive cloth-bound cover, Electronics for Technicians sells for $9.95 and certainly contains all the study material needed for anyone interested in learning basic theory.

## RCA Manuals

The RCA *Solid-State Hobby Circuits Manual* contains complete construction information on 35 circuits of general interest to experimenters. Power supplies, oscillators, keyers, preamplifiers, amplifiers, and numerous other items are covered in detail. This manual also contains sections on theory and practical application of most solid state devices, and gives information on construction practices and trouble-shooting.

The revised and expanded RCA *Receiving Tube Manual* contains up-to-date information on tube types and technology; detailed descriptive data and application information for the complete line of home-entertainment types of receiving tubes for TV and Hi-Fi enthusiasts.

Seven other technical manuals are available from RCA. *RCA Transistor Manual* is a 544 page book containing text, data, and typical circuits for the complete line of transistors, silicon rectifiers, and other semiconductor diodes.

*RCA Silicon Power Circuits Manual* is a 416 page book providing design information for a broad range of power circuits using silicon transistors, rectifiers, and thyristors.

*RCA Linear Integrated Circuits* (352 pgs.) contains basic principles of design and application information for linear integrated circuits.

*RCA Silicon Controlled Rectifier Experimenter's Manual* is a 136 page book containing 24 interesting control circuits using semiconductor devices available in kit form.

*RCA Transmitting Tubes* is a 320 page book giving data on more than 180 RCA power tubes with plate input ratings up to 4 KW.

*RCA Phototubes and Photocells* (192 pgs.) contains design information and data for 90 photosensitive devices.

*RCA Tunnel Diodes* is a 160 page book containing information for RCA tunnel diodes for switching and microwave applications.

Prices range from $ .65 to $5.75. For a complete brochure and prices write Commercial Engineering, RCA Electronics Components, Harrison, N.J. 07029.

## Motorola Semiconductor Handbook

*The Semiconductor Power Circuits Handbook* contains the latest information in power circuit design. Some 150 new circuits have been specifically designed for users of power transistors, thyristors, rectifiers and zener diodes. This 264 page manual includes many designs being published for the first time. It is divided into six chapters devoted to motor speed controls, inverters and converters, regulators, statis switches, audio and servo amplifiers, and miscellaneous thyristor switch applications. Copies may be obtained by sending S2 to Motorola Inc., Box 20924, Phoenix, Arizona 85036.

### Hayden Books

This one is a beauty. The *Transistor and Diode Laboratory Course*, by Harry E. Stockman, clearly illustrates and develops the concept of transistor theory. This 117 page book is designed either for the classroom or for home study. The first half of the book is devoted to theory, providing a background in transistor technology. The remainder is experiments dealing with intricate transistor networks. Each chapter is followed by a question and answer session. For anyone who wants a more sophisticated approach to transistor theory and application, this book is a must. Available for $3.95 from Hayden Book Company, Inc., 116 West 14 Street, N. Y., N. Y. 10011.

### New Books From Sams

*Reference Data for Radio Engineers* (Fifth Edition) 50% more information with a completely new format. Catalog No. 20678, $20.

*Amateur Radio SSB Guide.* Basic principles, building and troubleshooting. Catalog No. 20629, $3.95.

*Learn Electronics Through Troubleshooting.* A basic, practical approach to learning the fundamentals of electronics. Catalog No. 20651, $6.95.

*Novel Electronics Circuits.* 77 new circuits and devices to build. Catalog No. 20692, $2.50.

*The Radio Amateur's FM Repeater Handbook.* A 288 page book by Ken Sessions. Catalog No. 65080, $6.95.

*73 Dipole and Long Wire Antennas.* Covers practically every type of wire antenna used by amateurs. Catalog No. 65071, $4.50.

*Amateur Tests and Measurements.* Tests and adjustments to transmitters, receivers, and antennas. Catalog No. 65072, $4.95.

*Ham Antenna Construction Projects.* (Second Edition) Modern versions of all classic antennas. Catalog No. 20654, $3.95.

*Handbook of Electronic Tables and Formulas.* One book with all the charts, tables, symbols, and all you need. (Third Edition). Catalog No. 20648, $5.50.

*FET Principles, Experiments, and Projects.* Breadboarding to teach FET operating characteristics. Catalog No. 20594, $4.95.

*Know Your Tube and Transistor Testers.* Trouble-shooting and repairing various makes and models. Catalog No. 20630, $3.50

Ed Baker, WØEDO
9937 Truman Road
Independence, Missouri

# Economy Chronometer

How would you like to have an illuminated station clock for less than $5.00?

The unit described was built at a total cost of $3.14 plus tax, but, with a well-stocked junk box, this figure could be reduced still further.

The secret of such a bargain lies in the fact that most "electric" automobile clocks are really mechanical clocks which are wound electrically every two to five minutes. Since this winding is done by a pulse through an electro magnet, the clock doesn't care whether this pulse is ac or dc, thus making it a simple matter to power the clock in the home station.

These clocks are available from your local salvage yard, and sell for 50 cents to $3.00, depending on the condition and whether or not *you* remove it from the wreck.

The major enemies of auto clocks are moisture and dust. The latter is the most common but least damaging. In selecting a clock, pick one which shows no sign of rust on the face, hands, or any other exposed surface, and your chances of restoring it to service are almost a certainty.

To remove the clock from the case pry up the edges of the bezel which holds the glass and remove these parts. Two or three small screws or nuts in the back of the case will now allow the clock to be removed.

A large eye dropper or "ear" syringe will supply a low velocity air blast for cleaning. Do not attempt to use a brush, as fragments of the bristles will catch in the gears.

The most common cause of failure is in the winding mechanism, so a complete description of this operation is in order. On the back of the "works" is a rather large winding surrounded by a rotary armature. When this armature is aligned with the winding, the clock is wound. As the clock runs down, the armature moves away from the poles of the winding, and, near the end of its travel, a pin on the armature engages a Y-shaped yoke and closes a pair of contacts. These contacts are in series with the winding and the voltage source, so when they close, the winding is energized and the armature is drawn toward the poles of the winding. This rewinds the clock. This movement of the armature also opens the contacts by the action of the pin in the yoke. This contact between pin and yoke is where trouble develops. Just before the contacts close, the mechanism is at a point of maximum friction and minimum spring tension; so, with the collection of dust and evaporation of lubrication, the clock stops just short of rewinding.

After all traces of dust have been removed, apply a *drop* of solvent/lubricant of the type used for tuners and volume controls (Quietrol, Spra Kleen, etc.) to the yoke where it contacts the pin. Wind the clock by pushing the armature, and start it by lightly pushing the balance wheel. It will probably stop just before the contacts close. Without rewinding, start it again and let it run until the contacts do close. Rewind and repeat until it runs freely from rewind to point closure. Dry the yoke and apply a minute quantity of lubriplate (a very light lubricant cream available from hobby and gun shops) to the point of contact with the pin. If desired a small amount of the solvent/lubricant can be applied to the pivots and teeth of each gear. The smallest drop you can get is slightly too much for each point, so if you wish to skip this, the clock will probably run without it for years.

The points may be cleaned with a burnishing tool, but avoid excessive filing.

While the clock is "running in" the power supply can be prepared. The transformer can be any, which gives the proper voltage. My clock used 12 volts, so a 6.3 and 5 volt winding were connected in series to give 11.3 volts. This is plenty, since the winding is designed to work on 10-14 volts. The transformer also has a 90V winding which is not used, so the leads are taped to prevent shorts and left hanging free.

To determine the required voltage, look at the bulb in the socket which sits inside the case. If the bulb is missing, apply 6.3 ac between the input terminal and frame, and observe the armature. If it moves toward the poles of the winding (not necessarily all the way) use 6.3. If the winding buzzes and the armature doesn't move, the higher voltage will be required.

When the proper voltage is found, let the clock run until it rewinds a few times to make sure all is well, then re-install it in the case. Most of these clocks have a cable clamp on the back which will make a convenient point for the ground connection, or a self-threading screw can be installed in a spot where it will not hit the works.

These clocks come in a variety of sizes and shapes, and take naturally to panel mounting, or a small chassis or Mini-box can be used as a case. A switch may be installed to turn off the light, if desired, but the location of the bulb is such that it illuminates the clock face and little else, so it is left on in my installation.

The transformer can be mounted in the case with the clock, or up to 10 15 feet away, depending on your needs. Lamp cord is fine for this connection.

This will not bring National Bureau of Standards or even IBM into the shack, but it is a reasonably accurate timepiece, and the price is right.

...WØEDO

# 4 x 150 Sockets

*Larry Jack, WA3AQS*
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*Clinton, Maryland 20735*

It was about a week after completing the small sideband rig that I realized its single watt wasn't going to be enough. After a few, "You're readable, but kind'a weak" signal reports, I returned to the junk box, this time for parts to build a linear. From among the assorted trivia were unearthed a handful of 4x150's. Two hundred watts output at least—a very good tube for the new amplifier—but I didn't have any sockets for them. Being a little impatient to get started, and adventurous at heart, I elected to build the sockets rather than wait out an order from a supply house.

A simple modification of a regular octal socket provided a new base. A ceramic type (for its low losses) was selected. Then all the metal pins were carefully removed from the collar. The pins are crimped to make firm connections with the new size pins of the 4x150, and then are replaced back into the socket.

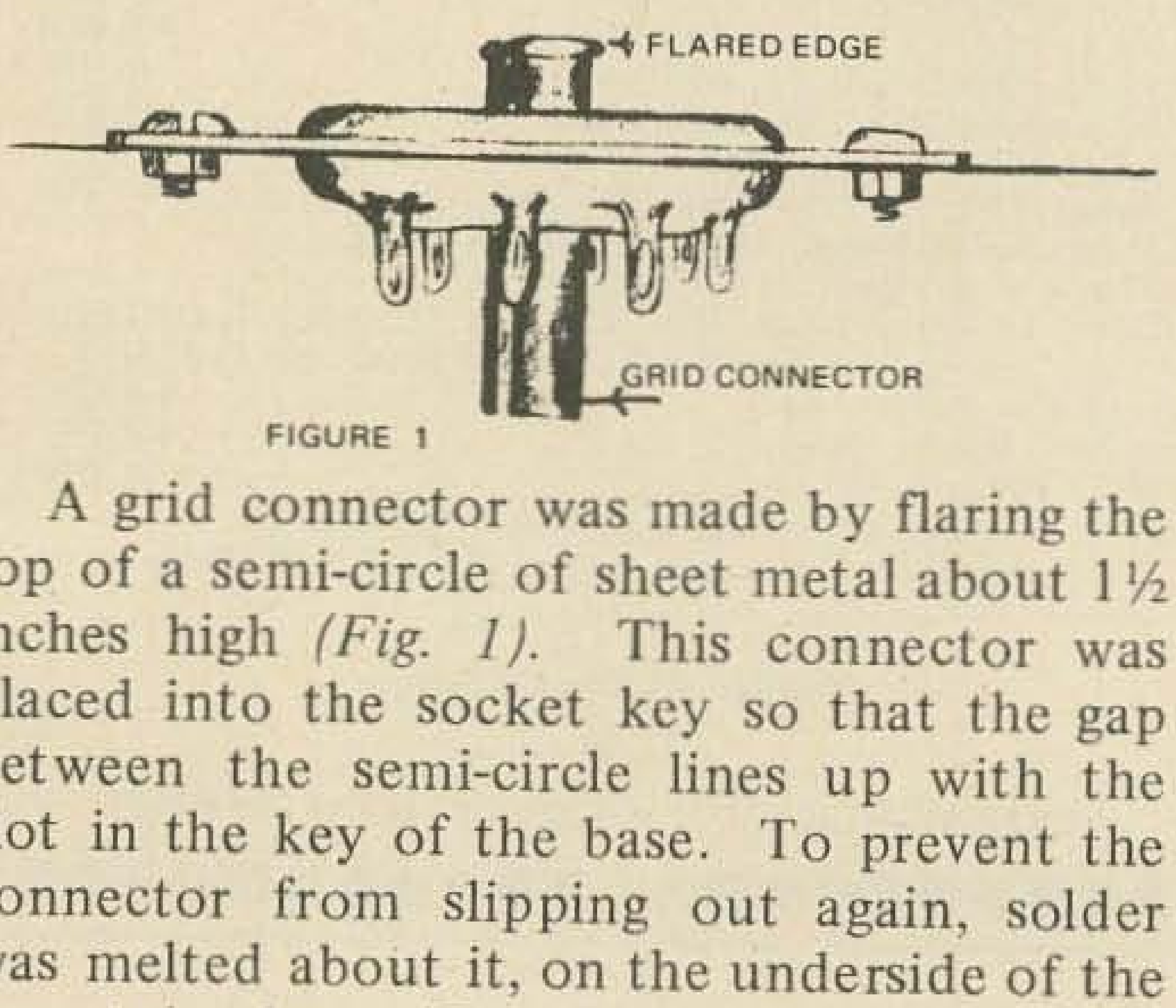


FIGURE 1

A grid connector was made by flaring the top of a semi-circle of sheet metal about 1½ inches high *(Fig. 1)*. This connector was placed into the socket key so that the gap between the semi-circle lines up with the slot in the key of the base. To prevent the connector from slipping out again, solder was melted about it, on the underside of the new tube base *(Fig. 2)*. For cooling, the tubes were placed almost directly in the mouth of a large squirrel cage blower.

I originally had used only a single .01 μF capacitor soldered directly at the socket pin as the screen by-pass. The rig took off, so to speak, in a very unstable fashion, so small straps on a standoff insulator with another .01 μF capacitor was put above the chassis to by-pass the tube's screen ring. This cured the trouble *(Fig. 2)*.

Cooling never figured as a problem. At 50 MHz with inputs reaching 600 watts, a single 200 cfm blower has kept a pair of one-fifties running cucumber cool. Not so many "kind'a weak" reports now.

...WA3AQS

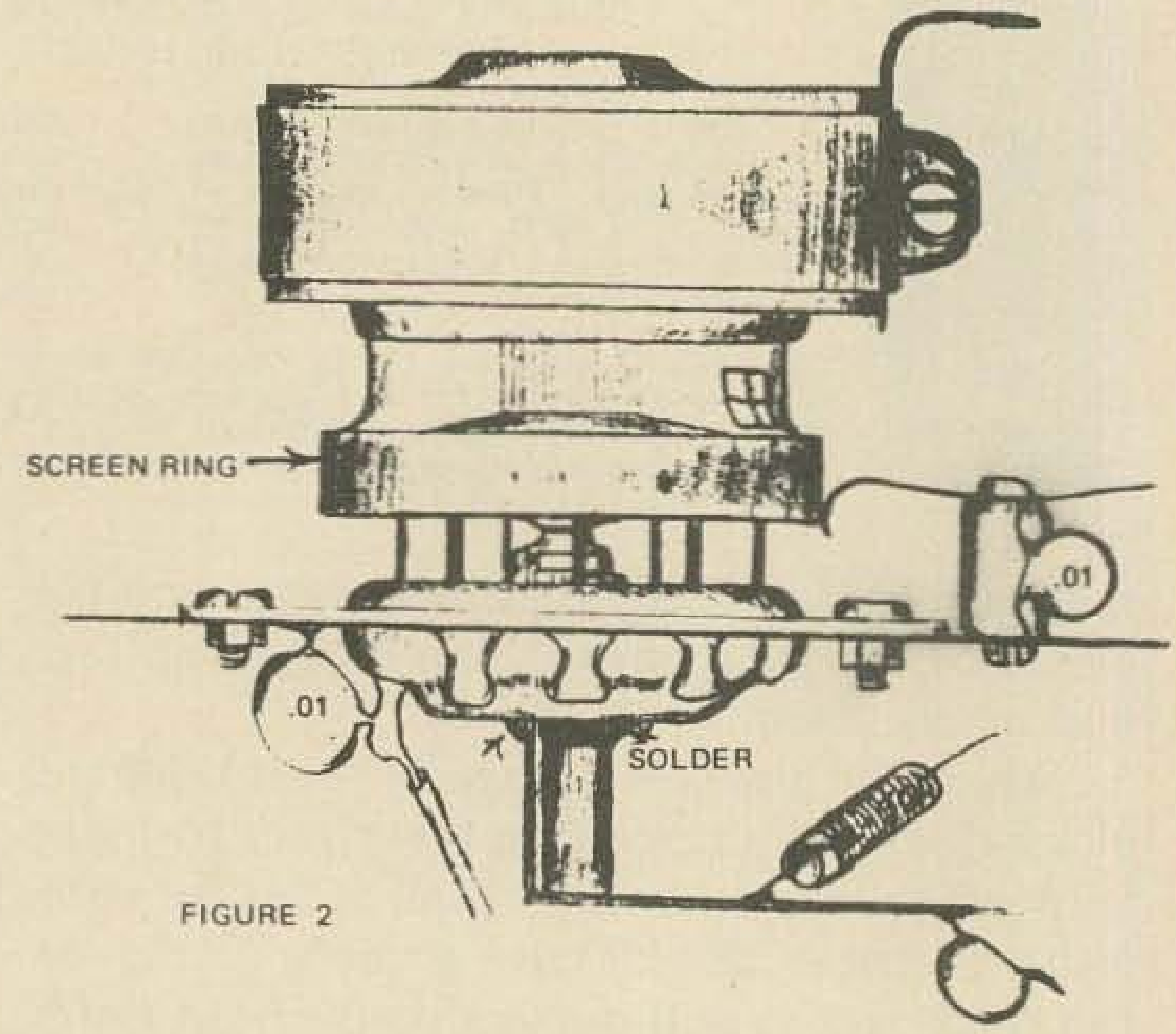


FIGURE 2

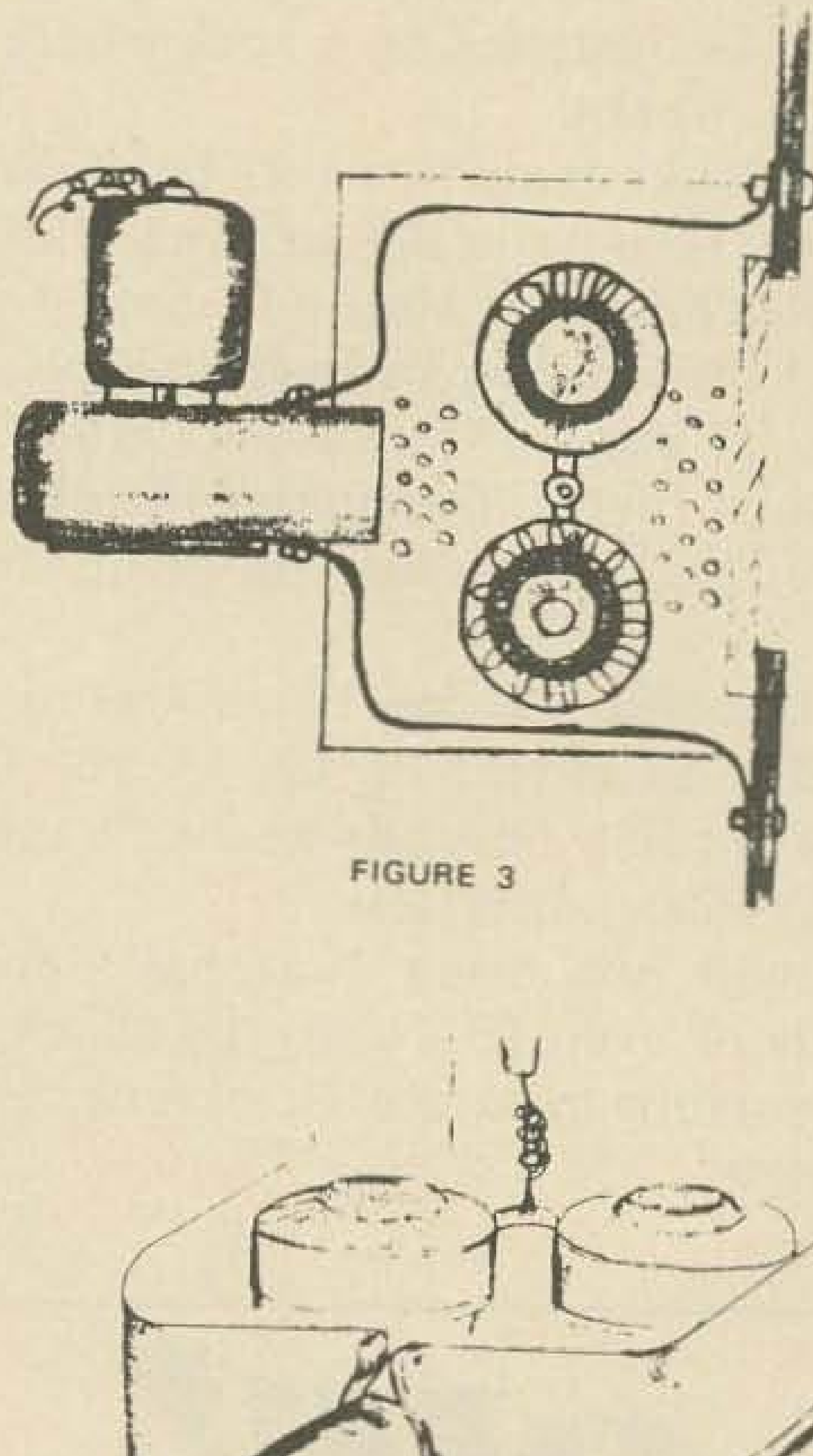


FIGURE 3

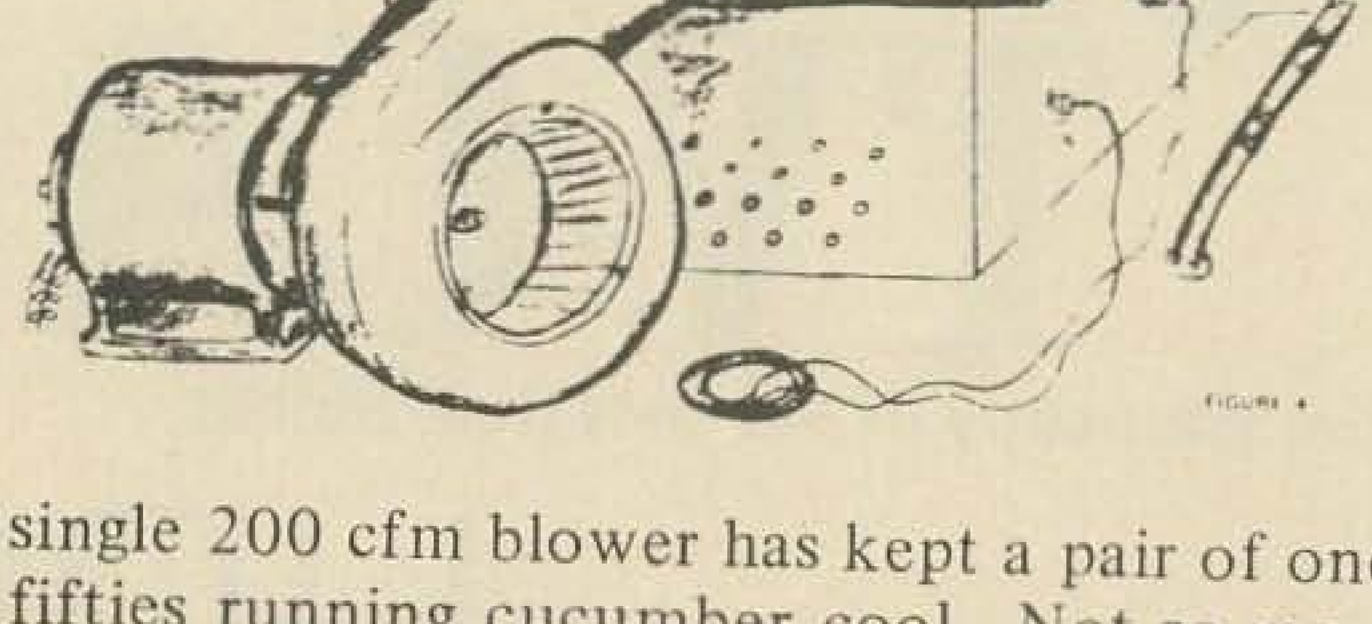


FIGURE 4

## RF Sealing Tape

RF sealing is one of the strategies employed in building transmitters that do not generate TVI. The unwanted *rf* is generated but the enclosure is designed so it never gets out.

The same approach is used to build receivers that do not respond to any *rf* except that which enters the receiver through a coax connector, and in the construction of laboratory signal generators.

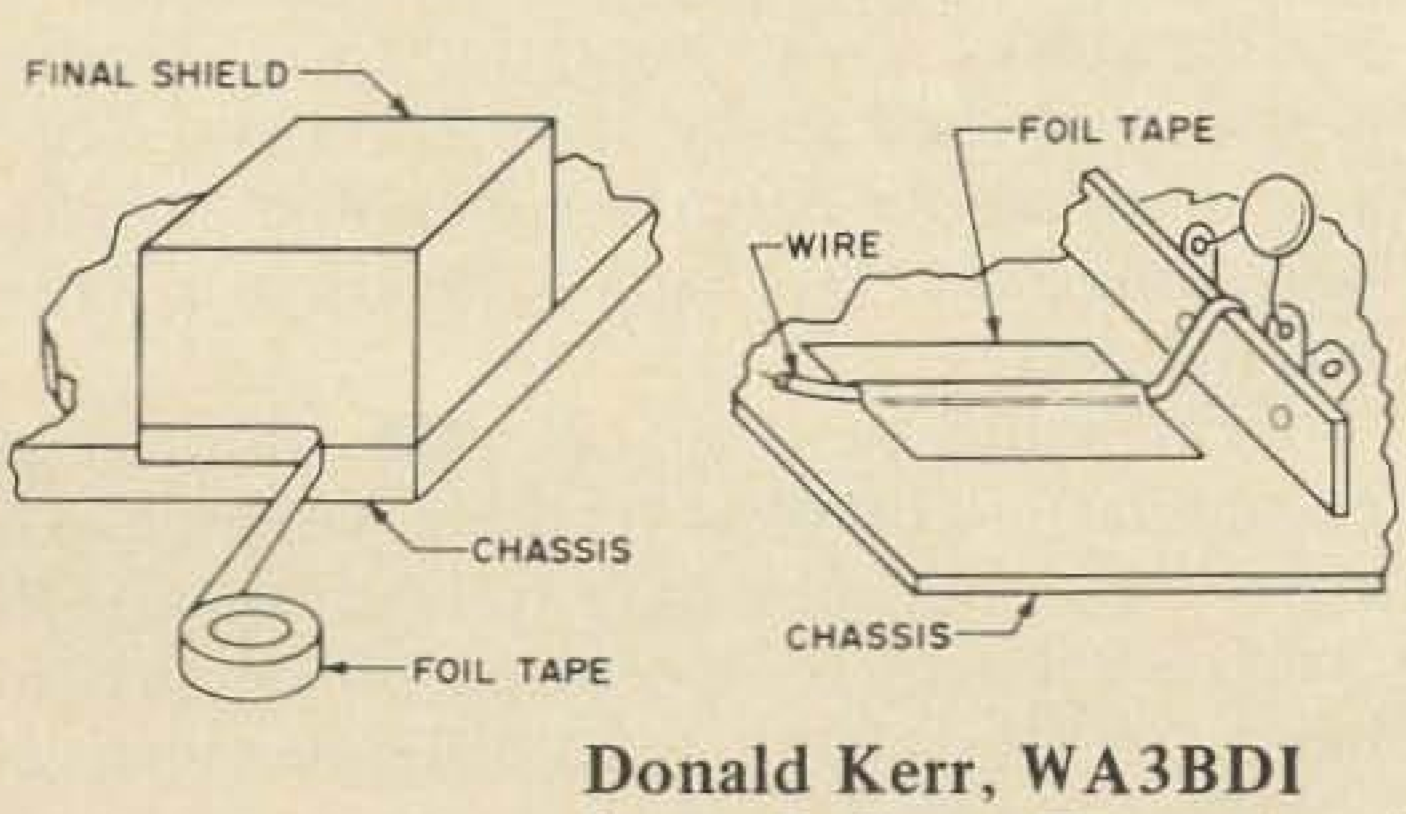
But did you ever try to convert a non-shielded enclosure into a shielded enclosure? It can be done, but ;ften it is a task to make strong men weep. Hinges, joints, ventilation, doors, meters, . . . and how about shielding some of the wiring that carries power through areas hot at *rf*?

**Scotch Rescue**

The 3M Company has developed a remarkable copper foil tape with an electrically conductive pressure sensitive adhesive. The tape adheres directly to clean metal with a good low resistance electrical connection between metal and copper foil. The tape can improve leaky shielding by up to 60 dB. It is designated "Scotch" Brand Electrical Tape No. X-1181 and comes in 54 foot rolls of assorted widths.

The tape is used alone, or with perforated or solid aluminum sheet. The sheet is available in most hardware stores. It is cut into sections, shaped to fit, and taped in place. Large shielding assemblies can be made up from smaller ones. You must wash the aluminum with detergent to get any oils off before taping.

One approach to reducing *rf* pickup by power or control wiring in transmitters is to use shielded wire. This is horrid stuff to work with, if you have ever tried it. A piece of ordinary hookup wire can be laid along the chassis and covered with a strip of shield tape, to achieve the same result.




Donald Kerr, WA3BDI
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*Brisbane, Queensland, Australia*

# *An All Band Curtain Array*

## *1.75 to 30 MHz*

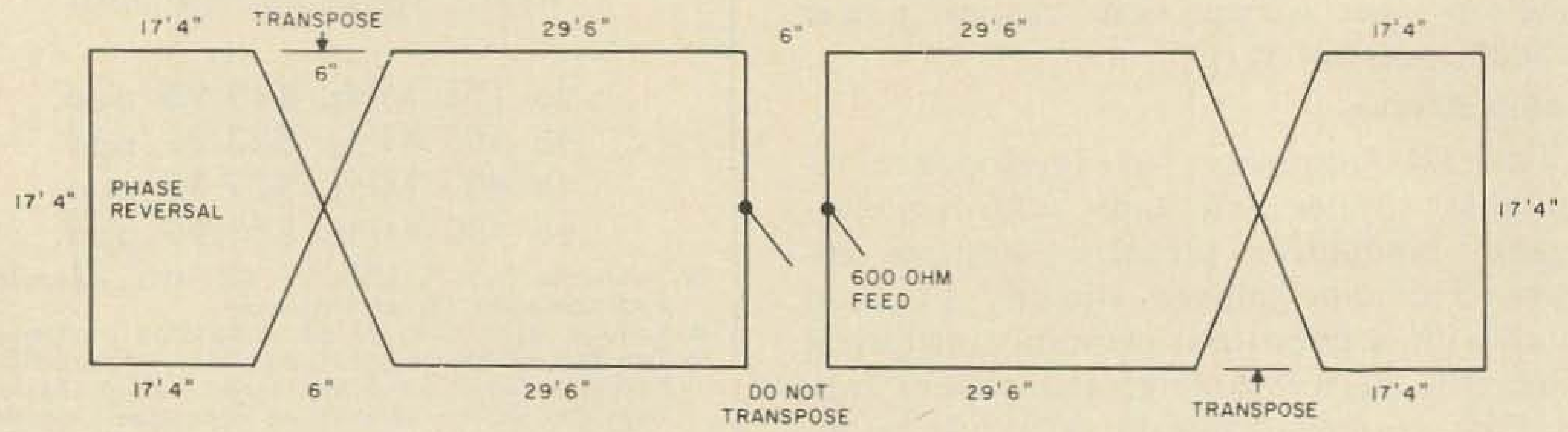


**Fig. 1.** Dimensions for the all band curtain array.

Looking for something better than a random length flat top for your multi-band operation? This pint sized array which puts out a big signal should more than provide the answer. After some cut and try trials, the configuration shown in **Fig. 1** was decided upon as the best all band result. It represents an attempt to get the *most* with the least outlay. All that is required over a flattop is some extra wire and insulators. It should be easily erected on any average lot, as the total length between poles is approximately 112 feet. It has superior gain over most flat-tops on 14, 21, and 28 MHz. Its low angle of radiation being one feature. If it is not possible to erect it to its full length, the 8 foot spacing at the transposed sections can be reduced somewhat with slightly less gain available.

On 1.75, and 7 MHz respectively, it really performs as a quarter, half, and 2 half waves in phase. However, the configuration at 7 MHz does add some gain and lower the angle of radiation slightly. If DX is desired on these bands, the bottom wire must be at least 30 feet above ground and preferably much more. For DX on 14 through 28 MHz the bottom wire should be a minimum of 20 feet above earth. On 28 MHz, there are some 8 wavelengths of wire up in space which adds to the signal.

Maximum radiation is mainly broadside on bands 1.75 through 21 MHz. It throws the sharpest beam with the most gain on the latter band, while on 14 MHz, the pattern is broad and something in shape like a three leaf clover on either side of the axis. No db measurements have been attempted, but its performance is far superior to a random length wire used at the same QTH and strung at a comparable height. Since it is horizontally polarized, the higher the array is strung up, the better.

Being multi-band, no attempt can be made to match the 600 ohm feedline, which can be any length, but may have to be pruned if the array is reticent to accept power on any one band. A flexible all band antenna tuner is a must for proper loading.

...VK4SS

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# *How To Tune A Circuit*

In these days of intricate and relatively inexpensive commercial radio equipment, home building of ham gear is not so common as it used to be. However, a great deal of pleasure and satisfaction may still be had from the designing and building of simple receivers, converters, etc., even if you never intend to actually use them on the air.

One fairly critical part of most simple projects is the tuning circuit. At frequencies through the VHF region, a tuning circuit usually consists of an inductor (coil) and a variable capacitor, which is adjustable over a reasonably wide range. It is easy to find, by the trial and error method, some combination of inductance and capacitance that will tune to the desired frequency. The trouble usually begins when you try to band-spread the circuit; that is, to make the entire tuning range of the variable capacitor cover only the desired frequency range. This frequency range may be only several hundred kilohertz wide, such as an amateur band or a short-wave broadcast band.

This article will attempt to illustrate the problems involved, and how to solve them by the use of a grid-dip oscillator and some simple charts and formulas. First, however, a few words about circuit theory may be in order.

An inductor or a capacitor will oppose the flow of an alternating current. This property is called reactance, and differs from resistance in that the current through the reactance is 90 degrees (or one-quarter cycle) out of phase with the voltage. In an inductor the current lags the voltage by 90 degrees, and in a capacitor the current leads the voltage by 90 degrees. The amount of reactance is determined by the value of inductance or capacitance, and by the frequency of the alternating current. Inductive reactance increases with an increase in frequency, while capacitive reactance decreases with an increase in frequency.

When an inductor and a capacitor are connected, either in series or parallel, there will be one frequency at which their reactances are equal. Since the inductive reactance causes a current lag of 90 degrees, and the capacitive reactance causes a current lead

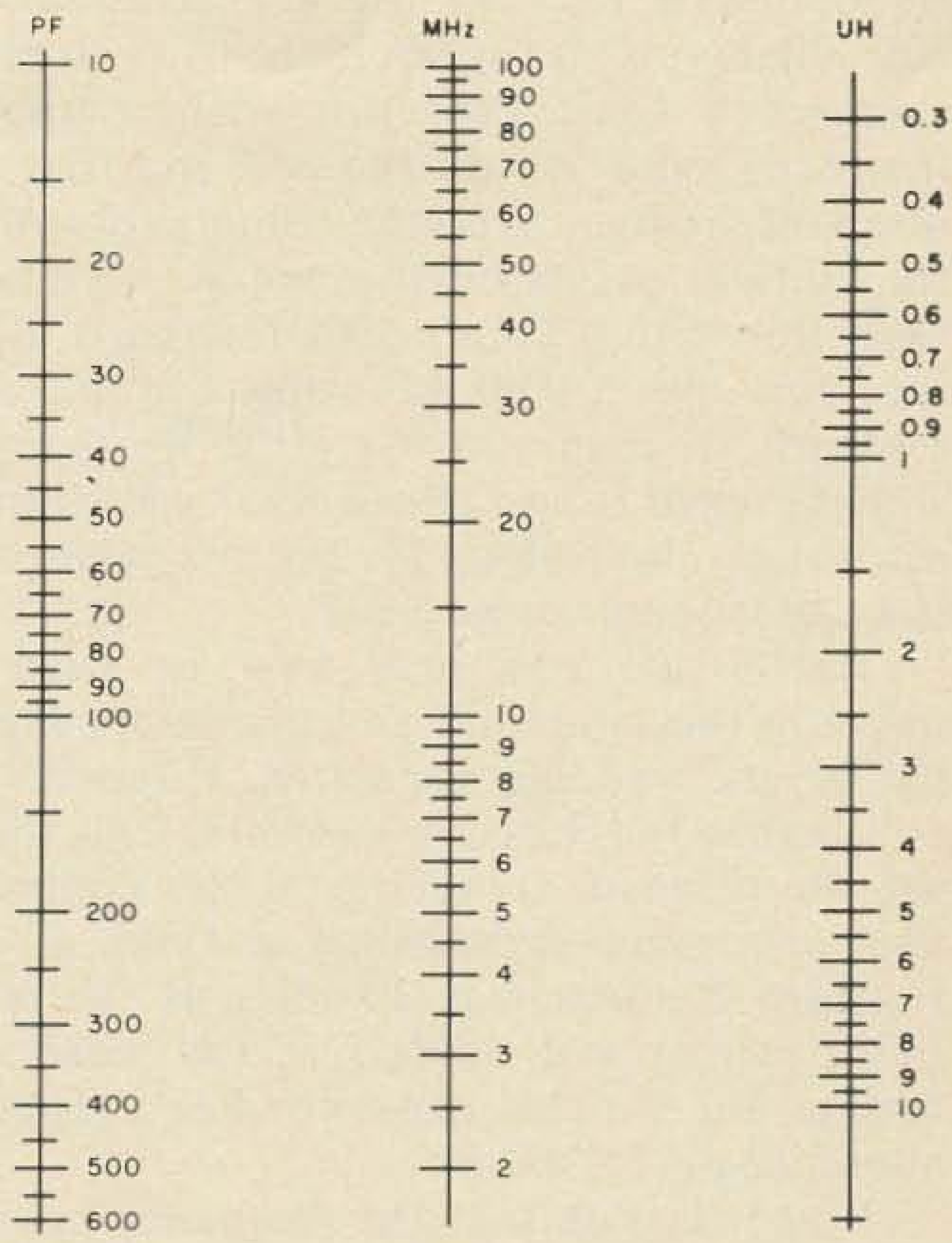



**Fig. 1.** Resonant frequency chart. By laying a straight edge across two known quantities, the third can be determined.

of 90 degrees, the reactances cancel each other, and the circuit is said to be in resonance. The series resonant circuit offers a very low resistance to the flow of alternating current at the resonant frequency, and the parallel resonant circuit offers a very high resistance to the flow of alternating current at the resonant frequency.

The frequency of resonance may be found by using the formula: $f=\frac{1}{2\pi\sqrt{lc}}$ with f in Hertz, L in Henrys, and C in Farads. A simpler method is to use a chart like the one in **Fig. 1**. By laying a straight edge across two known values, the other quantity may easily be found. Charts covering a wide frequency range may be found in Allied's Electronic Data Handbook and other similar publications. There is also a chart on page 70 of the August 1967 issue of 73 Magazine.

Let us say that you wish to build a circuit that tunes from 7.0 MHz to 7.3 MHz. You have a variable capacitor from the junk box that you wish to use, a few surplus coils with unknown inductance values, and an assortment of small fixed capacitors. You also must have a calibrated grid-dip oscillator.

In order to find the capacitance of the variable capacitor, you will first need a known value of inductance. Pick a likely-looking coil from the junk box, or wind one by guess or by using a coil winding chart. The chart found in Allied's Electronic Data

Handbook is easy to use and accurate for coil diameters from ½ inch to 5 inches. Connect a fixed capacitor with a known (marked) value across the coil and find the resonant frequency of the combination with the grid-dip oscillator. If possible, use a mica capacitor with a 5% or 10% tolerance. Let's say you use a 100 pF capacitor and the resonant frequency is 9.2 MHz. By laying a straight edge across these two values on a resonance chart (**Fig. 1**), the inductance of the coil is found to be 3 uH.

The 3 uH coil may now be used to measure the minimum and maximum capacity of the variable capacitor. Connect the coil across the variable capacitor and measure the resonant frequency at the minimum and maximum capacitance settings. If the resonant frequency is 20 MHz at the minimum setting and 5 MHz at the maximum setting, the variable capacitor has a range of about 22 pF to 350 pF.

You will note that the frequency ratio (4 to 1) is equal to the square-root of the capacity ratio (16 to 1). This is important to remember, and is true also for the inductance ratio when the capacity is held constant. Thus, in the circuit above, if it were desired to bring the lowest frequency down from 5 MHz to 2.5 MHz, a 2 to 1 frequency ratio, the capacity or inductance would have to be increased by 2 squared, or 4 times (1400 pF with 3 uH, or 12 uH with 350 pF).

Now that the variable capacitor has been measured, a coil can be chosen that will tune the desired 7.0 to 7.3 MHz range. It may be seen, by checking our resonance chart, that the 3 uH coil used in measuring the variable capacitor will tune to 7.0 MHz with about 175 pF, and to 7.3 MHz with about 160 pF. As this is well within the range of our variable capacitor, we may as well use it in our circuit.

**Band-Spreading**

Although our circuit will tune through the range of 7.0 to 7.3 MHz, the required capacity change of 15 pF would be covered in only a small fraction of a turn of the capacitor, and tuning would be very difficult. This problem is easy to solve, however, by the addition of two more capacitors to the circuit. Since we need a variable capacitor with a range of 160 pF to 175 pF, a capacitor may be added in series with the variable to lower the total maximum capacitance from 350 pF to 175 pF, and a capacitor may be added in parallel with these two to raise the minimum capacitance from 22 pF to 160 pF. See **Fig. 2**. The series capacitor is called a padder and the parallel capacitor is called a trimmer.

The value of the trimmer should be determined first. Its approximate value can be found by subtracting the minimum capacitance of the variable from the desired minimum capacitance. Thus 160 pF minus 22 pF equals 138 pF for the trimmer. The value of the series combination of the variable at maximum capacitance and the padder is equal to the total desired maximum capacitance minus the trimmer capacitance. Therefore 175 pF minus 138 pF equals 37 pF for the combination of the variable (set at 350 pF) and the padder. The value of the padder may be found by the formula: $C1=CtC2/C2-Ct$, where C1 is the padder, C2 is the variable, and Ct is the desired total. This works out to 41 pF for the padder.

Since the padder is only about twice the value of the minimum capacitance of the variable, it will have a noticeable affect on the total minimum capacitance, making it 152 pF instead of the desired 160 pF. This difference will be more than made up for, however, when other parts of the circuit are connected to the tuned circuit. Stray circuit capacitance and the input or output capacitance of the tube or transistor used will add from 5 to 10 pF or more to the total capacitance. At the higher frequencies this becomes increasingly important, and should be allowed for.

When building a circuit one stage at a time, remember that when the following stage is connected it will upset the output tuning of the previous stage. It may be helpful to connect a small value of capacitance temporarily across a tuned circuit that will later be connected to another stage. When the other stage is connected you can remove the capacitor. At high frequencies, where the adjustment range may be small, this may keep you from having to rewind the coil.

A good type of capacitor to use for trimmers and padders is the adjustable mica

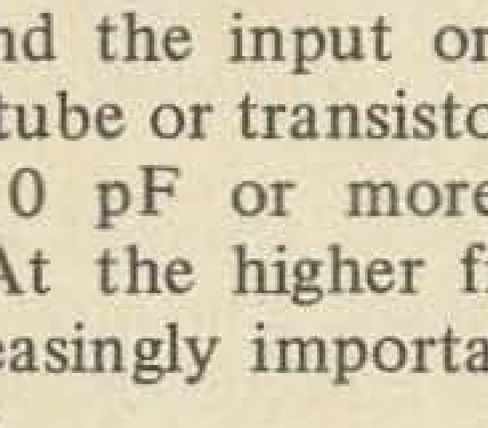
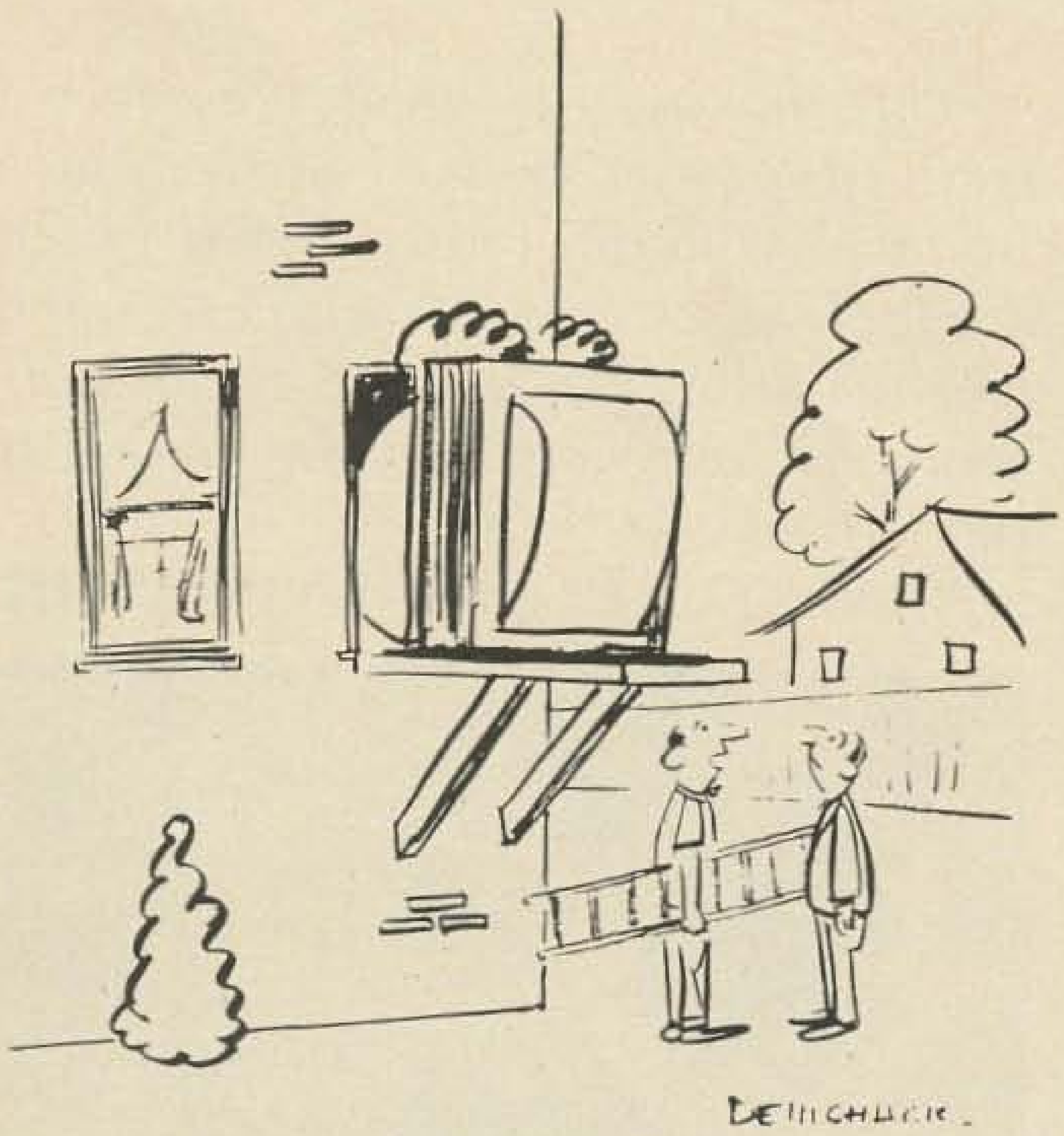



**Fig. 2.** The 22 to 350 pf variable capacitor is effectively changed to 152 to 175 pf by the addition of two extra capacitors.



"I added a linear."

compression type. These are small and inexpensive, and come in sizes ranging from about 1 pF to over 3000 pF. The minimum to maximum capacitance ratios vary from about 10 to 1 in the small sizes to about 2 to 1 in the largest sizes. When using adjustable capacitors set the high frequency limit with the trimmer, and the low frequency limit with the padder. Since the adjustments affect one another they may have to be repeated several times. If maximum stability is important, fixed silver mica or adjustable air capacitors should be used.



I have not mentioned circuit Q. This quantity is important in the output circuit of transmitters, in circuits where maximum selectivity is important, and many other places. However, in most simple low-power circuits the Q may be safely ignored.

. . . K5LLI

# TEST EQUIPMENT

## MINIATURE TEST LABORATORY


| | |
|---|---|
| AC Voltmeter | DC Voltmeter |
| Ohmmeter | Milliammeter |
| RF Signal Generator | AF Signal Generator |
| Resistance Substitution | Capacitance Substitution |
| 9V DC Supply | RF Field Strength |
| Self Powered | 7½"x 3¾"x 3¼", 1¾ lbs. |

Thanks to transistors and printed circuits you can hold this complete lab in one hand. Not long ago this would have been a whole shelf full of test equipment. 455 kHz generator for aligning IF's, 400 Hz generator for audio circuits. Plus a normal VOM and R & C substitution. Field Strength meter for tuning transmitters. Everything in one small box!

Model SE-400 Mini-Lab – ONLY $25.00

## TRANSISTOR POWER SUPPLY


Worth its weight in batteries. Invaluable for testing transistorized or IC gear. Saves its price in batteries for long range operation of radios, cassette tape recorders, etc. 0-20 VDC @ 150-200 mA. Metered and regulated.

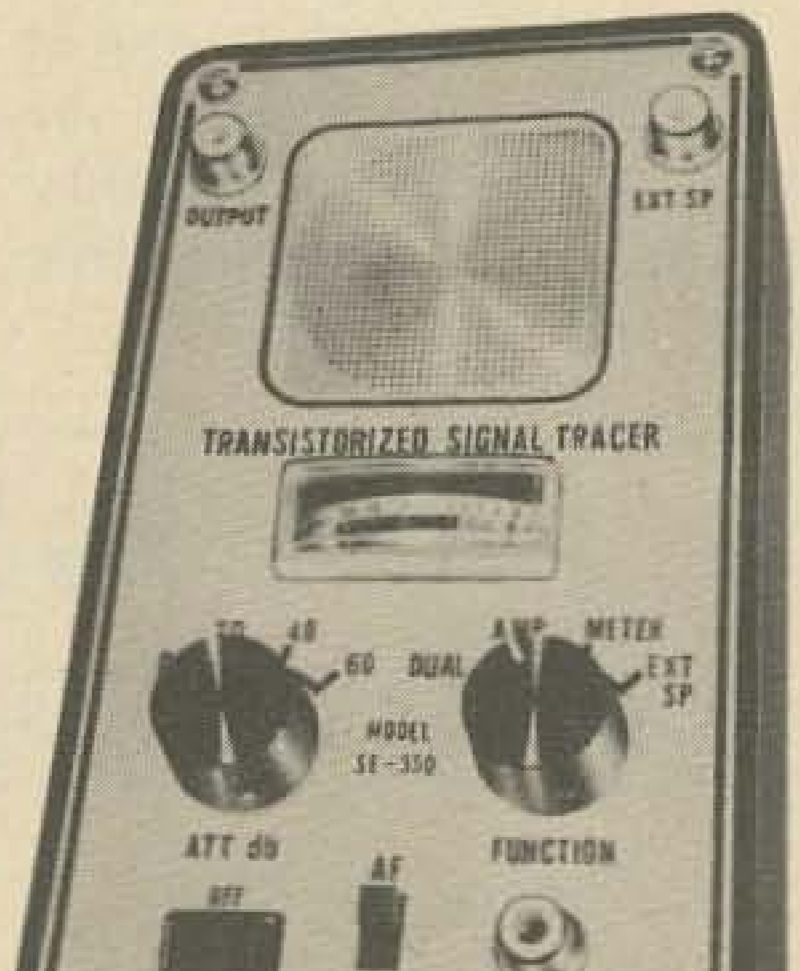
Model SE-100 Power Supply–ONLY $16.95

*The day of the great big piece of test equipment is past, made a memory by modern transistorized PC test equipment. Now a complete service lab, including RF and AF signal generators, is built into a case about the size of an old VOM!*

## MINIATURE AF GENERATOR


Mini-AF Generator for the laboratory or ham work bench. 10 to 100,000 Hz in four bands, sine or square wave. World's smallest. 7½"x 3¾"x 4", 2 lbs! Built-in AC power supply stabilized to 0.1%. The output is maintained at minimum distortion and constant level with FET oscillator and thermister and heavy inverse feedback.

Model 6803 AF Generator – ONLY $59.95




## MINIATURE SIGNAL TRACER

This is by far the single most valuable piece of test equipment for servicing receivers and audio equipment. Built in meter for measuring gain of each stage under test. Easy to find weak or defective stages. Output speaker built in or to VTVM or scope. No line cord since it is self powered.

Model SE-350 Signal Tracer–ONLY $22.50

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**Please allow a little extra for postage charges.**
**Distributors: Write for our distributor prices**
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## SSB Escalator – Part II

Since the original article on *rf* SSB speech clipping appeared in 73 Magazine (p. 16, Dec., '66), I have received a number of inquiries relative to the construction of the clipper unit.

Resistors R3 and R4 in *Fig. 1* should be interchanged (this was a printer's error). Replace the 300Ω cathode resistor of V2 with one of 68Ω and the 47k screen resistor with one of 20k. At the grid input of V1 the 22k resistor is omitted and a 140 pF APC variable capacitor is substituted for the fixed 180 pF condenser for maximum tuning of the signal. Mount the mechanical filter topside with its midpoint baffle shield omitted—an original but later-proved unnecessary precaution.

It is important that the filter employed be identical to the one in the exciter unit. If the carrier frequency is not down on the filter skirt at or very close to that in the exciter unit, one of two undesirable things will take place: either the lower voice frequencies will be out of range of the passband and the audio will sound tinny, or insufficient sideband rejection of the lower clipped voice frequencies will occur with unwanted, newly generated frequencies. It may be preferable to extract the *rf* signal at the output of the balanced modulator rather than at the output of the following *if* stage. In place of the original Millen *if* transformer, T1, try a less expensive one; T2 may be a Miller 912-C4 *if* transformer. The .01 mfd coupling condenser in the secondary lead of T2 may be left out.

The power supply can be placed on the same chassis with the clipper unit although a larger chassis, of course, will be required. Any power supply system that will deliver from 30 to 50 mA at a regulated voltage of 105 to 150V will be satisfactory.

The following simplifications may be made: Omit the sub-miniature switch, S1, and run the two RG-174/U coax input and output leads directly to the two jacks mentioned in the paper. A short coax-cabled jumper between the two jacks will restore the original exciter operation. Omit both the no-clip gain control and the DPDT switch, S2. Simply rely on the clip level control to adjust the amount of *rf* clipping.

If excessive hum is encountered when clipping, it may, unfortunately, be necessary to shield the exciter's audio input stage.

**Louis Berman, K6BW**

# NEW PRODUCTS

## Heath 2 Meter Transceiver

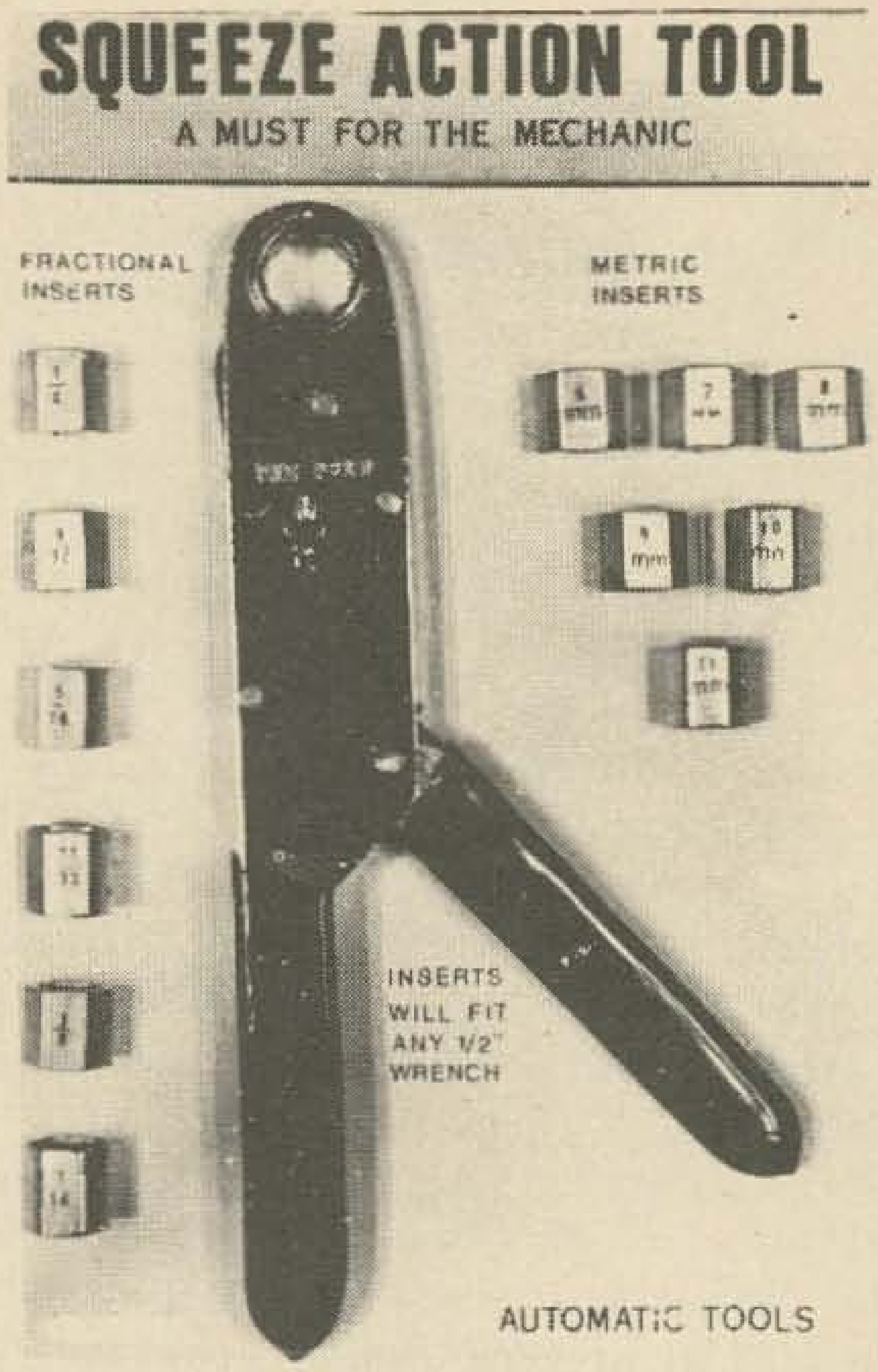
The latest in a growing line of "single banders" has come out of the Heath Company. This new unit, the model HW-17, covers the amateur two meter band and also has facilities for the MARS and CAP frequencies. Crystal controlled, the output is about 10 watts AM.

The dual-conversion solid state receiver has 1 microvolt sensitivity and features a prealigned FET tuner, ANL, Squelch, "Spot" function, lighted dial and a relative power output meter. It comes with a built-in AC power supply and microphone. The DC supply for mobile operation is optional at $24.95. Priced at $129.95, this is a best buy item. For further information, write Heath Company, Benton Harbor, Michigan 49022.

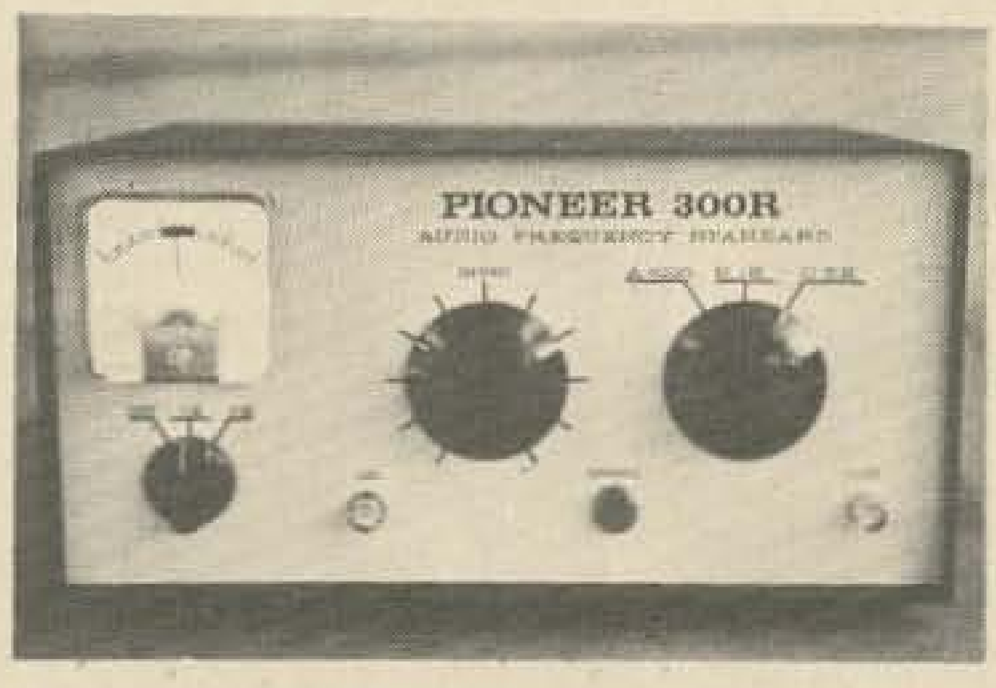
## SQUEEZE ACTION RATCHET WRENCH

Fulfills the requirements of professional and home mechanics. In hard to reach areas, turning is accomplished by merely squeezing spring loaded scissor type handle. Where there is more room it can be operated like a conventional ratcheting box wrench. For reverse action, just turn the tool over. Box socket is ½". Twelve hex inserts range from ¼" thru 5/16" and millimeters from 6 mm thru 11 mm. A rubber friction lock keeps the insert firmly in position. Retail $12.95.

For further information contact THE JAY THOMAS COMPANY, 117 West Oxford Street, Dept. M.M.-5, Chula Vista, California 92011.




## Pioneer 300R Audio Frequency Standard




The Pioneer 300R is a highly stable seconcary frequency standard of completely solid state design, using quartz resonators for stability. It functions as a tone receiver or tone transmitter. The stability is .005% and switching allows selection of up to three standard frequencies. It provides a built-in attenuator for receive applications.

It can be used in the receive mode for calibrating oscillators directly without the use of an oscilloscope or other indicating device normally needed with a standard to indicate zero beat. It is an indispensable piece of equipment for RTTY, and a valuable calibrator for oscillators, oscilloscopes, and bridges. Accurate inductance and capacitance measurements can be made using this precision source. To guarantee stability over a wide range of temperatures, the resonators are kept at a nearly constant temperature in an insulated and shielded oven. The oven comes as a sealed unit with desired resonators included inside. Additional frequencies may be obtained for $35 each.

For further information write Pioneer Electronics, 738 Pacific St., San Luis Obispo, California 93401.

## Linear Systems, Inc.

David C. Thompson, President of Linear Systems, Inc., has announced the election of David K. Bradley as Vice President, Marketing for the firm. Mr. Bradley previously was National Sales Manager for the SBE line of amateur radio products at Raytheon Company, South San Francisco, California. He has been active on several EIA committees in the amateur and citizens band business. Mr. Bradley is well known in the amateur radio fraternity and has the amateur license W6CUB. Prior to joining Raytheon, Mr. Bradley owned and operated an amateur radio distributorship in Northern California. Mr. Thompson stated that Mr. Bradley brings a unique combination of technical and marketing experience to the company. This capability fits the needs of Linear Systems, Inc., which Mr. Thompson stated plans to become a broad based communications company.

## Optiflex

Fiber optics is that light-piping idea you have been reading about sometimes over the past few years. IBM uses fiber optic devices to pipe light to convenient corners of their card-reading machines, eliminating many individual lamp assemblies. Now the idea is appearing in service gear.

Amertest Products' handy little lamp consists of a conventional penlight plus a flexible fiber optic cable. The cable really is flexible enough to tie into knots. It's a nonconductor, too, so that you can poke it into live circuits and assemblies without concern about new unwanted connections inside the gear or out to the real world, including yourself. Just right for getting some light into those dark corners.

Suggested list price on the Optiflex lamp is $4.65. For additional data inquire at your dealer's, or write to Amertest Products Corp., 144-27 Jamaica Ave., Jamaica, L.I., N.Y. 11435.

## AMD Microphone

If you are interested in outdoor amateur operating, serious on-location tape recording, in speech work, or public speaking applications, here is a microphone that may well be a Best Buy.

Since it is a cardioid microphone it has a strong null toward the cable-attachment end. This avoids crowd noise problems, and greatly alleviates the nuisance of audio feedback in public address applications.

For outdoor tape recording and amateur operating, its built-in windscreen styling reduces or eliminates the need for the frequently-seen large plastic foam cover. And the microphone's 100 to 12,000 Hz response is adequate for all speech and some musical applications.

Special connector wiring in the microphone stem offers the user a choice of 600 ohm impedance (-73 db sensitivity) or 50K ohm impedance (-54 db sensitivity.) It has an on-off switch, and comes with 20 feet of cable with a standard phone plug, and a swivel microphone stand connector.

Priced at $13.95 retail, from AMD Electronics, 663 Dowd Ave., Elizabeth, N.J. 07201.

## FCC Recognizes Thailand—Almost

The FCC has announced that it is now permissable to contact stations in Thailand using U.S. calls/HS. Communications are still prohibited with the HS prefix stations.

# *Adapting A Mobile Antenna System for Vacation Use*

*Bud Michaels, WB2WYO*
*510 High Street*
*Victor, New York 14564*

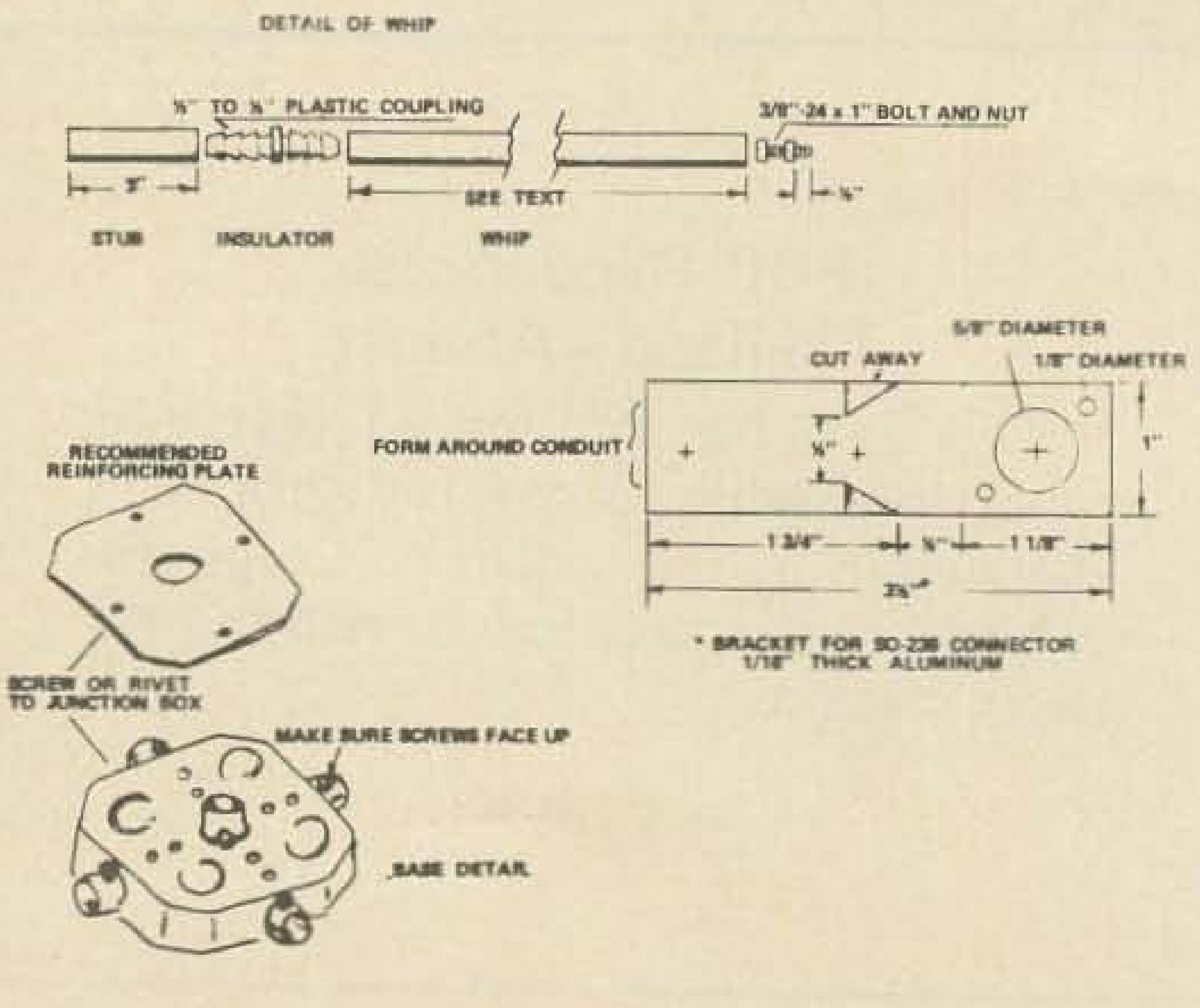
A last-minute decision to take a rig along on vacation left me with the problem of what to use for an antenna. We would be moving from campsite to campsite every few days, so my inherent laziness precluded an elaborate antenna system. Likewise, I didn't have much enthusiasm for disturbing three years' accummulation of rust and crud to dismantle a mobile whip antenna, offered by a friend, along with a complete set of resonators.

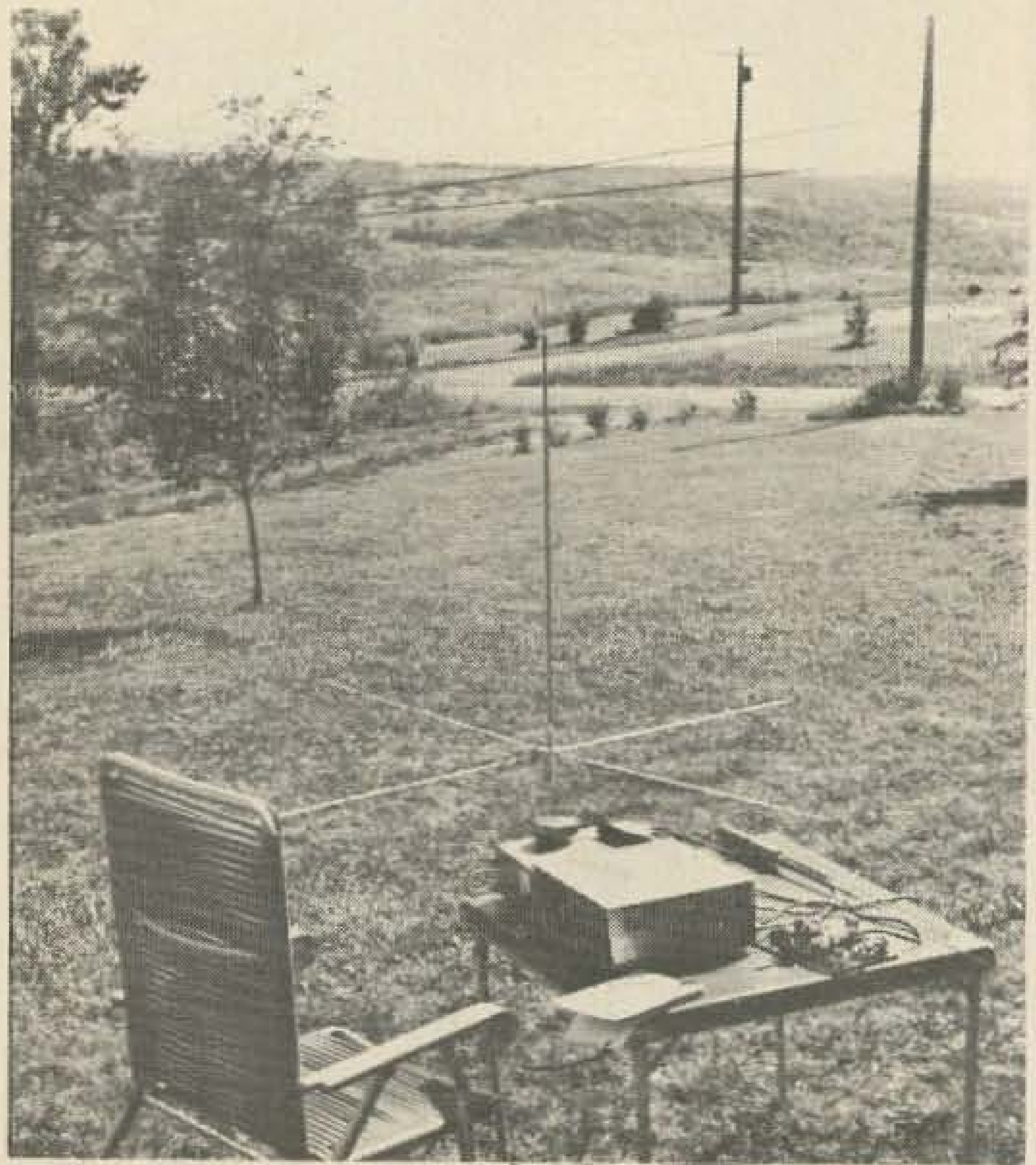
After much consideration, the mobile system seemed the most practical, and I accepted the loan of the resonators, but struck out on my own to devise a whip and base; one that would allow me to use the resonators, yet not necessitate tying the car down at the campsite.

The problem was solved using EMT electrical conduit. A whip, base and supports/radials were made using ½" diameter conduit and a square junction box. The whole affair cost less than $5.00 and proved to be a truly effective and simple antenna system. In fact, I'm collecting my own set of resonators in anticipation of next year's vacation.

**Making the Whip**

Cut a piece of ½" diameter conduit to 54". (This dimension is for Newtronics resonators. For other resonators, rely on manufacturer's specs or measure a friend's antenna.) A pipe cutter does a neater and faster job than



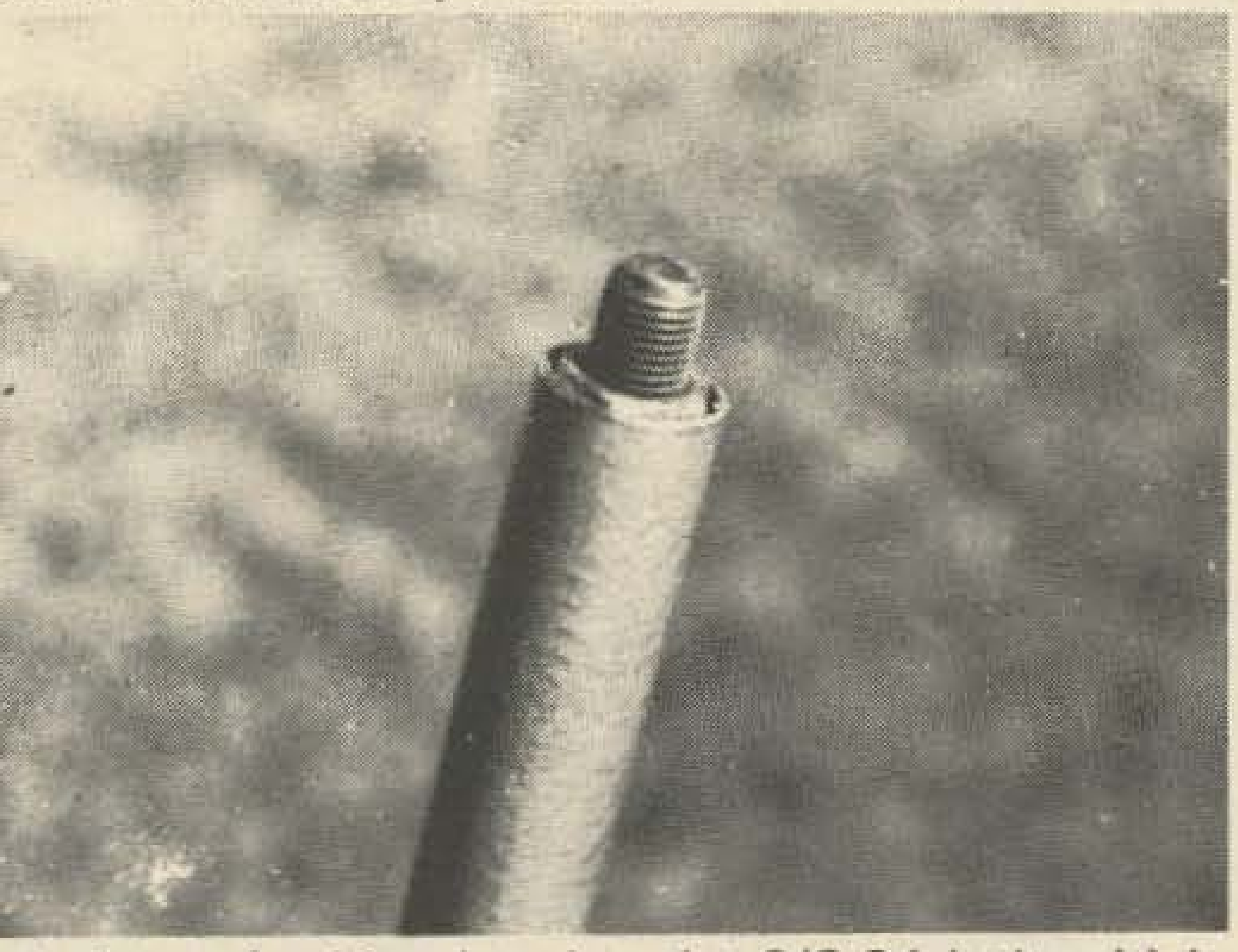


Antenna set up in front yard of author's home for SWR measurements. Additional ground was required for 40-meter operation.

a hacksaw. File away the burrs at both ends, then brighten up the metal inside one end of the conduit so it will take solder.

File the edges off the head of a 3/8"–24x 1" bolt, and a 3/8"–24 nut so they will fit snugly into the conduit. Thread the nut onto the bolt, leaving ½" of the bolt extending. Tin the bolt and nut, then slip them into the conduit with the nut flush with the end of the conduit. Solder them in place. This forms the means of attaching the resonators to the whip.

The whip must be insulated from the base. This is done using a ½" to ½" plastic water pipe coupling. Cut a short piece of conduit, around three inches long. Clamp this in a vise and warm with a torch until you can force the plastic coupling in. Quickly cool the assembly, lest the heat distort the coupling. Do the same with the bottom of the whip, so when finished you have the plastic coupling (our "insulator") between the whip and stub. The plastic coupling will most likely slip out of the conduit, and epoxy cement or "pop" rivets can be used to make the joint more permanent.

I found it more convenient to attach an SO-239 connector so that the coax cable could be more easily connected. Details are given for making a bracket to mount the connector. (Naturally, this idea came *after* vacation!) The center wire from the connector is soldered to the conduit through a hole made for the purpose. If you do not wish to use a connector, the coax can be soldered directly to the whip; the shield being soldered to the stub.



End view of whip showing the 3/8-24 bolt which screws into mobile-antenna resonators.

**Base**

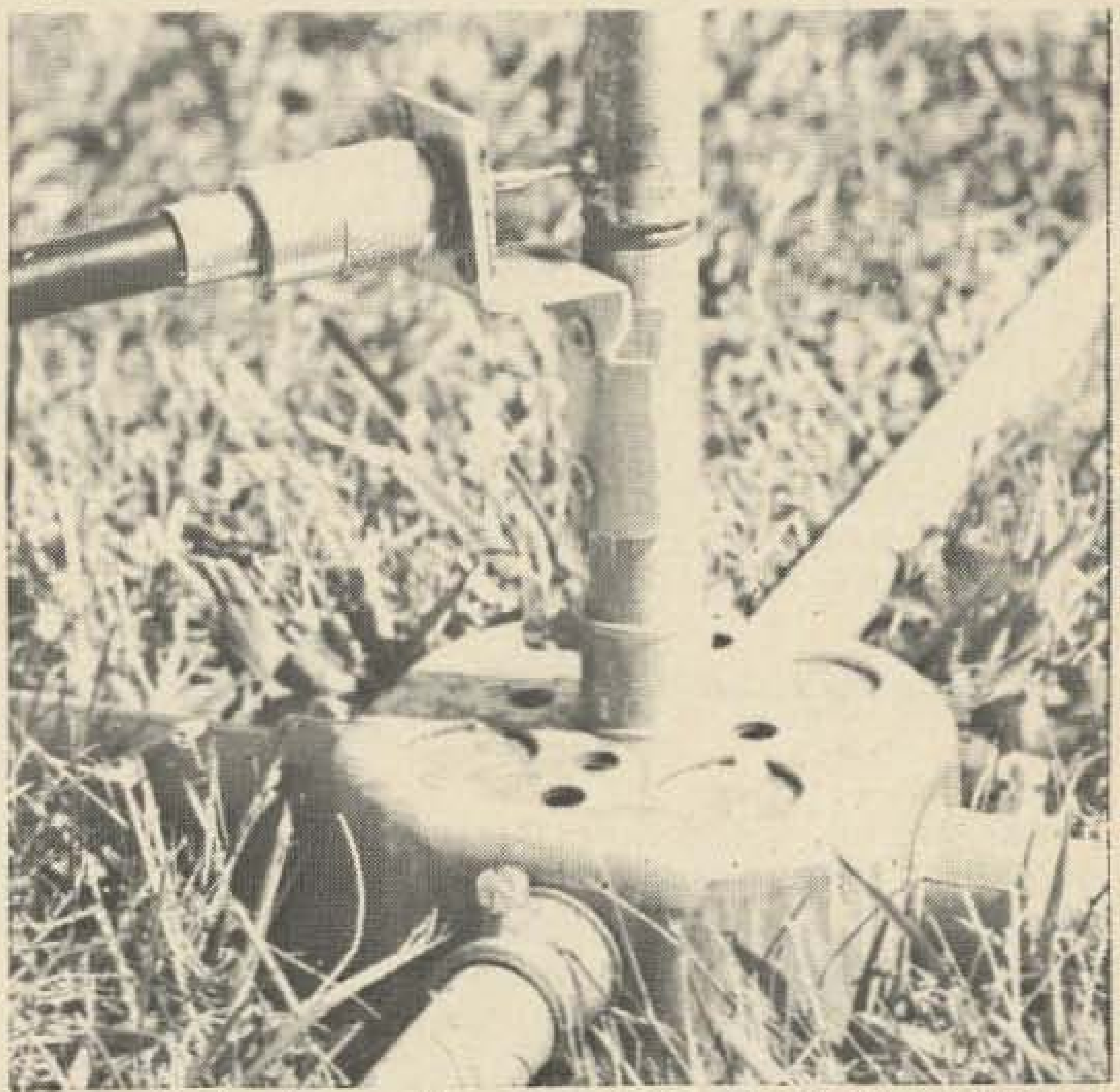
The base is made from a 4" square electrical junction box. Be sure to use one with ½" knockouts. Five ½" conduit connectors are screwed into the knockout holes, as shown, with their screw heads facing upwards. Don't overlook this simple point, otherwise, it will be awkward to disassemble the antenna for take-down. Here's another bit of hindsight: the top of the junction box is not too sturdy, owing to the knockouts stamped in the metal. Make a plate to fit over the top, as shown in the illustration. Screw or rivet this reinforcing plate to the box, then install the center connector. You will find this arrangement holds up much better, especially if you anticipate small boys will be using your antenna for a "Maypole."

**Support—Radials**

The four supports/radials are made from five foot lengths of conduit. Five feet is a convenient length to carry, and two can be cut from one 10-foot length of conduit (standard length). Don't make them any shorter, or mechanical stability and antenna radiation will suffer. If you can make them longer, so much the better; especially if you intend doing any work on the 80 and 40 meter bands.

**Setting Up**

Using the antenna system is simplicity itself. Place the four radials into the connectors and tighten the screws securely, yet not enough to deform the conduit. Attach the whip to the center connector, then screw the resonator to the top of the whip. Follow the manufacturer's instructions for adjusting the resonator to the lowest swr. I did have trouble bringing the swr down on the 75 meter resonator, due to poor ground conditions. (After all, five foot long radials at 75 meters is a joke!) The problem was relieved somewhat following a suggestion by WA2AOD; use kitchen aluminum foil swiped from the XYL to increase the ground plane. Four 15' long strips placed under the radials helped get my signal out with acceptable performance.



View of the base. These were taken before the reinforcing plate, mentioned in the text, was added. Coax bracket is held to base with "pop" rivets.

**Some Other Ideas**

The success of this arrangement prompted me to do some experimenting after we returned home. Using the same base, I made an 18' vertical antenna using one 10' section of conduit, joined with a regular ½"-to-½" coupling. The antenna was base loaded with a coil. While the junction of the two lengths of conduit was not the strongest, I did manage to keep the antenna up all weekend and worked quite a few stations on 80 and 40 meter CW. (This, by the way, was done after the junction box top was reinforced as described above.) As a practical limit, it seems that 20' is the maximum height for conduit "verticals" because of the lack of rigidity at the joints. If you could come up with a stronger joint, I imagine these might serve admirably for field day use, with a minimum of guying.

...WB2WYO

# LETTERS

This is in response to your letter of February 19, 1969, concerning the implementation of the second phase of the incentive licensing frequency reservations. In establishing the time schedule for the reservations of frequencies in Docket 15928, the Commission states that "Notwithstanding this schedule, the Commission intends careful review and if it is determined that there is insufficient occupancy of any part of the reserved frequency segments, then the effective date of the implementation date will necessarily be stayed in whole or in part, as appropriate." This statement has been reiterated in a number of Commission actions since the determination in Docket 15928.

A petition (RM 1393) is on file requesting the Commission to rescind that portion of Docket 15928 which would reserve additional frequencies in the 7 Mc/s and 14 Mc/s bands for Extra Class licensees. As previously stated, the Commission will review the occupancy of the segments now reserved and determine, prior to the November 22, 1969, scheduled date for implementation of the second frequency reservation, whether additional reservations are justified.

**James E. Barr**
**Chief, Safety and Special Radio Services Bureau**
**F.C.C.**

Say Wayne, I just picked up 73 and liked very much your thoughts on incentive licensing. Your positive approach to this and other matters merits careful attention. I also, of course, note your continuing license study articles, which are by far the best that have appeared in ham publications. I have been helping some hams with some of the basics for their licenses (I hope) and your articles have saved me some time of having to go into Terman or the ARRL handbook, etc. Thanks to you and your staff for publishing these articles and not just questions and answers as have some of the other magazines.

Incidently, you mention other mags saying things about 73; yes, I have read these and started adding certain things up; in fact, I went back several years in the various ham magazines and read about what is and was going on. You are right and they are wrong. Say, Wayne, do tell us all about the IARU, CQ, and other things that the amateurs are anxiously waiting to hear about. Don't be too harsh on the ARRL though, they are trying to do a good job handling all that traffic and keeping the nets on frequency and holding elections and partitioning the FCC and stuff like that there.

**Bob, W7JLU**
**Portland, Oregon**

I consider 73 to be one of the finest magazines in the amateur radio field, or indeed, in any field. This is about the fourth year I have been reading 73 regularly and I have thoroughly enjoyed each and every issue.

In comparison to the technistic platitude that is QST and the artistic mediocrity that is CQ, 73, like the farmer, is outstanding in its field. You have managed to keep a sense of humor throughout these times of peril for amateur radio in general. This is certainly a relief from the competition who feel that they can be dry and serious for 11 months out of the year if they make it up with a whopping April issue.

In summary, then, I think 73 is the greatest, and I sincerely hope it can stay that way for many years to come. Above all, I can only hope and pray that your idea that ham radio is *fun* will have a rebirth among the electronistic and scientistic types who've pervaded the radiophonic world recently. My amateur Extra Class license notwithstanding, I'd rather chew the rag about music, girls, politics, or UFO's than build my own self-neutralized class $AB_2$ variable-preble amplifier module with limited-fidelity sideband autonizer.

**Lon J. Berman, WB2IWI/2**

## Open Letter

If you did not read Wayne Green's excellent editorial in March 73 Magazine, you should have! It was timely, pointed and full of meat!

Amateur Radio greatly needs the shot in the arm that a well-conducted Public Relations program could give–provided that the PR people are properly "Amateur-Radio-oriented!" ARRL desperately needs a better image with the Radio Amateur, with the public and most of all with the U.S. Government, to whom we owe our very existence–and continuence!

Wayne mentioned certain writers and a cartoonist who could help. There are many qualified writers in the field who could and would contribute articles and material to this endeavor, given the slightest opportunity–and acceptance by editors.

The capable Ray Meyers, W6MLZ, it has been reported, offered to serve ARRL as its PR man, for the customary $1 a year, plus normal operating expenses. Ray's qualifications need not be discussed here–they are completely adequate, and his devotion to Amateur Radio is well known through many years of dedicated service as a writer, lecturer, Director of ARRL, and columnist. Ray's generous offer was spurned by ARRL. Why?

ARRL's feeble attempts at PR have been through NON-licensed-Amateur personnel. Although Don Waters did a commendable job on his reporting of ARRL's status–it lacked the touch of a genuine Amateur, fighting for his own hobby.

This writer urges YOU to immediately contact your ARRL Director, by telephone or mail, and demand that ARRL institute a program of PR, with a "man in Washington" (a legalized ham-lobbyist) without delay. Let there be no referral to a committee or a "study by the Secretary to determine the need" or other typical procedural jazz by the ARRL Board. Demand that the Directors, at this meeting, set up such a program and that they follow through to see that it is done. As Green says, it may already be too late, but the effort must be made. Take action now!

In reference to Wayne Green's mention of band occupancy, a complete study should be made, by ARRL (or someone concerned with the progress and growth of Amateur Radio) to determine what changes are necessary and vital in regard to band usage. In the opinion of this writer, (a consistently active ham for 49 hears) the CW bands are loaded when contests are on–and pretty empty at other times. The VHF bands are consistently empty, except during "openings" or contests. Ten meters, formerly the work horse of casual rag chewers, shows little occupancy now. Such an occupancy study, plus recommendations, both *qualified* and *studied*–to FCC–should result in changes, even though temporary, that would raise the occupancy of our empty bands segments and reduce the QRM in the other sections.

There is nothing sacred about FCC regulations. They can and should be changed when the need arises and without long delays, hearings and other proceedings.

ARRL should have a better relationship with FCC and be able to advise FCC when and how the band segments should be changed and redeployed! No one is served by holding to long usage concepts of the bands when it is obvious to any active ham that changes are desperately needed.

On this point, why are so many licensees who are now permitted to utilize the "restricted" segments, still holding forth in the cluttered-up sections?

**A. David Middelton, W7ZC**
**Former ARRL Director**

With reference to certain aspects of the "de W2NSD/1" article in your March issue, you may be interested in the following information.

In the April 1967 QST, there appeared a request that members advise their Directors with respect to their opinions on (1) dues; (2) freeloaders; (3) docket 15928; (4) by-laws; (5) CB liaison. I wrote my Director, Gil Crossley, and sent copies to the then Vice-Director and to Harry Dannals, Hudson Division Director, since I had a permanent QTH at my boyhood home in that area.

My letter, in part, read: "Final item–amateur radio must have adequate representation in Washington. Maybe "lobby" is a nasty word to some, but it is a recognized procedure. We desperately need it, both for our protection and advancement. I spent many years in Washington as an industrial representative, and I know how much the right word in the right ear at the right time can accomplish. Please have this considered."

I had no reply from either Harry or the V-D, at that time W3KT, but I received a very nice note from Gil, which read, in part: "Relative to representation in Washington–that is very well taken care of, with amateurs in the different departments of the government and legislative halls. What I am saying is not generally taken by many amateurs but things can't happen without our knowing it at once. I certainly felt the same before I was on the Board. For example, Bob Booth our legal advisor is president of the legal organization that practices before the FCC. To have a so-called lobby, it would have to be registered and we would likely lose our tax exempt statis." (Sic)

Now, it seems to me that he simply does not understand what a lobbyist does, in the sense of the scope of the job beyond collection of information. So, I wonder if the other Directors may not likewise lack that understanding? If so, how can the question possibly receive adequate consideration?

Also, I thought that the tax-exemption matter might be of interest to you. In any event, I don't recall that "lobbying," in any context, was considered at the subsequent Board of Directors meeting.

**Al Smith, W2AFJ/K3ZMS**
**Doylestown, Pennsylvania**

Like you say, the rush to Extra Class doesn't seem to have materialized; this is going to crowd hell out of the segments assigned to General Class. I have talked with holders of Extra Class tickets and they tell me that most, if not all, their cronies are General Class; therefore, they will be using the upper segments in order to chat with them. This is going to give our friend, Chop Chop, a chance to say the Extra Class segments are not being utilized to any great extent, so, like 11 meters, we may expect to lose that portion of the band to other services. Those Extra Class tickets should have been allowed to use a part of the CW portion for phone. Then, maybe there would have been a bit more incentive, nicht wahr?

**Bert Berthelsen, W5IOI**
**Ormond Beach, Florida**

I appreciate the FB job on your Advanced theory articles–and now the Extra. *Many tnx!*

Guys older in years (but not old timers in Ham Radio) such as myself, need this stuff interpreted and written as you are doing.

**Bill, WA8AME**
**(Now Advanced Class!)**

73 is excellent, no rubbishy padding (i.e., DX reports). Please keep up the good work! Over in the U.K., we find it very difficult to find *practical* articles on the advanced semi-conductor devices, i.e., I.C.'s and FET's etc., so your really great articles are appreciated. A couple of years ago, I subscribed to QST, but in one full year, I personally found only one article (on Ferrite Toroids) of real value, and needless to say, you had already covered them (and better) six months earlier!! Yes! I guess I'm sold on 73.

73 and all the best for 1969.

**Chas, 93RNV**
**Cheshire, England**

I first went on the air with the call 2-KJ in Brooklyn, N.Y., in 1919, and have been on and off ever since. In almost fifty-years of ham activity, I have never encountered a situation such as now exists in Phoenix, Arizona, on the twenty meter band, approximately 14.34Ø MHz.

Time after time, I have heard K7GRU come on and create what appears to be deliberate interference. Very often he interferes with the operation of the Coast Guard Net trying to run overseas welfare traffic; he indulges in invective and name calling. He settles down on QSO's in progress and talks of his technical excellence and the efficiency of his equipment yet his signal is often ten kHz wide. There is more but this is enough to give you my thoughts on the matter. If anyone ever tried to give amateur radio a bad name, it is he.

**A. R. Taylor, WA5WMJ**
**Gravette, Arkansas**

Every project that I have built from "73" Magazine has worked the first time. Can't say the same for any other magazine. The best one of all was "A Beginner's Receiver," 73 June 1963.

I would also like to see a BC-454 or BC-455 conversion to 14 MHz to 17 MHz or 15 MHz to 18 MHz. Maybe some reader would forward his conversion to me?

I believe you have the best magazine going. Maybe Playboy is better, but they don't have too many radio articles.

**Dick Heydt**
**P.O. Box 222**
**East Granby, Conn. 06026**

Just a word of appreciation for the series on the Advanced Class. Recently a friend of mine called to say that he was going to Kansas City in about a week to try for the Extra license and suggested that I go along and try for the Advanced. I did an intensive study using the series from 73 and passed with few errors. The series was interesting, (unusual for such a technical subject) well-written, and very practical. I am looking forward to the Extra Class series.

**Horton Presley, KØHVK**
**Ottawa, Kansas**

73 came in late this month and I miss the letters from your readers.

I believe your graphs showing the negative results of incentive licensing only proves my contention that the majority of US amateurs do not approve of this and are not going to support it. They feel as I do, the only way now to defeat it is to ignore it and the FCC will in the near future rescind it.

They know it was instigated by a small selfish group that had undue influence with the FCC through the ARRL for the express purpose of giving themselves an advantage of QRM free operating frequencies.

The vast majority of amateurs that have carefully thought this issue out know that passing the advanced and extra class exams will not accomplish any better operating practices or will it clean up the violations being practiced on our bands. So it has no useful purpose.

You have the wrong attitude Wayne. Laws can be changed–remember prohibition?

The FCC said they would review the problem after it had been in use and would if the frequencies were not used sufficiently rescind it. Certainly only 6000 amateurs out of a quarter of a million does not constitute a sufficient number to justify any special frequencies assigned to them. So the majority of amateurs have in my opinion decided this was unjustly forced upon them and that the only way now to defeat it is to resign from the ARRL and refuse to take the new tests in protest and to hope the FCC will see the mistake they have made.

The FCC has unfairly discriminated against the CW operator. They now make him take the most complex theory tests (both Advanced and Extra) when he is using the simplest of equipment, just to get the full use of the CW frequencies he is or was assigned. I am a CW man.

This irresponsible action of the ARRL has accomplished only one thing and that is it has emphasized to the commercial interests and to the forthcoming convention of frequency allocations that the amateur bands are too large and that the amateur can afford to lose some of his frequencies because the ARRL feels the great majority of amateurs can be forced into a much smaller segment of the bands that we now hold. This is the interpretation the commercial interests will give to this and use it against the amateur frequency assignments.

I was a member of the ARRL back in the early

20's and I knew Percy Maxim personally and I sure liked the old man. He would not have approved this action of the ARRL.

The ARRL knew they had made a mistake after they made this proposal but they were not big enough to admit it and went along with the hope the FCC would have the good sense not to approve it. This was proved by the futile way they have tried to justify and defend it even saying they did it just to create a controversy. How insane has an organization to become before it is committed? They don't have to be, they have committed suicide by themselves–"Give a fool enough rope, etc."

Wayne, for your information, this incentive licensing has done much harm in many ways. I would like to mention a few instances that have come to my attention. I have a local friend that has been a ham for many, many years; he is sixty years old and has been very active in the past in the local radio club, on the TVI committee, etc., and has given many hours of code and theory classes and has many local hams that owe him for their tickets. He has always been a general and is a retired dentist. Well, he went to Miami and took the Extra exam. He passed the CW but failed the theory. This was very embarrassing to him and he has given up completely–I never hear him on the air anymore and he gave me four big boxes of parts and equipment–the contents of his junk box. You see, the ARRL has caused us to lose a very fine amateur. This is just one case I know about, there must be thousands of others that have just given up because of this irresponsible act of the ARRL and the FCC. In the interest of amateur radio, I think you should still fight for the rescinding of this provision that has been forced on us.

One of your arguments can be that amateur radio is truly world-wide and international and that it is unfair to the USA amateurs to be restricted by special examination from use of parts of the bands that other countries do not restrict. Amateur radio is international and the rules should be international–this is only fair play.

For example, this has brought about another problem that of reciprocal licensing. We have here in South Florida a lot of retired Canadian hams that live here permanently but because they are Canadians, have their VE calls and the Ft. Lauderdale, Fla., USA, address in the Canadian call book. Now, with this incentive licensing that they do not have in Canada they do not know what parts of the bands they can use legally in the US. VE3CI/W4 Heith Love talked with me about this situation the other day; it affects him. So you see, this unnecessary act is causing many problems that did not exist before and have no need to exist now–it should be rescinded.

Needless to say, I am no longer a member of the ARRL. An organization that willfully disrespects the majority of its membership is not a democratic organization.

Many of those 6000 Extra Class are old timers that grandfathered in and have not been on the air for many years; we have several locally.

Wayne, I wonder what has happened to the old steam in you–why has the fire gone out? Have you given up and joined the opposition? God help us!

**George Taylor, W4PZS**
**1133 S.W. Fifth Place**
**Fort Lauderdale, Florida**

In reference to your de W2NSD/1 editorial in the January issue, you should have a divorce victim's net. I don't think you would have any trouble in getting divorced people to talk. The QSO would start: "Let me tell you about my case–it's different." This type of QSO would last for hours and far into the morning.

Your mention of missionaries on the ham bands recalls to mind the fact that the Seventh-day Adventists (who were the cause of my troubles) did have and probably still do have, Bible networks. I used to get a kick out of listening to some unsuspecting ham joining the round table, and then getting the drift of what was going on–pulling out but fast.

A psychiatrist once said that most marriages were *dull*. I would challenge his statement and say that most successful marriages are *comfortable*. Marriages that are *exciting* quite often become *tiresome* and don't last too long.

So, perhaps QSO's are not so *dull* but *comfortable* and *most* hams like it that way.

**George Partis, W6GHV**
**Founder & Executive Director**
*United States Divorce Reform, Inc.*
**Kenwood, California 95452**

Each article published brings quite a mail bag from interested hams seeking further information or confirmation, not all of whom think to include an SASE (or even postage). The 4-BTV evaluation article netted me 22 such letters, mostly from people wanting to know if I really meant the antenna was that good (one old timer in Iowa asked bluntly, "What am I supposed to do with all that goddam wire,"–he got a polite reply and a sketch of a proposed layout of the radials for his small lot. 'The Gentrac' article has kept my mailbox busy–one from a missionary radio technician in the Amazon jungle who was attempting to build a Gentrac for his work and needed some advice.

**Peter Lovelock, W6AJZ**
**Santa Monica, California**

I would like to introduce a new and different net–The Handicappers Information Net. This net is now meeting Mondays, Wednesdays, and Fridays from 2000 to 2100 GMT on 7270 kHz. Although this is primarily a net for handicapped persons, all amateurs are invited to participate. Our goals are to aid handicapped persons in their daily personal problems, to help handicapped amateurs advance their class of license, and to interest and assist other handicapped people in obtaining an amateur license.

To make a success of our goals we need the help of many amateurs. Volunteers are needed to help set up stations for newly licensed handicapped amateurs and to give advice and encouragement to those studying for their licenses. Many members have donated various pieces of equipment while others have offered the loan of equipment for use by handicapped members.

At the present time we are helping three future members obtain their Novice licenses. In order to help more we need your help. For further information, check into the net or contact Otto Huggins, WA5TIK, Assistant Net Manager, L. E. "Gib" Gibbins, W5PCN, Equipment Co-ordinator, Sandy McDowell, W5QZY, or me.

This is a chance to give to others the pleasure of ham radio that you now enjoy and of having the personal satisfaction of knowing you have helped others.

**Kathleen Wilson, WA5QQR**
**Net Manager**
**Handicappers Information Net**

In your interesting article on Tesla you mentioned some references. Where? What did you do with them?

**Owen Thompson, WA4NXA**

*I never thought you'd ask...here they are...ed.*

Prodigal Genius: The Life of Nikola Tesla, John J. O'Neill, Ives Washburn, Inc. 1944.

Experiments with Alternate Currents of High Potential and High Frequency, Nikola Tesla, McGraw-Hill 1904.

Nikola Tesla: Lectures, Patents, Articles, Nikola Tesla Museum, Beograd, Yugoslavia 1956.

"Tesla's Oscillator and Other Inventions," Thomas Commerford Martin, *Century,* April, 1895.

"The Tesla Steam Turbine:" *Scientific American,* Sept. 30, 1911.

"Nikola Tesla," Kenneth M. Swezey, *Science,* 16 May, 1958.

"My Inventions," Nikola Tesla, *Electrical Experimenter,* a series begun February, 1919.

"Some Personal Recollections," Nikola Tesla, *Scientific American,* June 5, 1915.

"The Problem of Increasing Human Energy," Nikola Tesla, *Century,* May, 1900.

"Nikola Tesla–Last of the Pioneers?" Leland L. Anderson, *Journal of Engineering Education,* June, 1959.

It has been a number of years since I have written to you, nevertheless, I buy 73 and read de W2NSD/1 your editorials beat any other Ham Radio magazine on the market from QST to them all. I particularly have enjoyed your excursion around differents part of the globe, especially Europe. I would like to call your attention to January's issue on page 100, European VHF, by Lee Grimes, who is stationed there in Berlin. This article was one of the best I ever read; it was most informative. I am sure that there are thousands of us who enjoyed this article. The Editorial Liberties in the February issue brought some snickers about the ARRL requesting character references from some other Hams in order to renew your license or obtain a Ham license. Your article on Nikola Tesla and his contribution to electronics was well appreciated; however, I know I will never have the brains to pass the Extra Class exam. I am satisfied with the small amount of the frequency band that I'm allowed to operate on. I agree that the incentive deal didn't change the picture one iota as far as I can see.

**Kenneth Mahoney, K6OPG**

Reference is made to your letter of 7 February 1969 concerning amateur radio operations from Navassa Island.

Navassa Island is a small, rocky island with sheer sides extremely inhospitable in nature. It is uninhabited, lacks any source of potable water, and the terrain is rough and broken. The only installation on the island is an automated lighthouse maintained by the Coast Guard. A landing can only be accomplished from a small boat and requires scaling a 40-foot Jacobs ladder, which is an especially hazardous undertaking.

While we recognize that a well outfitted and organized group could reduce the hazards of visiting Navassa to some extent, we would not be able to supervise the operations proposed to the degree that would be necessary to assure the reasonable safety of the individuals concerned. Since the island is under the jurisdiction of the Coast Guard, we would retain responsibility for the safety and well-being of visitors in the same way as we would for visitors to any other Coast Guard property.

With the exception of government employees on official business, since 1963 it has been the judgment of the Coast Guard that all requests from individuals to visit Navassa Island should be denied. There have been no new developments which would prompt us to change our position. The reasons for this position are several. In addition to the dangers present in effecting a landing together with the complete lack of facilities or means of sustenance, the location remote from civilization would make any visitor a likely Search and Rescue case. Furthermore, Haiti lays claim to Navassa as a Haitian dependency and refuses to recognize it as a U.S. territory. In view of this political situation a visit with radio equipment could easily be misinterpreted, as it was recently in the Middle East.

Moreover, call sign prefix "KC4" that was available for assignment to amateur stations has been deleted by the FCC, and the Commission no longer classes Navassa as a separate country for "DX" awards.

Therefore, the Coast Guard feels that, due to all of the surrounding circumstances, it is in the best interest of all concerned to deny individuals the authority to visit Navassa for any purpose save official business. Consequently, we must deny your request.

If the Coast Guard can provide any additional information or be of further assistance, please feel free to call.

**P. E. Trimble**
**Vice Admiral, U.S. Coast Guard**
**Acting Commandant**

*(FCC is running DXCC for the ARRL now, I see....ed.)*

**Lines Created on the Passing of Robert Evans, W3NO**

We say 73 to our dear friend, and strain to hear SK
For W3NO passes only to continue life,
Perhaps not far away.
We, here on this plane, shall hear that call again,
And know it bears another consciousness that we knew,
But still aware the old exists in us.
For what new wavelength, frequency or harmony do we seek,
In what direction do we steer within the universal spectrum,
To next discern that faint CQ DX?
Do our communicators search to find a device,
A demodulator to transform that invarient part of him,
That we might understand a message coming through?
We are beings of vibrations, constant motion, ever change.
Have 3FT and 3NO become as One, or only part of us?
The answer might be found within the realm of transformation of ourselves.
Amateurs have played their part in great discovery.
There awaits uncovery of a cosmic law by their probing mind.
A few, perhaps, will make the search and answers find.
Meanwhile, we really mean not to say farewell, but simply wait for us.
We're not far behind,
For how now he measures time.

**S. Lee Maulsby, W3RKK**

**Million Dollar Suit Progress Report**

As previously reported, the preliminary hearing before Judge Lieb in Federal Court in Tampa on Jan. 8th produced nothing concrete. The Judge asked for further briefs of law from both attorneys, to help him make a determination as to the proper disposition of the base. As a result, W4GJO's attorney has filed two further briefs, approximating 35 pages of well-researched law.

The opposing lawyers are asking that the case be remanded to Circuit Court in Sarasota County for trial on the "Nuisance," "electronic invasion of privacy" and million dollar damage charges. Our position is that Circuit Court has no jurisdiction in a matter involving a Federally granted privilege and responsibility. We also feel that it belongs in *no* court at this time, since the complainant fails to allege that he has exhausted his administrative remedies before the FCC. (Although, in fact, the FCC Field Engineers did investigate before the suit was ever filed, and gave W4GJO a clean bill.) We feel that the case should be dismissed by the Federal Judge, leaving the complainant free to take it to the FCC. Only if the FCC had found W4GJO at fault, and had he failed to comply with FCC orders, should the Federal Court be involved in enforcing an order of the FCC. This is clearly not the case. If the complainant feels the FCC ruling against him is in error, he should take it to Federal Appeals Court in Washington, D.C. We are currently awaiting the ruling from Judge Lieb.

In the meantime, our case against the complainant remains in the local court. The temporary injunction against the TVI complainant has been lifted, in return for sworn agreement that he will do nothing further to harass W5GJO or his family. There will probably be further hearings in this case before it comes to trial.

ARRL has provided much helpful material, but they feel that they cannot participate directly or financially until and unless the case comes to trial in a Federal Appeals court. Mr. Bob Booth, the ARRL General Counsel, continues to monitor the case closely, and is being provided with complete files of the great volume of paper-work involved in the case.

Good attorneys don't come cheap, and expenses to date exceed $2500. Few individual hams could handle this, but together it should be easy to finance fighting our case. Thanks to 73 Magazine, Florida DX Report, the QCWA News and many others, many contributions have been received, and needless to say, they are greatly appreciated. It's impossible to estimate what total costs may be. The case could be dismissed soon and no appeal made, or it could go on into other or higher courts and drag on indefinitely!

The Sarasota Amateur Radio Association, Inc., P. O. Box 3323, Sarasota, Florida 33578 has set up and is administering a fund to help underwrite legal costs in the case. Your help is urgently requested! Any unused funds will be returned to contributors furnishing names and addresses.

Not only is the future of ham radio as we know it today at stake, but it appears that this case strikes at the very power of the FCC to regulate! *Your* right to operate your amateur radio station without intimidation is involved!

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Ozzie Jaeger, W3EB/6, and Jo Jennings, W6EI, the founder of Jennings Radio Mfg. Co., now a division of ITT Corp. Jo is the inventor of the famous Jennings vacuum variable capacitors and high power vacuum switches.

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Our extremely large stock of diodes and diode assemblies and experience in design and installation, for new or existing equipment, will meet the needs of individuals, commercial or industrial applications. When properly applied, these individual units and large assemblies carry our money back guarantee against defects or workmanship.

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**JI has some other plans afoot that may interest you such as a surprisingly inexpensive (not cheap) line of "OZ-PAK" assemblies which will be available in kit form and capable of rectifying the full 2 kw PEP limit in any popular power supply configuration. Later we will have a series of well designed regulated power supplies for 6 and 12 volts output at 2-4 amperes and other currents. Heavy duty battery chargers or rectifier assemblies are already available.**

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**WANTED:** Schematics & Instruction Manual for Farnsworth Model 600A camera & control monitor. Contact G. D. Petrizze, 2135 N. Allen Avenue, Altadena, California 91001.

**T.V. CAMERAS**—Heavy Duty Industrial. Trade-ins. These are beefed-up babies that really give "positively the brightest, clearest picture you ever saw!" Complete with Schematic lens and vidicon, $250. C.C.T.V. Center, Inc., Route 46, Little Falls, N.J. (201) 256-7379.

**EXCELLENT NEW** HW-32A with calibrator, manuals, plus Hygain 18V; all for $125. Jim Sandberg, K6HE, 1138 Rustic Road, Escondido, California.

**THE OZAUKEE RADIO** Club will have its annual hamfest at the Belgium Community Center at Belgium, Wisconsin, on May 25th, 1969. Further information can be obtained from Ozaukee R.C., Box 13, Port Washington, Wisconsin.

**WANTED:** Very low frequency receiver (MSL-5). Write WA7KDZ, Box 355, Kent, Washington 98031.

**CONVERTERS,** three transistor, low noise, 50-54 MHz in, 14-18 MHz out. Adjustable frequency, $5.00. Solid state decade amplifiers, $35. Syntelex, 39 Lucille, Dumont, N.J. 07628.

**3000 V** @ 3μf brand new GE Pyronal oil capacitors $3 each. Can mail, 3-lbs. each shipping wt., FOB. P. Wandelt, RR#1, Unadilla, New York 13849.

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**RTTY GEAR FOR SALE.** List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

**WANTED:** Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

**TEST EQUIPMENT WANTED:** Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), USM-( ), TS-( ), SG-( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, Texas 75040.

**HAMFEST**, May 25th at Wabash, Indiana, 4-H fairgrounds. $1.00 registration, no selling charge, rain or shine. Information? Write K9AYB, 434 Stitt Street, Wabash, Indiana 46992.

**ATTENTION 160 METER FANS:** Change any coax fed 75/80 meter inverted vee/dipole into an efficient 160 meter antenna. Adapts within seconds, right in the hamshack. PL-259 and SO-239 connectors. Perfect for residential areas. TOP BAND SYSTEMS' MODEL 86ADP 160 meter adaptor. $4.75 ppd. Martin Hartstein, 5349 Abbeyfield, Long Beach, California 90815.

**Swan 350,** VOX, calibrator 117 xc supply spare finals and antenna $350, NCX-3 with NCX-D supply $200. Also two meter gear. WA2NM, 212-428-6133.

**WANTED.** Tents, Camping gear, Ampex or equal hi-fi stereo tape equipment. large 12½-16" Cassagerian telescope. Pentax & Cannon Demi 35 mm cameras. Will buy or swap for electronic equipment such as ham gear—CCTV & Broadcast equipment listed in our new flyer 969M1—free. Denson Electronic Corp., P.O.Box 85, Rockville, Conn. 06066, Telephone (203) 875-5198.

**SWAP: DAVCO** DR-30 wAC/DC PS-SPKR, Factory updated and overhauled, for SBE-33 wDC PS or SBE-34 or transceiver. Rankin, W4ZUS, NAVEOD-FAC, Indian Head, Md. 20640.

**INDIANAPOLIS HAM** Association ARRL Central Division—(Sat.) May 24, Lafayette Square (Airconditioned) Mall. Ham & Manufacturer displays—free flea market or $1.00 reserved. 1000-seat cinema technical sessions—$1.00 family registration (Ham-XYL-kids)—$2.00 at door. Banquet reservations $10 ea/$18 couple. Barry Goldwater (K7UGA/K3VIF) guest of honor with Stu Meyers as Master of Ceremonies. (Pre-reservations before May 12) Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Indiana, 46227.

**EICO 753 Xcvr** $140, homebrew, dc supply $30, Hustler mobile ant with 80M and 40M resonators with bumber mount $20, Hallicrafters S77 S.W. radio $40, WB6LGQ, 10926 Swinton Ave., Granada Hills, California 91344.

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**LM-14** freq. meter .125-20 mc, .01%, w/ser.-matched calib. & tech. data. 100% OK. . . . . . . 57.50
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**HAMFEST** sponsored by Lancaster & Fairfield County ARC at Derby Downs one mile south of Lancaster, Ohio on BIS Road, Route 793, June 8th. Gigantic Swap Shop. $1.00 registration with prizes every half hour. Main prize drawing. Good food at reasonable prices.

**WRL's used gear** has trial-terms-guarantee! KWM1, $299.95; SR34AC, $149.95; HE45B, $79.95; Swan 240, $179.95; Galaxy V, $229.95; B&W 5100B, $109.95; HX20, $149.95; HX50, $249.95; Ameco R5, $59.95; SX146, $189.95; HR20, $79.95; NC303, $199.95; SB301, $269.95. Hundreds more. Free "blue book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

**The Augusta (Maine)** Amateur Radio Club will hold their 10th annual Hamfest at the Calumet Club, route 104 Augusta on 15 June, preceeded with an open house and get together on Saturday evening the 14th at the same location. Pre-registration, adults $4.25; children under 12, $3.25; at the door, $5.00

**COLLINS ARC-2** 2-9 MHz transceiver $80. Quality. .55-42 MHz receiver Hallicrafters ARR-7, 6-position crystal filter, many features $80. Jerry Malone, WØMII, 27 Maple, Cambridge, Mass. 02139.

**SOMERSET COUNTY Hamfest**—June 8th, Casebeer Church Grove, Route 219, 7 miles north of Somerset, Pa. (9 a.m.-5 p.m.). Write Theodore J. Leonberger, K3RCI, Rd. 2, Rockwood, Pa. 15557.

**St. PETERSBURG AMATEUR** Radio Club, Inc. will hold its annual Hamfest at Lake Maggiore Park, entrance gate at 9th Street and 38th Avenue South, St. Petersburg, Florida, Sunday, May 18. All Hams and guests cordially invited. This is an old fashioned Hamfest with picnic lunch, swap table and prizes.

**SPECIAL CLOSE-OUT SALE.** Rectifiers, transistors, and many other electronic parts. Lowest prices. Send 15¢ for catalog. Electronic Components Co., P.O. Box 2902 S., Baton Rouge, La.

**FANTASTIC**—1969 New England ARRL Convention May 24-25, Swampcott, Massachusetts. Save money! Early bird registration $10.50 including Saturday dinner, dance and night club entertainment. Be a winner. Every major manufacturer will exhibit, plus top speakers from Science and Industry. Tickets: W1KCO, John McCormick, Berkeley Street, Taunton, Massachusetts.

**INDIANAPOLIS HAM CONVENTION.** (Sat.) May 24. (9 to 5) at beautiful Lafayette Square Mall. Indoor manufacturer's displays—for sale or auction. Free outdoor flea market. 80+ shops, cinema, for XYL & kids, inside airconditioned mall. Airports & Interstate—½ mile. Write: Indianapolis Ham Association, 309 Benton Drive, Indianapolis, Ind. 46227

**3 Plastic Holders** will frame and protect 60 cards, $1.00—or 10 holders, $3.00. Prepaid & guaranteed. Patent 3309805. Tepabco Box 198N, Gallatin, Tennessee 37066.

**Need a Variable Capacitor** for that homebrew project? We may have what you need at more than 50% below regular amateur net. Send for free flyer. A.R.C. Sales, 181 E. Wilson Bridge Road, Worthington, Ohio 43085.

**The Atlanta Radio Club** will hold its annual Hamfest on June 14 & 15 at the North DeKalb Shopping Center, Atlanta, Georgia. This promises to be one of the biggest and best Hamfests ever held in Atlanta. In addition to regular Hamfest activities, we are aiming for the largest amount of equipment to be bought, traded and sold, of any Hamfest in the Southeastern United States. There will be plenty of parking spaces for trucks and station wagons, along with inside space for displays. Further details may be obtained by writing John Fearon, 3384 Peachtree Rd., N.E., Suite 705, Atlanta, Ga. 30326.

**The East Coast VHF** Society will operate station WA2WEB/1 on 432 MHz from Mt. Equinox, Vermont on June 21 and 22, 1969. The express purpose of the expedition is to provide amateurs on the East Coast of the United States with the opportunity of contacting the state of Vermont on 432 MHz. The station will be on the air for approximately 24 hours for scheduled and non-scheduled contacts. Schedules are requested from interested amateurs. Write: East Coast VHF Society, P.O.Box 1263, Paterson, N.J. 07509. All correspondence and schedules will be confirmed prior to expedition.

**Regulated Power** Supply Kits, .6-4 AMP, $2.75 to $8.50. Zeners, thermistors, 25¢. 10A Triac, $1.75. Diodes, 5¢. Nixie, $5.00. Decimal Counter Kits, $3.50. Catalog. Murphy, 204 Roslyn Ave., Carle Place, N.Y. 11514.

**AUCTION—June 8th,** Manchester Radio Club at Tower Hill, Candia, N.H.—Map and information S.A.S.E. W1HPM, P.O.Box 661, Manchester, N.H. 03105.

## How to Wrinkle a Wrinkle Finish

When I build, I seldom strive for compactness, since I like lots of room for modifications, pruning, and possible additional circuitry. I also like the neat appearance of rack mounting, and I'm fortunate in having a free source of 1/8" aluminum from which to fashion panels. Finally, I have predilection for black wrinkle finish. Don't ask me why—I just dig it.

In the past I've tried about every make of black wrinkle enamel in spray can I could find, and the results were never encouraging. Many of you have probably had similar experiences. It doesn't wrinkle. It doesn't dry for three days, and is soft enough to scratch with your fingernail for two or three weeks. At best, it looks like a sloppy job using standard spray enamel.

Finally, I hit on a solution. Follow the directions on the can: two *heavy* coats three minutes apart. Let it stand for about ten minutes after the second coat, and while it's standing, fire up the XYL's oven to 250 degrees. Pop in the panel and bake it for a good two hours. It thoroughly stinks up the house, but the result is beautiful even wrinkling that's as hard as any professional paint job.

Bob Grenell, W8RHR

# PROPAGATION CHART

**May, 1969**

J. H. Nelson

| SUN | MON | TUES | WED | THUR | FRI | SAT |
|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

**Legend: Good O Fair (open) Poor □**

## EASTERN UNITED STATES TO:

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

## CENTRAL UNITED STATES TO:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALASKA | 14 | 14 | 14 | 14 | 7A | 7 | 7 | 7A | 14 | 14 | 14 | 14 |
| ARGENTINA | 21 | 21 | 21 | 14 | 14 | 7A | 14 | 21 | 21 | 21A | 21 | 21 |
| AUSTRALIA | 21A | 21 | 14 | 14 | 14 | 14 | 14 | 14 | 7A | 7B | 14A | 21 |
| CANAL ZONE | 21 | 21 | 14A | 14 | 14 | 14 | 14 | 21 | 21 | 21 | 21A | 21A |
| ENGLAND | 14 | 14 | 7A | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14A | 14 |
| HAWAII | 21 | 21 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14A | 14A |
| INDIA | 14 | 14 | 14 | 7A | 7B | 7B | 7B | 7A | 14 | 14 | 14 | 14 |
| JAPAN | 14 | 14 | 14 | 14 | 7B | 7B | 7 | 7A | 14 | 14 | 14 | 14 |
| MEXICO | 14 | 14 | 14 | 7A | 7 | 7 | 7A | 14 | 14 | 14 | 14 | 14A |
| PHILIPPINES | 14 | 14 | 14 | 14 | 7B | 7B | 7B | 7A | 14 | 14 | 14 | 14 |
| PUERTO RICO | 21 | 14A | 14 | 14 | 7A | 7A | 14 | 14 | 14 | 21 | 21 | 21 |
| SOUTH AFRICA | 14 | 7A | 7B | 7B | 7A | 14 | 14 | 14 | 14 | 14A | 14 | 14 |
| U. S. S. R. | 7A | 7A | 7 | 7 | 7B | 7B | 14 | 14 | 14 | 14 | 14 | 14 |

## WESTERN UNITED STATES TO:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALASKA | 14 | 14 | 14 | 7A | 7A | 7 | 7 | 7 | 7A | 14 | 14 | 14 |
| ARGENTINA | 21 | 21 | 21 | 14 | 14 | 7A | 14 | 14A | 21 | 21 | 21A | 21A |
| AUSTRALIA | 28 | 28 | 21 | 21 | 14A | 14 | 14 | 14 | 7A | 7 | 14A | 21 |
| CANAL ZONE | 21A | 21 | 21 | 14 | 14 | 14 | 14 | 14 | 14A | 21 | 21 | 21A |
| ENGLAND | 14 | 14 | 7A | 7 | 7 | 7 | 7B | 14 | 14 | 14 | 14 | 14 |
| HAWAII | 21A | 21A | 21A | 21 | 14 | 14 | 14 | 14 | 14 | 21 | 21 | 21 |
| INDIA | 14 | 14 | 14 | 14 | 7A | 7B | 7B | 7A | 14 | 14 | 14 | 14 |
| JAPAN | 14 | 14 | 14 | 14 | 14 | 14 | 7 | 7A | 14 | 14 | 14 | 14 |
| MEXICO | 21 | 14A | 14 | 14 | 7A | 7 | 14 | 14 | 14 | 14 | 14A | 21 |
| PHILIPPINES | 14 | 14 | 14 | 14 | 14 | 14 | 7B | 7A | 14 | 14 | 14 | 14 |
| PUERTO RICO | 21 | 21 | 14 | 14 | 14 | 7A | 14 | 14 | 14 | 14 | 21 | 21 |
| SOUTH AFRICA | 14 | 7B | 7B | 7B | 7B | 7B | 7B | 14 | 14 | 14 | 14 | 14 |
| U. S. S. R. | 7A | 7A | 7 | 7 | 7B | 7B | 7B | 7A | 14 | 14 | 14 | 14 |
| EAST COAST | 21 | 14A | 14 | 14 | 7A | 7 | 14 | 14 | 14 | 14 | 14 | 14 |

A - Next higher frequency may be useful this period
B - Difficult circuit this period.

## INDEX TO ADVERTISERS

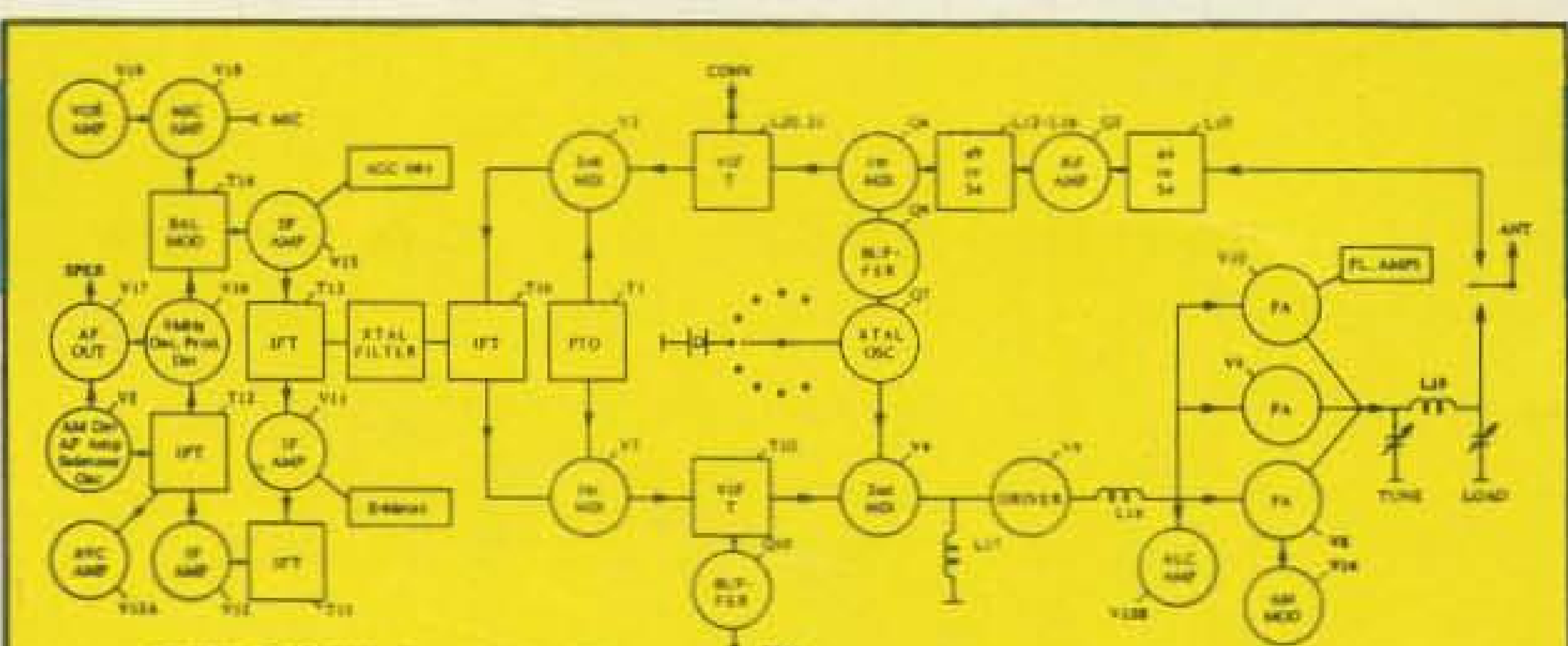
# NEW DRAKE MODEL *TR-6* 6-M SIDEBAND TRANSCEIVER

- ***Exclusive Features***
- ***Greatest Value***
- ***Unmatched Performance***


Model TR-6 **$599^95** Amateur Net

### COMPARE THESE FEATURES

- **Full coverage of 6 meter band plus MARS.**
- **Four IF band widths:** 2.4 kHz upper sideband (supplied), 2.4 kHz lower sideband, 6.0 kHz AM, 0.3 kHz CW, all selectable with front panel switch.
- **Function switch selects product or envelope detector as well as built-in AM screen modulator.** Compatible with linear amplifiers.
- **No carrier balance or carrier insertion adjustment for AM or CW**
- **Shift carrier CW system for compatibility and versatility.**
- **Ultra-stable linear VFO.** 600 kHz in one range. 1 kc readability.
- **Built-in PTT, VOX, ANTI-VOX, 100 kHz calibrator.**
- **ALC prevents flat-topping.**
- **Ample metering provisions with two meters.** For ALC, S-Meter, Transmitter Plate Current, Relative RF Output.
- **RV6 External VFO allows split-frequency operation.** (RV3, RV4 usable).
- **Fast or slow AGC for receiving.** For meteor scatter work, selectable from front panel.
- **Ultimate receiver front end performance using FET's.** Less than $1/10\mu V$ required for 10 dB S/N ratio on SSB.
- **Input and outputs provided for Drake TC-2 or other 2-meter transverters.** All switching done internally with band switch.
- **300 watts CW and PEP input.**
- **6JB6 final tubes eliminate replacement problems.**
- **Extra input and output jacks for converters and/or outboard receivers.** Permits monitoring of more than one frequency simultaneously.



**BLOCK DIAGRAM – Drake Model TR-6**

**Plug-in noise blanker accessory: $95.00**

See your distributor or write for free brochure:

**R. L. DRAKE COMPANY**

**Dept.** 349, 540 Richard St., Miamisburg, Ohio 45342

### GENERAL SPECIFICATIONS

**SIZE:** 5⅝" high, 10¾" wide, 16⅛" deep (plus feet and knobs). **WEIGHT:** 15¾ lbs.
**FREQUENCY COVERAGE:** 49.4 to 54.0 MHz (crystals supplied for 49.9 to 51.1 only).
**VFO DIAL CALIBRATION:** 1 kHz divisions; dial accuracy is within ±1 kHz.
**CALIBRATOR:** 100 kHz calibrator built in.
**FREQUENCY STABILITY:** Less than 100 Hz overall drift per hour after 15 minutes warm-up; less than 100 Hz for 10% supply voltage change.
**SPLIT FREQUENCY OPERATION:** Xmt and Rcv frequencies may be separated by up to 600 kHz by use of the RV-6 or FF-1 accessories.
**MODES:** SSB, AM, and CW.
**POWER SUPPLIES:** Drake AC-3, AC-4, DC-3, DC-4 or DC-24.
**TUBES AND SEMICONDUCTORS:** 19 tubes, 7 bipolar and 3 field effect transistors, 12 diodes.

### RECEIVER SPECIFICATIONS

**SENSITIVITY:** Less than 1/10 microvolt for 10 db S+N/N ratio at 2.4 kHz band width.
**SELECTIVITY:** 6 dB bandwidth 2.4 kHz with USB filter provided. Accessory filters available for LSB, AM (6 kHz) and CW (.3 kHz).
**AUDIO RESPONSE:** 400 to 2800 Hz at 6 dB.
**INPUT:** 50 ohms unbalanced.
**OUTPUT:** 4 ohms to speaker or headphones.
**AUDIO OUTPUT POWER:** 2 watts at 10% HD.
**AVC:** Output variation less than 3 dB for 60 dB input change. Fast attack. Release time selectable.
**MANUAL GAIN CONTROLS:** RF gain control sets threshold for AVC, AF gain control.
**DETECTORS:** Switch on front panel. Product detector for SSB and CW Envelope detector for AM.
**NOISE BLANKER:** On-off switch for accessory noise blanker on front panel.
**INPUT:** 13.9 to 14.5 MHz receiving input/output jack for converters and/or outboard IF receivers.

### TRANSMITTER SPECIFICATIONS

**POWER INPUT:** 300 W PEP on SSB, 300 W PEP on AM. 300 W CW (50% maximum duty cycle).
**OUTPUT IMPEDANCE:** 50 ohms nom. unbalanced, 2:1 max. SWR. Adjustable loading.
**MODES:** SSB (USB provided, LSB with accessory filter), AM (controlled carrier system), CW (semi-break in, Sidetone).
**AMPLIFIED AGC:** Prevents flat-topping.
**CARRIER INSERTION AND SHIFT:** Automatic on AM and CW, shifted carrier CW system.
**VOX AND PTT:** VOX and Anti-VOX built-in.
**AUDIO RESPONSE:** 400 to 2800 Hz at 6 dB.
**40 dB SIDEBAND SUPPRESSION** above 1 KHz. 50 dB carrier suppression.
**DISTORTION PRODUCTS:** Down 30 dB minimum from PEP level.
**MONITORING AND METERING:** Final plate current, AGC action, and relative output can be read on meters. Sidetone for keyed CW.
**14 MHz OUTPUT:** 13.9 to 14.5 MHz output for Drake TC-2 and other transverters.

### TR-6 ACCESSORIES

**RV6** Remote VFO. Separates receive and transmit frequencies within the same range .... $99.95
**FF1** Fixed frequency adaptor .......... $24.50
**MMK-3** Mobile mounting kit .......... $6.95
**Power supplies**
**AC-4** 120 V 50/60 Hz .......... $99.95
**DC-4** 12 VDC .......... $125.00
**DC-24** 24 VDC .......... $210.00
**MS-4** Matching speaker .......... $19.95